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

JUL 17 2009

Minas M. Arabatzis, Chief
Planning Division
Army Corps of Engineers, Philadelphia District
Wanamaker Building, 100 Penn Square East
Philadelphia, Pennsylvania 19107-3390

RE: Delaware River Deepening

Dear Mr. Arabatzis:

Enclosed is the biological opinion (Opinion), issued under Section 7(a)(2) of the Endangered Species Act (ESA), for the Army Corps of Engineer's (ACOE) proposed deepening of the Delaware River Main Channel, Philadelphia to the Sea Federal Navigation Project, pursuant to Section 7 of the Endangered Species Act (ESA) of 1973, as amended. This Opinion is based on NOAA's National Marine Fisheries Service's (NMFS) independent evaluation of the following: ACOE's Biological Assessment (BA) dated January 2009, a supplement to the BA dated February 9, 2009, an Environmental Assessment dated April 2009, NMFS October 25, 1996 Opinion on dredging in the Philadelphia District of the Army Corps of Engineers (ACOE), a May 25, 1999 supplement to that Opinion, the February 2, 2001 Opinion on the Delaware River Main Channel Blasting Project, scientific papers and other sources of information. The Opinion concludes that the proposed action is likely to adversely affect but is not likely to jeopardize the continued existence of the loggerhead or Kemp's ridley sea turtle or shortnose sturgeon. Additionally, NMFS has concluded that the proposed action is not likely to adversely affect leatherback or green sea turtles and, therefore, is not likely to jeopardize the continued existence of these species. Because no critical habitat is designated in the action area, none will be affected by the proposed action.

Incidental take is defined as take that is incidental to, and not the purpose of, the carrying out of an otherwise lawful activity. Under the terms of section 7(b)(4) and section 7(o)(2) of the ESA, taking that is incidental to and not intended as part of the agency action is not considered to be prohibited under the ESA provided that such taking is in compliance with the terms and conditions of this Incidental Take Statement. The Incidental Take Statement (ITS) accompanying the Opinion, pursuant to Section 7 (b)(4) of the ESA, exempts the incidental taking of a certain number of sea turtles and shortnose sturgeon from several sources including entrainment in hopper and cutterhead dredges, exposure to sound and pressure waves associated with blasting, and capture in mechanical dredges. Based on the estimates of take calculated in

the Opinion, a total of no more than 57 shortnose sturgeon are likely to be lethally taken in association with project operations. This level of take accounts for the initial deepening as well as 10 years of maintenance and includes take associated with blasting and mechanical dredging operations. For sea turtles, no more than 20 sea turtles are likely to be killed in association with project operations, including the initial deepening and 10 years of maintenance.

The ITS specifies sixteen reasonable and prudent measures (RPMs) and 33 Terms and Conditions necessary to minimize and monitor take of listed species. The RPMs and Terms and Conditions outlined in the ITS are non-discretionary, and must be undertaken so that they become binding conditions for the exemption in section 7(o)(2) to apply. Failure to implement the terms and conditions through enforceable measures may result in a lapse of the protective coverage of section 7(o)(2). Monitoring that is required by the ITS will continue to supply information on the level of take resulting from the proposed action.

This Opinion concludes consultation for the ACOE's proposed deepening of the Delaware River Main Channel, Philadelphia to the Sea navigation project. Reinitiation of consultation is required and shall be requested by ACOE or by NMFS, where discretionary Federal involvement or control over the action has been retained or is authorized by law and: (1) the amount or extent of taking specified in the incidental take statement is exceeded; (2) new information reveals effects of the action that may not have been previously considered; (3) the identified action is subsequently modified in a manner that causes an effect to listed species; or (4) a new species is listed or critical habitat designated that may be affected by the identified action.

Please note that by issuance of this Opinion, NMFS is withdrawing the Opinion dated January 31, 2001 regarding the effects of the proposed blasting at Marcus Hook. We look forward to continuing to work cooperatively with your office to minimize the effects of dredging projects in the Philadelphia District on listed species. For further information regarding any consultation requirements, please contact Julie Crocker of my staff at (978)282-8480 or by e-mail (Julie.Crocker@noaa.gov). Thank you for working cooperatively with my staff throughout this consultation process.

Sincerely,

for Patricia A. Kurkul
Regional Administrator

EC: Williams - GCNE
Greene - F/NER4
Brandreth, Pasquale - ACOE

File Code: ACOE NAP DE River Main Channel Deepening
PCTS: F/NER/2009/00615

NATIONAL MARINE FISHERIES SERVICE
ENDANGERED SPECIES ACT
BIOLOGICAL OPINION

Agency: Army Corps of Engineers (ACOE), Philadelphia District

Activity Considered: Deepening of the Delaware River Federal Navigation Channel
F/NER/2009/00615

Conducted by: National Marine Fisheries Service
Northeast Region

Date Issued: 7/17/09

Approved by: Chris Mantzouris for Patricia Kurkul

This constitutes the biological opinion (Opinion) of NOAA's National Marine Fisheries Service (NMFS) issued pursuant to Section 7 of the Endangered Species Act (ESA) of 1973, as amended, on the effects of the US Army Corps of Engineers proposed deepening of the Delaware River Federal navigation channel from Philadelphia to the Sea. This Opinion is based on information provided in the Biological Assessment (BA) dated January 2009, a supplement to the BA dated February 9, 2009, an Environmental Assessment dated April 2009, NMFS October 25, 1996 Opinion on dredging in the Philadelphia District of the Army Corps of Engineers (ACOE), a May 25, 1999 supplement to that Opinion, the February 2, 2001 Opinion on the Delaware River Main Channel Blasting Project, scientific papers and other sources of information. A complete administrative record of this consultation will be kept at the NMFS Northeast Regional Office. Formal consultation was initiated on February 9, 2009.

PROJECT HISTORY

Delaware River Channel

The existing Delaware River Philadelphia to the Sea Federal navigation project was authorized by Congress in 1910 and modified in 1930, '35, '38, '45, '54 and '58. This 96.5 mile long channel is authorized for depths of 37 to 40 feet. 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[1] and 1,000 feet wide; thence to the Philadelphia Naval Base, 40 feet deep and 800 feet wide, with a 1,200-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. 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,

1 All depths refer to mean low water.

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'; and, 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 the 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. See Figure 1 for map of the project location.

The existing authorized channel is maintained by the ACOE at 40 feet and is routinely dredged. 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 approximately 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.

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 dredged material disposal. 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 and is only used for disposal of material removed from the Bay (reaches D and E).

ESA Consultation on ACOE Maintenance of the Existing Channel

In September 1986, the Philadelphia District initiated formal consultation under Section 7 of the ESA, 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 provided to NMFS with the initiation request. It was determined by the ACOE that maintenance dredging activities in the southern reaches of the Delaware River, specifically from Philadelphia to the Sea, were not likely to adversely affect shortnose sturgeon. In a letter dated June 17, 1994 NMFS provided concurrence with this determination.

In September 1995, consultation was reinitiated regarding potential impacts associated with dredging projects permitted, funded or conducted by the Philadelphia District. This batched consultation was to consider effects of the following actions on NMFS listed species: maintenance of the Philadelphia to Trenton Federal navigation channel, maintenance of the Philadelphia to the Sea Federal navigation channel, several beach nourishment projects which used sand dredged from Delaware Bay and authorized borrow areas located along the New Jersey and Delaware coasts, and dredging projects conducted by private applicants and authorized by the ACOE through their regulatory authority under Section 10 of the Rivers and Harbors Act. "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 provided to NMFS for their review. An Opinion was issued by the NMFS on November 26, 1996 which considered effects of all projects conducted or authorized by the ACOE in the Philadelphia District. The Opinion concluded that the District's dredging program, including maintenance of the Philadelphia to the Sea and Philadelphia to Trenton navigation projects, may adversely affect sea turtles and shortnose sturgeon, but was not likely to jeopardize the continued existence of any threatened or endangered species under the jurisdiction of the NMFS. The Opinion included an Incidental Take Statement which exempted the annual take by injury or mortality of three (3) shortnose sturgeon. This Opinion was amended with a revised Incidental Take Statement (ITS) on May 25, 1999. The amended take statement issued on May 25, 1999 exempts the annual take of up to 4 shortnose sturgeon and 4 loggerhead sea turtles or 1 Kemp's ridley or 1 green sea turtle.

Channel Deepening Proposal and Consultation History

In 1983, the Philadelphia district was directed by Congress to begin feasibility studies regarding modifying the existing 40-foot Delaware River main shipping channel. In 1992, a final feasibility report recommended that the channel be deepened to 45 feet. Congress authorized the deepening project for construction in 1992. The project would involve deepening the main channel of the DE River from 40 to 45 feet from Philadelphia Harbor, PA and Beckett Street Terminal, Camden, NJ to the mouth of the Delaware Bay as well as the widening of 12 of the 16 bends in the channel and deepening the Marcus Hook Anchorage. It was anticipated that the project would result in the removal of approximately 26 million cubic yards (CY) of material.

An environmental impact statement (EIS) for this project was issued in 1992, a supplemental EIS was issued in 1997 and a Record of Decision (ROD) was signed in 1998. NMFS provided comments to the ACOE on the EIS and SEIS in letters dated March 1, 1995, February 14, 1997 and September 29, 1997.

In May 2000, the Philadelphia District submitted a BA and request for consultation considering the effects of proposed rock blasting in the Marcus Hook range of the main channel deepening project on shortnose sturgeon. On January 31, 2001 NMFS issued an 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 shortnose sturgeon. The Opinion included an Incidental Take Statement that exempts the lethal take of 2 shortnose sturgeon and an unquantifiable amount of non-lethal take. The ITS included reasonable and prudent measures and terms and conditions including a time of year restriction, reporting requirements, and other measures to minimize the potential for injury or mortality of shortnose sturgeon during blasting operations.

Planning for the deepening project was suspended in 2002 as a result of a review by the Government Accounting Office (GAO) regarding the economic benefits of the project and the environmental impacts. 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, NMFS was notified that the project

was reactivated and a Public Notice was posted on the Philadelphia District's (District) website on December 18, 2008 announcing that the District would conduct an environmental review of all applicable, existing and new information generated subsequent to the 1997 SEIS. NMFS commented on that notice in a letter dated December 30, 2008. Also in this letter, NMFS indicated that upon review of the project materials, it appeared that reinitiation of the 1996 and 2001 consultations was appropriate.

Reinitiation of consultation is required if: "(a) the amount or extent of taking specified in the ITS is exceeded; (b) new information reveals effects of these actions that may affect listed species or critical habitat in a manner or to an extent not previously considered; (c) any of the identified actions are subsequently modified in a manner that causes an effect to the listed species that was not considered in the BO; or (d) a new species is listed or critical habitat designated that may be affected by the identified actions" (50CFR402.16).

As noted above, on November 26, 1996, NMFS issued a Biological Opinion to the Philadelphia District, which concluded that maintenance dredging operations within the Philadelphia District were not likely to jeopardize the continued existence of any threatened or endangered species listed under NMFS' jurisdiction. Following the exceedence of the ITS in 1998, on May 25, 1999, in response to the authorized take level being exceeded, consultation was reinitiated and NMFS issued a revised Incidental Take Statement (ITS). Additionally, consultation on the blasting portion of the project was completed in February 2001. As noted in the December 2008 letter, NMFS believed that there was new information that indicated that the proposed deepening may have effects to listed species in a manner or to an extent not previously considered. This information included new information on the distribution and seasonal movements of shortnose sturgeon in the Delaware River as well as new information on the vulnerability of the species to capture in mechanical dredges and entrainment in hydraulic hopper dredges. Additionally, the project had been modified from the proposal outlined in the 1992 EIS and 1997 SEIS. Modifications include changes to the amount of material to be removed in the initial dredge cycle as well as in maintenance dredging, plans for beneficial reuse of the material, and the anticipated schedule for completion.

On January 26, 2009, NMFS received a letter from the ACOE requesting the initiation of consultation regarding the effects of the proposed deepening on listed species. Supplemental information was provided by the ACOE on February 9, 2009. Also sent in February 2009 was a letter from the ACOE clarifying that the scope of the proposed action under consultation was the initial dredge cycle necessary to deepen the channel to 45 feet, including blasting at Marcus Hook, and, collectively referred to as the "construction" phase of the project, and 10 years of ACOE planned maintenance dredging. On March 12, 2009, a revised project schedule was provided to NMFS by the ACOE and on April 3, 2009 a final Environmental Assessment was distributed by the ACOE. Consultation was initiated on February 9, 2009. As discussed with ACOE, it is the intention of NMFS that this Opinion will replace the Opinion related to effects of blasting dated February 2, 2001 and that portion of the 1996 Opinion as amended in 1999 that relates to the deepening of the Philadelphia to the Sea navigation project.

DESCRIPTION OF THE PROPOSED ACTION

Action Area

The action area is defined in 50 CFR 402.02 as "all areas to be affected directly or indirectly by the Federal action and not merely the immediate area involved in the action." The action area for this consultation includes the area affected by dredging and disposal activities as well as the area transited by project vessels. The action area, therefore, includes the entirety of the Philadelphia to the Sea Federal navigation channel, including the authorized anchorages and bends to be widened. Additionally, the action area includes the beneficial use disposal areas at Kelly Island and Broadkill Beach. Further, the action area includes the areas where project vessels will transit to offload dredged material at the upland disposal areas, which is limited to the navigation channel and adjacent berthing areas. The action area will also encompass the underwater area where dredging will result in increased suspended sediment and where sound pressure waves associated with blasting will be experienced. The size of the sediment plume will vary depending on the type of dredge used and is detailed below. Effects of blasting are expected to be limited to an area with a radius of 500 feet around the detonation site. The action area is illustrated in Figure 1, and is largely consistent with the Philadelphia to the sea navigation channel.

Physical Characteristics of the Action Area

The Delaware River Estuary is 132 miles 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 45 miles 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 at the Capes; to 27 miles at its widest point (near Miah Maull Shoal). Water depth in the bay is less than 30 feet deep in 80 percent of the bay and is less than 10 feet deep in much of the tidal river area.

Artificial Island is located approximately 2 miles 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. 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 channel has depths of up to 40 feet (12.1 meters). The Delaware River between the fall line at Trenton (RM 138) and Philadelphia (RM 100) is tidal freshwater with semidiurnal tides. Mean tidal range at Philadelphia 5.9 ft (1.8 m) (U.S. Army Engineer District, 1975); water pH generally is about 6-8.

Tidal flow as measured near the Delaware Memorial Bridge (RM 67), 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.

Proposed Deepening Project

The deepening project as authorized by Congress (shown on Figure 1) provides for modifying the existing Delaware River Federal Navigation channel Philadelphia to the 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 channel is divided into six reaches as follows: AA - RM 102-97.1; A - RM 97-85.1; B – RM 85-67.1; C – RM 67-55.1; D – RM55-41.1; and, E – RM 41-5. Reaches D and E are considered to be in Delaware Bay. The lowermost end of reach E is located approximately 5 miles from the theoretical line between Cape Henlopen and Cape May Point.

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. See Table 1 (below) for a description of the amount of material to be removed from each channel range.

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. The existing turning basin adjacent to the former Philadelphia Naval Shipyard will not be deepened as part of the 45 foot project.

Also included as part of the Federal project is the relocation and addition of navigation 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);
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).

The current dredged material disposal plan for the riverine portion of the project will utilize the existing upland Federal disposal 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.

INITIAL DREDGING CYCLE

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 Table 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. Blasting would be used, followed by removal with mechanical dredge.

The channel dredging project will use hydraulic hopper and cutterhead dredges. Rock will be removed from the channel with an excavator. Initial construction is currently expected to begin no earlier than the fall of 2009. It is anticipated that initial construction will be conducted over a five year period (August 2009-January 2014). A summary of the proposed dredging schedule is shown in Table 1.

Table 1. Summary of initial dredging quantities

Channel Reach	River Mile	Duration (Months)	Volume (CY)	Type of Dredge	Scheduled Dates
Reach C - Killicohook	68.3	1.65	932,600	cutterhead	August - September 2009
Reach C - Reedy Pt South	63.9	2.76	597,800	cutterhead	October - December 2009
Reach C - Killicohook	60.3	1.38	972,400	cutterhead	January - February 2010
Reach AA - National Park	99.2	2.88	994,000	cutterhead	August -November 2010
Reach A = Pedricktown North	96.8	6.10	1,666,000	hopper	August 2010 - February 2011
Reach E Broadkill Beach	15.6	3.00	1,598,700	hopper (2)	April - June 2011
Reach E Kelly Island	30.8-36.4	4.50	2,483,000	hopper (2)	April - August 2012
Reach D Reedy Pt South	55.8	1.13	396,300	hopper	December 2012- January 2013
Reach D Artificial Island	51.8	4.63	1,654,800	hopper	February - May 2013
Reach B Oldmans		0.89	1,671,400	cutterhead	August 2013
Reach B Pedricktown North		3.51	1,050,700	cutterhead	August - November 2013
Reach B Pedricktown South		3.13	1,942,800	cutterhead	August - December 2013

Figure 2 shows the construction schedule and the type of dredge that would be used for different sections of the river for the Deepening Project as provided by the ACOE. The ACOE has indicated that the dredging plan was, to the extent practicable, 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. As noted in Table 1, several different types of dredges will be used for deepening activities.

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 excavate sediments from the channel bottom. Hopper dredges have propulsion power adequate for required free-running speed and dredging against strong currents.

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). 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 a full load is achieved, the vessel suspends dredging, the dragarms are heaved aboard, and the dredge travels to the placement site where dredged material is disposed of. A hopper dredge will be used in reach A, D and E.

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. 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. Because the bucket dredge loads scows or hopper barges, work is suspended when a fully loaded barge is moved away and replaced with another empty scow or barge. Spuds are typically employed to maintain the position of a floating bucket dredge plant. A mechanical dredge will be used to remove debris following blasting in reach B.

Hydraulic Cutterhead Pipeline Dredges
The cutterhead dredge 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. The dredge used for this project is expected to have a pump and pipeline with approximately 30" diameter. 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 cutterhead pipeline plant employs spuds and anchors in a manner similar to floating mechanical dredges. A cutterhead dredge will be used in reaches AA, B and C.

Rock Blasting
Approximately 77,000 cubic yards of bedrock from 18 acres in reach B near Marcus Hook, PA (RM 76.4 to 84.6) would be removed to deepen the navigation channel to a depth of 45 ft below mean lower low water. Rock will be placed in the Fort Mifflin dredged material disposal site located in Philadelphia. In order to remove the rock by blasting, holes drilled into the rock will be 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. Blasting operations will occur up to five days a week between December 1 and March 15, with approximately 2 to 6 blasts per day. Blasting will occur in the winter of 2009-2010 and 2010-2011.

The ACOE has built several measures into the proposed action designed to minimize the effects of blasting on fish. These include plans to:

- Minimize the size of explosive charges per delay (time lag during detonation and the number of days of explosive exposure);
- Subdivide the explosives deployment, using electric detonating caps with delays (preferable) or delay connectors for detonation cord (less useful), to reduce total pressure;
- Use decking (explosives separated by delays) in drill holes to reduce total pressure;

- Use angular stemming material (rock piled at an angle on top of drill holes) to reduce energy dispersal;
- Use scare charges for each blast; and
- Monitor impacts to fish from blasting.

Specifically, for each blast, the ACOE proposes to monitor an area with a radius of 500 feet surrounding the detonation site with sonar or other imaging techniques designed to document fish in this area. Surveys will begin 20 minutes prior to the blast and if any fish are observed in the monitoring zone, blasting will be delayed until the fish leave the area. Additionally, two scare charges shall be used at each blast. The scare charges shall be detonated in close proximity to each blast. Each individual scare charge shall not exceed a TNT-equivalent weight of 0.1 lb. 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. The ACOE will also monitor blast pressures and upper limits will be imposed on each series of 5 blasts so that average peak pressure shall not exceed 70 pounds per square inch (psi) at a distance of 140 feet and maximum peak pressure shall not exceed 120 psi at a distance of 140 feet.

DREDGED MATERIAL DISPOSAL

As stated above, it is anticipated that approximately 16 million cy of material will be removed from the channel over a five year period during initial construction. All material removed from reaches AA, A, B and C, regardless of dredge type, will be disposed of at an upland location. Material removed from reaches D and E will be used at a beneficial use site (see below) or the open water disposal site located in the Bay (Buoy 10). Approximately 4 million cy of suitable material removed from the channel in reaches D and E will be used for wetland restoration or beach nourishment. Descriptions of the proposed beneficial use sites are provided below.

KELLY ISLAND (DELAWARE)

As stated by the ACOE, 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.

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.

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 with construction scheduled to occur between April and September.

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. As noted in the BA, 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 hightide 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.

BROADKILL BEACH (DELAWARE)

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 May 1 and September 15: 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 bulldozer and is expected to take six months to complete.

The dredge 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. The remainder of the pipeline extending to the beach, and back to the dredge, can rest on the bottom.

MAINTENANCE DREDGING

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 (Reaches AA – C) usually takes place over an approximately 2 month period between August and December primarily using a hydraulic cutterhead dredge; however, a hopper dredge may occasionally be used for this work. Approximately 3,845,000 cy of material will be removed from the river annually, with the majority of material removed from the Marcus Hook, Deepwater and New Castle ranges. 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 but typically occurs in the summer and fall. On average, approximately 472,000 cy of material will be removed from the bay annually. Dredging in this area is done using a hopper dredge with open water disposal (at Buoy 10). As explained above, the proposed action under consideration in this consultation includes 10 years of annual maintenance dredging.

LISTED SPECIES IN THE ACTION AREA

Several species listed under NMFS' jurisdiction occur in the action area for this consultation. A population of endangered shortnose sturgeon exists in the Delaware River. Several species of listed sea turtles occur in Delaware Bay during the warmer months. While listed whales occur seasonally off the Atlantic coast of Delaware and occasional transient right and humpback whales have been documented near the mouth of Delaware Bay, no listed whales are known to occur in the action area. As such, no whale species will be further discussed in this Opinion.

The hawksbill turtle (*Eretmochelys imbricata*) is relatively uncommon in the waters of the continental US. Hawksbills prefer coral reefs, such as those found in the Caribbean and Central America. However, there are accounts of hawksbills in south Florida and a number are encountered in Texas each year. Most of the Texas records report small turtles, probably in the 1-2 year class range. Many 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. No takes of hawksbill sea turtles have been recorded in northeast or mid-Atlantic fisheries covered by the NEFSC observer program. In the north Atlantic, small hawksbills have stranded as far north as Cape Cod, Massachusetts (STSSN database). Many of these strandings were observed after hurricanes or offshore storms. There have been no verified observations of hawksbills in the action area outside of rare stranding events. Based on this information, NMFS has determined that hawksbill sea turtles are not likely to occur in the action area. As such, effects of the action on hawksbills will not be considered further in this consultation.

STATUS OF AFFECTED SPECIES

NMFS has determined that the action being considered in this biological opinion may affect the following endangered or threatened species under NMFS' jurisdiction:

Sea Turtles

Loggerhead sea turtle (*Caretta caretta*)	Threatened
Leatherback sea turtle (*Dermochelys coriacea*)	Endangered
Kemp's ridley sea turtle (*Lepidochelys kempi*)	Endangered
Green sea turtle (*Chelonia mydas*)	Endangered/Threatened[2]

Fish

Shortnose sturgeon (*Acipenser brevirostrum*)	Endangered

This section will focus on the status of the various species within the action area, summarizing information necessary to establish the environmental baseline and to assess the effects of the proposed action.

Status of Sea Turtles

Sea turtles continue to be affected by many factors occurring on the nesting beaches and in the water. Poaching, habitat loss, and nesting predation by introduced species affect hatchlings and nesting females while on land. Fishery interactions, vessel interactions, and (non-fishery) dredging operations, for example, affect sea turtles in the neritic zone (defined as the marine environment extending from mean low water down to 200m (660 foot) depths, generally corresponding to the continental shelf (Lalli and Parsons 1997; Encyclopedia Britannica 2008)). Fishery interactions also affect sea turtles when these species and the fisheries co-occur in the oceanic zone (defined as the open ocean environment where bottom depths are greater than 200m (Lalli and Parsons 1997))3. As a result, sea turtles still face many of the original threats that were the cause of their listing under the ESA.

Sea turtles are listed under the ESA at the species level rather than as subspecies or distinct population segments (DPS). Therefore, information on the range-wide status of each species is included to provide the reader with information on the status of each species, overall. Additional background information on the range-wide status of these species can be found in a number of published documents, including sea turtle status reviews and biological reports (NMFS and USFWS 1995; Hirth 1997; USFWS 1997; Marine Turtle Expert Working Group (TEWG) 1998; TEWG 2000; NMFS and USFWS 2007a; 2007b; 2007c; 2007d; Leatherback TEWG 2007), and recovery plans for the loggerhead sea turtle (NMFS and USFWS 1991a), leatherback sea turtle (NMFS and USFWS 1992; NMFS and USFWS 1998a;), Kemp's ridley sea turtle (USFWS and NMFS 1992), and green sea turtle (NMFS and USFWS 1991b; NMFS and USFWS 1998b).

Loggerhead sea turtles

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

3 As described in Bolten (2003), oceanographic terms have frequently been used incorrectly to describe sea turtle life stages. In turtle literature the terms benthic and pelagic were used incorrectly to refer to the neritic and oceanic zones, respectively. The term benthic refers to occurring on the bottom of a body of water, whereas the term pelagic refers to in the water column. Turtles can be "benthic" or pelagic" in either the neritic or oceanic zones.

Loggerhead sea turtles are a cosmopolitan species. They are found in temperate and subtropical waters and occupy a range of habitats including offshore waters, continental shelves, bays, estuaries, and lagoons. The loggerhead is the most abundant species of sea turtle in U.S. waters. Genetic differences exist between loggerhead sea turtles that nest and forage in the different ocean basins (Bowen 2003; Bowen and Karl 2007). Differences in the maternally inherited mitochondrial DNA also exist between loggerhead nesting groups that occur within the same ocean basin (TEWG 2000; Pearce 2001; Bowen 2003; Bowen *et al.* 2005; Shamblin 2007). Site fidelity of females to one or more nesting beaches in an area is believed to account for these genetic differences (TEWG 2000; Bowen 2003). However, loggerhead sea turtles are currently listed under the ESA at the species level rather than as subspecies or distinct population segments (DPS). The ESA requires NMFS to ultimately conclude whether the action under consultation, in light of the Status of the Species, Environmental Baseline and Cumulative Effects,(as discussed below), is likely to jeopardize the species as it is listed. Therefore, information on the range-wide status of the species is included.

Pacific Ocean. In the Pacific Ocean, major loggerhead nesting grounds are generally located in temperate and subtropical regions with scattered nesting in the tropics. The abundance of loggerhead sea turtles at nesting colonies throughout the Pacific basin has declined dramatically over the past ten to twenty years. Loggerhead sea turtles in the Pacific Ocean are represented by a northwestern Pacific nesting group (located in Japan) and a smaller southwestern Pacific nesting group that occurs in Australia (Great Barrier Reef and Queensland), New Caledonia, New Zealand, Indonesia, and Papua New Guinea. Data from 1995 estimated the Japanese nesting group at 1,000 adult females (Bolten *et al.* 1996). More recent information suggests that nest numbers have increased somewhat over the period of 1998-2004 (NMFS and USFWS 2007a). However, this time period is too short to make a determination of the overall trend in nesting (NMFS and USFWS 2007a). Genetic analyses of loggerhead females nesting in Japan indicate the presence of genetically distinct nesting colonies (Hatase *et al.* 2002).

In Australia, long-term census data have been collected at some rookeries since the late 1960s and early 1970s, and nearly all the data show marked declines in nesting since the mid-1980s. The nesting group in Queensland, Australia was as low as 300 adult females in 1997 (Limpus and Limpus 2003).

Pacific loggerhead sea turtles are captured, injured, or killed in numerous Pacific fisheries including gillnet, longline, and trawl fisheries in the western and/or eastern Pacific Ocean (NMFS and USFWS 2007a). In Australia, where sea turtles are taken in bottom trawl and longline fisheries, efforts have been made to reduce fishery bycatch (NMFS and USFWS 2007a).

Indian Ocean. Loggerhead sea turtles are distributed throughout the Indian Ocean, along most mainland coasts and island groups (Baldwin *et al.* 2003). Throughout the Indian Ocean, loggerhead sea turtles face many of the same threats as in other parts of the world including loss of nesting beach habitat, fishery interactions, and turtle meat and/or egg harvesting.

In the southwestern Indian Ocean, loggerhead nesting has shown signs of recovery in South Africa where protection measures have been in place for decades. However, in other southwestern areas (*e.g.*, Madagascar and Mozambique) loggerhead nesting groups are still affected by subsistence

hunting of adults and eggs (Baldwin *et al.* 2003). The largest known nesting group of loggerheads in the world occurs in Oman in the northern Indian Ocean. An estimated 20,000 to 40,000 females nest at Masirah, the largest nesting site within Oman, each year (Baldwin *et al.* 2003). In the eastern Indian Ocean, all known nesting sites are found in Western Australia (Dodd 1988). As has been found in other areas, nesting numbers are disproportionate within the area with the majority of nesting occurring at a single location. This may, however, be the result of fox predation on eggs at other Western Australia nesting sites (Baldwin *et al.* 2003).

Mediterranean Sea. Nesting in the Mediterranean Sea is confined almost exclusively to the eastern basin (Margaritoulis *et al.* 2003). The greatest numbers of nests in the Mediterranean are found in Greece with an average of 3,050 nests per year (Margaritoulis *et al.* 2003; NMFS and USFWS 2007a). Turkey has the second largest number of nests with 2,000 nests per year (NMFS and USFWS 2007a). There is a long history of exploitation of loggerheads in the Mediterranean (Margaritoulis *et al.* 2003). Although much of this is now prohibited, some directed captures still occur (Margaritoulis *et al.* 2003). Loggerheads in the Mediterranean also face the threat of habitat degradation, incidental fishery interactions, vessel strikes, and marine pollution (Margaritoulis *et al.* 2003). Longline fisheries, in particular, are believed to catch thousands of juvenile loggerheads each year (NMFS and USFWS 2007a), although genetic analyses indicate that only a portion of the loggerheads captured originate from loggerhead nesting groups in the Mediterranean (Laurent *et al.* 1998).

Atlantic Ocean. Ehrhart *et al.* (2003) provided a summary of the literature identifying known nesting habitats and foraging areas for loggerheads within the Atlantic Ocean. Detailed information is also provided in the 5-year status review for loggerheads (NMFS and USFWS 2007a) and the final revised recovery plan for loggerheads in the Northwest Atlantic Ocean (NMFS and USFWS 2008), which was recently published by NMFS and FWS in December 2008 and is a second revision to the original recovery plan that was approved in 1984 (NMFS 1984) and most recently revised in 1991 (NMFS and USFWS 1991a).

Briefly, nesting occurs on island and mainland beaches on both sides of the Atlantic and both north and south of the Equator (Ehrhart *et al.* 2003). By far, the majority of Atlantic nesting occurs on beaches of the southeastern U.S. (NMFS and USFWS 2007a). Annual nest counts for loggerhead sea turtles on beaches from other countries are in the hundreds with the exception of Brazil, where a total of 4,837 nests were reported for the 2003-2004 nesting season (Marcovaldi and Chaloupka 2007; NMFS and USFWS 2007a), and Mexico, where several thousand nests are estimated to be laid each year and the Yucatán nesting population had a range of 903-2,331 nests per year from 1987-2001 (Zurita *et al.* 2003; NMFS and USFWS 2008). In both the eastern and western Atlantic, waters as far north as 41°N to 42°N latitude are used for foraging by juveniles as well as adults (Shoop 1987; Shoop and Kenney 1992; Ehrhart *et al.* 2003; Mitchell *et al.* 2003). Of all loggerhead populations in the Atlantic Ocean, those comprising individuals that nest and/or forage in U.S. waters of the Northwest Atlantic have been most extensively studied.

In U.S. Atlantic waters, loggerheads commonly occur throughout the inner continental shelf from Florida to Cape Cod, Massachusetts and in the Gulf of Mexico from Florida to Texas, although their presence varies with the seasons due to changes in water temperature (Shoop and Kenney 1992;

Epperly *et al.* 1995a, 1995b; Braun and Epperly 1996; Epperly and Braun-McNeill 2002; Mitchell *et al.* 2003). Loggerheads have been observed in waters with surface temperatures of 7° to 30°C, but water temperatures ≥11°C are most favorable (Shoop and Kenney 1992; Epperly *et al.* 1995b). The presence of loggerhead sea turtles in U.S. Atlantic waters is also influenced by depth. Aerial surveys of continental shelf waters north of Cape Hatteras, North Carolina indicate that loggerhead sea turtles are most commonly sighted in waters with bottom depths ranging from 22 to 49 m deep (Shoop and Kenney 1992). However, survey and satellite tracking data support that they occur in waters from the beach to beyond the continental shelf (Mitchell *et al.* 2003; Braun-McNeill and Epperly 2004; Blumenthal *et al.* 2006; Hawkes *et al.* 2006; McClellan and Read 2007).

Loggerhead sea turtles occur year round in ocean waters off North Carolina, South Carolina, Georgia, and Florida. In these areas of the South Atlantic Bight, water temperature is influenced by the proximity of the Gulf Stream. As coastal water temperatures warm in the spring, loggerheads begin to migrate to inshore waters of the southeast U.S. (*e.g.*, Pamlico and Core Sounds) and also move up the U.S. Atlantic coast (Epperly *et al.* 1995a, 1995b, 1995c; Braun-McNeill and Epperly 2004), occurring in Virginia foraging areas as early as April and on the most northern foraging grounds in the Gulf of Maine in June (Shoop and Kenney 1992). The trend is reversed in the fall as water temperatures cool. The large majority leave the Gulf of Maine by mid-September but some may remain in Mid-Atlantic and Northeast areas until late fall. By December, loggerheads have migrated from inshore and more northern coastal waters to waters offshore of North Carolina, particularly off of Cape Hatteras, and waters further south where the influence of the Gulf Stream provides temperatures favorable to sea turtles (Shoop and Kenney 1992; Epperly *et al.* 1995b; Epperly and Braun-McNeill 2002).

Loggerheads mate from late March to early June, and eggs are laid throughout the summer, with a mean clutch size of 100-126 eggs in the southeastern U.S. Individual females nest multiple times during a nesting season, with a mean of 4.1 nests per individual (Murphy and Hopkins 1984). Nesting migrations for an individual female loggerhead are usually on an interval of 2 to 3 years, but can vary from 1 to 7 years (Dodd 1988).

For the past decade or so, the scientific literature has recognized five distinct nesting groups, or subpopulations, of loggerhead sea turtles in the Northwest Atlantic, divided geographically as follows: (1) a northern group of nesting females that nest from North Carolina to northeast Florida at about 29□N latitude; (2) a south Florida group of nesting females that nest from 29□N latitude on the east coast to Sarasota on the west coast; (3) a Florida Panhandle group of nesting females that nest around Eglin Air Force Base and the beaches near Panama City, Florida; (4) a Yucatán group of nesting females that nest on beaches of the eastern Yucatán Peninsula, Mexico (Márquez 1990; TEWG 2000); and (5) a Dry Tortugas group that nests on beaches of the islands of the Dry Tortugas, near Key West, Florida (NMFS SEFSC 2001). Genetic analyses of mitochondrial DNA, which a sea turtle inherits from its mother, indicate that there are genetic differences between loggerheads that nest at and originate from the beaches used by each of the five identified nesting groups of females (TEWG 2000). However, analyses of microsatellite loci from nuclear DNA, which represents the genetic contribution from both parents, indicates little to no genetic differences between loggerheads originating from nesting beaches of the five Northwest Atlantic nesting groups (Pearce and Bowen 2001; Bowen 2003; Bowen *et al.* 2005; Shamblin 2007). These results suggest

that female loggerheads have site fidelity to nesting beaches within a particular area, while males provide an avenue of gene flow between nesting groups by mating with females that originate from different nesting groups (Bowen 2003; Bowen *et al.* 2005). The extent of such gene flow, however, is unclear (Shamblin 2007).

The lack of genetic structure makes it difficult to designate specific boundaries for the nesting subpopulations based on genetic differences alone. Therefore, the Loggerhead Recovery Team recently used a combination of geographic distribution of nesting densities, geographic separation, and geopolitical boundaries, in addition to genetic differences, to reassess the designation of these subpopulations to identify recovery units for use in the 2008 recovery plan.

In the final revised recovery plan, the Loggerhead Recovery Team designated five recovery units for the Northwest Atlantic population of loggerhead sea turtles based on the aforementioned nesting groups and inclusive of a few other nesting areas not mentioned above. The first four of these recovery units represent nesting assemblages located in the southeast U.S. The fifth recovery unit is composed of all other nesting assemblages of loggerheads within the Greater Caribbean, outside the U.S., but which occur within U.S. waters during some portion of their lives. The five recovery units representing nesting assemblages are: (1) the Northern Recovery Unit (NRU: Florida/Georgia border through southern Virginia), (2) the Peninsular Florida Recovery Unit (PFRU: Florida/Georgia border through Pinellas County, Florida), (3) the Dry Tortugas Recovery Unit (DTRU: islands located west of Key West, Florida), (4) the Northern Gulf of Mexico Recovery Unit (NGMRU: Franklin County, Florida through Texas), and (5) the Greater Caribbean Recovery Unit (GCRU: Mexico through French Guiana, The Bahamas, Lesser Antilles, and Greater Antilles). The Recovery Team evaluated the status and trends of the Northwest Atlantic loggerhead population for each of the five recovery units, using nesting data available as of October 2008 (NMFS and USFWS 2008).

From the beginning of standardized surveys in 1989 until 1998, the PFRU, the largest nesting assemblage in the Northwest Atlantic by an order of magnitude, had a significant increase in the number of nests. However, from 1998 through 2007, Witherington *et al.* (2009) reported a decrease of 39.9% in annual nest counts. In 2008, a slight increase in nest counts was reported, but this did not alter the declining trend. The Loggerhead Recovery Team acknowledged that this dramatic change in status for the PFRU is a serious concern and requires immediate attention to determine the cause(s) of this change and the actions needed to reverse it. The NRU, the second largest nesting assemblage of loggerheads in the U.S., has been declining at a rate of 1.3% annually since standardized surveys were implemented in 1983. Overall, there is strong statistical data to suggest the NRU has experienced a long-term decline. The NGMRU has shown a significant declining trend of 6.8% annually since index nesting beach surveys were initiated in 1997. However, evaluation of long-term nesting trends for the NGMRU is difficult because of changed and expanded beach coverage. No statistical trends in nesting abundance can be determined for the DTRU because of the lack of long-term data. Similarly, statistically valid analyses of long-term nesting trends for the entire GCRU are not available because there are few long-term standardized nesting surveys representative of the region. Additionally, changing survey effort at monitored beaches and scattered and low-level nesting by loggerheads at many locations currently precludes comprehensive analyses (NMFS and USFWS 2008).

Sea turtle nesting surveys are important in that they provide information on the relative abundance of nesting each year, and the contribution of each nesting group to total nesting of the species. Nest counts can also be used to estimate the number of reproductively mature females nesting annually. The final revised recovery plan compiled the most recent information on mean number of loggerhead nests and the approximated counts of nesting females per year for four of the five identified recovery units (i.e., nesting groups). They are: (1) for the NRU, a mean of 5,215 loggerhead nests per year with approximately 1,272 females nesting per year; (2) for the PFRU, a mean of 64,513 nests per year with approximately 15,735 females nesting per year; (3) for the DTRU, a mean of 246 nests per year with approximately 60 females nesting per year; and (4) for the NGMRU, a mean of 906 nests per year with approximately 221 females nesting per year. For the GCRU, the only estimate available for the number of loggerhead nests per year is from Quintana Roo, Yucatán, Mexico, where a range of 903-2,331 nests per year was estimated from 1987-2001 (NMFS and USFWS 2007a). There are no annual nest estimates available for the Yucatán since 2001 or for any other regions in the GCRU, nor are there any estimates of the number of nesting females per year for any nesting assemblage in this recovery unit.

Unlike nesting surveys, in-water studies of sea turtles typically sample both sexes and multiple age classes. In-water studies have been conducted in some areas of the Northwest Atlantic and provide data by which to assess the relative abundance of loggerhead sea turtles and changes in abundance over time (Maier *et al.* 2004; Morreale *et al.* 2004; Mansfield 2006; Ehrhart *et al.* 2007; Epperly *et al.* 2007). Maier *et al.* (2004) used fishery-independent trawl data to establish a regional index of loggerhead abundance for the southeast coast of the U.S. (Winyah Bay, South Carolina to St. Augustine, Florida) during the period 2000-2003. A comparison of loggerhead catch data from this study with historical values suggested that in-water populations of loggerhead sea turtles along the southeast U.S. coast appear to be larger, possibly an order of magnitude higher than they were 25 years ago (Maier *et al.* 2004). A comparison of catch rates for sea turtles in pound net gear fished in the Pamlico-Albemarle Estuarine Complex of North Carolina between the years 1995-1997 and 2001-2003 similarly found a significant increase in catch rates for loggerhead sea turtles for the latter period (Epperly *et al.* 2007). A long-term, on-going study of loggerhead abundance in the Indian River Lagoon System of Florida found a significant increase in the relative abundance of loggerheads over the last 4 years of the study (Ehrhart *et al.* 2007). However, there was no discernible trend in loggerhead abundance during the 24-year time period of the study (1982-2006) (Ehrhart *et al.* 2007).

In contrast to these studies, Morreale *et al.* (2004) observed a decline in the incidental catch of loggerhead sea turtles in pound net gear fished around Long Island, New York, during the period 2002-2004 in comparison to the period 1987-1992, with only two loggerheads observed captured in pound net gear during the period 2002-2004. No additional loggerheads were reported captured in pound net gear through 2007, although 2 were found cold-stunned on Long Island bay beaches in the fall of 2007 (Memo to the File, L. Lankshear, December 2007). Using aerial surveys, Mansfield (2006) also found a decline in the densities of loggerhead sea turtles in Chesapeake Bay over the period 2001-2004 compared to aerial survey data collected in the 1980s. Significantly fewer loggerheads ($p<0.05$) were observed in both the spring (May-June) and the summer (July-August) of 2001-2004 compared to those observed during aerial surveys in the 1980s (Mansfield 2006). A

comparison of median densities from the 1980s to the 2000s suggested that there had been a 63.2% reduction in densities during the spring residency period and a 74.9% reduction in densities during the summer residency period (Mansfield 2006).

The diversity of a sea turtle's life history leaves them susceptible to many natural and human impacts, including impacts while they are on land, in the neritic environment, and in the oceanic environment. Recent studies have established that the loggerhead's life history is more complex than previously believed. Rather than making discrete developmental shifts from oceanic to neritic environments, research is showing that both adults and (presumed) neritic stage juveniles continue to use the oceanic environment and will move back and forth between the two habitats (Witzell 2002; Blumenthal *et al.* 2006; Hawkes *et al.* 2006; McClellan and Read 2007). One of the studies tracked the movements of adult post-nesting females and found that differences in habitat use were related to body size with larger turtles staying in coastal waters and smaller turtles traveling to oceanic waters (Hawkes *et al.* 2006). A tracking study of large juveniles found that the habitat preferences of this life stage were also diverse with some remaining in neritic waters and others moving off into oceanic waters (McClellan and Read 2007). However, unlike the Hawkes *et al.* (2006) study, there was no significant difference in the body size of turtles that remained in neritic waters versus oceanic waters (McClellan and Read 2007). In either case, the research not only supports the need to revise the life history model for loggerheads but also demonstrates that threats to loggerheads in both the neritic and oceanic environments are likely impacting multiple life stages of this species.

The 5-year status review and final revised recovery plan provide a summary of natural as well as anthropogenic threats to loggerhead sea turtles (NMFS and USFWS 2007a, 2008). Amongst those of natural origin, hurricanes are known to be destructive to sea turtle nests. Sand accretion, rainfall, and wave action that result from these storms can appreciably reduce hatchling success. Other sources of natural mortality include cold stunning and biotoxin exposure.

Anthropogenic factors that impact hatchlings and adult females on land, or the success of nesting and hatching include: beach erosion, beach armoring, and nourishment; artificial lighting; beach cleaning; increased human presence; recreational beach equipment; beach driving; coastal construction and fishing piers; exotic dune and beach vegetation; and poaching. An increased human presence at some nesting beaches or close to nesting beaches has led to secondary threats such as the introduction of exotic fire ants, feral hogs, dogs, and an increased presence of native species (*e.g.*, raccoons, armadillos, and opossums) which raid nests and feed on turtle eggs (NMFS and USFWS 2007a, 2008). Although sea turtle nesting beaches are protected along large expanses of the Northwest Atlantic coast (in areas like Merritt Island, Archie Carr, and Hobe Sound National Wildlife Refuges), other areas along these coasts have limited or no protection. Sea turtle nesting and hatching success on unprotected high density east Florida nesting beaches from Indian River to Broward County are affected by all of the above threats.

Loggerheads are affected by a completely different set of anthropogenic threats in the marine environment. These include oil and gas exploration, coastal development, and transportation; marine pollution; underwater explosions; hopper dredging; offshore artificial lighting; power plant entrainment and/or impingement; entanglement in debris; ingestion of marine debris; marina and

dock construction and operation; boat collisions; poaching; and fishery interactions.

A 1990 National Research Council (NRC) report concluded that for juveniles, subadults, and breeders in coastal waters, the most important source of human caused mortality in U.S. Atlantic waters was fishery interactions. Of these, the U.S. south Atlantic and Gulf of Mexico shrimp fisheries were considered to pose the greatest cause of mortality to neritic juvenile and adult age classes of loggerheads, accounting for an estimated 5,000 to 50,000 loggerhead deaths each year (NRC 1990). Significant changes to the south Atlantic and Gulf of Mexico shrimp fisheries have occurred since 1990, and the effects of these shrimp fisheries on ESA-listed species, including loggerhead sea turtles, have been assessed several times through section 7 consultation. There is also a lengthy regulatory history with regard to the use of Turtle Excluder Devices (TEDs) in the U.S. south Atlantic and Gulf of Mexico shrimp fisheries (Epperly and Teas 2002; NMFS 2002b; Lewison *et al.* 2003). Section 7 consultation was reinitiated in 2002 to, in part, consider the effect of a new rulemaking that would require increasing the size of TED escape openings to allow larger loggerheads (and green sea turtles) to escape from shrimp trawl gear. The resulting Opinion was completed in December 2002 and concluded that, as a result of the new rule, annual loggerhead mortality from capture in shrimp trawls would decline from an estimated 62,294 to 3,947 turtles assuming that all TEDs were installed properly and that compliance was 100% (Epperly *et al.* 2002; NMFS 2002b). The total level of take for loggerhead sea turtles (individuals caught in the gear regardless of whether they subsequently escaped through the TED opening) as a result of the U.S. south Atlantic and Gulf of Mexico shrimp fisheries was estimated to be 163,160 loggerheads per year (NMFS 2002b). On February 21, 2003, NMFS issued the final rule in the *Federal Register* to require the use of the larger opening TEDs (68 FR 8456). The rule also provided the measures to disallow several previously approved TED designs that did not function properly under normal fishing conditions, and to require modifications to the trynet and bait shrimp exemptions to the TED requirements to decrease mortality of sea turtles.

The NRC (1990) report also stated that other U.S. Atlantic fisheries collectively accounted for 500 to 5,000 loggerhead deaths each year, but recognized that there was considerable uncertainty in the estimate. Subsequent studies suggest that these numbers were underestimated. For example, the first estimate of loggerhead sea turtle bycatch in U.S. Mid-Atlantic bottom otter trawl gear was completed in September 2006 (Murray 2006). Observers reported 66 loggerhead sea turtle interactions with bottom otter trawl gear during the period of which 38 were reported as alive and uninjured and 28 were reported as dead, injured, resuscitated, or of unknown condition (Murray 2006). Seventy-seven percent of observed sea turtle interactions occurred on vessels fishing for summer flounder (50%) and croaker (27%). The remaining 23% of observed interactions occurred on vessels targeting weakfish (11%), long-finned squid (8%), groundfish (3%), and short-finned squid (1%). Based on observed interactions and fishing effort as reported on VTRs, the average annual loggerhead bycatch in these bottom otter trawl fisheries combined was estimated to be 616 sea turtles per year for the period 1996-2004 (Murray 2006).

The U.S. tuna and swordfish longline fisheries that are managed under the Highly Migratory Species (HMS) FMP were estimated to capture 1,905 loggerheads (no more than 339 mortalities) for each 3-year period (NMFS 2004c). NMFS has mandated gear changes for the HMS fishery to reduce sea turtle bycatch and the likelihood of death from those takes that would still occur (Fairfield-Walsh

and Garrison 2007). In 2006, there were 46 observed interactions between loggerhead sea turtles and longline gear used in the HMS fishery. Nearly all of the loggerheads (42 of 46) were released alive but with injuries (Fairfield-Walsh and Garrison 2007). The majority of the injured sea turtles had been hooked internally (Fairfield-Walsh and Garrison 2007). Based on the observed take, an estimated 561 (range = 318-981) loggerhead sea turtles are estimated to have been taken in the longline fisheries managed under the HMS FMP in 2006 (Fairfield-Walsh and Garrison 2007). This number is an increase from 2005 when 274 loggerheads were estimated to have been taken in the fisheries, but is still lower than some previous years in the period of 1992-2006 (Fairfield-Walsh and Garrison 2007). This fishery represents just one of several longline fisheries operating in the Atlantic Ocean. Lewison *et al.* (2004) estimated that 150,000-200,000 loggerheads were taken in the Atlantic longline fisheries in 2000 (includes the U.S. Atlantic tuna and swordfish longline fisheries as well as others).

Summary of Status for Loggerhead Sea Turtles

Loggerheads are a long-lived species and reach sexual maturity relatively late at around 20-38 years (NMFS SEFSC 2001). The species continues to be affected by many factors occurring on nesting beaches and in the water. These include poaching, habitat loss, and nesting predation by introduced species that affect hatchlings and nesting females on land, as well as fishery interactions, vessel interactions, and non-fishery (e.g., dredging) operations affecting all sexes and age classes in the water (NRC 1990; NMFS and USFWS 2007a). As a result, loggerheads still face many of the original threats that were the cause of their listing under the ESA.

There are no population estimates for loggerhead sea turtles in any of the ocean basins in which they occur. Based on their 5-year status review of the species, NMFS and USFWS (2007a) determined that loggerhead sea turtles should not be delisted or reclassified as endangered.

Based on the most recent information, a decline in the annual nest counts has been measured or suggested for three of the five recovery units for loggerheads in the Northwest Atlantic. These include the PFRU, which is the largest (in terms of number of nests laid) in the Atlantic Ocean. NMFS has convened a new Loggerhead Turtle Expert Working Group (TEWG) to review all available information on Atlantic loggerheads in order to determine what can be said about the status of this species in the Atlantic. A final report from the Loggerhead TEWG is not yet available. An interim update was provided by the Loggerhead TEWG to NMFS in December 2007 (letter to J. Lecky, NMFS Office of Protected Resources, from N. Thompson, NMFS Northeast Fisheries Science Center, December 4, 2007).

In summary, the memo stated that nest counts, fishery dependent data, and stranding data do not provide the necessary insight into loggerhead sea turtle population dynamics to properly assess species status. As has been stated in the literature (Meylan 1982; Ross 1996; Zurita *et al.* 2003; Hawkes *et al.* 2005), the TEWG remarked that nest counts alone provide no insight into the trend/abundance of sexually mature males or of other age classes of either sex (Loggerhead TEWG 2007; letter to J. Lecky, NMFS Office of Protected Resources, from N. Thompson, NMFS Northeast Fisheries Science Center, December 4, 2007). In addition, the TEWG stated that interpreting the meaning of a decline in nest counts in terms of the status/trend of the number of nesting females in the population is difficult since converting nest counts to the number of nesting

females is confounded by several issues such as variability in the number of nests per female per year; variability in remigration interval; and, as the ability to nest is resource dependent, the effect of habitat changes and the availability of food resources (Loggerhead TEWG 2007). The TEWG is continuing to explore several hypotheses for why nest counts have been declining. These hypotheses will be more fully discussed in the final report (letter to J. Lecky, NMFS Office of Protected Resources, from N. Thompson, NMFS Northeast Fisheries Science Center, December 4, 2007).

Finally, as mentioned previously, a final revised recovery plan for loggerhead sea turtles in the Northwest Atlantic was recently published by NMFS and FWS in December 2008. The revised recovery plan is significant in that it identifies five unique recovery units, which comprise the population of loggerheads in the Northwest Atlantic, and describes specific recovery criteria for each recovery unit.

Green sea turtle

Green turtles are distributed circumglobally, and can be found in the Pacific, Indian and Atlantic Oceans as well as the Mediterranean Sea (NMFS and USFWS 1991b; Seminoff 2004; NMFS and USFWS 2007d). In 1978, the Atlantic population of the green sea turtle was listed as threatened under the ESA, except for the breeding populations in Florida and on the Pacific coast of Mexico, which were listed as endangered. As it is difficult to differentiate between breeding populations away from the nesting beaches, in water all green sea turtles are considered endangered.

Pacific Ocean. Green turtles occur in the eastern, central, and western Pacific. Foraging areas are also found throughout the Pacific and along the southwestern U.S. coast (NMFS and USFWS 1998b). Nesting is known to occur in the Hawaiian archipelago, American Samoa, Guam, and various other sites in the Pacific but none of these are considered large breeding sites (with 2,000 or more nesting females per year)(NMFS and USFWS 1998b). The main nesting sites for the green sea turtle in the eastern Pacific are located in Michoacan, Mexico, and in the Galapagos Islands, Ecuador (NMFS and USFWS 2007d). The number of nesting females per year exceed 1,000 females at each site (NMFS and USFWS 2007d). However, historically, greater than 20,000 females per year are believed to have nested in Michoacan, alone (Cliffton *et al.* 1982; NMFS and USFWS 2007d). Thus the current number of nesting females is still far below what has historically occurred.

Historically, green turtles were used in many areas of the Pacific for food. They were also commercially exploited and this, coupled with habitat degradation led to their decline in the Pacific (NMFS and USFWS 1998b). Green turtles in the Pacific continue to be affected by poaching, habitat loss or degradation, fishing gear interactions, and fibropappiloma (NMFS and USFWS 1998b; NMFS 2004).

Indian Ocean. There are numerous nesting sites for green sea turtles in the Indian Ocean. One of the largest nesting sites for green sea turtles worldwide occurs on the beaches of Oman where an estimated 20,000 green sea turtles nest annually (Hirth 1997; Ferreira *et al.* 2003). Based on a review of the 32 Index Sites used to monitor green sea turtle nesting worldwide, Seminoff (2004) concluded that declines in green turtle nesting were evident for many of the Indian Ocean Index

Sites. While several of these had not demonstrated further declines in the more recent past, only the Comoros Island Index Site in the Western Indian Ocean showed evidence of increased nesting (Seminoff 2004).

Atlantic Ocean. As has occurred in other oceans of its range, green turtles were once the target of directed fisheries in the United States and throughout the Caribbean. In 1890, over one million pounds of green turtles were taken in the Gulf of Mexico green sea turtle fishery (Doughty 1984). However, declines in the turtle fishery throughout the Gulf of Mexico were evident by 1902 (Doughty 1984).

In the western Atlantic, green sea turtles range from Massachusetts to Argentina, including the Gulf of Mexico and Caribbean (Wynne and Schwartz 1999). Green turtles occur seasonally in Mid-Atlantic and Northeast waters such as Long Island Sound (Musick and Limpus 1997; Morreale and Standora 1998; Morreale *et al.* 2004), presumably for foraging.

Some of the principal feeding pastures in the western Atlantic Ocean include the upper west coast of Florida and the northwestern coast of the Yucatan Peninsula. Additional important foraging areas in the western Atlantic include the Mosquito and Indian River Lagoon systems and nearshore wormrock reefs between Sebastian and Ft. Pierce Inlets in Florida, Florida Bay, the Culebra archipelago and other Puerto Rico coastal waters, the south coast of Cuba, the Mosquito Coast of Nicaragua, the Caribbean Coast of Panama, and scattered areas along Colombia and Brazil (Hirth 1971).

Age at maturity for green sea turtles is estimated to be 20-50 years (Balazs 1982, Frazer and Ehrhart 1985; Seminoff 2004). As is the case with the other turtle species described above, adult females may nest multiple times in a season and typically do not nest in successive years (NMFS and USFWS 1991b; Hirth 1997).

As is also the case for the other sea turtle species described above, nest count information for green sea turtles provides information on the relative abundance of nesting, and the contribution of each nesting group to total nesting of the species. Nest counts can also be used to estimate the number of reproductively mature females nesting annually. The 2007 status review for the species identified eight geographic areas considered to be primary sites for green sea turtle nesting in the Atlantic/Caribbean, and reviewed the trend in nest count data for each (NMFS and USFWS 2007d). These include: (1)Yucatán Peninsula, Mexico, (2) Tortuguero, Costa Rica, (3) Aves Island, Venezuela, (4) Galibi Reserve, Suriname, (5) Isla Trindade, Brazil, (6) Ascension Island, United Kingdom, (7) Bioko Island, Equatorial Guinea, and (8) Bijagos Achipelago (Guinea-Bissau) (NMFS and USFWS 2007d). Nesting at all of these sites was considered to be stable or increasing with the exception of Bioko Island and the Bijagos Archipelago where the lack of sufficient data precluded a meaningful trend assessment for either site (NMFS and USFWS 2007d). Seminoff (2004) likewise reviewed green sea turtle nesting data for eight sites in the western, eastern, and central Atlantic, including all of the above with the exception that nesting in Florida was reviewed in place of Isla Trindade, Brazil. Seminoff (2004) concluded that all sites in the central and western Atlantic showed increased nesting with the exception of nesting at Aves Island, Venezuela, while both sites in the eastern Atlantic demonstrated decreased nesting. These sites are not inclusive of all green sea

turtle nesting in the Atlantic. However, other sites are not believed to support nesting levels high enough that would change the overall status of the species in the Atlantic (NMFS and USFWS 2007d).

By far, the most important nesting concentration for green turtles in the western Atlantic is in Tortuguero, Costa Rica (NMFS and USFWS 2007d). Nesting in the area has increased considerably since the 1970's and nest count data from 1999-2003 suggest nesting by 17,402-37,290 females per year (NMFS and USFWS 2007d). The number of females nesting per year on beaches in the Yucatán , at Aves Island, Galibi Reserve, and Isla Trindade number in the hundreds to low thousands, depending on the site (NMFS and USFWS 2007d). In the U.S., certain Florida nesting beaches have been designated index beaches. Index beaches were established to standardize data collection methods and effort on key nesting beaches. The pattern of green turtle nesting shows biennial peaks in abundance, with a generally positive trend during the ten years of regular monitoring since establishment of the index beaches in 1989, perhaps due to increased protective legislation throughout the Caribbean (Meylan *et al.* 1995).

An average of 5,039 green turtle nests were laid annually in Florida between 2001 and 2006 with a low of 581 in 2001 and a high of 9,644 in 2005 (NMFS and USFWS 2007d). Occasional nesting has been documented along the Gulf coast of Florida, at southwest Florida beaches, as well as the beaches on the Florida Panhandle (Meylan *et al.* 1995). More recently, green turtle nesting occurred on Bald Head Island, North Carolina just east of the mouth of the Cape Fear River, on Onslow Island, and on Cape Hatteras National Seashore. Increased nesting has also been observed along the Atlantic Coast of Florida, on beaches where only loggerhead nesting was observed in the past (Pritchard 1997).

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

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

Summary of Status of Green Sea Turtles
A review of 32 Index Sites[4] distributed globally revealed a 48% to 67% decline in the number of

4 The 32 Index Sites include all of the major known nesting areas as well as many of the lesser nesting areas for which quantitative data are available.

mature females nesting annually over the last 3-generations[5] (Seminoff 2004). An evaluation of green sea turtle nesting sites was also conducted as part of the 2007 status review of the species (NMFS and USFWS 2007d). Of the 23 nesting groups assessed in that report, 10 were considered to be increasing, 9 were considered stable, and 4 were considered to be decreasing (NMFS and USFWS 2007d). Nesting groups were considered to be doing relatively well (the number of sites with increasing nesting were greater than the number of sites with decreasing nesting) in the Pacific, western Atlantic, and central Atlantic (NMFS and USFWS 2007d). The report also estimates that 108,761 to 150,521 females nest each year among the 46 sites (NMFS and USFWS 2007d). However, given the late age to maturity for green sea turtles, caution is urged regarding the status for any of the nesting groups since no area has a dataset spanning a full green sea turtle generation (NMFS and USFWS 2007d).

There is cautious optimism that green sea turtle abundance is increasing in the Atlantic. Seminoff (2004) and NMFS and USFWS (2007d) made comparable conclusions with regard to nesting for four nesting sites in the western Atlantic. Each also concluded that nesting at Tortuguero, Costa Rica represented the most important nesting area for green sea turtles in the western Atlantic and that nesting had increased markedly since the 1970's (Seminoff 2004; NMFS and USFWS 2007d). However, the 2007 status review also noted that the Tortuguero nesting stock continued to be affected by ongoing directed take at their primary foraging area in Nicaragua (NMFS and USFWS 2007d). As with the other sea turtle species, fishery mortality accounts for a large proportion of annual human-caused mortality outside the nesting beaches, while other activities like dredging, pollution, and habitat destruction account for an unknown level of additional mortality.

Kemp's ridley sea turtle

The Kemp's ridley is one of the least abundant of the world's sea turtle species. In contrast to loggerhead, leatherback and green sea turtles which are found in multiple oceans of the world, Kemp's ridleys typically occur only in the Gulf of Mexico and the northern half of the Atlantic Ocean (USFWS and NMFS 1992).

The majority of Kemp's ridleys nest along a single stretch of beach near Rancho Nuevo, Tamaulipas, Mexico (Carr 1963; USFWS and NMFS 1992; NMFS and USFWS 2007c). There is a limited amount of scattered nesting to the north and south of the primary nesting beach (NMFS and USFWS 2007c). The number of nesting adult females reached an estimated low of 300 in 1985 (USFWS and NMFS 1992; TEWG 2000; NMFS and USFWS 2007c). Conservation efforts by Mexican and U.S. agencies have aided this species by eliminating egg harvest, protecting eggs and hatchlings, and reducing at-sea mortality through fishing regulations (TEWG 2000). From 1985 to 1999, the number of nests observed at Rancho Nuevo, and nearby beaches increased at a mean rate of 11.3% (95% C.I. slope = 0.096-0.130) per year (TEWG 2000). An estimated 5,500 females nested in Tamaulipas over a 3-day period in May 2007 (NMFS and USFWS 2007c).

Kemp's ridleys mature at 10-17 years (Caillouet *et al.* 1995; Schmid and Witzell 1997; Snover *et al.* 2007; NMFS and USFWS 2007c). Nesting occurs from April through July each year with hatchlings emerging after 45-58 days (USFWS and NMFS 1992). Once they leave the beach,

5 Generation times ranged from 35.5 years to 49.5 years for the assessment depending on the Index Beach site

neonates presumably enter the Gulf of Mexico where they feed on available sargassum and associated infauna or other epipelagic species (USFWS and NMFS 1992). The presence of juvenile turtles along both the Atlantic and Gulf of Mexico coasts of the U.S., where they are recruited to the coastal neritic environment, indicates that post-hatchlings are distributed in both the Gulf of Mexico and Atlantic Ocean (TEWG 2000).

The location and size classes of dead turtles recovered by the STSSN suggests that benthic immature developmental areas occur in many areas along the U.S. coast and that these areas may change given resource quality and quantity (TEWG 2000). Foraging areas documented along the Atlantic coast include Pamlico Sound (NC), Chesapeake Bay, Long Island Sound, Charleston Harbor (SC) and Delaware Bay. Developmental habitats are defined by several characteristics, including coastal areas sheltered from high winds and waves such as embayments and estuaries, and nearshore temperate waters shallower than 50m (NMFS and USFWS 2007c). The suitability of these habitats depends on resource availability, with optimal environments providing rich sources of crabs and other invertebrates. A wide variety of substrates have been documented to provide good foraging habitats, including seagrass beds, oyster reefs, sandy and mud bottoms and rock outcroppings (NMFS and USFWS 2007c). Adults are primarily found in near-shore waters of 37m or less that are rich in crabs and have a sandy or muddy bottom (NMFS and USFWS 2007c).

Next to loggerheads, Kemp's ridleys are the second most abundant sea turtle in Virginia and Maryland state waters, arriving in these areas during May and June (Keinath *et al.* 1987; Musick and Limpus 1997). In the Chesapeake Bay, where the seasonal juvenile population of Kemp's ridley sea turtles is estimated to be 211 to 1,083 turtles (Musick and Limpus 1997), ridleys frequently forage in submerged aquatic grass beds for crabs (Musick and Limpus 1997). Kemp's ridleys consume a variety of crab species, including *Callinectes* sp., *Ovalipes* sp., *Libinia* sp., and *Cancer* sp. Mollusks, shrimp, and fish are consumed less frequently (Bjorndal 1997). Upon leaving Chesapeake Bay in autumn, juvenile ridleys migrate down the coast, passing Cape Hatteras in December and January (Musick and Limpus 1997). These larger juveniles are joined there by juveniles of the same size from North Carolina sounds and smaller juveniles from New York and New England to form one of the densest concentrations of Kemp's ridleys outside of the Gulf of Mexico (Epperly *et al.* 1995a; Epperly *et al.* 1995b; Musick and Limpus 1997).

Kemp's ridleys face many of the same natural threats as loggerheads, including destruction of nesting habitat from storm events, natural predators at sea, and oceanic events such as cold-stunning. Although cold-stunning can occur throughout the range of the species, it may be a greater risk for sea turtles that utilize the more northern habitats of Cape Cod Bay and Long Island Sound. For example, as reported in the national STSSN database, in the winter of 1999/2000, there was a major cold-stunning event where 218 Kemp's ridleys, 54 loggerheads, and 5 green turtles were found on Cape Cod beaches. Annual cold stun events do not always occur at this magnitude; the extent of episodic major cold stun events may be associated with numbers of turtles utilizing Northeast waters in a given year, oceanographic conditions and the occurrence of storm events in the late fall. Although many cold-stun turtles can survive if found early enough, cold-stunning events can represent a significant cause of natural mortality.

Like other turtle species, the severe decline in the Kemp's ridley population appears to have been

heavily influenced by a combination of exploitation of eggs and impacts from fishery interactions. From the 1940s through the early 1960s, nests from Ranch Nuevo were heavily exploited (USFWS and NMFS 1992), but beach protection in 1966 helped to curtail this activity (USFWS and NMFS 1992). Following World War II, there was a substantial increase in the number of trawl vessels, particularly shrimp trawlers, in the Gulf of Mexico where the adult Kemp's ridley turtles occur. Information from fishers helped to demonstrate the high number of turtles taken in these shrimp trawls (USFWS and NMFS 1992). Subsequently, NMFS has worked with the industry to reduce turtle takes in shrimp trawls and other trawl fisheries, including the development and use of TEDs. As described above, there is lengthy regulatory history with regard to the use of TEDs in the U.S. south Atlantic and Gulf of Mexico shrimp fisheries (Epperly and Teas 2002; NMFS 2002; Lewison *et al.* 2003). NMFS Biological Opinion completed in 2002 concluded that 155,503 Kemp's ridley sea turtles would be taken (captured in a net) annually in the fishery with 4,208 of the takes resulting in mortality (NMFS 2002).

Although changes in the use of shrimp trawls and other trawl gear has helped to reduce mortality of Kemp's ridleys, this species is also affected by other sources of anthropogenic impacts similar to those discussed above. For example, in the spring of 2000, a total of five Kemp's ridley carcasses were recovered from the same North Carolina beaches where 275 loggerhead carcasses were found. Cause of death for most of the turtles recovered was unknown, but the mass mortality event was suspected to have been from a large-mesh gillnet fishery operating offshore in the preceding weeks. The five ridley carcasses that were found are likely to have been only a minimum count of the number of Kemp's ridleys that were killed or seriously injured as a result of the fishery interaction since it is unlikely that all of the carcasses washed ashore.

Summary of Status for Kemp's ridley Sea Turtles

The majority of Kemp's ridleys nest along a single stretch of beach near Rancho Nuevo, Tamaulipas, Mexico (Carr 1963; USFWS and NMFS 1992; NMFS and USFWS 2007c). The number of nesting females in the Kemp's ridley population declined dramatically from the late 1940s through the mid 1980s, with an estimated 40,000 nesting females in a single arribada in 1947 and fewer than 250 nesting females in the entire 1985 nesting season (USFWS and NMFS 1992; TEWG 2000). However, the total annual number of nests at Rancho Nuevo gradually began to increase in the 1990's (NMFS and USFWS 2007c). Based on the number of nests laid in 2006 and the remigration interval for Kemp's ridley sea turtles, there were an estimated 7,000-8,000 adult female Kemps ridley sea turtles in 2006 (NMFS and USFWS 2007c). The number of adult males in the population is unknown but sex ratios of hatchlings and immature ridleys suggest that the population is female biased (NMFS and USFWS 2007c). Based on its 5-year status review of the species, NMFS and the USFWS (2007c) determined that Kemp's ridley sea turtles should not be reclassified as threatened under the ESA.

Leatherback sea turtle

Leatherback sea turtles are widely distributed throughout the oceans of the world, and are found in waters of the Atlantic and Pacific Oceans, the Caribbean Sea, and the Gulf of Mexico (Ernst and Barbour 1972). Leatherback sea turtles are the largest living turtles and range farther than any other sea turtles species; their large size and tolerance of relatively low temperatures allows them to occur in northern waters such as off Labrador and in the Barents Sea (NMFS and USFWS 1995).

In 1980, the leatherback population was estimated at approximately 115,000 adult females globally (Pritchard 1982). By 1995, this global population of adult females was estimated to have declined to 34,500 (Spotila *et al.* 1996). However, the most recent population size estimate for the North Atlantic alone is a range of 34,000-94,000 adult leatherbacks (Leatherback TEWG 2007). Thus, there is uncertainty with respect to global population estimates of leatherback sea turtles.

Pacific Ocean. Leatherback nesting has been declining at all major Pacific basin nesting beaches for the last two decades (Spotila *et al.* 1996; NMFS and USFWS 1998a; Sarti *et al.* 2000; Spotila *et al.* 2000). Leatherback turtles disappeared from India before 1930, have been virtually extinct in Sri Lanka since 1994, and appear to be approaching extinction in Malaysia (Spotila *et al.* 2000). For example, the nesting group on Terengganu (Malaysia) - which was one of the most significant nesting sites in the western Pacific Ocean - has declined severely from an estimated 3,103 females in 1968 to 2 nesting females in 1994 (Chan and Liew 1996). Nesting groups of leatherback turtles along the coasts of the Solomon Islands, which historically supported important nesting groups, are also reported to be declining (D. Broderick, pers. comm., *in* Dutton *et al.* 1999). In Fiji, Thailand, Australia, and Papua-New Guinea (East Papua), leatherback turtles have only been known to nest in low densities and scattered colonies.

Only an Indonesian nesting group has remained relatively abundant in the Pacific basin. The largest, extant leatherback nesting group in the Indo-Pacific lies on the north Vogelkop coast of Irian Jaya (West Papua), Indonesia, with over 1,000 nesting females during the 1996 season (Suarez *et al.* 2000). During the early-to-mid 1980s, the number of female leatherback turtles nesting on the two primary beaches of Irian Jaya appeared to be stable. However, in 1999, for example, local Indonesian villagers started reporting dramatic declines in sea turtles near their villages (Suarez 1999). Declines in nesting groups have been reported throughout the western Pacific region where observers report that nesting groups are well below abundance levels that were observed several decades ago (*e.g.*, Suarez 1999).

In the western Pacific Ocean and South China Seas, leatherback turtles are captured, injured, or killed in numerous fisheries including Japanese longline fisheries. Leatherback turtles in the western Pacific are also threatened by poaching of eggs, killing of nesting females, human encroachment on nesting beaches, incidental capture in fishing gear, beach erosion, and egg predation by animals.

In the eastern Pacific Ocean, leatherback nesting is declining along the Pacific coast of Mexico and Costa Rica. According to reports from the late 1970s and early 1980s, three beaches located on the Pacific coast of Mexico supported as many as half of all leatherback turtle nests. Since the early 1980s, the eastern Pacific Mexican population of adult female leatherback turtles has declined to slightly more than 200 during 1998-99 and 1999-2000 (Sarti *et al.* 2000). Spotila *et al.* (2000) reported the decline of the leatherback nesting at Playa Grande, Costa Rica, which had been the fourth largest nesting group in the world. Between 1988 and 1999, the nesting group declined from 1,367 to 117 female leatherback turtles. Based on their models, Spotila *et al.* (2000) estimated that the group could fall to less than 50 females by 2003-2004. An analysis of the Costa Rican nesting beaches indicates a decline in nesting during the past 15 years of monitoring (1989-2004) with

approximately 1,504 females nesting in 1988-89 to an average of 188 females nesting in 2000-2001 and 2003-2004 (NMFS and USFWS 2007b). A similar dramatic decline has been seen on nesting beaches in Pacific Mexico, where tens of thousands of leatherback nests were laid on the beaches in the 1980s but where a total of only 120 nests on the four primary index beaches (combined) were counted in the 2003-2004 season.

Commercial and artisanal swordfish fisheries off Chile, Columbia, Ecuador, and Peru, purse seine fisheries for tuna in the eastern tropical Pacific Ocean, and California/Oregon drift gillnet fisheries are known to capture, injure or kill leatherback turtles in the eastern Pacific Ocean. Given the declines in leatherback nesting in the Pacific, some researchers have concluded that the leatherback is on the verge of extinction in the Pacific Ocean (*e.g.,* Spotila *et al.* 1996; Spotila *et al.* 2000).

Indian Ocean. Leatherbacks nest in several areas around the Indian Ocean. These sites include Tongaland, South Africa (Pritchard 2002), and the Andaman and Nicobar Islands (Andrews *et al.* 2002). Intensive survey and tagging work in 2001 provided new information on the level of nesting in the Andaman and Nicobar Islands (Andrews *et al.* 2002). Based on the survey and tagging work, it was estimated that 400-500 female leatherbacks nest annually on Great Nicobar Island (Andrews *et al.* 2002). The number of nesting females using the Andaman and Nicobar Islands combined was estimated around 1000 (Andrews and Shanker 2002). Some nesting also occurs along the coast of Sri Lanka although in much smaller numbers than in the past (Pritchard 2002).

Atlantic Ocean. Evidence from tag returns and strandings in the western Atlantic suggests that adult leatherback sea turtles engage in routine migrations between boreal, temperate and tropical waters (NMFS and USFWS 1992). Leatherbacks are frequently thought of as a pelagic species that feed on jellyfish (*i.e.*, *Stomolophus, Chryaora*, and *Aurelia* (Rebel 1974)), and tunicates (salps, pyrosomas) in oceanic habitat. However, leatherbacks are also known to use coastal waters of the U.S. continental shelf (James *et al.* 2005b; Eckert *et al.* 2006; Murphy *et al.* 2006) as well as the European continental shelf on a seasonal basis (Witt *et al.* 2007).

A 1979 aerial survey of the outer Continental Shelf from Cape Hatteras, North Carolina to Cape Sable, Nova Scotia showed leatherbacks to be present throughout the area with the most numerous sightings made from the Gulf of Maine south to Long Island. Leatherbacks were sighted in water depths ranging from 1-4151m but 84.4% of sightings were in waters less than 180 m (Shoop and Kenney 1992). Leatherbacks were sighted in waters within a sea surface temperature range similar to that observed for loggerheads; from 7-27.2°C (Shoop and Kenney 1992). However, leatherbacks appear to have a greater tolerance for colder waters in comparison to loggerhead sea turtles since more leatherbacks were found at the lower temperatures as compared to loggerheads (Shoop and Kenney 1992). This aerial survey estimated the leatherback population for the northeastern U.S. at approximately 300-600 animals (from near Nova Scotia, Canada to Cape Hatteras, North Carolina). However, the estimate was based on turtles visible at the surface and does not include those that were below the surface out of view. Therefore, it likely underestimates the leatherback population for the northeastern U.S. Estimates of leatherback abundance of 1,052 turtles (C.V.= 0.38) and 1,174 turtles (C.V.= 0.52) were obtained from surveys conducted from Virginia to the Gulf of St. Lawrence in 1995 and 1998, respectively (Palka 2000). However, since these estimates were also based on sightings of leatherbacks at the surface, the author considered the estimates to be

negatively biased and the true abundance of leatherbacks may be 4.27 times the estimates (Palka 2000). Studies of satellite tagged leatherbacks suggest that they spend a 10% - 41% of their time at the surface, depending on the phase of their migratory cycle (James *et al.* 2005a). The greatest amount of surface time (up to 41%) was recorded when leatherbacks occurred in continental shelf and slope waters north of 38° N (James *et al.* 2005a).

Leatherbacks are a long lived species (> 30 years). They mature at a younger age than loggerhead turtles, with an estimated age at sexual maturity of about 13-14 years for females with 9 years reported as a likely minimum (Zug and Parham 1996) and 19 years as a likely maximum (NMFS SEFSC 2001). In the U.S. and Caribbean, female leatherbacks nest from March through July. They nest frequently (up to 7 nests per year) during a nesting season and nest about every 2-3 years. During each nesting, they produce 100 eggs or more in each clutch and can produce 700 eggs or more per nesting season (Schultz 1975). However, a significant portion (up to approximately 30%) of the eggs can be infertile. Therefore, the actual proportion of eggs that can result in hatchlings is less than this seasonal estimate. As is the case with other sea turtle species, leatherback hatchlings enter the water soon after hatching. Based on a review of all sightings of leatherback sea turtles of <145 cm (56.55 in) curved carapace length (CCL), Eckert (1999) found that leatherback juveniles remain in waters warmer than 26° C until they exceed 100 cm (39 in) CCL.

As described above, sea turtle nesting survey data is important in that it provides information on the relative abundance of nesting, and the contribution of each population/subpopulation to total nesting of the species. Nest counts can also be used to estimate the number of reproductively mature females nesting annually, and as an indicator of the trend in the number of nesting females in the nesting group. The 5-year review for leatherback sea turtles (NMFS and USFWS 2007b) compiled the most recent information on mean number of leatherback nests per year for each of the seven leatherback populations or groups of populations that were identified by the Leatherback TEWG as occurring within the Atlantic. These are: Florida, North Caribbean, Western Caribbean, Southern Caribbean, West Africa, South Africa, and Brazil. In the U.S., the Florida Statewide Nesting Beach Survey program has documented an increase in leatherback nesting numbers from 98 nests in 1988 to between 800 and 900 nests in the early 2000s (NMFS and USFWS 2007b). An analysis of Florida's Index Nesting Beach Survey sites from 1989-2006 shows a substantial increase in leatherback nesting in Florida during this time, with an annual growth rate of approximately 1.17 (Leatherback TEWG 2007). The TEWG reports an increasing or stable trend for all of the seven populations or groups of populations with the exception of the Western Caribbean and West Africa. However, caution is also warranted even for those that were identified as stable or increasing. In St. Croix, for example, researchers have noted a declining presence of neophytes (first-time nesters) since 2002 (Garner *et al.* 2006). In addition, the leatherback rookery along the northern coast of South America in French Guiana and Suriname supports the majority of leatherback nesting in the western Atlantic (Leatherback TEWG 2007), and represents more than half of total nesting by leatherback sea turtles world-wide (Hilterman and Goverse 2004). Nest numbers in Suriname have shown an increase and the long-term trend for the Suriname and French Guiana nesting group seems to show an increase (Hilterman and Goverse 2004). In 2001, the number of nests for Suriname and French Guiana combined was 60,000, one of the highest numbers observed for this region in 35 years (Hilterman and Goverse 2004). The most recent Leatherback TEWG report (2007) indicates that using nest numbers from 1967-2005, a positive population growth rate was found over the 39-

year period for French Guinea and Suriname, with a 95% probability that the population was growing. Nevertheless, given the magnitude of leatherback nesting in this area compared to other nest sites, impacts to this area that negatively impact leatherback sea turtles could have profound impacts on the species, overall.

Tag return data demonstrate that leatherbacks that nest in South America also use U.S. waters. A nesting female tagged May 29, 1990, in French Guiana was later recovered and released alive from the York River, VA. Another nester tagged in French Guiana was later found dead in Palm Beach, Florida (STSSN database). Many other examples also exist. For example, leatherbacks tagged at nesting beaches in Costa Rica have been found in Texas, Florida, South Carolina, Delaware, and New York (STSSN database). Leatherback turtles tagged in Puerto Rico, Trinidad, and the Virgin Islands have also been subsequently found on U.S. beaches of southern, Mid-Atlantic and northern states (STSSN database).

Of the Atlantic turtle species, leatherbacks seem to be the most vulnerable to entanglement in fishing gear. This susceptibility may be the result of their body type (large size, long pectoral flippers, and lack of a hard shell), and their attraction to gelatinous organisms and algae that collect on buoys and buoy lines at or near the surface, and perhaps to the lightsticks used to attract target species in longline fisheries. They are also susceptible to entanglement in gillnets (used in various fisheries) and capture in trawl gear (*e.g.*, shrimp trawls, bottom otter trawls). Sea turtles entangled in fishing gear generally have a reduced ability to feed, dive, surface to breathe or perform any other behavior essential to survival (Balazs 1985). In addition to drowning from forced submergence, they may be more susceptible to boat strikes if forced to remain at the surface, and entangling lines can constrict blood flow resulting in tissue necrosis.

Leatherbacks are exposed to pelagic longline fisheries in many areas of their range. According to observer records, an estimated 6,363 leatherback sea turtles were caught by the U.S. Atlantic tuna and swordfish longline fisheries between 1992-1999, of which 88 were released dead (NMFS SEFSC 2001). Since the U.S. fleet accounts for only 5-8% of the hooks fished in the Atlantic Ocean, adding up the under-represented observed takes of the other 23 countries actively fishing in the area would likely result in annual take estimates of thousands of leatherbacks over different life stages (NMFS SEFSC 2001).

Leatherbacks are susceptible to entanglement in the lines associated with trap/pot gear used in several fisheries. From 1990-2000, 92 entangled leatherbacks were reported from New York through Maine (Dwyer *et al.* 2002). Additional leatherbacks stranded wrapped in line of unknown origin or with evidence of a past entanglement (Dwyer *et al.* 2002). A review of leatherback mortality documented by the STSSN in Massachusetts suggests that vessel strikes and entanglement in fixed gear (primarily lobster pots and whelk pots) are the principal sources of this mortality (Dwyer *et al.* 2002). Fixed gear fisheries in the Mid-Atlantic have also contributed to leatherback entanglements. For example, in North Carolina, two leatherback sea turtles were reported entangled in a crab pot buoy inside Hatteras Inlet (NMFS SEFSC 2001). A third leatherback was reported entangled in a crab pot buoy in Pamlico Sound off of Ocracoke. This turtle was disentangled and released alive; however, lacerations on the front flippers from the lines were evident (NMFS SEFSC 2001). In the Southeast, leatherbacks are vulnerable to entanglement in Florida's lobster pot and

stone crab fisheries as documented on stranding forms. In the U.S. Virgin Islands, where one of five leatherback strandings from 1982 to 1997 were due to entanglement (Boulon 2000), leatherbacks have been observed with their flippers wrapped in the line of West Indian fish traps (R. Boulon, pers. comm. to Joanne Braun-McNeill, NMFS SEFSC 2001).

Leatherback interactions with the U.S. south Atlantic and Gulf of Mexico shrimp fisheries, are also known to occur (NMFS 2002). Leatherbacks are likely to encounter shrimp trawls working in the coastal waters off the Atlantic coast (from Cape Canaveral, Florida through North Carolina) as they make their annual spring migration north. For many years, TEDs that were required for use in the U.S. south Atlantic and Gulf of Mexico shrimp fisheries were less effective for leatherbacks as compared to the smaller, hard-shelled turtle species, because the TED openings were too small to allow leatherbacks to escape. To address this problem, on February 21, 2003, NMFS issued a final rule to amend the TED regulations. Modifications to the design of TEDs are now required in order to exclude leatherbacks as well as large loggerhead and green turtles.

Other trawl fisheries are also known to interact with leatherback sea turtles although on a much smaller scale. In October 2001, for example, a fisheries observer documented the capture of a leatherback in a bottom otter trawl fishing for *Loligo* squid off of Delaware. TEDs are not required in this fishery. In November 2007, fisheries observers reported the capture of a leatherback sea turtle in bottom otter trawl gear fishing for summer flounder.

Gillnet fisheries operating in the nearshore waters of the Mid-Atlantic states are also known to capture, injure and/or kill leatherbacks when these fisheries and leatherbacks co-occur. Data collected by the NEFSC Fisheries Observer Program from 1994 through 1998 (excluding 1997) indicate that a total of 37 leatherbacks were incidentally captured (16 lethally) in drift gillnets set in offshore waters from Maine to Florida during this period. Observer coverage for this period ranged from 54% to 92%. In North Carolina, a leatherback was reported captured in a gillnet set in Pamlico Sound in the spring of 1990 (D. Fletcher, pers.comm. to Sheryan Epperly, NMFS SEFSC 2001). Five other leatherbacks were released alive from nets set in North Carolina during the spring months: one was from a net (unknown gear) set in the nearshore waters near the North Carolina/Virginia border (1985); two others had been caught in gillnets set off of Beaufort Inlet (1990); a fourth was caught in a gillnet set off of Hatteras Island (1993), and a fifth was caught in a sink net set in New River Inlet (1993). In addition to these, in September 1995, two dead leatherbacks were removed from a 11-inch (28.2 cm) monofilament shark gillnet set in the nearshore waters off of Cape Hatteras, North Carolina (STSSN unpublished data reported in NMFS SEFSC 2001).

Fishing gear interactions and poaching are problems for leatherbacks throughout their range. Entanglements are common in Canadian waters where Goff and Lien (1988) reported that 14 of 20 leatherbacks encountered off the coast of Newfoundland/Labrador were entangled in fishing gear including salmon net, herring net, gillnet, trawl line and crab pot line. Leatherbacks are known to drown in fish nets set in coastal waters of Sao Tome, West Africa (Castroviejo *et al.* 1994; Graff 1995). Gillnets are one of the suspected causes for the decline in the leatherback sea turtle population in French Guiana (Chevalier *et al.* 1999), and gillnets targeting green and hawksbill turtles in the waters of coastal Nicaragua also incidentally catch leatherback turtles (Lagueux *et al.*

1998). Observers on shrimp trawlers operating in the northeastern region of Venezuela documented the capture of six leatherbacks from 13,600 trawls (Marcano and Alio 2000). An estimated 1,000 mature female leatherback sea turtles are caught annually in fishing nets off of Trinidad and Tobago with mortality estimated to be between 50-95% (Eckert and Lien 1999). However, many of the turtles do not die as a result of drowning, but rather because the fishermen butcher them in order to get them out of their nets (NMFS SEFSC 2001).

Leatherback sea turtles may be more susceptible to marine debris ingestion than other species due to the tendency of floating debris to concentrate in convergence zones that adults and juveniles use for feeding areas (Shoop and Kenney 1992; Lutcavage *et al.* 1997). Investigations of the stomach contents of leatherback sea turtles revealed that a substantial percentage (44% of the 16 cases examined) contained plastic (Mrosovsky 1981). Along the coast of Peru, intestinal contents of 19 of 140 (13%) leatherback carcasses were found to contain plastic bags and film (Fritts 1982). The presence of plastic debris in the digestive tract suggests that leatherbacks might not be able to distinguish between prey items and plastic debris (Mrosovsky 1981). Balazs (1985) speculated that the object may resemble a food item by its shape, color, size or even movement as it drifts about, and induce a feeding response in leatherbacks.

Summary of Status for Leatherback Sea Turtles
In the Pacific Ocean, the abundance of leatherback turtles on nesting beaches has declined dramatically over the past 10 to 20 years: nesting groups throughout the eastern and western Pacific Ocean have been reduced to a fraction of their former abundance by the combined effects of human activities that have reduced the number of nesting females and reduced the reproductive success of females that manage to nest (for example, egg poaching) (NMFS and USFWS 2007b). No reliable long term trend data for the Indian Ocean populations are currently available. While leatherbacks are known to occur in the Mediterranean Sea, nesting in this region is not known to occur (NMFS and USFWS 2007b).

Nest counts in many areas of the Atlantic show increasing trends, including for beaches in Suriname and French Guiana which support the majority of leatherback nesting (NMFS and USFWS 2007b). The species as a whole continues to face numerous threats at nesting and marine habitats. The long term recovery potential of this species may be further threatened by observed low genetic diversity, even in the largest nesting groups like French Guiana and Suriname (NMFS and USFWS 2007b).

Based on its 5-year status review of the species, NMFS and the USFWS (2007b) determined that endangered leatherback sea turtles should not be delisted or reclassified as threatened. However, it was also determined that an analysis and review of the species should be conducted in the future to determine whether DPS's should be identified for the leatherback, and what the status of any DPSs should be (NMFS and USFWS 2007b).

Shortnose Sturgeon
Like the sea turtle species discussed above, shortnose sturgeon are listed throughout their range. As such, the status of the species as a whole will be discussed below. Additionally, information specific to the Delaware River population of shortnose sturgeon, which occurs in the action area,

will be discussed in more detail.

Shortnose sturgeon life history
Shortnose sturgeon are benthic fish that mainly occupy the deep channel sections of large rivers. They feed on a variety of benthic and epibenthic invertebrates including mollusks, crustaceans (amphipods, chironomids, isopods), and oligochaete worms (Vladykov and Greeley 1963; Dadswell 1979 *in* NMFS 1998). Shortnose sturgeon have similar lengths at maturity (45-55 cm fork length) throughout their range, but, because sturgeon in southern rivers grow faster than those in northern rivers, southern sturgeon mature at younger ages (Dadswell et al. 1984). Shortnose sturgeon are long-lived (30-40 years) and, particularly in the northern extent of their range, mature at late ages. In the north, males reach maturity at 5 to 10 years, while females mature between 7 and 13 years. Based on limited data, females spawn every three to five years while males spawn approximately every two years. The spawning period is estimated to last from a few days to several weeks. Spawning begins from late winter/early spring (southern rivers) to mid to late spring (northern rivers)[6] when the freshwater temperatures increase to 8-9°C. Several published reports have presented the problems facing long-lived species that delay sexual maturity (Crouse et al. 1987; Crowder et al. 1994; Crouse 1999). In general, these reports concluded that animals that delay sexual maturity and reproduction must have high annual survival as juveniles through adults to ensure that enough juveniles survive to reproductive maturity and then reproduce enough times to maintain stable population sizes.

Total instantaneous mortality rates (Z) are available for the Saint John River (0.12 - 0.15; ages 14-55; Dadswell 1979), Upper Connecticut River (0.12; Taubert 1980b), and Pee Dee-Winyah River (0.08-0.12; Dadswell et al. 1984). Total instantaneous natural mortality (M) for shortnose sturgeon in the lower Connecticut River was estimated to be 0.13 (T. Savoy, Connecticut Department of Environmental Protection, personal communication). There is no recruitment information available for shortnose sturgeon because there are no commercial fisheries for the species. Estimates of annual egg production for this species are difficult to calculate because females do not spawn every year (Dadswell et al. 1984). Further, females may abort spawning attempts, possibly due to interrupted migrations or unsuitable environmental conditions (NMFS 1998). Thus, annual egg production is likely to vary greatly in this species. Fecundity estimates have been made and range from 27,000 to 208,000 eggs/female (Dadswell et al. 1984).

At hatching, shortnose sturgeon are blackish-colored, 7-11mm long and resemble tadpoles (Buckley and Kynard 1981). In 9-12 days, the yolk sac is absorbed and the sturgeon develops into larvae which are about 15mm total length (TL; Buckley and Kynard 1981). Sturgeon larvae are believed to begin downstream migrations at about 20mm TL. Laboratory studies suggest that young sturgeon move downstream in a 2-step migration; a 2 to 3-day migration by larvae followed by a residency period by young of the year (YOY), then a resumption of migration by yearlings in the second summer of life (Kynard 1997). Juvenile shortnose sturgeon (3-10 years old) reside in the interface between saltwater and freshwater in most rivers (NMFS 1998).

In populations that have free access to the total length of a river (e.g., no dams within the species'

6 For purposes of this consultation, Northern rivers are considered to include tributaries of the Chesapeake Bay northward to the St. John River in Canada. Southern rivers are those south of the Chesapeake Bay.

range in a river: Saint John, Kennebec, Altamaha, Savannah, Delaware and Merrimack Rivers), spawning areas are located at the farthest upstream reach of the river (NMFS 1998). In the northern extent of their range, shortnose sturgeon exhibit three distinct movement patterns. These migratory movements are associated with spawning, feeding, and overwintering activities. In spring, as water temperatures rise above 8°C, pre-spawning shortnose sturgeon move from overwintering grounds to spawning areas. Spawning occurs from mid/late March to mid/late May depending upon location and water temperature. Sturgeon spawn in upper, freshwater areas and feed and overwinter in both fresh and saline habitats. Shortnose sturgeon spawning migrations are characterized by rapid, directed and often extensive upstream movement (NMFS 1998).

Shortnose sturgeon are believed to spawn at discrete sites within their natal river (Kieffer and Kynard 1996). In the Merrimack River, males returned to only one reach during a four year telemetry study (Kieffer and Kynard 1996). Squires (1982) found that during the three years of the study in the Androscoggin River, adults returned to a 1-km reach below the Brunswick Dam and Kieffer and Kynard (1996) found that adults spawned within a 2-km reach in the Connecticut River for three consecutive years. Spawning occurs over channel habitats containing gravel, rubble, or rock-cobble substrates (Dadswell et al. 1984; NMFS 1998). Additional environmental conditions associated with spawning activity include decreasing river discharge following the peak spring freshet, water temperatures ranging from 8 - 12° , and bottom water velocities of 0.4 to 0.7 m/sec (Dadswell et al. 1984; NMFS 1998). For northern shortnose sturgeon, the temperature range for spawning is 6.5-18.0°C (Kieffer and Kynard in press). Eggs are separate when spawned but become adhesive within approximately 20 minutes of fertilization (Dadswell et al. 1984). Between 8° and 12°C, eggs generally hatch after approximately 13 days. The larvae are photonegative, remaining on the bottom for several days. Buckley and Kynard (1981) found week old larvae to be photonegative and form aggregations with other larvae in concealment.

Adult shortnose sturgeon typically leave the spawning grounds soon after spawning. Non-spawning movements include rapid, directed post-spawning movements to downstream feeding areas in spring and localized, wandering movements in summer and winter (Dadswell et al. 1984; Buckley and Kynard 1985; O'Herron et al. 1993). Kieffer and Kynard (1993) reported that post-spawning migrations were correlated with increasing spring water temperature and river discharge. Young-of-the-year shortnose sturgeon are believed to move downstream after hatching (Dovel 1981) but remain within freshwater habitats. Older juveniles tend to move downstream in fall and winter as water temperatures decline and the salt wedge recedes. Juveniles move upstream in spring and feed mostly in freshwater reaches during summer.

Juvenile shortnose sturgeon generally move upstream in spring and summer and move back downstream in fall and winter; however, these movements usually occur in the region above the saltwater/freshwater interface (Dadswell et al. 1984; Hall et al. 1991). Non-spawning movements include wandering movements in summer and winter (Dadswell et al. 1984; Buckley and Kynard 1985; O'Herron et al. 1993). Kieffer and Kynard (1993) reported that post-spawning migrations were correlated with increasing spring water temperature and river discharge. Adult sturgeon occurring in freshwater or freshwater/tidal reaches of rivers in summer and winter often occupy only a few short reaches of the total length (Buckley and Kynard 1985). Summer concentration areas in southern rivers are cool, deep, thermal refugia, where adult and juvenile shortnose sturgeon

congregate (Flourney et al. 1992; Rogers and Weber 1994; Rogers and Weber 1995; Weber 1996). While shortnose sturgeon are occasionally collected near the mouths of rivers and often spend time in estuaries, they are not known to participate in coastal migrations and are rarely documented in their non-natal river.

The temperature preference for shortnose sturgeon is not known (Dadswell et al. 1984) but shortnose sturgeon have been found in waters with temperatures as low as 2 to 3°C (Dadswell et al. 1984) and as high as 34°C (Heidt and Gilbert 1978). However, temperatures above 28°C are thought to adversely affect shortnose sturgeon. In the Altamaha River, temperatures of 28-30°C during summer months create unsuitable conditions and shortnose sturgeon are found in deep cool water refuges.

Shortnose sturgeon are known to occur at a wide range of depths. A minimum depth of 0.6m is necessary for the unimpeded swimming by adults. Shortnose sturgeon are known to occur at depths of up to 30m but are generally found in waters less than 20m (Dadswell et al. 1984; Dadswell 1979). Shortnose sturgeon have also demonstrated tolerance to a wide range of salinities. Shortnose sturgeon have been documented in freshwater (Taubert 1980; Taubert and Dadswell 1980) and in waters with salinity of 30 parts-per-thousand (ppt) (Holland and Yeverton 1973; Saunders and Smith 1978). Mcleave et al. (1977) reported adults moving freely through a wide range of salinities, crossing waters with differences of up to 10ppt within a two hour period. The tolerance of shortnose sturgeon to increasing salinity is thought to increase with age (Kynard 1996). Shortnose sturgeon typically occur in the deepest parts of rivers or estuaries where suitable oxygen and salinity values are present (Gilbert 1989).

Status and Trends of Shortnose Sturgeon Rangewide

Shortnose sturgeon were listed as endangered on March 11, 1967 (32 FR 4001), and the species remained on the endangered species list with the enactment of the ESA in 1973. Although the original listing notice did not cite reasons for listing the species, a 1973 Resource Publication, issued by the US Department of the Interior, stated that shortnose sturgeon were "in peril...gone in most of the rivers of its former range [but] probably not as yet extinct" (USDOI 1973). Pollution and overfishing, including bycatch in the shad fishery, were listed as principal reasons for the species' decline. In the late nineteenth and early twentieth centuries, shortnose sturgeon commonly were taken in a commercial fishery for the closely related and commercially valuable Atlantic sturgeon (*Acipenser oxyrinchus*). More than a century of extensive fishing for sturgeon contributed to the decline of shortnose sturgeon along the east coast. Heavy industrial development during the twentieth century in rivers inhabited by sturgeon impaired water quality and impeded these species' recovery; possibly resulting in substantially reduced abundance of shortnose sturgeon populations within portions of the species' ranges (e.g., southernmost rivers of the species range: Santilla, St. Marys and St. Johns Rivers). A shortnose sturgeon recovery plan was published in December 1998 to promote the conservation and recovery of the species (see NMFS 1998). Shortnose sturgeon are listed as "vulnerable" on the IUCN Red List.

Although shortnose sturgeon are listed as endangered range-wide, in the 1998 recovery plan for this species, NMFS recognized 19 separate populations occurring throughout the range of the species. These populations are in New Brunswick Canada (1); Maine (2); Massachusetts (1); Connecticut

(1); New York (1); New Jersey/Delaware (1); Maryland and Virginia (1); North Carolina (1); South Carolina (4); Georgia (4); and Florida (2). NMFS has not formally recognized distinct population segments (DPS)[7] of shortnose sturgeon under the ESA. Although genetic information within and among shortnose sturgeon occurring in different river systems is largely unknown, life history studies indicate that shortnose sturgeon populations from different river systems are substantially reproductively isolated (Kynard 1997) and, therefore, should be considered discrete. The 1998 Recovery Plan indicates that while genetic information may reveal that interbreeding does not occur between rivers that drain into a common estuary, at this time, such river systems are considered a single population compromised of breeding subpopulations (NMFS 1998). A status review for this species is currently ongoing and no report is currently available.

Studies conducted since the issuance of the 1988 Recovery Plan have provided evidence that suggests that years of isolation between populations of shortnose sturgeon have led to morphological and genetic variation. Walsh et al. (2001) examined morphological and genetic variation of shortnose sturgeon in three rivers (Kennebec, Androscoggin, and Hudson). The study found that the Hudson River shortnose sturgeon population differed markedly from the other two rivers for most morphological features (total length, fork length, head and snout length, mouth width, interorbital width and dorsal scute count, left lateral scute count, right ventral scute count). Significant differences were found between fish from Androscoggin and Kennebec rivers for interorbital width and lateral scute counts which suggests that even though the Androscoggin and Kennebec rivers drain into a common estuary, these rivers support largely discrete populations of shortnose sturgeon. The study also found significant genetic differences among all three populations indicating substantial reproductive isolation among them and that the observed morphological differences may be partly or wholly genetic.

Grunwald et al. (2002) examined mitochondrial DNA (mtDNA) from shortnose sturgeon in eleven river populations. The analysis demonstrated that all shortnose sturgeon populations examined showed moderate to high levels of genetic diversity as measured by haplotypic diversity indices. The limited sharing of haplotypes and the high number of private haplotypes are indicative of high homing fidelity and low gene flow. The researchers determined that glaciation in the Pleistocene Era was likely the most significant factor in shaping the phylogeographic pattern of mtDNA diversity and population structure of shortnose sturgeon. The Northern glaciated region extended south to the Hudson River while the southern non-glaciated region begins with the Delaware River. There is a high prevalence of haplotypes restricted to either of these two regions and relatively few are shared; this represents a historical subdivision that is tied to an important geological phenomenon that reflects historical isolation. Analyses of haplotype frequencies at the level of individual rivers showed significant differences among all systems in which reproduction is known to occur. This implies that although higher level genetic stock relationships exist (i.e., southern vs. northern and other regional subdivisions), shortnose sturgeon appear to be discrete stocks, and low gene flow exists between the majority of populations.

---

7 The definition of species under the ESA includes any subspecies of fish, wildlife, or plants, and any distinct population segment of any species of vertebrate fish or wildlife which interbreeds when mature. To be considered a DPS, a population segment must meet two criteria under NMFS policy. First, it must be discrete, or separated, from other populations of its species or subspecies. Second, it must be significant, or essential, to the long-term conservation status of its species or subspecies. This formal legal procedure to designate DPSs for shortnose sturgeon has not been undertaken.

Waldman et al. (2002) also conducted mtDNA analysis on shortnose sturgeon from 11 river systems and identified 29 haplotypes. Of these haplotypes, 11 were unique to northern, glaciated systems and 13 were unique to the southern non-glaciated systems. Only 5 were shared between them. This analysis suggests that shortnose sturgeon show high structuring and discreteness and that low gene flow rates indicated strong homing fidelity.

Wirgin et al. (2005), also conducted mtDNA analysis on shortnose sturgeon from 12 rivers (St. John, Kennebec, Androscoggin, Upper Connecticut, Lower Connecticut, Hudson, Delaware, Chesapeake Bay, Cooper, Peedee, Savannah, Ogeechee and Altamaha). This analysis suggested that most population segments are independent and that genetic variation among groups was high.

The best available information demonstrates differences in life history and habitat preferences between northern and southern river systems and given the species' anadromous breeding habits, the rare occurrence of migration between river systems, and the documented genetic differences between river populations, it is unlikely that populations in adjacent river systems interbreed with any regularity. This likely accounts for the failure of shortnose sturgeon to repopulate river systems from which they have been extirpated, despite the geographic closeness of persisting populations. This characteristic of shortnose sturgeon also complicates recovery and persistence of this species in the future because, if a river population is extirpated in the future, it is unlikely that this river will be recolonized. Consequently, this Opinion will treat the nineteen separate populations of shortnose sturgeon as subpopulations (one of which occurs in the action area) for the purposes of this analysis.

Historically, shortnose sturgeon are believed to have inhabited nearly all major rivers and estuaries along nearly the entire east coast of North America. The range extended from the St John River in New Brunswick, Canada to the Indian River in Florida. Today, only 19 populations remain ranging from the St. Johns River, Florida (possibly extirpated from this system) to the Saint John River in New Brunswick, Canada. Shortnose sturgeon are large, long lived fish species. The present range of shortnose sturgeon is disjunct, with northern populations separated from southern populations by a distance of about 400 km. The species is anadromous in the southern portion of its range (i.e., south of Chesapeake Bay), while northern populations are amphidromous (NMFS 1998). Population sizes vary across the species' range. From available estimates, the smallest populations occur in the Cape Fear (~8 adults; Moser and Ross 1995) and Merrimack Rivers (~100 adults; M. Kieffer, United States Geological Survey, personal communication), while the largest populations are found in the Saint John (~100,000; Dadswell 1979) and Hudson Rivers (~61,000; Bain et al. 1998). As indicated in Kynard 1996, adult abundance is less than the minimum estimated viable population abundance of 1000 adults for 5 of 11 surveyed northern populations and all natural southern populations. Kynard 1996 indicates that all aspects of the species' life history indicate that shortnose sturgeon should be abundant in most rivers. As such, the expected abundance of adults in northern and north-central populations should be thousands to tens of thousands of adults. Expected abundance in southern rivers is uncertain, but large rivers should likely have thousands of adults. The only river systems likely supporting populations of these sizes are the St John, Hudson and possibly the Delaware and the Kennebec, making the continued success of shortnose sturgeon in these rivers critical to the species as a whole. While no reliable estimate of the size of either the total species or the shortnose sturgeon population in the Northeastern United States exists, it is

clearly below the size that could be supported if the threats to shortnose sturgeon were removed.

Threats to shortnose sturgeon recovery
The Shortnose Sturgeon Recovery Plan (NMFS 1998) identifies habitat degradation or loss (resulting, for example, from dams, bridge construction, channel dredging, and pollutant discharges) and mortality (resulting, for example, from impingement on cooling water intake screens, dredging and incidental capture in other fisheries) as principal threats to the species' survival.

Several natural and anthropogenic factors continue to threaten the recovery of shortnose sturgeon. Shortnose sturgeon continue to be taken incidentally in fisheries along the east coast and are probably targeted by poachers throughout their range (Dadswell 1979; Dovel et al. 1992; Collins et al. 1996). Bridge construction and demolition projects may interfere with normal shortnose sturgeon migratory movements and disturb sturgeon concentration areas. Unless appropriate precautions are made, internal damage and/or death may result from blasting projects with powerful explosives. Hydroelectric dams may affect shortnose sturgeon by restricting habitat, altering river flows or temperatures necessary for successful spawning and/or migration and causing mortalities to fish that become entrained in turbines. Maintenance dredging of Federal navigation channels and other areas can adversely affect or jeopardize shortnose sturgeon populations. Hydraulic dredges can lethally take sturgeon by entraining sturgeon in dredge dragarms and impeller pumps. Mechanical dredges have also been documented to lethally take shortnose sturgeon. In addition to direct effects, dredging operations may also impact shortnose sturgeon by destroying benthic feeding areas, disrupting spawning migrations, and filling spawning habitat with resuspended fine sediments. Shortnose sturgeon are susceptible to impingement on cooling water intake screens at power plants. Electric power and nuclear power generating plants can affect sturgeon by impinging larger fish on cooling water intake screens and entraining larval fish. The operation of power plants can have unforeseen and extremely detrimental impacts to water quality which can affect shortnose sturgeon. For example, the St. Stephen Power Plant near Lake Moultrie, South Carolina was shut down for several days in June 1991 when large mats of aquatic plants entered the plant's intake canal and clogged the cooling water intake gates. Decomposing plant material in the tailrace canal coupled with the turbine shut down (allowing no flow of water) triggered a low dissolved oxygen water condition downstream and a subsequent fish kill. The South Carolina Wildlife and Marine Resources Department reported that twenty shortnose sturgeon were killed during this low dissolved oxygen event.

Contaminants, including toxic metals, polychlorinated aromatic hydrocarbons (PAHs), pesticides, and polychlorinated biphenyls (PCBs) can have substantial deleterious effects on aquatic life including production of acute lesions, growth retardation, and reproductive impairment (Cooper 1989; Sinderman 1994). Ultimately, toxins introduced to the water column become associated with the benthos and can be particularly harmful to benthic organisms (Varanasi 1992) like sturgeon. Heavy metals and organochlorine compounds are known to accumulate in fat tissues of sturgeon, but their long term effects are not yet known (Ruelle and Henry 1992; Ruelle and Kennlyne 1993). Available data suggests that early life stages of fish are more susceptible to environmental and pollutant stress than older life stages (Rosenthal and Alderdice 1976).

Although there is scant information available on the levels of contaminants in shortnose sturgeon

tissues, some research on other related species indicates that concern about the effects of contaminants on the health of sturgeon populations is warranted. Detectible levels of chlordane, DDE (1,1-dichloro-2, 2-bis(p-chlorophenyl)ethylene), DDT (dichlorodiphenyl-trichloroethane), and dieldrin, and elevated levels of PCBs, cadmium, mercury, and selenium were found in pallid sturgeon tissue from the Missouri River (Ruelle and Henry 1994). These compounds were found in high enough levels to suggest they may be causing reproductive failure and/or increased physiological stress (Ruelle and Henry 1994). In addition to compiling data on contaminant levels, Ruelle and Henry also determined that heavy metals and organochlorine compounds (i.e. PCBs) accumulate in fat tissues. Although the long term effects of the accumulation of contaminants in fat tissues is not yet known, some speculate that lipophilic toxins could be transferred to eggs and potentially inhibit egg viability. In other fish species, reproductive impairment, reduced egg viability, and reduced survival of larval fish are associated with elevated levels of environmental contaminants including chlorinated hydrocarbons. A strong correlation that has been made between fish weight, fish fork length, and DDE concentration in pallid sturgeon livers indicates that DDE increases proportionally with fish size (NMFS 1998).

Contaminant analysis was conducted on two shortnose sturgeon from the Delaware River in the fall of 2002. Muscle, liver, and gonad tissue were analyzed for contaminants (ERC 2002). Sixteen metals, two semivolatile compounds, three organochlorine pesticides, one PCB Aroclor, as well as polychlorinated dibenzo-p-dioxins (PCDDs), and polychlorinated dibenzofurans (PCDFs) were detected in one or more of the tissue samples. Levels of aluminum, cadmium, PCDDs, PCDFs, PCBs, DDE (an organochlorine pesticide) were detected in the "adverse affect" range. It is of particular concern that of the above chemicals, PCDDs, DDE, PCBs and cadmium, were detected as these have been identified as endocrine disrupting chemicals. Contaminant analysis conducted in 2003 of tissues from a shortnose sturgeon from the Kennebec River revealed the presence of fourteen metals, one semivolatile compound, one PCB Aroclor, Polychlorinated dibenzo-p-dioxins (PCDDs) and polychlorinated dibenzofurans (PCDFs) in one or more of the tissue samples. Of these chemicals, cadmium and zinc were detected at concentrations above an adverse effect concentration reported for fish in the literature (ERC 2003). While no directed studies of chemical contamination in shortnose sturgeon have been undertaken, it is evident that the heavy industrialization of the rivers where shortnose sturgeon are found is likely adversely affecting this species.

During summer months, especially in southern areas, shortnose sturgeon must cope with the physiological stress of water temperatures that may exceed 28°C. Flourney et al.(1992) suspected that, during these periods, shortnose sturgeon congregate in river regions which support conditions that relieve physiological stress (i.e., in cool deep thermal refuges). In southern rivers where sturgeon movements have been tracked, sturgeon refrain from moving during warm water conditions and are often captured at release locations during these periods (Flourney et al.1992; Rogers and Weber 1994; Weber 1996). The loss and/or manipulation of these discrete refuge habitats may limit or be limiting population survival, especially in southern river systems.

Pulp mill, silvicultural, agricultural, and sewer discharges, as well as a combination of non-point source discharges, which contain elevated temperatures or high biological demand, can reduce dissolved oxygen levels. Shortnose sturgeon are known to be adversely affected by dissolved

oxygen levels below 5 mg/L. Shortnose sturgeon may be less tolerant of low dissolved oxygen levels in high ambient water temperatures and show signs of stress in water temperatures higher than 28°C (Flourney et al. 1992). At these temperatures, concomitant low levels of dissolved oxygen may be lethal.

Status and Distribution of Shortnose Sturgeon in the Action Area
The action area is limited to a stretch of the Delaware River and Delaware Bay as identified in the "Description of the Action Area" above (i.e., RM 100 – RM 5). As such, this section will discuss the available information related to the presence of shortnose sturgeon in the action area.

Shortnose sturgeon occur in the Delaware River from the lower bay upstream to at least Lambertville, New Jersey (river mile 148). Tagging studies by O'Herron et al. (1993) found that the most heavily used portion of the river appears to be between river mile 118 below Burlington Island and river mile 137 at the Trenton Rapids. Hastings et al. (1987) used Floy T-anchor tags in a tag-and-recapture experiment from 1981 to 1984 to estimate the size of the Delaware River population in the Trenton to Florence reach. Population sizes by three estimation procedures ranged from 6,408 to 14,080 adult sturgeon. These estimates compare favorably with those based upon similar methods in similar river systems. This is the best available information on population size, but because the recruitment and migration rates between the population segment studied and the total population in the river are unknown, model assumptions may have been violated.

In the Delaware River, movement to the spawning grounds occurs in early spring, typically in late March[8], with spawning occurring through the end of April. Movement to the spawning areas is triggered in part by water temperature and fish typically arrive at the spawning locations when water temperatures are between 8-9°C with most spawning occurring when water temperatures are between 10 and 15°C. Until recently, actual spawning (i.e., fertilized eggs or larvae) had not been documented in this area; however, the concentrated use of the Scudders Falls region in the spring by large numbers of mature male and female shortnose sturgeon indicated that this is the major spawning area (O'Herron et al. 1993). The same area was identified as a likely spawning area based on the collection of two ripe females in the spring of 1965 (Hoff 1965). The capture of early life stages (eggs and larvae) in this region in the spring of 2008 confirms that this area of the river is used for spawning and as a nursery area (ERC 2009). During the spawning period, males remain on the spawning grounds for approximately a week while females only stay for a few days (O'Herron and Hastings 1985). After spawning, which typically ceases by the time water temperatures reach 15°C (although sturgeon have been reported on the spawning grounds at water temperatures as high as 18°C), shortnose sturgeon move rapidly downstream to the Philadelphia area.

Shortnose sturgeon eggs generally hatch after approximately 9-12 days (Buckley and Kynard 1981). The larvae are photonegative, remaining on the bottom for several days. Buckley and Kynard

8 Based on US Geological Survey (USGS) water temperature data for the Delaware River at the Trenton gage (USGS gage 01463500; the site closest to the Scudders Falls area), for the period 2003-2009, water temperature reached 8°C sometime between March 26 (2006) and April 21 (2007), with temperatures typically reaching 8°C in the last few days of March. During this period, mean water temperatures at Trenton reached 10°C between March 28 (2004) and April 22 (2007) and 15°C between April 15 (2006) and April 21 (2003). There is typically a three to four week period with mean daily temperatures between 8 and 15°C.

(1981) found week old larvae to be photonegative and form aggregations with other larvae in concealment. Larvae are expected to begin swimming downstream at 9-14 days old (Richmond and Kynard 1995). Larvae are expected to be less than 20mm TL at this time (Richmond and Kynard 1995). This initial downstream migration generally lasts two to three days (Richmond and Kynard 1995). Studies (Kynard and Horgan 2002) suggest that larvae move approximately 7.5km/day during this initial 2 to 3 day migration. Laboratory studies indicate that young sturgeon move downstream in a 2-step migration: the initial 2-3 day migration followed by a residency period of the Young of the Year (YOY), then a resumption of migration by yearlings in the second summer of life (Buckley and Kynard 1981).

No studies have been conducted on juveniles in the Delaware River. As shortnose sturgeon demonstrate nearly identical migration patterns in all rivers, it is likely that juveniles in the Delaware River exhibit similar migration patterns to sturgeon in other river systems. As such, it is likely that yearlings are concentrated in the upper Delaware River above Philadelphia.

As noted above, due to limited information on juvenile shortnose sturgeon, it is difficult to ascertain their distribution and nursery habitat (O'Herron 2000, pers. comm.). In other river systems, older juveniles (3-10 years old) occur in the saltwater/freshwater interface (NMFS 1998). In these systems, juveniles moved back and forth in the low salinity portion of the salt wedge during summer. In the Delaware River the oligohaline/fresh interface can range from as far south as Wilmington, Delaware, north to Philadelphia, Pennsylvania, depending upon meteorological conditions such as excessive rainfall or drought. As a result, it is possible that in the Delaware River, juveniles could range from Artificial Island (river mile 54) to the Schuylkill River (river mile 92) (O'Herron 2000, pers. comm.). The distribution of juveniles in the river is likely highly influenced by flow and salinity. In years of high flow (for example, due to excessive rains or a significant spring runoff), the salt wedge will be pushed seaward and the low salinity reaches preferred by juveniles will extend further downriver. In these years, shortnose sturgeon juveniles are likely to be found further downstream in the summer months. In years of low flow, the salt wedge will be higher in the river and in these years juveniles are likely to be concentrated further upstream.

O'Herron believes that if juveniles are present within this range they would likely aggregate closer to the downstream boundary in the winter when freshwater input is normally greater (O'Herron 2000, pers. comm.). Research in other river systems indicates that juveniles are typically found over silt and sand/mud substrates in deep water of 10-20m. Juvenile sturgeon primarily feed in 10 to 20 meter deep river channels, over sand-mud or gravel-mud bottoms (Pottle and Dadswell 1979). However, little is known about the specific feeding habits of juvenile shortnose sturgeon in the Delaware River.

As noted above, after spawning, adult shortnose sturgeon migrate rapidly downstream to the Philadelphia area (RM 100). After adult sturgeon migrate to the area around Philadelphia, many adults return upriver to between river mile 127 and 134 within a few weeks, while others gradually move to the same area over the course of the summer (O'Herron 1993). By the time water temperatures have reached 10°C, typically by mid-November[9], adult sturgeon have returned to the

9 Based on information from the USGS gage at Philadelphia (01467200) during the 2003-2008 time period, mean water

overwintering grounds around Duck Island and Newbold Island. These patterns are generally supported by the movement of radio-tagged fish in the region between river mile 125 and river mile 148 as presented by Brundage (1986). Based on water temperature data collected at the USGS gage at Philadelphia, in general, shortnose sturgeon are expected to be at the overwintering grounds between early November and mid-April. Adult sturgeon overwinter in dense sedentary aggregations in the upper tidal reaches of the Delaware between river mile 118 and 131. The areas around Duck Island and Newbold Island seem to be regions of intense overwintering concentrations. However, unlike sturgeon in other river systems, shortnose sturgeon in the Delaware do not appear to remain as stationary during overwintering periods. Overwintering fish have been found to be generally active, appearing at the surface and even breaching through the skim ice (O'Herron 1993). Due to the relatively active nature of these fish, the use of the river during the winter is difficult to predict. However, O'Herron et al. (1993) found that the typical overwintering movements are fairly localized and sturgeon appear to remain within 1.24 river miles of the aggregation site (O'Herron and Able 1986). Investigations with video equipment by the ACOE in March 2005 (Versar 2006) documented two sturgeon of unknown species at Marcus Hook and 1 sturgeon of unknown species at Tinicum. Gillnetting in these same areas caught only one Atlantic sturgeon and no shortnose sturgeon. Video surveys of the known overwintering area near Newbold documented 61 shortnose sturgeon in approximately 1/3 of the survey effort. This study supports the conclusion that the vast majority of shortnose sturgeon overwinter near Duck and Newbold Island but that a limited number of shortnose sturgeon occur in other downstream areas, including Marcus Hook, during the winter months. The overwintering location of juvenile shortnose sturgeon is not known but believed to be on the freshwater side of the oligohaline/fresh water interface (O'Herron 1990). In the Delaware River, the oligohaline/freshwater interface occurs in the area between Wilmington, Delaware and Marcus Hook, Pennsylvania (O'Herron 1990).

Shortnose sturgeon appear to be strictly benthic feeders (Dadswell 1984). Adults eat mollusks, insects, crustaceans and small fish. Juveniles eat crustaceans and insects. While shortnose sturgeon forage on a variety of organisms, in the Delaware River, sturgeon primarily feed on the Asiatic river clam (*Corbicula manilensis*). *Corbicula* is widely distributed at all depths in the upper tidal Delaware River, but it is considerably more numerous in the shallows on both sides of the river than in the navigation channels. Foraging is heaviest immediately after spawning in the spring and during the summer and fall, and lighter in the winter.

Historically, sturgeon were relatively rare below Philadelphia due to poor water quality. Since the 1990s, the water quality in the Philadelphia area has improved leading to an increased use of the lower river by shortnose sturgeon. Few studies have been conducted to document the use of the river below Philadelphia by sturgeon. Brundage and Meadows (1982) have reported incidental captures in commercial gillnets in the lower Delaware. During a study focusing on Atlantic sturgeon, Shirey et al. (1999) captured 9 shortnose sturgeon in 1998. During the June through September study period, Atlantic and shortnose sturgeon were found to use the area on the west side of the shipping channel between Deep Water Point, New Jersey and the Delaware-Pennsylvania line. The most frequently utilized areas within this section were off the northern and southern ends of Cherry Island Flats in the vicinity of the Marcus Hook Bar. A total of 25 shortnose sturgeon have

---

temperatures reached 10°C between October 29 (2005 and 2006) and November 14 (2003). In the spring, mean water temperature reached 10°C between April 2 (2006) and April 21 (2009).

been captured by Shirey in this region of the river from 1992 - 2004, with capture rates ranging from 0-10 fish per year (Shirey 2006). Shortnose sturgeon have also been documented on the trash racks of the Salem nuclear power plant in Salem, New Jersey at Artificial Island. The intakes for this plant are located in Delaware Bay. While the available information does not identify the area below Philadelphia as a concentration area for adult shortnose sturgeon, it is apparent that this species does occur in the lower Delaware River and upper Delaware Bay.

In May 2005, a one-year survey for juvenile sturgeon in the Delaware River in the vicinity of the proposed Crown Landing LNG project was initiated. The objective of the survey was to obtain information on the occurrence and distribution of juvenile shortnose and Atlantic sturgeon near the proposed project site to be located near RM 78, approximately 20 miles south of Philadelphia. 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, at RM 81), and one near the upstream end of the Cherry Island Flats (at RM 74; 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 at RM 78 and one was taken at the downstream sampling station at RM 74. Total length ranged from 311-367mm. During the September – December sampling, one juvenile shortnose sturgeon was caught in September at RM 78 and one in November at the same location. One adult shortnose sturgeon was captured in October at RM 74. 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 (RM 74) is consistent with the capture location of several adult sturgeon reported by Shirey et al. 1999 and Shirey 2006.

Brundage compiled a report presenting an analysis of telemetry data from receivers located at Torresdale RM 93, Tinicum RM 86, Bellevue RM 73 and New Castle RM 58 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 proposed Crown Landing LNG facility. 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 RM 126-132. 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 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 Torresdale to New Castle area as a short-term migratory route rather than a long-term concentration or foraging area. Adult sturgeon in this region of the river are highly mobile, and as noted above, likely using the area as a migration route.

Information on the use of the river by juveniles is lacking and the information available is extremely limited (i.e., 5 captures). As evidenced by the Crown Landing study, juvenile shortnose sturgeon have been documented between RM 81-74 from June – November. Due to the limited geographic scope of this study, it is difficult to use these results to predict the occurrence of juvenile shortnose sturgeon throughout the action area. However, the April – August time frame is when flows in the Delaware River are highest and the time when the action area is likely to experience the low salinity levels preferred by juveniles (FERC 2005). Beginning in August, flows decrease and the salt wedge begins to move upstream, which may preclude juveniles from occurring in the action area. Based on this information, it is likely that juvenile shortnose sturgeon are present in the action area at least during the April – August time frame. The capture of juvenile shortnose sturgeon in the RM 81-74 range in November of 2005 suggests that if water conditions are appropriate, juveniles may also be present in this 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.

In 2005, the ACOE conducted investigations to determine the use of the Marcus Hook region by sturgeon. Surveys for the presence of Atlantic and shortnose sturgeon were conducted between March 4 and March 25, 2005 primarily using a Video Ray® Explorer submersible remotely operated vehicle (ROV). The Video Ray® was attached to a 1.0 x 1.0 x 1.5 meter aluminum sled which was towed over channel bottom habitats behind a 25-foot research boat. All images captured by the underwater camera were transmitted through the unit's electronic tether and recorded on video cassettes. A total of 43 hours of bottom video were collected on 14 separate survey days. Twelve days of survey work were conducted at the Marcus Hook, Eddystone, Chester, and Tinicum ranges, while two separate days of survey work were conducted up river near Trenton, New Jersey, at an area known to have an over wintering population of shortnose sturgeon.

The sled was generally towed on the bottom parallel to the centerline of the channel and into the current at 0.8 knots. Tow track logs were maintained throughout the survey and any fish seen on the ROV monitor was noted. Boat position during each video tow was recorded every five minutes with the vessel's Furuno GPS. The Sony digital recorder recorded a time stamp that could be matched with the geographic coordinates taken from the on-board GPS. Digital tapes were

reviewed in a darkened laboratory at normal or slow speed using a high quality 28-inch television screen as a monitor. When a fish image was observed the tape was slowed and advanced frame by frame (30 images per second were recorded by the system). The time stamp where an individual fish was observed was recorded by the technician. Each fish was identified to the lowest practical taxon (usually species) and counted. A staff fishery biologist reviewed questionable images and species identifications. Distances traveled by the sled between time stamps were calculated based on the GPS coordinates recorded in the field during each tow. Total fish counts between the recorded coordinates within a particular tow were converted to observed numbers per 100 meters of tow track.

Limited 25-foot otter trawling and gillnet sets were conducted initially to provide density data, and later to provide ground truth information on the fish species seen in the video recording. Large boulders and other snags that tore the net and hung up the vessel early on in the study prompted abandoning this effort for safety reasons given the high degree of tanker traffic in the lower Delaware River. The trawl net was a 7.6-m (25-foot) experimental semi-balloon otter trawl with 44.5-mm stretch mesh body fitted with a 3.2-mm stretch mesh liner in the cod end. Otter trawls were generally conducted for five minutes unless a snag or tanker traffic caused a reduction in tow time. Experimental gillnets were periodically deployed throughout the survey period in the Marcus Hook area. One experimental gillnet was 91.4-m in length and 3-m deep and was composed of six 15.2-m panels of varying mesh size. Of the six panels in each net, two panels were 50.8-mm stretch mesh, 2 panels were 101.6-mm stretch mesh and two panels were 152.4-mm stretch mesh. Another gillnet was 100 m in length and consisted of four 25 x 2-m panels of 2.5-10.2-cm stretched monofilament mesh in 2.5 cm increments. Gill nets were generally set an hour before slack high or low water and allowed to fish for two hours as the nets had to be retrieved before maximum currents were reached.

Turbidity in the Marcus Hook region of the Delaware River limited visibility to about 18 inches in front of the camera. However, despite the reduced visibility, several different fish species were recorded by the system including sturgeon. In general, fish that encountered the sled between the leading edge of the sled runners were relatively easy to distinguish. The major fish species seen in the video images were confirmed by the trawl and gillnet samples. In the Marcus Hook project area, a total of 39 survey miles of bottom habitat were recorded in twelve separate survey days. Eight different species were observed on the tapes from a total of 411 fish encountered by the camera. White perch, unidentified catfish, and unidentified shiner were the most common taxa observed. Three unidentified sturgeon were seen on the tapes, two in the Marcus Hook Range, and one in the Tinicum Range. Although it could not be determined if these sturgeon were Atlantic or shortnose, gillnetting in the Marcus Hook anchorage produced one juvenile Atlantic sturgeon that was 396 mm in total length, 342 mm in fork length, and weighed 250 g.

Water clarity in the Trenton survey area was much greater (about 6 feet ahead of the camera) and large numbers of shortnose sturgeon were seen in the video recordings. In a total of 7.9 survey miles completed in two separate days of bottom imaging, 61 shortnose sturgeons were observed. To provide a comparative measure of project area density (where visibility was limited) to up river densities (where visibility was greater), each of the 61 sturgeon images were classified as to whether the individual fish was observed between the sled runners or whether they were seen ahead of the

sled. Real time play backs of video recordings in the upriver sites indicated that the sturgeon did not react to the approaching sled until the cross bar directly in front of the camera was nearly upon it. Thirty of the 61 upstream sturgeon images were captured when the individual fish was between the runners. Using this criterion, approximately 10 times more sturgeon were encountered in the upriver area relative to the project site near Marcus Hook where three sturgeons were observed. Using the number of sturgeon observed per 100 meters of bottom surveyed, the relative sturgeon density in the project area was several orders of magnitude less than those observed in the Trenton area. As calculated in the report, the relative density of unidentified sturgeon in the Marcus Hook area was 0.005 fish per 100 meters while the densities of shortnose sturgeon between the sled runners in the upriver area was 0.235 fish per 100 meters.

The results of the video sled survey in the Marcus Hook project area confirmed that sturgeons are using the area in the winter months. However, sturgeon relative densities in the project area were much lower than those observed near Trenton, New Jersey, even when the upriver counts were adjusted for the higher visibility (i.e., between runner sturgeon counts). The sturgeons seen near Trenton were very much concentrated in several large aggregations, which were surveyed in multiple passes on the two sampling dates devoted to this area. The lack of avoidance of the approaching sled seen in the upriver video recordings where water clarity was good suggests that little to no avoidance of the sled occurred in the low visibility downriver project area. Video surveys in the downriver project area did not encounter large aggregations of sturgeon as was observed in the upstream survey area despite having five times more sampling effort than the upstream area. This suggests that sturgeons that do occur in the Marcus Hook area during the winter are more dispersed and that the overall number of shortnose sturgeon occurring in this area in the winter months is low.

As described in the "Description of the Action" section above, dredging will occur in six river reaches: AA - RM 102-97.1; A - RM 97-85.1; B – RM 85-67.1; C – RM 67-55.1; D – RM 55-41.1; and, E – RM 41-5. The discussion below will summarize the likely seasonal distribution of shortnose sturgeon in these river reaches. Based on the best available information, eggs, larvae and young of the year are not likely to be in the action area. Due to the benthic, adhesive nature of the eggs, they only occur in the immediate vicinity of the spawning area, located at least 30 miles upstream of the action area. Larvae are also limited to an area close to the spawning grounds, and therefore, not likely to occur in the action area. While limited information is available on the distribution of young of the year, this life stage is relatively intolerant to salinity and is also expected to occur upstream of the action area where salinity levels are lower. Distribution of adult and juvenile shortnose sturgeon in the action area is influenced by seasonal water temperature, the distribution of forage items, and salinity.

Although they have been documented in waters with salinities as high as 31 parts per thousand (ppt), shortnose sturgeon are typically concentrated in areas with salinity levels of less than 3 ppt (Dadswell et al. 1984). Jenkins et al. (1993) demonstrated in lab studies that 76 day old shortnose sturgeon experienced 100% mortality in salinity greater than 14 ppt. One year old shortnose sturgeon were able to tolerate salinity levels as high as 20 ppt for up to 18 hours but experienced 100% mortality at salinity levels of 30 ppt. A salinity of 9 ppt appeared to be a threshold at which significant mortalities began to occur, especially among the youngest fish (Jenkins et al. 1993). The

distribution of salinity in the Delaware estuary exhibits significant variability on both spatial and temporal scales, and at any given time reflects the opposing influences of freshwater inflow from tributaries versus saltwater inflow from the Atlantic Ocean. The estuary can be divided into four longitudinal salinity zones. Starting at the downstream end, the mouth of the Bay to RM 34 is considered polyhaline (18-30ppt), RM 34-44 is mesohaline (5-18ppt), RM 44-79 is oligohaline (0.5-5ppt), and Marcus Hook (RM 79) to Trenton is considered Fresh (0.0-0.5ppt). Based on this information and the known tolerances and preferences of shortnose sturgeon to salinity, shortnose sturgeon are most likely to occur upstream of RM 44 where salinity is typically less than 5ppt. As tolerance to salinity increases with age and size, large juveniles and adults are likely to be present through the mesohaline area extending to RM 34. Due to the typical high salinities experienced in the polyhaline zone (below RM 34), shortnose sturgeon are likely to be rare in this reach of the river.

Both adult and juvenile shortnose sturgeon are likely to occur in reach AA (RM 102-97) any time water temperatures are greater than 10°C (the trigger for movement to overwintering areas) in mid-late November and return to above 10°C in early April[10]. Shortnose sturgeon in this reach are likely to be using it is a migration corridor and for opportunistic foraging. This reach of the river is not known to be a concentration area for any life stage of shortnose sturgeon. Similarly, reach A (RM 97-85) is also likely to be used by migrating shortnose sturgeon and for opportunistic foraging. This reach of the river includes the Torresdale Range (RM 93), an area which the 2003-2004 telemetry study noted above suggests may be a relatively high use area for shortnose sturgeon in the April – October time frame. The number of shortnose sturgeon utilizing the Torresdale area suggests that conditions in Torresdale may support a shortnose sturgeon foraging or resting area; however, the tracking data indicates that shortnose sturgeon in this reach are highly mobile. Reach B (RM 85-67) encompasses the Cherry Island Flats and Marcus Hook Bar areas. The capture of multiple shortnose sturgeon in this reach during the summer months (Shirey 1999 and 2006) indicates that shortnose sturgeon are likely to be foraging here in this summer and that it may serve as a summer concentration area. Evidence also suggests that at least some shortnose sturgeon may overwinter near Marcus Hook, or that at least that some shortnose sturgeon are present in this area during the winter (Versar 2006). As such, shortnose sturgeon could be present in Reach B year round, with the highest numbers present when water temperatures are above 10°C between April and November. Reach C encompasses the area from RM 67-55 and includes the New Castle range where the 2003-2004 telemetry studies indicated was an area frequented by shortnose sturgeon. This area also includes the outlet of the Chesapeake-Delaware canal which has been documented to be used by shortnose sturgeon moving between the upper Chesapeake Bay and the Delaware River. Based on the best available information, shortnose sturgeon are likely to be present in this reach of the river when water temperatures are greater than 10°C (mid April – mid November). Reach D includes RM 55-41 and includes the area near Artificial Island. Shortnose sturgeon have occasionally been recorded at the Salem Nuclear Generating Facility intakes with at least 10 live sturgeon observed at the trash racks between April and early November since 1979. One dead shortnose sturgeon was observed at the intake in January 1978 and one in late November 2007. However, due to the level of decomposition observed with these fish, it is unlikely that they died at the intakes or that they died during the winter months. Shortnose sturgeon are likely to at least occasionally occur in Reach

10 For example, in 2004 temperatures reached 10°C on April 2 and dropped to 10°C on November 13. In 2005 temperatures were above 10°C between April 11 and November 23.

D; however, the low number of documented occurrences in this reach combined with the higher salinity levels, make this reach less likely to be used than other upstream reaches. Reach E includes RM 41- 5. Based on the best available information, including the high salinity levels in this reach, shortnose sturgeon are expected to be rare in this reach; however, occasional shortnose sturgeon may occur in this reach between late April and mid-November.

ENVIRONMENTAL BASELINE

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

Federal Actions that have Undergone Formal or Early Section 7 Consultation

NMFS has undertaken several ESA section 7 consultations to address the effects of vessel operations and gear associated with federally-permitted fisheries on threatened and endangered species in the action area. Each of those consultations sought to develop ways of reducing the probability of adverse impacts of the action on listed species. Additionally, NMFS has consulted on dredging and construction projects authorized by the ACOE. Consultations are detailed below.

Delaware River – Philadelphia to Trenton Federal Navigation Project – Dredging

The Delaware River Philadelphia to Trenton Federal Navigation Channel is maintained by the ACOE. As explained in the Consultation History section above, a batched consultation was completed in 1996 between NMFS and the ACOE on the effects of the ACOE's authorization and completion of several Federal navigation projects, including the Philadelphia to Trenton project, as well as their regulatory dredging program. The Opinion was reinitiated in 1998 with an amendment issued in 1999. The amended Opinion included an Incidental Take Statement exempting the annual take (entrainment and mortality) of four shortnose sturgeon, 4 loggerhead, 1 Kemp's ridley, and 1 green sea turtle. This take applies to the Philadelphia to Trenton project, the existing Philadelphia to the Sea project, and the ACOE regulatory program where private dredging activities are authorized.

Dredging in the Philadelphia to Trenton project has caused shortnose sturgeon mortality and may have affected shortnose sturgeon distribution and foraging habitat. In mid-March 1996, three subadult shortnose sturgeon were found in a dredge discharge pool on Money Island, near Newbold Island. The dead sturgeon were found on the side of the spill area into which the hydraulic pipeline dredge was pumping, and the presence of large amounts of roe in two specimens and minimal decomposition indicates that the fish were alive and in good condition prior to entrainment. In January 1998, three shortnose sturgeon were discovered in the hydraulic maintenance dredge spoil in the Florence to Trenton section of the upper Delaware River. These fish also appeared to have been alive and in good condition prior to entrainment.

Dredging was being conducted in the Kinkora and Florence ranges when takes occurred; this area is overlaps with where shortnose sturgeon are known to overwinter in large aggregations. Since dredging involves removing the bottom material down to a specified depth, the benthic environment could be severely impacted by dredging operations. As shortnose sturgeon are benthic species, the alteration of the benthic habitat could have affected sturgeon prey distribution and/or foraging ability. Since 1998 the ACOE has been avoiding dredging in the overwintering area during the time of year when shortnose sturgeon are present. Habitats affected by the Philadelphia to Trenton project include foraging, overwintering and nursery habitats. It is important to note that outside of the use of inspectors at upland dredge disposal area, no observers have been used to detect interactions with listed species during this project.

Delaware River – Philadelphia to the Sea Federal Navigation Project
As noted in the Consultation History section, the existing 40 foot Philadelphia to the Sea navigation project is maintained with hopper and cutterhead dredges annually. As noted above, an Opinion was issued in 1996 and amended in 1999 that considered the effects of the maintenance of this project on shortnose sturgeon and sea turtles. The Philadelphia District Endangered Species Monitoring Program began in August 1992. Since that time, all hopper dredge operations conducted downstream of the Delaware Memorial Bridge between May and November have used endangered species observers to monitor for interactions with sea turtles. No shortnose sturgeon have been observed during any hopper dredging event. Several sea turtles have been entrained during hopper dredging operations including two loggerheads in August 1993 and 1 loggerhead on June 22, 1994. Relocation trawling was conducted in 1994, and eight loggerheads were captured and relocated away from the channel. On November 13, 1995 one loggerhead was entrained by a hopper dredge working in the channel. On July 27, 2005, fresh loggerhead parts were observed in the hopper basket during two different loads. Outside of the disposal site inspectors working at upland disposal areas, no endangered species observers have been used during any cutterhead dredging operations for this project or at any hopper dredge operation upstream of the Delaware Memorial Bridge.

Emergency Repairs of the Flood Protection Levy at Morrisville, Pennsylvania
During the winter of 2003, a storm sewer pipe that penetrated the flood protection levy located in Morrisville, Pennsylvania collapsed during a high river flow event. The pipe collapse caused the earth and stone riprap over the pipe to settle into two large riverside sinkholes exposing the underlying earthen levy to river erosion. The sinkholes and collapsed pipe created a safety issue for the residents of Morrisville due to the possibility of flooding caused by failure of the levy or the backing up of stormwater during heavy rains. The ACOE attempted to make all necessary repairs before the shortnose sturgeon spawning season. However, due to high river flows, the repair work was not accomplished before the water temperatures reached 8°C (which occurred on April 13, 2003). On May 1, 2003, the ACOE requested the initiation of an emergency consultation pursuant to Section 7 of the ESA and approval to suspend a previously negotiated time of year restriction and allow the emergency repairs to the storm sewer pipe to proceed. The emergency repairs began with the installation of a cofferdam on May 27, 2003 and the emergency repair work was completed on August 29, 2003. A pump was run continuously to dewater the cofferdam so work could proceed in the dry.

NMFS issued a Biological Opinion on April 19, 2004 assessing the impacts of the emergency work on shortnose sturgeon. The Opinion concluded that based on the timing of spawning, the likely dates that the majority of larvae had left the action area and the location of the project (i.e., on the river bank), the number of shortnose sturgeon larvae that were directly affected by the emergency action was likely a very small percentage of the total number of larvae spawned in 2003. Take consisted of shortnose sturgeon larvae and occurred in the form of harassment (successful passage through the pump) and mortality (resulting from entrainment in the pump). In the Opinion, NMFS determined that an unquantifiable but very small percentage of the total number of shortnose sturgeon larvae spawned in 2003 were taken by this action, and only 10% of the take incidental to this emergency action was lethal. The Opinion concluded that the action had adversely affected but was not likely to jeopardize the continued existence of shortnose sturgeon.

Crown Landing LNG Project

On May 23, 2006 NMFS issued an Opinion to the Federal Energy Regulatory Commission (FERC) and the ACOE regarding the on the effects of the issuance of an Order by FERC) to British Petroleum/Crown Landing LLC (Crown Landing) to site, construct and operate a Liquefied Natural Gas (LNG) import terminal on the banks of Delaware River and the effects of the US Army Corps of Engineers (ACOE) issuing two permits to Crown Landing for the construction of this facility. The Opinion included an ITS exempting the take (lethal entrainment in cutterhead dredge) of up to 3 shortnose sturgeon during the initial dredging needed to create the berthing area and the death of up to an additional 3 shortnose sturgeon over the first ten years of maintenance dredging permitted by the ACOE. As explained in the "Effects of the Action" section of this Opinion, only transient shortnose sturgeon are likely to occur in the project area and all other effects on shortnose sturgeon and their habitat are likely to be insignificant or discountable. The Opinion also concluded that the project is not likely to alter the Delaware River in a way that would make the action area unsuitable for use as a migratory pathway for any life stage of shortnose sturgeon. In the Opinion, NMFS concluded that the proposed action was not likely to adversely affect listed sea turtles. To date, the proposed project has not been constructed. Due to issues related to Coastal Zone Management Act consistency determinations, it is currently unknown whether the project will move forward as planned or whether it will be surrendered or modified.

Salem and Hope Creek Nuclear Generating Stations

PSEG Nuclear operates two nuclear power plants pursuant to licenses issued by the US Nuclear Regulatory Commission (NRC). These facilities are the Salem and Hope Creek Generating Stations (Salem and HCGS), which are located on adjacent sites within a 740-acre parcel of property at the southern end of Artificial Island in Lower Alloways Creek Township, Salem County, New Jersey. Consultation pursuant to Section 7 of the ESA between NRC and NMFS on the effects of the operation of these facilities has been ongoing since 1979. A Biological Opinions (Opinion) was issued by NMFS in April 1980 in which NMFS concluded that the ongoing operation of the facilities was not likely to jeopardize the continued existence of shortnose sturgeon. Consultation was reinitiated in 1988 due to the documentation of impingement of sea turtles at the Salem facility. An Opinion was issued on January 2, 1991 in which NMFS concluded that the ongoing operation was not likely to jeopardize shortnose sturgeon, Kemp's ridley, green or loggerhead sea turtles. Consultation was reinitiated in 1992 due to the number of sea turtle impingements at the Salem

intake exceeding the number exempted in the 1991 Incidental Take Statement. A new Opinion was issued on August 4, 1992. Consultation was again reinitiated in January 1993 when the number of sea turtle impingements exceeded the 1992 ITS with an Opinion issued on May 14, 1993. In 1998 the NRC requested that NMFS modify the Reasonable and Prudent Measures and Terms and Conditions of the ITS, and, specifically, remove a sea turtle study requirement. NMFS responded to this request in a letter dated January 21, 1999. Accompanying this letter was a revised ITS which served to amend the May 14, 1993 Opinion. The 1999 ITS exempts the annual take (capture at intake with injury or mortality) of 5 shortnose sturgeon, 30 loggerhead sea turtles, 5 green sea turtles, and 5 Kemp's ridleys. With the exception of 1991 and 1992, when 23 and 10 sea turtles were captured at the intakes, the actual level of take has been far lower than the exempted level. Inclusive of 1991 and 1992, for the period between 1979 and 1992, a total of 2 green, 23 Kemp's ridley and 60 loggerheads have been captured at the intakes. Since monitoring of the intakes was initiated in 1978, 18 shortnose sturgeon have been recovered from the Salem intakes. No shortnose sturgeon or sea turtles have been observed at the Hope Creek intakes. No sea turtles have been captured at Salem since 2001.

Emergency Clean-Up Actions associated with the M/V Athos I Spill
On November 26, 2004, during docking operations at the Citgo facility in Paulsboro, New Jersey (RM 90), the hull of the tank vessel M/V Athos I was punctured by a submerged object causing the discharge of approximately 473,000 gallons of crude oil (low aromatic, sweet, product code: 1267) into the Delaware River. The emergency cleanup action was initiated under US Coast Guard (USCG) oversight. Pursuant to the emergency consultation procedures outlined in Section 7 of the ESA, the USCG initiated emergency consultation on the effects of the cleanup action on shortnose sturgeon. In a letter dated January 20, 2006, NMFS concluded that "while it is likely that the spill itself negatively impacted shortnose sturgeon in the Delaware River, likely by introducing contaminants into the environment and by altering normal behaviors, there is no evidence that suggests that the cleanup and response activities had an adverse affect on shortnose sturgeon. The removal of oil by mechanical means and the removal of oiled wildlife likely beneficially affected shortnose sturgeon as it minimized, to the extent possible, the potential for shortnose sturgeon to come into contact with the oil or to be contaminated by toxins through the food chain." In this letter NMFS concurred with the determination made by the USCG that the response activities associated with the November 26, 2004 spill of the M/V Athos I did not adversely affect shortnose sturgeon.

Scientific Studies
Shortnose sturgeon in the Delaware River have been the focus of a long history of scientific research, beginning in approximately 1962. As a result of techniques associated with these sampling studies, shortnose sturgeon have been subjected to capturing, handling, and tagging. It is possible that research in the action area may have influenced and/or altered the migration patterns, reproductive success, foraging behavior, and survival of shortnose sturgeon. Through 2001, Environmental Research and Consulting Inc. (principal investigators John O'Herron and Hal Brundage) reported the captures, handling and tagging of over 3000 shortnose sturgeon. Eleven accidental shortnose sturgeon mortalities were reported during that time.

Currently, only one valid research permit for shortnose sturgeon in the Delaware River is in place (Permit No. 1486, issued December 22, 2004 to Mr. Hal Brundage). This permit authorizes the

capture, handling and tagging of 1,750 adult and juvenile shortnose sturgeon annually. Internal ultrasonic tagging, Floy T-bar tagging, PIT tagging and tissue and genetic sampling is authorized for a subset of the captured fish. The permit also authorizes the accidental mortality of up to 25 adult and 25 juvenile shortnose sturgeon over the five year life of the permit. A Biological Opinion was completed on December 21, 2004 which concluded that this action may adversely affect but is not likely to jeopardize the continued existence of shortnose sturgeon. This permit is valid for five years.

Vessel Operations
Potential adverse effects from federal vessel operations in the action area of this consultation include operations of the US Navy (USN) and the US Coast Guard (USCG), which maintain the largest federal vessel fleets, the EPA, the National Oceanic and Atmospheric Administration (NOAA), and the ACOE. NMFS has conducted formal consultations with the USCG, the USN, EPA and NOAA on their vessel operations. In addition to operation of ACOE vessels, NMFS has consulted with the ACOE to provide recommended permit restrictions for operations of contract or private vessels around whales. Through the section 7 process, where applicable, NMFS has and will continue to establish conservation measures for all these agency vessel operations to avoid adverse effects to listed species. Refer to the biological opinions for the USCG (September 15, 1995; July 22, 1996; and June 8, 1998) and the USN (May 15, 1997) for detail on the scope of vessel operations for these agencies and conservation measures being implemented as standard operating procedures.

Non-Federally Regulated Actions

Contaminants and Water Quality
Historically, shortnose sturgeon were rare in the area below Philadelphia, likely as a result of poor water quality precluding migration further downstream. However, in the past 20 to 30 years, the water quality has improved and sturgeon have been found farther downstream. It is likely that contaminants remain in the water and in the action area, albeit to reduced levels.

Point source discharges (i.e., municipal wastewater, industrial or power plant cooling water or waste water) and compounds associated with discharges (i.e., metals, dioxins, dissolved solids, phenols, and hydrocarbons) contribute to poor water quality and may also impact the health of sturgeon populations. The compounds associated with discharges can alter the pH or receiving waters, which may lead to mortality, changes in fish behavior, deformations, and reduced egg production and survival.

Sources of contamination in the action area include atmospheric loading of pollutants, stormwater runoff from coastal development, groundwater discharges, and industrial development. Chemical contaminants may also have an effect on sea turtle reproduction and survival. While the effects of contaminants on turtles is relatively unclear, pollution may be linked to the fibropapilloma virus that kills many turtles each year (NMFS 1997). If pollution is not the causal agent, it may make sea turtles more susceptible to disease by weakening their immune systems.

Contaminants have been detected in Delaware River fish. PCB's have been detected in elevated

levels in several species of fish. Large portions of the Delaware River is bordered by highly industrialized waterfront development. Sewage treatment facilities, refineries, manufacturing plants and power generating facilities all intake and discharge water directly from the Delaware River. This results in large temperature variations, heavy metals, dioxin, dissolved solids, phenols and hydrocarbons which may alter the pH of the water eventually leading to fish mortality. Industrialized development, especially the presence of refineries, has also resulted in storage and leakage of hazardous material into the Delaware River. Presently 13 Superfund sites have been identified in Marcus Hook and one dumpsite has yet to be labeled as a Superfund site, but does contain hazardous waste. It is possible that the presence of contaminants in the action area may have adversely affected shortnose sturgeon abundance, reproductive success and survival.

Several characteristics of shortnose sturgeon life history including long life span, extended residence in estuarine habitats, and being a benthic omnivore, predispose this species to long term, repeated exposure to environmental contaminants and bioaccumulation of toxicants (Dadswell 1979). Toxins introduced to the water column become associated with the benthos and can be particularly harmful to benthic organisms (Varanasi 1992) like sturgeon. Heavy metals and organochlorine compounds are known to accumulate in fat tissues of sturgeon, but their long term effects are not yet known (Ruelle and Henry 1992; Ruelle and Keenlyne 1993). Available data suggest that early life stages of fish are more susceptible to environmental and pollutant stress than older life stages (Rosenthal and Alderdice 1976). Although there have not been any studies to assess the impact of contaminants on shortnose sturgeon, elevated levels of environmental contaminants, including chlorinated hydrocarbons, in several other fish species are associated with reproductive impairment (Cameron et al. 1992; Longwell et al. 1992), reduced egg viability (Von Westernhagen et al. 1981; Hansen 1985; Mac and Edsall 1991), and reduced survival of larval fish (Berlin et al. 1981; Giesy et al. 1986). Some researchers have speculated that PCBs may reduce the shortnose sturgeon's resistance to fin rot (Dovel et al. 1992).

Although there is scant information available on levels of contaminants in shortnose sturgeon tissues, some research on other, related species indicates that concern about effects of contaminants on the health of sturgeon populations is warranted. Detectable levels of chlordane, DDE, DDT, and dieldrin, and elevated levels of PCBs, cadmium, mercury, and selenium were found in pallid sturgeon tissue from the Missouri River (US Fish and Wildlife Service 1993). These compounds may affect physiological processes and impede a fish's ability to withstand stress. PCBs are believed to adversely affect reproduction in pallid sturgeon (Ruelle and Keenlyne 1993). Ruelle and Henry (1992) found a strong correlation between fish weight $r = 0.91$, $p < 0.01$), fish fork length $r = 0.91$, $p < 0.01$), and DDE concentration in pallid sturgeon livers, indicating that DDE concentration increases proportionally with fish size.

Contaminant analysis was conducted on two shortnose sturgeon from the Delaware River in the fall of 2002. Muscle, liver, and gonad tissue were analyzed for contaminants (ERC 2002). Sixteen metals, two semivolatile compounds, three organochlorine pesticides, one PCB Aroclor, as well as polychlorinated dibenzo-p-dioxins (PCDDs), and polychlorinated dibenzofurans (PCDFs) were detected in one or more of the tissue samples. Levels of aluminum, cadmium, PCDDs, PCDFs, PCBs and DDE (an organochlorine pesticide) were detected in the "adverse affect" range. It is of particular concern that of the above chemicals, PCDDs, DDE, PCBs and cadmium, were detected as

these have been identified as endocrine disrupting chemicals. While no directed studies of chemical contamination in shortnose sturgeon in the Delaware River have been undertaken, it is evident that the heavy industrialization of the Delaware River is likely adversely affecting this population.

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

Marine debris (*e.g.*, discarded fishing line or lines from boats) can entangle turtles in the water and drown them. Turtles commonly ingest plastic or mistake debris for food. Chemical contaminants may also have an effect on sea turtle reproduction and survival. Excessive turbidity due to coastal development and/or construction sites could influence sea turtle foraging ability. As mentioned previously, turtles are not very easily affected by changes in water quality or increased suspended sediments, but if these alterations make habitat less suitable for turtles and hinder their capability to forage, eventually they would tend to leave or avoid these less desirable areas (Ruben and Morreale 1999). Noise pollution has been raised, primarily, as a concern for marine mammals but may be a concern for other marine organisms, including sea turtles.

The Delaware Department of Natural Resources issues National Pollutant Discharge Elimination System permits for discharges in the State of Delaware. NMFS receives copies of draft permits during the Public Notice period and provides comments to the State with the goal of assuring that any permits issued do not have more than a minor detrimental effect on listed species in the receiving waters.

Global Climate Change

There is a large and growing body of literature on past, present, and future impacts of global climate change induced by human activities - frequently referred to in layman's terms as "global warming." Some of the likely effects commonly mentioned are sea level rise, increased frequency of severe weather events, and change in air and water temperatures. The Environmental Protection Agency's climate change webpage provides basic background information on these and other measured or anticipated effects (see www. epa.gov/climatechange/index.html). Activities in the action area that may have affected or continue to affect the environmental baseline by contributing to global warming include the combustion of fossil fuels by vessels.

The effects of global climate change on sea turtles is typically viewed as being detrimental to the species (NMFS and USFWS 2007a; 2007b; 2007c; 2007d). Changes in water temperature would be expected to affect prey distribution and/or abundance, salinity, and water circulation patterns perhaps even to the extent that the Gulf Stream is disrupted (Gagosian 2003; NMFS and USFWS 2007a; 2007b; 2007c; 2007d). The effects of these on the action area and on sea turtles present in the action area cannot, for the most part, be accurately predicted at this time. Several studies have, however, investigated the effects of changes in sea surface temperature and air temperatures on turtle reproductive behavior. For loggerhead sea turtles, warmer sea surface temperatures in the spring have been correlated to an earlier onset of nesting (Weishampel *et al.* 2004; Hawkes *et al.*

2007), shorter internesting intervals (Hays *et al.* 2002), and a decrease in the length of the nesting season (Pike *et al.* 2006). Green sea turtles also exhibited shorter internesting intervals in response to warming water temperatures (2002).

Air temperatures also play a role in sea turtle reproduction. In marine turtles, sex is determined by temperature in the middle third of incubation with female offspring produced at higher temperatures and males at lower temperatures within a thermal tolerance range of 25-35° C (Ackerman 1997). Based on modeling, a 2° C increase in air temperature is expected to result in a sex ratio of over 80% female offspring for loggerhead nesting beaches in the vicinity of Southport, NC. Farther to the south at Cape Canaveral, Florida, a 2°C increase in air temperature would likely result in production of 100% females while a 3°C increase in air temperature would likely exceed the thermal threshold of turtle clutches resulting in death (Hawkes *et al.* 2007). Thus changes in air temperature as a result of global climate change may alter sex ratios and may reduce hatchling production in the most southern nesting areas of the U.S. Given that the south Florida nesting group is the largest loggerhead nesting group in the Atlantic (in terms of nests laid), a decline in the success of nesting as a result of global climate change could have profound effects on the abundance and distribution of the loggerhead species in the Atlantic.

For green sea turtles, incubation temperatures also appeared to affect hatchling size with smaller turtles produced at higher incubation temperatures (Glen *et al.* 2003). It is unknown whether this effect is species specific and what impact it has on the survival of the offspring.

While the type and extent of effects to sea turtles as a result of global climate change are still speculative, a disruption of the Gulf Stream such as might occur as a result of global climate change (Gagosian 2003), would be expected to have profound effects on every aspect of sea turtle life history from hatching success, oceanic migrations at all life stages, foraging, and nesting.

The impact of climate change on shortnose sturgeon in the action area is likely to be related to changes in water temperatures, potential changes to salinity in rivers, and the potential decline of forage. These changes may effect the distribution of species and the fitness of individuals and populations due to the potential loss of foraging opportunities, displacement from ideal habitats and potential increase in susceptibility to disease (Elliot and Simmonds 2007). Similarly to sea turtles, a decline in reproductive fitness as a result of global climate change could have profound effects on the abundance and distribution of shortnose sturgeon in the action area, and throughout their range. As described above, global climate change is likely to negatively affect sea turtles – affecting when females lay their eggs, the survival of the eggs, sex ratios of offspring, and the stability of the Gulf Stream – and shortnose sturgeon. To the extent that air pollution, for example from the combustion of fossil fuels by vessels operating in the action area, contributes to global climate change, then it is also expected to negatively affect sea turtles and shortnose sturgeon in the action area.

Private and Commercial Vessel Operations

Private and commercial vessels, including fishing vessels, operating in the action area of this consultation also have the potential to interact with sea turtles. The effects of fishing vessels, recreational vessels, or other types of commercial vessels on listed species may involve disturbance or injury/mortality due to collisions or entanglement in anchor lines. It is important to note that

minor vessel collisions may not kill an animal directly, but may weaken or otherwise affect it so it is more likely to become vulnerable to effects such as entanglements. Listed species may also be affected by fuel oil spills resulting from vessel accidents. Fuel oil spills could affect animals directly or indirectly through the food chain. Fuel spills involving fishing vessels are common events. However, these spills typically involve small amounts of material that are unlikely to adversely affect listed species. Larger oil spills may result from accidents, although these events would be rare and involve small areas. No direct adverse effects on listed sea turtles resulting from fishing vessel fuel spills have been documented.

Non-Federally Regulated Fishery Operations
Directed fishing for shortnose sturgeon, as well as incidental capture in the operation of other fisheries is prohibited by the ESA. However, shortnose sturgeon are taken incidentally to the operation of fisheries targeting other anadromous species along the East Coast and are probably targeted by poachers (NMFS 1998). The incidental take of shortnose sturgeon in the river has not been well documented due to confusion over distinguishing between Atlantic sturgeon and shortnose sturgeon. The incidental take of shortnose sturgeon on the Hudson River has been documented in both commercial shad fisheries as well as recreational hook and line fisheries. Although, commercial fisheries are prohibited in Pennsylvania state waters, New Jersey and Delaware do permit commercial fisheries to operate in designated portions of the Delaware River (Miller 2000, pers. Comm.; Boriek 2000, pers. comm.). American shad, eel, and blue crab are the species targeted by commercial fisherman, however, in the action area the level of commercial fishing is very minimal (Miller 2000, pers. Comm.; Boriek 2000, pers. comm.). Recreational hook and line fisheries, that target largemouth bass, striped bass, white catfish and channel catfish, are permitted throughout the River (Coughman 2000, pers. comm.; Boriek 2000, pers. comm.). There are no reported mortalities of shortnose sturgeon from the gillnet fishery for American shad (R. Allen, 2008, NJ Bureau of Marine Fisheries, pers. comm.). While there have been few documented incidental takes of shortnose sturgeon in fisheries in the Delaware River, it is possible that unreported incidental takes have occurred in recreational hook and line fisheries and commercial fisheries operating in the action area (Coughman 2000, pers. comm.). Almost every year between late March and early April during the American shad fishing season, the NJ Division of Fish and Wildlife receives reports from hook and line anglers of foul hooked and released shortnose sturgeon in the vicinity of Scudder's Falls (M. Boriek, 2008, NJ Bureau of Freshwater Fisheries, pers. comm.).

In Spring 2006, a NJ Division of Fish and Wildlife Conservation Officer discovered a shortnose sturgeon in an angler's car trunk. The angler had caught the sturgeon while bottom fishing in Trenton City. A Conservation Officer observed the angler (who was urged by his friend to keep the fish) as he carried the fish in a plastic bag, then placed the bag in the trunk of his car. The officer apprehended the bag, took pictures of the fish, then released it live (B. Herrighty, 2007, NJ Division of Fish and Wildlife Conservation Officer, pers. comm.). Images of the fish were distributed to staff of the Division's Bureau's of Freshwater and Marine Fisheries, and the Endangered and Nongame Species Program, who confirmed it to be a shortnose sturgeon. It is likely that other incidents similar to this have occurred and gone undetected.

Very little is known about the level of listed species take in fisheries that operate strictly in state

waters. However, depending on the fishery in question, many state permit holders also hold federal licenses; therefore, section 7 consultations on federal actions in those fisheries address some state-water activity. Impacts on sea turtles and shortnose sturgeon from state fisheries may be greater than those from federal activities in certain areas due to the distribution of these species. Nearshore entanglements of turtles have been documented; however, information is not currently available on whether the vessels involved were permitted by the state or by NMFS.

Summary and synthesis of the Status of Species, Environmental Baseline, and Cumulative Effects sections

The Status of the Species, Environmental Baseline, and Cumulative Effects Sections, taken together, establish a "baseline" against which the effects of the proposed action are analyzed to determine whether the action—the ACOE's proposed deepening of the Philadelphia to the Sea Federal Navigation project and 10 years of proposed maintenance dredging - is likely to jeopardize the continued existence of the species. To the extent available information allows, this "baseline" (which does not include the future effects of the proposed action) would be compared to the backdrop plus the effects of the proposed action. The difference in the two trajectories would be reviewed to determine whether the proposed action is likely to jeopardize the continued existence of the species. This section synthesizes the Status of the Species, the Environmental Baseline, and Cumulative Effects sections as best as possible given that some information on sea turtles and shortnose sturgeon is quantified, yet much remains qualitative or unknown.

Summary of status of sea turtle species

Leatherback and *Kemp's ridley sea turtles* are endangered species, meaning that they are in danger of extinction throughout all or a significant portion of their ranges. The loggerhead sea turtle is a threatened species, meaning that it is likely to become an endangered species in the foreseeable future throughout all or a significant portion of its range. Green sea turtles in U.S. waters are listed as threatened except for the Florida breeding population which is listed as endangered. For purposes of this Opinion, NMFS considers the trend of the sea turtle species considered in this Opinion to be declining for loggerhead, leatherback, and green sea turtles, and stable for Kemp's ridley sea turtles. These trends are the result of past, present, and likely future human activities and natural events, some effects of which are positive, some negative, and some unknown, as discussed previously in the Status of the Species, Environmental Baseline, and Cumulative Effects Sections taken together. Additional information is provided below.

Loggerhead Sea Turtles. Loggerhead sea turtles are listed as a single species classified as "threatened" under the ESA. Loggerhead nesting occurs on beaches of the Pacific, Indian, and Atlantic oceans, and Mediterranean Sea. Genetic analyses of maternally inherited mitochondrial DNA demonstrate the existence of separate, genetically distinct nesting groups between as well as within the ocean basins (TEWG 2000; Bowen and Karl 2007).

It takes decades for loggerhead sea turtles to reach maturity. Once they have reached maturity, females typically lay multiple clutches of eggs within a season, but do not typically lay eggs every season (NMFS and USFWS 1991a). There are many natural and anthropogenic factors affecting survival of turtles prior to their reaching maturity as well as for those adults who have reached

maturity. As described above, negative impacts causing death of various age classes occur both on land and in the water. In addition, given the distances traveled by loggerheads in the course of their development, actions to address the negative impacts require the work of multiple countries at both the national and international level (NMFS and USFWS 2007a). Many actions have been taken to address known negative impacts to loggerhead sea turtles. However, many remain unaddressed, have not been sufficiently addressed, or have been addressed in some manner but whose success cannot be quantified.

There are no population estimates for loggerhead sea turtles. Sea turtle nesting data, in terms of the number of nests laid each year, is collected for loggerhead sea turtles for at least some nesting beaches within each of the ocean basins and the Mediterranean Sea. From this, the number of reproductively mature females utilizing those nesting beaches can be estimated based on the presumed remigration interval and the average number of nests laid by a female loggerhead sea turtle per season. These estimates provide a minimum count of the number of loggerhead sea turtles in any particular nesting group. The estimates do not account for adult females who nest on beaches with no or little survey coverage, and do not account for adult males or juveniles of either sex. The proportion of adult males to females from each nesting group, and the age structure of each loggerhead nesting group is currently unknown. For these reasons, nest counts cannot be used to estimate the total population size of a nesting group and, similarly, trends in the number of nests laid cannot be used as an indicator of the population trend (whether decreasing, increasing or stable) (Meylan 1982; Ross 1996; Zurita *et al.* 2003; Hawkes *et al.* 2005; Loggerhead TEWG 2007).

Nevertheless, nest count data are a valuable source of information for each loggerhead nesting group and for loggerheads as a species since the number of nests laid reflect the reproductive output of the nesting group each year, and also provide insight on the contribution of each nesting group to the species. Based on a comparison of the available nesting data, the world's largest known loggerhead nesting group (in terms of estimated number of nesting females) occurs in Oman in the northern Indian Ocean where an estimated 20,000-40,000 females nest each year (Baldwin *et al.* 2003). The world's second largest known loggerhead nesting group occurs along the east coast of the United States where approximately 15,966 females nest per year on south Florida beaches (based on a mean of 65,460 nests laid per year from 1989-2006; NMFS and USFWS 2007a). The world's third largest loggerhead nesting group also occurs in the United States, from approximately northern Florida through North Carolina. However, the mean nest count for this nesting group, the third largest loggerhead nesting group in the world, is 5,151 nests laid per year (NMFS and USFWS 2007a) – less than 1/10th the mean number of nests laid by the south Florida nesting group. Thus, while loggerhead nesting occurs at multiple sites within multiple ocean basins and the Mediterranean Sea, the extent of nesting is disproportionate amongst the various sites and only two geographic areas, Oman and south Florida, U.S., account for the majority of nesting for the species, worldwide.

Declines in loggerhead nesting have been noted at nesting beaches throughout the range of the species. These include nesting for the south Florida nesting group – the second largest loggerhead nesting group in the world and the largest of all of the loggerhead nesting groups in the Atlantic (Dodd 2003; Meylan *et al.* 2006; Letter to NMFS from the Director, Fish and Wildlife Research Institute, Florida Fish and Wildlife Conservation Commission, October 25, 2006; Fish and Wildlife

Research Institute, Florida Fish and Wildlife Conservation Commission web posting November 2007; NMFS and USFWS 2007a).

In light of the above, for purposes of this Opinion, NMFS considers the trend for loggerheads as a species to be declining. NMFS recognizes that the available nest count data only provides information on the number of females currently nesting, and is not necessarily a reflection of the number of mature females available to nest or the number of immature females that will reach maturity and nest in the future. Also, the trend in the number of nests laid is not a reflection of the overall trend in any nesting group given that the proportion of adult males to females, and the age structure of each loggerhead nesting group is currently unknown. This determination that the trend for loggerheads as a species is declining provides benefit of the doubt to the species given its threatened classification under the ESA, the many on-going negative impacts to the species across all areas of its range and to all age classes, and information to suggest that fewer nests are being laid (potentially reducing the number of offspring that will mature and contribute to the species' continued existence).

Leatherback turtles. Leatherback sea turtles are listed as a single species classified as "endangered" under the ESA. Leatherbacks are widely distributed throughout the oceans of the world, and are found in waters of the Atlantic, Pacific, and Indian Oceans, the Caribbean Sea, Mediterranean Sea, and the Gulf of Mexico (Ernst and Barbour 1972). Leatherback nesting occurs on beaches of the Atlantic, Pacific and Indian Oceans as well as in the Caribbean (NMFS and USFWS 2007b).

Like loggerheads, sexually mature female leatherbacks typically nest in non-successive years and lay multiple clutches in each of the years that nesting occurs. Leatherbacks face a multitude of threats that can cause death prior to and after reaching maturity. Some activities resulting in leatherback mortality have been addressed. However, many others remain to be addressed. Given their range and distribution, international efforts are needed to address all known threats to leatherback sea turtle survival (NMFS and USFWS 2007b).

There are some population estimates for leatherback sea turtles although there appears to be considerable uncertainty in the numbers. In 1980, the global population of adult leatherback females was estimated to be approximately 115,000 (Pritchard 1982). By 1995, this global population of adult females was estimated to be 34,500 (Spotila *et al.* 1996). However, the most recent population size estimate for the North Atlantic alone is 34,000-94,000 adult leatherbacks (Leatherback TEWG 2007; NMFS and USFWS 2007b).

Leatherback nesting in the eastern Atlantic (*i.e.*, off Africa) and in the Caribbean appears to be stable, but there is conflicting information for some sites and it is certain that some nesting groups (*e.g.*, St. John and St. Thomas, U.S. Virgin Islands) have been extirpated (NMFS and USFWS 1995). Data collected for some nesting beaches in the western Atlantic, including leatherback nesting beaches in the U.S. clearly indicate increasing numbers of nests (NMFS SEFSC 2001; NMFS and USFWS 2007b). However, declines in nesting have been noted for beaches in the western Caribbean (NMFS and USFWS 2007b). The largest leatherback rookery in the western Atlantic remains along the northern coast of South America in French Guiana and Suriname. More than half the present world leatherback population is estimated to be nesting on the beaches in and

close to the Marowijne River Estuary in Suriname and French Guiana (Hilterman and Goverse 2004). The long-term trend for the Suriname and French Guiana nesting group seems to show an increase (Hilterman and Goverse 2004). In 2001, the number of nests for Suriname and French Guiana combined was 60,000, one of the highest numbers observed for this region in 35 years (Hilterman and Goverse 2004). Studies by Girondot *et al.* (2007) also suggest that the trend for the Suriname - French Guiana nesting population over the last 36 years is stable or slightly increasing.

Increased nesting by leatherbacks in the Atlantic is not expected to affect leatherback abundance in the Pacific where the abundance of leatherback turtles on nesting beaches has declined dramatically over the past 10 to 20 years (NMFS and USFWS 2007b). Although genetic analyses suggest little difference between Atlantic and Pacific leatherbacks (Bowen and Karl 2007), it is generally recognized that there is little to no genetic exchange between these turtles.

In addition, Atlantic and Pacific leatherbacks are impacted by different activities (NMFS and USFWS 1992; 1998a). However, the ESA-listing of leatherbacks as a species means that the effects of a proposed action must, ultimately, be considered at the species level for section 7 consultations. In light of the above, for purposes of this Opinion, NMFS considers the trend for leatherbacks, as a species, to be declining. NMFS recognizes that the nest count data available for leatherbacks in the Atlantic clearly indicates increased nesting at many sites, and that the activities affecting declines in nesting by leatherbacks in the Pacific are not the same as those activities affecting leatherbacks in the Atlantic. However, NMFS also recognizes that the nest count data, including data for leatherbacks in the Atlantic, only provides information on the number of females currently nesting, and is not necessarily a reflection of the number of mature females in the Atlantic that are available to nest or the number of immature females that will reach maturity and nest in the future. Also, the trend in the number of nests laid is not a reflection of the overall trend in any leatherback population given that the proportion of adult males to females, and the age structure of the population(s) is unknown. This determination that the trend for leatherbacks as a species is declining provides benefit of the doubt to the species given its endangered classification under the ESA, the many on-going negative impacts to the species across all areas of its range and to all age classes, the uncertainty in the population estimates, the dramatic decline in leatherback nesting in the Pacific, and the disproportionate nesting of leatherbacks with more than half of the species nesting occurring in one area of the world (thus negative impacts to this area could have very large impacts on reproductive success of the species).

Kemp's Ridley Sea Turtles. Kemp's ridley sea turtles are listed as a single species classified as "endangered" under the ESA. Kemp's ridleys occur in the Atlantic Ocean and Gulf of Mexico. The only major nesting site for ridleys is a single stretch of beach near Rancho Nuevo, Tamaulipas, Mexico (Carr 1963; USFWS and NMFS 1992; NMFS and USFWS 2007c). Approximately 60% of its nesting occurs here with a limited amount of scattered nesting to the north and south of the primary nesting beach (NMFS and USFWS 2007c).

Age to maturity for Kemp's ridley sea turtles occurs earlier than for either loggerhead or leatherback sea turtles. However, maturation may still take 10-17 years (NMFS and USFWS 2007c). As is the case with the other turtle species, adult, female Kemp's ridleys typically lay multiple nests in a nesting season but do not typically nest every nesting season (TEWG 2000;

NMFS and USFWS 2007c). Although actions have been taken to protect the nesting beach habitat, and to address activities known to be negatively impacting Kemp's ridley sea turtles, Kemp's ridleys continue to be impacted by anthropogenic activities (see sections 3.1.3 and 4.1).

Nest count data provides the best available information on the number of adult females nesting each year. As is the case with the other sea turtles species discussed above, nest count data must be interpreted with caution given that these estimates provide a minimum count of the number of nesting Kemp's ridley sea turtles. In addition, the estimates do not account for adult males or juveniles of either sex. Without information on the proportion of adult males to females, and the age structure of the Kemp's ridley population, nest counts cannot be used to estimate the total population size and, similarly, trends in the number of nests laid cannot be used as an indicator of the population trend (whether decreasing, increasing or stable) (Meylan 1982; Ross 1996; Zurita *et al.* 2003; Hawkes *et al.* 2005; Loggerhead TEWG 2007). Nevertheless, the nesting data does provide valuable information on the extent of Kemp's ridley nesting and the trend in the number of nests laid. Estimates of the adult female nesting population reached a low of approximately 250-300 in 1985 (USFWS and NMFS 1992; TEWG 2000). From 1985 to 1999, the number of nests observed at Rancho Nuevo, and nearby beaches increased at a mean rate of 11.3% per year (TEWG 2000). Current estimates suggest an adult female population of 7,000-8,000 Kemp's ridleys (NMFS and USFWS 2007c).

The most recent review of the Kemp's ridley as a species suggests that it is in the early stages of recovery (NMFS and USFWS 2007c). The nest count data indicates increased nesting and an increased number of nesting females in the population. In light of this information, for purposes of this Opinion, NMFS considers the trend for Kemp's ridley sea turtles to be stable. This determination that the trend for Kemp's ridleys as a species is stable provides benefit of the doubt to the species given the species classification of "endangered" under the ESA, the caveats associated with using nesting data as indicators of population size and population trends, that the estimated number of nesting females in the current population is still far below historical numbers (Stephens and Alvarado-Bremer 2003; NMFS and USFWS 2007c), the many on-going negative impacts to the species, and given that the majority of nesting for the species occurs in one area.

Green Sea Turtles. Green sea turtles are listed as both threatened and endangered under the ESA. Breeding colony populations in Florida and on the Pacific cost of Mexico are considered endangered while all others are considered threatened. Due to the inability to distinguish between these populations away from the nesting beach, for this Opinion, green turtles are considered endangered wherever they occur in U.S. waters. Green turtles are distributed circumglobally, and can be found in the Pacific, Indian and Atlantic Oceans as well as the Mediterranean Sea (NMFS and USFWS 1991; Seminoff 2004; NMFS and USFWS 2007d).

Green sea turtles appear to have the latest age to maturity of all of the sea turtles with age at maturity occurring after 2-5 decades (NMFS and USFWS 2007d). As is the case with all of the other turtle species mentioned here, mature green sea turtles typically nest more than once in a nesting season but do not nest every nesting season. As is also the case with the other turtle species, green sea turtles face numerous threats on land and in the water that affect the survival of all age classes.

A review of 32 Index Sites distributed globally revealed a 48% to 67% decline in the number of mature females nesting annually over the last 3-generations (Seminoff 2004). For example, in the eastern Pacific, the main nesting sites for the green sea turtle are located in Michoacan, Mexico, and in the Galapagos Islands, Ecuador where the number of nesting females exceed 1,000 females per year at each site (NMFS and USFWS 2007d). Historically, however, greater than 20,000 females per year are believed to have nested in Michoacan, alone (Cliffton *et al.* 1982; NMFS and USFWS 2007d). However, the decline is not consistent across all green sea turtle nesting areas. Increases in the number of nests counted and, presumably, the number of mature females laying nests, were recorded for several areas (Seminoff 2004; NMFS and USFWS 2007d). Of the 32 index sites reviewed by Seminoff (2004), the trend in nesting was described as: increasing for 10 sites, decreasing for 19 sites, and stable (no change) for 3 sites. Of the 46 green sea turtle nesting sites reviewed for the 5-year status review, the trend in nesting was described as increasing for 12 sites, decreasing for 4 sites, stable for 10 sites, and unknown for 20 sites (NMFS and USFWS 2007d). The greatest abundance of green sea turtle nesting in the western Atlantic occurs on beaches in Tortuguero, Costa Rica (NMFS and USFWS 2007d). Nesting in the area has increased considerably since the 1970's and nest count data from 1999-2003 suggest nesting by 17,402-37,290 females per year (NMFS and USFWS 2007d). One of the largest nesting sites for green sea turtles worldwide is still believed to be on the beaches of Oman in the Indian Ocean (Hirth 1997; Ferreira *et al.* 2003; NMFS and USFWS 2007d). However, nesting data for this area has not been published since the 1980's and updated nest numbers are needed (NMFS and USFWS 2007d).

The results of genetic analyses show that green sea turtles in the Atlantic do not contribute to green sea turtle nesting elsewhere in the species range (Bowen and Karl 2007). Therefore, increased nesting by green sea turtles in the Atlantic is not expected to affect green sea turtle abundance in other ocean basins in which the species occurs. However, the ESA-listing of green sea turtles as a species across ocean basins means that the effects of a proposed action must, ultimately, be considered at the species level for section 7 consultations. In light of the above, for purposes of this Opinion, NMFS considers the trend for green sea turtles, as a species, to be declining. NMFS recognizes that the nest count data available for green sea turtles in the Atlantic clearly indicates increased nesting at many sites. However, NMFS also recognizes that the nest count data, including data for green sea turtles in the Atlantic, only provides information on the number of females currently nesting, and is not necessarily a reflection of the number of mature females available to nest or the number of immature females that will reach maturity and nest in the future. Also, the trend in the number of green sea turtle nests laid is not an indication of the overall population trend given that the proportion of adult males to females, and the age structure of the population(s) is unknown. Finally, given the late age to maturity for green sea turtles (20 to 50 years; Balazs 1982, Frazer and Ehrhart 1985; Seminoff 2004), caution is urged regarding the trend for any of the nesting groups since no area has a dataset spanning a full green sea turtle generation (NMFS and USFWS 2007d). This determination that the trend for green sea turtles as a species is declining provides benefit of the doubt to the species given its endangered and threatened classification under the ESA, the many on-going negative impacts to the species across all areas of its range and to all age classes, the declining or uncertain trend in nesting for the majority of the world's nesting sites for green sea turtles, and the lack of up-to-date nesting information for the largest green sea turtle nesting site in the Indian Ocean and possibly the world.

Summary of status of shortnose sturgeon
Historically, shortnose sturgeon are believed to have inhabited nearly all major rivers and estuaries along nearly the entire east coast of North America. Today, only 19 populations remain. The present range of shortnose sturgeon is disjunct, with northern populations separated from southern populations by a distance of about 400 km. Population sizes range from under 100 adults in the Cape Fear and Merrimack Rivers to tens of thousands in the St. John and Hudson Rivers. As indicated in Kynard 1996, adult abundance is less than the minimum estimated viable population abundance of 1000 adults for 5 of 11 surveyed northern populations and all natural southern populations. The only river systems likely supporting populations close to expected abundance are the St John, Hudson and possibly the Delaware and the Kennebec (Kynard 1996), making the continued success of shortnose sturgeon in these rivers critical to the species as a whole.

Population sizes of the Delaware River population by three estimation procedures ranged from 6,408 to 14,080 adult sturgeon. This is the best available information on population size, but because the recruitment and migration rates between the population segment studied and the total population in the river are unknown, model assumptions may have been violated. Based on comparison to older population estimates, NMFS assumes that this population is increasing or at worst is stable.

While no reliable estimate of the size of either the shortnose sturgeon population in the Northeastern US or of the species throughout its range exists, it is clearly below the size that could be supported if the threats to shortnose sturgeon were removed. Based on the number of adults in population for which estimates are available, there are at least 104,662 adult shortnose sturgeon, including 18,000 in the Saint John River in Canada. The lack of information on the status of populations such as that in the Chesapeake Bay add uncertainty to determination on the status of this species as a whole. Based on the best available information, NMFS believes that the status of shortnose sturgeon throughout their range is at best stable, with gains in populations such as the Hudson, Delaware and Kennebec, offsetting the continued decline of southern river populations, and at worst declining.

EFFECTS OF THE ACTION
This section of an Opinion assesses the direct and indirect effects of the proposed action on threatened and endangered species or critical habitat, together with the effects of other activities that are interrelated or interdependent (50 CFR 402.02). Indirect effects are those that are caused later in time, but are still reasonably certain to occur. Interrelated actions are those that are part of a larger action and depend upon the larger action for their justification. Interdependent actions are those that have no independent utility apart from the action under consideration (50 CFR 402.02). This Opinion examines the likely effects (direct and indirect) of the proposed action on shortnose and sea turtles in the action area and their habitat within the context of the species current status, the environmental baseline and cumulative effects. As explained in the Description of the Action, the proposed action under consideration in this Opinion is the initial dredging cycle needed to deepen the channel which will be conducted over 5 years (2009-2014), the disposal of dredged material resulting from this dredging, including beneficial use of material at Broadkill Beach and Kelly Island, blasting of rock material at Marcus Hook and subsequent removal with a mechanical dredge, as well as 10 years of maintenance dredging.

Initial Dredging Cycle
As explained in the Description of the Action section above, both hydraulic cutterhead and hopper dredges will be used for the initial deepening. Refer to Table 1 and Figure 2 in the "Description of the Action" section for a summary of the proposed dredging by reach. The effects of dredging on listed species will be different depending on the type of dredge used and the geographical area where dredging will occur. As such, the following discussion of effects of dredging will be organized by dredge type. Below, the discussion will consider the effects of cutterhead and hopper dredging, including the risk of entrainment of shortnose sturgeon and sea turtles as well as the effects of suspended sediment associated with these dredges. Following, there is a discussion of blasting and associated debris removal with a mechanical dredge. Last, there is a discussion of other effects of the project which are not specific to the type of equipment used. This includes effects on prey and foraging and changes in the characteristics of the river (i.e., sediment type, location of the salt wedge).

Hopper Dredge
A large self propelled hopper dredge will be used for dredging near Camden (Reach A) and in the Bay at Reach D and Reach E. At Reach A, dredging is scheduled over approximately 180 days from August 2010-March 2011 (1,666,600cy). Shortnose sturgeon are likely to be present in this reach from mid-April through mid-November and therefore could be exposed to effects of dredging during August – November (approximately 1mcy during this time of year). Dredging at Reach E, with disposal at Broadkill Beach (1,598,700 cy) is scheduled for April – June 2011. Shortnose sturgeon and sea turtles are likely to be present in May and June (approximately 1mcy during this time of year). At Reach E Kelly Island, dredging is scheduled for mid-April 2012-August 2012 (2.483mcy total). Shortnose sturgeon could be present during this time period and as sea turtles are only likely to occur in this reach from May – November, they would only be exposed to effects of dredging conducted between May and August (approximately 2.2mcy removed during this time). Dredging at Reach D near RM 55.8 is scheduled for December 2012 – January 2013. No listed species are likely to be present during this dredging operation. Dredging at Reach D near RM 51.8 is scheduled for February 2013 – May 2013. Sea turtles are likely to be present in May and shortnose sturgeon are likely to be present from mid-April through May (approximately 400,000cy removed during this time).

As outlined above, sea turtles are likely to occur in Delaware Bay from May through mid-November each year with the largest numbers present from June through October of any year (Stetzar 2002). The majority of sea turtles in the Delaware Estuary are juvenile loggerheads; however, adult loggerheads, juvenile Kemp's ridley, adult and juvenile leatherback and adult green sea turtles have also been documented. The Delaware Estuary is an important foraging area for sea turtles and an important developmental habitat for juvenile sea turtles, particularly loggerheads. The only dredging operations that are scheduled to occur in the geographic region of the action area where sea turtles are likely to occur are deepening and maintenance in Reaches D and E. Sea turtles are likely to be present during dredging at Reach E in May and June 2011 and at Reach E from May – August 2012. Additionally, sea turtles are likely to be present during dredging at Reach D from May – July 2013. The primary concern for loggerhead, Kemp's ridley and green sea turtles is entrainment in the draghead of the hopper dredge, while the main concern for leatherback sea turtles is the potential

for vessel collisions. The proposed action may also affect sea turtle foraging.

Entrainment in Hopper Dredges – Sea Turtles
The areas to be dredged in Reaches D and E are part of the summer developmental habitat of juvenile sea turtles as well as foraging areas. Sea turtles are likely to be feeding on or near the bottom of the water column during the warmer months, with loggerhead and Kemp's ridley sea turtles being the most common species in these waters. Although not expected to be as numerous as loggerheads and Kemp's ridleys, green sea turtles are also likely to occur in the action area and this species may be impacted by the proposed project. Leatherback sea turtles may also be present in the action area while migrating or foraging, but are more subject to vessel collisions than dredge entrainment due to their size and behavioral characteristics.

One of the main factors influencing sea turtle presence in northern waters is seasonal temperature patterns (Ruben and Morreale 1999). Temperature is correlated with the time of year, with the warmer waters in the late spring, summer, and early fall being the most suitable for cold-blooded sea turtles. Sea turtles are most likely to occur in the action area between June and October when water temperatures are above 11°C and depending on seasonal patterns, could be present in May and early November. Sea turtles have been documented in the action area by the CETAP aerial and boat surveys as well as by surveys conducted by NMFS Northeast Science Center and fisheries observers. Additionally, satellite tracked sea turtles have been documented in the action area (seaturtle.org tracking database). The majority of sea turtle observations have been of loggerhead sea turtles, although all four species of sea turtles have been recorded in the area.

To some extent, water depth also dictates the number of sea turtles occurring in a particular area. The only areas to be dredged have water depths of less than 45 feet. Satellite tracking studies of sea turtles in the Northeast found that foraging turtles mainly occurred in areas where the water depth was between approximately 16 and 49 ft (Ruben and Morreale 1999). This depth was interpreted not to be as much an upper physiological depth limit for turtles, as a natural limiting depth where light and food are most suitable for foraging turtles (Morreale and Standora 1990). The areas to be dredged and the depths preferred by sea turtles do overlap, suggesting that if suitable forage was present, loggerheads and Kemp's ridleys may be foraging in the channel areas where dredging will occur. As there are no SAV beds in any of the channel areas where dredging will occur, green sea turtles are not likely to use the areas to be dredged for foraging.

As noted above, approximately 1,598,700cy of material will be removed from Reach E (near RM 15.6) from approximately April – June 2011, with approximately two-thirds of that material (i.e., approximately 1 million cy) removed during the months of May and June when sea turtles are likely to be present. Dredging of approximately 2,483,000 cy will also occur at Reach E (RM 30.8-36.4, Kelly Island) over approximately 135 days between April and August 2012 with approximately 2.2mcy removed during the time when sea turtles are likely to be present. Additionally, 396,300cy of material will be removed from Reach D (Reedy Point South) from December 2012-January 2013. As sea turtles are only known to occur in the action area between May and mid-November, no sea turtles are likely to be present when this dredging cycle occurs. Dredging will take place in Reach D/Artificial Island) from February 2013-May 2013, with approximately 400,000cy removed in May. As noted above, the primary concern for loggerhead, Kemp's ridley and green sea turtles is

entrainment in the draghead of the hopper dredge, while the main concern for leatherback sea turtles involves the potential for vessel collisions.

Leatherback turtles are not vulnerable to entrainment in dredge dragheads due to their large size. Therefore, this section of the Opinion will only consider the effects of entrainment on loggerhead, Kemp's ridley and green sea turtles. Entrainment is the most imminent danger for sea turtles during hopper dredging operations. The National Research Council's Committee on Sea Turtle Conservation (1990) estimated that dredging mortalities, along with boat strikes, were second only to fishery interactions as a source of probable lethal takes of sea turtles. Experience has shown that injuries sustained by sea turtles entrained in hopper dredge dragheads are usually fatal. Mortality in hopper dredging operations most often occurs when turtles are sucked into the dredge draghead, pumped through the intake pipe and then killed as they cycle through the centrifugal pump and into the hopper. Because entrainment is believed to occur primarily while the draghead is operating on the bottom, it is likely that only those species feeding or resting on or near the bottom would be vulnerable to entrainment. Additionally, animals may be entrained if suction is created in the draghead by current flow while the device is being placed or removed, or if the dredge is operating on an uneven or rocky substrate and rises off the bottom. Recent information from the ACOE suggests that the risk of entrainment is highest when the bottom terrain is uneven or when the dredge is conducting "clean up" operations at the end of a dredge cycle when the bottom is trenched and the dredge is working to level out the bottom. In these instances, it is difficult for the dredge operator to keep the draghead buried in the sand and sea turtles near the bottom may be more vulnerable to entrainment.

Sea turtles have been killed in hopper dredge operations along the East and Gulf coasts of the US. Documented turtle mortalities during dredging operations in the ACOE South Atlantic Division (SAD; i.e., south of the Virginia/North Carolina border) are more common than in the ACOE North Atlantic Division (NAD; Virginia-Maine) probably due to the greater abundance of turtles in these waters and the greater frequency of hopper dredge operations. For example, in the ACOE SAD, over 400 sea turtles have been entrained in hopper dredges since 1980 and in the Gulf Region over 160 sea turtles have been killed since 1995. Records of sea turtle entrainment in the ACOE NAD began in 1994. Since this time, at least 66 sea turtles deaths (see Table 2 below) related to hopper dredge activities have been recorded in waters north of the North Carolina/Virginia border (ACOE Sea Turtle Database[11]).

Official records of sea turtle mortality in dredging activities in the ACOE NAD begin in the early 1990s. Before this time, endangered species observers were not required on board hopper dredges and dredge baskets were not inspected for sea turtles or sea turtle parts. The majority of sea turtle takes in the NAD have occurred in the Norfolk district. This is largely a function of the large number of loggerhead and Kemp's ridley sea turtles that occur in the Chesapeake Bay each summer and the intense dredging operations that are conducted to maintain the Chesapeake Bay entrance channels and for beach nourishment projects at Virginia Beach. However, since 1992, the take of 10 sea turtles (all loggerheads) has been recorded during hopper dredge operations in the Philadelphia, Baltimore and New York Districts. Hopper dredging is relatively rare in New England

11 The USACE Sea Turtle Data Warehouse is maintained by the ACOE's Environmental Laboratory and contains information on ACOE dredging projects conducted since 1980 with a focus on information on interactions with sea turtles.

waters where sea turtles are known to occur, with most hopper dredge operations being completed by the specialized Government owned dredge Currituck which operates at low suction and has been demonstrated to have a very low likelihood of entraining or impinging sea turtles. To date, no hopper dredge operations (other than the Currituck) have occurred in the New England District in areas or at times when sea turtles are likely to be present.

Of the 10 sea turtle mortalities attributed to hopper dredge operations outside of the Norfolk District, 6 have occurred in the Philadelphia District, 3 in the Baltimore District and 1 in the New York District. As explained in the ACOE BA, the Philadelphia District Endangered Species Monitoring Program began in 1992. For four hopper dredging projects conducted in 1992 – 1994, observers were present to provide approximately 25% coverage (6 hours on, 6 hours off on a biweekly basis). No sea turtles were observed during the 8/25-10/13/92 dredging at Bethany Bay, DE or the 10/24-11/14/92 dredging at Cape May, NJ. The dredge McFarland worked in the Delaware River entrance channel from 6/23 – 7/23/93 with no sea turtle observations. The dredge continued at Cape May from 7/24-8/2 and 8/10-8/19/93. Fresh sea turtle parts were observed in the inflow screening on two separate dates three days apart at Cape May. Additionally, three live sea turtles were observed from the bridge during dredging operations. Dredging with the McFarland continued in the Delaware Bay entrance channel from 6/13-8/10/94. During this dredging cycle, relocation trawling was conducted in an attempt to capture sea turtles in the area where dredging was occurring and move them away from the dredge. Eight loggerhead sea turtles were captured alive with the trawl and relocated away from the dredging site. One loggerhead was taken by the dredge on June 22, 1994. Since this event in 1994, dredge observer coverage was increased to 50%. On November 3, 1995, one loggerhead was taken by a hopper dredge operating in the entrance channel. In 1999, dredging occurred in July at the entrance channel. Three decomposed loggerheads were observed at Brandywine Shoal and Reedy Island by the dredge observer while the dredge was transiting to the disposal site. There is no evidence to suggest that these turtles were killed during dredging operations. On July 27, 2005 fresh loggerhead parts were observed in two different dredge loads while dredging was being conducted in the Miah Maul Range of the channel in Delaware Bay. It is currently unknown whether these were parts of the same turtle or two different turtles.

In addition to sea turtles observed as entrained, one loggerhead was killed during dredging operations off Sea Girt, New Jersey during an ACOE New York District beach renourishment project on August 23, 1997. This turtle was closed up in the hinge between the draghead and the dragarm as the dragarm lifted off the bottom.

Most of the available information on the effects of hopper dredging on sea turtles in the ACOE NAD has come from operations in Virginia waters, particularly in the entrance channels to the Chesapeake Bay. Since 1994, 63 sea turtles mortalities have been observed on hopper dredges operating in Virginia waters. In Thimble Shoals Channel, maintenance dredging took several turtles during the warmer months of 1996 (1 loggerhead) and 2000 (2 loggerheads, 1 unknown). A total of 6 turtles (5 loggerhead, 1 unknown) were taken in association with dredging in Thimble Shoal Channel during 2001, and one turtle was taken in May 2002 (1 loggerhead). Nine sea turtle takes were reported during dredging conducted in September and October 2003 (7 loggerhead, 1 Kemp's ridley, 1 unknown). Most recently, Thimble Shoals Channel was dredged in the spring of 2009,

with 3 loggerheads killed during this operation.

Incidental takes have occurred in the Cape Henry and York Spit Channels as well. In May and June 1994, parts of at least five sea turtles were observed (at least 4 loggerheads and 1 unknown) during dredging at Cape Henry. In September and October 2001, 3 turtle takes were observed (1 Kemp's ridley and 2 loggerheads). Eight turtle takes were observed during dredging at Cape Henry in April, May, June and October 2002 (1 green, 1 Kemp's and 6 loggerhead). Three loggerheads were killed during the dredging of the Cape Henry Channel in the summer of 2006. At York Spit, four loggerheads were taken in dredging operations occurring during one week in June 1994. Nine turtles were taken in dredging operations at York Spit in 2002 (8 loggerheads, 1 Kemp's ridley). York Spit was last dredged in the summer of 2007, with the take of 1 Kemp's ridley reported. In 1998, dredging in the York River Entrance Channel took 5 loggerheads. No turtles had been observed in dredging operations in Rappahannock Shoal Channels or the Sandbridge Shoals borrow area.

It should be noted that the observed takes may not be representative of all the turtles killed during dredge operations. Typically, endangered species observers are required to observe a total of 50% of the dredge activity (i.e., 6 hours on watch, 6 hours off watch). As such, if the observer was off watch or the cage was emptied and not inspected or the dredge company either did not report or was unable to identify the turtle incident, there is the possibility that a turtle could be taken by the dredge and go unnoticed. Additionally, in older Opinions, NMFS frequently only required 25% observer coverage and monitoring of the overflows which has since been determined to not be as effective as monitoring of the intakes. These conditions may have led to sea turtle takes going undetected.

NMFS raised this issue to the ACOE Norfolk District during the 2002 season, after several turtles were taken in the Cape Henry and York Spit Channels, and expressed the need for 100% observer coverage. On September 30, 2002, the ACOE informed the dredge contractor that when the observer was not present, the cage should not be opened unless it is clogged. This modification was to ensure that any sea turtles that were taken and on the intake screen (or in the cage area) would remain there until the observer evaluated the load. The ACOE's letter further stated "Crew members will only go into the cage and remove wood, rocks, and man-made debris; any aquatic biological material is left in the cage for the observer to document and clear out when they return on duty. In addition, the observer is the only one allowed to clean off the overflow screen. This practice provides us with 100% observation coverage and shall continue." Theoretically, all sea turtle parts were observed under this scheme, but the frequency of clogging in the cage is unknown at this time. The most effective way to ensure that 100% observer coverage is attained is to have a NMFS-approved endangered species observer monitoring all loads at all times. This level of observer coverage would document all turtle interactions and better quantify the impact of dredging on turtle populations. More recently issued Opinions have required 100% observer coverage which increases the likelihood of takes being detected and reported.

Sea turtles have been found resting in deeper waters, which could increase the likelihood of interactions from dredging activities. In 1981, observers documented the take of 71 loggerheads by a hopper dredge at the Port Canaveral Ship Channel, Florida (Slay and Richardson 1988). This channel is a deep, low productivity environment in the Southeast Atlantic where sea turtles are

known to rest on the bottom, making them extremely vulnerable to entrainment. The large number of turtle mortalities at the Port Canaveral Ship Channel in the early 1980s resulted in part from turtles being buried in the soft bottom mud, a behavior known as brumation. Chelonid turtles have been found to make use of deeper, less productive channels as resting areas that afford protection from predators because of the low energy, deep water conditions. While sea turtle brumation has not been documented in mid-Atlantic or New England waters, it is possible that this phenomenon occurs in these waters.

It is likely that not all sea turtles killed by dredges are observed onboard the hopper dredge. Several sea turtles stranded on Virginia shores with crushing type injuries from May 25 to October 15, 2002. The Virginia Marine Science Museum (VMSM) found 10 loggerheads, 2 Kemp's ridleys, and 1 leatherback exhibiting injuries and structural damage consistent with what they have seen in animals that were known dredge takes. While it cannot be conclusively determined that these strandings were the result of dredge interactions, the link is possible given the location of the strandings (e.g., in the southern Chesapeake Bay near ongoing dredging activity), the time of the documented strandings in relation to dredge operations, the lack of other ongoing activities which may have caused such damage, and the nature of the injuries (e.g., crushed or shattered carapaces and/or flipper bones, black mud in mouth). Additionally, in 1992, three dead sea turtles were found on an Ocean City, Maryland beach while dredging operations were ongoing at a borrow area located 3 miles offshore. Necropsy results indicate that the deaths of all three turtles were dredge related. It is unknown if turtles observed on the beach with these types of injuries were crushed by the dredge and subsequently stranded on shore or whether they were entrained in the dredge, entered the hopper and then were discharged onto the beach with the dredge spoils.

A dredge could crush an animal as it was setting the draghead on the bottom, or if the draghead was lifting on and off the bottom due to uneven terrain, but the actual cause of these crushing injuries cannot be determined at this time. Further analyses need to be conducted to better understand the link between crushed strandings and dredging activities, and if those strandings need to be factored into an incidental take level. More research also needs to be conducted to determine if sea turtles are in fact undergoing brumation in mid-Atlantic or New England waters. Regardless, it is possible that dredges are taking animals that are not observed on the dredge which may result in strandings on nearby beaches.

Due to the nature of interactions between listed species and dredge operations, it is difficult to predict the number of interactions that are likely to occur from a particular dredging operation. Projects that occur in an identical location with the same equipment year after year may result in interactions in some years and none in other years as noted in the examples of sea turtle takes above. Dredging operations may go on for months, with sea turtle takes occurring intermittently throughout the duration of the action. For example, dredging occurred at Cape Henry over 160 days in 2002 with 8 sea turtle takes occurring over 3 separate weeks while dredging at York Spit in 1994 resulted in 4 sea turtle takes in one week. In Delaware Bay, dredge cycles have been conducted during the May-November period with no observed entrainment and as many as two sea turtles have been entrained in as little as three weeks. Even in locations where thousands of sea turtles are known to be present (i.e., Chesapeake Bay) and where dredges are operating in areas with preferred sea turtle depths and forage items (as evidenced by entrainment of these species in the dredge), the numbers

of sea turtles entrained is an extremely small percentage of the likely number of sea turtles in the action area. This is likely due to the distribution of individuals throughout the action area, the relatively small area which is affected at any given moment and the ability of some sea turtles to avoid the dredge even if they are in the immediate area.

The number of interactions between dredge equipment and sea turtles seems to be best associated with the volume of material removed, which is closely correlated to the length of time dredging takes, with a greater number of interactions associated with a greater volume of material removed and a longer duration of dredging. The number of interactions is also heavily influenced by the time of year dredging occurs (with more interactions correlated to times of year when more sea turtles are present in the action area) and the type of dredge plant used (sea turtles are apparently capable of avoiding pipeline and mechanical dredges as no takes of sea turtles have been reported with these types of dredges). The number of interactions may also be influenced by the terrain in the area being dredged, with interactions more likely when the draghead is moving up and off the bottom frequently. Interactions are also more likely at times and in areas when sea turtle forage items are concentrated in the area being dredged, as sea turtles are more likely to be spending time on the bottom while foraging.

As explained above, since 1992 endangered species observers have worked on all hopper dredge operations below the Delaware Memorial Bridge operating between June and November. Prior to 1995, observers worked one week on, one week off, resulting in approximately 25% observer coverage. Since this date, observers have provided continuous 6-hour on 6-hour off coverage. Cages are generally not cleaned without the observer being present, so it is likely that greater than 50% of material has been observed and that the number of entrainments that go undetected is low. Six sea turtles have been entrained in hopper dredges operating in Delaware Bay since 1993. As sea turtles have been documented in the action area and suitable habitat and forage items are present, it is likely that sea turtles will be present in the action area when dredging takes place.

NMFS has compiled a dataset representing all of the hopper dredge projects in the Philadelphia District that have reported the cubic yardage removed as well as the number of takes observed. Records for 12 projects occurring during "sea turtle season" (i.e., May – November 15) in the Philadelphia District are available that report the cubic yardage removed during a project. Of these, 7 projects involved dredging in the Philadelphia to the Sea navigation channel and 5 involved dredging off the Atlantic coast of Delaware. The distribution of sea turtles in offshore locations such as offshore borrow areas used for beach nourishment is not expected to be comparable to the distribution of sea turtles in estuarine foraging areas such as Delaware Bay. Additionally, as evidenced in the sea turtle database, very few sea turtles have been entrained in hopper dredges operating at any offshore borrow area. This is true even in the southeast, where large numbers of sea turtles are present year round. This is likely due to the transitory nature of most sea turtles occurring in offshore borrow areas as well as the widely distributed nature of sea turtles in offshore waters. As such, NMFS has excluded the 5 projects involving dredging off the Atlantic coast of Delaware from the dataset used to estimate an entrainment rate for sea turtles in hopper dredges operating in Delaware Bay (see Table 2 below). As explained above, for projects prior to 1995, observers were only present on the dredge for every other week of dredging. For projects in 1995 to the present, observers were present on board the dredge full time and worked a 6-hour on, 6-hour off

shift. The only time that cages (where sea turtle parts are typically observed) were cleaned by anyone other than the observer was when there was a clog. If a turtle or turtle part was observed in such an instance, crew were instructed to inform the observer, even if off-duty. As such, it is reasonable to expect that even though there was only 50% observer coverage, an extremely small amount of biological material went unobserved. To make the data from the 1993 and 1994 dredge events when observers were only on board every other week, comparable to the 1995-2006 data when observers were on board full time, NMFS has assumed that an equal number of turtles were entrained when observers were not present. This calculation is reflected in Table 2 as "adjusted entrainment number."

Table 2. Sea turtle entrainment in Philadelphia District dredging operations

Project	Dates	CY Removed	Observed Entrainment	Adjusted Entrainment Number
Philadelphia to the Sea - Mia Maul, Brandywine, Deepwater and Liston ranges	08/08/06 - 08/23/06; 09/07/06 - 11/16/06	390,000	0	0
De River Brandywine and Deepwater Ranges	11/01/2005 - 11/18/2005	167,982	0	0
Philadelphia to the Sea - Miah Maul and Brandwine	10/04/05 - 10/22/2005	162,682	0	0
Delaware Bay - Miah Maul	7/24/05 - 7/27/05	50,000	2	1
Philadelphia to the Sea - Miah Maul and Brandwine	10/07/95 -11/16/95	218,151	1	1
Delaware River Nav Channel - Miah Maul	McFarland 6/15/94-8/10/94	2,830,000	1	2
Cape May Inlet Beachfill - Brandywine Range	07/24/93 - 08/19/93	275,000	2	4

Based on this data, NMFS has made calculations which indicate that an average of 1 sea turtle is killed for approximately every 450,000cy removed. This calculation has been based on a number of assumptions including the following: that sea turtles are evenly distributed throughout all channel reaches for which takes have occurred, that all dredges will take an identical number of sea turtles, and that sea turtles are equally likely to be encountered throughout the May to November time frame. Therefore, the best available information indicates that for dredging in Reaches D and E of the navigation channel during the time of year when sea turtles are likely to be present, 1 sea turtle is likely to be entrained for every 450,000 cubic yards of material removed by a hopper dredge. While this estimate is based on several assumptions, it is reasonable because it uses the best available information on entrainment of sea turtles from past dredging operations in the action area, includes

multiple projects over several years, and all of the projects have had observer coverage.

With the exception of one green turtle in a Virginia dredge, all other sea turtles entrained in dredges operating in the ACOE NAD have been loggerheads and Kemp's ridley. Of these 69 sea turtles, 59 have been loggerhead, 5 have been Kemp's ridleys, 1 green and 4 unknown. Overall, of those identified to species, approximately 90% of the sea turtles taken in dredges operating in the ACOE North Atlantic Division have been loggerheads. No Kemp's ridleys or greens have been taken in dredge operations outside of the Chesapeake Bay area. The high percentage of loggerheads is likely due to several factors including their tendency to forage on the bottom where the dredge is operating and the fact that this species is the most numerous of the sea turtle species in Northeast and Mid-Atlantic waters. It is likely that the documentation of only one green sea turtle take in Virginia dredging operations is a reflection of the low numbers of green sea turtles that occur in waters north of North Carolina. The low number of green sea turtles in the action area makes an interaction with a green sea turtle extremely unlikely to occur.

Based on the above information, NMFS believes that it is reasonable to expect that 1 sea turtle is likely to be injured or killed for approximately every 450,000 cy of material removed from the proposed borrow area and that at least 90% will be loggerheads. Based on the information outlined above and the volume of material estimated to be removed from each reach during the time of year when sea turtles are likely to be present (in parentheses below), NMFS anticipates the following levels of entrainment:

- Reach E April – June 2011 (approx 1 mcy during May and June when sea turtles are likely to be present) : no more than 3 sea turtles
- Reach E April – August 2012 (2.2 mcy during May – August when sea turtles are likely to be present): no more than 5 sea turtles
- Reach D December 2012 – Jan 2013: none
- Reach D February – May 2013 (400,000 cy during May when sea turtles are likely to be present): no more than 1 sea turtle.

As such, NMFS anticipates that no more than 9 sea turtles are likely to be entrained in the initial dredge cycle operating on the schedule outlined above. NMFS expects that nearly all of the sea turtles will be loggerheads and that the entrainment of a Kemp's ridley during a particular dredge cycle will be rare; however, as Kemp's ridleys have been documented in the action area and have been entrained in hopper dredges, it is likely that this species will interact with the dredge over the course of the project life. As explained above, approximately 90% of the sea turtles taken in dredges operating in the ACOE North Atlantic Division have been loggerheads and all sea turtles entrained in hopper dredges operating in Delaware Bay have been loggerheads. As Kemp's ridleys have been documented in the action area and are known to be vulnerable to entrainment in hopper dredges, it is reasonable to expect that Kemp's ridleys could also be entrained during the proposed project. Based on the ratio of sea turtle entrainment in the ACOE NAD, NMFS anticipates that over the life of the project, for every 10 sea turtle interactions only 1 of them is likely to be with a Kemp's ridley. As such, for the initial dredge cycle necessary to deepen the channel, no more than 1 of the 9 sea turtles likely to be entrained will be a Kemp's ridley, with the remainder being loggerheads. As noted above, no interactions with green sea turtles are likely.

Entrainment – Shortnose Sturgeon

Shortnose sturgeon are also vulnerable to entrainment in hopper dredges. As noted above, a hopper dredge will also be used for deepening at Reach A near Camden. Dredging is scheduled over approximately 180 days from August 2010-February 2011 (1,666,600cy). Shortnose sturgeon are likely to be present during August – November (approximately 1mcy removed during this time of year). Dredging of this reach of the navigation channel has occurred routinely in the past. However, no observers have been present on board the dredge. As such, there is no information on any historic interactions that may have occurred. However, shortnose sturgeon have been entrained in hopper dredges operating in the Kennebec River, Maine. For example, five shortnose sturgeon were entrained in the hopper dredge McFarland over three days of dredging in the Kennebec River Federal navigation channel at Doubling Point. Based on the time of year (early October) and the geographic location of the incidents, it is assumed that these fish were in the process of migrating upstream to overwintering areas. Additionally, other species of sturgeon have been entrained in other hopper dredging events in the US, including Gulf sturgeon. Hopper dredges are also used to maintain the Hudson River navigation channel in New York. However, dredging is timed to minimize the potential for shortnose sturgeon occurrence in the area being dredged. Further, no endangered species observers are used.

As noted above, no shortnose sturgeon have been observed entrained in any hopper dredge operating in the Delaware River or Delaware Bay. As noted above, endangered species observers have not been used on any hopper dredge operating upstream of the Delaware Memorial Bridge. Observers are used on hopper dredges operating below the bridge. Complete data sets from 7 hopper dredging events in Delaware Bay at a time of year when shortnose sturgeon are likely to be present and two cutterhead dredging events in the upper river are available (see Table 3 below). As explained in the cutterhead dredging section below, five shortnose sturgeon have been observed entrained during two separate dredging events in the upper Delaware River with the fish observed at the Money Island disposal site.

Table 3. Shortnose Sturgeon Mortalities Associated with Delaware River Dredging

Project	Type of Dredge	Dates	CY Removed	Sturgeon Entrained
Kinkora to Trenton	cutterhead	March 1996	509,946	2
Kinkora to Trenton	cutterhead	January 1998	512,923	3
Philadelphia to the Sea - Mia Maul, Brandywine, Deepwater and Liston ranges	hopper	08/08/06 - 08/23/06; 09/07/06 - 11/16/06	390,000	0
De River Brandywine and Deepwater Ranges	hopper	11/01/2005 - 11/18/2005	167,982	0
Philadelphia to the Sea - Miah Maul and Brandwine	hopper	10/04/05 - 10/22/2005	162,682	0
Delaware Bay - Miah Maul	hopper	7/24/05 - 7/27/05	50,000	0
Philadelphia to the Sea - Miah Maul and Brandwine	hopper	10/07/95 -11/16/95	218,151	0

Delaware River Nav Channel - Miah Maul	hopper	McFarland 6/15/94-8/10/94	2,830,000	0
Cape May Inlet Beachfill - Brandywine Range	hopper	07/24/93 - 08/19/93	275,000	0

Limited information is available on the likely entrainment rates and it is difficult to make a comparison between the likelihood of entrainment in a hopper dredge vs. a cutterhead dredge. However, it is likely that aquatic organisms, including shortnose sturgeon, may be more vulnerable to entrainment in a hopper dredge than a cutterhead. This is due to the larger size of the hopper draghead, the stronger suction and the faster speed at which the draghead moves which may make escape more difficult. A cutterhead dredge has a smaller intake, moves more slowly and is typically buried in the sediment. While in general the risk of entrainment is likely higher in a hopper dredge than a cutterhead dredge, there is no quantitative way to calculate the difference in the level of risk. While neither the Money Island dataset (2 events) or the hopper dredge dataset (7 events in DE Bay with observers) are perfect estimates of the risk of entrainment in a cutterhead operating in these reaches, the data sets, when combined, allow NMFS to calculate a risk of entrainment. NMFS believes that using this dataset of 9 events (see Table 3) is reasonable because it is based on dredging events in the same river system and incorporates entrainment data from dredge types where shortnose sturgeon entrainment is known to occur and at times of year when shortnose sturgeon were likely present in the areas being dredged. Using these data sets, an entrainment rate of 1 shortnose sturgeon per approximately every 1 million cy of material removed is calculated. Based on this calculation, no more than 1 shortnose sturgeon is likely to be entrained in the hopper dredge operating at Reach A from August 2010 – February 2011 when approximately 1 million cy of material will be removed during the time of year when shortnose sturgeon are likely to be present. This calculation has been based on a number of assumptions including the following: that shortnose sturgeon are evenly distributed throughout all channel reaches used in this estimate, that all dredges will have the same entrainment rate, and that shortnose sturgeon are equally likely to be encountered throughout the time period when dredging will occur. While this estimate is based on several assumptions, it is reasonable because it uses the best available information on entrainment of shortnose sturgeon from past dredging operations, including dredging operations in the action area, it includes multiple projects over several years, and all of the projects have had observer coverage.

There is evidence that some shortnose sturgeon, particularly juveniles or smaller adults, could be entrained in the dredge and survive the experience. However, as the extent of internal injuries and the likelihood of survival is unknown, and the size of the fish likely to be entrained is impossible to predict, it is reasonable to conclude that any shortnose sturgeon entrained in the hopper dredge are likely to be killed.

A hopper dredge will also be used for dredging in Reaches D and E. As explained above, since 1992, endangered species observers have been present for at least a portion of all hopper dredging done during the June – November time frame below the Delaware Memorial Bridge. As explained above, shortnose sturgeon are only likely to occur in reaches D and E during the mid-April to mid-November time frame. No shortnose sturgeon have been documented during any hopper dredge activity in the Philadelphia to the Sea maintenance. Little is known about the distribution of shortnose sturgeon in Delaware Bay. However, shortnose sturgeon have been documented at the

Salem Nuclear Generating Facility at Artificial Island. The known occurrence of shortnose sturgeon in Reaches D and E and the lack of documented occurrence of entrainment of shortnose sturgeon in other hopper dredging operations in this area and the extent of the observer coverage (i.e., at least 25% coverage over 7 events over 15 years) leads to the conclusion that it is extremely unlikely that a shortnose sturgeon will become entrained in a hopper dredge operating in Reach D or Reach E. As such, no shortnose sturgeon are likely to be injured or killed during hopper dredging operations at these reaches. This is likely due to the wide distribution of shortnose sturgeon in the Bay, the higher salinity in these reaches which limits shortnose sturgeon use of the area, and the overall rare, transient nature of any occurrences of shortnose sturgeon in these channel reaches.

Interactions with the Sediment Plume- Hopper Dredge
Dredging operations cause sediment to be suspended in the water column. This results in a sediment plume in the water, typically present from the dredge site and decreasing in concentration as sediment falls out of the water column as distance increases from the dredge site. The nature, degree, and extent of sediment suspension around a dredging operation are controlled by many factors including : the particle size distribution, solids concentration, and composition of the dredged material; the dredge type and size, discharge/cutter configuration, discharge rate, and solids concentration of the slurry; operational procedures used; and the characteristics of the hydraulic regime in the vicinity of the operation, including water composition, temperature and hydrodynamic forces (i.e., waves, currents, etc.) causing vertical and horizontal mixing (ACOE 1983).

Resuspension of fine-grained dredged material during hopper dredging operations is caused by the dragheads as they are pulled through the sediment, turbulence generated by the vessel and its prop wash, and overflow of turbid water during hopper filling operations. During the filling operation, dredged material slurry is often pumped into the hoppers after they have been filled with slurry in order to maximize the amount of solid material in the hopper. The lower density, turbid water at the surface of the filled hoppers overflows and is usually discharged through ports located near the waterline of the dredge. Use of this "overflow" technique results in a larger sediment plume than if no overflow is used. The ACOE has indicated that overflow is not authorized for the deepening project. In 2001, a study was done of overflow and nonoverflow hopper dredging. Monitoring of the sediment plumes was accomplished using a boat-mounted 1,200-kHz Broad-Band Acoustic Doppler Current Profiler (ADCP). The instrument collects velocity vectors in the water column together with backscatter levels to determine the position and relative intensity of the sediment plume. Along with the ADCP, a MicroLite recording instrument with an Optical Backscatterance (OBS) Sensor was towed by the vessel at a depth of 15 ft. The MicroLite recorded data at 0.5-sec intervals. Navigation data for monitoring were obtained by a Starlink differential Global Positioning System (GPS). The GPS monitors the boat position from the starting and ending points along each transect.

Transects were monitored in the test area to obtain the background levels of suspended materials prior to dredging activities. A period of 8 minutes following the dredge passing during non-overflow dredging showed the level of suspended material to be returning to background levels. No lateral dispersion of the plume out of the channel was observed during the non-overflow dredging operation. During overflow dredging, a wider transect was performed to determine the lateral extent of the plume. No significant change above background levels could be detected. At 1-hr elapsed

time following the end of the overflow dredging operation, the levels of suspended material returned to background conditions. Again, no lateral dispersion of the plume out of the channel area was observed.

No information is available on the effects of total suspended solids (TSS) on juvenile and adult sea turtles. Studies of the effects of turbid waters on fish suggest that concentrations of suspended solids can reach thousands of milligrams per liter before an acute toxic reaction is expected (Burton 1993). TSS is most likely to affect sea turtles if a plume causes a barrier to normal behaviors or if sediment settles on the bottom affecting sea turtle prey. As sea turtles are highly mobile they are likely to be able to avoid any sediment plume and any effect on sea turtle or whale movements is likely to be insignificant. While an increase in suspended sediments may cause sea turtles to alter their normal movements, any change in behavior is likely to be insignificant as it will only involve movement to alter course out of the sediment plume, which is expected to be limited to the navigation channel and be present at any location for no more than 8 minutes. Based on this information, any increase in suspended sediment is not likely to affect the movement of sea turtles between foraging areas or while migrating or otherwise negatively affect listed species in the action area. Based on this information, it is likely that the effect of the suspension of sediment resulting from dredging operations will be insignificant.

The life stages of shortnose sturgeon most vulnerable to increased sediment are eggs and larvae which are subject to burial and suffocation. As noted above, no eggs and/or larvae will be present in the action area. Juvenile and adult shortnose sturgeon are frequently found in turbid water and would be capable of avoiding any sediment plume by swimming higher in the water column. Laboratory studies (Niklitschek 2001 and Secor and Niklitschek 2001) have demonstrated shortnose sturgeon are able to actively avoid areas with unfavorable water quality conditions and that they will seek out more favorable conditions when available. While the increase in suspended sediments may cause shortnose sturgeon to alter their normal movements, any change in behavior is likely to be insignificant as it will only involve movement further up in the water column, or movement to an area just outside of the navigation channel. Based on this information, any increase in suspended sediment is not likely to affect the movement of shortnose sturgeon between foraging areas and/or concentration areas during any phase of dredging or otherwise negatively affect shortnose sturgeon in the action area.

Hydraulic Cutterhead Dredge

A cutterhead dredge will be used to remove sediments in Reaches AA, B and C. Dredging at Reach C near RM 68.3 is scheduled to occur over approximately 50 days in August and September 2009 (932,600cy removed). Dredging near RM 63.9 is scheduled over 83 days in October –December 2009 (597,800cy removed) and dredging at RM 60.3 is scheduled for approximately 42 days in January and February 2010(972,400cy removed). Sea turtles are extremely unlikely to occur this far up the Delaware River and therefore, will not be exposed to effects of dredging in these reaches. Based on the available information on the distribution of shortnose sturgeon in the action area, shortnose sturgeon are likely to be present at Reach C from mid-April through mid-November. As such, dredging scheduled for August and September 2009 may affect shortnose sturgeon. Shortnose sturgeon are also likely to be present in October and early November prior to the movement to the overwintering grounds. No shortnose sturgeon are likely to be present during the January and

February 2010 dredging. Hydraulic cutterhead dredging will also be used at Reach AA (National Park; RM 99.2 – near Philadelphia) from August – November 2010 (994,000 cy over 87 days). Shortnose sturgeon may be present during this time. No sea turtles would occur this far upstream.

Hydraulic cutterhead dredging will also be used at Reach B near Oldmans at RM 85. Dredging will occur for approximately 27 days in August 2013 (1,617,400cy). Dredging will also occur near Pedricktown North over 105 days August – November 2013 (1,050,700cy) and near Pedricktown South over 94 days September –December 2013. Shortnose sturgeon are expected to be in this portion of the action area from mid-April through mid–November. As such, the dredging scheduled between August 2013 and November 2013 could result in effects to shortnose sturgeon. No sea turtles would occur at Reach B.

Risk of Entrainment in Cutterhead Dredge

Maintenance of the existing 40 foot channel occurs routinely with some dredging accomplished with a cutterhead dredge. A cutterhead dredge is also used in the upriver Philadelphia to Trenton navigation channel. With a cutterhead dredge, material is pumped directly from the dredged area to a disposal site. As such, there is no opportunity to monitor for biological material on board the dredge. Prior to 1996, it was presumed that shortnose sturgeon were mobile enough to avoid the suction of an oncoming cutterhead dredge and that any sturgeon in the vicinity of such an operation would be able to avoid the intake and escape. However, in mid-March 1996, two shortnose sturgeon were found in a dredge discharge pool on Money Island, near Newbold Island. The dead sturgeon were found on the side of the spill area into which the hydraulic pipeline dredge was pumping. An assessment of the condition of the fish indicated that the fish were alive and in good condition prior to entrainment and that they were both adult females. The area where dredging was occurring was a known overwintering area for shortnose sturgeon and large numbers of shortnose sturgeon were known to be concentrated in the general area. A total of 509,946 cy were dredged between Florence and the upper end of Newbold Island during this dredge cycle. Since that time, dredging occurring in the winter months in the Newbold – Kinkora range required that inspectors conduct daily inspections of the dredge spoil area in an attempt to detect the presence of any sturgeon. In January 1998, three shortnose 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 at this time. A total of 512,923 cy of material was dredged between Florence and upper Newbold Island during that dredge cycle. While it is possible that not all shortnose sturgeon killed during dredging operations were observed at the dredge disposal pool, ACOE has indicated that due to flow patterns in the pool, it is expected that all large material (i.e., sturgeon, logs etc.) will move towards the edges of the pool and be readily observable. There are no other records of entrainment of shortnose sturgeon in cutterhead dredges in the Delaware River; however, this is likely due to the lack of observer presence. The risk of an individual shortnose sturgeon being entrained in a cutterhead dredge is difficult to calculate. While a large area overall will be dredged, the dredge operates in an extremely small area at any given time (i.e., the river bottom in the immediate vicinity of the intake). As shortnose sturgeon are well distributed throughout the action area and an individual would need to be in the immediate area where the dredge is operating to be entrained, the overall risk of entrainment in areas where shortnose sturgeon are active and not concentrated, is low. It is likely that the majority of shortnose sturgeon will never encounter the dredge as they would not occur in the immediate area when the

dredge is operating. However, as evidenced by the 5 sturgeon observed at the Money Island disposal site, entrainment can happen.

Using the limited dataset of the two dredge events noted above, an entrainment rate of 1 shortnose sturgeon per approximately every 200,000 cy of material can be calculated. However, it is unreasonable to apply that entrainment rate to the dredging to be conducted for the deepening of reaches AA, B and C. This is because the entrainment rate is calculated for events occurring in shortnose sturgeon overwintering habitats where large numbers (thousands) of shortnose sturgeon are concentrated in a limited geographic area (less than 2 miles of river reach). Further, shortnose sturgeon are relatively inactive in the winter months when these dredging events took place and are known to spend considerable amounts of time resting on the bottom and making limited movements. The reaches that will be deepened are likely to be used for summer foraging and for migrating between overwintering and foraging areas; as such, shortnose sturgeon are not expected to be densely concentrated in any of the reaches but rather, are expected to be distributed throughout the action area. As explained in the hopper dredge section above, shortnose sturgeon have been observed entrained in hopper dredges. Limited information is available on the likely entrainment rates and it is difficult to make a comparison between the likelihood of entrainment in a hopper dredge vs. a cutterhead dredge. However, it is likely that aquatic organisms, including shortnose sturgeon, may be more vulnerable to entrainment in a hopper dredge than a cutterhead. This is due to the larger size of the hopper draghead, the stronger suction and the faster speed at which the draghead moves which may make escape more difficult. A cutterhead dredge has a smaller intake, moves more slowly and is typically buried in the sediment. While in general the risk of entrainment is likely higher in a hopper dredge than a cutterhead dredge, there is no quantitative way to calculate the difference in the level of risk. While neither the Money Island dataset (2 events) or the hopper dredge dataset (7 events in DE Bay with observers) are perfect estimates of the risk of entrainment in a cutterhead operating in these reaches, the data sets, when combined, allow NMFS to calculate a risk of entrainment. NMFS believes that using this dataset of 9 events (see Table 4) is reasonable because it is based on dredging events in the same river system and incorporates entrainment data from dredge types where shortnose sturgeon entrainment is known to occur and at times of year when shortnose sturgeon were likely present in the areas being dredged. Using these data sets, an entrainment rate of 1 shortnose sturgeon per approximately every 1 million cy of material removed is calculated. See Table 3 above (p. 76-77) for this data set information.

Using this entrainment rate, NMFS has calculated the following levels of entrainment expected to be removed by cutterhead dredge in each river reach. These entrainment rates are based on the amount of material expected to be removed during the time of year when shortnose sturgeon are likely to be present.

- Reach C Aug-February 2009 (1,530,400 during August – November when shortnose sturgeon likely to occur): no more than 2 shortnose sturgeon
- Reach AA National Park August –November 2010 (994,000): no more than 1 shortnose sturgeon
- Reach B Oldmans August 2013 (1,671,400): no more than 2 shortnose sturgeon
- Reach B Pedricktown North August – November 2013 (1,050,700): no more than 1 shortnose sturgeon

- Reach B Pedricktown South September –December 2013 (1,942,800 with approx 62%, 1,214,250 prior to mid-November): no more than 2 shortnose sturgeon.

Therefore, based on these estimates, the proposed deepening is expected to result in the death of 8 shortnose sturgeon. Due to the suction, travel through up to 3 miles of pipe and any residency period in the disposal area, all entrained shortnose sturgeon are expected to be killed. As explained above, sea turtles are extremely unlikely to occur in any of the reaches where a cutterhead dredge will be used and therefore no sea turtles would be entrained in dredges operating in these reaches.

Interactions with the Sediment Plume

Dredging operations cause sediment to be suspended in the water column. This results in a sediment plume in the river, typically present from the dredge site and decreasing in concentration as sediment falls out of the water column as distance increases from the dredge site. Dredging with a pipeline dredge minimizes the amount of material re-suspended in the water column as the material is essentially vacuumed up and transported to the disposal site in a pipe.

As reported by ACOE, a near-field water quality modeling of dredging operations in the Delaware River was conducted in 2001. The purpose of the modeling was to evaluate the potential for sediment contaminants released during the dredging process to exceed applicable water quality criteria. The model predicted suspended sediment concentrations in the water column at downstream distances from a working cutterhead dredge in fine-grained dredged material. Suspended sediment concentrations were highest at the bottom of the water column, and returned to background concentrations within 100 meters downstream of the dredge.

In 2005, FERC presented NMFS with an analysis of results from the DREDGE model used to estimate the extent of any sediment plume associated with the proposed dredging at the Crown Landing LNG berth (FERC 2005). The model results indicated that the concentration of suspended sediments resulting from hydraulic dredging would be highest close to the bottom and would decrease rapidly downstream and higher in the water column. Based on a conservative (i.e., low) TSS background concentration of 5mg/L, the modeling results indicated that elevated TSS concentrations (i.e., above background levels) would be present at the bottom 2 meters of the water column for a distance of approximately 1,150 feet. Based on these analyses, elevated suspended sediment levels are expected to be present only within 1,150 feet of the location of the cutterhead. Turbidity levels associated with cutterhead dredge sediment plumes typically range from 11.5 to 282 mg/L with the highest levels detected adjacent to the cutterhead and concentrations decreasing with greater distance from the dredge (see U. Washington 2001).

Studies of the effects of turbid waters on fish suggest that concentrations of suspended solids can reach thousands of milligrams per liter before an acute toxic reaction is expected (Burton 1993). The studies reviewed by Burton demonstrated lethal effects to fish at concentrations of 580mg/L to 700,000mg/L depending on species. Sublethal effects have been observed at substantially lower turbidity levels. For example, prey consumption was significantly lower for striped bass larvae tested at concentrations of 200 and 500 mg/L compared to larvae exposed to 0 and 75 mg/L (Breitburg 1988 in Burton 1993). Studies with striped bass adults showed that pre-spawners did not avoid concentrations of 954 to 1,920 mg/L to reach spawning sites (Summerfelt and Moiser 1976 and Combs 1979 in Burton 1993). While there have been no directed studies on the effects of TSS

on shortnose sturgeon, shortnose sturgeon juveniles and adults are often documented in turbid water and Dadswell (1984) reports that shortnose sturgeon are more active under lowered light conditions, such as those in turbid waters. As such, shortnose sturgeon are assumed to be as least as tolerant to suspended sediment as other estuarine fish such as striped bass.

The life stages of shortnose sturgeon most vulnerable to increased sediment are eggs and larvae which are subject to burial and suffocation. As noted above, no eggs and/or larvae will be present in the action area. Juvenile and adult shortnose sturgeon are frequently found in turbid water and would be capable of avoiding any sediment plume by swimming higher in the water column. Laboratory studies (Niklitschek 2001 and Secor and Niklitschek 2001) have demonstrated shortnose sturgeon are able to actively avoid areas with unfavorable water quality conditions and that they will seek out more favorable conditions when available. While the increase in suspended sediments may cause shortnose sturgeon to alter their normal movements, any change in behavior is likely to be insignificant as it will only involve movement further up in the water column. Based on this information, any increase in suspended sediment is not likely to affect the movement of shortnose sturgeon between foraging areas and/or concentration areas during any phase of dredging or otherwise negatively affect shortnose sturgeon in the action area.

Dredged Material Disposal

As indicated above, all material removed via a cutterhead dredge will be piped directly from the intake to an upland disposal area. The pipe will extend up to 3 miles, depending on the distance between the dredge site and the disposal site. The pipe will be approximately 30" in diameter and be laid on the river bottom. While the presence of the pipe will cause a small amount of benthic habitat to be unavailable to shortnose sturgeon, the extremely small area affected will cause any effects to be insignificant and discountable. There are not likely to be any other effects of disposal operations on shortnose sturgeon.

For hopper dredge operations, approximately 4 million cy of material will be disposed of at the Kelly Island and Broadkill Beach disposal areas. For these projects, sand will be placed along the shoreline. While this could cause a small increase in suspended sediment in the immediate vicinity of sand placement, any effects are likely to be minor and temporary. Impacts associated with this action include a short term localized increase in turbidity during disposal operations. During the discharge of sediment at a disposal site, suspended sediment levels have been reported as high as 500mg/L within 250 feet of the disposal vessel and decreasing to background levels (i.e., 15-100mg/L depending on location) within 1000-6500 feet (ACOE 1983). For this project, the ACOE has reported that because the dredged material is clean sand, the material will settle out quickly and any sediment plume will be localized and temporary.

No information is available on the effects of TSS on juvenile and adult sea turtles. Studies of the effects of turbid waters on fish suggest that concentrations of suspended solids can reach thousands of milligrams per liter before an acute toxic reaction is expected (Burton 1993). TSS is most likely to affect sea turtles if a plume causes a barrier to normal behaviors or if sediment settles on the bottom affecting sea turtle prey. As sea turtles are highly mobile they are likely to be able to avoid any sediment plume and any effect on sea turtle movements is likely to be insignificant. Additionally, the TSS levels expected (40-475mg/L depending on the type of dredge used and site

specific conditions during dredging and up to 500mg/L for disposal) are below those shown to have an adverse effect on fish (580mg/L for the most sensitive species, with 1,000mg/L more typical; see summary of scientific literature in Burton 1993) and benthic communities (590mg/L (EPA 1986)). Based on this information, it is likely that the effects of the discharge of sediments at the open water disposal site will be insignificant.

Maintenance Dredging – Entrainment

The proposed action includes dredging necessary to maintain the channel at 45 feet. As such, the ACOE has indicated that once the channel is deepened to 45 feet, maintenance dredging activities will begin. The proposed action under consideration in this consultation includes 10 years of maintenance dredging. The ACOE has indicated that, on average, approximately 472,000 cubic yards of material will be removed from the Bay annually in order to maintain the 45 foot channel. However, dredging is not expected to occur in each range each year. As explained above, NMFS has estimated an entrainment rate for sea turtles in hopper dredges operating in Reaches D and E of the Philadelphia to the Sea project as 1 sea turtle per every 450,000 cubic yards of material removed during the time of year when sea turtles are likely to be present (i.e., May – November 15).

Provided that maintenance occurs during the May – November window when sea turtles are likely to be present, as explained above, approximately 1 sea turtle is likely to be entrained for each 450,000 cy of material removed. Over the 10 year maintenance cycle, approximately 4,720,000cy of material will be removed from the Bay. No more than 11 sea turtles are likely to be killed over the 10 year maintenance cycle, with no more than 1 being a Kemp's ridley and the remainder being loggerheads. Also as explained above, it is extremely unlikely that any shortnose sturgeon will be entrained by a hopper dredge operating in Reaches D or E. As such, no shortnose sturgeon are likely to be entrained during maintenance dredging operations in these reaches.

Maintenance dredging will also occur in the river. The ACOE has indicated that annually on average, approximately 3,845,000 cy of material will be removed from the river (reaches AA, A, B and C), typically occurring over a two month period between August and December. The ACOE has also indicated that a cutterhead dredge will be used for maintenance dredging activities. As explained above, NMFS has calculated an entrainment rate of 1 shortnose sturgeon per every 1 million cubic yards of material removed from these reaches with a cutterhead dredge. As such, no more than 4 shortnose sturgeon are likely to be entrained and killed during each year of maintenance dredging.

Collisions with dredges

There have not been any reports of dredge vessels colliding with listed species but contact injuries resulting from dredge movements could occur at or near the water surface and could therefore involve any of the listed species present in the area. Because the dredge is unlikely to be moving at speeds greater than three knots during dredging operations, blunt trauma injuries resulting from contact with the hull are unlikely during dredging. It is more likely that contact injuries during actual dredging would involve the propeller of the vessel. Contact injuries with the dredge are more likely to occur when the dredge is moving from the dredging area to port, or between dredge locations. While the distance between these areas is relatively short, the dredge in transit would be moving at faster speeds than during dredging operations, particularly when empty while returning to

the borrow area.

The dredge vessel may collide with sea turtles when they are at the surface. These species have been documented with injuries consistent with vessel interactions and it is reasonable to believe that the dredge vessels considered in this Opinion could inflict such injuries on sea turtles, should they collide. As mentioned, sea turtles are found distributed throughout the action area in the warmer months, generally from May through mid-November.

Interactions between vessels and sea turtles occur and can take many forms, from the most severe (death or bisection of an animal or penetration to the viscera), to severed limbs or cracks to the carapace which can also lead to mortality directly or indirectly. Sea turtle stranding data for the U.S. Gulf of Mexico and Atlantic coasts, Puerto Rico, and the U.S. Virgin Islands show that between 1986 and 1993, about 9% of living and dead stranded sea turtles had propeller or other boat strike injuries (Lutcavage et al. 1997). According to 2001 STSSN stranding data, at least 33 sea turtles (loggerhead, green, Kemp's ridley and leatherbacks) that stranded on beaches within the northeast (Maine through North Carolina) were struck by a boat. This number underestimates the actual number of boat strikes that occur since not every boat struck turtle will strand, every stranded turtle will not be found, and many stranded turtles are too decomposed to determine whether the turtle was struck by a boat. It should be noted, however, that it is not known whether all boat strikes were the cause of death or whether they occurred post-mortem (NMFS SEFSC 2001).

Information is lacking on the type or speed of vessels involved in turtle vessel strikes. However, there does appear to be a correlation between the number of vessel struck turtles and the level of recreational boat traffic (NRC 1990). Although little is known about a sea turtle's reaction to vessel traffic, it is generally assumed that turtles are more likely to avoid injury from slower-moving vessels since the turtle has more time to maneuver and avoid the vessel. The speed of the dredge is not expected to exceed 3 knots while dredging or while transiting to the pump out site with a full load and it is expected to operate at a maximum speed of 10 knots while empty. In addition, the risk of ship strike will be influenced by the amount of time the animal remains near the surface of the water. For the proposed action, the greatest risk of vessel collision will occur during transit between shore and the areas to be dredged. The presence of an experienced endangered species observer who can advise the vessel operator to slow the vessel or maneuver safely when sea turtles are spotted will further reduce to a discountable level the potential for interaction with vessels.

There is limited information on the risk that vessel operations pose to shortnose sturgeon. While occasionally shortnose sturgeon have been documented at power plant intakes with injuries that appear consistent with propeller strikes (i.e., deep lateral wounds), it is unclear whether these injuries appeared pre or post mortem or whether they were actually attributable to vessel operations. Based on the fact that shortnose sturgeon spend the majority of their time near the bottom of the water column (i.e., in the bottom meter) and the clearance required for safe navigation of project vessels (i.e., at least 5 feet between the ship and the bottom), and the lack of documented occurrences of strikes between dredge vessels and shortnose sturgeon it is extremely unlikely that any interactions between project vessels and shortnose sturgeon will occur.

Blasting and Mechanical Dredging

As part of the proposed 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 in this area. Blasting will occur at Reach B (Marcus Hook) from December 2010- January 2011 with mechanical rock removal continuing through February 2011. This cycle will repeat from December 2011-February 2012. During this time of year, the majority of adult shortnose sturgeon are expected to be located at the overwintering area between mile 118 and 131 which is over 33 river miles from the blasting site (RM 76.4-84.6). However, as noted above, studies conducted by the ACOE in March 2005, indicate that sturgeon are present in the Marcus Hook area during the winter months. While the three sturgeon observed on video at the Marcus Hook area could not be identified to species, the size of the fish suggests that they could be shortnose sturgeon. Presuming the worst case, that all three of the fish were shortnose sturgeon, the density estimate calculated in Versar 2006 (which was based on the video monitoring at Marcus Hook) indicates that there are 0.005 sturgeon/100 m, or one shortnose sturgeon per 20,000m.

Blasting operations would occur up to five days a week during the December – January blasting period, but the actual blasting would only occur for a brief period each day. Blasting could impact shortnose sturgeon by causing physical injury or mortality to individual fish and by displacing shortnose sturgeon from the area where blasting is occurring. Effects to shortnose sturgeon also include modifications to the benthic community and reduced foraging opportunities.

The blasting plan has been designed to minimize the potential for fish mortality. As such, as noted above, all blasting will occur between December and January when fish density, including shortnose sturgeon, is expected to be lowest. Controlled blasting methods will be employed 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. Additionally, the following measures will be taken:

- 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, with average pressure not exceeding 70 pounds per square inch (psi) at a distance of 140 feet and maximum peak pressure not exceeding 120 psi 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.

Available Information on Effects of Blasting on Fish
There have been numerous studies that have assessed the direct impact of underwater blasting on fish. While not all of the studies have focused exclusively on shortnose sturgeon, the results demonstrate that blasting does have an adverse impact on fish. Teleki and Chamberlain (1978) found that several physical and biological variables were the principal components in determining the magnitude of the blasting effect on fish. Physical components include detonation velocity, density of material to be blasted, and charge weight, while the biological variables are fish shape, location of fish in the water column, and swimbladder development. Composition of the explosive, water depth, and bottom composition also interact to determine the characteristics of the explosion pressure wave and the extent of any resultant fish kill. Furthermore, the more rapid the detonation velocity, the more abrupt the resultant hydraulic pressure gradient, and the more difficulty fish appear to have adjusting to the pressure changes.

A blasting study conducted in Nanticoke, Lake Erie, found that fish were killed in radii ranging from 20 to 50 m for 22.7 kg per charge and from 45 to 110 m for 272.4 kg per charge (Teleki and Chamberlain 1978). Approximately 201 blasts were detonated in 4 to 8 m of water. Of the thirteen fish species studied, mortality differed by species at identical pressure. No shortnose sturgeon were tested. Common blast induced injuries included swimbladder rupturing and hemorrhaging in the coelomic and pericardial cavities.

The effects of blasting on thirteen species of fish were measured in deep water (46 m) explosion tests in the Chesapeake Bay opposite the mouth of the Patuxent River (Wiley et al. 1981). No shortnose sturgeon were tested. Fish were held in cages at varying depths during 16 midwater detonations with 32 kg explosives. For the 32 kg charges, the pressure wave was propagated horizontally most strongly at the depth at which the explosion occurred. While the extent of the injury varied with species, the fish with swimbladders are far more vulnerable than those lacking swimbladders, and toadfish and catfish were the most resistant to damage of those species with a swimbladder.

Many fish exposed to blasting exhibit injuries to the kidney and swimbladder, thus affecting their fitness (Wiley et al. 1981). Efficient osmoregulation is very important in fishes; even slight bruises to the kidney could seriously affect this efficiency, causing at least a higher expenditure of energy. Burst swimbladders cause the fish to lose their ability to regulate the volume of their swimbladders (destroying buoyancy control) and probably increases their vulnerability to predators.

Wiley et al. (1981) found that the oscillatory response of the swimbladder was a likely cause of the fishes' injuries. Their analyses demonstrate that fish mortality is strongly dependent on the depth of the fish. For larger fish (like shortnose sturgeon) at shallower depths (~7 to 11 m), the swimbladder does not have time to fully respond to the positive portion of the explosion wave. Thus, at shallow depth the larger fish are in effect protected from harm by their swimbladders, while at the resonance depth their swimbladders are burst.

Burton (1994) conducted experiments to estimate the effects of blasting to remove approximately 1,600 cubic yards of bedrock during construction of a natural gas pipeline in the Delaware River near Easton, Pennsylvania (upriver from Marcus Hook area). American shad and smallmouth bass

juveniles were exposed to charges of 112.5 and 957 kg of explosives in depths ranging between 0.5 and 2 m. The fish were caged at a range of distances from the blasts. Tests with American shad were inconclusive due to an unavoidable delay between stocking the chambers and detonation of the explosives; however, successful tests with smallmouth bass suggested that the explosives created a maximum kill radius of 12 m (for both charge magnitudes). No fish were killed by the shock wave at the 24 m position and beyond.

The preceding studies were conducted on other fish species, but the nature of the injuries and the optimal distance from the detonations could be applied to blasting activities and shortnose sturgeon. The effects of blasting on shortnose sturgeon have been examined however. Test blasting was conducted in the Wilmington Harbor, North Carolina, in December 1998 and January 1999 in order to adequately assess the impacts of blasting on shortnose sturgeon, the size of the LD1 area (the lethal distance from the blast where 1% of the fish died), and the efficiency of an air curtain for mitigating blast effects. 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.

As explained in Moser 1999(a), the test blasting consisted of 32-33 blasts (3 rows of 10 to 11 blast holes per row with each hole and row 10 feet apart), about 24 to 28 kg of explosives per hole, stemming each hole with angular rock, and an approximate 25 msec delay after each blast. During test blasting, 50 hatchery reared juvenile striped bass and shortnose sturgeon were placed in 0.25" plastic mesh cylinder cages (2 feet in diameter by 3 feet long) 3 feet from the bottom (worst case scenario for blast pressure as confirmed by test blast pressure results) at 35, 70, 140, 280, and 560 feet upstream and downstream of the blast location. For each test, 200 caged shortnose sturgeon were held at a control location 0.5 mi from the test blast area. The caged fish had a mean weight of 55 grams. The cages were enclosed in a 0.6" nylon mesh sock to prevent the escape of any sturgeon if the cage was damaged during blasting. The caging experiments were conducted during a total of seven blasts between December 9, 1998 and January 7, 1999. Three test blasts were conducted with the air curtain in place and 4 were conducted without 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. Mortality rates for control fish were generally low, with 15 fish dead or mortally injured on inspection (out of a total of 1400 samples). The numbers of injured, dead, and mortally injured sturgeon varied greatly between tests. Of the 500 fish tested during each blast, mortalities (dead or mortally injured) ranged from 1 to 89 fish. Mortality rates for shortnose sturgeon as compared to the other species tested were low, with the author of the report concluding that this was likely due to the larger size of shortnose sturgeon tested (approximately 30cm average) as compared to the size of the other species (3cm – 20cm).

In addition to the external examinations of fish immediately following the blast and 24 hours later, a sample of 10 randomly selected, apparently unaffected, sturgeon from each of seven cages nearest the blasts were sacrificed and later necropsied (Moser 1999b). After the necropsy was completed, the total extent of injury was scored on a scale of 0-10, with 10 being the most severe level of injury observed. It is important to note that all of the fish necropsied were alive 24 hours following the blast and appeared to be uninjured based on the initial external observations. Fish scored at 7 or higher were thought to be unlikely to survive and function normally with the injuries they sustained.

Injuries ranged from no sign of external injury to extensive internal hemorrhaging and ruptured swim bladders.

All fish necropsied were in apparently normal condition when sacrificied 24 hours after the blast. The fish were swimming normally in their cages and exhibited no outward signs of stress or physical discomfort (Moser 1999b). However, internal examinations revealed extensive damage in many of the fish necropsied. Of the 70 sturgeon necropsied, ten had an index of injury of 7 or higher, meaning that they likely would not have survived the injuries sustained during blasting. While sturgeon had relatively little damage to their swim bladders, they more often had distended intestines with gas bubbles inside and hemorrhage to the body wall lining. In the fish caged 70 feet away, there was no sign of hemorrhage or swim bladder damage but two of the fish exhibited distended intestines, which may have been caused by the blast. Moser (1999) speculated that sturgeon fared better than striped bass because their air bladder has a free connection to the esophagus, allowing gas to be expelled rapidly without damage to the swim bladder. Additionally, there was no clear relationship between size and the Index of Injury, size and gut fullness, or Index of Injury and gut fullness. The author notes that external observation of the fish following blasting was not sufficient to identify all blast-related injuries and that many of the internal injuries observed in fish that externally appeared unaffected would have resulted in eventual mortality.

Effects of Proposed Blasting on Shortnose Sturgeon

The distribution of adult sturgeon in the lower Delaware River is relatively unknown. While the immediate area to be blasted (river mile 76.4 to river mile 84.6) is not a known concentration area for adult sturgeon, the species has been documented below Philadelphia and in the vicinity of the blasting area. Due to the lack of studies on overwintering sturgeon outside of the known upstream concentration area, the best available information is the survey conducted by ACOE in 2005 (Versar 2006). As noted above, in this study, video and net sampling was conducted with three sturgeon observed on video in the Marcus Hook area and no shortnose sturgeon captured with any nets.

Shortnose sturgeon appear to be able to withstand some degree of blasting at a certain distance from the detonation, but it is apparent from the study results outlined above that blasting may injure the species both internally and externally. The presence of adults and/or juveniles in the action area during blasting could result in injury and/or mortality. The severity of the impact that blasting has on fish is dependent on several biological and physical variables. The physical variables are detonation velocity, density of material to be blasted and charge weight, while the biological variables are fish shape, location of fish in the water column, and swimbladder development(Teleki and Chamberlain 1978). The interactions of other factors such as composition of explosive, water depth, and bottom composition, determine the extent of the pressure wave and consequential fish kills (Teleki and Chamberlain 1978). Results from previous blasting studies conducted on thirteen species of fish other than shortnose sturgeon, revealed that swimbladder rupture and hemorrhaging in the pericardial and ceolomic cavities were common injuries that resulted. While studies on shortnose sturgeon revealed that they also suffer from swimbladder ruptures, more common blast induced injuries that resulted were distended intestines with gas bubbles inside and hemorrhage to the body wall lining (Moser 1999a, Moser 1999b). Overall, however, it is difficult to determine the extent of internal injury because many fish did not exhibit external stress or physical discomfort despite extensive internal damage. Approximately 10% of fish that appeared to have suffered no

injury, sustained injuries from the blasting that it is speculated would have lead to their eventual death. If shortnose sturgeon are present in the action area during blasting, they may suffer injury and/or mortality.

Underwater noise may also limit the distribution and foraging of shortnose sturgeon. Large detonations and the presence of heavy machinery working beneath the water, may deter sturgeon from entering the blasting area. If juvenile and adult shortnose sturgeon are in the action area their distribution and foraging habitat may be limited and/or altered by activities and results associated with the blasting.

Based on the information presented above, shortnose sturgeon within 500 feet of a detonation resulting in peak pressures of 120 psi and average pressure of 70 psi, consistent with the proposed action would be exposed to noise and pressure levels that could cause adverse effects. These effects could range from avoidance behaviors, temporary stunning, external or internal injury with full recovery, injury with delayed mortality or injury sufficient to cause immediate mortality. Based on the best available information, it is likely that the smaller the fish is and the closer it is to the blast the more significant the injuries would be.

The ACOE will utilize measures to minimize the potential for blasting to occur if shortnose sturgeon are within 500 feet of the blast site. The ACOE will use a combination of sonar and other imaging (video or DIDSON for example) techniques to monitor an area with a radius of 500 feet surrounding the blast site. Outside of the 500 foot zone, no effects to fish are likely (ACOE 2008 and ACOE 2009). Monitoring will begin 20 minutes prior to the detonation and no blasting will occur until any fish observed have left the area. As such, the risk of shortnose sturgeon being within close enough proximity to be injured or killed during a detonation is low. However, as the survey will need to stop at some point so that detonation can begin, there is a small risk that a shortnose sturgeon could swim into the area prior to or during blasting and not be detected. As this is likely to be a rare occurrence, it is not likely to happen more than once per each winter season that dredging occurs. Based on the density estimates of sturgeon in the Marcus Hook area (0.005/100m) and the worst case assumption that all of the sturgeon observed were shortnose sturgeon, NMFS has estimated that at any given time, no more than 3 shortnose sturgeon are likely to occur in an area at Marcus Hook with a radius of 500 feet. As such, it is reasonable to expect that if the monitoring is not successful once per winter, then no more than 3 shortnose sturgeon per winter will be close enough to the detonation site to experience effects ranging from temporary stunning to death. As explained above, sturgeon within 500 feet of the blast are expected to experience effects that could range from avoidance of the area to mortality. As such, NMFS has determined that over the course of two winters of blasting, no more than 6 shortnose sturgeon will be stunned, injured or killed due to exposure to a detonation.

After blasting is completed, mechanical dredging will be used to remove debris. In rare occurrences shortnose sturgeon have been captured in dredge buckets and placed in the scow. Very few mechanical dredge operations have employed observers to document interactions between sturgeon and the dredge. However, captures of shortnose and Atlantic sturgeon have been documented in the Kennebec River, Maine. It is unknown if this is due to a unique situation in this river or the intense observer coverage at dredging operations in this river. Based on the occurrence of shortnose

sturgeon in the area where mechanical dredging will take place and the documented vulnerability of this species to capture with mechanical dredges, it is likely that a small number of shortnose sturgeon will be captured by the mechanical dredge removing debris following blasting. Due to the relatively low level of risk that an individual shortnose sturgeon would be captured in the slow moving dredge bucket, no more than 1 shortnose sturgeon is likely to be captured during each winter when mechanical dredging is used. Shortnose sturgeon captured in a dredge bucket could be injured or killed. Sources of mortality include injuries suffered during contact with the dredge bucket or burial in the dredge scow. Of the three captures of sturgeon with mechanical dredges in the Kennebec River (two shortnose, 1 Atlantic), one of the shortnose sturgeon was killed. This fish suffered from a large laceration, likely experienced due to contact with the dredge bucket. As the risk of mortality once captured is high, it is reasonable to expect that both of the shortnose sturgeon likely to be captured in the dredge bucket could suffer injury or mortality due to contact with the dredge bucket or through suffocation due to burial in the scow.

In summary, blasting and subsequent removal of debris with a mechanical dredge is likely to result in injury or mortality to no more than 6 shortnose sturgeon via exposure to the sound and pressure of detonations, and the capture and associated injury or mortality of no more than 2 shortnose sturgeon in mechanical dredges.

Effects on Benthic Resources and Foraging

Dredging

Since dredging involves removing the bottom material down to a specified depth, the benthic environment will be impacted by dredging operations. No sea grass beds occur in the areas to be dredged with a hopper dredge, therefore green sea turtles will not use the areas as foraging areas. Thus, NMFS anticipates that the dredging activities are not likely to disrupt normal feeding behaviors for green sea turtles. Records from previous dredge events occurring in the lower channel indicate that some benthic resources, including whelks, horseshoe crabs, blue crabs and rock crabs are entrained during dredging. Other sources of information indicate that potential sea turtle forage items are present in the channel, including jellyfish, clams, mussels, sea urchins, whelks, horseshoe crabs, blue crabs and rock crabs. Shortnose sturgeon feed on a variety of benthic invertebrates. The preferred forage item in the Delaware River is the Asiatic river clam (*Corbicula manilensis*). The proposed dredging is likely to entrain and kill at least some of these potential forage items.

Of the listed species found in the action area, loggerhead and Kemp's ridley sea turtles and shortnose sturgeon are the most likely to utilize the channel areas for feeding with the sea turtles foraging mainly on benthic species, namely crabs and mollusks (Morreale and Standora 1992, Bjorndal 1997) and shortnose sturgeon on benthic invertebrates including Asiatic river clams. As noted above, suitable sea turtle and sturgeon foraging items occur in the channel. As preferred sea turtle and sturgeon foraging items occur at the channel areas and depths are suitable for use by sea turtles and sturgeon, some foraging by these species likely occurs at these sites.

Dredging can cause indirect effects on sea turtles by reducing prey species through the alteration of the existing biotic assemblages. Kemp's ridley and loggerhead sea turtles typically feed on crabs, other crustaceans and mollusks. Some of the prey species targeted by turtles, including crabs, are mobile; therefore, some individuals are likely to avoid the dredge. However, shortnose sturgeon

forage items have limited mobility (clams and other benthic invertebrates) and are unlikely to be able to actively avoid the dredge. The Delaware River estuary is approximately 700 square miles. The Philadelphia to the Sea navigation channel is approximately 15.3 square miles. The ACOE has estimated that approximately 8.5 square miles will be dredged (approximately 55% of the existing channel, or 1.2% of the estuary) with no more than 0.33% of the estuary dredged in a particular year. While there is likely to be some reduction in the amount of prey in the channel areas, the area affected is small (i.e., less than 1% of the estuary annually) and the action will result in the loss of only a portion of the available forage in the dredged area. Depending on the species, recolonization of a dredged channel can begin in as short as a month (Guerra-Garcia and Garcia-Gomez 2006). The dredged area is expected to be completely recolonized by benthic organisms within approximately 12 months (USACE 2001, US DOI 2000). These conclusions are supported by the conclusions of a benthic habitat study which examined an area of Thimble Shoal following dredging and concluded that recolonization of the dredged area was rapid with macrobenthic organisms abundant on the first sampling date following cessation of dredging activities (less than a month later). Benthic sampling done by O'Herron and Hastings (1985) in association with past ACOE maintenance dredging in the Delaware River found that *Corbicula* recolonized the dredge areas during the subsequent growing season. However, the post-dredge individuals collected were smaller than pre-dredge individuals and provided less biomass. O'Herron and Hastings (1985) found that adult shortnose sturgeon may not be able to efficiently utilize new molluscan colonizers due to the limited biomass until the end of the second growing season after dredging. Based on this information, sea turtles and shortnose sturgeon should only be exposed to a reduction in forage in the areas where dredging occurs for one to two seasons immediately following dredging.

Shortnose sturgeon generally feed when the water temperature exceeds 10°C and in general, foraging is heavy immediately after spawning in the spring and during the summer and fall, with lighter foraging during the winter (ACOE 2000, NMFS 1996). The likelihood that sturgeon are actively foraging in the action area is low, but shortnose sturgeon could still be feeding in the vicinity of the blasting. As noted above, shortnose sturgeon in the Delaware River primarily forage on the Asiatic river clam. Fine clean sand, clay, and coarse sand are preferred substrates for this clam, although this species may be present in lower numbers on almost any substrate (Gottfried and Osborne 1982, Belanger et al. 1985, Blalock and Herod 1999). The substrate in the area proposed for blasting is primarily rock and is not expected to be a concentration area for this prey species, but *Corbicula* has been found on gravel and bedrock substrates in the Susquehanna River. Thus, this species (or any other secondary prey species) may be found in the action area and any organism present on the rock to be removed by blasting or in the immediate project area would be destroyed. The impact should not extend beyond the immediate blasting area as previous studies indicate that invertebrates are relatively insensitive to pressure related damage from underwater detonations (ACOE 2000). This could be attributable 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). Nevertheless, the area immediately surrounding the blast zone would be void of preferred sturgeon prey and thus, shortnose sturgeon would not be likely to forage in this area.

It is important to note however, that while blasting will destroy all of the prey resources in the immediate area, the impacts will not be permanent and as discussed above for dredging, the benthic

community will likely reestablish after a couple years.

NMFS anticipates that while the dredging activities may temporarily disrupt normal feeding behaviors for sea turtles and shortnose sturgeon by causing them to move to alternate areas, the action is not likely to remove critical amounts of prey resources from the action area and any disruption to normal foraging is likely to be insignificant. Additionally, as (1) the area to be affected by dredging and blastin is small; (2) few motile organisms will be affected by the proposed dredging and; (3), recolonization of the benthic community will be rapid and complete within 2 years, NMFS has determined that any effects to foraging sea turtles and shortnose sturgeon will be temporary and insignificant.

Effects of Deepening on Substrate/Habitat Type

During the consultation process, NMFS requested information on the potential of the proposed deepening to alter the substrate type in areas to be dredged. If substrate type was altered, the benthic community that recolonizes the dredged area could be fundamentally different than the original community and this could affect the availability of forage items for listed species. However, the ACOE has indicated that the remaining sub-surface strata below the dredging pay-prism is consistent with the maintenance material removed during a typical dredging operation. The maintenance material removed from this project historically consists of a mixture of sand and mud. Typical material densities vary in range from silt/mud between 1137 (g/l) to 1337 (g/l) and sands 1526 (g/l) to 1874 (g/l). The ACOE has indicated that the same ratio is anticipated as a result of the deepening project and that no alterations in the type of sediment occurring in the dredged areas will result from the proposed action.

Effects of Deepening on Salinity

As explained above, the action area experiences a wide variety of salinity influenced by multiple factors. Also as explained above, the salinity gradient effects the distribution of listed species in the action area with sea turtles less likely to occur as salinity decreases and shortnose sturgeon more prevalent in the low salinity reaches. Concerns have been raised that the proposed deepening could alter the salinity regime in the estuary. The ACOE has conducted several models to estimate any modifications to the salinity regime that could result from deepening. The model developed by ACOE to predict changes in salinity takes into account the proposed deepening to 45 feet, predicted increases in consumptive use of freshwater for drinking water, and predicted sea level rises through 2040. The model estimates that the 10 ppt isohaline, which can fluctuate naturally over a 30 mile zone of the estuary, moved upstream an average of from 0.0 to 1.0 miles with the deepened channel. The maximum monthly average increase in salinity within the mesohaline zone was 0.1 to 0.3 ppt. This increase is not expected to alter the distribution of shortnose sturgeon or sea turtles in the action area or otherwise affect these species.

Increased Use of Channel

During the consultation process, NMFS requested information from ACOE as to whether there would be any expected port expansion that is expected to result from the proposed deepening. The ACOE indicated that 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.

CUMULATIVE EFFECTS

Cumulative effects are defined in 50 CFR §402.02 as those effects of future state or private activities, not involving Federal activities, that are reasonably certain to occur within the action area of the Federal action subject to consultation.

Several features of the shortnose sturgeon's natural history, including delayed maturation, non-annual spawning (Dadswell et al. 1984; Boreman 1997), and long life-span, affect the rate at which recovery can proceed. The effects of future state and private activities in the action area that are reasonably certain to occur during the dredging operations are recreational and commercial fisheries, pollutants, and development and/or construction activities resulting in excessive water turbidity and habitat degradation.

Impacts to shortnose sturgeon from non-federal activities are largely unknown in this river. It is possible that occasional recreational and commercial fishing for anadromous fish species may result in incidental takes of shortnose sturgeon. However, positive identification and distinction between Atlantic sturgeon and shortnose sturgeon are difficult and therefore, historically, takes have not been quantified. Pollution from point and non-point sources has been a major problem in this river system, which continues to receive discharges from sewer treatment facilities and paper production facilities (metals, dioxin, dissolved solids, phenols, and hydrocarbons). Contaminants introduced into the water column or through the food chain, eventually become associated with the benthos where bottom dwelling species like shortnose sturgeon are particularly vulnerable.

Natural mortality of sea turtles, including disease (parasites) and predation, occurs in the action area. Sources of anthropogenic mortality, injury, and/or harassment of listed species in the action area include incidental takes in state-regulated fishing activities, private vessel interactions, marine debris and/or contaminants, and for sea turtles, dredging operations.

Scientific Studies

It is likely that additional scientific studies will be conducted on shortnose sturgeon in the action

area. Continued capturing, handling, tagging, and tracking of shortnose sturgeon may affect their migration, reproduction, foraging, and survival.

Contaminants and Water Quality
Contaminants associated with the action area are directly linked to industrial development along the waterfront. PCB's, heavy metals, and waste associated with point source discharges and refineries are likely to be present in the future due to continued operation of industrial facilities. In addition many contaminants such as PCB's remain present in the environment for prolonged periods of time and thus would not disappear even if contaminant input were to decrease. It is likely that shortnose sturgeon will continue to be affected by contaminants in the action area in the future.

Industrialized waterfront development will continue to impact the water quality in and around the action area. Refineries, sewage treatment facilities, manufacturing plants, and generating facilities present in the action area are likely to continue to operate. Excessive water turbidity, water temperature variations and increased shipping traffic are likely with continued future operation of these facilities. As a result, shortnose sturgeon foraging and/or distribution in the action area may be adversely affected.

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

Marine debris (e.g., discarded fishing line, lines from boats, plastics) can entangle turtles in the water and drown them. Turtles commonly ingest plastic or mistake debris for food, as observed with the leatherback sea turtle. The leatherback's preferred diet includes jellyfish, but similar looking plastic bags are often found in the turtle's stomach contents (Magnuson et al. 1990). It is anticipated that marine debris will continue to impact listed species in the action area.

Sources of contamination in the action area include atmospheric loading of pollutants, stormwater runoff from coastal development, groundwater discharges, and industrial development. Chemical contamination may have an effect on listed species reproduction and survival. While the effects of contaminants on sea turtles are relatively unclear, pollution may also make sea turtles more susceptible to disease by weakening their immune systems. While dependent upon environmental stewardship and clean up efforts, impacts from marine pollution, excessive turbidity, and chemical contamination on marine resources and the ecosystem of the action area are expected to continue in the future.

Fisheries
Incidental take of shortnose sturgeon is likely with the continued operation of hook and line and commercial fisheries in the Delaware River. There have been no documented takes in the action area, however, there is always the potential for this to occur when fisheries are known to operate in the presence of shortnose sturgeon. Thus, the operation of these hook and line fisheries and commercial fisheries could result in future shortnose sturgeon mortality and/or injury.

Impacts to shortnose sturgeon from non-federal activities are unknown in this river. It is possible that occasional recreational and commercial fishing for anadromous fish species may result in incidental takes of shortnose sturgeon. However, positive identification and distinction between Atlantic sturgeon and shortnose sturgeon are difficult and therefore, historically, takes have not been quantified. Pollution from point and non-point sources has been a major problem in this river system, which continues to receive discharges from sewer treatment facilities and industrial facilities. Contaminants introduced into the water column or through the food chain, eventually become associated with the benthos where bottom dwelling species like shortnose sturgeon are particularly vulnerable.

Future commercial fishing activities in state waters may take several protected species. However, it is not clear to what extent these future activities would affect listed species differently than the current state fishery activities described in the Environmental Baseline section. The Atlantic Coastal Cooperative Statistics Program (ACCSP) and the NMFS sea turtle/fishery strategy, when implemented, are expected to provide information on takes of protected species in state fisheries and systematically collected fishing effort data which will be useful in monitoring impacts of the fisheries. NMFS expects these state water fisheries to continue in the future, and as such, the potential for interactions with listed species will also continue.

As noted in the Environmental Baseline section, private vessel activities in the action area may adversely affect listed species in a number of ways, including entanglement, boat strike, or harassment. It is not possible to predict whether additional impacts from these private activities will occur in the future, but it appears likely that they will continue, especially if actions are not taken to minimize these impacts.

As noted above, impacts to listed species from all of these activities are largely unknown. However, NMFS has no information to suggest that the effects of future activities in the action area will be any different from effects of activities that have occurred in the past.

INTEGRATION AND SYNTHESIS OF EFFECTS

In the effects analysis outlined above, NMFS considered potential effects from the following sources: (1) deepening of the channel with cutterhead and hopper dredges; (2) blasting at Marcus Hook and associated debris removal with a mechanical dredge; (3) physical alteration of the action area including disruption of benthic communities, changes in substrate type and changes in salinity in the action area. In addition to these categories of effects, NMFS considered the potential for collisions between listed species and project vessels and the potential for the deepened channel to result in an increase in vessel traffic in the action area.

Shortnose sturgeon

NMFS has estimated that the proposed action is likely to result in the mortality of shortnose sturgeon due to entrainment in cutterhead and hopper dredges operating to deepen and maintain a deepened channel as well as in the injury or mortality of shortnose sturgeon resulting from exposure to blasting, capture in a mechanical dredge removing debris from blasting, and disturbance of shortnose sturgeon occurring in the area where blasting will occur. As explained above, the only

life stage of shortnose sturgeon likely to occur in the action area are juveniles and adults. Also, with the exception of Reach B where shortnose sturgeon may occur year round, the occurrence of shortnose sturgeon in the action area is limited to the time of year when water temperatures are greater than 10°C (typically mid-April to mid-November).

As explained in the "Effects of the Action" section above, dredging necessary to deepen the channel is likely to result in the entrainment of 1 shortnose sturgeon per 1,000,000cy of material removed with a cutterhead dredge in the river and 1 shortnose sturgeon per every 1,000,000 cy of material removed with a hopper dredge in the river and no entrainment for dredges operating in the Bay (Reaches D and E). This entrainment rate is expected to result in the mortality of no more than 8 shortnose sturgeon in cutterhead dredges and no more than 1 shortnose sturgeon in hopper dredges. Additionally, maintenance dredging in the river will also result in the mortality of shortnose sturgeon. NMFS has estimated that no more than 4 shortnose sturgeon are likely to be entrained and killed annually in maintenance dredging activities; thus, over the 10 year maintenance cycle contemplated in this Opinion, up to 40 shortnose sturgeon could be entrained and killed. Blasting will be conducted in the Marcus Hook area between December and February during the winters of 2009-2010 and 2010-2011. In the "Effects of the Action" section above, NMFS has estimated that no more than 3 shortnose sturgeon per winter are likely to be close enough to the detonation site that they will experience any effects from sound or pressure waves and that any of these fish may experience injuries which may result in mortality. Therefore, over the two winters of blasting, no more than 6 shortnose sturgeon will experience effects ranging from temporary stunning to mortal injury and death. Additionally, NMFS expects that no more than 1 shortnose sturgeon per winter (over two winters) is likely to be captured in the mechanical dredge operating to remove debris from the blasting area and that these 2 fish may be killed. Thus, in its entirety, the proposed action is likely to result in direct physical effects (i.e., capture, physical injury or mortality) to no more than 57 shortnose sturgeon, with no more than 57 mortalities.

While the dredging is likely to kill up to 57 shortnose sturgeon over a fifteen year period (i.e., 5 year initial deepening, plus 10 years of maintenance), this number represents a very small percentage of the shortnose sturgeon population in the Delaware River, which is believed to be increasing, and an even smaller percentage of the total population of shortnose sturgeon rangewide. It is also important to note that this mortality estimate is considered to be a worst case scenario and is based on conservative assumptions outlined in the "Effects of the Action" section above. Additionally, no more than 4 mortalities are expected to occur in any given year. The best available population estimates indicate that there are between 6,000 -14,000 adult shortnose sturgeon in the Delaware River and an unknown number of juveniles. While the death of 57 juvenile or adult shortnose sturgeon will reduce the number of shortnose sturgeon in the population compared to the number that would have been present absent the proposed action, it is not likely that this reduction in numbers will change the status of this population or its increasing trend as this loss represents only 0.4-0.95% of the population depending on the population estimate used.

This action is expected to have an undetectable reduction in reproduction of shortnose sturgeon in the Delaware River because, at worst, it would result in the loss of no more than 4 pre-spawning shortnose sturgeon per year. As thousands of shortnose sturgeon are expected to spawn each year in the Delaware River, the reduction in available spawners by no more than 4 each year and no more

than 57 over the 15 year project period is expected to result in an insignificant reduction in the number of eggs laid or larvae produced and similarly, an insignificant effect on the strength of subsequent year classes. Additionally, the proposed action will not affect spawning habitat in any way and will not create any barrier to pre-spawning sturgeon accessing the overwintering sites or the spawning grounds.

The proposed action is not likely to reduce distribution because the action will not impede shortnose sturgeon from accessing any seasonal concentration areas, including foraging, spawning or overwintering grounds in the Delaware River. Further, the action is not expected to reduce the river by river distribution of shortnose sturgeon. Additionally as the number of shortnose sturgeon likely to be killed as a result of the proposed action is less than 1% of the Delaware River population, there is not likely to be a loss of any unique genetic haplotypes and therefore, it is unlikely to result in the loss of genetic diversity.

While generally speaking, the loss of a small number of individuals from a subpopulation or species may have an appreciable effect on the numbers, reproduction and distribution of the species, this is likely to occur only when there are very few individuals in a population, the individuals occur in a very limited geographic range or the species has extremely low levels of genetic diversity. This situation is not likely in the case of shortnose sturgeon because: the species is widely geographically distributed, it is not known to have low levels of genetic diversity (see status of the species section above), and there are thousands of shortnose sturgeon spawning each year.

Based on the information provided above, the death of up to 57 shortnose sturgeon over a 15 year time period as a result of the proposed deepening project will not appreciably reduce the likelihood of survival (i.e., it will not increase the risk of extinction faced by this species) for this species given that: (1) the population trend of shortnose sturgeon in the Delaware River is increasing; (2) the death of 57 shortnose sturgeon represents an extremely small percentage of the number of shortnose sturgeon in the Delaware River and a even smaller percentage of the species as a whole; (3) the loss of these shortnose sturgeon will not change the status or trends of the species as a whole; (4) the loss of these shortnose sturgeon is likely to have an undetectable effect on reproductive output of the Delaware River population of shortnose sturgeon or the species as a whole; (5) and, the action will have no effect on the distribution of shortnose sturgeon in the action area or throughout its range.

Section 4(a)(1) of the ESA requires listing of a species if it is in danger of extinction throughout all or a significant portion of its range (i.e., "endangered"), or likely to become in danger of extinction throughout all or a significant portion of its range in the foreseeable future (i.e., "threatened") because of any of the following five listing factors: (1) The present or threatened destruction, modification, or curtailment of its habitat or range, (2) overutilization for commercial, recreational, scientific, or educational purposes, (3) disease or predation, (4) the inadequacy of existing regulatory mechanisms, (5) other natural or manmade factors affecting its continued existence. Recovery of a species occurs when listing it as an endangered or threatened species is no longer warranted. As explained above, the proposed action will not appreciably reduce the likelihood of survival of shortnose sturgeon. Also, it is not expected to modify, curtail or destroy the range of the species since it will result in an extremely small reduction in the number of shortnose sturgeon in any geographic area and since it will not affect the overall distribution of shortnose sturgeon other

than to cause minor temporary adjustments in movements in the action area. The proposed action will not utilize shortnose sturgeon for recreational, scientific or commercial purposes, affect the adequacy of existing regulatory mechanisms to protect any of these species of sea turtles, or affect their continued existence. The effects of the proposed action will not hasten the extinction timeline or otherwise increase the danger of extinction since the action will cause the mortality of only an extremely small percentage of the shortnose sturgeon in the Delaware River and an even smaller percentage of the species as a whole and these mortalities are not expected to result in the reduction of overall reproductive fitness for the species as a whole. Therefore, the proposed action will not appreciably reduce the likelihood that shortnose sturgeon can be brought to the point at which they are no longer listed as endangered or threatened. Based on the analysis presented herein, the proposed action, resulting in the mortality of no more than 57 shortnose sturgeon over a 15 year time period, is not likely to appreciably reduce the survival and recovery of this species.

Green and leatherback sea turtles

As noted in sections above, the physical disturbance of sediments and entrainment of associated benthic resources, could reduce the availability of sea turtle prey in the affected areas, but these reductions will be localized and temporary, and foraging turtles are not likely to be limited by the reductions and any effects will be insignificant. Also, as explained above, no green or leatherback sea turtles are likely to be entrained in any dredge operating to deepen or maintain the channel and neither of these species is likely to be involved in any collision with a project vessel. As all effects to green and leatherback sea turtles from the proposed project are likely to be insignificant or discountable, this action is not likely to adversely affect these species.

Kemp's ridley and Loggerhead sea turtles

In the "Effects of the Action" section above, NMFS determined that Kemp's ridleys could be entrained in a hopper dredge working to deepen Reach D or E or by a hopper dredge conducting maintenance dredging activities in either of these reaches. Based on a calculated entrainment rate of sea turtles for projects using hopper dredges in the action area, NMFS estimates that 1 sea turtle is likely to be entrained for every 450,000 cy of material removed with a hopper dredge. Also, based on the ratio of loggerhead and Kemp's ridleys entrained in other hopper dredge operations in the ACOE North Atlantic District, NMFS estimated that no more than 10% of the sea turtles entrained during project operations were likely to be Kemp's ridleys with the remainder loggerheads. Based on this, NMFS determined that of the 9 sea turtles likely to be entrained during the initial deepening, no more than 1 is likely to be a Kemp's ridley, with the remainder loggerheads. Similarly, of the 11 sea turtles likely to be entrained during 10 years of maintenance dredging in the Bay, no more than 1 is likely to be a Kemp's ridley, with the remainder loggerheads. As such, the proposed action is likely to result in the entrainment and mortality of no more than 20 sea turtles over a 15 year period, with no more than 2 of these being Kemp's ridleys and the remainder loggerheads.

Kemp's ridley sea turtles

The lethal removal of this number of Kemp's ridley sea turtles over the 15 year time period, whether males or females, immature or mature animals, would reduce the number of Kemp's ridley sea turtles as compared to the number of Kemp's ridleys that would have been present in the absence of the proposed action assuming all other variables remained the same; the loss of 2 Kemp's ridley over a 15 year time period represents a very small percentage of the species as a whole (less than

0.03%). The loss of up to 2 female Kemp's ridley sea turtles, annually, would be expected to reduce the reproduction of Kemp's ridley sea turtles as compared to the reproductive output of Kemp's ridley sea turtles in the absence of the proposed action. As described in the "Status of the Species" section above, NMFS considers the trend for Kemp's ridley sea turtles to be stable. Nevertheless, the death of up to 2 Kemp's ridley sea turtles annually as a result of the proposed deepening project will not appreciably reduce the likelihood of survival for the species for the following reasons. From 1985 to 1999, the number of Kemp's ridley nests observed at Rancho Nuevo and nearby beaches increased at a mean rate of 11.3% per year. An estimated 4,047 females nested in 2006 and an estimated 5,500 females nested in Tamaulipas (the primary but not sole nesting site) over a 3-day period in May 2007 (NMFS and USFWS 2007c). Based on the number of nests laid in 2006 and the remigration interval for Kemp's ridley sea turtles, there were an estimated 7,000-8,000 adult female Kemp's ridleys in 2006 (NMFS and USFWS 2007c). The observed increase in nesting of Kemp's ridley sea turtles suggests that the combined impact to Kemp's ridley sea turtles from on-going activities as described in the *Environmental Baseline*, *Cumulative Effects*, and the *Status of the Species* (for those activities that occur outside of the action area of this Opinion) are less than what has occurred in the past. The result of which is that more female Kemp's ridley sea turtles are maturing and subsequently nesting, and/or are surviving to an older age and producing more nests across their lifetime.

As described in the *Status of the Species* and *Environmental Baseline*, action has been taken to reduce anthropogenic effects to Kemp's ridley sea turtles. These include regulatory measures implemented in 2002 to reduce the number and severity of Kemp's ridley sea turtle interactions in the U.S. south Atlantic and Gulf of Mexico shrimp fisheries -- a leading known cause of Kemp's ridley sea turtle mortality. Since these regulatory measures are relatively recent, it is unlikely that current nesting trends reflect the benefit of these measures to Kemp's ridley sea turtles. Therefore, the current nesting trends for Kemp's ridley sea turtles are likely to improve as a result of regulatory action taken for the U.S. south Atlantic and Gulf of Mexico shrimp fisheries. There are no new known sources of injury or mortality for Kemp's ridley sea turtles.

While generally speaking, the loss of a small number of individuals from a subpopulation or species may have an appreciable reduction on the numbers, reproduction and distribution of the species this is likely to occur only when there are very few individuals in a population, the individuals occur in a very limited geographic range or the species has extremely low levels of genetic diversity. This situation is not likely in the case of Kemp's ridleys because: the species is widely geographically distributed, it is not known to have low levels of genetic diversity, there are several thousand individuals in the population and the number of Kemp's ridleys is likely to be increasing and at worst is stable. This action is not likely to reduce distribution of Kemp's ridleys because the action will not impede Kemp's ridleys from accessing the Delaware Bay foraging grounds or disrupt other migratory behaviors.

Based on the information provided above, the death of up to 2 Kemp's ridley sea turtles over a 15 year time period as a result of the proposed deepening project will not appreciably reduce the likelihood of survival (i.e., it will not increase the risk of extinction faced by this species) for Kemp's ridley sea turtles given that: (1) the species' nesting trend is increasing; (2) the death of 2 Kemp's ridleys represents an extremely small percentage of the species as a whole; (3) the loss of

these Kemp's ridleys will not change the status or trends of the species as a whole; (4) the loss of these loggerheads is likely to have an undetectable effect on reproductive output of the species as a whole; (5) the action will have no effect on the distribution of Kemp's ridleys in the action area or throughout its range; and (6) given measures that reduce the number of Kemp's ridley sea turtles injured and killed (which should result in increases to the numbers of Kemp's ridley sea turtles that would not have occurred in the absence of those regulatory measures).

Section 4(a)(1) of the ESA requires listing of a species if it is in danger of extinction throughout all or a significant portion of its range (i.e., "endangered"), or likely to become in danger of extinction throughout all or a significant portion of its range in the foreseeable future (i.e., "threatened") because of any of the following five listing factors: (1) The present or threatened destruction, modification, or curtailment of its habitat or range, (2) overutilization for commercial, recreational, scientific, or educational purposes, (3) disease or predation, (4) the inadequacy of existing regulatory mechanisms, (5) other natural or manmade factors affecting its continued existence. Recovery of a species occurs when listing it as an endangered or threatened species is no longer warranted. As explained above, the proposed action will not appreciably reduce the likelihood of survival of the Kemp's ridley sea turtle species. Also, it is not expected to modify, curtail or destroy the range of the species since it will result in an extremely small reduction in the number of Kemp's ridley sea turtles in any geographic area and since it will not affect the overall distribution of Kemp's ridley sea turtles other than to cause minor temporary adjustments in movements in the action area. The proposed action will not utilize Kemp's ridley sea turtles for recreational, scientific or commercial purposes, affect the adequacy of existing regulatory mechanisms to protect any of these species of sea turtles, or affect their continued existence. The effects of the proposed action will not hasten the extinction timeline or otherwise increase the danger of extinction since the action will cause the mortality of only an extremely small percentage of the Kemp's ridleys and these mortalities are not expected to result in the reduction of overall reproductive fitness for the species as a whole. Therefore, the proposed action will not appreciably reduce the likelihood that Kemp's ridley sea turtles can be brought to the point at which they are no longer listed as endangered or threatened. Based on the analysis presented herein, the proposed action, resulting in the mortality of no more than 2 Kemp's ridleys over a 15 year time period, is not likely to appreciably reduce the survival and recovery of this species.

Loggerhead sea turtles

Loggerheads are threatened throughout their entire range. This species exists as five subpopulations in the western Atlantic, recognized as recovery units in the 2008 Recovery Plan for this species, that show limited evidence of interbreeding. Based on information provided in this Opinion, NMFS anticipates the entrainment and mortality of no more than 20 loggerhead sea turtles over a period of 15 years. The lethal removal of this number of loggerhead sea turtles from the action area would be expected to reduce the number of loggerhead sea turtles from the recovery unit of which they originated as compared to the number of loggerheads that would have been present in the absence of the proposed actions (assuming all other variables remained the same). However, this does not necessarily mean that these recovery units will experience reductions in reproduction, numbers or distribution in response to these effects to the extent that survival and recovery would be appreciably reduced. The final revised recovery plan compiled the most recent information on mean number of loggerhead nests and the approximated counts of nesting females per year for four

of the five identified recovery units (i.e., nesting groups). They are: (1) for the NRU, a mean of 5,215 loggerhead nests per year with approximately 1,272 females nesting per year; (2) for the PFRU, a mean of 64,513 nests per year with approximately 15,735 females nesting per year; (3) for the DTRU, a mean of 246 nests per year with approximately 60 females nesting per year; and (4) for the NGMRU, a mean of 906 nests per year with approximately 221 females nesting per year. For the GCRU, the only estimate available for the number of loggerhead nests per year is from Quintana Roo, Yucatán, Mexico, where a range of 903-2,331 nests per year was estimated from 1987-2001 (NMFS and USFWS 2007a). There are no annual nest estimates available for the Yucatán since 2001 or for any other regions in the GCRU, nor are there any estimates of the number of nesting females per year for any nesting assemblage in this recovery unit.

It is likely that the sea turtles entrained in hopper dredges operating in Delaware Bay originate from several of the recovery units. Limited information is available on the genetic makeup of sea turtles in the mid-Atlantic, including Delaware Bay. Cohorts from each of the five western Atlantic subpopulations are expected to occur in the action area. Genetic analysis of samples collected from immature loggerhead sea turtles captured in pound nets in the Pamlico-Albemarle Estuarine Complex in North Carolina from September-December of 1995-1997 indicated that cohorts from all five western Atlantic subpopulations were present (Bass et al. 2004). In a separate study, genetic analysis of samples collected from loggerhead sea turtles from Massachusetts to Florida found that all five western Atlantic loggerhead subpopulations were represented (Bowen et al. 2004). Bass et al. (2004) found that 80 percent of the juveniles and sub-adults utilizing the foraging habitat originated from the south Florida nesting population, 12 percent from the northern subpopulation, 6 percent from the Yucatan subpopulation, and 2 percent from other rookeries. The previously defined loggerhead subpopulations do not share the exact delineations of the recovery units identified in the 2008 recovery plan. However, the PFRU encompasses both the south Florida and Florida panhandle subpopulations, the NRU is roughly equivalent to the northern nesting group, the Dry Tortugas subpopulation is equivalent to the DTRU, and the Yucatan subpopulation is included in the GCRU.

Based on the genetic analysis presented in Bass et al. (2004) and the small number of loggerheads from the DTRU or the NGMRU likely to occur in the action area it is extremely unlikely that any of the up to 20 loggerheads that are likely to be entrained during dredging operations are likely to have originated from either of these recovery units. The majority, at least 80% of the loggerheads entrained, are likely to have originated from the PFRU, with the remainder from the NRU and GCRU. As such, 16 of the sea turtles are expected to be from the PFRU, 3 from the NRU and 1 from the GCRU.

As noted above, the most recent population estimates indicate that there are approximately 15,735 females nesting annually in the PFRU and approximately 1,272 females nesting per year in the NRU. For the GCRU, the only estimate available for the number of loggerhead nests per year is from Quintana Roo, Yucatán, Mexico, where a range of 903-2,331 nests per year was estimated from 1987-2001 (NMFS and USFWS 2007a). There are no annual nest estimates available for the Yucatán since 2001 or for any other regions in the GCRU, nor are there any estimates of the number of nesting females per year for any nesting assemblage in this recovery unit; however, the 2008 recovery plan indicates that the Yucatan nesting aggregation has at least 1,000 nesting females

annually. As the numbers outlined here are only for nesting females, the total number of loggerhead sea turtles in each recovery unit is likely significantly higher. The loss of 16 loggerheads over a 15 year time period represents an extremely small percentage of the number of sea turtles in the PFRU. Even if the total population was limited to 15,735 loggerheads, the loss of 16 individuals would represent approximately 0.1% of the population. Similarly, the loss of 3 loggerheads over a 15 year period from the NRU represents an extremely small percentage of the recovery unit. Even if the total population was limited to 1,272 sea turtles, the loss of 3 individuals would represent approximately 0.24% of the population. The loss of 1 loggerhead over a 15 year time period from the GCRU, which is expected to support at least 1,000 nesting females, represents less than 0.1% of the population. The loss of such a small percentage of the individuals from any of these recovery units represents an even smaller percentage of the species as a whole. As such, it is unlikely that the death of these individuals will have a detectable effect on the numbers and population trends of loggerheads in these recovery units or the number of loggerheads in the population as a whole. Additionally, this action is not likely to reduce distribution of loggerheads because the action will not impede loggerheads from accessing suitable foraging grounds or disrupt other migratory behaviors.

In general, while the loss of a small number of individuals from a subpopulation or species may have an appreciable reduction on the numbers, reproduction and distribution of the species, this is likely to occur only when there are very few individuals in a population, the individuals occur in a very limited geographic range or the species has extremely low levels of genetic diversity. This situation is not likely in the case of loggerhead sea turtles because: the species is widely geographically distributed, it is not known to have low levels of genetic diversity, and there are several thousand individuals in the population.

Based on the information provided above, the death of up to 20 loggerhead sea turtles over a 15 year time period as a result of the proposed deepening project will not appreciably reduce the likelihood of survival (i.e., it will not increase the risk of extinction faced by this species) for loggerhead sea turtles given that: (1) the death of 20 loggerheads represents an extremely small percentage of the species as a whole; (2) the loss of these loggerheads will not change the status or trends of any nesting aggregation, recovery unit or the species as a whole; (3) the loss of these loggerheads is likely to have an undetectable effect on reproductive output of any nesting aggregation or the species as a whole; and, (4) the action will have no effect on the distribution of loggerheads in the action area or throughout its range.

Section 4(a)(1) of the ESA requires listing of a species if it is in danger of extinction throughout all or a significant portion of its range (i.e., "endangered"), or likely to become in danger of extinction throughout all or a significant portion of its range in the foreseeable future (i.e., "threatened") because of any of the following five listing factors: (1) The present or threatened destruction, modification, or curtailment of its habitat or range, (2) overutilization for commercial, recreational, scientific, or educational purposes, (3) disease or predation, (4) the inadequacy of existing regulatory mechanisms, (5) other natural or manmade factors affecting its continued existence. Recovery of a species occurs when listing it as an endangered or threatened species is no longer warranted. As explained above, the proposed action will not appreciably reduce the likelihood of survival of the loggerhead sea turtle species. Also, it is not expected to modify, curtail or destroy

the range of the species since it will result in an extremely small reduction in the number of loggerheads in any geographic area and since it will not affect the overall distribution of loggerheads other than to cause minor temporary adjustments in movements in the action area. The proposed action will not utilize loggerheads for recreational, scientific or commercial purposes, affect the adequacy of existing regulatory mechanisms to protect any of these species of sea turtles, or affect their continued existence. The effects of the proposed action will not hasten the extinction timeline or otherwise increase the danger of extinction since the action will cause the mortality of only an extremely small percentage of the loggerheads in any nesting aggregation, recovery unit or the species as whole and these mortalities are not expected to result in the reduction of overall reproductive fitness for the species as a whole. Therefore, the proposed action will not appreciably reduce the likelihood that loggerhead sea turtles can be brought to the point at which they are no longer listed as endangered or threatened. Based on the analysis presented herein, the proposed action, resulting in the mortality of no more than 20 loggerheads over a 15 year time period, is not likely to appreciably reduce the survival and recovery of this species.

CONCLUSION

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

INCIDENTAL TAKE STATEMENT

Section 9 of the ESA and Federal regulations pursuant to section 4(d) of the ESA prohibit the take of endangered and threatened species respectively, without special exemption. Take is defined as to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture or collect, or to attempt to engage in any such conduct. NMFS interprets the term "harm" as an act which actually kills or injures fish or wildlife. Such an act may include significant habitat modification or degradation where it actually kills or injures fish or wildlife by significantly impairing essential behavioral patterns, including breeding, spawning, rearing, migrating, feeding or sheltering (50 CFR §222.102). Incidental take is defined as take that is incidental to, and not the purpose of, the carrying out of an otherwise lawful activity. Under the terms of section 7(b)(4) and section 7(o)(2), taking that is incidental to and not intended as part of the agency action is not considered to be prohibited under the ESA provided that such taking is in compliance with the terms and conditions of this Incidental Take Statement.

Amount or Extent of Incidental Take

The proposed dredging project has the potential to directly affect shortnose sturgeon by causing sturgeon to become entrained in the dredge. These interactions are likely to cause mortality to the affected shortnose sturgeon. Based on the known seasonal distribution of shortnose sturgeon in the Delaware River information available on historic interactions between listed species and dredging operations, and the entrainments rates calculated in the accompanying Opinion, NMFS anticipates the following levels of take:

Contract 1 (Reach C) – 1 shortnose sturgeon

Contract 3 (Reaches AA and A) – 2 shortnose sturgeon
Contract 4 (Reach E) – 3 sea turtles
Contract 5 (Reach E) – 5 sea turtles
Contract 6 (Reach D) – 1 sea turtle
Contract 7 (Reach B) – 5 shortnose sturgeon

NMFS anticipates that of the 9 sea turtles likely to be killed during dredging operations, no more than 1 is likely to be a Kemp's ridley and the remainder are likely to be loggerheads. All of the take noted above for sea turtles and shortnose sturgeon is likely to be lethal take due to entrainment in a cutterhead or hopper dredge.

Annual maintenance dredging will also occur. As outlined in the "Effects of the Action" section of the accompanying Opinion, for shortnose sturgeon, no more than one is likely to be killed for every 1,000,000 cy of material removed from the river (Reaches AA, A, B or C) with no shortnose sturgeon take likely to occur for maintenance dredging in Reaches D or E. As explained in the accompanying Opinion, NMFS has estimated that for sea turtles, no more than 1 sea turtle is likely to be killed for every 450,000 cy of material removed from Reaches D and E during annual maintenance dredging, with no more than 9 sea turtles entrained over the 10 years of maintenance, with no more than 1 a Kemp's ridley. All take associated with maintenance dredging is likely to be lethal due to entrainment in a cutterhead or hopper dredge. NMFS has also estimated that no more than 4 shortnose sturgeon are likely to be killed during maintenance dredging operations each year.

Additionally, the take of shortnose sturgeon is likely during blasting and subsequent debris removal with a mechanical dredge. Blasting and debris removal will occur over two winters. As explained in the effects of the action section in the accompanying Opinion, no more than 3 shortnose sturgeon per winter are likely to be exposed to sound and pressure waves that could cause adverse affects. These sturgeon could be temporarily stunned and experience complete recovery (harm), or experience minor to significant injury resulting in mortality. As such, the lethal take of no more than 6 shortnose sturgeon during blasting operations is likely. Additionally, the capture and subsequent injury and/or mortality of no more than 2 shortnose sturgeon in the mechanical dredge is likely (one per winter).

Based on these estimates, a total of no more than 57 shortnose sturgeon are likely to be lethally taken in association with project operations. This level of take accounts for the initial deepening as well as 10 years of maintenance and includes take associated with blasting and mechanical dredging operations. For sea turtles, no more than 20 sea turtles are likely to be killed in association with project operations, including the initial deepening and 10 years of maintenance. NMFS believes this level of incidental take is reasonable given the seasonal distribution and abundance of shortnose sturgeon and sea turtles in the action area, the level of take historically in other dredging projects in the action area, and the level of take of shortnose sturgeon and sea turtles at other dredging projects. In the accompanying biological opinion, NMFS determined that this level of anticipated take is not likely to result in jeopardy to shortnose sturgeon, or loggerhead or Kemp's ridley sea turtles.

Reasonable and prudent measures
NMFS believes the following reasonable and prudent measures are necessary and appropriate to

minimize and monitor impacts of incidental take resulting from the proposed action:

RPMs related to Dredging Activities

1. NMFS must be contacted prior to the commencement of dredging and again upon completion of the dredging activity. This applies to all contracts executed in the initial construction of the 45-foot channel and all subsequent maintenance dredging activities.

2. For cutterhead dredging, an inspector, with sufficient training to identify sturgeon, must be present at the disposal site to conduct daily inspections for biological materials, including shortnose sturgeon or sturgeon parts. This applies to the initial construction of the 45-foot channel and all subsequent maintenance dredging activities using a cutterhead dredge, regardless of time of year or reach being dredged.

3. The ACOE shall ensure that for dredging occurring in the Bay (i.e., reaches D and E) from May 1 – November 15, hopper dredges are outfitted with state-of-the-art sea turtle deflectors on the draghead and operated in a manner that will reduce the risk of interactions with sea turtles.

4. For hopper dredge operations in the river (i.e., reaches AA, A, B or C), a NMFS-approved observer must be present on board the hopper dredge any time it is operating in the river.

5. For hopper dredge operations in the Bay (reaches D and E), a NMFS-approved observer must be present on board the hopper dredge from May 1 – November 15.

6. The ACOE shall ensure that dredges are equipped and operated in a manner that provides endangered/threatened species observers with a reasonable opportunity for detecting interactions with listed species and that provides for handling, collection, and resuscitation of turtles injured during project activity. Full cooperation with the endangered/threatened species observer program is essential for compliance with the ITS.

7. The ACOE shall ensure that all measures are taken to protect any turtles or shortnose sturgeon that survive entrainment in a hopper dredge.

8. All interactions with listed species during dredging operations must be properly documented and promptly reported to NMFS.

RPMs related to Blasting and Associated Mechanical Dredging

9. Each winter, NMFS must be contacted prior to the commencement of blasting and again upon completion of the blasting and subsequent mechanical dredging activity.

10. The ACOE will utilize a procedure designed in association with NMFS to minimize the potential for detonations to occur when shortnose sturgeon are within 500 feet of the blast location.

11. Blasting must be conducted in a manner designed to minimize the potential for fish kills.

12. Acoustic measurement of the first three detonations must be conducted to confirm the underwater pressure levels estimated by ACOE.

13. The ACOE must design and implement a monitoring plan to ensure that any shortnose sturgeon killed during blasting are recorded.

14. An endangered species observer must be present to observe all mechanical dredging activities where debris will be deposited to monitor for any capture of shortnose sturgeon.

15. The ACOE must ensure that all measures are taken to protect any shortnose sturgeon that survive capture in the mechanical dredge.

16. All interactions or observations of shortnose sturgeon must be reported to NMFS within 24 hours.

Terms and conditions

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

1. To implement RPM #1, the ACOE must contact NMFS (Julie Crocker: by email (julie.crocker@noaa.gov) or phone (978) 282-8480 or (978)-281-9328)) within 3 days of the commencement of each dredging cycle (initial construction and maintenance) and again within 3 days of the completion of dredging activity. This correspondence will serve both to alert NMFS of the commencement and cessation of dredging activities and to give NMFS an opportunity to provide ACOE with any updated contact information or reporting forms.

2. To implement RPM #2, for cutterhead dredging, the ACOE must require at least daily inspections at the disposal area in order to document any fish entrained in the dredge, including shortnose sturgeon or their parts. The ACOE must provide training in sturgeon identification to inspectors working at the dredge disposal site.

3. To implement RPM #2, the ACOE shall ensure that the disposal site is equipped and operated in a manner that provides the inspector with a reasonable opportunity for detecting interactions with listed species and that provides for handling and collection of listed species during project activity.

4. To implement RPM #3, hopper dredges operating in Reaches D or E from May 1 – November 15, must be equipped with the rigid deflector draghead as designed by the ACOE Engineering Research and Development Center, formerly the Waterways Experimental Station (WES), or if that is unavailable, a rigid sea turtle deflector attached to the draghead. Deflectors must be checked and/or adjusted by a designated expert prior to a dredge operation to insure proper installment and operation during dredging. The deflector must be checked after every load throughout the dredge operation to ensure that proper installation is maintained. Since operator skill is important to the effectiveness of the WES-developed

draghead, operators must be properly instructed in its use. Dredge inspectors must ensure that all measures to protect sea turtles are being followed during dredge operations.

5. To implement RPM #4, observer coverage on hopper dredges operating in the river (reaches AA – C) must be sufficient for 100% monitoring of hopper dredging operations. This monitoring coverage must involve the placement of a NMFS-approved observer on board the dredge for every day that dredging is occurring. The observer must work a shift schedule appropriate to allow for the observation of at least 50% of the dredge loads (e.g., 12 hours on, 12 hours off). The ACOE must ensure that ACOE dredge operators and/or any dredge contractor adhere to the attached "Monitoring Specifications for Hopper Dredges" with trained NMFS-approved observers, in accordance with the attached "Observer Protocol" and "Observer Criteria" (Appendix A).

6. To implement RPM #5, observer coverage is required on all hopper dredges operating in the Bay (reaches D and E) during the period of May 1 - November 15. This monitoring coverage must involve the placement of a NMFS-approved observer on board the dredge for every day that dredging is occurring. The observer must work a shift schedule appropriate to allow for the observation of at least 50% of the dredge loads (e.g., 12 hours on, 12 hours off). ACOE must ensure that ACOE dredge operators and/or any dredge contractor adhere to the attached "Monitoring Specifications for Hopper Dredges" with trained NMFS-approved observers, in accordance with the attached "Observer Protocol" and "Observer Criteria" (Appendix A).

7. To implement RPM #5, the ACOE shall require of the dredge operator that, when the observer is off watch, the cage shall not be opened unless it is clogged. The ACOE shall also require that if it is necessary to clean the cage when the observer is off watch, any aquatic biological material is left in the cage for the observer to document and clear out when they return on duty. In addition, the observer shall be the only one allowed to clean off the overflow screen.

8. To implement RPM #6, if sea turtles are present during dredging or material transport, vessels transiting the area must post a bridge watch, avoid intentional approaches closer than 100 yards when in transit, and reduce speeds to below 4 knots if bridge watch identifies a listed species in the immediate vicinity of the dredge.

9. To implement RPM #6, the ACOE must ensure that all contracted personnel involved in operating hopper dredges receive thorough training on measures of dredge operation that will minimize takes of sea turtles. Training shall include measures discussed in Appendix A.

10. To implement RPM #7, the procedures for handling live sea turtles must be followed in the unlikely event that a sea turtle survives entrainment in the dredge (Appendix B).

11. To implement RPM #8, if a shortnose sturgeon, sea turtle or their parts are taken in dredging operations, the take must be documented on the form included as Appendix C and submitted to NMFS along with the final report (T&C # 19).

12. To implement RPM #8, the ACOE must contact NMFS within 24 hours of any interactions with shortnose sturgeon or sea turtles, including non-lethal and lethal takes. NMFS will provide contact information annually when alerted of the start of dredging activity. Until alerted otherwise, the ACOE should contact Julie Crocker: by email (julie.crocker@noaa.gov) or phone (978) 282-8480 or the Section 7 Coordinator by phone (978)281-9328 or fax 978-281-9394).

13. To implement RPM #8, the ACOE must photograph and measure any shortnose sturgeon or sea turtles observed during project operations (including whole sturgeon or sea turtles or body parts observed at the disposal location or on board the dredge, hopper or scow) and the corresponding form (Appendix C) must be completed and submitted to NMFS **within 24 hours** by fax (978-281-9394).

14. To implement RPM #8, in the event of any lethal takes of shortnose sturgeon or sea turtles, any dead specimens or body parts must be photographed, measured, and preserved (refrigerate or freeze) until disposal procedures are discussed with NMFS. The form included as Appendix C must be completed and submitted to NMFS as noted above.

15. To implement RPM #8, if a dead sea turtle or sea turtle part is taken in dredging operations, a genetic sample must be taken following the procedure outlined in Appendix D.

16. To implement RPM #8, the ACOE must require that if any lethal take of shortnose sturgeon occurs, the NMFS-approved observer must take fin clips (according to the procedure outlined in Appendix E) to be returned to NMFS for ongoing analysis of the genetic composition of the Delaware River shortnose sturgeon population.

17. To implement RPM #8, if a decomposed turtle or turtle part is entrained during dredging operations, an incident report must be completed and the specimen must be photographed. Any turtle parts that are considered 'not fresh' (i.e., they were obviously dead prior to the dredge take and ACOE anticipates that they will not be counted towards the ITS) must be frozen and transported to a nearby stranding or rehabilitation facility for review. ACOE must ensure that the observer submits the incident report for the decomposed turtle part, as well as photographs, to NMFS within 24 hours of the take (see Appendix C) and request concurrence that this take should not be attributed to the Incidental Take Statement. NMFS shall have the final say in determining if the take should count towards the Incidental Take Statement.

18. To implement RPM #8, any time a take occurs ACOE must immediately contact NMFS at (978) 281-9328 to review the situation. At that time, ACOE must provide NMFS with information on the amount of material dredged thus far and the amount remaining to be dredged during that cycle. Also at that time, ACOE should discuss with NMFS whether any new management measures could be implemented to prevent the total incidental take level from being exceeded

19. To implement RPM #8, the ACOE must submit a final report summarizing the results of dredging and any takes of listed species to NMFS within 30 working days of the completion

of each dredging contract (by mail to the attention of the Section 7 Coordinator, NMFS Protected Resources Division, 55 Great Republic Drive, Gloucester, MA 01930). This report must be submitted at the close of each dredging contract during construction of the 45 foot channel as well as each time maintenance dredging is required.

20. To implement RPM#8 and #16, if the take estimate for any contract is exceeded, ACOE must work with NMFS to determine whether the additional take represents new information revealing effects of the action that may not have been previously considered.

21. To implement RPM #9, each winter that blasting is undertaken, the ACOE must inform NMFS of the commencement of blasting operations 3 days prior to the actual start date and of the completion date within 3 days after the actual end of operations.

22. To implement RPM #10, at least 45 days prior to the commencement of blasting, the ACOE will submit to NMFS a plan outlining the measures the ACOE will take to ensure that no shortnose sturgeon are present within 500 feet of the detonation site. This plan must involve the use of an underwater imaging system (sonar fish finder, DIDSON, video etc.) to document the presence of fish in the area surrounding the blast site. This plan must be developed with input from shortnose sturgeon experts. The plan must also contain measures to ensure that the 500-foot radius surrounding the detonation site is clear within 30 minutes of the commencement of the detonation.

23. To implement RPM#11, the ACOE will not commence blasting operations prior to receiving confirmation from NMFS that the blasting plan is acceptable.

24. To implement RPM#11, the ACOE will ensure that no blasting occur when shortnose sturgeon are detected within 500 feet of the blast site and that the contractor follows all procedures outlined in the plan described in T&C #20.

25. To implement RPM #12, acoustic monitoring must be conducted on the first day of blasting to verify that sound levels at 140 feet and 500 feet from the blasting is less than or equal to the values estimated by ACOE (i.e., peak 120psi, average 70psi at 140 feet, with noise levels below 180dB at 500 feet). Results of this monitoring must be reported to NMFS prior to any subsequent blasting.

26. To implement RPM#13, at least 45 days prior to the commencement of blasting, the ACOE will submit to NMFS a plan outlining the measures the ACOE will take to monitor for injured or dead shortnose sturgeon following blasting. This plan must include the use of observers to monitor an area with a radius of at least 1000 feet surrounding the blast site for dead fish.

27. To implement RPM#14, for mechanical dredging following blasting operations, the ACOE must require that observer coverage is sufficient for 100% monitoring of dredging operations. This monitoring coverage must involve the placement of a NMFS-approved observer on board the dredge for every day that dredging is occurring. The observer must work a shift schedule appropriate to allow for the observation of at least 50% of the dredge

loads (e.g., 12 hours on, 12 hours off). The NMFS approved observer must observe all discharges of dredged material from the dredge bucket to the scow or hopper. All biological material disposed of at the disposal site must be documented by a NMFS-approved observer as outlined in Appendix F.

28. To implement RPM #14, the ACOE must contact NMFS within 24 hours of any interactions with shortnose sturgeon or sea turtles, including non-lethal and lethal takes. NMFS will provide contact information annually when alerted of the start of dredging activity. Until alerted otherwise, the ACOE should contact Julie Crocker: by email (julie.crocker@noaa.gov) or phone (978) 282-8480 or the Section 7 Coordinator by phone (978)281-9328 or fax 978-281-9394).

29. To implement RPM #15, any shortnose sturgeon observed in the dredge scow during mechanical dredging operations must be removed with a net and, if alive, returned to the river away from the blasting site.

30. To implement RPM #16, the ACOE must photograph and measure any shortnose sturgeon observed during blasting operations (including whole sturgeon or body parts observed at the detonation site, on board the scow, or at the disposal site) and the corresponding form (Appendix C) must be completed and submitted to NMFS **within 24 hours** by fax (978-281-9394) or e-mail (Julie.Crocker@noaa.gov).

31. To implement RPM #16, in the event of any lethal takes of shortnose sturgeon, any dead specimens or body parts must be photographed, measured, and preserved (refrigerate or freeze) until disposal procedures are discussed with NMFS. The form included as Appendix C must be completed and submitted to NMFS as noted above.

32. To implement RPM #16, the ACOE must submit a final report summarizing the results of blasting and associated mechanical dredging and any takes of listed species to NMFS within 30 working days of each winter's blasting activities by mail (to the attention of the Section 7 Coordinator, NMFS Protected Resources Division, 55 Great Republic Drive, Gloucester, MA 01930).

33. To implement RPM #16, the ACOE must require that if any lethal take of shortnose sturgeon occurs, the NMFS-approved observer must take fin clips (according to the procedure outlined in Appendix E) to be returned to NMFS for ongoing analysis of the genetic composition of the Delaware River shortnose sturgeon population.

The reasonable and prudent measures, with their implementing terms and conditions, are designed to minimize and monitor the impact of incidental take that might otherwise result from the proposed action. Specifically, these RPMs and Terms and Conditions will keep NMFS informed of when and where dredging and blasting activities are taking place and will require ACOE to report any take in a reasonable amount of time, as well as implement measures to monitor for entrainment during dredging and avoid conducting blasting activities when shortnose sturgeon are in the immediate area surrounding the blast site. The ACOE has reviewed the RPMs and Terms and Conditions outlined above and has agreed to implement all of these measures as described herein and in the referenced

Appendices. The discussion below explains why each of these RPMs and Terms and Conditions are necessary and appropriate to minimize or monitor the level of incidental take associated with the proposed action and how they represent only a minor change to the action as proposed by the ACOE.

RPM #1 and #9 and Term and Condition #1 and #21 are necessary and appropriate because they will serve to ensure that NMFS is aware of the dates and locations of all dredging and blasting activities. This will allow NMFS to monitor the duration and seasonality of dredging activities as well as give NMFS an opportunity to provide ACOE with any updated contact information for NMFS staff. This is only a minor change because it is not expected to result in any delay to the project and will merely involve an occasional telephone call or e-mail between ACOE and NMFS staff.

Several of the RPMs (#2,4, 5 and 14) as well as the implementing Term and Conditions (#2, 3, 5,6,7, and 27-28) are necessary and appropriate because they require that the ACOE have sufficient observer coverage to ensure the detection of any interactions with listed species. This is necessary for the monitoring of the level of take associated with the proposed action. The inclusion of these RPMs and Terms and Conditions is only a minor change as the ACOE included some level of observer coverage in the original project description and the increase in coverage (i.e., the addition of the month of May for hopper dredges operating in the Bay, the addition of observers for hopper dredges operating in the river) will represent only a small increase in the cost of the project and will not result in any delays. These also represent only a minor change as in many instances they serve to clarify the duties of the inspectors or observers.

RPM #3 and Term and Condition #4, is necessary and appropriate as the use of draghead deflectors is accepted standard practice for hopper dredges operating in places and at times of year when sea turtles are known to be present and has been documented to reduce the risk of entrainment for sea turtles, thereby minimizing the potential for take of these species. This represents only a minor change as all of the hopper dredges likely to be used for this project, including the ACOE owned McFarland which may be used for maintenance dredging, already have draghead deflectors, dredge operators are already familiar with their use, and the use will not affect the efficiency of the dredging operation. Additionally, maintenance of the existing channel is conducted with draghead deflectors in place.

RPM #6 and Term and Condition #8 are necessary and appropriate as they will require that dredge operators use best management practices, including slowing down to 4 knots should listed species be observed, that will minimize the likelihood of take. This represents only a minor change as following these procedures should not increase the cost of the dredging operation or result in any delays of reduction of efficiency of the dredging project.

RPM #7 and #15 and Term and Condition #10, #11, and 29 are necessary and appropriate to ensure that any sea turtles or shortnose sturgeon that survive entrainment in a hopper dredge or capture in a mechanical dredge are given the maximum probability of remaining alive and not suffering additional injury or subsequent mortality through inappropriate handling. This represents only a minor change as following these procedures will not result in an increase in cost or any delays to the

proposed project.

RPM #8 and #16 and Terms and Conditions (#11 – 20, #30-33) are necessary and appropriate to ensure the proper handling and documentation of any interactions with listed species as well as requiring that these interactions are reported to NMFS in a timely manner with all of the necessary information. This is essential for monitoring the level of incidental take associated with the proposed action. RPM #20 requires that ACOE work with NMFS to determine if any takes above those estimated for each contract represent new information on the effects of the project that was not previously considered. In a situation where the estimated level of take for a particular contract is exceeded but the overall level of take exempted by the ITS is not exceeded, compliance with this condition will allow ACOE and NMFS to determine if reinitiation of consultation is necessary at the time that the take occurs. These RPMs and Terms and Conditions represent only a minor change as compliance will not result in any increased cost, delay of the project or decrease in the efficiency of the dredging operations.

RPM #10 and #11 and their implementing Terms and Conditions (#22-24) are necessary and appropriate to minimize the potential for blasting activities to take place when shortnose sturgeon are within 500 meters of the detonation site. This represents only a minor change as the plan to be implemented will be designed by ACOE in cooperation with NMFS and is not anticipated to result in any increased cost, delays of the project or decreased efficiency of blasting operations. Further, the plan will not alter the time of year or location of detonation sites.

RPM #12 and Term and Condition #25 are necessary and appropriate because they are designed to verify that the sound and pressure levels presented by ACOE and relied on by NMFS in estimating take are valid and that a 500 meter exclusion zone is sufficient. This RPM and Term and Condition does not cause more than minor changes because it merely provides additional clarification to the requirement already imposed by the ACOE to conduct underwater monitoring of pressure levels associated with blasting. The clarification of the already required pressure monitoring and the inclusion of sound monitoring will not cause delays to the project or add a significant cost.

RPM #13 and Term and Condition #26 are necessary and appropriate to ensure the proper handling and documentation of any interactions with listed species. This represents only a minor change as the monitoring plan will be developed by ACOE in cooperation with NMFS and it is not anticipated to result in any increased cost, delay of the project or decrease in the efficiency of the dredging operations.

CONSERVATION RECOMMENDATIONS

Section 7(a)(1) of the ESA directs Federal agencies to utilize their authorities to further the purposes of the ESA by carrying out conservation programs for the benefit of endangered and threatened species. Conservation recommendations are discretionary agency activities to minimize or avoid adverse effects of a proposed action on listed species or critical habitat, to help implement recovery plans, or to develop information. NMFS has determined that the proposed action is not likely to jeopardize the continued existence of shortnose sturgeon, Kemp's ridley or loggerhead sea turtles

and is not likely to adversely affect green or leatherback sea turtles. To further reduce the adverse effects of the dredging on listed species, NMFS recommends that ACOE implement the following conservation recommendations.

(1) To the extent practicable, the ACOE should avoid dredging during times of year when listed species are likely to be present.

(2) Population information on certain life stages of shortnose sturgeon is still sparse for this river system. The ACOE should continue to support studies to evaluate habitat and the use of the river, in general, by juveniles as well as use of the area below Philadelphia by all life stages.

(3) If any lethal take occurs, the ACOE should arrange for contaminant analysis of the specimen. If this recommendation is to be implemented, the fish should be immediately frozen and NMFS should be contacted within 24 hours to provide instructions on shipping and preparation

REINITIATION OF CONSULTATION

This concludes formal consultation on the proposal by the ACOE to deepen the Delaware River Philadelphia to the Sea federal navigation project. As provided in 50 CFR §402.16, reinitiation of formal consultation is required where discretionary federal agency involvement or control over the action has been retained (or is authorized by law) and if: (1) the amount or extent of taking specified in the incidental take statement is exceeded; (2) new information reveals effects of the action that may not have been previously considered; (3) the identified action is subsequently modified in a manner that causes an effect to listed species; or (4) a new species is listed or critical habitat designated that may be affected by the identified action. In instances where the amount or extent of incidental take is exceeded, Section 7 consultation must be reinitiated immediately.

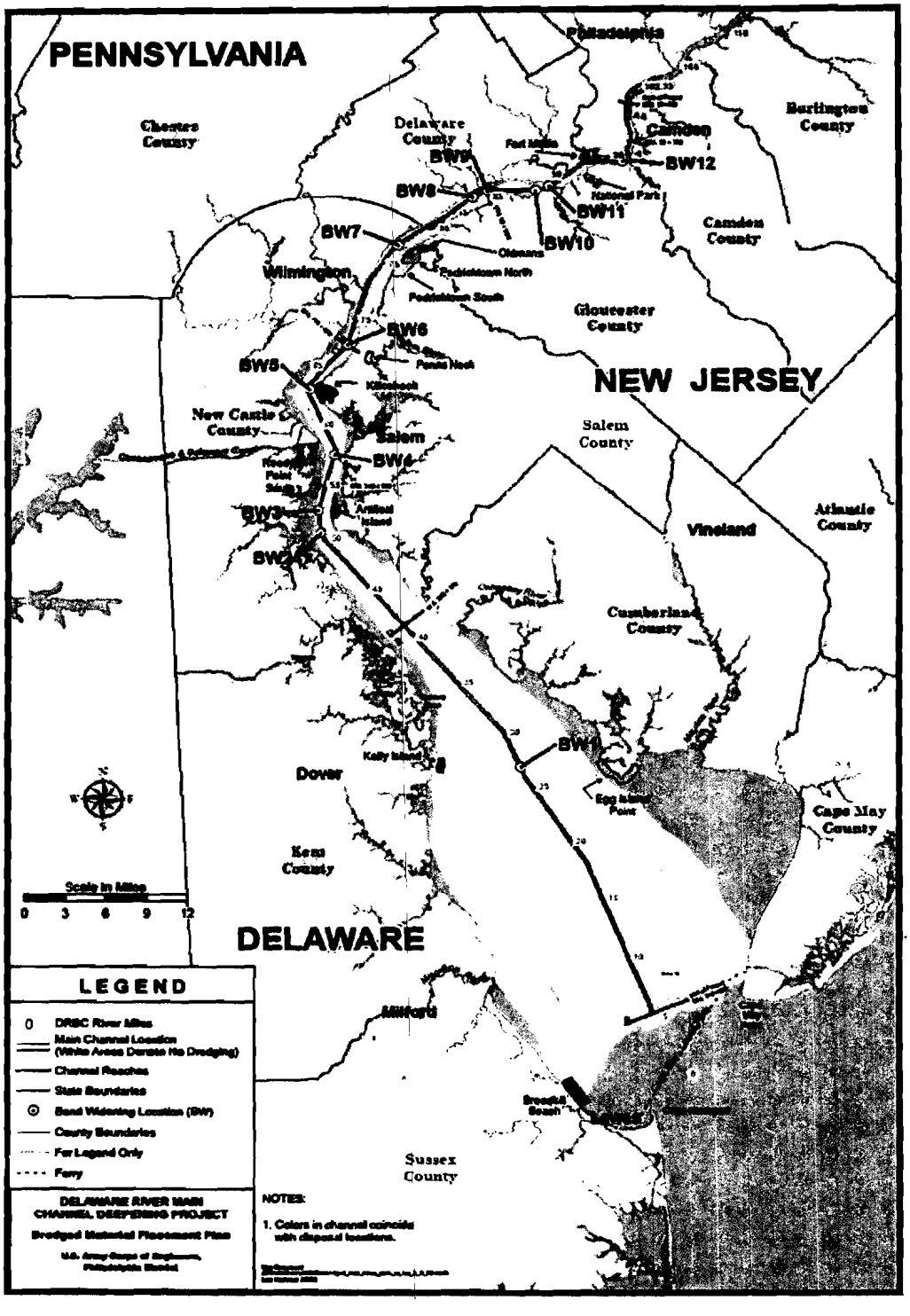
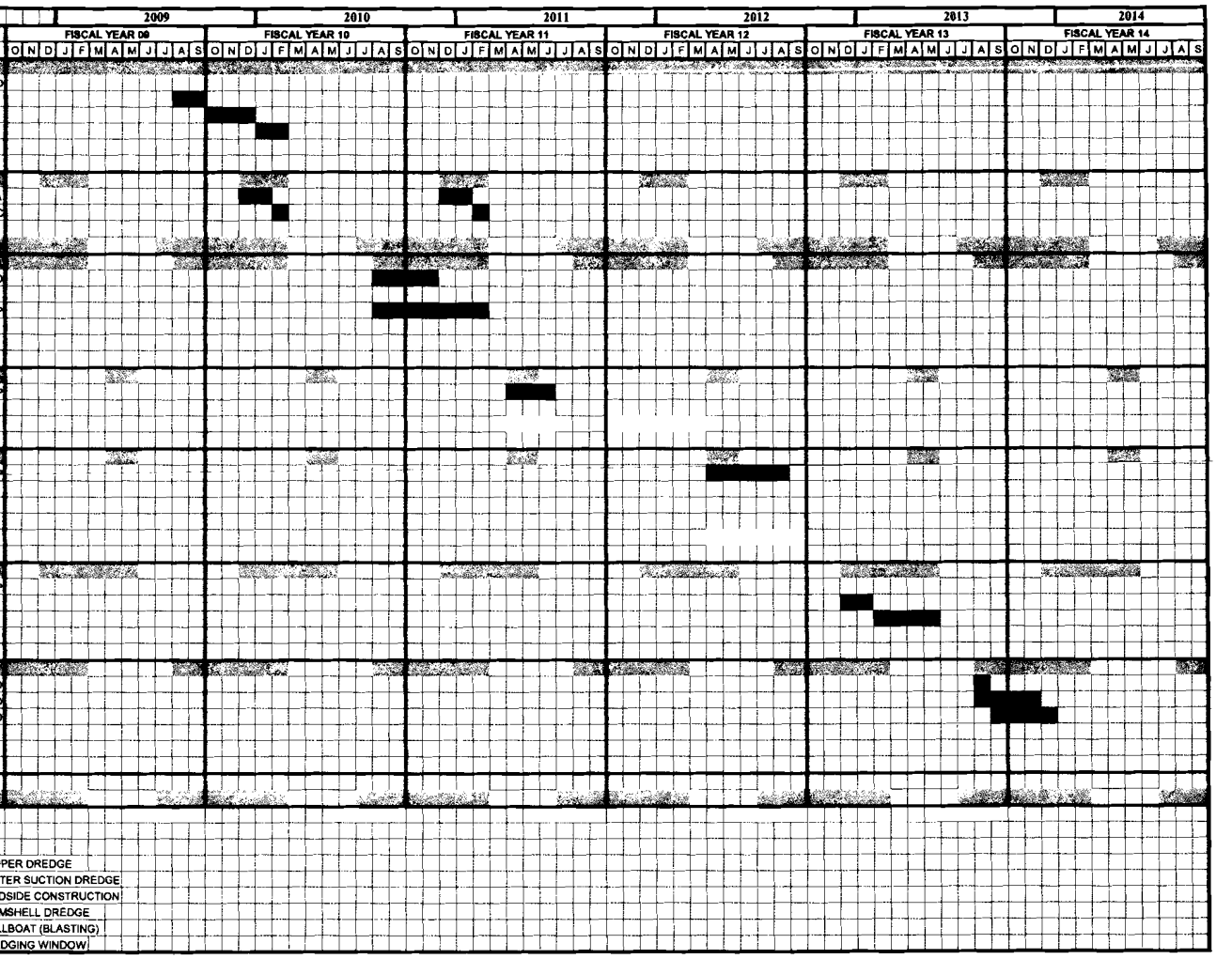


Figure 1. Main Channel Deepening Project with Reaches Identified

☐ = Action Area

Figure 2.

DELAWARE DEEPENING DREDGING CONTRACTS	River Mile	Duration (Mo)	Estimated Quantity (cy)	Dredge	
Contract No. 1 (award year 1)					
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	
Construct Project			**2,502,800**		
Contract No. 2 (award year 1)					
Reach B - Rock Blasting		3.17		1	BLA
Reach B - Rock Dredging - Fort Mifflin		1.27		1	MEC
Construct Project			**77,000**		
Contract No. 3 (award year 2)					
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				
Construct Project			**2,660,600**		
Contract No. 4 (award year 3)					
Reach E - Broadkill Beach - Dredge		3		2	HOP
461+300 to 512+000	15.6				
Construct Project			**1,568,700**		
					hyd
Contract No. 5 (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**		
Contract No. 6 (award year 5)					
Reach D -				1	HOP
249+000 to 270+000 - Reedy Pt. South	55.8	1.13	396,300		
270+000 to 324+000 - Artificial Island	51.8	4.63	1,654,800		
Construct Project			**2,051,100**		
Contract No. 7 (award year 6)					
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	0.0				
Construct Project			**4,664,900**		
		19.21	**15,961,100**		
UPDATED 9 March 2009 (2:00 a.m.)			(No Rock)		



HOP	HOPPER DREDGE
HYD	CUTTER SUCTION DREDGE
	LANDSIDE CONSTRUCTION
MEC	CLAMSHELL DREDGE
BLA	DRILLBOAT (BLASTING)
	DREDGING WINDOW

APPENDIX A.

MONITORING SPECIFICATIONS FOR HOPPER DREDGES

I. EQUIPMENT SPECIFICATIONS

A. Baskets or screening

Baskets or screening must be installed over the hopper inflows with openings no smaller than 4 inches by 4 inches to provide 100% coverage of all dredged material and shall remain in place during all dredging operations between May 1 and November 15 of any calendar year. Baskets/screening will allow for better monitoring by observers of the dredged material intake for sea turtles and their remains. The baskets or screening must be safely accessible to the observer and designed for efficient cleaning.

B. Draghead

The draghead of the dredge shall remain on the bottom **at all times** during a pumping operation, except when:

1) the dredge is not in a pumping operation, and the suction pumps are turned completely off;
2) the dredge is being re-oriented to the next dredge line during borrow activities; and
3) the vessel's safety is at risk (i.e., the dragarm is trailing too far under the ship's hull).

At initiation of dredging, the draghead shall be placed on the bottom during priming of the suction pump. If the draghead and/or dragarm become clogged during dredging activity, the pump shall be shut down, the dragarms raised, whereby the draghead and/or dragarm can be flushed out by trailing the dragarm along side the ship. If plugging conditions persist, the draghead shall be placed on deck, whereby sufficient numbers of water ports can be opened on the draghead to prevent future plugging.

Upon completion of a dredge track line, the drag tender shall:

1) throttle back on the RPMs of the suction pump engine to an idling speed (e.g., generally less than 100 RPMs) **prior to** raising the draghead off the bottom, so that no flow of material is coming through the pipe into the dredge hopper. Before the draghead is raised, the vacuum gauge on the pipe should read zero, so that no suction exists both in the dragarm and draghead, and no suction force exists that can impinge a turtle on the draghead grate;
2) hold the draghead firmly on the bottom with no flow conditions for approximately 10 to 15 seconds before raising the draghead; then, raise the draghead quickly off the bottom and up to a mid-water column level, to further reduce the potential for any adverse interaction with nearby turtles;
3) re-orient the dredge quickly to the next dredge line; and

4) re-position the draghead firmly on the bottom prior to bringing the dredge pump to normal pumping speed, and re-starting dredging activity.

C. Floodlights

Floodlights must be installed to allow the NMFS-approved observer to safely observe and monitor the baskets or screens.

D. Intervals between dredging

Sufficient time must be allotted between each dredging cycle for the NMFS-approved observer to inspect and thoroughly clean the baskets and screens for sea turtles and/or turtle parts and document the findings. Between each dredging cycle, the NMFS-approved observer should also examine and clean the dragheads and document the findings.

II. OBSERVER PROTOCOL

A. Basic Requirement

A NMFS-approved observer with demonstrated ability to identify sea turtle species must be placed aboard the dredge(s) being used, starting immediately upon project commencement to monitor for the presence of listed species and/or parts being entrained or present in the vicinity of dredge operations.

B. Duty Cycle

Beginning May 1, NMFS-approved observers are to be onboard for every day of the dredging project until project completion or November 15, whichever comes first. While onboard, the observer must work a shift schedule appropriate to allow for the observation of at least 50% of the dredge loads (e.g., 12 hours on, 12 hours off). The ACOE shall require of the dredge operator that, when the observer is off watch, the cage shall not be opened unless it is clogged. The ACOE shall also require that if it is necessary to clean the cage when the observer is off watch, any aquatic biological material is left in the cage for the observer to document and clear out when they return on duty. In addition, the observer shall be the only one allowed to clean off the overflow screen.

C. Inspection of Dredge Spoils

During the required inspection coverage, the trained NMFS-approved observer shall inspect the galvanized screens and baskets at the completion of each loading cycle for evidence of sea turtles or shortnose sturgeon. The Endangered Species Observation Form shall be completed for each loading cycle, whether listed species are present or not. If any whole (alive or dead) or turtle parts are taken incidental to the project(s), Julie Crocker (978) 282-8480 or Pat Scida (978) 281-9328 must be contacted within 24 hours of the take. An incident report for sea turtle/shortnose sturgeon take (Appendix F) shall also be completed by the observer and sent to Julie Crocker via FAX (978) 281-9394 within 24 hours of the take. Incident reports shall be completed for every

take regardless of the state of decomposition. NMFS will determine if the take should be attributed to the incidental take level, after the incident report is received. Every incidental take (alive or dead, decomposed or fresh) should be photographed, and photographs shall be sent to NMFS either electronically (julie.crocker@noaa.gov) or through the mail. Weekly reports, including all completed load sheets, photographs, and relevant incident reports, as well as a final report, shall be submitted to NMFS NER, Protected Resources Division, 55 Great Republic Drive, Gloucester, MA 01930-2298.

D. Information to be Collected

For each sighting of any endangered or threatened marine species (including whales as well as sea turtles), record the following information on the Endangered Species Observation Form (Appendix E):

1) Date, time, coordinates of vessel
2) Visibility, weather, sea state
3) Vector of sighting (distance, bearing)
4) Duration of sighting
5) Species and number of animals
6) Observed behaviors (feeding, diving, breaching, etc.)
7) Description of interaction with the operation

E. Disposition of Parts

If any whole turtles or shortnose sturgeon (alive or dead, decomposed or fresh) or turtle or shortnose sturgeon parts are taken incidental to the project(s), Julie Crocker (978) 282-8480 or Pat Scida (978) 281-9208 must be contacted within 24 hours of the take. All whole dead sea turtles or shortnose sturgeon, or turtle or shortnose sturgeon parts, must be photographed and described in detail on the Incident Report of Sea Turtle Mortality (Appendix F). The photographs and reports should be submitted to Julie Crocker, NMFS, Protected Resources Division, 55 Great Republic Drive, Gloucester, MA 01930-2298. After NMFS is notified of the take, it may instruct the observer to save the animal for future analysis if there is freezer space. Regardless, any dead **Kemp's ridley** sea turtles shall be photographed, placed in plastic bags, labeled with location, load number, date, and time taken, and placed in cold storage. Dead turtles or turtle parts will be further labeled as recent or old kills based on evidence such as fresh blood, odor, and length of time in water since death. Disposition of dead sea turtles/shortnose sturgeon will be determined by NMFS at the time of the take notification. If the species is unidentifiable or if there are entrails that may have come from a turtle, the subject should be photographed, placed in plastic bags, labeled with location, load number, date and time taken, and placed in cold storage. Dead Kemp's ridley or unidentifiable species or parts will be collected by NMFS or NMFS-approved personnel (contact Julie Crocker at (978) 282-8480.

Live turtles (both injured and uninjured) should be held onboard the dredge until transported as soon as possible to the appropriate stranding network personnel for rehabilitation (Appendix B). No live turtles should be released back into the water without first being checked by a qualified veterinarian or a rehabilitation facility. The NMFS Stranding Network Coordinator ((978) 281-

9351) should also be contacted immediately for any marine mammal injuries or mortalities.

III. OBSERVER REQUIREMENTS

Submission of resumes of endangered species observer candidates to NMFS for final approval ensures that the observers placed onboard the dredges are qualified to document takes of endangered and threatened species, to confirm that incidental take levels are not exceeded, and to provide expert advice on ways to avoid impacting endangered and threatened species. NMFS does not offer certificates of approval for observers, but approves observers on a case-by-case basis.

A. Qualifications

Observers must be able to:

1) differentiate between leatherback (*Dermochelys coriacea*), loggerhead *Caretta caretta*), Kemp's ridley *(Lepidochelys kempii*), green (*Chelonia mydas*), and hawksbill *(Eretmochelys imbricata*) turtles and their parts, and shortnose (*Acipenser brevirostrum*) and Atlantic (*Acipenser oxyrinchus oxyrinchus*) sturgeon and their parts;
2) handle live sea turtles and sturgeon and resuscitate and release them according accepted procedures;
3) correctly measure the total length and width of live and whole dead sea turtle and sturgeon species;
4) observe and advise on the appropriate screening of the dredge's overflow, skimmer funnels, and dragheads; and
5) identify marine mammal species and behaviors.

B. Training

Ideally, the applicant will have educational background in marine biology, general experience aboard dredges, and hands-on field experience with the species of concern. For observer candidates who do not have sufficient experience or educational background to gain immediate approval as endangered species observers, the below observer training is necessary to be considered admissible by NMFS. We can assist the ACOE by identifying groups or individuals capable of providing acceptable observer training. Therefore, at a minimum, observer training must include:

1) instruction on how to identify sea turtles and sturgeon and their parts;
2) instruction on appropriate screening on hopper dredges for the monitoring of sea turtles and sturgeon (whole or parts);
3) demonstration of the proper handling of live sea turtles and sturgeon incidentally captured during project operations. Observers may be required to resuscitate sea turtles according to accepted procedures prior to release;

4) instruction on standardized measurement methods for sea turtle and sturgeon lengths and widths; and

5) instruction on how to identify marine mammals; and

6) instruction on dredging operations and procedures, including safety precautions onboard a vessel.

APPENDIX B

Sea Turtle Handling and Resuscitation

It is unlikely that sea turtles will survive entrainment in a hopper dredge, as the turtles found in the dragheads are usually dead, dying, or dismantled. However, the procedures for handling live sea turtles follow in case the unlikely event should occur. These guidelines are adapted from 50 CFR § 223.206(d)(1).

Please photograph all turtles (alive or dead) and turtle parts found during dredging activities and complete the Incident Report of Sea Turtle Take (Appendix C).

Dead sea turtles
The procedures for handling dead sea turtles and parts are described in Appendix C-II-E.

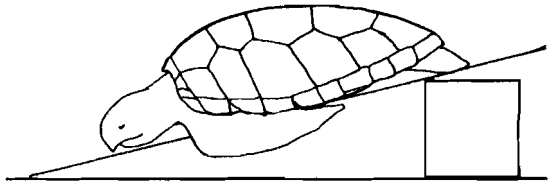
Live sea turtles
When a sea turtle is found in the dredge gear, observe it for activity and potential injuries.

- **If the turtle is actively moving**, it should be retained onboard until evaluated for injuries by a permitted rehabilitation facility. Due to the potential for internal injuries associated with hopper entrainment, it is necessary to transport the live turtle to the nearest rehabilitation facility as soon as possible, following these steps:
  1) Contact the nearest rehabilitation facility to inform them of the incident. If the rehabilitation personnel cannot be reached immediately, please contact NMFS stranding hotline at 978-281-9351 or NMFS Sea Turtle Stranding Coordinator at 978-281-9328.
  2) Keep the turtle shaded and moist (e.g., with a water-soaked towel over the eyes, carapace, and flippers), and in a confined location free from potential injury.
  3) Contact the crew boat to pick up the turtle as soon as possible from the dredge (within 12 to 24 hours maximum). The crew boat should be aware of the potential for such an incident to occur and should develop an appropriate protocol for transporting live sea turtles.
  4) Transport the live turtle to the closest permitted rehabilitation facility able to handle such a case.

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

- **If a turtle appears to be comatose** (unconscious), contact the designated stranding/rehabilitation personnel immediately. Once the rehabilitation personnel has been informed of the incident, attempts should be made to revive the turtle at once. Sea turtles have been known to revive up to 24 hours after resuscitation procedures have been followed.
  - Place the animal on its bottom shell (plastron) so that the turtle is right side up and elevate the hindquarters at least 6 inches for a period of 4 up to 24 hours. The degree of elevation depends on the size of the turtle; greater elevations are required for larger turtles.

- Periodically, rock the turtle gently left to right and right to left by holding the outer edge of the shell (carapace) and lifting one side about 3 inches then alternate to the other side.
- Periodically, gently touch the eye and pinch the tail (reflex test) to see if there is a response.
- Keep the turtle in a safe, contained place, shaded, and moist (e.g., with a water-soaked towel over the eyes, carapace, and flippers) and observe it for up to 24 hours.
- If the turtle begins actively moving, retain the turtle until the appropriate rehabilitation personnel can evaluate the animal. The rehabilitation facility should eventually release the animal in a manner that minimizes the chances of re-impingement and potential harm to the animal (i.e., from cold stunning).
- Turtles that fail to move within several hours (up to 24) must be handled in the manner described in Appendix C-II-E, or transported to a suitable facility for necropsy (if the condition of the sea turtle allows and the rehabilitation facility wants to necropsy the animal).



Stranding/rehabiliton contacts

Sea Turtles in Delaware Bay

- NMFS Stranding Hotline: (978) 281-9351 or NERStranding.staff@noaa.gov

Delaware:

- MERR Institute, Inc.
  Nassau, DE
  302-228-5029

New Jersey

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

-

APPENDIX C

ENDANGERED SPECIES OBSERVER FORM
Delaware River Deepening Project

Daily Report

Date: _____
Geographic Site: _____
Location: Lat/Long _____ Vessel Name _____

Weather conditions: _____
_____
Water temperature: Surface _____ Below midwater (if known) _____

Condition of screening apparatus: _____
_____
_____
Incidents involving endangered or threatened species? (Circle) Yes No
(*If yes, fill out Incident Report of Sea Turtle/Shortnose Sturgeon Mortality*)

Comments (type of material, biological specimens, unusual circumstances, etc:)
_____
_____
_____

Observer's Name: _____
Observer's Signature: _____

Species	# of Sightings	# of Animals	Comments

Incident Report of Sea Turtle Take

Species _____ Date _____ Time (specimen found) _____

Geographic Site _____
Location: Lat/Long _____
Vessel Name _____ Load # _____
Begin load time _____ End load time _____
Begin dump time _____ End dump time _____

Sampling method _____
Condition of screening _____
Location where specimen recovered _____
_____

Draghead deflector used? YES NO Rigid deflector draghead? YES NO
Condition of deflector _____
_____

Weather conditions _____
_____

Water temp: Surface _____ Below midwater (if known) _____
Species Information: *(please designate cm/m or inches.)*
Head width _____ Plastron length _____
Straight carapace length _____ Straight carapace width _____
Curved carapace length _____ Curved carapace width _____

Condition of specimen/description of animal (please complete attached diagram)
_____
_____
_____

Turtle Decomposed: NO SLIGHTLY MODERATELY SEVERELY

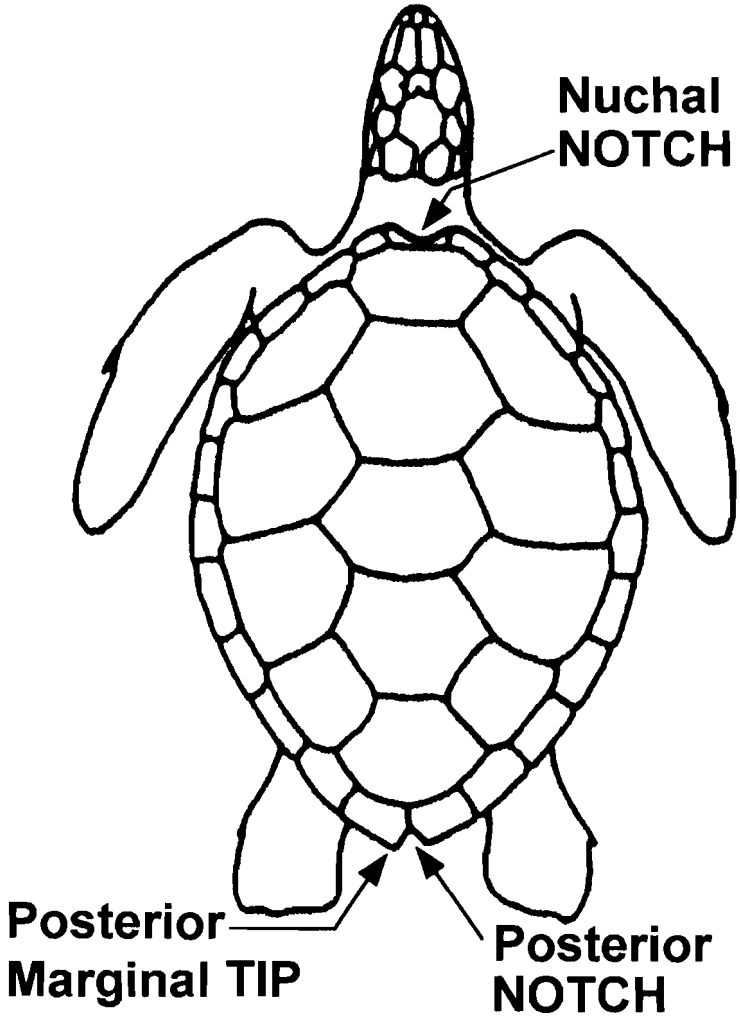
Turtle tagged: YES NO *Please record all tag numbers.* Tag # _____
Genetic sample taken: YES NO
Photograph attached: YES NO
(please label *species, date, geographic site* and *vessel name* on back of photograph)

Comments/other (include justification on how species was identified) _____
_____
_____
_____

Observer's Name _____
Observer's Signature _____

Incident Report of Sea Turtle Take

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



Description of animal:

APPENDIX D
Protocol for Collecting Tissue from Sea Turtles for Genetic Analysis

Materials for Collecting Genetic Tissue Samples

- surgical gloves
- alcohol swabs
- betadine swabs
- sterile disposable biopsy punches
- sterile disposable scalpels
- permanent marker to externally label the vials
- scotch tape to protect external labels on the vials
- pencil to write on internal waterproof label
- waterproof label, 1/4" x 4"
- screw-cap vial of saturated NaCl with 20% DMSO*, wrapped in parafilm
- piece of parafilm to wrap the cap of the vial after sample is taken
- vial storage box

* The 20% DMSO buffer within the vials is nontoxic and nonflammable. Handling the buffer without gloves may result in exposure to DMSO. This substance soaks into skin very rapidly and is commonly used to alleviate muscle aches. DMSO will produce a garlic/oyster taste in the mouth along with breath odor. The protocol requires that you wear gloves each time you collect a sample and handle the buffer vials. DO **NOT** store the buffer where it will experience extreme heat. The buffer must be stored at room temperature or cooler, such as in a refrigerator.

Please collect two small pieces of muscle tissue from all live, comatose, and dead stranded loggerhead, green, leatherback, and hybrid sea turtles (and any hawksbills, although this would be a rare incident). A muscle sample can be obtained no matter what stage of decomposition a carcass is in. Please utilize the equipment in these kits for genetic sampling of **turtles only** and contact the NMFS sea turtle stranding coordinator when you need additional biopsy supplies.

Sampling Protocol for Dead Turtles

1. Put on a pair of surgical gloves. The best place to obtain the muscle sample is on the ventral side where the front flippers insert near the plastron. It is not necessary to cut very deeply to get muscle tissue.

2. Using a new (sterile and disposable) scalpel cut out two pieces of muscle of a size that will fit in the vial.

3. Transfer both samples directly from the scalpel to a single vial of 20% DMSO saturated with salt.

4. Use the pencil to write the stranding ID, date, species ID and SCL on the waterproof label and place it in the vial with the samples.

5. Label the outside of the vial using the permanent marker with stranding ID, date, species ID and SCL .

6. Apply a piece of clear scotch tape over the what you have written on the outside of the vial to protect the label from being erased or smeared.

7. Wrap parafilm around the cap of the vial by stretching as you wrap.

8. Place the vial in the vial storage box.

9. Complete the Sea Turtle Biopsy Sample Collection Log.

10. Attach a copy of the STSSN form to the Collection Log - be sure to indicate on the STSSN form that a genetic sample was taken.

11. Dispose of the used scalpel and gloves. It is very important to use a new scalpel for each animal to avoid cross contamination.

At the end of the calendar year submit all genetic samples to:

Sea Turtle Stranding Coordinator
NMFS Protected Resources Division
55 Great Republic Drive
Gloucester, MA 01930
(978)281-9328

APPENDIX D
Protocol for Collecting Tissue from Sea Turtles for Genetic Analysis

Materials for Collecting Genetic Tissue Samples

- surgical gloves
- alcohol swabs
- betadine swabs
- sterile disposable biopsy punches
- sterile disposable scalpels
- permanent marker to externally label the vials
- scotch tape to protect external labels on the vials
- pencil to write on internal waterproof label
- waterproof label, 1/4" x 4"
- screw-cap vial of saturated NaCl with 20% DMSO*, wrapped in parafilm
- piece of parafilm to wrap the cap of the vial after sample is taken
- vial storage box

* The 20% DMSO buffer within the vials is nontoxic and nonflammable. Handling the buffer without gloves may result in exposure to DMSO. This substance soaks into skin very rapidly and is commonly used to alleviate muscle aches. DMSO will produce a garlic/oyster taste in the mouth along with breath odor. The protocol requires that you wear gloves each time you collect a sample and handle the buffer vials. DO **NOT** store the buffer where it will experience extreme heat. The buffer must be stored at room temperature or cooler, such as in a refrigerator.

Please collect two small pieces of muscle tissue from all live, comatose, and dead stranded loggerhead, green, leatherback, and hybrid sea turtles (and any hawksbills, although this would be a rare incident). A muscle sample can be obtained no matter what stage of decomposition a carcass is in. Please utilize the equipment in these kits for genetic sampling of **turtles only** and contact the NMFS sea turtle stranding coordinator when you need additional biopsy supplies.

Sampling Protocol for Dead Turtles

1. Put on a pair of surgical gloves. The best place to obtain the muscle sample is on the ventral side where the front flippers insert near the plastron. It is not necessary to cut very deeply to get muscle tissue.

2. Using a new (sterile and disposable) scalpel cut out two pieces of muscle of a size that will fit in the vial.

3. Transfer both samples directly from the scalpel to a single vial of 20% DMSO saturated with salt.

4. Use the pencil to write the stranding ID, date, species ID and SCL on the waterproof label and place it in the vial with the samples.

5. Label the outside of the vial using the permanent marker with stranding ID, date, species ID and SCL .

6. Apply a piece of clear scotch tape over the what you have written on the outside of the vial to protect the label from being erased or smeared.

7. Wrap parafilm around the cap of the vial by stretching as you wrap.

8. Place the vial in the vial storage box.

9. Complete the Sea Turtle Biopsy Sample Collection Log.

10. Attach a copy of the STSSN form to the Collection Log - be sure to indicate on the STSSN form that a genetic sample was taken.

11. Dispose of the used scalpel and gloves. It is very important to use a new scalpel for each animal to avoid cross contamination.

At the end of the calendar year submit all genetic samples to:

Sea Turtle Stranding Coordinator
NMFS Protected Resources Division
55 Great Republic Drive
Gloucester, MA 01930
(978)281-9328

APPENDIX E

Procedure for obtaining fin clips from sturgeon for genetic analysis

Updated April 2009

Obtaining Sample

1. Wash hands and use disposable gloves. Ensure that any knife, scalpel or scissors used for sampling has been thoroughly cleaned and wiped with alcohol to minimize the risk of contamination.

2. For any sturgeon, after the specimen has been measured and photographed, take a one-cm square clip from the pelvic fin.

3. Each fin clip should be placed into a vial of 95% non-denatured ethanol and the vial should be labeled with the species name, date, name of project and the fork length and total length of the fish along with a note identifying the fish to the appropriate observer report. All vials should be sealed with a lid and further secured with tape Please use permanent marker and cover any markings with tape to minimize the chance of smearing or erasure.

Storage of Sample

1. If possible, place the vial on ice for the first 24 hours. If ice is not available, please refrigerate the vial. Send as soon as possible as instructed below.

Sending of Sample

1. Vials should be placed into Ziploc or similar resealable plastic bags. Vials should be then wrapped in bubble wrap or newspaper (to prevent breakage) and sent to:

   Julie Carter
   NOAA/NOS – Marine Forensics
   219 Fort Johnson Road
   Charleston, SC 29412-9110
   Phone: 843-762-8547

2. Upon sending a sample, contact Kim Damon-Randall at NMFS Northeast Regional Office (978-282-8485) to report that a sample has been sent.

APPENDIX E

Procedure for obtaining fin clips from sturgeon for genetic analysis

Updated April 2009

Obtaining Sample

1. Wash hands and use disposable gloves. Ensure that any knife, scalpel or scissors used for sampling has been thoroughly cleaned and wiped with alcohol to minimize the risk of contamination.

2. For any sturgeon, after the specimen has been measured and photographed, take a one-cm square clip from the pelvic fin.

3. Each fin clip should be placed into a vial of 95% non-denatured ethanol and the vial should be labeled with the species name, date, name of project and the fork length and total length of the fish along with a note identifying the fish to the appropriate observer report. All vials should be sealed with a lid and further secured with tape Please use permanent marker and cover any markings with tape to minimize the chance of smearing or erasure.

Storage of Sample

1. If possible, place the vial on ice for the first 24 hours. If ice is not available, please refrigerate the vial. Send as soon as possible as instructed below.

Sending of Sample

1. Vials should be placed into Ziploc or similar resealable plastic bags. Vials should be then wrapped in bubble wrap or newspaper (to prevent breakage) and sent to:

   Julie Carter
   NOAA/NOS – Marine Forensics
   219 Fort Johnson Road
   Charleston, SC 29412-9110
   Phone: 843-762-8547

2. Upon sending a sample, contact Kim Damon-Randall at NMFS Northeast Regional Office (978-282-8485) to report that a sample has been sent.

APPENDIX F

MONITORING SPECIFICATIONS FOR MECHANICAL DREDGES

I. EQUIPMENT SPECIFICATIONS

A. Floodlights

Should dredging occur at night or in poor lighting conditions, floodlights must be installed to allow the NMFS-approved observer to safely observe and monitor dredge bucket and scow.

B. Intervals between dredging

Sufficient time must be allotted between each dredging cycle for the NMFS-approved observer to inspect the dredge bucket and scow for shortnose sturgeon and/or sturgeon parts and document the findings.

II. OBSERVER PROTOCOL

A. Basic Requirement

A NMFS-approved observer with demonstrated ability to identify shortnose sturgeon must be placed aboard the dredge(s) being used; starting immediately upon project commencement to monitor for the presence of listed species and/or parts being taken or present in the vicinity of dredge operations.

B. Duty Cycle

A NMFS-approved observers must be onboard during dredging until the project is completed. While onboard, observers shall provide the required inspection coverage to provide 100% coverage of all dredge-cycles.

C. Inspection of Dredge Spoils

During the required inspection coverage, the NMFS-approved observer shall observe the bucket as it comes out of the water and as the load is deposited into the scow during each dredge cycle for evidence of shortnose sturgeon. If any whole shortnose sturgeon (alive or dead) or shortnose sturgeon parts are taken incidental to the project(s), Julie Crocker (978) 282-8480 or Pat Scida (978) 281-9328 must be contacted **within 24 hours** of the take. An incident report for shortnose sturgeon take shall also be completed by the observer and sent to Julie Crocker via FAX (978) 281-9394 or e-mail (Julie.Crocker@noaa.gov) within 24 hours of the take. Incident reports shall be completed for every take regardless of the state of decomposition. Every incidental take (alive or dead, decomposed or fresh) must be photographed. A final report including all completed load sheets, photographs, and relevant incident reports are to be submitted to the attention of the Section 7

Coordinator, NMFS Protected Resources Division, 55 Great Republic Drive, Gloucester, MA 01930.

D. Inspection of Disposal

The NMFS-approved observer shall observe all disposal operations to inspect for any whole shortnose sturgeon or sturgeon parts that may have been missed when the load was deposited into the scow. If any whole shortnose sturgeon (alive or dead) or shortnose sturgeon parts are observed during disposal operation, the procedure for notification and documentation outlined above should be completed.

E. Disposition of Parts

As required above, NMFS must be contacted as soon as possible following a take. Any dead shortnose sturgeon should be refrigerated or frozen until disposition can be discussed with NMFS. Under no circumstances should dead sturgeon be disposed of without confirmation of disposition details with NMFS.

III. OBSERVER REQUIREMENTS

Submission of resumes of endangered species observer candidates to NMFS for final approval ensures that the observers placed onboard the dredges are qualified to document takes of endangered and threatened species, to confirm that incidental take levels are not exceeded, and to provide expert advice on ways to avoid impacting endangered and threatened species. NMFS does not offer certificates of approval for observers, but approves observers on a case-by-case basis.

A. Qualifications

Observers must be able to:

1) differentiate between shortnose (*Acipenser brevirostrum*) and Atlantic (*Acipenser oxyrinchus oxyrinchus*) sturgeon and their parts;
2) handle live sturgeon;
3) correctly measure the total length and width of live and whole dead sturgeon species;

B. Training

Ideally, the applicant will have educational background in biology, general experience aboard dredges, and hands-on field experience with the species of concern. For observer candidates who do not have sufficient experience or educational background to gain immediate approval as endangered species observers, we note below the observer training necessary to be considered admissible by NMFS. We can assist the ACOE by identifying groups or individuals capable of providing acceptable observer training. Therefore, at a minimum, observer training must include:

1) instruction on how to identify sturgeon and their parts;

2) instruction on appropriate screening on hopper dredges for the monitoring of sturgeon(whole or parts);

3) demonstration of the proper handling of live sturgeon incidentally captured during project operations;

4) instruction on standardized measurement methods for sturgeon lengths and widths; and