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**NATIONAL MARINE FISHERIES SERVICE**
**ENDANGERED SPECIES ACT**
**BIOLOGICAL OPINION**

**Action Agencies:** Army Corps of Engineers (USACE), Norfolk District (lead)
USACE, Baltimore District
Bureau of Ocean Energy Management
U.S. Environmental Protection Agency
U.S. Navy

**Activity Considered:** Maintenance of Chesapeake Bay Entrance Channels and use of sand borrow areas for beach nourishment
**F/NER/2012/01587**
GARFO-2012-00010

**Conducted by:** National Marine Fisheries Service
Northeast Region

**Date Issued:** 10/16/12

**Approved by:** for John Bullard



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## 1.0 Introduction

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 following projects:

- Cape Henry Channel;
- York Spit Channel;
- Rappahannock Shoal;
- York River Entrance Channel;
- Sandbridge Beach Nourishment and Hurricane Protection Project;
- Virginia Beach Hurricane Protection Project;
- Thimble Shoals Channel;
- Atlantic Ocean Channel;
- Norfolk Harbor Channels;
- Craney Island Eastward Expansion; and,
- Dredged Material Disposal Areas: Dam Neck Ocean Disposal Site, Wolf Trap Alternate Placement Site, Rappahannock Shoal Deep Alternate Open Water Site, Craney Island Dredged Material Management Area, and, Norfolk Ocean Dredged Material Disposal Site.



This Opinion is based on information provided in the Biological Assessments (BA) dated April, May and July 2012, past consultations with the USACE Norfolk and Baltimore Districts and scientific papers and other sources of information as cited in this Opinion. We will keep a complete administrative record of this consultation at our Northeast Regional Office. This Opinion replaces the following Opinions which are hereby withdrawn: Thimble Shoals and Atlantic Ocean Channel (April 25, 2002), Virginia Beach Hurricane Protection Project – Thimble Shoals Surround and Atlantic Ocean Channel Borrow Area (December 2,2005), Cape Henry, York Spit, York River Entrance Channel and Rappahanock Shoals (July 24, 2003), and Sandbridge Beach (April 2,1993, amended on August 20, 2001). Consultation was initiated on May 23, 2012. A draft of the Reasonable and Prudent Measures and Terms and Conditions was sent to USACE on August 29, 2012. A complete draft of the Biological Opinion was provided to USACE on September 28, 2012; comments were received on September 6 and October 4, 2012 and incorporated as appropriate.

## 2.0 CONSULTATION HISTORY

Consultation between USACE and NMFS on effects of dredging in the Chesapeake Bay navigation channels and borrow areas has been ongoing since the 1980s. We have completed numerous consultations, culminating in four separate Opinions, most of which have been reinitiated multiple times (see below for detailed history). In all of these Opinions we concluded that the proposed dredging was likely to adversely affect, but not likely to jeopardize any species of listed sea turtle and was not likely to adversely affect any species of listed whales. In February 2012, we published two final rules listing five Distinct Population Segments (DPS) of

Atlantic sturgeon. The New York Bight, Chesapeake Bay, South Atlantic and Carolina DPSs are listed as endangered and the Gulf of Maine DPS is listed as threatened. 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 Opinion; or (d) a new species is listed or critical habitat designated that may be affected by the identified actions" (50 CFR § 402.16).

The USACE prepared BAs to supplement the BAs prepared previously for the channels and dredged material disposal areas listed in Section 1.0. These BAs were submitted to us along with requests to reinitiate consultation and produce new Biological Opinions. Because the actions considered in these Opinions are similar, they take place in the same geographic area, and affect the same species in the same manner, we determined it would be most efficient to combine the analysis of effects of continued dredging of these channels and borrow areas in one consultation. As such, while there are seven independent actions considered here (i.e., dredging Baltimore Harbor Entrance Channels, York River Entrance Channel, Sandbridge Shoal, Virginia Beach Nourishment, Port of Norfolk Entrance Channels, Norfolk Harbor Channels and Craney Island Eastward Expansion), we are producing one Biological Opinion. This type of "multi-action" consultation is contemplated in the NMFS-USFWS Section 7 Consultation Handbook (see page 5-5). Below, we detail the consultation history for each of these activities.

In the future, reinitiation of consultation may be necessary (see 50 CFR§ 402.16). Depending on the circumstances associated with the cause for reinitiation, it may not be necessary to reinitiate consultation for all of the actions considered here. For example, if a new species is listed that may be affected by dredging activities, it would likely be necessary to reinitiate consultation on all of the activities considered here. However, if the cause for reinitiation has effects that are limited to one action (for example, a change in dredge type, dredge volume or disposal area), reinitiation of consultation on only that action would be necessary. We expect that determinations about the scope of any future reinitiation(s) will be made in cooperation between the USACE and us.



### 2.1 Norfolk Harbor -- Thimble Shoals and Atlantic Ocean Channel

Previous consultations for Thimble Shoals Channel regarding maintenance dredging operations were conducted on April 16, 1984, March 14, 1985, March 20, 1985, and March 10, 1986 and were concluded informally due to scheduling of dredging outside of the time of year when sea turtles would be present. Formal consultation for dredging activities in Thimble Shoals Channel (TSC) and Atlantic Ocean Channel (AOC) was initiated on April 14, 1999; a biological opinion was issued on February 7, 2001. Consultation was re-initiated on March 30, 2001 to account for sand borrow for beach nourishment in Atlantic Ocean Channel and associated impacts to listed sea turtles and other listed species. An amendment to the February 7, 2001 BO was issued on May 30, 2001. The Corps requested re-initiation of consultation on August 15, 2001 due to a change in the scope of the project; a revised biological opinion was issued on September 6, 2001. On December 4, 2001, the Corps re-initiated consultation in regards to the 50-foot deepening of the Norfolk Harbor and Channels project which would require the removal of a total of up to 7.5 million cubic yards in the inner Norfolk Harbor and 5 million cubic yards of dredged material from TSC and AOC. We issued the most recent Biological Opinion on April 25, 2002. In this Opinion, we concluded that the proposed dredging may adversely affect but is not likely to jeopardize the continued existence of any listed species. An ITS was included with this Opinion, exempting the lethal take of up to 18 loggerheads and 4 Kemp's ridley during each dredge event and the non-lethal capture of an "unquantifiable" number of loggerheads and Kemp's ridleys during each relocation trawling event.

### 2.2 Baltimore Harbor Entrance Channels and York River Entrance Channel

Formal consultation for dredging activities in Cape Henry Channel (CHC), York Spit Channel (YSC), Rappahannock Shoal Channel (RSC), and York River Entrance Channel (YEC) was initiated on May 18, 1993. A biological opinion was issued on October 6, 1993. Consultation was re-initiated on October 12, 2001 to account for greater dredging quantities, project durations, and associated impacts to listed sea turtles; a new Opinion was issued on January 24, 2002. In letters dated January 15 and February 6, 2003, the Corps requested reinitiation of consultation as the exempted level of take was exceeded in 2002. A new Opinion was issued on July 24, 2003. In this Opinion, we concluded that the proposed dredging was not likely to jeopardize the continued existence of any listed species. An ITS was included with this Opinion, exempting the annual lethal take of up to 18 loggerheads, up to 4 Kemp's ridleys and 1 green, depending on the volume of material removed from the channels. The ITS also exempted the capture of up to 120 sea turtles (loggerhead, Kemp's ridley and green) during each relocation trawling event. The ITS also exempted one lethal take of a loggerhead, Kemp's ridley or loggerhead sea turtle during each relocation trawling event.

### 2.3 Sandbridge Shoal

Formal consultation for the use of the Sandbridge Shoal borrow area was initiated in May 1992. A Biological Opinion was issued by NMFS on April 2, 1993. This Opinion was amended by letter issued August 20, 2001 to account for greater dredging quantities, project durations, and associated impacts to listed sea turtles. In 2007, USACE requested that we waive the requirement for 100% endangered species observer coverage for dredging planned for 2007. This request was due to the presence of unexploded ordinance in the area to be dredged and the placement of screening on the dragheads. We granted that request by letter and determined that the use of UXO screening did not require reinitiation of the consultation. The 1993 Opinion, as amended in 2001, concluded that dredging in Sandbridge Shoal was not likely to jeopardize the continued existence of any species of whale or sea turtle. An ITS was included with the Opinion, exempting the lethal take of five loggerhead sea turtles and one Kemp's ridley or green sea turtle for each biennial dredge event. This consultation was reinitiated in 2012. In September 2012, we issued a new Opinion on effects of proposed dredging at Sandbridge Shoal in 2012-2013 with placement of 1.5-2 million cubic yards of sand along Sandbridge Beach. We concluded that the proposed action was not likely to jeopardize any DPS of Atlantic sturgeon or any species of listed sea turtle. The ITS exempted the lethal take of six loggerheads and one Kemp's ridley or green and one Atlantic sturgeon from any of the five DPSs. Use of the Sandbridge Shoal borrow areas requires coordination with the Bureau of Ocean Energy Management (BOEM); the USACE was designated the lead agency for purposes of complying with ESA requirements per 50 C.F.R 5402.07 and served as the lead agency for biological consultation.

## 2.4 Virginia Beach Nourishment and Hurricane Protection Project

Formal consultation for dredging activities at the Thimble Shoals Surround borrow area (TSS) and the Atlantic Ocean Offshore borrow area (AOO) was initiated with the submittal of a BA by the USACE in January 2005. We issued a Biological Opinion on December 2, 2005. In this Opinion, we concluded that the proposed dredging may adversely affect but is not likely to jeopardize the continued existence of loggerhead and Kemp's ridley sea turtles and is not likely to adversely affect leatherback or green sea turtles or right, humpback or fin whales. An ITS was included with this Opinion, exempting the lethal take of 4 loggerheads and 1 Kemp's ridley during each dredge event and the non-lethal capture of 45 sea turtles (loggerhead, Kemp's ridley and green) during each relocation trawling event. The ITS also exempted one lethal take of a loggerhead, Kemp's ridley or loggerhead sea turtle during each relocation trawling event.

## 2.5 Norfolk Harbor Channels

We previously considered effects of maintenance dredging and deepening of the Norfolk Harbor inner channels. These actions were considered in the Biological Opinion dated April 25, 2002 described in Section 2.1 above. In the Opinion, we determined that dredging in the inner channels was not likely to adversely affect any species of sea turtles because a hydraulic cutterhead or mechanical dredge would be used and these dredge types are not known to capture, injure or kill sea turtles.

## 2.6 Craney Island Eastward Expansion

Consultation between NMFS and USACE on the Craney Island Eastward Expansion project was completed informally in 2006. In a letter dated June 15, 2006, we concluded that the proposed action was not likely to adversely affect any species of sea turtle. This conclusion was based on the use of mechanical or hydraulic dredges for dredged material removal and the lack of benthic prey at the site.



## 3.0 DESCRIPTION OF THE PROPOSED ACTION

This Opinion considers the effects of future new work dredging, continued maintenance dredging, and sand borrow operations in several Federal navigation channels located in the Chesapeake Bay and Atlantic Ocean as well as the use of three sand borrow areas. These activities are carried out by the USACE or the U.S. Navy and their contractors as independent actions as detailed below. Additionally, authorization with BOEM, in the form of a lease, is required for use of the Sandbridge Shoal borrow area. The U.S. EPA has regulatory authority over the designation of ocean disposal sites.

## 3.1 Port of Hampton Roads Approach Channels – Thimble Shoals and Atlantic Ocean Channel

The Atlantic Ocean Channel (AOC) and Thimble Shoals Channel (TSC) make up the approach channels to the Port of Hampton Roads. These channels provide access for all ships calling on port facilities, naval bases, and shipyards in the Hampton Roads areas. All commercial tonnage entering and leaving the Port of Hampton Roads passes through these channels. The USACE Norfolk District is responsible for maintaining these Federal navigation channels to ensure safe passage for all vessel traffic. In order to provide depths needed for safe navigation of larger vessels, maintenance dredging of these Federal navigation channels must occur before shoaling causes draft restrictions and/or other safety concerns. The location of TSC and AOC is depicted in Appendix A.

The proposed action involves continued ongoing sand borrow operations, maintenance and future new work dredging of the AOC and TSC and the use of the associated dredged material placement sites. The project includes the entire footprint of these channels and the shoals contained within each channel, plus the entire footprint of the associated dredged material placement sites. The AOC and TSC are preferred sand borrow sources for beach nourishment and port development projects in the Hampton Roads region. Projects that have historically used, or are proposing to borrow from, the TSC and AOC includes the Craney Island Eastward Expansion, Virginia Beach Hurricane Protection Project, Willoughby Spit and Vicinity Hurricane Protection Project, and JEB Fort Story Beach Replenishment Project (U.S. Navy).

The AOC and TSC normally require maintenance dredging every two to five years but dredging is typically located in distinct shoaled areas within the channels. These shoaled areas vary from year to year, but are often located along the toe of the channel. New work dredging may also occur when Congress authorizes and appropriates funding for channel improvements. The duration of dredging, the amount of material removed from each shoal, and the frequency in which each shoal is dredged is dependent on several factors. These factors include, but are not limited to environmental conditions, funding, whether it is new work or maintenance dredging, location, length of time after the last dredging cycle, time of year restrictions, availability of suitable dredge plant, emergencies, and others. It is important to note that the areas within the channel that are dredged during each cycle are relatively small in comparison to the total channel dimensions. The primary objective is to provide vessels with safe, navigable passage to the Port of Hampton Roads in support of commerce and national defense.

*Atlantic Ocean Channel Federal Navigation Project*
The Water Resources Development Act (WRDA) of 1986 authorized the AOC. WRDA authorized the USACE to construct the AOC as part of the Norfolk Harbor and Channels, Virginia. The AOC consists of a channel 11.1 miles long, 1,300 feet wide, and 60 feet deep located 3-4 miles east of the Thimble Shoal Channel, in the Atlantic Ocean at the mouth of the Chesapeake Bay off the coast of Virginia Beach, Virginia. As part of the 50-foot inbound construction effort in 2006, the channel was deepened to provide for a depth and width of 52 feet and 1,300 feet, respectively. Although authorized to a depth of 60 feet, the channel has not been dredged past the current depth of 52 feet. The channel is currently maintained to full width and a depth of 52 feet to enable loaded colliers to transit the channel with ship drafts as great as 50 feet. The AOC is managed by the Norfolk District.

*Thimble Shoal Federal Navigation Project*
The TSC was authorized by the River and Harbor Act of August 8, 1917, and modified by the River and Harbor Act of September 3, 1954, October 27, 1965, and the WRDA of 1986. The project consists of a channel 55 feet deep, 1,000 feet wide, and approximately 13.4 miles long between 55-foot contours and is located in the southern part of the Chesapeake Bay, just off the shoreline of the City of Norfolk and City of Virginia Beach. Deepening work for the Thimble Shoal channel to -52 feet was completed in 2003. The Thimble Shoal Channel is managed by the Norfolk District.

## 3.2 Port of Baltimore Approach Channels

Cape Henry Channel (CHC), York Spit Channel (YSC) and Rappahanock Shoals Channel (RSC) make up the Chesapeake Bay approach channels to the Port of Baltimore. All commercial tonnage entering and leaving the Port of Baltimore pass through these channels. The Norfolk District maintains these Federal navigation channels in coordination with Baltimore District; however, the budget for maintenance dredging of these channels is the responsibility of Baltimore District.
In order to provide depths needed for safe navigation of larger vessels, maintenance dredging of these Federal navigation channels must occur before shoaling causes draft restrictions and/or other safety concerns. All of these channels and placement sites are depicted in Appendix A.

The proposed project involves continued ongoing maintenance dredging of the CHC, YSC and RSC and the use of the associated dredged material placement sites. New work dredging may also occur when Congress authorizes and appropriates funding for channel improvements. The project includes the entire footprint of these channels and the shoals contained within each channel, plus the entire footprint of the associated dredged material placement sites. The CHC, YSC and RSC normally require dredging every two to five years; dredging is typically located in distinct shoaled areas within the channels and not through the entirety of the channel. These shoaled areas vary from year to year, but are often located along the toe of the channel. The duration of dredging, the amount of material removed from each shoal, and the frequency in which each shoal is dredged is dependent on several factors. These factors include, but are not limited to: environmental conditions, funding, location, degree of shoaling, time of year restrictions, availability of suitable dredge plant, navigation emergencies, and others.



*Cape Henry Federal Navigation Project*
The CHC was authorized under the River and Harbor Act of 1945 and Section 101 of the River and Harbor Act of 1970 as part of the Baltimore District - USACE 50-Foot Project. The River & Harbor Act of 1945 authorized increasing the channel depth to 39 feet deep and 1,000 feet wide in the CHC and YSC in Virginia. The River and Harbor Act of 1970 authorized a uniform main channel 50 feet deep, and generally 800 (in Maryland) or 1,000 (in Virginia) feet wide through the Chesapeake Bay from the Virginia Capes to Fort McHenry in the Port of Baltimore, a distance of 175 miles. The CHC Federal Navigation Channel is a 1,000 foot wide channel approximately 4.7 nautical miles long located between the -50 foot contours at the entrance to the Chesapeake Bay just south of the Chesapeake Bay Bridge Tunnel. The Norfolk District in coordination with the Baltimore District maintains the CHC.

*Rappahannock Shoal Federal Navigation Project*
The RSC was authorized under Section 101 of the River and Harbor Act of 1970 as part of the Baltimore District - USACE 50-Foot Project. The River and Harbor Act of 1970 authorized a uniform main channel 50 feet deep, and generally 800 (in Maryland) or 1,000 (in Virginia) feet wide through the Chesapeake Bay from the Virginia Capes to Fort McHenry in the Port of Baltimore, a distance of 175 miles, which includes the RSC. Dredging of the initial phase reduced the channel widths in the RSC from 1,000 to 800 feet wide. The RSC is 50 feet deep, 800 feet wide and approximately 10.3 nautical miles long and traverses the Rappahannock Shoal

from southeast to northwest. The Norfolk District in coordination with the Baltimore District maintains the RSC CHC.

*York Spit Federal Navigation Project*
The YSC was authorized to a depth of -37 feet under the River and Harbor Act of 1930. After World War II, the River & Harbor Act of 1945 authorized increasing the channel depth to 39 feet deep and 1,000 feet wide in the CHC and YSC in Virginia. Finally, the YSC was authorized to -50 feet via Section 101 of the River and Harbor Act of 1970, as part of the Baltimore District - USACE 50-Foot Project, which authorized a uniform main channel 50 feet deep, and generally 800 (in Maryland) or 1,000 (in Virginia) feet wide through the Chesapeake Bay from the Virginia Capes to Fort McHenry in the Port of Baltimore, a distance of 175 miles. Dredging of the initial phase reduced the channel widths in the YSC from 1,000 to 800 feet wide. The YSC is 800 feet wide, -52 feet deep and is approximately 18.4 nautical miles long. The YSC is located between the -50 foot contours, just north of the Chesapeake Bay Bridge Tunnel and is maintained by the Norfolk District in coordination with the Baltimore District.

## 3.3 York River Entrance Channel Federal Navigation Project

The Norfolk District is responsible for maintenance dredging the YREC Federal Navigation Project.
In order to provide depths needed for safe navigation of larger vessels, maintenance dredging of this Federal navigation channel must occur on or before shoaling causes draft restrictions and/or other safety concerns. The location of YREC is depicted in Appendix A.

The proposed project involves continued ongoing maintenance dredging of YREC and the use of the associated dredged material placement sites. New work dredging may also occur when Congress authorizes and appropriates funding for channel improvements. The project includes the entire footprint of these channels and the shoals contained within each channel, plus the entire footprint of the associated dredged material placement sites. The YREC normally requires dredging every two to five years; dredging is typically located in distinct shoaled areas within the channel and not through the entirety of the channel. These shoaled areas vary from year to year, but are often located along the toe of the channel. The duration of dredging, the amount of material removed from each shoal, and the frequency in which each shoal is dredged is dependent on several factors. These factors include, but are not limited to: environmental conditions, funding, location, degree of shoaling, time of year restrictions, availability of suitable dredge plant, navigation emergencies, and others.

The YREC was first dredged in 1951 and 1952, when the natural entrance channel into the York River was deepened by the USACE for the Department of the Navy. The original channel dimensions provided for a 39-foot deep channel at mean low water, 750 feet wide at the bottom, and approximately 11 miles long. There was no dredging of the YREC between 1952 and 1998. In 1995, the Chief of Engineers authorized the current project under Section 107 of the River and Harbor Act of 1960. The YREC project consists of a channel 37 feet deep at mean lower low water (mllw), 750 feet wide at the bottom, and approximately 23 miles long. New work was authorized in 1995, and the channel was dredged to its current dimensions in 1999. The channel begins at the 38-foot contour in the Chesapeake Bay and ends at a point adjacent to the piers at the Yorktown U.S. Naval Weapons Station, approximately 8 miles above the river mouth.

### 3.4 Virginia Beach Nourishment and Hurricane Protection Project

The Virginia Beach Hurricane Protection Project is conducted under authority of the WRDA of 1986, as modified by the WRDA of 1992 and 1996. The project was authorized in Section 102 of the WRDA of 1992 (Public Law [P.L.] 102-580) as amended in 1996, and is funded by the Federal Government and the city of Virginia Beach, Virginia, acting as the project's non-Federal sponsor.

The hurricane protection site is located at Cape Henry, Virginia Beach, Virginia, as generally described in the "Beach Erosion Control and Hurricane Protection Study Virginia Beach, Virginia General Reevaluation Report Main Report and Appendices," dated September 1993 and revised January 1994, and approved by the Assistant Secretary of the Army for Civil Works on February l, l994, and as further defined by Draft plans and Specifications which are incorporated herein by reference. The authorized duration of the initial project of hurricane protection is 50 years, including initial construction and periodic nourishment. Sand to be placed at the hurricane protection site may be obtained from Federal navigation channels or the Thimble Shoals Channel Borrow Area (TSS) and the Atlantic Ocean Channel Borrow Area (AOO). The location of these borrow areas are illustrated in Appendix A.

The TSS area is a rectangle surrounding a short reach of the Thimble Shoals Channel located in the lower Chesapeake Bay between deep water in Hampton Roads and the Atlantic Ocean. It is approximately 2 miles off the Chesapeake Bay shoreline, with its western terminus approximately 5,400 feet east of the Chesapeake Bay Bridge Tunnel. The TSS is about 5,700 feet in length and approximately 1,200 feet wide, totaling about 19,60 acres. Depths in the area range from about 35 to 50 feet and do not include the Thimble Shoals Channel.

The AOO area is roughly triangular in shape and is located between the 3-mile limit and just outside the 3-mile limit off Cape Henry, Virginia. It encompasses about 9,253 acres and extends southeasterly from a point due east of the Cape Henry lighthouse and in the direction of the continental slope. It is bounded to the east by the Atlantic Ocean Channel deepwater route east of the Virginia Beach oceanfront. This borrow site does not include any section of the Atlantic Ocean Channel deepwater route. This borrow site is located about 5 miles from the TSS borrow area.

Maintenance of the hurricane protection project will require that approximately 1,000,000 cubic yards (cy) of sand be dredged and placed on the beach during the initial maintenance, with an additional 2,000,000 cy to be dredged and placed every 3 to 4 years.

The maintenance borrow activities may be rotated among these sites over the 50-year period. Approximately 12.5 million cy of sand may be dredged and used for beach nourishment over the 50-year period, with approximately 8.125 MCY (66%) of the volume to be removed from Atlantic Ocean Channel and Thimble Shoals Channel. The remaining 4.375 MCY is likely to be removed from the AOO and TSS. Dredging will be accomplished via hopper dredge, although there is a possibility that a hydraulic cutterhead dredge may be used in the AOO. Dredged beach-quality sand may be placed on the site by means of hydraulically pumping from the dredging site directly to the beach via a hydraulic dredge and pipeline, if the sand source is less than 2 miles from the beach; or, if the sand source is more than 2 miles from the beach, a hopper dredge may be used.

### 3.5 Sandbridge Beach Nourishment and Hurricane Protection

The Advanced Engineering and Design Study for Beach Erosion and Hurricane Protection at Virginia Beach, Virginia, including Sandbridge Beach, was authorized by Section 1(a) of the Water Resources Development Act of 1974 (Public Law 93-251, 93'd Congress, H.R. 10203.7 March 1974). The applicable portion of the authorizing act is as follows:

"Sec. I (a) The Secretary of the Army, acting through the Chief of Engineers, is hereby authorized to undertake the Phase I Design Memorandum stage of advanced engineering and design of the following multi-purpose water resources development projects, substantially in accordance with, and subject to the conditions recommended by the Chief of Engineers in the reports here in after designated."

Middle Atlantic Coastal Area

"The project for hurricane-flood protection at Virginia Beach, Virginia: House Document Numbered 92-365, at an estimated cost of 8,954,000 (1974 dollars)."

BOEM will authorize the use of sand from an OCS sand borrow area for the project under the OCS Lands Act, 43 U.S.C. §1337(k). In 1994, OCSLA was amended to allow BOEM to convey, on a noncompetitive basis, the rights to OCS sand, gravel, or shell resources for use in a program for shore protection, beach restoration, or coastal wetlands restoration undertaken by a Federal, State, or local government agency (43 U.S.C.§ 1337(k)(2)(A)(i)). An agreement will be negotiated between BOEM, the USACE Norfolk District, and the City of Virginia Beach for the dredging and relocation of the sand.

The beach nourishment will occur along a five mile stretch of the Sandbridge Beach between Back Bay NWR at the southern most extent (36.698017 N, -75.924196 W-WSG84 datum) and the U.S. Naval Fleet Anti-Air Warfare Training Center at the northern most extent (36.760823 N, - 75.948829 W) along the beach. The borrow areas (A and B) are located about three miles offshore at Sandbridge Shoal perpendicular to the beach nourishment reach (Appendix A). A no dredging zone separates the two borrow areas to protect underground cable lines. The coordinates for these borrow areas start at the three miles state waters boundary from east to west and are approximate as follows:

Area A: 36.7396 N, - 75.8762 W; 36.7235 N, - 75.8315 W
Area B: 36.7638 N, - 75.8860 W; 36.7537 N, - 75.8387 W

The proposed action would involve beach nourishment at the Sandbridge oceanfront, an area approximately 5 miles long and 725 feet wide (as illustrated in Appendix A). The specific beach area covered extends from the U.S. Naval Fleet Anti-Air Warfare Training Center at Dam Neck to the north to Back Bay National Wildlife Refuge (NWR) to the south. The project dimensions include a 50-foot wide berm at an elevation of 6 feet North American Vertical Datum (NGVD) with a foreshore slope of approximately 1:20 (one vertical value to 20 horizontal) for a distance of approximately 5 miles. The designated borrow area is Sandbridge Shoal (Appendix A), located approximately 3 nautical miles from the shoreline, outside of Virginia's territorial sea. There are two selected borrow areas within Sandbridge Shoal, Area B to the north and Area A to the south; depths range from 30 to 65 feet. The area between the two borrow areas is restricted due to the presence of a buried Navy submarine communications cable. Beach quality sand would most likely be removed by trailing suction hopper dredge with the possibility of using a hydraulic pipeline dredge (i.e. cutterhead).

The hopper dredge is a self-propelled vessel equipped with trailing suction dragheads and a hopper that collects sand. When the hopper is full, material is transported to a pump-out buoy located offshore. The material would then be pumped through a pipeline, which runs along the ocean floor, and up onto the beach where bulldozers and graders will distribute the sand. There are known ordinance issues located within the Sandbridge Shoals area, UXO screening will be required for this action. This is due to training operations at the U.S. Naval Fleet Anti-Air Warfare Training Center at Dam Neck. Ordinances have been found in earlier dredging actions for this on-going project.

A hydraulic pipeline dredge uses a cutterhead to loosen or dislodge sediments to hydraulically capture the material. The sluried sediment is transported through a pipeline to the placement site. Because pipeline dredges pump directly to the placement site, they can operate continuously and can be very productive, and cost efficient. Once the material is placed on the beach similar construction methods are used to distribute the material properly.

USACE states the purpose of the proposed action is to provide protection from erosion induced damages including limited protection to the beach and to residential structures from storm damage. Several alternatives were considered in the feasibility phase of the project including structural, non-structural and a no action alternative. Neither one nor a combination of the other alternatives discussed provided an acceptable solution in terms of feasibility and/or economics, environmental, and technical concerns, to the existing beach erosion and hurricane protection needs; and, thus were eliminated from further consideration as viable solutions to coastal erosion and storm problems at Sandbridge Beach.

As previously mentioned, the proposed action will utilize either a hopper style dredge or a hydraulic pipeline dredge to borrow beach quality sand from authorized sites along Sandbridge Shoals to renourish the beach at Sandbridge Beach via the placement of dredged material onto the beach.

### 3.6 Norfolk Harbor Channels

The Norfolk Harbor Channels are part of the larger Port of Hampton Roads complex and include the deep draft channels in the Elizabeth River and Hampton Roads. Portions of the Norfolk Harbor project have been authorized and modified by the Rivers and Harbors Act of July 5, 1884, 2 March 1907, 25 June 1910, 4 March 1913, 8 August 1917, 3 March 1925, 30 August 1935, 2 March 1945, 24 July 1946, 30 June 1948, 3 September 1954, 27 October 1965, the Flood Control Act of 1965, and the WRDA of 1986. The authorized project includes the following:

- A channel 55 feet deep over its 800 to 1,500-foot width from the 55-foot contour in Hampton Roads to Lamberts Point (Norfolk Harbor Channel - Sewells Point to Lamberts Bend);
- Sewells Point Anchorages and 50-foot Anchorages;
- A channel 55 feet deep and 800 feet wide from Norfolk Harbor Channel in Hampton Roads to Newport News (Channel to Newport News);
- Newport News Anchorages;
- A channel 45-feet deep over its 375 feet to 750-foot width from Lamberts Point to the N&W Railroad Bridge (Norfolk Harbor Channel - Lamberts Bend to Paradise Creek);
- A channel 40-feet deep over its 250 to 500-foot width to the U.S. Routes 460 and 13 Highway Bridge (Norfolk Harbor - Southern Branch Channel); hence a channel 35-feet deep over its 250 feet to 300 feet width to a point 0.8-mile above Interstate 64 high level bridge;
- A channel 25-feet deep over its 200 feet to 500 feet width from the junction with the Southern Branch of the Elizabeth River to the N&W Railroad Bridge on the Eastern Branch of the Elizabeth River (Norfolk Harbor – Eastern Branch Channel);
- A channel 18 feet deep over its 150 feet to 300 feet width and 1.72 mile length on the Western Branch of the Elizabeth River (Norfolk Harbor – Western Branch Channel);
- A channel 12 feet deep, 100 feet wide, and 0.73 mile in length in Scotts Creek (Norfolk Harbor – Scotts Creek Channel);
- Craney Island Dredged Material Management Area (CIDMMA) consist of a 2,500 acre upland confined disposal facility for the placement of navigation related dredged material from Norfolk Harbor and adjacent waters.



The Norfolk District is responsible for maintaining these Federal navigation channels and anchorages to ensure safe passage for all vessel traffic. A specific description of the channel reaches, anchorages, and dredged material placement sites serving the greater port of Hampton Roads follows and is depicted in Appendix A.

The Norfolk Harbor Channels provide access for all ships calling on port facilities, naval bases, and shipyards in the Hampton Roads area. All commercial tonnage entering and leaving the Port of Hampton Roads passes through one or more of these channels. The Norfolk District is responsible for maintaining these Federal navigation channels to ensure safe passage for all vessel traffic utilizing the port. In order to provide depths needed for safe navigation of larger vessels, maintenance dredging of these Federal navigation channels must occur before shoaling causes draft restrictions and/or other safety concerns. The proposed project activity will involve ongoing maintenance and future new work dredging of the Norfolk Harbor channels and the use of the associated dredged material placement sites. The project includes the entire footprint of these channels and the shoals contained within each channel, plus the entire footprint of the associated dredged material placement sites. Portions of these channels require maintenance dredging annually, but dredging is typically located in distinct shoaled areas within the channels. The duration of dredging, the amount of material removed from each channel reach and the frequency in which each shoal is dredged is dependent on several factors. These factors include, but are not limited to: new work dredging (deepening) to authorized depths, environmental conditions and windows, funding, location, length of time after the last dredging cycle, availability of suitable dredge plant, emergencies, and others. It is important to note that the areas within the channel that are maintenance dredged during each cycle are relatively small in comparison to the total channel dimensions. However, new work dredging projects that are initiated to deepen navigation channels to Congressionally-authorized depths involve dredging a large part of the channel to establish required channel depths. The amount of dredged material removed during a period of new work construction (deepening) may significantly exceed average maintenance dredging volumes. However, this may also be dependent on how Congress funds the project for the fiscal year. The primary objective of maintenance and new work dredging is to provide vessels with safe, navigable passage to the Port of Hampton Roads in support of commerce and national defense.

*Norfolk Harbor Channel - Sewells Point to Lamberts Bend*
The Norfolk Harbor Channel Sewells Point to Lamberts Bend consists of a channel 55-feet deep and 800 feet to 1,500 feet in width from the 55-foot contour in Hampton Roads near the Hampton Roads Bridge-Tunnel to Lamberts Bend a distance of approximately 8.0 miles. The channel is currently maintained to a depth of 50 feet.

*Norfolk Harbor Channel - Lamberts Bend to Paradise Creek*
The Norfolk Harbor Channel Lamberts Bend to Paradise Creek consists of a channel 45 feet deep and 350 feet to 750 feet in width from Lamberts Bend to Paradise Creek near the N&W Railroad Bridge. This channel is located in the main stem and southern branch of the Elizabeth River from Lamberts Bend to Paradise Creek in the cities of Norfolk, Portsmouth, and Chesapeake. The channel is maintained to a depth of 50 feet from Lamberts Bend to the U.S. Navy Deperm Station and a depth of 47 feet from The U.S. Navy Deperm Station to the Norfolk Naval Shipyard. These depths are to provide safe navigation for an aircraft carrier corridor for naval vessels accessing the shipyard. This element may be maintained by the U.S. Navy or USACE with military construction funding. The remaining channel from the Norfolk Naval Shipyard to Paradise Creek at the N&W Railroad Bridge is currently maintained to a depth of 40 feet.

*Norfolk Harbor - Southern Branch Channel*
The Norfolk Harbor - Southern Branch Channel consists of a channel 40 feet deep and 250 feet to 500 feet wide from the Norfolk Southern Railway Bridge to the U.S. Routes 460 and 13 Highway Bridge; thence 35 feet deep and 250 to 300 feet wide to a point 0.8 miles above the Interstate 64 high level bridge. The channel is located from the Norfolk and Western Railroad Bridge at Paradise Creek to the turning basin at Newton Creek and then to a point 0.8-mile above Interstate 64 high level bridge. The project includes a turning basin at the mouth of St. Julians Creek, 40 feet deep, 400 to 600 feet long, and 800 feet wide; a turning basin not yet constructed at the mouth of Milldam Creek, 40 feet deep and 800 feet square; a turning basin at the mouth of Newton Creek 35 feet deep and 600 feet square; and a turning basin at the mouth of Mains Creek, the upstream bend of the project, 35 feet deep and 800 feet square. All 40-foot features authorized by the 1986 WRDA have not yet been constructed. The Southern Branch Channel is currently maintained to a depth of 35 feet.

*Norfolk Harbor – Eastern Branch Channel*
The Eastern Branch Channel is located at the junction of the Elizabeth River main stem, southern branch, and eastern branch and extends 2.5 miles upstream in the eastern branch of the Elizabeth River.The Norfolk Harbor – Eastern Branch Channel consists of a channel 25 feet deep and 500 feet wide from the junction of the Elizabeth River branches to the N&W Railroad Bridge, from the N&W Railroad Bridge a channel 25 feet deep and 300 feet wide to the Campostella Bridge, thence a channel 25 feet deep and 200 feet wide to the N&W Railroad Bridge (formerly Virginian), including a turning basin 25 feet deep and approximately 55 acres in size located at the upstream end of the project.

*Norfolk Harbor – Western Branch Channel*
The Western Branch Channel is located at the junction of the Elizabeth River main stem with the western branch and extends 1.72 miles upstream in the western branch of the Elizabeth River. The Norfolk Harbor – Western Branch Channel consists of a channel 24 feet deep and 300 feet wide to a point 0.78 mile from the 40-foot channel; thence a channel 24 feet deep and 200 feet wide for a distance of 0.37 mile; thence a channel 18 feet deep and 150 feet wide and 0.57 mile in length to a point 0.34 mile above the West Norfolk Bridge.

*Norfolk Harbor – Scotts Creek Channel*
Scotts Creek Channel is located at the junction of the Elizabeth River main stem with Scotts Creek and extends 0.73 miles upstream in Scotts Creek. The Norfolk Harbor – Scotts Creek Channel consists of a channel 12-feet deep and 100 feet wide and 0.73 mile in length from its junction with the 40-foot channel.

*Channel to Newport News and Anchorages*
The Channel to Newport News is located from Norfolk Harbor Channel in Hampton Roads to Newport News. The Channel to Newport News federal navigation project was authorized by the River and Harbor Act of 25 June 1910 and modified by the River and Harbor Acts of 8 August 1917, 21 January 1927, 27 October 1965, and the WRDA of 1986. The project consists of a channel 55 feet deep and 800 feet wide from Norfolk Harbor Channel in Hampton Roads to Newport News, a distance of about 5.4 miles, and two deep-draft anchorage berths opposite Newport News 45 feet deep over a 1,200 foot swinging radius.

*Norfolk Harbor Anchorages*
The Norfolk Harbor Fifty-Foot Anchorages consists of three fixed mooring anchorage facilities with a depth of 55 feet, each capable of accommodating two large vessels simultaneously with a swinging radius of 1,200 feet. The Norfolk Harbor Sewells Point Anchorages consists of two anchorages 45 feet deep with a swinging radius of 1,200 feet.

## 3.7 Craney Island Eastward Expansion
The Craney Island Eastward Expansion (CIEE) project is located on the east side of the existing CIDMMA. The project activities are bounded by the CIDMMA on the west and the Norfolk Harbor Channel – Sewells Point to Lamberts Bend to the east. The CIEE is a water resources development project in the Port of Hampton Roads complex. The project consists of construction of a new 522-acre dredged material containment cell and marine terminal. CIEE was Congressionally-authorized in the WRDA of 2007 (Public Law 110-114), Section 1001 (45),

which became law on November 8, 2007. The authorization established a fifty percent cost share of the Federal government for the development of the new dredged material containment cell. The CIEE project consists of multiple construction elements within Hampton Roads and the Elizabeth River. The location of the project is illustrated in Appendix A.

The Craney Island Eastward Expansion Project is a dual purpose project that provides a new dredged material containment cell for additional dredged material placement capacity for dredging projects in the Port of Hampton Roads and a new marine terminal at the completion of filling of the containment cell. The site may also serve as a logistical and tactical area supporting deployment of national defense forces. The proposed Federal action will consists of new work dredging of the main dike footprint, access channels, and wharf access area to remove unsuitable marine clays underlying the marine terminal and to establish safe navigable depths for deep-draft vessels accessing the terminal wharf. Perimeter and division dikes will be constructed through the placement of suitable sand and rock caisson fill in the main dike footprint and sand fill in the south and north perimeter dikes and division dike.

The proposed project activity will involve multiple construction phases of new work dredging and fill elements over a period of approximately 15-years to construct the new containment cell, access channel, and wharf access elements. The project includes the entire footprint of the 522-acre containment cell, access channels, and wharf access area, plus the entire footprint of the associated dredged material placement sites. The duration of dredging, the amount of material removed and/or filled during each dredging or fill phase will be contingent on Federal and state funding. The entire footprint of the main dike, access channels, wharf access area, north and south perimeter dikes, and division dike will be dredged and/or filled over multiple construction phases to the required depths and elevations. The volumes of new work dredging and fill activities for each construction element are presented in Table 1.

The project includes the following elements:

- New work dredging totaling approximately 31.3 million cubic yards of dredged material for the main dike, access channels, and wharf access construction. Approximately 6.8 million cubic yards will be removed with a hydraulic pipeline dredge and placed upland in CIDMMA and 24.5 million cubic yards will be dredged with a mechanical dredge, transported by barge placed at the Norfolk Ocean Disposal Area (NODS); and,
- Dike construction (main dike, perimeter and division dikes) will require approximately 16.2 million cubic yards of sand fill and 3.3 million cubic yards of quarry rock for suitable infill.

Construction of the CIEE new containment cell will occur in two phases creating a 197-acre south sub-containment cell (south cell) and 325-acre north sub-containment cell (north cell). The south cell will be constructed first. Once the dikes of the south cell are completed it will become the primary placement site for dredged material inflows from Port of Hampton Roads. After the south cell is filled, it will be turned over to the Virginia Port Authority for marine terminal construction. Construction of the north cell will follow completion of the south cell. The work will be accomplished by the Norfolk District and the Virginia Port Authority. A description of the construction elements follows and is depicted in Appendix A.

**Table 1**. Fill Activity at CIEE

| **Fill Activity** | **Total Volume** |
|---|---|
| CIEE – Main Dike fill (5,500 linear feet), North Cell Construction | 15,000,000 |
| CIEE – South Perimeter Dike fill | 1,500,000 |
| CIEE – North Perimeter Dike fill | 1,500,000 |
| CIEE – Division Dike fill | 1,500,000 |
| ***TOTAL FILL VOLUME 19,500,000*** | |

*New Work Dredging of Main Dike, Access Channels, and Wharf Access*
The main dike footprint extends approximately 8,500 feet running north-south, forming the east perimeter of the Eastward Expansion. New work dredging of the main dike footprint will remove marine clays that comprise the Norfolk geologic formation. Dredging of the main dike will range from a depth of -90 feet to -130 feet and construct a 120 feet wide trench bottom. The main dike will be located approximately 2,500 feet east of the existing CIDMMA. The length of the main dike that will be constructed with the south cell is approximately 3,000 linear feet. The remaining 5,500 linear feet of main dike will be constructed in a late phase during construction of the north cell.

The access channels consist of two channels to a depth of 50 feet, 300 feet wide, and approximately 1,200 feet long from the Norfolk Harbor Channel – Sewells Point to Lamberts Bend to the CIEE main dike.

The wharf access dredging will consists of new work dredging to a depth of 50 feet from the Norfolk Harbor Channel – Sewells Point to Lamberts Bend to the completed terminal to provide wharf access for deep-draft vessels to the terminal.

*Construction of Perimeter and Division Dikes*
The construction of the perimeter and division dikes for the new containment cell will consist of placement of suitable fill for the main dike footprint, south and north perimeter dikes, and the division dike. Main dike dimensions will consists of a dike approximately 8,500 linear feet in length, and 240 feet top width. The south, north and division dikes will be approximately 2,500 linear feet in length and approximately 240 feet top width.

### 3.8 Dredged Material Disposal Areas
Any material that is not used for hurricane protection at Craney Island,Virginia Beach, Sandbridge Beach or Ft. Story will be placed at one of the ocean disposal sites noted below.

*Dam Neck Ocean Disposal Site*

The Dam Neck Ocean Disposal Site (DNODS) site was officially designated as an ocean placement site in 1993, pursuant to Section 102 (c) of the Marine Protection, Research, and Sanctuaries Act of 1972 (as amended, 33 U.S.C. 1401 *et seq*). The administrator of the Environmental Protection Agency (EPA) designated this ocean placement site in March of 1988 (53 FR 10382). This site is authorized to receive dredged material from the Atlantic Ocean Channel, the Cape Henry Channel, and the Thimble Shoal Channel. An Environmental Impact Statement and related Supplements, titled "Final Supplement 1 to the Final Environmental Impact Statement and Appendix: Dam Neck Ocean Disposal Site and Site Evaluation Study, Norfolk Harbor and Channels, Virginia, Deepening and Disposal" was finalized in May of 1985. The initial deepening of Thimble Shoal Channel by the USACE triggered a need for a placement site relatively close to the dredge site. The DNODS disposal site was developed in 1967 to accommodate the deepening work in Thimble Shoal Channel (-45 feet). The DNODS has an area of about 9-square nautical miles. The average water depth in the placement site is about 40 feet. An estimated 1.5 million cubic yards of dredged material are placed at this site every two years from the aforementioned navigation projects. Placement activities at DNODS placement area are performed primarily by hopper dredge. The DNODS was designed to accommodate approximately 50 million cubic yards of dredge material. The DNODS is located approximately 4 nautical miles off the coast of Virginia Beach, Virginia.
The DNODS boundary coordinates are as follows:

36.856694 N, - 75.9115 W;
36.856694 N, -75.884139 W;
36.774278 N, - 75.860889 W;
36.774306 N, - 75.905278 W;
36.834861 N, - 75.905278 W.

*Wolf Trap Alternate Placement Site*
The WTA is a 2,300-acre (4,500 acres with the designated buffer zone) area located in the Chesapeake Bay, east of New Point Comfort and south of Wolf Trap light, east of Mathews County. Water depths over the site range from -32.0 to -37.0 feet mean low low water. As a result of monitoring efforts from both the Virginia Institute of Marine Science and the Waterways Experiment Station from 1987 to 1991, the area was classified into six equally divided cells. It is intended that all six cells be utilized for placement of dredged material, and that the material be placed in a manner consistent within the criteria established in the project's environmental assessment published in July 1992. This placement site is currently used for the periodic maintenance dredging of the York River Entrance and York Spit Channels. The WTA is a 2,300-acre (4,400 acres with the designated buffer zone) area located in the Chesapeake Bay near Mathews County, east of New Point Comfort and south of Wolf Trap light.
The WTA boundary coordinates are as follows:

37.363063 N, -76.178684 W;
37.363063 N, -76.157913 W;
37.274736 N, -76.194135 W;
37.274736 N, -76.173363 W.

*Rappahannock Shoal Deep Alternate Open Water Site*
The RSA is an area approximately 4.5 nautical miles by 0.8 nautical miles in dimension, has an area of approximately 3,100 acres in size, and is the primary placement site for dredged material

from RSC. The site is located approximately 1-mile west of the RSC. The average water depth is 39 feet. The site has capacity to manage dredged material over a 20-year planning period, the site has not been utilized for dredged material placement since 1989. The RSA boundary coordinates are as follows:

37.666797 N,-76.174662 W;
37.666796 N,-76.191337 W;
37.591797 N,-76.191321 W;
37.591799 N,76.174662 W.

*Norfolk Ocean Dredged Material Disposal Site*
The NODS was designated by the Environmental Protection Agency (EPA) pursuant to Section 102(c) of the Marine Protection, Research, and Sanctuaries Act of 1972, as amended, as suitable for ocean disposal of dredged material on July 2, 1993 (FR. Vol. 5a No. 126). NODS is located in the Atlantic Ocean approximately 17 miles east of Cape Henry and is approximately 50 square nautical miles in size. The site is circular with a radius of 4 nautical miles and the water depth ranges from 43 to 85 feet. The NODS has unlimited capacity and was designated for use as a placement site for suitable materials from the Inner Harbor channels within the Port of Hampton Roads and other lower Chesapeake Bay dredged material. The only prior use of the NODS was by the U.S. Navy in August of 1993 for the placement of dredged material from the Naval Supply Center Cheatham Annex and the Yorktown Naval Weapons Station. Future placement at the NODS may include the Craney Island Eastern Expansion project, the Midtown Tunnel/Downtown Tunnel/MLK Expressway Project, and Baltimore Harbor Federal navigation project channels. The NODS is located in the Atlantic Ocean approximately 17 miles east of Cape Henry and approximately 2 statute miles north/northwest of The Chesapeake Light Tower. The NODS is approximately 50 square nautical miles in size with a circular radius of 4 nautical miles and water depths ranging from 43 to 85 feet. The center point coordinate of the site is north latitude 36° 59’ and west longitude 75° 39’.

*Craney Island Dredged Material Management Area and Facilities*
The Craney Island Dredged Material Management Area (CIDMMA) was authorized by the Rivers and Harbors act of 1946. It was constructed on 2,500 acres of river bottom in Hampton Roads in the City of Portsmouth, Virginia. CIDMMA is the primary dredged material placement area for construction and maintenance of navigation channels in the Hampton Roads port complex. It provides essential dredged material placement capacity for the Federal Navigation Channels, U.S. Navy facilities, Virginia Port Authority facilities and other commercial port facilities in Hampton Roads. The CIDMMA is an upland confined placement area that is enclosed by a perimeter containment dike and divided into three sub-containment cells by two division dikes.

The Craney Island Rehandling Basin (CIRB) is located to the east of the upland containment area and consists of a subaqueous rectangular area 1,400 feet in length by 1,100 feet in width and 40 feet in depth. The CIRB is connected by two access channels being 1,500 feet in length, 20 feet in depth and 200 feet wide. The basin is meant for the deposit of dredged material from dump scows from mechanical dredging operations. The project also provides for a debris channel, a segment of channel that connects the rehandling basin to the CIDMMA bulkhead. The debris channel is 80 feet wide and 13 feet deep.

## 3.9 Information on Dredges that may be used

Nearly all dredging in the Chesapeake Bay considered in this Opinion will occur with a hydraulic hopper dredge. However, USACE has indicated that a hydraulic cutterhead dredge is the preferred dredging method for Norfolk Harbor and CIEE project elements within economic pumping distances of CIDMMA. Additionally, hydraulic cutterhead dredge may beused at Sandbridge Shoal and/or at AOO. A mechanical dredge will be used for some of the dredging at CIEE and in some of the Norfolk Harbor channels.

### *3.9.1 Self-Propelled Hopper Dredges*

Hopper dredges are typically self-propelled seagoing vessels. They are equipped with propulsion machinery, sediment containers (i.e., hoppers), dredge pumps, and other specialized equipment required to 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.

### *3.9.2 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.

### *3.9.3 Mechanical Dredges*

Mechanical dredging will be used in association with CIEE and in some of the Norfolk Harbor Channels. Mechanical dredges are relatively stationary. While operating, the dredge swings slowly in an arc across the channel cut as material is excavated. This is accomplished by pivoting the dredge on vertical pilings called spuds that are alternately raised and lowered from the stern corners of the dredge. Cables to anchors, set roughly perpendicular to the forward section of the dredge, are used to shift the lateral position of the digging area. Periodically, as the cut advances, the anchors are reset. Bucket dredging entails lowering the open bucket through the water column, closing the bucket after impact on the bottom, lifting the bucket up through the water column, and emptying the bucket into a barge. An environmental clamshell dredge differs from traditional dredging buckets by having an outer covering that seals when the bucket is closed. Water passes through its top moveable vents as it submerges, thereby reducing turbidity. Once it lifts off the bottom and closes, the covering seals over the bucket and minimizes overspill as the dredge bucket moves back up through the water column.

### 3.10 Bed Leveling Devices

USACE has indicated that in certain circumstances, a dredge contractor may employ a bed-leveler device to smooth the channel bottom or to reduce the heights of disposal mounds created during hydraulic placement operations. The USACE has reported that they are not aware of any instances where bed-leveling has been utilized in the action area. However, bed-leveling may be a preferred alternative during certain phases of the dredging operations (i.e. clean-up phase) and it is possible that a bed leveler will be used during this dredge cycle.

Bed leveling techniques have been documented as far back as 1565 (USACE, 2006). However, the use of bed-levelers in U.S. waters is not well documented. The devices are typically used during final clean-up operations when localized mounds or ridges exist shallower than required dredging depths. Passage of a draghead can create ridges up to two feet high and can require multiple passes to reduce the height during clean-up operations. Often these areas cannot be efficiently or economically dredged to specified depths and make it difficult to maintain hard contact between the draghead and channel bottom. Bed-leveler devices may consist of a large customized plow or a box beam suspended from a work-barge that can be pushed or towed by a tug. The bed-leveler may be towed by a short or long towing line depending on the sea-state. Bed-leveler size and geometry can vary but are typically thirty and fifty feet in width and may weigh from twenty-five to fifty tons. Bed-levelers are generally towed at speeds ranging from 1-2 knots. Bed-leveler operation can be affected by sea state conditions and generally require longer towing line in rougher waters.



The USACE-ERDC has performed an engineering evaluation on various configurations of bed-leveler prototypes to determine their performance aspects for production rates (i.e. ability to remove target material), ability to deflect model turtles, and bed-leveler construction and operation in the field. Model studies were performed at Texas A&M. The study tested conceptual designs using a conventional straight square tube box-beam, a 90-degree raked plow (i.e. inclined), a 90-degree square tube box beam plow, a 130- degree box square tube box beam plow. Model study results indicated that the straight square tube box beam design provided the highest production rate moving sediment in the direction of the bed leveler device but provided the least turtle shedding capability. The 90-degree raked (inclined) plow produced an increased vertical downward force on the towing cables resulting in some operational difficulty. In general, the increase in the sweep angle increased the side-spilling or side-casting of sediment which also accounted for the designs ability to shed model turtles from in front of the bed-leveler device. The 130-degree box beam plow likely provides the optimal mix of production, turtle shedding capability, and operational deployment. The conceptual bed-leveling designs tested in the model study are presented in Appendix F of USACE's BA (Appendix B of this Opinion).

### 3.10 Interrelated or Interdependent Actions

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; see also 1998 FWS-NMFS Joint Consultation Handbook, pp. 4-26 to 4-28). We have not identified any interrelated or interdependent actions.

### 3.11 Summary of Proposed Action

The proposed activity has a 50-year life; therefore, this consultation considers effects of the actions described above from now through 2062. The action considered here includes dredging, as summarized in the table below, as well as fill activities associated with the CIEE and continued use of several dredged material disposal sites and placement of sand on Virginia Beach and Sandbridge Beach as well as at the U.S. Navy's Fort Story Facility.

The following table summarizes the anticipated dredging during this period:

**Table 2**. Anticipated dredging considered in this consultation

| Channel | Type of Dredge | Typical Volume Removed | Frequency of Dredge Events | Number of events in 50 years | Volume Removed in 50 years |
|---|---|---|---|---|---|
| **Baltimore Harbor Entrance Channels** | | | | | |
| *Cape Henry* | *H* | *1.1 mcy* | *1-2 years* | *25-50* | *Up to 50 mcy* |
| *York Spit Channel* | *H* | *0.5 mcy* | *2 years* | *25* | *12.5 mcy* |
| *Rappahannock Shoals Channel* | *H* | *no maintenance dredging to date* | *Every 20 years* | *2* | *Up to 2 mcy* |
| **Total: 64.5 MCY** | | | | | |
| **York River Entrance Channel** | **H** | **0.5 mcy** | **Every 3 years** | **13** | **6.5 mcy** |
| **Hampton Roads Approach Channels** | | | | | |
| *Thimble Shoals Channel-maintenance* | *H* | *0.75 mcy* | *Every 3 years* | *13* | *10 mcy* |
| *Thimble Shoals Channel – Willoughby Spit & Vicinity HPP Borrow* | *H* | *1.0 mcy* | *Every 5 years* | *10* | *5.0 mcy* |
| *Atlantic Ocean Channel-maintenance* | *H* | *0.33 mcy* | *Every 3 years* | *13* | *4.5 mcy* |
| *Atlantic Ocean Channel-VBHPP Borrow* | *H* | *0.5 mcy* | *Every 3years* | *16* | *8.1 mcy* |
| *Atlantic Ocean Channel – CIEE Borrow* | *H* | *Subject to Federal Funding* | *Subject to Federal Funding* | *Subject to Federal Funding* | *16.2 mcy* |
| *Atlantic Ocean Channel – JEB Fort Story Borrow* | *H* | *0.65 mcy* | *Every 10 years* | *5* | *6.5 mcy* |
| **Total: 14.5 mcy** | | | | | |
| **VA Beach Hurricane Protection** | **H** | **0.27 mcy** | **Every 3 years** | **16** | **4.4 mcy** |
| **Sandbridge** | **H or C** | **0.5 mcy** | **Every 2 years** | **25** | **12.5 mcy** |
| **Norfolk Harbor Channels** | | | | | |
| *Norfolk Harbor Channel – Sewells Point to Lamberts Bend* | *C or M* | *1 mcy* | *annually* | *50* | *50 mcy* |
| *Norfolk Harbor Channel – Lamberts Bend to Paradise Creek* | *C or M* | *0.4 mcy* | *3 years* | *16* | *6.4 mcy* |
| *Norfolk Harbor - Southern Branch* | *M* | *0.1 mcy* | *3 years* | *16* | *1.6 mcy* |

| | | | | | |
|---|---|---|---|---|---|
| *Channel* | | | | | |
| *Norfolk Harbor – Eastern Branch Channel* | *M* | *0.1 mcy* | *15 years* | *3* | *0.3 mcy* |
| *Norfolk Harbor – Western Branch Channel* | *M* | *0.1 mcy* | *15 years* | *3* | *0.3 mcy* |
| *Norfolk Harbor – Scotts Creek Channel* | *M* | *0.03 mcy* | *15 years* | *3* | *0.09 mcy* |
| *Channel To Newport News* | *C* | *0.75 mcy* | *5 years* | *10* | *7.5 mcy* |
| *Craney Island Rehandling Basin* | *C* | *1.5 mcy* | 1.5 years | *33* | *49.5 mcy* |
| Sewells Point and Fifty-foot Anchorages, Newport News Anchorages | *C* | *0.25 mcy each anchorage* | 10 years | *5* | *2.5 mcy* |
| **Total: 118.19 mcy** | | | | | |
| **Craney Island Eastward Expansion** | | | | | |
| CIEE – Main Dike dredging (8,500 linear feet) | *C or M* | *Subject to Federal Funding* | *Subject to Federal Funding* | *Subject to Federal Funding* | 22,400,000 |
| CIEE – Access Channel dredging | *C or M* | *Subject to Federal Funding* | *Subject to Federal Funding* | *Subject to Federal Funding* | 1,600,000 |
| CIEE – Wharf Access dredging | *C or M* | *Subject to Federal Funding* | *Subject to Federal Funding* | *Subject to Federal Funding* | 7,300,000 |
| **Total: 31.3 mcy (6.8 mcy cutterhead; 24.5 mcy mechanical)** | | | | | |

### 3.12 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 dredges and dredged material disposal vessels. The action area, therefore, includes the entirety of the navigation channels, borrow areas and disposal areas noted above. The action area will also encompass the underwater area where dredging will result in increased suspended sediment. The size of the sediment plume will vary depending on the type of dredge used and is detailed below.

## 4.0 Species that are not likely to be adversely affected by the proposed action

### 4.1 SHORTNOSE STURGEON

Shortnose sturgeon are benthic fish that occur in large coastal rivers of eastern North America. They range from as far south as the St. Johns River, Florida (possibly extirpated from this system) to as far north as the Saint John River in New Brunswick, Canada. Shortnose sturgeon occur in 19 rivers along the U.S. Atlantic coast. Shortnose sturgeon historically occurred in the Chesapeake Bay, but prior to 1996, the best available information suggested that the species was either extirpated from the area or present in extremely low numbers. Before 1996, there were only 15 published historic records of shortnose sturgeon in the Chesapeake Bay, and most of these were based on personal observations from the upper Chesapeake Bay during the 1970s and 1980s (Dadswell et al. 1984). From February through November 1997, a Fish and Wildlife Service reward program was in effect for Atlantic sturgeon in Virginia's major tributaries (James, York, and Rappahannock Rivers). A sturgeon captured from the Rappahannock River in May 1997 was confirmed as a shortnose sturgeon (Spells 1998). This capture represents the only recent capture of a shortnose sturgeon in Virginia. On October 22, 2003, an endangered species observer initially reported the capture of one shortnose sturgeon in a sea turtle relocation trawling operation in Thimble Shoals Channel. Several Atlantic sturgeon were captured during the relocation trawl and due to the difficulty in distinguishing these species, the fish was initially reported as a shortnose sturgeon. The captured fish was reported as 123 cm fork length (FL), which is close to the maximum length of shortnose sturgeon in northern river systems reported in the literature (130 cm FL) and far greater than the maximum length of shortnose sturgeon in southern river systems (97 cm FL). Further analysis resulted in the observer correcting the report and stating that the fish was actually an Atlantic sturgeon.

Despite numerous studies that have occurred to document the presence of Atlantic sturgeon in Virginia waters, only one shortnose sturgeon has been captured. Because we anticipate that shortnose sturgeon would have been captured in sampling gear if present, and that these captures would be reported to NMFS, we believe this lack of captures is indicative of the rarity of shortnose sturgeon in Virginia waters of the Chesapeake Bay. We do not anticipate that shortnose sturgeon would be present in the action area and therefore, any effects to shortnose sturgeon are extremely unlikely to occur. The lack of any interactions with shortnose sturgeon during dredging or relocation trawling associated with any of the channels or borrow areas to date, supports this determination. Because any effects to shortnose sturgeon are extremely unlikely to occur, all effects to this species are discountable. As such, we have determined that the proposed action is not likely to adversely affect this species and it is not considered further in this Opinion.

## 4.2 HAWKSBILL SEA TURTLE

The hawksbill sea turtle is listed as endangered. This species is uncommon in the waters of the continental U.S. Hawksbills prefer coral reef habitats, such as those found in the Caribbean and Central America. Mona Island (Puerto Rico) and Buck Island (St. Croix, U.S. Virgin Islands) contain especially important foraging and nesting habitat for hawksbills. Within the continental U.S., nesting is restricted to the southeast coast of Florida and the Florida Keys, but nesting is rare in these areas. Hawksbills have been recorded from all the Gulf States and along the east coast of the U.S. as far north as Massachusetts, but sightings north of Florida are rare. Many of these strandings in the North Atlantic were observed after hurricanes or offshore storms. Aside from Florida, Texas is the only other U.S. state where hawksbills are sighted with any regularity.

Only two hawksbill sea turtles have been documented in Virginia waters since 1979 (Mansfield 2006) and no hawksbill sea turtles have ever been documented in the Chesapeake Bay. The occurrence of Hawksbill sea turtles in the Chesapeake Bay would be an extremely rare occurrence. Because Hawksbill sea turtles are so unlikely to occur in the action area, impacts to this species are considered extremely unlikely. The lack of any interactions with hawksbills during dredging or relocation trawling associated with any of the channels or borrow areas to date, supports this determination. Because any effects to hawksbills are extremely unlikely to occur, all effects to hawksbill sea turtles are discountable. As such, we have determined that the proposed action is not likely to adversely affect this species and it is not considered further in this Opinion.

## 4.3 SPERM, BLUE, RIGHT, HUMPBACK AND FIN WHALES

Sperm whales and blue whales are listed as endangered. During surveys for the Cetacean and Turtle Assessment Program (CeTAP), sperm whales were observed along the shelf edge, centered around the 1,000 m depth contour but extending seaward out to the 2,000 m depth contour (CeTAP 1982). Although blue whales are occasionally seen in U.S. waters, they are more commonly found in Canadian waters and are rare in continental shelf waters of the eastern U.S. (Waring *et al.* 2000). Given the predominantly offshore distribution of these two cetacean species, both are highly unlikely to occur in the action area or to be affected by the actions considered in this Opinion.

The Chesapeake Bay is not a high use area for whales. Transient individual right, humpback and fin whales may occasionally be present in the lower Bay for brief periods during annual migrations or during the summer months, but no whales are known to be resident in this area and even transient whales are considered rare in the lower Bay. Because any effects to whales are extremely unlikely to occur, all effects to whales are discountable. As such, we have determined that the proposed action is not likely to adversely affect right, humpback or fin whales. These species will not be considered further in this Opinion.

# 5.0 STATUS OF LISTED SPECIES IN THE ACTION AREA THAT MAY BE AFFECTED BY THE PROPOSED ACTIONS

Several species listed under NMFS' jurisdiction occur in the action area for this consultation. 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***

| | |
|---|---|
| Northwest Atlantic DPS of 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[1] | |

***Fish***

| | |
|---|---|
| Gulf of Maine DPS of Atlantic sturgeon (*Acipenser oxyrinchus oxyrinchus*) | Threatened |
| New York Bight DPS of Atlantic sturgeon | Endangered |
| Chesapeake Bay DPS of Atlantic sturgeon | Endangered |
| South Atlantic DPS of Atlantic sturgeon | Endangered |
| Carolina DPS of Atlantic sturgeon | 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.

## 5.1 OVERVIEW OF STATUS OF SEA TURTLES

With the exception of loggerheads, 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 leatherback, Kemp's ridley and green sea turtles is included to provide the status of each species overall. Information on the status of loggerheads will only be presented for the DPS affected by this action. 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; Marine Turtle Expert Working Group [TEWG] 1998, 2000, 2007, 2009; NMFS and USFWS 2007a, 2007b, 2007c, 2007d; Conant *et al.* 2009), and recovery plans for the loggerhead sea turtle (NMFS and USFWS 2008), Kemp's ridley sea turtle (NMFS *et al.* 2011), leatherback sea turtle (NMFS and USFWS 1992, 1998a), Kemp's ridley sea turtle (NMFS *et al.* 2011)and green sea turtle (NMFS and USFWS 1991, 1998b).

*2010 BP Deepwater Horizon Oil Spill*

The April 20, 2010, explosion of the Deepwater Horizon oil rig affected sea turtles in the Gulf of Mexico. There is an on-going assessment of the long-term effects of the spill on Gulf of Mexico marine life, including sea turtle populations. Following the spill, juvenile Kemp's ridley, green, and loggerhead sea turtles were found in *Sargassum* algae mats in the convergence zones, where currents meet and oil collected. Sea turtles found in these areas were often coated in oil and/or had ingested oil. Approximately 536 live adult and juvenile sea turtles were recovered from the Gulf and brought into rehabilitation centers; of these, 456 were visibly oiled (these and the following numbers were obtained from http://www.nmfs.noaa.gov/pr/health/oilspill/). To date, 469 of the live recovered sea turtles have been successfully returned to the wild, 25 died during



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

rehabilitation, and 42 are still in care but are expected to be returned to the wild eventually. During the clean-up period, 613 dead sea turtles were recovered in coastal waters or on beaches in Mississippi, Alabama, Louisiana, and the Florida Panhandle. As of February 2011, 478 of these dead turtles had been examined. Many of the examined sea turtles showed indications that they had died as a result of interactions with trawl gear, most likely used in the shrimp fishery, and not as a result of exposure to or ingestion of oil.

During the spring and summer of 2010, nearly 300 sea turtle nests were relocated from the northern Gulf to the east coast of Florida with the goal of preventing hatchlings from entering the oiled waters of the northern Gulf. From these relocated nests, 14,676 sea turtles, including 14,235 loggerheads, 125 Kemp's ridleys, and 316 greens, were ultimately released from Florida beaches.

A thorough assessment of the long-term effects of the spill on sea turtles has not yet been completed. The spill resulted in the direct mortality of many sea turtles and may have had sublethal effects or caused environmental damage that will impact other sea turtles into the future. The population level effects of the spill and associated response activity are likely to remain unknown for some period into the future.

## 5.2 Northwest Atlantic DPS of loggerhead sea turtle

The loggerhead is the most abundant species of sea turtle in U.S. waters. Loggerhead sea turtles are found in temperate and subtropical waters and occupy a range of habitats including offshore waters, continental shelves, bays, estuaries, and lagoons. They are also exposed to a variety of natural and anthropogenic threats in the terrestrial and marine environment.

*Listing History*

Loggerhead sea turtles were listed as threatened throughout their global range on July 28, 1978. Since that time, several status reviews have been conducted to review the status of the species and make recommendations regarding its ESA listing status. Based on a 2007 5-year status review of the species, which discussed a variety of threats to loggerheads including climate change, NMFS and FWS determined that loggerhead sea turtles should not be delisted or reclassified as endangered. However, we also determined that an analysis and review of the species should be conducted in the future to determine whether DPSs should be identified for the loggerhead (NMFS and USFWS 2007a). 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; TEWG 2009; NMFS and USFWS 2008). 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).

In part to evaluate those genetic differences, in 2008, NMFS and FWS established a Loggerhead Biological Review Team (BRT) to assess the global loggerhead population structure to determine whether DPSs exist and, if so, the status of each DPS. The BRT evaluated genetic data, tagging and telemetry data, demographic information, oceanographic features, and geographic barriers to determine whether population segments exist. The BRT report was completed in August 2009 (Conant *et al.* 2009). In this report, the BRT identified the following nine DPSs as being discrete from other conspecific population segments and significant to the species: (1) North Pacific Ocean, (2) South Pacific Ocean, (3) North Indian Ocean, (4) Southeast Indo-Pacific Ocean, (5) Southwest Indian Ocean, (6) Northwest Atlantic Ocean, (7) Northeast Atlantic Ocean, (8) Mediterranean Sea, and (9) South Atlantic Ocean.

The BRT concluded that although some DPSs are indicating increasing trends at nesting beaches (Southwest Indian Ocean and South Atlantic Ocean), available information about anthropogenic threats to juveniles and adults in neritic and oceanic environments indicate possible unsustainable additional mortalities. According to an analysis using expert opinion in a matrix model framework, the BRT report stated that all loggerhead DPSs have the potential to decline in the foreseeable future. Based on the threat matrix analysis, the potential for future decline was reported as greatest for the North Indian Ocean, Northwest Atlantic Ocean, Northeast Atlantic Ocean, Mediterranean Sea, and South Atlantic Ocean DPSs (Conant *et al.* 2009). The BRT concluded that the North Pacific Ocean, South Pacific Ocean, North Indian Ocean, Southeast Indo-Pacific Ocean, Northwest Atlantic Ocean, Northeast Atlantic Ocean, and Mediterranean Sea DPSs were at risk of extinction. The BRT concluded that although the Southwest Indian Ocean and South Atlantic Ocean DPSs were likely not currently at immediate risk of extinction, the extinction risk was likely to increase in the foreseeable future.

On March 16, 2010, NMFS and USFWS published a proposed rule (75 FR 12598) to divide the worldwide population of loggerhead sea turtles into nine DPSs, as described in the 2009 Status Review. Two of the DPSs were proposed to be listed as threatened and seven of the DPSs, including the Northwest Atlantic Ocean DPS, were proposed to be listed as endangered. NMFS and the USFWS accepted comments on the proposed rule through September 13, 2010 (75 FR 30769, June 2, 2010). On March 22, 2011 (76 FR 15932), NMFS and USFWS extended the date by which a final determination on the listing action will be made to no later than September 16, 2011. This action was taken to address the interpretation of the existing data on status and trends and its relevance to the assessment of risk of extinction for the Northwest Atlantic Ocean DPS, as well as the magnitude and immediacy of the fisheries bycatch threat and measures to reduce this threat. New information or analyses to help clarify these issues were requested by April 11, 2011.

On September 22, 2011, NMFS and USFWS issued a final rule (76 FR 58868), determining that the loggerhead sea turtle is composed of nine DPSs (as defined in Conant *et al*., 2009) that constitute species that may be listed as threatened or endangered under the ESA. Five DPSs were listed as endangered (North Pacific Ocean, South Pacific Ocean, North Indian Ocean, Northeast Atlantic Ocean, and Mediterranean Sea), and four DPSs were listed as threatened (Northwest Atlantic Ocean, South Atlantic Ocean, Southeast Indo-Pacific Ocean, and Southwest Indian Ocean). Note that the Northwest Atlantic Ocean (NWA) DPS and the Southeast Indo-Pacific Ocean DPS were originally proposed as endangered. The NWA DPS was determined to be threatened based on review of nesting data available after the proposed rule was published, information provided in public comments on the proposed rule, and further discussions within the agencies. The two primary factors considered were population abundance and population trend. NMFS and USFWS found that an endangered status for the NWA DPS was not warranted given the large size of the nesting population, the overall nesting population remains widespread, the trend for the nesting population appears to be stabilizing, and substantial conservation efforts are underway to address threats. This final listing rule became effective on October 24, 2011.

The September 2011 final rule also noted that critical habitat for the two DPSs occurring within the U.S. (NWA DPS and North Pacific DPS) will be designated in a future rulemaking. Information from the public related to the identification of critical habitat, essential physical or biological features for this species, and other relevant impacts of a critical habitat designation was solicited. Currently, no critical habitat is designated for any DPS of loggerhead sea turtles, and therefore, no critical habitat for any DPS occurs in the action area.

*Presence of Loggerhead Sea Turtles in the Action Area*
The effects of this proposed action are only experienced within the Atlantic Ocean. NMFS has considered the available information on the distribution of the 9 DPSs to determine the origin of any loggerhead sea turtles that may occur in the action area. As noted in Conant *et al.* (2009), the range of the four DPSs occurring in the Atlantic Ocean are as follows: NWA DPS – north of the equator, south of 60° N latitude, and west of 40° W longitude; Northeast Atlantic Ocean (NEA) DPS – north of the equator, south of 60° N latitude, east of 40° W longitude, and west of 5° 36’ W longitude; South Atlantic DPS – south of the equator, north of 60° S latitude, west of 20° E longitude, and east of 60° W longitude; Mediterranean DPS – the Mediterranean Sea east of 5° 36’ W longitude. These boundaries were determined based on oceanographic features, loggerhead sightings, thermal tolerance, fishery bycatch data, and information on loggerhead distribution from satellite telemetry and flipper tagging studies. While adults are highly structured with no overlap, there may be some degree of overlap by juveniles of the NWA, NEA, and Mediterranean DPSs on oceanic foraging grounds (Laurent *et al.* 1993, 1998; Bolten *et al.* 1998; LaCasella *et al.* 2005; Carreras *et al.* 2006, Monzón-Argüello *et al.* 2006; Revelles *et al.* 2007). Previous literature (Bowen *et al.* 2004) has suggested that there is the potential, albeit small, for some juveniles from the Mediterranean DPS to be present in U.S. Atlantic coastal foraging grounds. These conclusions must be interpreted with caution however, as they may reflect a shared common haplotype and lack of representative sampling at Eastern Atlantic rookeries rather than an actual presence of Mediterranean DPS turtles in US Atlantic coastal waters. A re-analysis of the data by the Atlantic loggerhead Turtle Expert Working Group has found that that it is unlikely that U.S. fishing fleets are interacting with either the Northeast Atlantic loggerhead DPS or the Mediterranean loggerhead DPS (Peter Dutton, NMFS, Marine Turtle Genetics Program, Program Leader, personal communication, September 10, 2011). Given that the action area is a subset of the area fished by US fleets, it is reasonable to assume that based on this new analysis, no individuals from the Mediterranean DPS or Northeast Atlantic DPS would be present in the action area. Sea turtles of the South Atlantic DPS do not inhabit the action area of this consultation (Conant *et al.* 2009). As such, the remainder of this consultation will only focus on the NWA DPS, listed as threatened.

*Distribution and Life History*
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), the TEWG report (2009), and the final revised recovery plan for loggerheads in the Northwest Atlantic Ocean (NMFS and USFWS 2008), which is a second revision to the original recovery plan that was

approved in 1984 and subsequently revised in 1991.

In the 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). 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; Braun-McNeill *et al.* 2008; Mitchell *et al.* 2003). Loggerheads have been observed in waters with surface temperatures of 7°C 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 water depth. Aerial surveys of continental shelf waters north of Cape Hatteras, North Carolina indicated that loggerhead sea turtles were most commonly sighted in waters with bottom depths ranging from 22 m to 49 m deep (Shoop and Kenney 1992). However, more recent 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; Mansfield 2006; Blumenthal *et al.* 2006; Hawkes *et al.* 2006; McClellan and Read 2007; Mansfield *et al.* 2009).

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 United States (*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/May 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 turtles 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).



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; Mansfield *et al.* 2009). 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 adults staying in coastal waters and smaller adults 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).

Pelagic and benthic juveniles are omnivorous and forage on crabs, mollusks, jellyfish, and vegetation at or near the surface (Dodd 1988; NMFS and USFWS 2008). Sub-adult and adult loggerheads are primarily coastal dwelling and typically prey on benthic invertebrates such as mollusks and decapod crustaceans in hard bottom habitats (NMFS and USFWS 2008).

As presented below, Table 3 from the 2008 loggerhead recovery plan (Table 3 in this Opinion) highlights the key life history parameters for loggerheads nesting in the United States.

**Table 3.** Typical values of life history parameters for loggerheads nesting in the U.S.

| **Life History Parameter** | **Data** |
|---|---|
| Clutch size | 100-126 eggs[1] |
| Egg incubation duration (varies depending on time of year and latitude) | 42-75 days[2,3] |
| Pivotal temperature (incubation temperature that produces an equal number of males and females) | 29.0°C[5] |
| Nest productivity (emerged hatchlings/total eggs) x 100 (varies depending on site specific factors) | 45-70%[2,6] |
| Clutch frequency (number of nests/female/season) | 3-5.5 nests[7] |
| Internesting interval (number of days between successive nests within a season) | 12-15 days[8] |
| Juvenile (<87 cm CCL) sex ratio | 65-70% female[4] |
| Remigration interval (number of years between successive nesting migrations) | 2.5-3.7 years[9] |
| Nesting season | late April-early September |
| Hatching season | late June-early November |
| Age at sexual maturity | 32-35 years[10] |
| Life span | >57 years[11] |

1 Dodd 1988.
2 Dodd and Mackinnon (1999, 2000, 2001, 2002, 2003, 2004).
3 Blair Witherington, FFWCC, personal communication, 2006 (information based on nests monitored throughout Florida beaches in 2005, n=865).
4 National Marine Fisheries Service (2001); Allen Foley, FFWCC, personal communication, 2005.
5 Mrosovsky (1988).
6 Blair Witherington, FFWCC, personal communication, 2006 (information based on nests monitored throughout Florida beaches in 2005, n=1,680).
7 Murphy and Hopkins (1984); Frazer and Richardson (1985); Ehrhart, unpublished data; Hawkes *et al*. 2005; Scott 2006; Tony Tucker, Mote Marine Laboratory, personal communication, 2008.
8 Caldwell (1962), Dodd (1988).
9 Richardson *et al*. (1978); Bjorndal *et al*. (1983); Ehrhart, unpublished data.
10 Melissa Snover, NMFS, personal communication, 2005; see Table A1-6.
11 Dahlen *et al*. (2000).

*Population Dynamics and Status*
By far, the majority of Atlantic nesting occurs on beaches of the southeastern United States (NMFS and USFWS 2007a). 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; and (5) a Dry Tortugas group that nests on beaches of the islands of the Dry Tortugas, near Key West, Florida and on Cal Sal Bank (TEWG 2009). 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 2009). 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 in the 2008 recovery plan.



In the 2008 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 United States. The fifth recovery unit is composed of all other nesting assemblages of loggerheads within the Greater Caribbean, outside the United States, 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, 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). The level and consistency of nesting coverage varies among recovery units, with coverage in Florida generally being the most consistent and thorough over time. Since 1989, nest count surveys in Florida have occurred in the form of statewide surveys (a near complete census of entire Florida nesting) and index beach surveys (Witherington *et al.* 2009). Index beaches were established to standardize data collection methods and maintain a constant level of effort on key nesting beaches over time.

Note that NMFS and USFWS (2008), Witherington *et al.* (2009), and TEWG (2009) analyzed the status of the nesting assemblages within the NWA DPS using standardized data collected over periods ranging from 10-23 years. These analyses used different analytical approaches, but found the same finding that there had been a significant, overall nesting decline within the NWA DPS. However, with the addition of nesting data from 2008-2010, the trend line changes showing a very slight negative trend, but the rate of decline is not statistically different from zero (76 FR 58868, September 22, 2011). The nesting data presented in the Recovery Plan (through 2008) is described below, with updated trend information through 2010 for two recovery units.



From the beginning of standardized index 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 2008, there was a 41% decrease in annual nest counts from index beaches, which represent an average of 70% of the statewide nesting activity (NMFS and USFWS 2008). From 1989-2008, the PFRU had an overall declining nesting trend of 26% (95% CI: -42% to -5%; NMFS and USFWS 2008). With the addition of nesting data through 2010, the nesting trend for the PFRU does not show a nesting decline statistically different from zero (76 FR 58868, September 22, 2011). The NRU, the second largest nesting assemblage of loggerheads in the United States, has been declining at a rate of 1.3% annually since 1983 (NMFS and USFWS 2008). The NRU dataset included 11 beaches with an uninterrupted time series of coverage of at least 20 years; these beaches represent approximately 27% of NRU nesting (in 2008). Through 2008, there was strong statistical data to suggest the NRU has experienced a long-term decline, but with the inclusion of nesting data through 2010, nesting for the NRU is showing possible signs of stabilizing (76 FR 58868, September 22, 2011). Evaluation of long-term nesting trends for the NGMRU is difficult because of changed and expanded beach coverage. However, the NGMRU has shown a significant declining trend of 4.7% annually since index nesting beach surveys were initiated in 1997 (NMFS and USFWS 2008). 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 census 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 2008 recovery plan compiled 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 (from 1989-2008) with approximately 1,272 females nesting per year; (2) for the PFRU, a mean of 64,513 nests per year (from 1989-2007) with approximately 15,735 females nesting per year; (3) for the DTRU, a mean of 246 nests per year (from 1995-2004, excluding 2002) with approximately 60 females nesting per year; and (4) for the NGMRU, a mean of 906 nests per year (from 1995-2007) 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. Note that the above values for average nesting females per year were based upon 4.1 nests per female per Murphy and Hopkins (1984).

Genetic studies of juvenile and a few adult loggerhead sea turtles collected from Northwest Atlantic foraging areas (beach strandings, a power plant in Florida, and North Carolina fisheries) show that the loggerheads that occupy East Coast U.S. waters originate from these Northwest Atlantic nesting groups; primarily from the nearby nesting beaches of southern Florida, as well as the northern Florida to North Carolina beaches, and finally from the beaches of the Yucatán Peninsula, Mexico (Rankin-Baransky *et al.* 2001; Witzell *et al.* 2002; Bass *et al.* 2004; Bowen *et al.* 2004). The contribution of these three nesting assemblages varies somewhat among the foraging habitats and age classes surveyed along the east coast. The distribution is not random and bears a significant relationship to the proximity and size of adjacent nesting colonies (Bowen *et al.* 2004). Bass *et al.* (2004) attribute the variety in the proportions of sea turtles from loggerhead turtle nesting assemblages documented in different east coast foraging habitats to a complex interplay of currents and the relative size and proximity of nesting beaches.

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.* 2005; Mansfield 2006; Ehrhart *et al.* 2007; Epperly *et al.* 2007). The TEWG (2009) used raw data from six in-water study sites to conduct trend analyses. They identified an increasing trend in the abundance of loggerheads from three of the four sites located in the Southeast United States, one site showed no discernible trend, and the two sites located in the northeast United States showed a decreasing trend in abundance of loggerheads. The 2008 loggerhead recovery plan also includes a full discussion of in-water population studies for which trend data have been reported, and a brief summary will be provided here.

Maier *et al.* (2004) used fishery-independent trawl data to establish a regional index of loggerhead abundance for the southeast coast of the United States (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, but the authors caution a direct comparison between the two studies given differences in sampling methodology (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 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). At St. Lucie Power Plant, data collected from 1977-2004 show an increasing trend of loggerheads at the power plant intake structures (FPL and Quantum Resources 2005).

In contrast to these studies, Morreale *et al.* (2005) observed a decline in the percentage and relative numbers of loggerhead sea turtles incidentally captured 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 (of a total 54 turtles) observed captured in pound net gear during the period 2002-2004. This is in contrast to the previous decade's study where numbers of individual loggerheads ranged from 11 to 28 per year (Morreale *et al.* 2005). No additional loggerheads were reported captured in pound net gear in New York through 2007, although two were found cold-stunned on Long Island bay beaches in the fall of 2007 (Memo to the File, L. Lankshear, December 2007). Potential explanations for this decline include major shifts in loggerhead foraging areas and/or increased mortality in pelagic or early benthic stage/age classes (Morreale *et al.* 2005). 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 decline in observed loggerhead populations in Chesapeake Bay may be related to a significant decline in prey, namely horseshoe crabs and blue crabs, with loggerheads redistributing outside of Bay waters (NMFS and USFWS 2008).



As with other turtle species, population estimates for loggerhead sea turtles are difficult to determine, largely given their life history characteristics. However, a recent loggerhead assessment using a demographic matrix model estimated that the loggerhead adult female population in the western North Atlantic ranges from 16,847 to 89,649, with a median size of 30,050 (NMFS SEFSC 2009). The model results for population trajectory suggest that the population is most likely declining, but this result was very sensitive to the choice of the position of the parameters within their range and hypothesized distributions. The pelagic stage survival parameter had the largest effect on the model results. As a result of the large uncertainty in our knowledge of loggerhead life history, at this point predicting the future populations or population trajectories of loggerhead sea turtles with precision is very uncertain. It should also be noted that additional analyses are underway which will incorporate any newly available information.

As part of the Atlantic Marine Assessment Program for Protected Species (AMAPPS), line transect aerial abundance surveys and turtle telemetry studies were conducted along the Atlantic coast in the summer of 2010. AMAPPS is a multi-agency initiative to assess marine mammal, sea turtle, and seabird abundance and distribution in the Atlantic. Aerial surveys were conducted from Cape Canaveral, Florida to the Gulf of St. Lawrence, Canada. Satellite tags on juvenile loggerheads were deployed in two locations – off the coasts of northern Florida to South Carolina (n=30) and off the New Jersey and Delaware coasts (n=14). As presented in NMFS NEFSC (2011), the 2010 survey found a preliminary total surface abundance estimate within the entire study area of about 60,000 loggerheads (CV=0.13) or 85,000 if a portion of unidentified hard-shelled sea turtles were included (CV=0.10). Surfacing times were generated from the satellite tag data collected during the aerial survey period, resulting in a 7% (5%-11% inter-quartile range) median surface time in the South Atlantic area and a 67% (57%-77% inter-quartile range) median surface time to the north. The calculated preliminary regional abundance estimate is about 588,000 loggerheads along the U.S. Atlantic coast, with an inter-quartile range of 382,000-817,000 (NMFS NEFSC 2011). The estimate increases to approximately 801,000 (inter-quartile range of 521,000-1,111,000) when based on known loggerheads and a portion of unidentified turtle sightings. The density of loggerheads was generally lower in the north than the south; based on number of turtle groups detected, 64% were seen south of Cape Hatteras, North Carolina, 30% in the southern Mid-Atlantic Bight, and 6% in the northern Mid-Atlantic Bight. Although they have been seen farther north in previous studies (*e.g.*, Shoop and Kenney 1992), no loggerheads were observed during the aerial surveys conducted in the summer of 2010 in the more northern zone encompassing Georges Bank, Cape Cod Bay, and the Gulf of Maine. These estimates of loggerhead abundance over the U.S. Atlantic continental shelf are considered very preliminary. A more thorough analysis will be completed pending the results of further studies related to improving estimates of regional and seasonal variation in loggerhead surface time (by increasing the sample size and geographical area of tagging) and other information needed to improve the biases inherent in aerial surveys of sea turtles (*e.g.*, research on depth of detection and species misidentification rate). This survey effort represents the most comprehensive assessment of sea turtle abundance and distribution in many years. Additional aerial surveys and research to improve the abundance estimates are anticipated in 2011-2014, depending on available funds.

*Threats*
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. The 5-year status review and 2008 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, biotoxin exposure, and native species predation.

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; beach pollution; increased human presence; recreational beach equipment; vehicular and pedestrian traffic; coastal development/construction; exotic dune and beach vegetation; removal of native 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 breeding adults in coastal waters, the most important source of human caused mortality in U.S. Atlantic waters was fishery interactions. The sizes and reproductive values of sea turtles taken by fisheries vary significantly, depending on the location and season of the fishery, and size-selectivity resulting from gear characteristics. Therefore, it is possible for fisheries that interact with fewer, more reproductively valuable turtles to have a greater detrimental effect on the population than one that takes greater numbers of less reproductively valuable turtles (Wallace *et al.* 2008). The Loggerhead Biological Review Team determined that the greatest threats to the NWA DPS of loggerheads result from cumulative fishery bycatch in neritic and oceanic habitats (Conant *et al.* 2009). Attaining a more thorough understanding of the characteristics, as well as the quantity of sea turtle bycatch across all fisheries is of great importance.

Finkbeiner *et al.* (2011) compiled cumulative sea turtle bycatch information in U.S. fisheries from 1990 through 2007, before and after implementation of bycatch mitigation measures. Information was obtained from peer reviewed publications and NMFS documents (e.g., Biological Opinions and bycatch reports). In the Atlantic, a mean estimate of 137,700 bycatch interactions, of which 4,500 were mortalities, occurred annually (since implementation of bycatch mitigation measures). Kemp's ridleys interacted with fisheries most frequently, with the highest level of mean annual mortality (2,700), followed by loggerheads (1,400), greens (300), and leatherbacks (40). The Southeast/Gulf of Mexico shrimp trawl fishery was responsible for the vast majority of U.S. interactions (up to 98%) and mortalities (more than 80%). While this provides an initial cumulative bycatch assessment, there are a number of caveats that should be considered when interpreting this information, such as sampling inconsistencies and limitations.

Of the many fisheries known to adversely affect loggerheads, the U.S. South Atlantic and Gulf of Mexico shrimp fisheries were considered to pose the greatest threat of mortality to neritic juvenile and adult age classes of loggerheads (NRC 1990, Finkbeiner *et al.* 2011). 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 2002a; Lewison *et al.* 2003). The current section 7 consultation on the U.S. South Atlantic and Gulf of Mexico shrimp fisheries was completed in 2002 and estimated the total annual level of take for loggerhead sea turtles to be 163,160 interactions (the total number of turtles that enter a shrimp trawl, which may then escape through the TED or fail to escape and be captured) with 3,948 of those takes being lethal (NMFS 2002a).

In addition to improvements in TED designs and TED enforcement, interactions between loggerheads and the shrimp fishery have also been declining because of reductions in fishing effort unrelated to fisheries management actions. The 2002 Opinion take estimates are based in part on fishery effort levels. In recent years, low shrimp prices, rising fuel costs, competition with imported products, and the impacts of recent hurricanes in the Gulf of Mexico have all impacted the shrimp fleets; in some cases reducing fishing effort by as much as 50% for offshore waters of the Gulf of Mexico (GMFMC 2007). As a result, loggerhead interactions and mortalities in the Gulf of Mexico have been substantially less than projected in the 2002 Opinion. In 2008, the estimated annual number of interactions between loggerheads and shrimp trawls in the Gulf of Mexico shrimp fishery is 23,336, with 647 (2.8%) of those interactions resulting in mortality (Memo from Dr. B. Ponwith, Southeast Fisheries Science Center to Dr. R. Crabtree, Southeast Region, PRD, December 2008). A new Biological Opinion on the Shrimp FMP was completed in May 2012; this Opinion does not contain a quantitative estimate of the number of interactions between loggerheads and the shrimp fishery.

Loggerhead sea turtles are also known to interact with non-shrimp trawl, gillnet, longline, dredge, pound net, pot/trap, and hook and line fisheries. The NRC (1990) report 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. The reduction of sea turtle captures in fishing operations is identified in recovery plans and 5-year status reviews as a priority for the recovery of all sea turtle species. In the threats analysis of the loggerhead recovery plan, trawl bycatch is identified as the greatest source of mortality. While loggerhead bycatch in U.S. Mid-Atlantic bottom otter trawl gear was previously estimated for the period 1996-2004 (Murray 2006, 2008), a recent bycatch analysis estimated the number of loggerhead sea turtle interactions with U.S. Mid-Atlantic bottom trawl gear from 2005-2008 (Warden 2011a). Northeast Fisheries Observer Program data from 1994-2008 were used to develop a model of interaction rates and those predicted rates were applied to 2005-2008 commercial fishing data to estimate the number of interactions for the trawl fleet. The number of predicted average annual loggerhead interactions for 2005-2008 was 292 (CV=0.13, 95% CI=221-369), with an additional 61 loggerheads (CV=0.17, 95% CI=41-83) interacting with trawls but being released through a TED. Of the 292 average annual observable loggerhead interactions, approximately 44 of those were adult equivalents. Warden (2011b) found that latitude, depth and SST were associated with the interaction rate, with the rates being highest south of 37°N latitude in waters < 50 m deep and SST > 15°C. This estimate is a decrease from the average annual loggerhead bycatch in bottom otter trawls during 1996-2004, estimated to be 616 sea turtles (CV=0.23, 95% CI over the 9-year period: 367-890) (Murray 2006, 2008).

There have been several published estimates of the number of loggerheads taken annually as a result of the dredge fishery for Atlantic sea scallops, ranging from a low of zero in 2005 (Murray 2007) to a high of 749 in 2003 (Murray 2004). Murray (2011) recently re-evaluated loggerhead sea turtle interactions in scallop dredge gear from 2001-2008. In that paper, the average number of annual observable interactions of hard-shelled sea turtles in the Mid-Atlantic scallop dredge fishery prior to the implementation of chain mats (January 1, 2001 through September 25, 2006) was estimated to be 288 turtles (CV = 0.14, 95% CI: 209-363) [equivalent to 49 adults], 218 of which were loggerheads [equivalent to 37 adults]. After the implementation of chain mats, the average annual number of observable interactions was estimated to be 20 hard-shelled sea turtles (CV = 0.48, 95% CI: 3-42), 19 of which were loggerheads. If the rate of observable interactions from dredges without chain mats had been applied to trips with chain mats, the estimated number of observable and inferred interactions of hard-shelled sea turtles after chain mats were implemented would have been 125 turtles per year (CV = 0.15, 95% CI: 88-163) [equivalent to 22 adults], 95 of which were loggerheads [equivalent to 16 adults]. Interaction rates of hard-shelled turtles were correlated with sea surface temperature, depth, and use of a chain mat. Results from this recent analysis suggest that chain mats and fishing effort reductions have contributed to the decline in estimated loggerhead sea turtle interactions with scallop dredge gear after 2006 (Murray 2011).

An estimate of the number of loggerheads taken annually in U.S. Mid-Atlantic gillnet fisheries has also recently been published (Murray 2009a, b). From 1995-2006, the annual bycatch of loggerheads in U.S. Mid-Atlantic gillnet gear was estimated to average 350 turtles (CV=0.20, 95% CI over the 12-year period: 234 to 504). Bycatch rates were correlated with latitude, sea surface temperature, and mesh size. The highest predicted bycatch rates occurred in warm waters of the southern Mid-Atlantic in large-mesh gillnets (Murray 2009a).



The U.S. tuna and swordfish longline fisheries that are managed under the Highly Migratory Species (HMS) FMP are estimated to capture 1,905 loggerheads (no more than 339 mortalities) for each 3-year period starting in 2007 (NMFS 2004a). NMFS has mandated gear changes for the HMS fishery to reduce sea turtle bycatch and the likelihood of death from those incidental takes that would still occur (Garrison and Stokes 2010). In 2010, there were 40 observed interactions between loggerhead sea turtles and longline gear used in the HMS fishery (Garrison and Stokes 2011a, 2011b). All of the loggerheads were released alive, with the vast majority released with all gear removed. While 2010 total estimates are not yet available, in 2009, 242.9 (95% CI: 167.9-351.2) loggerhead sea turtles are estimated to have been taken in the longline fisheries managed under the HMS FMP based on the observed takes (Garrison and Stokes 2010). The 2009 estimate is considerably lower than those in 2006 and 2007 and is consistent with historical averages since 2001 (Garrison and Stokes 2010). 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 all Atlantic longline fisheries in 2000 (including the U.S. Atlantic tuna and swordfish longline fisheries as well as others).

Documented takes also occur in other fishery gear types and by non-fishery mortality sources (*e.g.*, hopper dredges, power plants, vessel collisions), but quantitative estimates are unavailable. Past and future impacts of global climate change are considered in Section 6.0 below.

*Summary of Status for Loggerhead Sea Turtles*
Loggerheads are a long-lived species and reach sexual maturity relatively late at around 32-35 years in the Northwest Atlantic (NMFS and USFWS 2008). 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 that affects eggs, hatchlings, and nesting females on land, as well as

fishery interactions, vessel interactions, marine pollution, and non-fishery (*e.g.*, dredging) operations affecting all sexes and age classes in the water (NRC 1990; NMFS and USFWS 2007a, 2008). As a result, loggerheads still face many of the original threats that were the cause of their listing under the ESA.

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. The recovery plan noted a decline in annual nest counts for three of the five recovery units for loggerheads in the Northwest Atlantic, including the PFRU, which is the largest (in terms of number of nests laid) in the Atlantic Ocean. The nesting trends for the other two recovery units could not be determined due to an absence of long term data.

NMFS convened a new Loggerhead Turtle Expert Working Group (TEWG) to review all available information on Atlantic loggerheads in order to evaluate the status of this species in the Atlantic. A final report from the Loggerhead TEWG was published in July 2009. In this report, the TEWG indicated that it could not determine whether the decreasing annual numbers of nests among the Northwest Atlantic loggerhead subpopulations were due to stochastic processes resulting in fewer nests, a decreasing average reproductive output of adult females, decreasing numbers of adult females, or a combination of these factors. Many factors are responsible for past or present loggerhead mortality that could impact current nest numbers; however, no single mortality factor stands out as a likely primary factor. It is likely that several factors compound to create the current decline, including incidental capture (in fisheries, power plant intakes, and dredging operations), lower adult female survival rates, increases in the proportion of first-time nesters, continued directed harvest, and increases in mortality due to disease. Regardless, the TEWG stated that “it is clear that the current levels of hatchling output will result in depressed recruitment to subsequent life stages over the coming decades” (TEWG 2009). However, the report does not provide information on the rate or amount of expected decrease in recruitment but goes on to state that the ability to assess the current status of loggerhead subpopulations is limited due to a lack of fundamental life history information and specific census and mortality data.



While several documents reported the decline in nesting numbers in the NWA DPS (NMFS and USFWS 2008, TEWG 2009), when nest counts through 2010 are analyzed, the nesting trends from 1989-2010 are not significantly different than zero for all recovery units within the NWA DPS for which there are enough data to analyze (76 FR 58868, September 22, 2011). The SEFSC (2009) estimated the number of adult females in the NWA DPS at 30,000, and if a 1:1 adult sex ratio is assumed, the result is 60,000 adults in this DPS. Based on the reviews of nesting data, as well as information on population abundance and trends, NMFS and USFWS determined in the September 2011 listing rule that the NWA DPS should be listed as threatened. They found that an endangered status for the NWA DPS was not warranted given the large size of the nesting population, the overall nesting population remains widespread, the trend for the nesting population appears to be stabilizing, and substantial conservation efforts are underway to address threats.

## 5.3 Status of Kemp's Ridley Sea Turtles

*Distribution and Life History*

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 northwestern Atlantic Ocean (NMFS *et al.* 2011).

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 (NMFS *et al.* 2011). Females lay an average of 2.5 clutches within a season (TEWG 1998, 2000) and the mean remigration interval for adult females is 2 years (Marquez *et al.* 1982; TEWG 1998, 2000).

Once they leave the nesting beach, hatchlings presumably enter the Gulf of Mexico where they feed on available S*argassum* and associated infauna or other epipelagic species (NMFS *et al.* 2011). The presence of juvenile turtles along both the U.S. Atlantic and Gulf of Mexico coasts, where they are recruited to the coastal benthic environment, indicates that post-hatchlings are distributed in both the Gulf of Mexico and Atlantic Ocean (TEWG 2000).

The location and size classes of dead turtles recovered by the STSSN suggests that benthic immature developmental areas occur along the U.S. coast and that these areas may change given resource quality and quantity (TEWG 2000). 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 50 m (NMFS and USFWS 2007c). The suitability of these habitats depends on resource availability, with optimal environments providing rich sources of crabs and other invertebrates. Kemp's ridleys consume a variety of crab species, including *Callinectes*, *Ovalipes*, *Libinia*, and *Cancer* species. Mollusks, shrimp, and fish are consumed less frequently (Bjorndal 1997). A wide variety of substrates have been documented to provide good foraging habitat, including seagrass beds, oyster reefs, sandy and mud bottoms, and rock outcroppings (NMFS and USFWS 2007c).

Foraging areas documented along the U.S. Atlantic coast include Charleston Harbor, Pamlico Sound (Epperly *et al.* 1995c), Chesapeake Bay (Musick and Limpus 1997), Delaware Bay (Stetzar 2002), and Long Island Sound (Morreale and Standora 1993; Morreale *et al.* 2005). For instance, in the Chesapeake Bay, Kemp's ridleys frequently forage in submerged aquatic grass beds for crabs (Musick and Limpus 1997). Upon leaving Chesapeake Bay in autumn, juvenile Kemp's ridleys migrate down the coast, passing Cape Hatteras in December and January (Musick and Limpus 1997). These larger juveniles are joined 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, 1995b; Musick and Limpus 1997).

Adult Kemp's ridleys are found in the coastal regions of the Gulf of Mexico and southeastern United States, but are typically rare in the northeastern U.S. waters of the Atlantic (TEWG

2000). Adults are primarily found in nearshore waters of 37 m or less that are rich in crabs and have a sandy or muddy bottom (NMFS and USFWS 2007c).

*Population Dynamics and Status*

The majority of Kemp's ridleys nest along a single stretch of beach near Rancho Nuevo, Tamaulipas, Mexico (Carr 1963; NMFS and USFWS 2007c; NMFS *et al.* 2011). There is a limited amount of scattered nesting to the north and south of the primary nesting beach (NMFS and USFWS 2007c). Nesting often occurs in synchronized emergences termed *arribadas*. The number of recorded nests reached an estimated low of 702 nests in 1985, corresponding to fewer than 300 adult females nesting in that season (TEWG 2000; NMFS and USFWS 2007c; NMFS *et al.* 2011). 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). Since the mid-1980s, the number of nests observed at Rancho Nuevo and nearby beaches has increased 14-16% per year (Heppell *et al.* 2005), allowing cautious optimism that the population is on its way to recovery. An estimated 5,500 females nested in the State of Tamaulipas over a 3-day period in May 2007 and over 4,000 of those nested at Rancho Nuevo (NMFS and USFWS 2007c). In 2008, 17,882 nests were documented on Mexican nesting beaches (NMFS 2011). There is limited nesting in the United States, most of which is located in South Texas. While six nests were documented in 1996, a record 195 nests were found in 2008 (NMFS 2011).

*Threats*

Kemp's ridleys face many of the same natural threats as loggerheads, including destruction of nesting habitat from storm events, predators, and oceanographic-related 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. In the last five years (2006-2010), the number of cold-stunned turtles on Cape Cod beaches averaged 115 Kemp's ridleys, 7 loggerheads, and 7 greens (NMFS unpublished data). The numbers ranged from a low in 2007 of 27 Kemp's ridleys, 5 loggerheads, and 5 greens to a high in 2010 of 213 Kemp's ridleys, 4 loggerheads, and 14 greens. Annual cold stun events vary in magnitude; the extent of episodic major cold stun events may be associated with numbers of turtles utilizing Northeast U.S. waters in a given year, oceanographic conditions, and/or the occurrence of storm events in the late fall. Although many cold-stunned turtles can survive if they are found early enough, these events represent a significant source of natural mortality for Kemp's ridleys.

Like other sea 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, but beach protection in 1967 helped to curtail this activity (NMFS *et al.* 2011). Following World War II, there was a substantial increase in the number of trawl vessels, particularly shrimp trawlers, in the Gulf of Mexico where adult Kemp's ridley sea turtles occur. Information from fisheries observers 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 sea turtle takes in shrimp trawls and other trawl fisheries, including the development and use of turtle excluder devices (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 (NMFS 2002a; Epperly 2003; Lewison *et al.* 2003). The 2002 Biological Opinion on shrimp trawling in the southeastern United States concluded that 155,503 Kemp's ridley sea turtles would be taken annually in the fishery with 4,208 of the takes resulting in mortality (NMFS 2002a).

Although modifications to shrimp trawls have helped to reduce mortality of Kemp's ridleys, a recent assessment found that the Southeast/Gulf of Mexico shrimp trawl fishery remained responsible for the vast majority of U.S. fishery interactions (up to 98%) and mortalities (more than 80%). Finkbeiner *et al.* (2011) compiled cumulative sea turtle bycatch information in U.S. fisheries from 1990 through 2007, before and after implementation of bycatch mitigation measures. Information was obtained from peer reviewed publications and NMFS documents (e.g., Biological Opinions and bycatch reports). In the Atlantic, a mean estimate of 137,700 bycatch interactions, of which 4,500 were mortalities, occurred annually (since implementation of bycatch mitigation measures). Kemp's ridleys interacted with fisheries most frequently, with the highest level of mean annual mortality (2,700), followed by loggerheads (1,400), greens (300), and leatherbacks (40). While this provides an initial cumulative bycatch assessment, there are a number of caveats that should be considered when interpreting this information, such as sampling inconsistencies and limitations.

This species is also affected by other sources of anthropogenic impact (fishery and non-fishery related), similar to those discussed above. Three Kemp's ridley captures in Mid-Atlantic trawl fisheries were documented by NMFS observers between 1994 and 2008 (Warden and Bisack 2010), and eight Kemp's ridleys were documented by NMFS observers in mid-Atlantic sink gillnet fisheries between 1995 and 2006 (Murray 2009a). Additionally, 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. The cause of death for most of the turtles recovered was unknown, but the mass mortality event was suspected by NMFS to have been from a large-mesh gillnet fishery for monkfish and dogfish operating offshore in the preceding weeks (67 FR 71895, December 3, 2002). The five Kemp's 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. The NMFS Northeast Fisheries Science Center also documented 14 Kemp's ridleys entangled in or impinged on Virginia pound net leaders from 2002-2005. Note that bycatch estimates for Kemp's ridleys in various fishing gear types (*e.g.*, trawl, gillnet, dredge) are not available at this time, largely due to the low number of observed interactions precluding a robust estimate. Kemp's ridley interactions in non-fisheries have also been observed; for example, the Oyster Creek Nuclear Generating Station in Barnegat Bay, New Jersey, recorded a total of 27 Kemp's ridleys (15 of which were found alive) impinged or captured on their intake screens from 1992-2006 (NMFS 2006).

*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; NMFS and USFWS 2007c; NMFS *et al.* 2011). 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 300 nesting females in the entire 1985 nesting season (TEWG 2000; NMFS *et al.* 2011). However, the total annual number of nests at Rancho Nuevo gradually began to increase in the 1990s (NMFS and USFWS 2007c). Based on the number of nests laid in 2006 and the remigration interval for Kemp's ridley sea turtles (1.8-2 years), there were an estimated 7,000-8,000 adult female Kemp's 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 Kemp's ridleys suggest that the population is female-biased, suggesting that the number of adult males is less than the number of adult females (NMFS and USFWS 2007c). While there is cautious optimism for recovery, events such as the Deepwater Horizon oil release, and stranding events associated increased skimmer trawl use and poor TED compliance in the northern Gulf of Mexico may dampen recent population growth.

As with the other sea turtle species, fishery mortality accounts for a large proportion of annual human-caused mortality outside the nesting beaches, while other activities like dredging, pollution, and habitat destruction account for an unknown level of other mortality. Based on their 5-year status review of the species, NMFS and USFWS (2007c) determined that Kemp's ridley sea turtles should not be reclassified as threatened under the ESA. A revised bi-national recovery plan was published for public comment in 2010, and in September 2011, NMFS, USFWS, and the Services and the Secretary of Environment and Natural Resources, Mexico (SEMARNAT) released the second revision to the Kemp's ridley recovery plan.

### 5.4 Status of Green Sea Turtles

Green sea 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, 2007d; Seminoff 2004). In 1978, the Atlantic population of the green sea turtle was listed as threatened under the ESA, except for the breeding populations in Florida and on the Pacific coast of Mexico, which were listed as endangered. As it is difficult to differentiate between breeding populations away from the nesting beaches, all green sea turtles in the water are considered endangered.

*Pacific Ocean*

Green sea turtles occur in the western, central, and eastern Pacific. Foraging areas are also found throughout the Pacific and along the southwestern U.S. coast (NMFS and USFWS 1998b). In the western Pacific, major nesting rookeries at four sites including Heron Island (Australia), Raine Island (Australia), Guam, and Japan were evaluated and determined to be increasing in abundance, with the exception of Guam which appears stable (NMFS and USFWS 2007d). In the central Pacific, nesting occurs on French Frigate Shoals, Hawaii, which has also been reported as increasing with a mean of 400 nesting females annually from 2002-2006 (NMFS and USFWS 2007d). 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 exceeds 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). The Pacific Mexico green turtle nesting population (also called the black turtle) is considered endangered.

Historically, green sea turtles were used in many areas of the Pacific for food. They were also commercially exploited, which, coupled with habitat degradation, led to their decline in the

Pacific (NMFS and USFWS 1998b). Green sea turtles in the Pacific continue to be affected by poaching, habitat loss or degradation, fishing gear interactions, and fibropapillomatosis, which is a viral disease that causes tumors in affected turtles (NMFS and USFWS 1998b; NMFS 2004b).

*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 sea 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).

*Mediterranean Sea*

There are four nesting concentrations of green sea turtles in the Mediterranean from which data are available – Turkey, Cyprus, Israel, and Syria. Currently, approximately 300-400 females nest each year, about two-thirds of which nest in Turkey and one-third in Cyprus. Although green sea turtles are depleted from historic levels in the Mediterranean Sea (Kasparek *et al.* 2001), nesting data gathered since the early 1990s in Turkey, Cyprus, and Israel show no apparent trend in any direction. However, a declining trend is apparent along the coast of Palestine/Israel, where 300-350 nests were deposited each year in the 1950s (Sella 1982) compared to a mean of 6 nests per year from 1993-2004 (Kuller 1999; Y. Levy, Israeli Sea Turtle Rescue Center, unpublished data). A recent discovery of green sea turtle nesting in Syria adds roughly 100 nests per year to green sea turtle nesting activity in the Mediterranean (Rees *et al.* 2005). That such a major nesting concentration could have gone unnoticed until recently (the Syria coast was surveyed in 1991, but nesting activity was attributed to loggerheads) bodes well for the ongoing speculation that the unsurveyed coast of Libya may also host substantial nesting.



*Atlantic Ocean*

*Distribution and Life History*

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

In the western Atlantic, large juvenile and adult green sea turtles are largely herbivorous, occurring in habitats containing benthic algae and seagrasses from Massachusetts to Argentina, including the Gulf of Mexico and Caribbean (Wynne and Schwartz 1999). Green sea turtles occur seasonally in Mid-Atlantic and Northeast waters such as Chesapeake Bay and Long Island Sound (Musick and Limpus 1997; Morreale and Standora 1998; Morreale *et al.* 2005), which serve as foraging and developmental habitats.

Some of the principal feeding areas in the western Atlantic Ocean include the upper west coast of Florida, the Florida Keys, and the northwestern coast of the Yucatán 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). The waters surrounding the island of Culebra, Puerto Rico, and its outlying keys are designated critical habitat for the green sea turtle.

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 sea turtle species described above, adult females may nest multiple times in a season (average 3 nests/season with approximately 100 eggs/nest) and typically do not nest in successive years (NMFS and USFWS 1991; Hirth 1997).

*Population Dynamics and Status*

Like other sea turtle species, 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 5-year status review for the species identified eight geographic areas considered to be primary sites for threatened 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 is considered to be stable or increasing with the exception of Bioko Island, which may be declining. However, the lack of sufficient data precludes a meaningful trend assessment for this site (NMFS and USFWS 2007d).

Seminoff (2004) reviewed green sea turtle nesting data for eight sites in the western, eastern, and central Atlantic, including all of the above threatened nesting sites with the exception that nesting in Florida was reviewed in place of Isla Trindade, Brazil. He 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 Ocean. 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 sea turtles in the western Atlantic is in Tortuguero, Costa Rica (NMFS and USFWS 2007d). Nesting in the area has increased considerably since the 1970s 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).

The status of the endangered Florida breeding population was also evaluated in the 5-year review (NMFS and USFWS 2007d). The pattern of green sea turtle nesting shows biennial peaks in abundance, with a generally positive trend since establishment of the Florida index beach surveys in 1989. This trend is perhaps due to increased protective legislation throughout the Caribbean (Meylan *et al.* 1995), as well as protections in Florida and throughout the United States (NMFS and USFWS 2007d).

The statewide Florida surveys (2000-2006) have shown that a mean of approximately 5,600 nests are laid annually in Florida, with a low of 581 in 2001 to a high of 9,644 in 2005 (NMFS and USFWS 2007d). Most nesting occurs along the east coast of Florida, but occasional nesting has been documented along the Gulf coast of Florida, at Southwest Florida beaches, as well as the beaches in the Florida Panhandle (Meylan *et al.* 1995). More recently, green sea turtle nesting occurred on Bald Head Island, North Carolina (just east of the mouth of the Cape Fear River), Onslow Island, and Cape Hatteras National Seashore. One green sea turtle nested on a beach in Delaware in 2011, although its occurrence was considered very rare.

*Threats*

Green sea turtles face many of the same natural threats as loggerhead and Kemp's ridley sea turtles. In addition, green sea turtles appear to be particularly susceptible to fibropapillomatosis, an epizootic disease producing lobe-shaped tumors on the soft portion of a turtle's body. Juveniles appear to be most affected in that they have the highest incidence of disease and the most extensive lesions, whereas lesions in nesting adults are rare. Also, green sea turtles frequenting nearshore waters, areas adjacent to large human populations, and areas with low water turnover, such as lagoons, have a higher incidence of the disease than individuals in deeper, more remote waters. The occurrence of fibropapilloma tumors may result in impaired foraging, breathing, or swimming ability, leading potentially to death (George 1997).

As with the other sea turtle species, incidental fishery mortality accounts for a large proportion of annual human-caused mortality outside the nesting beaches. Witherington *et al.* (2009) observes that because green sea turtles spend a shorter time in oceanic waters and as older juveniles occur on shallow seagrass pastures (where benthic trawling is unlikely), they avoid high mortalities in pelagic longline and benthic trawl fisheries. Although the relatively low number of observed green sea turtle captures makes it difficult to estimate bycatch rates and annual take levels, green sea turtles have been observed captured in the pelagic driftnet, pelagic longline, southeast shrimp trawl, and mid-Atlantic trawl and gillnet fisheries. Murray (2009a) also lists five observed captures of green turtle in Mid-Atlantic sink gillnet gear between 1995 and 2006.

Finkbeiner *et al.* (2011) compiled cumulative sea turtle bycatch information in U.S. fisheries from 1990 through 2007, before and after implementation of bycatch mitigation measures. Information was obtained from peer reviewed publications and NMFS documents (e.g., Biological Opinions and bycatch reports). In the Atlantic, a mean estimate of 137,700 bycatch interactions, of which 4,500 were mortalities, occurred annually (since implementation of bycatch mitigation measures). Kemp's ridleys interacted with fisheries most frequently, with the highest level of mean annual mortality (2,700), followed by loggerheads (1,400), greens (300), and leatherbacks (40). The Southeast/Gulf of Mexico shrimp trawl fishery was responsible for the vast majority of U.S. interactions (up to 98%) and mortalities (more than 80%). While this provides an initial cumulative bycatch assessment, there are a number of caveats that should be considered when interpreting this information, such as sampling inconsistencies and limitations.

Other activities like channel dredging, marine debris, pollution, vessel strikes, power plant impingement, and habitat destruction account for an unquantifiable level of other mortality. Stranding reports indicate that between 200-400 green sea turtles strand annually along the eastern U.S. coast from a variety of causes most of which are unknown (STSSN database).

*Summary of Status of Green Sea Turtles*
A review of 32 Index Sites[2] distributed globally revealed a 48-67% decline in the number of mature females nesting annually over the last three generations[3] (Seminoff 2004). An evaluation of green sea turtle nesting sites was also conducted as part of the 5-year status review of the species (NMFS and USFWS 2007d). Of the 23 threatened nesting groups assessed in that report for which nesting abundance trends could be determined, ten were considered to be increasing, nine were considered stable, and four 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). However, nesting populations were determined to be doing relatively poorly in Southeast Asia, eastern Indian Ocean, and perhaps the Mediterranean. Overall, based on mean annual reproductive effort, the report estimated that 108,761 to 150,521 females nest each year among the 46 threatened and endangered nesting sites included in the evaluation (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).



Seminoff (2004) and NMFS and USFWS (2007d) made comparable conclusions with regard to nesting for four nesting sites in the western Atlantic that indicate sea turtle abundance is increasing in the Atlantic Ocean. 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 1970s (Seminoff 2004; NMFS and USFWS 2007d).

However, the 5-year 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). The endangered breeding population in Florida appears to be increasing based upon index nesting data from 1989-2010 (NMFS 2011).

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 hopper dredging, pollution, and habitat destruction account for an unknown level of other mortality. Based on its 5-year status review of the species, NMFS and USFWS (2007d) determined that the listing classification for green sea turtles should not be changed. However, it was also determined that an analysis and review of the species should be conducted in the future to determine whether DPSs should be identified (NMFS and USFWS 2007d).

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2 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.

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

## 5.5 Status of Leatherback Sea Turtles

Leatherback sea turtles are widely distributed throughout the oceans of the world, including the Atlantic, Pacific, and Indian Oceans, and the Mediterranean Sea (Ernst and Barbour 1972). Leatherbacks are the largest living turtles and range farther than any other sea turtle species. Their large size and tolerance of relatively low water temperatures allows them to occur in boreal waters such as those 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). The most recent population size estimate for the North Atlantic alone is a range of 34,000-94,000 adult leatherbacks (TEWG 2007). Thus, there is substantial 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, 2000; NMFS and USFWS 1998a, 2007b; Sarti *et al.* 2000). In the western Pacific, major nesting beaches occur in Papua New Guinea, Indonesia, Solomon Islands, and Vanuatu, with an approximate 2,700-4,500 total breeding females, estimated from nest counts (Dutton *et al.* 2007). While there appears to be overall long term population decline, the Indonesian nesting aggregation at Jamursba-Medi is currently stable (since 1999), although there is evidence to suggest a significant and continued decline in leatherback nesting in Papua New Guinea and Solomon Islands over the past 30 years (NMFS 2011). Leatherback sea 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). In Fiji, Thailand, and Australia, leatherback sea turtles have only been known to nest in low densities and scattered sites.

The largest, extant leatherback nesting group in the Indo-Pacific lies on the North Vogelkop coast of West Papua, Indonesia, with 3,000-5,000 nests reported annually in the 1990s (Suárez *et al.* 2000). However, in 1999, local villagers started reporting dramatic declines in sea turtles near their villages (Suárez 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.*, Suárez 1999).

Leatherback sea turtles in the western Pacific are 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, major leatherback nesting beaches are located in Mexico and Costa Rica, where nest numbers have been declining. According to reports from the late 1970s and early 1980s, beaches located on the Mexican Pacific coasts of Michoacán, Guerrero, and Oaxaca sustained a large portion, perhaps 50%, of all global nesting by leatherbacks (Sarti *et al.* 1996). A dramatic decline has been seen on nesting beaches in Pacific Mexico, where aerial survey data was used to estimate that tens of thousands of leatherback nests were laid on the beaches in the 1980s (Pritchard 1982), but a total of only 120 nests on the four primary index beaches (combined) were counted in the 2003-2004 season (Sarti Martinez *et al.* 2007). Since the early 1980s, the Mexican Pacific population of adult female leatherback turtles has declined to slightly more than 200 during 1998-1999 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 and the most important nesting beach in the Pacific. Between 1988 and 1999, the nesting group declined from 1,367 to 117 female leatherback sea turtles. Based on their models, Spotila *et al.* (2000) estimated that the group could fall to less than 50 females by 2003-2004. Another, more recent, analysis of the Costa Rican nesting beaches indicates a decline in nesting during 15 years of monitoring (1989-2004) with approximately 1,504 females nesting in 1988-1989 to an average of 188 females nesting in 2000-2001 and 2003-2004 (NMFS and USFWS 2007b), indicating that the reductions in nesting females were not as extreme as the reductions predicted by Spotila *et al.* (2000).

On September 26, 2007, NMFS received a petition to revise the critical habitat designation for leatherback sea turtles to include waters along the U.S. West Coast. On December 28, 2007, NMFS published a positive 90-day finding on the petition and convened a critical habitat review team. On January 26, 2012, NMFS published a final rule to revise the critical habitat designation to include three particular areas of marine habitat. The designation includes approximately 16,910 square miles along the California coast from Point Arena to Point Arguello east of the 3,000 meter depth contour, and 25,004 square miles from Cape Flattery, Washington to Cape Blanco, Oregon east of the 2,000 meter depth contour. The areas comprise approximately 41,914 square miles of marine habitat and include waters from the ocean surface down to a maximum depth of 262 feet. The designated critical habitat areas contain the physical or biological feature essential to the conservation of the species that may require special management conservation or protection. In particular, the team identified one Primary Constituent Element: the occurrence of prey species, primarily scyphomedusae of the order Semaeostomeae, of sufficient condition, distribution, diversity, abundance and density necessary to support individual as well as population growth, reproduction, and development of leatherbacks.



Leatherbacks in the eastern Pacific face a number of threats to their survival. For example, 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 leatherbacks 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, 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 1,000 (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).

*Mediterranean Sea*
Casale *et al.* (2003) reviewed the distribution of leatherback sea turtles in the Mediterranean. Among the 411 individual records of leatherback sightings in the Mediterranean, there were no nesting records. Nesting in the Mediterranean is believed to be extremely rare if it occurs at all. Leatherbacks found in Mediterranean waters originate from the Atlantic Ocean (P. Dutton, NMFS, unpublished data).

*Atlantic Ocean*
*Distribution and Life History*
Evidence from tag returns and strandings in the western Atlantic suggests that adult leatherback sea turtles engage in routine migrations between northern temperate and tropical waters (NMFS and USFWS 1992). Leatherbacks are frequently thought of as a pelagic species that feed on jellyfish (*e.g.*, *Stomolophus, Chryaora*, and *Aurelia* species) and tunicates (*e.g.*, salps, pyrosomas) (Rebel 1974; Davenport and Balazs 1991). However, leatherbacks are also known to use coastal waters of the U.S. continental shelf (James *et al.* 2005a; Eckert *et al.* 2006; Murphy *et al.* 2006), as well as the European continental shelf on a seasonal basis (Witt *et al.* 2007).

Tagging and satellite telemetry data indicate that leatherbacks from the western North Atlantic nesting beaches use the entire North Atlantic Ocean (TEWG 2007). 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 sea 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). Leatherbacks from the South Atlantic nesting assemblages (West Africa, South Africa, and Brazil) have not been re-sighted in the western North Atlantic (TEWG 2007).

The CETAP aerial survey of the outer Continental Shelf from Cape Hatteras, North Carolina to Cape Sable, Nova Scotia conducted between 1978 and 1982 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 to 4,151 m, 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 (Shoop and Kenney 1992). Studies of satellite tagged leatherbacks suggest that they spend 10%-41% of their time at the surface, depending on the phase of their migratory cycle (James *et al.* 2005b). 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.* 2005b).

In 1979, the waters adjacent to Sandy Point, St. Croix, U.S. Virgin Islands were designated as critical habitat for the leatherback sea turtle. On February 2, 2010, NMFS received a petition to revise the critical habitat designation for leatherback sea turtles to include waters adjacent to a major nesting beach in Puerto Rico. NMFS published a 90-day finding on the petition on July 16, 2010, which found that the petition did not present substantial scientific information indicating that the petitioned revision was warranted. The original petitioners submitted a second petition on November 2, 2010 to revise the critical habitat designation to again include waters adjacent to a major nesting beach in Puerto Rico, including additional information on the usage of the waters. NMFS determined on May 5, 2011, that a revision to critical habitat off Puerto Rico may be warranted, and an analysis is underway. Note that on August 4, 2011, FWS issued a determination that revision to critical habitat along Puerto Rico should be made and will be addressed during the future planned status review.

Leatherbacks are a long lived species (>30 years). They were originally believed to mature at a younger age than loggerhead sea turtles, with a previous 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). However, new sophisticated analyses suggest that leatherbacks in the Northwest Atlantic may reach maturity at 24.5-29 years of age (Avens *et al.* 2009). In the United States and Caribbean, female leatherbacks nest from March through July. In the Atlantic, most nesting females average between 150-160 cm curved carapace length (CCL), although smaller (<145 cm CCL) and larger nesters are observed (Stewart *et al.* 2007, TEWG 2007). They nest frequently (up to seven nests per year) during a nesting season and nest about every 2-3 years. 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 the total number of eggs produced per season. 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 CCL, Eckert (1999) found that leatherback juveniles remain in waters warmer than 26°C until they exceed 100 cm CCL.



*Population Dynamics and Status*

As described earlier, 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 (TEWG 2007).

In the United States, 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). Stewart *et al.* (2011) evaluated nest counts from 68 Florida beaches over 30 years (1979-2008) and found that nesting increased at all beaches with trends ranging from 3.1%-16.3% per year, with an overall increase of 10.2% per year. An analysis of Florida's index nesting beach 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 (TEWG 2007). The TEWG reports an increasing or stable nesting trend for all of the seven populations or groups of populations with the exception of the Western Caribbean and West Africa. 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 (TEWG 2007), and represents more than half of total nesting by leatherback sea turtles worldwide (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 TEWG (2007) report 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. Given the magnitude of leatherback nesting in this area compared to other nest sites, negative impacts in leatherback sea turtles in this area could have profound impacts on the entire species.

The CETAP aerial survey conducted from 1978-1982 estimated the summer leatherback population for the northeastern United States at approximately 300-600 animals (from near Nova Scotia, Canada to Cape Hatteras, North Carolina) (Shoop and Kenney 1992). 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 underestimated the leatherback population for the northeastern United States at the time of the survey. 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 higher (Palka 2000).



*Threats*

The 5-year status review (NMFS and USFWS 2007b) and TEWG (2007) report provide summaries of natural as well as anthropogenic threats to leatherback sea turtles. Of the Atlantic sea turtle species, leatherbacks seem to be the most vulnerable to entanglement in fishing gear, trap/pot gear in particular. This susceptibility may be the result of their body type (large size, long pectoral flippers, and lack of a hard shell), their diving and foraging behavior, their distributional overlap with the gear, their possible 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. Leatherbacks 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. The long-term impacts of entanglement on leatherback health remain unclear. Innis *et al.* (2010) conducted a health evaluation of leatherback sea turtles during direct capture (n=12) and disentanglement (n=7). They found no significant difference in many of the measured health parameters between entangled and directly captured turtles. However, blood parameters, including but not limited to sodium, chloride, and blood urea nitrogen, for entangled turtles showed several key differences that were most likely due to reduced foraging and associated seawater ingestion, as well as a general stress response.

Finkbeiner *et al.* (2011) compiled cumulative sea turtle bycatch information in U.S. fisheries from 1990 through 2007, before and after implementation of bycatch mitigation measures. Information was obtained from peer reviewed publications and NMFS documents (e.g., Biological Opinions and bycatch reports). In the Atlantic, a mean estimate of 137,700 bycatch interactions, of which 4,500 were mortalities, occurred annually (since implementation of bycatch mitigation measures). Kemp's ridleys interacted with fisheries most frequently, with the highest level of mean annual mortality (2,700), followed by loggerheads (1,400), greens (300), and leatherbacks (40). The Southeast/Gulf of Mexico shrimp trawl fishery was responsible for the vast majority of U.S. interactions (up to 98%) and mortalities (more than 80%). While this provides an initial cumulative bycatch assessment, there are a number of caveats that should be considered when interpreting this information, such as sampling inconsistencies and limitations.

Leatherbacks have been documented interacting with longline, trap/pot, trawl, and gillnet fishing gear. For instance, an estimated 6,363 leatherback sea turtles were documented as caught by the U.S. Atlantic tuna and swordfish longline fisheries between 1992-1999 (NMFS SEFSC 2001). Currently, the U.S. tuna and swordfish longline fisheries managed under the HMS FMP are estimated to capture 1,764 leatherbacks (no more than 252 mortalities) for each 3-year period starting in 2007 (NMFS 2004a). In 2010, there were 26 observed interactions between leatherback sea turtles and longline gear used in the HMS fishery (Garrison and Stokes 2011a, 2011b). All leatherbacks were released alive, with all gear removed for the majority of captures. While 2010 total estimates are not yet available, in 2009, 285.8 (95% CI: 209.6-389.7) leatherback sea turtles are estimated to have been taken in the longline fisheries managed under the HMS FMP based on the observed takes (Garrison and Stokes 2010). The 2009 estimate continues a downward trend since 2007 and remains well below the average prior to implementation of gear regulations (Garrison and Stokes 2010). Since the U.S. fleet accounts for only 5%-8% of the longline 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). Lewison *et al.* (2004) estimated that 30,000-60,000 leatherbacks were taken in all Atlantic longline fisheries in 2000 (including the U.S. Atlantic tuna and swordfish longline fisheries, as well as others).



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). More recently, from 2002 to 2010, NMFS received 137 reports of sea turtles entangled in vertical lines from Maine to Virginia, with 128 events confirmed (verified by photo documentation or response by a trained responder; NMFS 2008a). Of the 128 confirmed events during this period, 117 events involved leatherbacks. NMFS identified the gear type and fishery for 72 of the 117 confirmed events, which included lobster (42[4]), whelk/conch (15), black sea bass (10), crab (2), and research pot gear (1). 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).

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 U.S. 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, NMFS issued a final rule on February 21, 2003, to amend the TED regulations (68 FR 8456, February 21, 2003). Modifications to the design of TEDs are now required in order to exclude leatherbacks as well as large benthic immature and sexually mature loggerhead and green sea turtles. Given those modifications, Epperly *et al.* (2002) anticipated an average of 80 leatherback mortalities a year in shrimp gear interactions, dropping to an estimate of 26 leatherback mortalities in 2009 due to effort reduction in the Southeast shrimp fishery (Memo from Dr. B. Ponwith, SEFSC, to Dr. R. Crabtree, SERO, January 5, 2011).

Other trawl fisheries are also known to interact with leatherback sea turtles although on a much smaller scale. In October 2001, for example, a NMFS fisheries observer documented the take of a leatherback in a bottom otter trawl fishing for *Loligo* squid off of Delaware. TEDs are not currently 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 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 1994-1998 (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%-92%. In North Carolina, six additional leatherbacks were reported captured in gillnet sets in the spring (NMFS SEFSC 2001). In addition to these, in September 1995, two dead leatherbacks were removed from an 11-inch (28.2-cm) monofilament shark gillnet set in the nearshore waters off of Cape Hatteras (STSSN unpublished data reported in NMFS SEFSC 2001). Lastly, Murray (2009a) reports five observed leatherback captures in Mid-Atlantic sink gillnet fisheries between 1994 and 2008.

Fishing gear interactions can occur throughout the range of leatherbacks. Entanglements occur 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 sea turtles in the

[4] One case involved both lobster and whelk/conch gear.

waters of coastal Nicaragua also incidentally catch leatherback sea 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-M. 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). Many of the sea turtles do not die as a result of drowning, but rather because the fishermen cut them out of their nets (NMFS SEFSC 2001).

Leatherbacks may be more susceptible to marine debris ingestion than other sea turtle species due to the tendency of floating debris to concentrate in convergence zones that juveniles and adults use for feeding (Shoop and Kenney 1992; Lutcavage *et al.* 1997). Investigations of the necropsy results of leatherback sea turtles revealed that a substantial percentage (34% of the 408 leatherback necropsies' recorded between 1885 and 2007) reported plastic within the turtles' stomach contents, and in some cases (8.7% of those cases in which plastic was reported), blockage of the gut was found in a manner that may have caused the mortality (Mrosovsky *et al.* 2009). An increase in reports of plastic ingestion was evident in leatherback necropsies conducted after the late 1960s (Mrosovsky *et al.* 2009). 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 (*e.g.*, jellyfish) and plastic debris (Mrosovsky 1981). Balazs (1985) speculated that plastic objects may resemble food items by their shape, color, size, or even movements as they drift about, and induce a feeding response in leatherbacks.

*Summary of Status for Leatherback Sea Turtles*
In the Pacific Ocean, the abundance of leatherback sea 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 Ocean 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 in nesting and marine habitats. 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 pollution and habitat destruction account for an unknown level of other mortality. 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 USFWS (2007b) determined that endangered leatherback sea turtles should not be delisted or reclassified. However, it was also determined that an analysis and review of the species should be conducted in the future to determine whether DPSs should be identified (NMFS and USFWS 2007b).

## 5.6 Status of Atlantic sturgeon

The section below describes the Atlantic sturgeon listing, provides life history information that is relevant to all DPSs of Atlantic sturgeon and then provides information specific to the status of each DPS of Atlantic sturgeon. Below, we also provide a description of which Atlantic sturgeon DPSs likely occur in the action area and provide information on the use of the action area by Atlantic sturgeon.

The Atlantic sturgeon (*Acipenser oxyrinchus oxyrinchus*) is a subspecies of sturgeon distributed along the eastern coast of North America from Hamilton Inlet, Labrador, Canada to Cape Canaveral, Florida, USA (Scott and Scott, 1988; ASSRT, 2007; T. Savoy, CT DEP, pers. comm.). NMFS has delineated U.S. populations of Atlantic sturgeon into five DPSs[5] ( 77 FR 5880 and 77 FR 5914). These are: the Gulf of Maine, New York Bight, Chesapeake Bay, Carolina, and South Atlantic DPSs (see Figure 3). The results of genetic studies suggest that natal origin influences the distribution of Atlantic sturgeon in the marine environment (Wirgin and King, 2011). However, genetic data as well as tracking and tagging data demonstrate sturgeon from each DPS and Canada occur throughout the full range of the subspecies. Therefore, sturgeon originating from any of the five DPSs can be affected by threats in the marine, estuarine and riverine environment that occur far from natal spawning rivers.

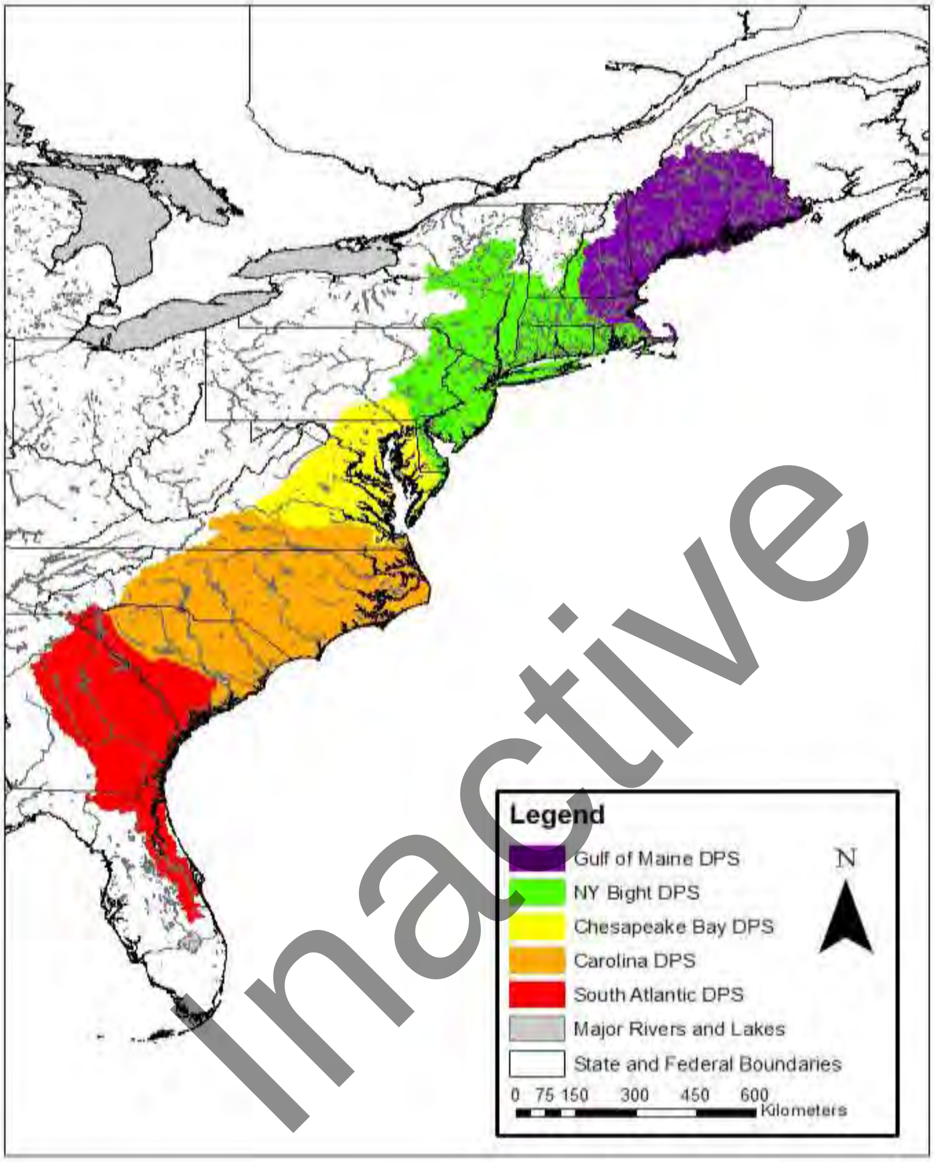
On February 6, 2012, we published notice in the *Federal Register* that we were listing the New York Bight, Chesapeake Bay, Carolina, and South Atlantic DPSs as "endangered," and the Gulf of Maine DPS as "threatened" (77 FR 5880 and 77 FR 5914). The effective date of the listings was April 6, 2012. The DPSs do not include Atlantic sturgeon that are spawned in Canadian rivers. Therefore, Canadian spawned fish are not included in the listings.

As described below, individuals originating from the five listed DPSs may occur in the action area. Information general to all Atlantic sturgeon as well as information specific to each of the relevant DPSs, is provided below.



**Figure 3**. Map Depicting the Boundaries of the five Atlantic sturgeon DPSs

[5] To be considered for listing under the ESA, a group of organisms must constitute a "species." A "species" is defined in section 3 of the ESA to include "any subspecies of fish or wildlife or plants, and any distinct population segment of any species of vertebrate fish or wildlife which interbreeds when mature."






### 5.6.1 *Atlantic sturgeon life history*

Atlantic sturgeon are long lived (approximately 60 years), late maturing, estuarine dependent, anadromous[6] fish (Bigelow and Schroeder, 1953; Vladykov and Greeley 1963; Mangin, 1964; Pikitch *et al.*, 2005; Dadswell, 2006; ASSRT, 2007).

The life history of Atlantic sturgeon can be divided up into five general categories as described in the table below (adapted from ASSRT 2007).

[6] Anadromous refers to a fish that is born in freshwater, spends most of its life in the sea, and returns to freshwater to spawn (NEFSC FAQs, available at http://www.nefsc.noaa.gov/faq/fishfaq1a.html, modified June 16, 2011).

| Age Class | Size | Description |
|---|---|---|
| **Egg** | | Fertilized or unfertilized |
| **Larvae** | | Negative photo-taxic, nourished by yolk sac |
| **Young of Year (YOY)** | **0.3 grams <41 cm TL** | Fish that are > 3 months and < one year; capable of capturing and consuming live food |
| **Sub-adults** | **>41 cm and <150 cm TL** | Fish that are at least age 1 and are not sexually mature |
| **Adults** | **>150 cm TL** | Sexually mature fish |

Table 4. Descriptions of Atlantic sturgeon life history stages.

They are a relatively large fish, even amongst sturgeon species (Pikitch *et al.*, 2005). Atlantic sturgeon are bottom feeders that suck food into a ventrally-located protruding mouth (Bigelow and Schroeder, 1953). Four barbels in front of the mouth assist the sturgeon in locating prey (Bigelow and Schroeder, 1953). Diets of adult and migrant subadult Atlantic sturgeon include mollusks, gastropods, amphipods, annelids, decapods, isopods, and fish such as sand lance (Bigelow and Schroeder, 1953; ASSRT, 2007; Guilbard *et al.*, 2007; Savoy, 2007). While in the river, Atlantic sturgeon feed on aquatic insects, insect larvae, and other invertebrates (Bigelow and Schroeder, 1953; ASSRT, 2007; Guilbard *et al.*, 2007).

Rate of maturation is affected by water temperature and gender. In general: (1) Atlantic sturgeon that originate from southern systems grow faster and mature sooner than Atlantic sturgeon that originate from more northern systems; (2) males grow faster than females; (3) fully mature females attain a larger size (i.e. length) than fully mature males; and (4) the length of Atlantic sturgeon caught since the mid-late 20th century have typically been less than 3 meters (m) (Smith *et al.*, 1982; Smith *et al.*, 1984; Smith, 1985; Scott and Scott, 1988; Young *et al.*, 1998; Collins *et al.*, 2000; Caron *et al.*, 2002; Dadswell, 2006; ASSRT, 2007; Kahnle *et al.*, 2007; DFO, 2011). The largest recorded Atlantic sturgeon was a female captured in 1924 that measured approximately 4.26 m (Vladykov and Greeley, 1963). Dadswell (2006) reported seeing seven fish of comparable size in the St. John River estuary from 1973 to 1995. Observations of large-sized sturgeon are particularly important given that egg production is correlated with age and body size (Smith *et al.*, 1982; Van Eenennaam *et al.*, 1996; Van Eenennaam and Doroshov, 1998; Dadswell, 2006). However, while females are prolific with egg production ranging from

400,000 to 4 million eggs per spawning year, females spawn at intervals of 2-5 years (Vladykov and Greeley, 1963; Smith *et al.*, 1982; Van Eenennaam *et al.*, 1996; Van Eenennaam and Doroshov, 1998; Stevenson and Secor, 1999; Dadswell, 2006). Given spawning periodicity and a female's relatively late age to maturity, the age at which 50 percent of the maximum lifetime egg production is achieved is estimated to be 29 years (Boreman, 1997). Males exhibit spawning periodicity of 1-5 years (Smith, 1985; Collins *et al.*, 2000; Caron *et al.*, 2002). While long-lived, Atlantic sturgeon are exposed to a multitude of threats prior to achieving maturation and have a limited number of spawning opportunities once mature.

Water temperature plays a primary role in triggering the timing of spawning migrations (ASMFC, 2009). Spawning migrations generally occur during February-March in southern systems, April-May in Mid-Atlantic systems, and May-July in Canadian systems (Murawski and Pacheco, 1977; Smith, 1985; Bain, 1997; Smith and Clugston, 1997; Caron *et al.*, 2002). Male sturgeon begin upstream spawning migrations when waters reach approximately 6° C (43° F) (Smith *et al.*, 1982; Dovel and Berggren, 1983; Smith, 1985; ASMFC, 2009), and remain on the spawning grounds throughout the spawning season (Bain, 1997). Females begin spawning migrations when temperatures are closer to 12° C to 13° C (54° to 55° F) (Dovel and Berggren, 1983; Smith, 1985; Collins *et al.*, 2000), make rapid spawning migrations upstream, and quickly depart following spawning (Bain, 1997).

The spawning areas in most U.S. rivers have not been well defined. However, the habitat characteristics of spawning areas have been identified based on historical accounts of where fisheries occurred, tracking and tagging studies of spawning sturgeon, and physiological needs of early life stages. Spawning is believed to occur in flowing water between the salt front of estuaries and the fall line of large rivers, when and where optimal flows are 46-76 cm/s and depths are 3-27 m (Borodin, 1925; Dees, 1961; Leland, 1968; Scott and Crossman, 1973; Crance, 1987; Shirey *et al.* 1999; Bain *et al.*, 2000; Collins *et al.*, 2000; Caron *et al.* 2002; Hatin *et al.* 2002; ASMFC, 2009). Sturgeon eggs are deposited on hard bottom substrate such as cobble, coarse sand, and bedrock (Dees, 1961; Scott and Crossman, 1973; Gilbert, 1989; Smith and Clugston, 1997; Bain *et al.* 2000; Collins *et al.*, 2000; Caron *et al.*, 2002; Hatin *et al.*, 2002; Mohler, 2003; ASMFC, 2009), and become adhesive shortly after fertilization (Murawski and Pacheco, 1977; Van den Avyle, 1983; Mohler, 2003). Incubation time for the eggs increases as water temperature decreases (Mohler, 2003). At temperatures of 20° and 18° C, hatching occurs approximately 94 and 140 hours, respectively, after egg deposition (ASSRT, 2007).

Larval Atlantic sturgeon (i.e. less than 4 weeks old, with total lengths (TL) less than 30 mm; Van Eenennaam *et al.* 1996) are assumed to undertake a demersal existence and inhabit the same riverine or estuarine areas where they were spawned (Smith *et al.*, 1980; Bain *et al.*, 2000; Kynard and Horgan, 2002; ASMFC, 2009). Studies suggest that age-0 (i.e., young-of-year), age-1, and age-2 Atlantic sturgeon occur in low salinity waters of the natal estuary (Haley, 1999; Hatin *et al.*, 2007; McCord *et al.*, 2007; Munro *et al.*, 2007) while older fish are more salt tolerant and occur in higher salinity waters as well as low salinity waters (Collins *et al.*, 2000). Atlantic sturgeon remain in the natal estuary for months to years before emigrating to open ocean as subadults (Holland and Yelverton, 1973; Dovel and Berggen, 1983; Waldman *et al.*, 1996; Dadswell, 2006; ASSRT, 2007).

After emigration from the natal estuary, subadults and adults travel within the marine environment, typically in waters less than 50 m in depth, using coastal bays, sounds, and ocean waters (Vladykov and Greeley, 1963; Murawski and Pacheco, 1977; Dovel and Berggren, 1983; Smith, 1985; Collins and Smith, 1997; Welsh *et al.*, 2002; Savoy and Pacileo, 2003; Stein *et al.*, 2004; USFWS, 2004; Laney *et al.*, 2007; Dunton *et al.*, 2010; Erickson *et al.*, 2011; Wirgin and King, 2011). Tracking and tagging studies reveal seasonal movements of Atlantic sturgeon along the coast. Satellite-tagged adult sturgeon from the Hudson River concentrated in the southern part of the Mid-Atlantic Bight at depths greater than 20 m during winter and spring, and in the northern portion of the Mid-Atlantic Bight at depths less than 20 m in summer and fall (Erickson *et al.*, 2011). Shirey (Delaware Department of Fish and Wildlife, unpublished data reviewed in ASMFC, 2009) found a similar movement pattern for juvenile Atlantic sturgeon based on recaptures of fish originally tagged in the Delaware River. After leaving the Delaware River estuary during the fall, juvenile Atlantic sturgeon were recaptured by commercial fishermen in nearshore waters along the Atlantic coast as far south as Cape Hatteras, North Carolina from November through early March. In the spring, a portion of the tagged fish re-entered the Delaware River estuary. However, many fish continued a northerly coastal migration through the Mid-Atlantic as well as into southern New England waters where they were recovered throughout the summer months. Movements as far north as Maine were documented. A southerly coastal migration was apparent from tag returns reported in the fall. The majority of these tag returns were reported from relatively shallow near shore fisheries with few fish reported from waters in excess of 25 m (C. Shirey, Delaware Department of Fish and Wildlife, unpublished data reviewed in ASMFC, 2009). Areas where migratory Atlantic sturgeon commonly aggregate include the Bay of Fundy (e.g., Minas and Cumberland Basins), Massachusetts Bay, Connecticut River estuary, Long Island Sound, New York Bight, Delaware Bay, Chesapeake Bay, and waters off of North Carolina from the Virginia/North Carolina border to Cape Hatteras at depths up to 24 m (Dovel and Berggren, 1983; Dadswell *et al.*, 1984; Johnson *et al.*, 1997; Rochard *et al.*, 1997; Kynard *et al.*, 2000; Eyler *et al.*, 2004; Stein *et al.*, 2004; Wehrell, 2005; Dadswell, 2006; ASSRT, 2007; Laney *et al.*, 2007). These sites may be used as foraging sites and/or thermal refuge.

### *5.6.2 Determination of DPS Composition in the Action Area*

As explained above, the range of all five DPSs overlaps and extends from Canada through Cape Canaveral, Florida. The Chesapeake Bay is known to be used by Atlantic sturgeon originating from all five DPSs. We have considered the best available information to determine from which DPSs individuals in the action area are likely to have originated. We have mixed-stock analyses from samples taken in a variety of coastal sampling programs; however, to date, we have no mixed-stock or individual assignment data for Atlantic sturgeon captured in the Chesapeake Bay. We have mixed-stock analysis of Atlantic sturgeon captured in waters off the coast of southern Virginia and North Carolina during the winter months. This area is a known overwintering aggregation; accordingly, we do not expect that the composition of individuals in this area during the winter months is representative of the composition of individuals in the action area year round. Genetic analysis has been completed on 173 samples obtained through NMFS NEFOP program. These fish have been captured in commercial fishing gear from Maine to North Carolina. Because this sampling overlaps with the action area, we consider it to be the best available information from which to determine the DPS composition in the action area. Based on the mixed-stock analysis resulting from the genetic assignments of the NEFOP samples, we have determined that Atlantic sturgeon in the action area likely originate from the five DPSs at the following frequencies: NYB 49%; South Atlantic 20%; Chesapeake Bay 14%; Gulf of Maine 11%; and Carolina 4%. Two percent of Atlantic sturgeon in the action area may originate from the St. John's River in Canada; these fish are not included in the 2012 ESA listing. The genetic assignments have a plus/minus 5% confidence interval; however, for purposes of section 7 consultation we have selected the reported values above, which approximate the mid-point of the range, as a reasonable indication of the likely genetic makeup of Atlantic sturgeon in the action area. These assignments and the data from which they are derived are described in detail in Damon-Randall *et al.* (2012a).

### *5.6.3 Distribution and Abundance*

Atlantic sturgeon underwent significant range-wide declines from historical abundance levels due to overfishing in the mid to late 19th century when a caviar market was established (Scott and Crossman, 1973; Taub, 1990; Kennebec River Resource Management Plan, 1993; Smith and Clugston, 1997; Dadswell, 2006; ASSRT, 2007). Abundance of spawning-aged females prior to this period of exploitation was predicted to be greater than 100,000 for the Delaware, and at least 10,000 females for other spawning stocks (Secor and Waldman, 1999; Secor, 2002). Historical records suggest that Atlantic sturgeon spawned in at least 35 rivers prior to this period. Currently, only 16 U.S. rivers are known to support spawning based on available evidence (i.e., presence of young-of-year or gravid Atlantic sturgeon documented within the past 15 years) (ASSRT, 2007). While there may be other rivers supporting spawning for which definitive evidence has not been obtained (e.g., in the Penobscot and York Rivers), the number of rivers supporting spawning of Atlantic sturgeon are approximately half of what they were historically. In addition, only four rivers (Kennebec, Hudson, Delaware, James) are known to currently support spawning from Maine through Virginia where historical records support there used to be fifteen spawning rivers (ASSRT, 2007). While spawning may also be occurring in other rivers (e.g., the Androscoggin River in Maine), we do not yet have confirmation of spawning in other Northeast rivers. Thus, there are substantial gaps in the range between Atlantic sturgeon spawning rivers amongst northern and mid-Atlantic states which could make recolonization of extirpated populations more difficult.



There are no current, published population abundance estimates for any of the currently known spawning stocks. Therefore, there are no published abundance estimates for any of the five DPSs of Atlantic sturgeon. An annual mean estimate of 863 mature adults (596 males and 267 females) was calculated for the Hudson River based on fishery-dependent data collected from 1985-1995 (Kahnle *et al.*, 2007). An estimate of 343 spawning adults per year is available for the Altamaha River, GA, based on fishery-independent data collected in 2004 and 2005 (Schueller and Peterson, 2006). Using the data collected from the Hudson River and Altamaha River to estimate the total number of Atlantic sturgeon in either subpopulation is not possible, since mature Atlantic sturgeon may not spawn every year (Vladykov and Greeley, 1963; Smith, 1985; Van Eenennaam *et al.*, 1996; Stevenson and Secor, 1999; Collins *et al.* 2000; Caron *et al.*, 2002), the age structure of these populations is not well understood, and stage to stage survival is unknown. In other words, the information that would allow us to take an estimate of annual spawning adults and expand that estimate to an estimate of the total number of individuals (e.g., yearlings, subadults, and adults) in a population is lacking. The ASSRT presumed that the Hudson and Altamaha rivers had the most robust of the remaining U.S. Atlantic sturgeon spawning populations and concluded that the other U.S. spawning populations were likely less than 300 spawning adults per year (ASSRT, 2007).

Kahnle *et al.* (2007) estimated the number of total mature adults per year in the Hudson River using data from surveys in the 1980s to mid-1990s and based on mean harvest by sex divided by sex specific exploitation rate. While this data is over 20 years old, it is currently the best available data on the abundance of Hudson River origin Atlantic sturgeon. The sex ratio of spawners is estimated to be approximately 70% males and 30% females. As noted above, Kahnle *et al.* (2007) estimated a mean annual number of mature adults at 596 males and 267 females. It is important to note that the authors of this paper have stated that this is an estimate of the annual mean number of Hudson River mature adults during the 1985-1995 period, not an estimate of the number of spawners per year.

### *5.6.4 Threats faced by Atlantic sturgeon throughout their range*

Atlantic sturgeon are susceptible to over exploitation given their life history characteristics (e.g., late maturity, dependence on a wide-variety of habitats). Similar to other sturgeon species (Vladykov and Greeley, 1963; Pikitch *et al.*, 2005), Atlantic sturgeon experienced range-wide declines from historical abundance levels due to overfishing (for caviar and meat) and impacts to habitat in the 19$^{th}$ and 20$^{th}$ centuries (Taub, 1990; Smith and Clugston, 1997; Secor and Waldman, 1999).

Based on the best available information, NMFS has concluded that unintended catch of Atlantic sturgeon in fisheries, vessel strikes, poor water quality, water availability, dams, lack of regulatory mechanisms for protecting the fish, and dredging are the most significant threats to Atlantic sturgeon (77 FR 5880 and 77 FR 5914; February 6, 2012). While all of the threats are not necessarily present in the same area at the same time, given that Atlantic sturgeon subadults and adults use ocean waters from the Labrador, Canada to Cape Canaveral, FL, as well as estuaries of large rivers along the U.S. East Coast, activities affecting these water bodies are likely to impact more than one Atlantic sturgeon DPS. In addition, given that Atlantic sturgeon depend on a variety of habitats, every life stage is likely affected by one or more of the identified threats.

An ASMFC interstate fishery management plan for sturgeon (Sturgeon FMP) was developed and implemented in 1990 (Taub, 1990). In 1998, the remaining Atlantic sturgeon fisheries in U.S. state waters were closed per Amendment 1 to the Sturgeon FMP. Complementary regulations were implemented by NMFS in 1999 that prohibit fishing for, harvesting, possessing or retaining Atlantic sturgeon or its parts in or from the Exclusive Economic Zone in the course of a commercial fishing activity.

Commercial fisheries for Atlantic sturgeon still exist in Canadian waters (DFO, 2011). Sturgeon belonging to one or more of the DPSs may be harvested in the Canadian fisheries. In particular, the Bay of Fundy fishery in the Saint John estuary may capture sturgeon of U.S. origin given that sturgeon from the Gulf of Maine and the New York Bight DPSs have been incidentally captured in other Bay of Fundy fisheries (DFO, 2010; Wirgin and King, 2011). Because Atlantic sturgeon are listed under Appendix II of the Convention on International Trade in Endangered Species (CITES), the U.S. and Canada are currently working on a conservation strategy to address the potential for captures of U.S. fish in Canadian directed Atlantic sturgeon fisheries and of Canadian fish incidentally in U.S. commercial fisheries. At this time, there are no estimates of the number of individuals from any of the DPSs that are captured or killed in Canadian fisheries each year.

Based on geographic distribution, most U.S. Atlantic sturgeon that are intercepted in Canadian fisheries are likely to originate from the Gulf of Maine DPS, with a smaller percentage from the New York Bight DPS.

Fisheries bycatch in U.S. waters is the primary threat faced by all 5 DPSs. At this time, we have an estimate of the number of Atlantic sturgeon captured and killed in sink gillnet and otter trawl fisheries authorized by Federal FMPs (NMFS NEFSC 2011) in the Northeast Region but do not have a similar estimate for Southeast fisheries. We also do not have an estimate of the number of Atlantic sturgeon captured or killed in state fisheries. At this time, we are not able to quantify the effects of other significant threats (e.g., vessel strikes, poor water quality, water availability, dams, and dredging) in terms of habitat impacts or loss of individuals. While we have some information on the number of mortalities that have occurred in the past in association with certain activities (e.g., mortalities in the Delaware and James rivers that are thought to be due to vessel strikes), we are not able to use those numbers to extrapolate effects throughout one or more DPS. This is because of (1) the small number of data points and, (2) lack of information on the percent of incidences that the observed mortalities represent.

As noted above, the NEFSC prepared an estimate of the number of encounters of Atlantic sturgeon in fisheries authorized by Northeast FMPs (NEFSC 2011). The analysis prepared by the NEFSC estimates that from 2006 through 2010 there were 2,250 to 3,862 encounters per year in observed gillnet and trawl fisheries, with an average of 3,118 encounters. Mortality rates in gillnet gear are approximately 20%. Mortality rates in otter trawl gear are believed to be lower at approximately 5%.



### 5.7 Gulf of Maine DPS of Atlantic sturgeon

The Gulf of Maine DPS includes the following: all anadromous Atlantic sturgeons that are spawned in the watersheds from the Maine/Canadian border and, extending southward, all watersheds draining into the Gulf of Maine as far south as Chatham, MA. Within this range, Atlantic sturgeon historically spawned in the Androscoggin, Kennebec, Merrimack, Penobscot, and Sheepscot Rivers (ASSRT, 2007). Spawning still occurs in the Kennebec River, and it is possible that it still occurs in the Penobscot River as well. Spawning in the Androscoggin River was just recently confirmed by the Maine Department of Marine Resources when they captured a larval Atlantic sturgeon during the 2011 spawning season below the Brunswick Dam; however, the extent of spawning in this river is unknown. There is no evidence of recent spawning in the remaining rivers. In the 1800s, construction of the Essex Dam on the Merrimack River at river kilometer (rkm) 49 blocked access to 58 percent of Atlantic sturgeon habitat in the river (Oakley, 2003; ASSRT, 2007). However, the accessible portions of the Merrimack seem to be suitable habitat for Atlantic sturgeon spawning and rearing (i.e., nursery habitat) (Keiffer and Kynard, 1993). Therefore, the availability of spawning habitat does not appear to be the reason for the lack of observed spawning in the Merrimack River. Studies are on-going to determine whether

Atlantic sturgeon are spawning in these rivers. Atlantic sturgeons that are spawned elsewhere continue to use habitats within all of these rivers as part of their overall marine range (ASSRT, 2007). The movement of subadult and adult sturgeon between rivers, including to and from the Kennebec River and the Penobscot River, demonstrates that coastal and marine migrations are key elements of Atlantic sturgeon life history for the Gulf of Maine DPS as well as likely throughout the entire range (ASSRT, 2007; Fernandes, *et al.*, 2010).

Bigelow and Schroeder (1953) surmised that Atlantic sturgeon likely spawned in Gulf of Maine Rivers in May-July. More recent captures of Atlantic sturgeon in spawning condition within the Kennebec River suggest that spawning more likely occurs in June-July (Squiers *et al.*, 1981; ASMFC, 1998; NMFS and USFWS, 1998). Evidence for the timing and location of Atlantic sturgeon spawning in the Kennebec River includes: (1) the capture of five adult male Atlantic sturgeon in spawning condition (i.e., expressing milt) in July 1994 below the (former) Edwards Dam; (2) capture of 31 adult Atlantic sturgeon from June 15,1980, through July 26,1980, in a small commercial fishery directed at Atlantic sturgeon from the South Gardiner area (above Merrymeeting Bay) that included at least 4 ripe males and 1 ripe female captured on July 26,1980; and, (3) capture of nine adults during a gillnet survey conducted from 1977-1981, the majority of which were captured in July in the area from Merrymeeting Bay and upriver as far as Gardiner, ME (NMFS and USFWS, 1998; ASMFC 2007). The low salinity values for waters above Merrymeeting Bay are consistent with values found in other rivers where successful Atlantic sturgeon spawning is known to occur.

Several threats play a role in shaping the current status of Gulf of Maine DPS Atlantic sturgeon. Historical records provide evidence of commercial fisheries for Atlantic sturgeon in the Kennebec and Androscoggin Rivers dating back to the 17th century (Squiers *et al.*, 1979). In 1849, 160 tons of sturgeon was caught in the Kennebec River by local fishermen (Squiers *et al.*, 1979). Following the 1880's, the sturgeon fishery was almost non-existent due to a collapse of the sturgeon stocks. All directed Atlantic sturgeon fishing as well as retention of Atlantic sturgeon by catch has been prohibited since 1998. Nevertheless, mortalities associated with bycatch in fisheries occurring in state and federal waters still occurs. In the marine range, Gulf of Maine DPS Atlantic sturgeon are incidentally captured in federal and state managed fisheries, reducing survivorship of subadult and adult Atlantic sturgeon (Stein *et al.*, 2004; ASMFC 2007). As explained above, we have estimates of the number of subadults and adults that are killed as a result of bycatch in fisheries authorized under Northeast FMPs. At this time, we are not able to quantify the impacts from other threats or estimate the number of individuals killed as a result of other anthropogenic threats. Habitat disturbance and direct mortality from anthropogenic sources are the primary concerns.

Riverine habitat may be impacted by dredging and other in-water activities, disturbing spawning habitat and also altering the benthic forage base. Many rivers in the Gulf of Maine region have navigation channels that are maintained by dredging. Dredging outside of Federal channels and in-water construction occurs throughout the Gulf of Maine region. While some dredging projects operate with observers present to document fish mortalities, many do not. To date we have not received any reports of Atlantic sturgeon killed during dredging projects in the Gulf of Maine region; however, as noted above, not all projects are monitored for interactions with fish. At this time, we do not have any information to quantify the number of Atlantic sturgeon killed or disturbed during dredging or in-water construction projects are also not able to quantify any effects to habitat.

Connectivity is disrupted by the presence of dams on several rivers in the Gulf of Maine region, including the Penobscot and Merrimack Rivers. While there are also dams on the Kennebec, Androscoggin and Saco Rivers, these dams are near the site of natural falls and likely represent the maximum upstream extent of sturgeon occurrence even if the dams were not present. Because no Atlantic sturgeon are known to occur upstream of any hydroelectric projects in the Gulf of Maine region, passage over hydroelectric dams or through hydroelectric turbines is not a source of injury or mortality in this area. While not expected to be killed or injured during passage at a dam, the extent that Atlantic sturgeon are affected by the existence of dams and their operations in the Gulf of Maine region is currently unknown. The documentation of an Atlantic sturgeon larvae downstream of the Brunswick Dam in the Androscoggin River suggests that Atlantic sturgeon spawning may be occurring in the vicinity of at least that project and therefore, may be affected by project operations. The range of Atlantic sturgeon in the Penobscot River is limited by the presence of the Veazie and Great Works Dams. Together these dams prevent Atlantic sturgeon from accessing approximately 29 km of habitat, including the presumed historical spawning habitat located downstream of Milford Falls, the site of the Milford Dam. While removal of the Veazie and Great Works Dams is anticipated to occur in the near future, the presence of these dams is currently preventing access to significant habitats within the Penobscot River. While Atlantic sturgeon are known to occur in the Penobscot River, it is unknown if spawning is currently occurring or whether the presence of the Veazie and Great Works Dams affects the likelihood of spawning occurring in this river. The Essex Dam on the Merrimack River blocks access to approximately 58% of historically accessible habitat in this river. Atlantic sturgeon occur in the Merrimack River but spawning has not been documented. Like the Penobscot, it is unknown how the Essex Dam affects the likelihood of spawning occurring in this river.

Gulf of Maine DPS Atlantic sturgeon may also be affected by degraded water quality. In general, water quality has improved in the Gulf of Maine over the past decades (Lichter *et al.* 2006; EPA, 2008). Many rivers in Maine, including the Androscoggin River, were heavily polluted in the past from industrial discharges from pulp and paper mills. While water quality has improved and most discharges are limited through regulations, many pollutants persist in the benthic environment. This can be particularly problematic if pollutants are present on spawning and nursery grounds as developing eggs and larvae are particularly susceptible to exposure to contaminants.

There are no empirical abundance estimates for the Gulf of Maine DPS. The Atlantic sturgeon SRT (2007) presumed that the Gulf of Maine DPS was comprised of less than 300 spawning adults per year, based on abundance estimates for the Hudson and Altamaha River riverine populations of Atlantic sturgeon. Surveys of the Kennebec River over two time periods, 1977-1981 and 1998-2000, resulted in the capture of nine adult Atlantic sturgeon (Squiers, 2004). However, since the surveys were primarily directed at capture of shortnose sturgeon, the capture gear used may not have been selective for the larger-sized, adult Atlantic sturgeon; several hundred subadult Atlantic sturgeon were caught in the Kennebec River during these studies.

*Summary of the Gulf of Maine DPS*
Spawning for the Gulf of Maine DPS is known to occur in the Kennebec and recent evidence suggests it may also be occurring in the Androscoggin. Spawning may be occurring in other rivers, such as the Sheepscot or Penobscot, but has not been confirmed. There are indications of increasing abundance of Atlantic sturgeon belonging to the Gulf of Maine DPS. Atlantic sturgeon continue to be present in the Kennebec River; in addition, they are captured in directed research projects in the Penobscot River, and are observed in rivers where they were unknown to occur or had not been observed to occur for many years (e.g., the Saco, Presumpscot, and Charles rivers). These observations suggest that abundance of the Gulf of Maine DPS of Atlantic sturgeon is sufficient such that recolonization to rivers historically suitable for spawning may be occurring. However, despite some positive signs, there is not enough information to establish a trend for this DPS.

Some of the impacts from the threats that contributed to the decline of the Gulf of Maine DPS have been removed (e.g., directed fishing), or reduced as a result of improvements in water quality and removal of dams (e.g., the Edwards Dam on the Kennebec River in 1999). There are strict regulations on the use of fishing gear in Maine state waters that incidentally catch sturgeon. In addition, there have been reductions in fishing effort in state and federal waters, which most likely would result in a reduction in bycatch mortality of Atlantic sturgeon. A significant amount of fishing in the Gulf of Maine is conducted using trawl gear, which is known to have a much lower mortality rate for Atlantic sturgeon caught in the gear compared to sink gillnet gear (ASMFC, 2007). Atlantic sturgeon from the GOM DPS are not commonly taken as bycatch in areas south of Chatham, MA, with only 8 percent (e.g., 7 of the 84 fish) of interactions observed in the Mid Atlantic/Carolina region being assigned to the Gulf of Maine DPS (Wirgin and King, 2011). Tagging results also indicate that Gulf of Maine DPS fish tend to remain within the waters of the Gulf of Maine and only occasionally venture to points south. However, data on Atlantic sturgeon incidentally caught in trawls and intertidal fish weirs fished in the Minas Basin area of the Bay of Fundy(Canada) indicate that approximately 35 percent originated from the Gulf of Maine DPS (Wirgin *et al.*, in draft).

As noted previously, studies have shown that in order to rebuild, Atlantic sturgeon can only sustain low levels of bycatch and other anthropogenic mortality (Boreman, 1997; ASMFC, 2007; Kahnle *et al.*, 2007; Brown and Murphy, 2010). NMFS has determined that the Gulf of Maine DPS is at risk of becoming endangered in the foreseeable future throughout all of its range (i.e., is a threatened species) based on the following: (1) significant declines in population sizes and the protracted period during which sturgeon populations have been depressed; (2) the limited amount of current spawning; and, (3) the impacts and threats that have and will continue to affect recovery.



### 5.8 New York Bight DPS of Atlantic sturgeon
The New York Bight DPS includes the following: all anadromous Atlantic sturgeon spawned in the watersheds that drain into coastal waters from Chatham, MA to the Delaware-Maryland border on Fenwick Island. Within this range, Atlantic sturgeon historically spawned in the Connecticut, Delaware, Hudson, and Taunton Rivers (Murawski and Pacheco, 1977; Secor, 2002; ASSRT, 2007). Spawning still occurs in the Delaware and Hudson Rivers, but there is no recent evidence (within the last 15 years) of spawning in the Connecticut and Taunton Rivers

(ASSRT, 2007). Atlantic sturgeon that are spawned elsewhere continue to use habitats within the Connecticut and Taunton Rivers as part of their overall marine range (ASSRT, 2007; Savoy, 2007; Wirgin and King, 2011).

The abundance of the Hudson River Atlantic sturgeon riverine population prior to the onset of expanded exploitation in the 1800s is unknown but has been conservatively estimated at 10,000 adult females (Secor, 2002). Current abundance is likely at least one order of magnitude smaller than historical levels (Secor, 2002; ASSRT, 2007; Kahnle *et al.*, 2007). As described above, an estimate of the mean annual number of mature adults (863 total; 596 males and 267 females) was calculated for the Hudson River riverine population based on fishery-dependent data collected from 1985-1995 (Kahnle *et al.*, 2007). Kahnle *et al.* (1998; 2007) also showed that the level of fishing mortality from the Hudson River Atlantic sturgeon fishery during the period of 1985-1995 exceeded the estimated sustainable level of fishing mortality for the riverine population and may have led to reduced recruitment. No data on abundance of juveniles are available prior to the 1970s; however, two estimates of immature Atlantic sturgeon have been calculated for the Hudson River population, one for the 1976 year class and one for the 1994 year class. Dovel and Berggren (1983) marked immature fish from 1976-1978. Estimates for the 1976 year class at age were approximately 25,000 individuals. Dovel and Berggren estimated that in 1976 there were approximately 100,000 juvenile (non-migrant) Atlantic sturgeon from approximately 6 year classes, excluding young of year.

In October of 1994, the NYDEC stocked 4,929 marked age-0 Atlantic sturgeon, provided by a USFWS hatchery, into the Hudson Estuary at Newburgh Bay. These fish were reared from Hudson River brood stock. In 1995, Cornell University sampling crews collected 15 stocked and 14 wild age-1 Atlantic sturgeon (Peterson *et al.* 2000). A Petersen mark-recapture population estimate from these data suggests that there were 9,529 (95% CI = 1,916 – 10,473) age-0 Atlantic sturgeon in the estuary in 1994. Since 4,929 were stocked, 4,600 fish were of wild origin, assuming equal survival for both hatchery and wild fish and that stocking mortality for hatchery fish was zero.

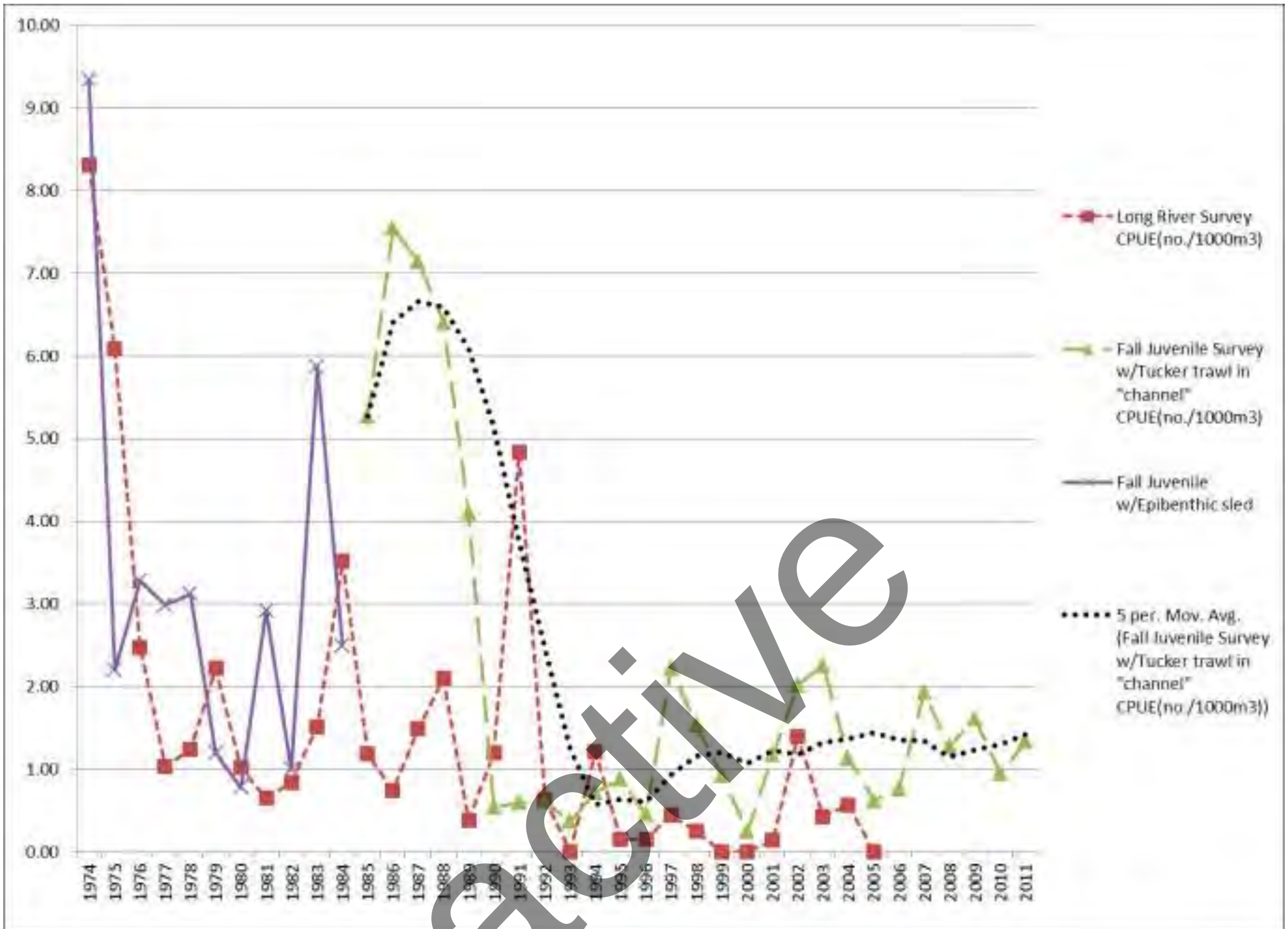
Information on trends for Atlantic sturgeon in the Hudson River are available from a number of long term surveys. From July to November during 1982-1990 and 1993, the NYSDEC sampled the abundance of juvenile fish in Haverstraw Bay and the Tappan Zee Bay. The CPUE of immature Atlantic sturgeon was 0.269 in 1982 and declined to zero by 1990. This study has not been carried out since this time.

The Long River Survey (LRS) samples ichthyoplankton river-wide from the George Washington Bridge (rkm 19) to Troy (rkm 246) using a stratified random design (CONED 1997). These data, which are collected from May-July, provide an annual index of juvenile Atlantic sturgeon in the Hudson River estuary since 1974. The Fall Juvenile Survey (FJS), conducted from July – October by the utilities, calculates an annual index of the number of fish captured per haul. Between 1974 and 1984, the shoals in the entire river (rkm 19-246) were sampled by epibenthic sled; in 1985 the gear was changed to a three-meter beam trawl. While neither of these studies were designed to catch sturgeon, given their consistent implementation over time they provide indications of trends in abundance, particularly over long time series. When examining CPUE, these studies suggest a sharp decline in the number of young Atlantic sturgeon in the early

1990s. While the amount of interannual variability makes it difficult to detect short term trends, a five year running average of CPUE from the FJS indicates a slowly increasing trend since about 1996. Interestingly, that is when the in-river fishery for Atlantic sturgeon closed. While that fishery was not targeting juveniles, a reduction in the number of adult mortalities would be expected to result in increased recruitment and increases in the number of young Atlantic sturgeon in the river. There also could have been bycatch of juveniles that would have suffered some mortality.

In 2000, the NYSDEC created a sturgeon juvenile survey program to supplement the utilities' survey; however, funds were cut in 2000, and the USFWS was contracted in 2003 to continue the program. In 2003 – 2005, 579 juveniles were collected (N = 122, 208, and 289, respectively) (Sweka et al. 2006). Pectoral spine analysis showed they ranged from 1 – 8 years of age, with the majority being ages 2 – 6. There has not been enough data collected to use this information to detect a trend, but at least during the 2003-2005 period, the number of juveniles collected increased each year which could be indicative of an increasing trend for juveniles.

As evidenced by estimates of juvenile abundance, the Atlantic sturgeon population in the Hudson River has declined over time. Peterson et al. (2000) found that the abundance of age-1 Atlantic sturgeon in the Hudson River declined 80% from 1977 to 1995. Similarly, longterm indices of juvenile abundance (the Hudson River Long River and Fall Shoals surveys) demonstrate a longterm declining trend in juvenile abundance. The figure below (Figure 7) illustrates the CPUE of Atlantic sturgeon in the two longterm surveys of the Hudson River. Please note that the Fall Shoals survey switched gear types in 1985. We do not have the CPUE data for the Long River Survey for 2006-2011.






CPUE for the Fall Juvenile Survey for the most recent five year period (2007-2011) is approximately 27% of the CPUE from 1985-1990, but is more than two times higher than the CPUE from 1991-1996 which may be suggestive of an increasing trend in juvenile abundance. Given the high variability between years, it is difficult to use this data to assess short term trends, however, when looking at a five-year moving average, the index appears to be increasing from lows in the early 1990s, but is still much lower than the 1970s and 1980s.

There is no abundance estimate for the Delaware River population of Atlantic sturgeon. Harvest records from the 1800’s indicate that this was historically a large population with an estimated 180,000 adult females prior to 1890 (Secor and Waldman, 1999; Secor, 2002). Sampling in 2009 to target young-of- the year (YOY) Atlantic sturgeon in the Delaware River (i.e., natal sturgeon) resulted in the capture of 34 YOY, ranging in size from 178 to 349 mm TL (Fisher, 2009) and the collection of 32 YOY Atlantic sturgeon in a separate study (Brundage and O’Herron in Calvo *et al.*, 2010). Genetics information collected from 33 of the 2009 year class YOY indicates that at least 3 females successfully contributed to the 2009 year class (Fisher, 2011). Therefore, while the capture of YOY in 2009 provides evidence that successful spawning is still occurring in the

Delaware River, the relatively low numbers suggest the existing riverine population is limited in size.

Several threats play a role in shaping the current status and trends observed in the Delaware River and Estuary. In-river threats include habitat disturbance from dredging, and impacts from historical pollution and impaired water quality. A dredged navigation channel extends from Trenton seaward through the tidal river (Brundage and O'Herron, 2009), and the river receives significant shipping traffic. Vessel strikes have been identified as a threat in the Delaware River; however, at this time we do not have information to quantify this threat or its impact to the population or the New York Bight DPS. Similar to the Hudson River, there is currently not enough information to determine a trend for the Delaware River population.

*Summary of the New York Bight DPS*
Atlantic sturgeon originating from the New York Bight DPS spawn in the Hudson and Delaware rivers. While genetic testing can differentiate between individuals originating from the Hudson or Delaware river the available information suggests that the straying rate is high between these rivers. There are no indications of increasing abundance for the New York Bight DPS (ASSRT, 2009; 2010). Some of the impact from the threats that contributed to the decline of the New York Bight DPS have been removed (e.g., directed fishing) or reduced as a result of improvements in water quality since passage of the Clean Water Act (CWA). In addition, there have been reductions in fishing effort in state and federal waters, which may result in a reduction in bycatch mortality of Atlantic sturgeon. Nevertheless, areas with persistent, degraded water quality, habitat impacts from dredging, continued bycatch in state and federally-managed fisheries, and vessel strikes remain significant threats to the New York Bight DPS.



In the marine range, New York Bight DPS Atlantic sturgeon are incidentally captured in federal and state managed fisheries, reducing survivorship of subadult and adult Atlantic sturgeon (Stein *et al.*, 2004; ASMFC 2007). As explained above, currently available estimates indicate that at least 4% of adults may be killed as a result of bycatch in fisheries authorized under Northeast FMPs. Based on mixed stock analysis results presented by Wirgin and King ( 2011), over 40 percent of the Atlantic sturgeon bycatch interactions in the Mid Atlantic Bight region were sturgeon from the New York Bight DPS. Individual-based assignment and mixed stock analysis of samples collected from sturgeon captured in Canadian fisheries in the Bay of Fundy indicated that approximately 1-2% were from the New York Bight DPS. At this time, we are not able to quantify the impacts from other threats or estimate the number of individuals killed as a result of other anthropogenic threats.

Riverine habitat may be impacted by dredging and other in-water activities, disturbing spawning habitat and also altering the benthic forage base. Both the Hudson and Delaware rivers have navigation channels that are maintained by dredging. Dredging is also used to maintain channels in the nearshore marine environment. Dredging outside of Federal channels and in-water construction occurs throughout the New York Bight region. While some dredging projects operate with observers present to document fish mortalities many do not. We have reports of one Atlantic sturgeon entrained during hopper dredging operations in Ambrose Channel, New Jersey. At this time, we do not have any information to quantify the number of Atlantic sturgeon killed or disturbed during dredging or in-water construction projects, we are also not able to quantify any effects to habitat.

In the Hudson and Delaware Rivers, dams do not block access to historical habitat. The Holyoke Dam on the Connecticut River blocks further upstream passage; however, the extent that Atlantic sturgeon would historically have used habitat upstream of Holyoke is unknown. Connectivity may be disrupted by the presence of dams on several smaller rivers in the New York Bight region. Because no Atlantic sturgeon occur upstream of any hydroelectric projects in the New York Bight region, passage over hydroelectric dams or through hydroelectric turbines is not a source of injury or mortality in this area. The extent that Atlantic sturgeon are affected by operations of dams in the New York Bight region is currently unknown.

New York Bight DPS Atlantic sturgeon may also be affected by degraded water quality. In general, water quality has improved in the Hudson and Delaware over the past decades (Lichter *et al.* 2006; EPA, 2008). Both the Hudson and Delaware rivers, as well as other rivers in the New York Bight region, were heavily polluted in the past from industrial and sanitary sewer discharges. While water quality has improved and most discharges are limited through regulations, many pollutants persist in the benthic environment. This can be particularly problematic if pollutants are present on spawning and nursery grounds as developing eggs and larvae are particularly susceptible to exposure to contaminants.

Vessel strikes occur in the Delaware River. Twenty-nine mortalities believed to be the result of vessel strikes were documented in the Delaware River from 2004 to 2008, and at least 13 of these fish were large adults. Given the time of year in which the fish were observed (predominantly May through July, with two in August), it is likely that many of the adults were migrating through the river to the spawning grounds. Because we do not know the percent of total vessel strikes that the observed mortalities represent, we are not able to quantify the number of individuals likely killed as a result of vessel strikes in the New York Bight DPS.

Studies have shown that to rebuild, Atlantic sturgeon can only sustain low levels of anthropogenic mortality (Boreman, 1997; ASMFC, 2007; Kahnle *et al.*, 2007; Brown and Murphy, 2010). There are no empirical abundance estimates of the number of Atlantic sturgeon in the New York Bight DPS. As described in the final listing rule, NMFS has determined that the New York Bight DPS is currently at risk of extinction due to: (1) precipitous declines in population sizes and the protracted period in which sturgeon populations have been depressed; (2) the limited amount of current spawning; and (3) the impacts and threats that have and will continue to affect population recovery.

## 5.9 Chesapeake Bay DPS of Atlantic sturgeon

The Chesapeake Bay DPS includes the following: all anadromous Atlantic sturgeons that are spawned in the watersheds that drain into the Chesapeake Bay and into coastal waters from the Delaware-Maryland border on Fenwick Island to Cape Henry, VA. Within this range, Atlantic sturgeon historically spawned in the Susquehanna, Potomac, James, York, Rappahannock, and Nottoway Rivers (ASSRT, 2007). Based on the review by Oakley (2003), 100 percent of Atlantic sturgeon habitat is currently accessible in these rivers since most of the barriers to passage (i.e. dams) are located upriver of where spawning is expected to have historically occurred (ASSRT, 2007). Spawning still occurs in the James River, and the presence of juvenile and adult sturgeon in the York River suggests that spawning may occur there as well (Musick *et* *al.*, 1994; ASSRT, 2007; Greene, 2009). However, conclusive evidence of current spawning is only available for the James River. Atlantic sturgeon that are spawned elsewhere are known to use the Chesapeake Bay for other life functions, such as foraging and as juvenile nursery habitat prior to entering the marine system as subadults (Vladykov and Greeley, 1963; ASSRT, 2007; Wirgin *et al.*, 2007; Grunwald *et al.*, 2008).

Age to maturity for Chesapeake Bay DPS Atlantic sturgeon is unknown. However, Atlantic sturgeon riverine populations exhibit clinal variation with faster growth and earlier age to maturity for those that originate from southern waters, and slower growth and later age to maturity for those that originate from northern waters (75 FR 61872; October 6, 2010). Age at maturity is 5 to 19 years for Atlantic sturgeon originating from South Carolina rivers (Smith *et al.*, 1982) and 11 to 21 years for Atlantic sturgeon originating from the Hudson River (Young *et al.*, 1998). Therefore, age at maturity for Atlantic sturgeon of the Chesapeake Bay DPS likely falls within these values.

Several threats play a role in shaping the current status of Chesapeake Bay DPS Atlantic sturgeon. Historical records provide evidence of the large-scale commercial exploitation of Atlantic sturgeon from the James River and Chesapeake Bay in the 19th century (Hildebrand and Schroeder, 1928; Vladykov and Greeley, 1963; ASMFC, 1998; Secor, 2002; Bushnoe *et al.*, 2005; ASSRT, 2007) as well as subsistence fishing and attempts at commercial fisheries as early as the 17th century (Secor, 2002; Bushnoe *et al.*, 2005; ASSRT, 2007; Balazik *et al.*, 2010). Habitat disturbance caused by in-river work such as dredging for navigational purposes is thought to have reduced available spawning habitat in the James River (Holton and Walsh, 1995; Bushnoe *et al.*, 2005; ASSRT, 2007). At this time, we do not have information to quantify this loss of spawning habitat.



Decreased water quality also threatens Atlantic sturgeon of the Chesapeake Bay DPS, especially since the Chesapeake Bay system is vulnerable to the effects of nutrient enrichment due to a relatively low tidal exchange and flushing rate, large surface to volume ratio, and strong stratification during the spring and summer months (Pyzik *et al.*, 2004; ASMFC, 1998; ASSRT, 2007; EPA, 2008). These conditions contribute to reductions in dissolved oxygen levels throughout the Bay. The availability of nursery habitat, in particular, may be limited given the recurrent hypoxia (low dissolved oxygen) conditions within the Bay (Niklitschek and Secor, 2005; 2010). At this time we do not have sufficient information to quantify the extent that degraded water quality effects habitat or individuals in the James River or throughout the Chesapeake Bay.

Vessel strikes have been observed in the James River (ASSRT, 2007). Eleven Atlantic sturgeon were reported to have been struck by vessels from 2005 through 2007. Several of these were mature individuals. Because we do not know the percent of total vessel strikes that the observed mortalities represent, we are not able to quantify the number of individuals likely killed as a result of vessel strikes in the New York Bight DPS.

In the marine and coastal range of the Chesapeake Bay DPS from Canada to Florida, fisheries bycatch in federally and state managed fisheries poses a threat to the DPS, reducing survivorship of subadults and adults and potentially causing an overall reduction in the spawning population

(Stein *et al.*, 2004; ASMFC, 2007; ASSRT, 2007).

*Summary of the Chesapeake Bay DPS*
Spawning for the Chesapeake Bay DPS is known to occur in only the James River. Spawning may be occurring in other rivers, such as the York, but has not been confirmed. There are anecdotal reports of increased sightings and captures of Atlantic sturgeon in the James River. However, this information has not been comprehensive enough to develop a population estimate for the James River or to provide sufficient evidence to confirm increased abundance. Some of the impact from the threats that facilitated the decline of the Chesapeake Bay DPS have been removed (e.g., directed fishing) or reduced as a result of improvements in water quality since passage of the Clean Water Act (CWA). We do not currently have enough information about any life stage to establish a trend for this DPS.

Areas with persistent, degraded water quality, habitat impacts from dredging, continued bycatch in U.S. state and federally-managed fisheries, Canadian fisheries and vessel strikes remain significant threats to the Chesapeake Bay DPS of Atlantic sturgeon. Studies have shown that Atlantic sturgeon can only sustain low levels of bycatch mortality (Boreman, 1997; ASMFC, 2007; Kahnle *et al.*, 2007). The Chesapeake Bay DPS is currently at risk of extinction given (1) precipitous declines in population sizes and the protracted period in which sturgeon populations have been depressed; (2) the limited amount of current spawning; and, (3) the impacts and threats that have and will continue to affect the potential for population recovery.

## 5.10 Carolina DPS of Atlantic sturgeon

The Carolina DPS includes all Atlantic sturgeon that spawn or are spawned in the watersheds (including all rivers and tributaries) from Albemarle Sound southward along the southern Virginia, North Carolina, and South Carolina coastal areas to Charleston Harbor. The marine range of Atlantic sturgeon from the Carolina DPS extends from the Hamilton Inlet, Labrador, Canada, to Cape Canaveral, Florida. Sturgeon are commonly captured 40 miles offshore (D. Fox, DSU, pers. comm.). Records providing fishery bycatch data by depth show the vast majority of Atlantic sturgeon bycatch via gillnets is observed in waters less than 50 meters deep (Stein et al. 2004, ASMFC 2007), but Atlantic sturgeon are recorded as bycatch out to 500 fathoms.

Rivers known to have current spawning populations within the range of the Carolina DPS include the Roanoke, Tar-Pamlico, Cape Fear, Waccamaw, and Pee Dee Rivers. We determined spawning was occurring if young-of-the-year (YOY) were observed, or mature adults were present, in freshwater portions of a system (Table 5). However, in some rivers, spawning by Atlantic sturgeon may not be contributing to population growth because of lack of suitable habitat and the presence of other stressors on juvenile survival and development. There may also be spawning populations in the Neuse, Santee and Cooper Rivers, though it is uncertain. Historically, both the Sampit and Ashley Rivers were documented to have spawning populations at one time. However, the spawning population in the Sampit River is believed to be extirpated and the current status of the spawning population in the Ashley River is unknown. Both rivers may be used as nursery habitat by young Atlantic sturgeon originating from other spawning populations. This represents our current knowledge of the river systems utilized by the Carolina DPS for specific life functions, such as spawning, nursery habitat, and foraging. However, fish from the Carolina DPS likely use other river systems than those listed here for their specific life functions.

| River/Estuary | Spawning Population | Data |
|---|---|---|
| Roanoke River, VA/NC; Albemarle Sound, NC | Yes | collection of 15 YOY (1997-1998); single YOY (2005) |
| Tar-Pamlico River, NC; Pamlico Sound | Yes | one YOY (2005) |
| Neuse River, NC; Pamlico Sound | Unknown | |
| Cape Fear River, NC | Yes | upstream migration of adults in the fall, carcass of a ripe female upstream in mid-September (2006) |
| Waccamaw River, SC; Winyah Bay | Yes | age-1, potentially YOY (1980s) |
| Pee Dee River, SC; Winyah Bay | Yes | running ripe male in Great Pee Dee River (2003) |
| Sampit, SC; Winyah Bay | Extirpated | |
| Santee River, SC | Unknown | |
| Cooper River, SC | Unknown | |
| Ashley River, SC | Unknown | |

**Table 5.** Major rivers, tributaries, and sounds within the range of the Carolina DPS and currently available data on the presence of an Atlantic sturgeon spawning population in each system.

The riverine spawning habitat of the Carolina DPS occurs within the Mid-Atlantic Coastal Plain ecoregion (TNC 2002a), which includes bottomland hardwood forests, swamps, and some of the world's most active coastal dunes, sounds, and estuaries. Natural fires, floods, and storms are so dominant in this region that the landscape changes very quickly. Rivers routinely change their courses and emerge from their banks. The primary threats to biological diversity in the Mid-Atlantic Coastal Plain, as listed by TNC are: global climate change and rising sea level; altered surface hydrology and landform alteration (e.g., flood-control and hydroelectric dams, inter-basin transfers of water, drainage ditches, breached levees, artificial levees, dredged inlets and river channels, beach renourishment, and spoil deposition banks and piles); a regionally receding water table, probably resulting from both over-use and inadequate recharge; fire suppression; land fragmentation, mainly by highway development; land-use conversion (e.g., from forests to timber plantations, farms, golf courses, housing developments, and resorts); the invasion of exotic plants and animals; air and water pollution, mainly from agricultural activities including concentrated animal feed operations; and over-harvesting and poaching of species. Many of the Carolina DPS' spawning rivers, located in the Mid-Coastal Plain, originate in areas of marl. Waters draining calcareous, impervious surface materials such as marl are: (1) likely to be alkaline; (2) dominated by surface run-off; (3) have little groundwater connection; and, (4) are seasonally ephemeral.

Historical landings data indicate that between 7,000 and 10,500 adult female Atlantic sturgeon were present in North Carolina prior to 1890 (Armstrong and Hightower 2002, Secor 2002). Secor (2002) estimates that 8,000 adult females were present in South Carolina during that same time-frame. Reductions from the commercial fishery and ongoing threats have drastically reduced the numbers of Atlantic sturgeon within the Carolina DPS. Currently, the Atlantic sturgeon spawning population in at least one river system within the Carolina DPS has been extirpated, with a potential extirpation in an additional system. The abundances of the remaining river populations within the DPS, each estimated to have fewer than 300 spawning adults, is estimated to be less than 3 percent of what they were historically (ASSRT 2007).

*Threats*

The Carolina DPS was listed as endangered under the ESA as a result of a combination of habitat curtailment and modification, overutilization (i.e, being taken as bycatch) in commercial fisheries, and the inadequacy of regulatory mechanisms in ameliorating these impacts and threats.

The modification and curtailment of Atlantic sturgeon habitat resulting from dams, dredging, and degraded water quality is contributing to the status of the Carolina DPS. Dams have curtailed Atlantic sturgeon spawning and juvenile developmental habitat by blocking over 60 percent of the historical sturgeon habitat upstream of the dams in the Cape Fear and Santee-Cooper River systems. Water quality (velocity, temperature, and dissolved oxygen (DO)) downstream of these dams, as well as on the Roanoke River, has been reduced, which modifies and curtails the extent of spawning and nursery habitat for the Carolina DPS. Dredging in spawning and nursery grounds modifies the quality of the habitat and is further curtailing the extent of available habitat in the Cape Fear and Cooper Rivers, where Atlantic sturgeon habitat has already been modified and curtailed by the presence of dams. Reductions in water quality from terrestrial activities have modified habitat utilized by the Carolina DPS. In the Pamlico and Neuse systems, nutrient-loading and seasonal anoxia are occurring, associated in part with concentrated animal feeding operations (CAFOs). Heavy industrial development and CAFOs have degraded water quality in the Cape Fear River. Water quality in the Waccamaw and Pee Dee rivers have been affected by industrialization and riverine sediment samples contain high levels of various toxins, including dioxins. Additional stressors arising from water allocation and climate change threaten to exacerbate water quality problems that are already present throughout the range of the Carolina DPS. Twenty interbasin water transfers in existence prior to 1993, averaging 66.5 million gallons per day (mgd), were authorized at their maximum levels without being subjected to an evaluation for certification by North Carolina Department of Environmental and Natural Resources or other resource agencies. Since the 1993 legislation requiring certificates for transfers, almost 170 mgd of interbasin water withdrawals have been authorized, with an additional 60 mgd pending certification. The removal of large amounts of water from the system will alter flows, temperature, and DO. Existing water allocation issues will likely be compounded by population growth and potentially climate change. Climate change is also predicted to elevate water temperatures and exacerbate nutrient-loading, pollution inputs, and lower DO, all of which are current stressors to the Carolina DPS.

Overutilization of Atlantic sturgeon from directed fishing caused initial severe declines in Atlantic sturgeon populations in the Southeast, from which they have never rebounded. Further, continued overutilization of Atlantic sturgeon as bycatch in commercial fisheries is an ongoing impact to the Carolina DPS. Little data exists on bycatch in the Southeast and high levels of bycatch underreporting are suspected. Further, a total population abundance for the DPS is not available, and it is therefore not possible to calculate the percentage of the DPS subject to bycatch mortality based on the available bycatch mortality rates for individual fisheries. However, fisheries known to incidentally catch Atlantic sturgeon occur throughout the marine range of the species and in some riverine waters as well. Because Atlantic sturgeon mix extensively in marine waters and may access multiple river systems, they are subject to being caught in multiple fisheries throughout their range. In addition, stress or injury to Atlantic sturgeon taken as bycatch but released alive may result in increased susceptibility to other threats, such as poor water quality (e.g., exposure to toxins and low DO). This may result in reduced ability to perform major life functions, such as foraging and spawning, or even post-capture mortality.

As a wide-ranging anadromous species, Carolina DPS Atlantic sturgeon are subject to numerous Federal (U.S. and Canadian), state and provincial, and inter-jurisdictional laws, regulations, and agency activities. While these mechanisms have addressed impacts to Atlantic sturgeon through directed fisheries, there are currently no mechanisms in place to address the significant risk posed to Atlantic sturgeon from commercial bycatch. Though statutory and regulatory mechanisms exist that authorize reducing the impact of dams on riverine and anadromous species, such as Atlantic sturgeon, and their habitat, these mechanisms have proven inadequate for preventing dams from blocking access to habitat upstream and degrading habitat downstream. Further, water quality continues to be a problem in the Carolina DPS, even with existing controls on some pollution sources. Current regulatory regimes are not necessarily effective in controlling water allocation issues (e.g., no restrictions on interbasin water transfers in South Carolina, the lack of ability to regulate non-point source pollution, etc.)

The recovery of Atlantic sturgeon along the Atlantic Coast, especially in areas where habitat is limited and water quality is severely degraded, will require improvements in the following areas: (1) elimination of barriers to spawning habitat either through dam removal, breaching, or installation of successful fish passage facilities; (2) operation of water control structures to provide appropriate flows, especially during spawning season; (3) imposition of dredging restrictions including seasonal moratoriums and avoidance of spawning/nursery habitat; and, (4) mitigation of water quality parameters that are restricting sturgeon use of a river (i.e., DO). Additional data regarding sturgeon use of riverine and estuarine environments is needed.

The concept of a viable population able to adapt to changing environmental conditions is critical to Atlantic sturgeon, and the low population numbers of every river population in the Carolina DPS put them in danger of extinction throughout their range; none of the populations are large or stable enough to provide with any level of certainty for continued existence of Atlantic sturgeon in this part of its range. Although the largest impact that caused the precipitous decline of the species has been curtailed (directed fishing), the population sizes within the Carolina DPS have remained relatively constant at greatly reduced levels (approximately 3 percent of historical population sizes) for 100 years. Small numbers of individuals resulting from drastic reductions in populations, such as occurred with Atlantic sturgeon due to the commercial fishery, can remove the buffer against natural demographic and environmental variability provided by large populations (Berry, 1971; Shaffer, 1981; Soulé, 1980). Recovery of depleted populations is an inherently slow process for a late-maturing species such as Atlantic sturgeon, and they continue to face a variety of other threats that contribute to their risk of extinction. While a long life-span also allows multiple opportunities to contribute to future generations, it also results increases the timeframe over which exposure to the multitude of threats facing the Carolina DPS can occur.

The viability of the Carolina DPS depends on having multiple self-sustaining riverine spawning populations and maintaining suitable habitat to support the various life functions (spawning, feeding, growth) of Atlantic sturgeon populations. Because a DPS is a group of populations, the stability, viability, and persistence of individual populations affects the persistence and viability of the larger DPS. The loss of any population within a DPS will result in: (1) a long-term gap in the range of the DPS that is unlikely to be recolonized; (2) loss of reproducing individuals; (3) loss of genetic biodiversity; (4) potential loss of unique haplotypes; (5) potential loss of adaptive traits; and (6) reduction in total number. The loss of a population will negatively impact the persistence and viability of the DPS as a whole, as fewer than two individuals per generation spawn outside their natal rivers (Secor and Waldman 1999). The persistence of individual populations, and in turn the DPS, depends on successful spawning and rearing within the freshwater habitat, the immigration into marine habitats to grow, and then the return of adults to natal rivers to spawn.

*Summary of the Status of the Carolina DPS of Atlantic Sturgeon*

In summary, the Carolina DPS is estimated to number less than 3 percent of its historic population size. There are estimated to be less than 300 spawning adults per year (total of both sexes) in each of the major river systems occupied by the DPS in which spawning still occurs, whose freshwater range occurs in the watersheds (including all rivers and tributaries) from Albemarle Sound southward along the southern Virginia, North Carolina, and South Carolina coastal areas to Charleston Harbor. Recovery of depleted populations is an inherently slow process for a late-maturing species such as Atlantic sturgeon. While a long life-span also allows multiple opportunities to contribute to future generations, this is hampered within the Carolina DPS by habitat alteration and bycatch. This DPS was severely depleted by past directed commercial fishing, and faces ongoing impacts and threats from habitat alteration or inaccessibility, bycatch, and the inadequacy of existing regulatory mechanisms to address and reduce habitat alterations and bycatch that have prevented river populations from rebounding and will prevent their recovery.

The presence of dams has resulted in the loss of over 60 percent of the historical sturgeon habitat on the Cape Fear River and in the Santee-Cooper system. Dams are contributing to the status of the Carolina DPS by curtailing the extent of available spawning habitat and further modifying the remaining habitat downstream by affecting water quality parameters (such as depth, temperature, velocity, and DO) that are important to sturgeon. Dredging is also contributing to the status of the Carolina DPS by modifying Atlantic sturgeon spawning and nursery habitat. Habitat modifications through reductions in water quality are contributing to the status of the Carolina DPS due to nutrient-loading, seasonal anoxia, and contaminated sediments. Interbasin water transfers and climate change threaten to exacerbate existing water quality issues. Bycatch is also a current threat to the Carolina DPS that is contributing to its status. Fisheries known to incidentally catch Atlantic sturgeon occur throughout the marine range of the species and in some riverine waters as well. Because Atlantic sturgeon mix extensively in marine waters and may utilize multiple river systems for nursery and foraging habitat in addition to their natal spawning river, they are subject to being caught in multiple fisheries throughout their range. In addition to direct mortality, stress or injury to Atlantic sturgeon taken as bycatch but released alive may result in increased susceptibility to other threats, such as poor water quality (e.g., exposure to toxins). This may result in reduced ability to perform major life functions, such as foraging and spawning, or even post-capture mortality. While many of the threats to the Carolina DPS have been ameliorated or reduced due to the existing regulatory mechanisms, such as the moratorium on directed fisheries for Atlantic sturgeon, bycatch is currently not being addressed through existing mechanisms. Further, access to habitat and water quality continues to be a problem even with NMFS' authority under the Federal Power Act to recommend fish passsage and existing controls on some pollution sources. The inadequacy of regulatory mechanisms to control bycatch and habitat alterations is contributing to the status of the Carolina DPS.

## 5.11 South Atlantic DPS of Atlantic sturgeon

The South Atlantic DPS includes all Atlantic sturgeon that spawn or are spawned in the watersheds (including all rivers and tributaries) of the Ashepoo, Combahee, and Edisto Rivers (ACE) Basin southward along the South Carolina, Georgia, and Florida coastal areas to the St. Johns River, Florida. The marine range of Atlantic sturgeon from the South Atlantic DPS extends from the Hamilton Inlet, Labrador, Canada, to Cape Canaveral, Florida.



Rivers known to have current spawning populations within the range of the South Atlantic DPS include the Combahee, Edisto, Savannah, Ogeechee, Altamaha, and Satilla Rivers. We determined spawning was occurring if young-of-the-year (YOY) were observed, or mature adults were present, in freshwater portions of a system (Table 6). However, in some rivers, spawning by Atlantic sturgeon may not be contributing to population growth because of lack of suitable habitat and the presence of other stressors on juvenile survival and development. Historically, both the Broad-Coosawatchie and St. Marys Rivers were documented to have spawning populations at one time; there is also evidence that spawning may have occurred in the St. Johns River or one of its tributaries. However, the spawning population in the St. Marys River, as well as any historical spawning population present in the St. Johns, is believed to be extirpated, and the status of the spawning population in the Broad-Coosawatchie is unknown. Both the St. Marys and St. Johns Rivers are used as nursery habitat by young Atlantic sturgeon originating from other spawning populations. The use of the Broad-Coosawatchie by sturgeon from other spawning populations is unknown at this time. The presence of historical and current spawning populations in the Ashepoo River has not been documented; however, this river may currently be used for nursery habitat by young Atlantic sturgeon originating from other spawning populations. This represents our current knowledge of the river systems utilized by the South Atlantic DPS for specific life functions, such as spawning, nursery habitat, and foraging. However, fish from the South Atlantic DPS likely use other river systems than those listed here for their specific life functions.

| River/Estuary | Spawning | Data |
| --- | --- | --- |

| | **Population** | |
|---|---|---|
| ACE (Ashepoo, Combahee, and Edisto Rivers) Basin, SC; St. Helena Sound | Yes | 1,331 YOY (1994-2001); gravid female and running ripe male in the Edisto (1997); 39 spawning adults (1998) |
| Broad-Coosawhatchie Rivers, SC; Port Royal Sound | Unknown | |
| Savannah River, SC/GA | Yes | 22 YOY (1999-2006); running ripe male (1997) |
| Ogeechee River, GA | Yes | age-1 captures, but high inter-annual variability (1991-1998); 17 YOY (2003); 9 YOY (2004) |
| Altamaha River, GA | Yes | 74 captured/308 estimated spawning adults (2004); 139 captured/378 estimated spawning adults (2005) |
| Satilla River, GA | Yes | 4 YOY and spawning adults (1995-1996) |
| St. Marys River, GA/FL | Extirpated | |
| St. Johns River, FL | Extirpated | |

Table 6. Major rivers, tributaries, and sounds within the range of the South Atlantic DPS and currently available data on the presence of an Atlantic sturgeon spawning population in each system.



The riverine spawning habitat of the South Atlantic DPS occurs within the South Atlantic Coastal Plain ecoregion (TNC 2002b), which includes fall-line sandhills, rolling longleaf pine uplands, wet pine flatwoods, isolated depression wetlands, small streams, large river systems, and estuaries. Other ecological systems in the ecoregion include maritime forests on barrier islands, pitcher plant seepage bogs and Altamaha grit (sandstone) outcrops. Other ecological systems in the ecoregion include maritime forests on barrier islands, pitcher plant seepage bogs and Altamaha grit (sandstone) outcrops. The primary threats to biological diversity in the South Atlantic Coastal Plain listed by TNC are intensive silvicultural practices, including conversion of natural forests to highly managed pine monocultures and the clear-cutting of bottomland hardwood forests. Changes in water quality and quantity, caused by hydrologic alterations (impoundments, groundwater withdrawal, and ditching), and point and nonpoint pollution, are threatening the aquatic systems. Development is a growing threat, especially in coastal areas. Agricultural conversion, fire regime alteration, and the introduction of nonnative species are additional threats to the ecoregion's diversity. The South Atlantic DPS' spawning rivers, located in the South Atlantic Coastal Plain, are primarily of two types: brownwater (with headwaters north of the Fall Line, silt-laden) and blackwater (with headwaters in the coastal plain, stained by tannic acids).

Secor (2002) estimates that 8,000 adult females were present in South Carolina prior to 1890. Prior to the collapse of the fishery in the late 1800s, the sturgeon fishery was the third largest fishery in Georgia. Secor (2002) estimated from U.S. Fish Commission landing reports that approximately 11,000 spawning females were likely present in the state prior to 1890. Reductions from the commercial fishery and ongoing threats have drastically reduced the numbers of Atlantic sturgeon within the South Atlantic DPS. Currently, the Atlantic sturgeon spawning population in at least two river systems within the South Atlantic DPS has been extirpated. The Altamaha River population of Atlantic sturgeon, with an estimated 343 adults spawning annually, is believed to be the largest population in the Southeast, yet is estimated to be only 6 percent of its historical population size. The abundances of the remaining river populations within the DPS, each estimated to have fewer than 300 spawning adults, is estimated to be less than 1 percent of what they were historically (ASSRT 2007).

*Threats*

The South Atlantic DPS was listed as endangered under the ESA as a result of a combination of habitat curtailment and modification, overutilization (i.e, being taken as bycatch) in commercial fisheries, and the inadequacy of regulatory mechanisms in ameliorating these impacts and threats.

The modification and curtailment of Atlantic sturgeon habitat resulting from dredging and degraded water quality is contributing to the status of the South Atlantic DPS. Dredging is a present threat to the South Atlantic DPS and is contributing to their status by modifying the quality and availability of Atlantic sturgeon habitat. Maintenance dredging is currently modifying Atlantic sturgeon nursery habitat in the Savannah River and modeling indicates that the proposed deepening of the navigation channel will result in reduced DO and upriver movement of the salt wedge, curtailing spawning habitat. Dredging is also modifying nursery and foraging habitat in the St. Johns Rivers. Reductions in water quality from terrestrial activities have modified habitat utilized by the South Atlantic DPS. Low DO is modifying sturgeon habitat in the Savannah due to dredging, and non-point source inputs are causing low DO in the Ogeechee River and in the St. Marys River, which completely eliminates juvenile nursery habitat in summer. Low DO has also been observed in the St. Johns River in the summer. Sturgeon are more sensitive to low DO and the negative (metabolic, growth, and feeding) effects caused by low DO increase when water temperatures are concurrently high, as they are within the range of the South Atlantic DPS. Additional stressors arising from water allocation and climate change threaten to exacerbate water quality problems that are already present throughout the range of the South Atlantic DPS. Large withdrawals of over 240 million gallons per day mgd of water occur in the Savannah River for power generation and municipal uses. However, users withdrawing less than 100,000 gallons per day (gpd) are not required to get permits, so actual water withdrawals from the Savannah and other rivers within the range of the South Atlantic DPS are likely much higher. The removal of large amounts of water from the system will alter flows, temperature, and DO. Water shortages and "water wars" are already occurring in the rivers occupied by the South Atlantic DPS and will likely be compounded in the future by population growth and potentially by climate change. Climate change is also predicted to elevate water temperatures and exacerbate nutrient-loading, pollution inputs, and lower DO, all of which are current stressors to the South Atlantic DPS.

Overutilization of Atlantic sturgeon from directed fishing caused initial severe declines in Atlantic sturgeon populations in the Southeast, from which they have never rebounded. Further, continued overutilization of Atlantic sturgeon as bycatch in commercial fisheries is an ongoing impact to the South Atlantic DPS. The loss of large subadults and adults as a result of bycatch impacts Atlantic sturgeon populations because they are a long-lived species, have an older age at maturity, have lower maximum fecundity values, and a large percentage of egg production occurs later in life. Little data exists on bycatch in the Southeast and high levels of bycatch underreporting are suspected. Further, a total population abundance for the DPS is not available, and it is therefore not possible to calculate the percentage of the DPS subject to bycatch mortality based on the available bycatch mortality rates for individual fisheries. However, fisheries known to incidentally catch Atlantic sturgeon occur throughout the marine range of the species and in some riverine waters as well. Because Atlantic sturgeon mix extensively in marine waters and may access multiple river systems, they are subject to being caught in multiple fisheries throughout their range. In addition, stress or injury to Atlantic sturgeon taken as bycatch but released alive may result in increased susceptibility to other threats, such as poor water quality (e.g., exposure to toxins and low DO). This may result in reduced ability to perform major life functions, such as foraging and spawning, or even post-capture mortality.

As a wide-ranging anadromous species, Atlantic sturgeon are subject to numerous Federal (U.S. and Canadian), state and provincial, and inter-jurisdictional laws, regulations, and agency activities. While these mechanisms have addressed impacts to Atlantic sturgeon through directed fisheries, there are currently no mechanisms in place to address the significant risk posed to Atlantic sturgeon from commercial bycatch. Though statutory and regulatory mechanisms exist that authorize reducing the impact of dams on riverine and anadromous species, such as Atlantic sturgeon, and their habitat, these mechanisms have proven inadequate for preventing dams from blocking access to habitat upstream and degrading habitat downstream. Further, water quality continues to be a problem in the South Atlantic DPS, even with existing controls on some pollution sources. Current regulatory regimes are not necessarily effective in controlling water allocation issues (e.g., no permit requirements for water withdrawals under 100,000 gpd in Georgia, no restrictions on interbasin water transfers in South Carolina, the lack of ability to regulate non-point source pollution.)

The recovery of Atlantic sturgeon along the Atlantic Coast, especially in areas where habitat is limited and water quality is severely degraded, will require improvements in the following areas: (1) elimination of barriers to spawning habitat either through dam removal, breaching, or installation of successful fish passage facilities; (2) operation of water control structures to provide appropriate flows, especially during spawning season; (3) imposition of dredging restrictions including seasonal moratoriums and avoidance of spawning/nursery habitat; and, (4) mitigation of water quality parameters that are restricting sturgeon use of a river (i.e., DO). Additional data regarding sturgeon use of riverine and estuarine environments is needed.

A viable population able to adapt to changing environmental conditions is critical to Atlantic sturgeon, and the low population numbers of every river population in the South Atlantic DPS put them in danger of extinction throughout their range; none of the populations are large or stable enough to provide with any level of certainty for continued existence of Atlantic sturgeon in this part of its range. Although the largest impact that caused the precipitous decline of the species has been curtailed (directed fishing), the population sizes within the South Atlantic DPS have remained relatively constant at greatly reduced levels (approximately 6 percent of historical population sizes in the Altamaha River, and 1 percent of historical population sizes in the remainder of the DPS) for 100 years. Small numbers of individuals resulting from drastic reductions in populations, such as occurred with Atlantic sturgeon due to the commercial fishery, can remove the buffer against natural demographic and environmental variability provided by large populations (Berry, 1971; Shaffer, 1981; Soulé, 1980). Recovery of depleted populations is an inherently slow process for a late-maturing species such as Atlantic sturgeon, and they continue to face a variety of other threats that contribute to their risk of extinction. While a long life-span also allows multiple opportunities to contribute to future generations, it also results increases the timeframe over which exposure to the multitude of threats facing the South Atlantic DPS can occur.

*Summary of the Status of the South Atlantic DPS of Atlantic Sturgeon*

The South Atlantic DPS is estimated to number fewer than 6 percent of its historical population size, with all river populations except the Altamaha estimated to be less than 1 percent of historical abundance. There are an estimated 343 spawning adults per year in the Altamaha and less than 300 spawning adults per year (total of both sexes) in each of the other major river systems occupied by the DPS in which spawning still occurs, whose freshwater range occurs in the watersheds (including all rivers and tributaries) of the ACE Basin southward along the South Carolina, Georgia, and Florida coastal areas to the St. Johns River, Florida. Recovery of depleted populations is an inherently slow process for a late-maturing species such as Atlantic sturgeon. Their late age at maturity provides more opportunities for individuals to be removed from the population before reproducing. While a long life-span also allows multiple opportunities to contribute to future generations, this is hampered within the South Atlantic DPS by habitat alteration, bycatch, and from the inadequacy of existing regulatory mechanisms to address and reduce habitat alterations and bycatch.



Dredging is contributing to the status of the South Atlantic DPS by modifying spawning, nursery, and foraging habitat. Habitat modifications through reductions in water quality are also contributing to the status of the South Atlantic DPS through reductions in DO, particularly during times of high water temperatures, which increase the detrimental effects on Atlantic sturgeon habitat. Interbasin water transfers and climate change threaten to exacerbate existing water quality issues. Bycatch is also a current impact to the South Atlantic DPS that is contributing to its status. Fisheries known to incidentally catch Atlantic sturgeon occur throughout the marine range of the species and in some riverine waters as well. Because Atlantic sturgeon mix extensively in marine waters and may utilize multiple river systems for nursery and foraging habitat in addition to their natal spawning river, they are subject to being caught in multiple fisheries throughout their range. In addition to direct mortality, stress or injury to Atlantic sturgeon taken as bycatch but released alive may result in increased susceptibility to other threats, such as poor water quality (e.g., exposure to toxins). This may result in reduced ability to perform major life functions, such as foraging and spawning, or even post-capture mortality. While many of the threats to the South Atlantic DPS have been ameliorated or reduced due to the existing regulatory mechanisms, such as the moratorium on directed fisheries for Atlantic sturgeon, bycatch is currently not being addressed through existing mechanisms. Further, access to habitat and water quality continues to be a problem even with NMFS' authority under the Federal Power Act to recommend fish passsage and existing controls on some pollution sources. There is a lack of regulation for some large water withdrawals, which threatens sturgeon habitat. Current regulatory regimes do not require a permit for water withdrawals under 100,000 gpd in Georgia and there are no restrictions on interbasin water transfers in South Carolina. Data required to evaluate water allocation issues are either very weak, in terms of determining the precise amounts of water currently being used, or non-existent, in terms of our knowledge of water supplies available for use under historical hydrologic conditions in the region. Existing water allocation issues will likely be compounded by population growth, drought, and potentially climate change. The inadequacy of regulatory mechanisms to control bycatch and habitat alterations is contributing to the status of the South Atlantic DPS.

## 5.12 Summary of Available Information on Use of Action Area by Listed Species

### *5.12.1 Sea turtles*

Sea turtles are seasonally present in the Chesapeake Bay from April to early November each year, with the highest number of individuals present from June to October. 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 when water temperatures are above 11°C and depending on seasonal weather patterns, could be present from early April through November. 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. 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). Some of 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 areas where dredging will occur.



### *5.12.2 Atlantic sturgeon in the Action Area*

Atlantic sturgeon are well distributed through the Chesapeake Bay. In the Bay area, spawning is only known to occur in the James River, which is outside of the action area. Young sturgeon are intolerant to salinity; as such, no eggs, larvae, or young of the year are likely to occur in the action area. Adult Atlantic sturgeon will pass through the action area as they move to the James River to spawn in the spring and then again as they return to the ocean. A fall spawning migration is also suspected in the James River but has not yet been confirmed. Subadult Atlantic sturgeon could be present in the action area year-round, but are less likely to be present in the winter months when individuals would be at overwintering areas, which are not known to occur in the action area.

The Chesapeake Bay is known to be a congregation area for sturgeon from multiple DPSs; particularly during the summer. We have determined that Atlantic sturgeon in the action area are likely to originate from all five DPSs at the following frequencies: NYB 49%; South Atlantic

20%; Chesapeake Bay 14%; Gulf of Maine 11%; and Carolina 4%.

## 6.0 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.

### 6.1 Federal Actions that have Undergone Formal or Early Section 7 Consultation

NMFS has undertaken several ESA section 7 consultations to address the effects of actions authorized, funded or carried out by Federal agencies. Each of those consultations sought to develop ways of reducing the probability of adverse impacts of the action on listed species. Consultations are detailed below.

#### *6.1.1 Maintenance of Federal Navigation Projects and Use of Sand Borrow Areas*

As explained in Section 2.0 above, USACE and NMFS have consulted previously on dredging of all channels and borrow areas considered in this Opinion. The use of endangered species observers began in 1994. Since then, a total of 64 sea turtles and two Atlantic sturgeon have been observed entrained in hopper dredges operating in the action area. All of these individuals were dead at the time of observation. Additionally, sea turtles and Atlantic sturgeon have been captured and released during sea turtle relocation trawling in association with hopper dredging. One sea turtle mortality has been recorded during relocation trawling. No interactions between sea turtles or Atlantic sturgeon have been observed during projects using a hydraulic pipeline (cutterhead) or mechanical dredge.



#### *6.1.2 Scientific Studies*

There is currently one scientific research permit issued pursuant to Section 10(a)(1)(A) of the ESA, that authorizes research on Atlantic sturgeon in the action area. Permit 16547 authorizes the US Fish and Wildlife Service to conduct research activities on Atlantic sturgeon in the Chesapeake Bay and tidal tributaries in Virginia. There is the potential for some research to take place in the action area. The permit authorizes the non-lethal capture, handling and sampling of a number of sturgeon and the unintentional mortality of three Atlantic sturgeon over the five year life of this permit. The permit expires in April 2017.

Several researchers, including the NMFS Northeast and Southeast Science Centers and several academic and independent researchers are authorized under various Section 10(a)(1)(A) permits to conduct surveys and sample sea turtles. Some of this activity may occur in the action area. More information on these permits can be obtained from: https://apps.nmfs.noaa.gov.

#### *6.1.3 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 USACE. NMFS has conducted formal consultations with the USCG, the USN, EPA and NOAA on their vessel operations. In addition to operation of USACE vessels, NMFS has consulted with the USACE to recommend 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. No interactions with sturgeon or sea turtles have been reported with any of the vessels considered in these Opinions.

### *6.1.4 Authorization of Fisheries through Fishery Management Plans*

NMFS authorizes the operation of several fisheries in the action area under the authority of the Magnuson-Stevens Fishery Conservation Act and through Fishery Management Plans and their implementing regulations. Commercial and recreational fisheries in the action area employ gear that is known to harass, injure, and/or kill sea turtles and Atlantic sturgeon. In the Northeast Region (Maine through Virginia), formal ESA section 7 consultations have been conducted on the American lobster, Atlantic bluefish, Atlantic mackerel/squid/ butterfish, Atlantic sea scallop, monkfish, northeast multispecies, red crab, spiny dogfish, summer flounder/scup/black sea bass, and tilefish fisheries. These consultations have considered effects to loggerhead, green, Kemp's ridley and leatherback sea turtles. We have completed Biological Opinions on the operations of these fisheries. In each of these Opinions, we concluded that the ongoing action was likely to adversely affect but was not likely to jeopardize the continued existence of any sea turtle species. Each of these Opinions included an incidental take statement (ITS) exempting a certain amount of lethal and/or non-lethal take resulting from interactions with the fishery. These ITSs are summarized in the table below. Further, in each Opinion, we concluded that the potential for interactions (i.e., vessel strikes) between sea turtles and fishing vessels was extremely low and similarly that any effects to sea turtle prey and/or habitat would be insignificant and discountable. We have also determined that the Atlantic herring and surf clam/ocean quahog fisheries do not adversely affect any species of listed sea turtles.



NMFS' Southeast Regional Office has carried out formal ESA section 7 consultations for several FMPs with action areas that at least partially overlap with the NEAMAP action area. These include: coastal migratory pelagics, swordfish/tuna/shark/ billfish (highly migratory species), snapper/grouper, dolphin/wahoo, and the Southeast shrimp trawl fisheries. The ITSs provided with these Opinions are included in the table below.

In addition to these consultations, NMFS has conducted a formal consultation on the pelagic longline component of the Atlantic highly migratory species FMP. Portions of this fishery occur within the NEAMAP action area. In a June 1, 2004 Opinion, NMFS concluded that the ongoing action was likely to adversely affect but was not likely to jeopardize the continued existence of loggerhead, Kemp's ridley or green sea turtles but was likely to jeopardize the continued existence of leatherback sea turtles. This Opinion included a Reasonable and Prudent Alternative that when implemented would modify operations of the fishery in a way that would remove jeopardy. This fishery is currently operated in a manner that is consistent with the RPA.

The RPA included an ITS which is reflected in the table below. Unless specifically noted, all numbers denote an annual number of captures that may be lethal or non-lethal.

**Table 7.** Information on Fisheries Opinions conducted by NMFS NERO and SERO for federally managed fisheries that operate in the action area

| **FMP** | **Date of Most Recent Opinion** | **Loggerhead** | **Kemp's ridley** | **Green** | **Leatherback** |
|---|---|---|---|---|---|
| American lobster | August 3, 2012 | 1 | 0 | 0 | 5 |
| Atlantic bluefish | October 29, 2010 | 82 (34 lethal) | 4 | 5 | 4 |
| Monkfish | October 29, 2010 | 173 (70 lethal) | 4 | 5 | 4 |
| Multispecies | October 29, 2010 | 46 in trawls (21 lethal) | 4 | 5 | 4 |
| Skate | October 29, 2010 | 39 (17 lethal) | 4 | 5 | 4 |
| Spiny dogfish | October 29, 2010 | 2 | 4 | 5 | 4 |
| Mackerel/squid/butterfish | October 29, 2010 | 62 (25 lethal) | 2 | 2 | 2 |
| Summer flounder/scup/black sea bass | October 29, 2010 | 205 (85 lethal) | 4 | 5 | 6 |
| Shark fisheries as managed under the Consolidated HMS FMP | May 20, 2008 | 679 (349 lethal) every 3 years | 2 (1 lethal) every 3 years | 2 (1 lethal) every 3 years | 74 (47 lethal) every 3 years |
| Atlantic sea scallop | July 12, 2012 | 2012: 301 (195 lethal); 2013 and beyond: 301 (115 lethal) | 3 | 2 | 2 |
| Coastal migratory pelagic | August 13, 2007 | 33 every 3 years | 4 every 3 years | 14 every 3 years | 2 every 3 years |
| Pelagic longline under the HMS FMP (per the RPA) | June 1, 2004 | 1,905 (339 lethal) every 3 years | *105 (18 lethal) every 3 years | *105 (18 lethal) every 3 years | 1764 (252 lethal) every 3 years |

**combination of 105 (18 lethal) Kemp's ridley, green, hawksbill, or Olive ridley*

We are in the process of reinitiating consultations that consider fisheries actions that may affect Atlantic sturgeon. Sturgeon originating from the five DPSs considered in this consultation are known to be captured and killed in fisheries operated in the action area. At the time of this writing, no Opinions considering effects of federally authorized fisheries on any DPS of Atlantic sturgeon have been completed. As noted in the Status of the Species section above, the NEFSC prepared a bycatch estimate for Atlantic sturgeon captured in sink gillnet and otter trawl fisheries operated from Maine through Virginia. This estimate indicates that, based on data from 2006-2010, annually, an average of 3,118 Atlantic sturgeon are captured in these fisheries with 1,569 in sink gillnet and 1,548 in otter trawls. The mortality rate in sink gillnets is estimated at approximately 20% and the mortality rate in otter trawls is estimated at 5%. Based on this estimate, a total of 391 Atlantic sturgeon are estimated to be killed annually in these fisheries that are prosecuted in the action area. We are currently in the process of determining the effects of this annual loss to each of the DPSs. At this time, there is no bycatch estimate for fisheries that are regulated by NMFS SERO. Any of these fisheries that operate with sink gillnets or otter trawls are likely to interact with Atlantic sturgeon and be an additional source of mortality in the action area. Also, as noted above, NMFS SERO has reinitiated the consultation for shrimp trawling; consultation on the smooth dogfish fishery is also currently being conducted by SERO in coordination with NMFS HMS.

#### *6.1.4 Other Federally Authorized Actions*
We have completed several informal consultations on effects of in-water construction activities in the Chesapeake Bay permitted by the USACE. This includes several dock, pier and bank stabilization projects. No interactions with shortnose or Atlantic sturgeon have been reported in association with any of these projects.

We have also completed several informal consultations on effects of private dredging projects permitted by the USACE. All of the dredging was with a mechanical or cutterhead dredge. No interactions with shortnose or Atlantic sturgeon have been reported in association with any of these projects.

### 6.2 State or Private Actions in the Action Area

#### *6.2.1 State Authorized Fisheries*
Atlantic and shortnose sturgeon, and sea turtles may be vulnerable to capture, injury and mortality in fisheries occurring in state waters. The action area includes portions of Virginia state waters. Information on the number of sturgeon captured or killed in state fisheries is extremely limited and as such, efforts are currently underway to obtain more information on the numbers of sturgeon captured and killed in state water fisheries. We are currently working with the Atlantic States Marine Fisheries Commission (ASMFC) and the coastal states to assess the impacts of state authorized fisheries on sturgeon. We anticipate that some states are likely to apply for ESA section 10(a)(1)(B) Incidental Take Permits to cover their fisheries; however, to date, no applications have been submitted. Below, we discuss the different fisheries authorized by the states and any available information on interactions between these fisheries and sturgeon.

*American Eel*
American eel (*Anguilla rostrata*) is exploited in fresh, brackish and coastal waters from the southern tip of Greenland to northeastern South America. American eel fisheries are conducted primarily in tidal and inland waters. Eels are typically caught with hook and line or with eel traps and may also be caught with fyke nets. Sturgeon and sea turtles are not known to interact with the eel fishery.

*Atlantic croaker*
Atlantic croaker (*Micropogonias undulates*) occur in coastal waters from the Gulf of Maine to Argentina, and are one of the most abundant inshore bottom-dwelling fish along the U.S. Atlantic coast. Atlantic croaker are managed under an ASMFC ISFMP (including Amendment 1 in 2005 and Addendum 1 in 2010), but no specific management measures are required.

Recreational fisheries for Atlantic croaker are likely to use hook and line; commercial fisheries targeting croaker primarily use otter trawls. The average annual bycatch of loggerhead sea turtles in bottom otter trawl gear used in the Atlantic croaker fishery was estimated to be 70 loggerhead sea turtles (Warden 2011). Additional information on sea turtle interactions with gillnet gear, including gillnet gear used in the Atlantic croaker fishery, has also been recently published by Murray (2009a, 2009b). The average annual bycatch of loggerhead sea turtles in gillnet gear used in the Atlantic croaker fishery, based on VTR data from 2002-2006, was estimated to be 11 per year with a 95% CI of 3-20 (Murray 2009b). A quantitative assessment of the number of Atlantic sturgeon captured in the croaker fishery is not available. Mortality rates of Atlantic sturgeon in commercial trawls has been estimated at 5%. A review of the NEFOP database indicates that from 2006-2010, 60 Atlantic sturgeon (out of a total of 726 observed interactions) were captured during observed trips where the trip target was identified as croaker. This represents a minimum number of Atlantic sturgeon captured in the croaker fishery during this time period as it only considers observed trips for boats with federal permits only. We do not have an estimate of the number of interactions between sturgeon or sea turtles with the croaker fishery in the action area.

*Horseshoe crabs*
ASMFC manages horseshoe crabs through an Interstate Fisheries Management Plan that sets state quotas, and allows states to set closed seasons. Horseshoe crabs are present in Chesapeake Bay. Stein *et al.* (2004) examined bycatch of Atlantic sturgeon using the NMFS sea-sampling/observer database (1989-2000) and found that the bycatch rate for horseshoe crabs was very low, at 0.05%. Few Atlantic sturgeon are expected to be caught in the horeshoe crab fishery in the action area. Sea turtles are not known to be captured during horseshoe crab fishing.

*Striped bass*
Striped bass are managed by ASMFC through Amendment 6 to the Interstate FMP, which requires minimum sizes for the commercial and recreational fisheries, possession limits for the recreational fishery, and state quotas for the commercial fishery (ASMFC 2003). Under Addendum 2, the coastwide striped bass quota remains the same, at 70% of historical levels. Data from the Atlantic Coast Sturgeon Tagging Database (2000-2004) shows that the striped bass fishery accounted for 43% of Atlantic sturgeon recaptures; however, no information on the total number of Atlantic sturgeon caught by fishermen targeting striped bass or the mortality rate is available. No information on interactions between sea turtles and the striped bass fishery is available.

*Weakfish*
The weakfish fishery occurs in both state and federal waters but the majority of commercially and recreationally caught weakfish are caught in state waters (ASMFC 2002). The dominant commercial gears include gill nets, pound nets, haul seines, and trawls, with the majority of

landings occurring in the fall and winter months (ASMFC 2002). Fishing for weakfish occurs in Chesapeake Bay.

The average annual bycatch of loggerhead sea turtles in bottom otter trawl gear used in the weakfish fishery was estimated to be 1 loggerhead sea turtle (Warden 2011). Additional information on sea turtle interactions with gillnet gear, including gillnet gear used in the weakfish fishery, has also been recently published by Murray (2009a, 2009b). The average annual bycatch of loggerhead sea turtles in gillnet gear used in the weakfish fishery, based on VTR data from 2002-2006, was estimated to be one (1) per year with a 95% CI of 0-1 (Murray 2009b).

A quantitative assessment of the number of Atlantic sturgeon captured in the weakfish fishery is not available. A review of the NEFOP database indicates that from 2006-2010, 36 Atlantic sturgeon (out of a total of 726 observed interactions) were captured during observed trips where the trip target was identified as weakfish. This represents a minimum number of Atlantic sturgeon captured in the weakfish fishery during this time period as it only considers observed trips, and most inshore fisheries are not observed. An earlier review of bycatch rates and landings for the weakfish fishery reported that the weakfish-striped bass fishery had an Atlantic sturgeon bycatch rate of 16% from 1989-2000; the weakfish-Atlantic croaker fishery had an Atlantic sturgeon bycatch rate of 0.02%, and the weakfish fishery had an Atlantic sturgeon bycatch rate of 1.0% (ASSRT 2007).

*American lobster trap fishery*
An American lobster trap fishery also occurs in Chesapeake Bay. This fishery is managed under the ASMFC's ISFMP. This fishery has also been identified as a source of gear causing injuries to, and mortality of, loggerhead and leatherback sea turtles as a result of entanglement in vertical buoy lines of the pot/trap gear. Between 2002 and 2008, the lobster trap fishery in state waters was verified as the fishery involved in at least 27 leatherback entanglements in the Northeast Region. All entanglements involved the vertical line of the gear. These verified/confirmed entanglements occurred in Maine, Massachusetts, and Rhode Island state waters from June through October (Northeast Region STDN database). While no entanglements in lobster gear have been reported for Chesapeake Bay, the potential for future entanglement exists. Atlantic sturgeon are not known to interact with lobster trap gear.

*Poundnet Fishery*
This fishery is managed by the states, except for regulations NMFS issued under the authority of the ESA to protect sea turtles. Pound nets with large mesh and stringer leaders set in the Chesapeake Bay have been observed to lethally take turtles as a result of entanglement in the leader. Virginia sea turtle strandings during the spring are consistently high, and given the best available information, including observer reports, the nature and location of the turtle strandings, the type of fishing gear in the vicinity of the greatest number of strandings, and the known interactions between sea turtles and large mesh and stringer pound net leaders, pound nets were considered to be a likely contributor to high sea turtle strandings in 2001 (and likely every spring). NMFS conducted pound net monitoring during the spring of 2002 and 2003. This monitoring documented 23 sea turtles either entangled in or impinged on pound net leaders, 18 of which were in leaders with less than 12 inches (30.5 cm) stretched mesh. Nine animals were

found entangled in leaders, of which 7 were dead, and 14 animals were found impinged on leaders, of which one was dead. In this situation, impingement refers to a sea turtle being held against the leader by the current, apparently unable to release itself under its own ability.

In 2004 and 2005, NMFS implemented a coordinated research program with pound net industry participants and other interested parties to develop and test a modified pound net leader design with the goal of eliminating or reducing sea turtle interactions while retaining an acceptable level of fish catch. During the 2-year study, the modified leader was found effective in reducing sea turtle interactions as compared to the unmodified leader. The final results of the 2004 study found that out of eight turtles impinged on or entangled in pound net leaders, seven were in an unmodified leader. One leatherback turtle was found entangled in the vertical lines of a modified leader. In response to the leatherback entanglement, the gear was further modified by increasing the stiffness of the vertical lines for the 2005 experiment. In 2005, 15 turtles entangled in or impinged on the leaders of unmodified leaders, and no turtles were found entangled in or impinged on modified leaders. In addition, there have been documented interactions between pound nets and Atlantic sturgeon; however, neither an interaction rate or mortality rate is currently available.

*Whelk and blue crab fisheries*
A whelk fishery using pot/trap gear is known to occur in offshore Virginia. This fishery operates when sea turtles may be in the area. Sea turtles (loggerheads and Kemp's ridleys in particular) are believed to become entangled in the top bridle line of the whelk pot, given a few documented entanglements of loggerheads in whelk pots, the configuration of the gear, and the turtles' preference for the pot contents. Research is underway to determine the magnitude of these interactions and to develop gear modifications to reduce these potential entanglements. In New England waters, leatherbacks have been found entangled in whelk pot lines, so if leatherback turtles overlap with this gear in the action area, entanglement may occur. The blue crab fishery using pot/trap gear also occurs in the action area. The magnitude of interactions with these pots and sea turtles is unknown, but loggerheads and leatherbacks have been found entangled in this gear. For instance, in May and June 2002, three leatherbacks were documented entangled in crab pot gear in various areas of the Chesapeake Bay. Given the plethora of crab pot gear throughout the action area, it is possible that these interactions are more frequent than what has been documented. No interactions between Atlantic sturgeon and crab pot gear has been reported to NMFS.

## 6.3 Other Impacts of Human Activities in the Action Area

### *6.3.1 Contaminants and Water Quality*
Point source discharges (i.e., municipal wastewater, paper mill effluent, 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 of receiving waters, which may lead to mortality, changes in fish behavior, deformations, and reduced egg production and survival. Agriculture and forestry occur within the Chesapeake Bay watershed, which potentially results in an increase in the amount of suspended sediment present in the river. Concentrated amounts of suspended solids discharged into a river system

may lead to smothering of fish eggs and larvae and may result in a reduction in the amount of available dissolved oxygen.

Within the action area, sea turtles and optimal sea turtle habitat most likely have been impacted by pollution. 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, 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).

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. Furthermore, the Bay watershed is highly developed, which contributes to impaired water quality via stormwater runoff or point sources. The mainstem Chesapeake Bay has historically had low levels of chemical contamination (Chesapeake Bay Program Office 1999).

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).

Water quality issues have been reported in at least localized areas of the Chesapeake Bay since the advent of the use of industrial fertilizers in the 1830s. Pollution increased in the Bay through the 19th century as increasing amounts of land were cleared and as industrial use of the area surrounding the Bay increased. Declines in shellfish beds were first reported in 1900 and by the 1940s advancements in fishing technology lead to decreases in fish populations in the Bay. Excess pollution to the Bay continued through to the early 1970s when regulation first began with the passage of the Clean Water Act. Also in the early 1970s, decreases in Bay grasses were recorded and a significant portion of bay grasses were destroyed by Tropical Storm Agnes in 1972. The loss of native oysters throughout the second half of the 20th century, largely due to introduced disease, also affected water quality in the Bay. In 1983, the first comprehensive report of Bay water quality highlighted four areas of concern: an overabundance of nitrogen and phosphorous pollution; dwindling underwater bay grasses; toxic chemical pollution; and, over-harvesting of living resources.

Since 1983, significant efforts have been made to clean up the Chesapeake Bay. While the levels of toxins and industrial pollutants have decreased, leading to largely improved water quality conditions, the Chesapeake Bay still faces many problems and remains polluted. Despite small successes in certain areas, the overall health of the Chesapeake Bay remains degraded.

Excess nutrients, such as nitrogen and phosphorous are pollutants. Rain washes nutrients off streets, rooftops, lawns, farms and industrial sites into the streams and rivers that flow into the Bay. Nutrient pollution is the largest problem currently affecting the Chesapeake Bay. Excess nutrients cause rapid growth of algae blooms which cloud the water and reduce the amount of sunlight reaching the Bay's aquatic life. When the algae blooms die, oxygen is depleted as the algae decay. Nutrients and sediment flowing into the Bay have reduced oxygen levels below what is needed by much of the aquatic life in the Bay.

Although there were improvements in the some areas of the Bay's health in 2009, the ecosystem remains in poor condition. EPA ranked the overall health of the Bay an average of 45 percent based on goals for water quality, habitats, and lower food web, and fish and shellfish abundance. This was a 6 percent increase from 2008. According to EPA, the modest gain in the health score was due to a large increase in adult blue crab population, expansion of underwater grass beds growing in the Bay's shallows, and improvements in water clarity and bottom habitat health as highlighted below:

- 12 percent of the Bay and its tidal tributaries met Clean Water Act standards for dissolved oxygen between 2007-2009, a decrease of 5 percent from 2006-2008.
- 26 percent of the tidal waters met or exceeded guidelines for water clarity, a 12 percent increase from 2008.
- Underwater bay grasses covered 9,039 more acres of the Bay's shallow waters for a total of 85,899 acres, 46 percent of the Bay-wide goal.
- The health of the Bay's bottom dwelling species reach a record high of 56 percent of the goal, improving by approximately 15% Bay-wide.
- The adult blue crab population increased to 223 million, its highest level since 1993.



## 7.0 CLIMATE CHANGE

The discussion below presents background information on global climate change and information on past and predicted future effects of global climate change throughout the range of the listed species considered here. Additionally, we present the available information on predicted effects of climate change in the action area (i.e., the lower Chesapeake Bay) and how listed sea turtles and sturgeon may be affected by those predicted environmental changes over the life of the proposed action (i.e., between now and 2062). Climate change is relevant to the Status of the Species, Environmental Baseline and Cumulative Effects sections of this Opinion; rather than include partial discussion in several sections of this Opinion, we are synthesizing this information into one discussion. Consideration of effects of the proposed action in light of predicted changes in environmental conditions due to anticipated climate change are included in the Effects of the Action section below (section 8.0 below).

### 7.1 Background Information on Global climate change

The global mean temperature has risen 0.76ºC (1.36°F) over the last 150 years, and the linear trend over the last 50 years is nearly twice that for the last 100 years (Intergovernmental Panel on Climate Change (IPCC) 2007a) and precipitation has increased nationally by 5%-10%, mostly due to an increase in heavy downpours (NAST 2000). There is a high confidence, based on substantial new evidence, that observed changes in marine systems are associated with rising water temperatures, as well as related changes in ice cover, salinity, oxygen levels, and circulation. Ocean acidification resulting from massive amounts of carbon dioxide and other pollutants released into the air can have major adverse impacts on the calcium balance in the oceans. Changes to the marine ecosystem due to climate change include shifts in ranges and changes in algal, plankton, and fish abundance (IPCC 2007b); these trends are most apparent over the past few decades. Information on future impacts of climate change in the action area is discussed below.

Climate model projections exhibit a wide range of plausible scenarios for both temperature and precipitation over the next century. Both of the principal climate models used by the National Assessment Synthesis Team (NAST) project warming in the southeast by the 2090s, but at different rates (NAST 2000): the Canadian model scenario shows the southeast U.S. experiencing a high degree of warming, which translates into lower soil moisture as higher temperatures increase evaporation; the Hadley model scenario projects less warming and a significant increase in precipitation (about 20%). The scenarios examined, which assume no major interventions to reduce continued growth of world greenhouse gases (GHG), indicate that temperatures in the U.S. will rise by about 3°-5°C (5°-9°F) on average in the next 100 years which is more than the projected global increase (NAST 2000). A warming of about 0.2°C (0.4°F) per decade is projected for the next two decades over a range of emission scenarios (IPCC 2007). This temperature increase will very likely be associated with more extreme precipitation and faster evaporation of water, leading to greater frequency of both very wet and very dry conditions. Climate warming has resulted in increased precipitation, river discharge, and glacial and sea-ice melting (Greene *et al.* 2008).

The past three decades have witnessed major changes in ocean circulation patterns in the Arctic, and these were accompanied by climate associated changes as well (Greene *et al.* 2008). Shifts in atmospheric conditions have altered Arctic Ocean circulation patterns and the export of freshwater to the North Atlantic (Greene *et al.* 2008, IPCC 2006). With respect specifically to the North Atlantic Oscillation (NAO), changes in salinity and temperature are thought to be the result of changes in the earth's atmosphere caused by anthropogenic forces (IPCC 2006). The NAO impacts climate variability throughout the northern hemisphere (IPCC 2006). Data from the 1960s through the present show that the NAO index has increased from minimum values in the 1960s to strongly positive index values in the 1990s and somewhat declined since (IPCC 2006). This warming extends over 1000m (0.62 miles) deep and is deeper than anywhere in the world oceans and is particularly evident under the Gulf Stream/ North Atlantic Current system (IPCC 2006). On a global scale, large discharges of freshwater into the North Atlantic subarctic seas can lead to intense stratification of the upper water column and a disruption of North Atlantic Deepwater (NADW) formation (Greene *et al.* 2008, IPCC 2006). There is evidence that the NADW has already freshened significantly (IPCC 2006). This in turn can lead to a slowing down of the global ocean thermohaline (large-scale circulation in the ocean that transforms low-density upper ocean waters to higher density intermediate and deep waters and returns those waters back to the upper ocean), which can have climatic ramifications for the whole earth system (Greene *et al.* 2008).

While predictions are available regarding potential effects of climate change globally, it is more difficult to assess the potential effects of climate change over the next few decades on coastal and marine resources on smaller geographic scales, such as the Delaware River, especially as climate variability is a dominant factor in shaping coastal and marine systems. The effects of future change will vary greatly in diverse coastal regions for the U.S. Warming is very likely to continue in the U.S. over the next 25 to 50 years regardless of reduction in GHGs, due to emissions that have already occurred (NAST 2000). It is very likely that the magnitude and frequency of ecosystem changes will continue to increase in the next 25 to 50 years, and it is possible that the rate of change will accelerate. Climate change can cause or exacerbate direct stress on ecosystems through high temperatures, a reduction in water availability, and altered frequency of extreme events and severe storms. Water temperatures in streams and rivers are likely to increase as the climate warms and are very likely to have both direct and indirect effects on aquatic ecosystems. Changes in temperature will be most evident during low flow periods when they are of greatest concern (NAST 2000). In some marine and freshwater systems, shifts in geographic ranges and changes in algal, plankton, and fish abundance are associated with high confidence with rising water temperatures, as well as related changes in ice cover, salinity, oxygen levels and circulation (IPCC 2007).

A warmer and drier climate is expected to result in reductions in stream flows and increases in water temperatures. Expected consequences could be a decrease in the amount of dissolved oxygen in surface waters and an increase in the concentration of nutrients and toxic chemicals due to reduced flushing rate (Murdoch *et al.* 2000). Because many rivers are already under a great deal of stress due to excessive water withdrawal or land development, and this stress may be exacerbated by changes in climate, anticipating and planning adaptive strategies may be critical (Hulme 2005). A warmer-wetter climate could ameliorate poor water quality conditions in places where human-caused concentrations of nutrients and pollutants other than heat currently degrade water quality (Murdoch *et al.* 2000). Increases in water temperature and changes in seasonal patterns of runoff will very likely disturb fish habitat and affect recreational uses of lakes, streams, and wetlands. Surface water resources in the southeast are intensively managed with dams and channels and almost all are affected by human activities; in some systems water quality is either below recommended levels or nearly so. A global analysis of the potential effects of climate change on river basins indicates that due to changes in discharge and water stress, the area of large river basins in need of reactive or proactive management interventions in response to climate change will be much higher for basins impacted by dams than for basins with free-flowing rivers (Palmer *et al.* 2008). Human-induced disturbances also influence coastal and marine systems, often reducing the ability of the systems to adapt so that systems that might ordinarily be capable of responding to variability and change are less able to do so. Because stresses on water quality are associated with many activities, the impacts of the existing stresses are likely to be exacerbated by climate change. Within 50 years, river basins that are impacted by dams or by extensive development may experience greater changes in discharge and water stress than unimpacted, free-flowing rivers (Palmer *et al.* 2008).

While debated, researchers anticipate: 1) the frequency and intensity of droughts and floods will change across the nation; 2) a warming of about 0.2$^{o}$C (0.4°F) per decade; and 3) a rise in sea level (NAST 2000). A warmer and drier climate will reduce stream flows and increase water temperature resulting in a decrease of DO and an increase in the concentration of nutrients and toxic chemicals due to reduced flushing. Sea level is expected to continue rising: during the 20th century global sea level has increased 15 to 20 cm (6-8 inches).

## 7.2 Species Specific Information on Climate Change Effects

### *7.2.1 Loggerhead Sea Turtles*

The most recent Recovery Plan for loggerhead sea turtles as well as the 2009 Status Review Report identifies global climate change as a threat to loggerhead sea turtles. However, trying to assess the likely effects of climate change on loggerhead sea turtles is extremely difficult given the uncertainty in all climate change models and the difficulty in determining the likely rate of temperature increases and the scope and scale of any accompanying habitat effects. Additionally, no significant climate change-related impacts to loggerhead sea turtle populations have been observed to date. Over the long-term, climate change related impacts are expected to influence biological trajectories on a century scale (Parmesan and Yohe 2003). As noted in the 2009 Status Review (Conant *et al.* 2009), impacts from global climate change induced by human activities are likely to become more apparent in future years (IPCC 2007). Climate change related increasing temperatures, sea level rise, changes in ocean productivity, and increased frequency of storm events may affect loggerhead sea turtles.

Increasing temperatures are expected to result in increased polar melting and changes in precipitation which may lead to rising sea levels (Titus and Narayanan 1995 in Conant *et al.* 2009), which could result in increased erosion rates along nesting beaches. Sea level rise could result in the inundation of nesting sites and decrease available nesting habitat (Daniels *et al.* 1993; Fish *et al.* 2005; Baker *et al.* 2006). The BRT noted that the loss of habitat as a result of climate change could be accelerated due to a combination of other environmental and oceanographic changes such as an increase in the frequency of storms and/or changes in prevailing currents, both of which could lead to increased beach loss via erosion (Antonelis *et al.* 2006; Baker *et al.* 2006; both in Conant *et al.* 2009). Along developed coastlines, and especially in areas where erosion control structures have been constructed to limit shoreline movement, rising sea levels may cause severe effects on nesting females and their eggs as nesting females may deposit eggs seaward of the erosion control structures potentially subjecting them to repeated tidal inundation. However, if global temperatures increase and there is a range shift northwards, beaches not currently used for nesting may become available for loggerhead sea turtles, which may offset some loss of accessibility to beaches in the southern portions of the range.



Climate change has the potential to result in changes at nesting beaches that may affect loggerhead sex ratios. Loggerhead sea turtles exhibit temperature-dependent sex determination. Rapidly increasing global temperatures may result in warmer incubation temperatures and highly female-biased sex ratios (*e.g.*, Glen and Mrosovsky 2004; Hawkes *et al.* 2009); however, to the extent that nesting can occur at beaches further north where sand temperatures are not as warm, these effects may be partially offset. The BRT specifically identified climate change as a threat to loggerhead sea turtles in the neritic/oceanic zone where climate change may result in future trophic changes, thus impacting loggerhead prey abundance and/or distribution. In the threats matrix analysis, climate change was considered for oceanic juveniles and adults and eggs/hatchlings. The report states that for oceanic juveniles and adults, "although the effect of trophic level change from…climate change…is unknown it is believed to be very low." For eggs/hatchlings the report states that total mortality from anthropogenic causes, including sea level rise resulting from climate change, is believed to be low relative to the entire life stage. However, only limited data are available on past trends related to climate effects on loggerhead sea turtles; current scientific methods are not able to reliably predict the future magnitude of climate change, associated impacts, whether and to what extent some impacts will offset others, or the adaptive capacity of this species.

However, Van Houtan and Halley (2011) recently developed climate based models to investigate loggerhead nesting (considering juvenile recruitment and breeding remigration) in the North Pacific and Northwest Atlantic. These models found that climate conditions/oceanographic influences explain loggerhead nesting variability, with climate models alone explaining an average 60% (range 18%-88%) of the observed nesting changes over the past several decades. In terms of future nesting projections, modeled climate data show a future positive trend for Florida nesting, with increases through 2040 as a result of the Atlantic Multidecadal Oscillation signal.

### *7.2.2 Kemp's Ridley Sea Turtles*

The recovery plan for Kemp's ridley sea turtles (NMFS *et al.* 2011) identifies climate change as a threat; however, as with the other species discussed above, no significant climate change-related impacts to Kemp's ridley sea turtles have been observed to date. Atmospheric warming could cause habitat alteration which may change food resources such as crabs and other invertebrates. It may increase hurricane activity, leading to an increase in debris in nearshore and offshore waters, which may result in an increase in entanglement, ingestion, or drowning. In addition, increased hurricane activity may cause damage to nesting beaches or inundate nests with sea water. Atmospheric warming may change convergence zones, currents and other oceanographic features that are relevant to Kemp's ridleys, as well as change rain regimes and levels of nearshore runoff.

Considering that the Kemp's ridley has temperature-dependent sex determination (Wibbels 2003) and the vast majority of the nesting range is restricted to the State of Tamaulipas, Mexico, global warming could potentially shift population sex ratios towards females and thus change the reproductive ecology of this species. A female bias is presumed to increase egg production (assuming that the availability of males does not become a limiting factor) (Coyne and Landry 2007) and increase the rate of recovery; however, it is unknown at what point the percentage of males may become insufficient to facilitate maximum fertilization rates in a population. If males become a limiting factor in the reproductive ecology of the Kemp's ridley, then reproductive output in the population could decrease (Coyne 2000). Low numbers of males could also result in the loss of genetic diversity within a population; however, there is currently no evidence that this is a problem in the Kemp's ridley population (NMFS *et al.* 2011). Models (Davenport 1997, Hulin and Guillon 2007, Hawkes *et al.* 2007, all referenced in NMFS *et al.* 2011) predict very long-term reductions in fertility in sea turtles due to climate change, but due to the relatively long life cycle of sea turtles, reductions may not be seen until 30 to 50 years in the future.

Another potential impact from global climate change is sea level rise, which may result in increased beach erosion at nesting sites. Beach erosion may be accelerated due to a combination of other environmental and oceanographic changes such as an increase in the frequency of storms and/or changes in prevailing currents. In the case of the Kemp's ridley where most of the critical nesting beaches are undeveloped, beaches may shift landward and still be available for nesting. The Padre Island National Seashore (PAIS) shoreline is accreting, unlike much of the Texas coast, and with nesting increasing and the sand temperatures slightly cooler than at

Rancho Nuevo, PAIS could become an increasingly important source of males for the population.

### *7.2.3 Green Sea Turtles*

The five year status review for green sea turtles (NMFS and USFWS 2007d) notes that global climate change is affecting green sea turtles and is likely to continue to be a threat. There is an increasing female bias in the sex ratio of green turtle hatchlings. While this is partly attributable to imperfect egg hatchery practices, global climate change is also implicated as a likely cause. This is because warmer sand temperatures at nesting beaches are likely to result in the production of more female embryos. At least one nesting site, Ascension Island, has had an increase in mean sand temperature in recent years (Hays *et al.* 2003 in NMFS and USFWS 2007d). Climate change may also affect nesting beaches through sea level rise, which may reduce the availability of nesting habitat and increase the risk of nest inundation. Loss of appropriate nesting habitat may also be accelerated by a combination of other environmental and oceanographic changes, such as an increase in the frequency of storms and/or changes in prevailing currents, both of which could lead to increased beach loss via erosion. Oceanic changes related to rising water temperatures could result in changes in the abundance and distribution of the primary food sources of green sea turtles, which in turn could result in changes in behavior and distribution of this species. Seagrass habitats may suffer from decreased productivity and/or increased stress due to sea level rise, as well as salinity and temperature changes (Short and Neckles 1999; Duarte 2002).

As noted above, the increasing female bias in green sea turtle hatchlings is thought to be at least partially linked to increases in temperatures at nesting beaches. However, at this time, we do not know how much of this bias is due to hatchery practice and how much is due to increased sand temperature. Because we do not have information to predict the extent and rate to which sand temperatures at the nesting beaches used by green sea turtles may increase in the short-term future, we cannot predict the extent of any future bias. Also, we do not know to what extent to which green sea turtles may be able to cope with this change by selecting cooler areas of the beach or shifting their nesting distribution to other beaches at which increases in sand temperature may not be experienced.



### *7.2.4 Leatherback sea turtles*

Global climate change has been identified as a factor that may affect leatherback habitat and biology (NMFS and USFWS 2007b); however, no significant climate change related impacts to leatherback sea turtle populations have been observed to date. Over the long term, climate change related impacts will likely influence biological trajectories in the future on a century scale (Parmesan and Yohe 2003). Changes in marine systems associated with rising water temperatures, changes in ice cover, salinity, oxygen levels and circulation including shifts in ranges and changes in algal, plankton, and fish abundance could affect leatherback prey distribution and abundance. Climate change is expected to expand foraging habitats into higher latitude waters and some concern has been noted that increasing temperatures may increase the female:male sex ratio of hatchlings on some beaches (Morosovsky *et al.* 1984 and Hawkes *et al.* 2007 in NMFS and USFWS 2007b). However, due to the tendency of leatherbacks to have individual nest placement preferences and deposit some clutches in the cooler tide zone of beaches, the effects of long-term climate on sex ratios may be mitigated (Kamel and Mrosovsky 2004 in NMFS and USFWS 2007b).

Additional potential effects of climate change on leatherbacks include range expansion and changes in migration routes as increasing ocean temperatures shift range-limiting isotherms north (Robinson *et al.* 2008). Leatherbacks have expanded their range in the Atlantic north by 330 km in the last 17 years as warming has caused the northerly migration of the 15°C sea surface temperature (SST) isotherm, the lower limit of thermal tolerance for leatherbacks (McMahon and Hays 2006). Leatherbacks are speculated to be the best able to cope with climate change of all the sea turtle species due to their wide geographic distribution and relatively weak beach fidelity. Leatherback sea turtles may be most affected by any changes in the distribution of their primary jellyfish prey, which may affect leatherback distribution and foraging behavior (NMFS and USFWS 2007b). Jellyfish populations may increase due to ocean warming and other factors (Brodeur *et al.* 1999; Attrill *et al.* 2007; Richardson *et al.* 2009). However, any increase in jellyfish populations may or may not impact leatherbacks as there is no evidence that any leatherback populations are currently food-limited.



Increasing temperatures are expected to result in increased polar melting and changes in precipitation which may lead to rising sea levels (Titus and Narayanan 1995 in Conant *et al.* 2009), which could result in increased erosion rates along nesting beaches. Sea level rise could result in the inundation of nesting sites and decrease available nesting habitat (Fish *et al.* 2005). This effect would potentially be accelerated due to a combination of other environmental and oceanographic changes such as an increase in the frequency of storms and/or changes in prevailing currents. While there is a reasonable degree of certainty that climate change related effects will be experienced globally (*e.g.*, rising temperatures and changes in precipitation patterns), due to a lack of scientific data, the specific effects of climate change on this species are not quantifiable at this time (Hawkes *et al.* 2009).

### *7.2.5 Atlantic sturgeon*

Global climate change may affect all DPSs of Atlantic sturgeon in the future; however, effects of increased water temperature and decreased water availability are most likely to effect the South Atlantic and Carolina DPSs. Rising sea level may result in the salt wedge moving upstream in affected rivers. Atlantic sturgeon spawning occurs in fresh water reaches of rivers because early life stages have little to no tolerance for salinity. Similarly, juvenile Atlantic sturgeon have limited tolerance to salinity and remain in waters with little to no salinity. If the salt wedge moves further upstream, Atlantic sturgeon spawning and rearing habitat could be restricted. In river systems with dams or natural falls that are impassable by sturgeon, the extent that spawning or rearing may be shifted upstream to compensate for the shift in the movement of the saltwedge would be limited. While there is an indication that an increase in sea level rise would result in a shift in the location of the salt wedge, at this time there are no predictions on the timing or extent of any shifts that may occur; thus, it is not possible to predict any future loss in spawning or rearing habitat. However, in all river systems, spawning occurs miles upstream of the saltwedge. It is unlikely that shifts in the location of the saltwedge would eliminate freshwater spawning or rearing habitat. If habitat was severely restricted, productivity or survivability may decrease.

The increased rainfall predicted by some models in some areas may increase runoff and scour spawning areas and flooding events could cause temporary water quality issues. Rising temperatures predicted for all of the U.S. could exacerbate existing water quality problems with DO and temperature. While this occurs primarily in rivers in the southeast U.S. and the Chesapeake Bay, it may start to occur more commonly in the northern rivers. Atlantic sturgeon prefer water temperatures up to approximately 28°C (82.4°F); these temperatures are experienced naturally in some areas of rivers during the summer months. If river temperatures rise and temperatures above 28°C are experienced in larger areas, sturgeon may be excluded from some habitats.

Increased droughts (and water withdrawal for human use) predicted by some models in some areas may cause loss of habitat including loss of access to spawning habitat. Drought conditions in the spring may also expose eggs and larvae in rearing habitats. If a river becomes too shallow or flows become intermittent, all Atlantic sturgeon life stages, including adults, may become susceptible to strandings or habitat restriction. Low flow and drought conditions are also expected to cause additional water quality issues. Any of the conditions associated with climate change are likely to disrupt river ecology causing shifts in community structure and the type and abundance of prey. Additionally, cues for spawning migration and spawning could occur earlier in the season causing a mismatch in prey that are currently available to developing sturgeon in rearing habitat.

### 7.3 Effects of Climate Change in the Action Area

In 2008, the Chesapeake Bay Program's Scientific and Technical Advisory Committee (STAC) reviewed the current understanding of climate change impacts on the tidal Chesapeake Bay and identified critical knowledge gaps and research priorities (Pyke et al. 2008). The report notes that the Bay is sensitive to climate-related forcings of atmospheric CO2 concentration, sea level, temperature, precipitation, and storm frequency and intensity and that scientists have detected significant warming and sea-level-rise trends during the 20$^{th}$ century in the Chesapeake Bay. Climate change scenarios for CO2 emissions examined by STAC suggest that the region is likely to experience significant changes in climatic conditions throughout the 21$^{st}$ century including increases in CO2 concentrations, sea level rise of 0.7 to 1.6 meters, and water temperature increasing by up to 2° to 6°C. The STAC also indicated that other changes are likely, but less certain, including increases in precipitation quantity (particularly in winter and spring), precipitation intensity, intensity of tropical and extratropical cyclones (though their frequency may decrease), and sea-level variability. Changes in annual streamflow are highly uncertain, though winter and spring flows will likely increase. The report notes that changes in human activities over the next century have the potential to either exacerbate or ameliorate the predicted climatically induced changes. Given the uncertainty in precipitation and streamflow forecasts, the direction of some changes remains unknown; however, the report states that certain consequences appear likely including increasing sea level in the Bay: increasing variability in salinity due to increases in precipitation intensity, drought, and storminess; more frequent blooms of harmful algae due to warming and higher $CO_2$ concentrations; potential decreases in the prevalence of eelgrass; possible increases in hypoxia due to warming and greater winter-spring streamflow; and, altered interactions among trophic levels, potentially favoring warm-water fish and shellfish species in the Bay.

In 2010, EPA conducted a preliminary assessment of climate change impacts on the Chesapeake Bay using a version of the Phase 5 Bay Watershed Model and tools developed for EPA's BASINS 4 system including the Climate Assessment Tool. Flows and associated nutrient and sediment loads were assessed in all river basins of the Chesapeake Bay with three key climate change scenarios reflecting the range of potential changes in temperature and precipitation in the year 2030. The three key scenarios came from a larger set of 42 climate change scenarios that were evaluated from 7 Global Climate Models, 2 scenarios from the IPCC Special Report on Emissions Scenarios storylines, and 3 assumptions about precipitation intensity in the largest events. The 42 climate change scenarios were run on the Phase 5 Watershed Model of the Monocacy River watershed, a subbasin of the Potomac River basin in the Piedmont region, using a 2030 estimated land use based on a sophisticated land use model containing socioeconomic estimates of development throughout the watershed.

The results provide an indication of likely precipitation and flow patterns under future potential climate conditions (Linker et al. 2007, 2008). Projected temperature increases tend to increase evapotranspiration in the Bay watershed, effectively offsetting increases in precipitation. The preliminary analysis indicated overall decreases in annual stream flow as well as decreases in nitrogen and phosphorus loads. The higher intensity precipitation events yielded estimated increases in annual sediment loads.

Assuming that there is a linear trend in increasing water temperatures, and that a predicted 2-6°C increase in water temperature by 2100 for the Chesaepeake Bay would also be experienced in the action area, one could anticipate a 0.02-.07°C increase each year. Because the action considered here will be complete in 50 years, we expect an increase in temperature of no more than 3.5°C in the action area over the duration of the proposed action.

### 7.4 Effects of Climate Change in the Action Area to Atlantic sturgeon

As there is significant uncertainty in the rate and timing of change as well as the effect of any changes that may be experienced in the action area due to climate change, it is difficult to predict the impact of these changes on Atlantic sturgeon; however, we have considered the available information to consider likely impacts to sturgeon in the action area. The proposed action under consideration will take place through 2062; thus, we consider here, likely effects of climate change during that period.

Over time, the most likely effect to Atlantic sturgeon would be if sea level rise was great enough to consistently shift the salt wedge far enough north in a spawning river which would restrict the range of juvenile sturgeon and may affect the development of these life stages. However, there are no spawning rivers in the action area (the nearest is the James River, maintenance of which is not considered in this Opinion).

In the action area, it is possible that changing seasonal temperature regimes could result in changes in the timing of seasonal migrations through the area as sturgeon move throughout the area. There could be shifts in the timing of spawning. Presumably, if water temperatures warm earlier in the spring, because water temperature is a primary spawning cue, spawning migrations and spawning events could occur earlier in the year. However, because spawning is not triggered solely by water temperature, but also by day length (which would not be affected by climate change) and river flow (which could be affected by climate change), it is not possible to predict how any change in water temperature or river flow by itself will affect the seasonal movements of sturgeon through the action area. However, it seems most likely that spawning would shift earlier in the year.

Any forage species that are temperature dependent may also shift in distribution as water temperatures warm. However, because we do not know the adaptive capacity of these individuals or how much of a change in temperature would be necessary to cause a shift in distribution, it is not possible to predict how these changes may affect foraging sturgeon. If sturgeon distribution shifted along with prey distribution, it is likely that there would be minimal, if any, impact on the availability of food. Similarly, if sturgeon shifted to areas where different forage was available and sturgeon were able to obtain sufficient nutrition from that new source of forage, any effect would be minimal. The greatest potential for effect to forage resources would be if sturgeon shifted to an area or time where insufficient forage was available; however, the likelihood of this happening seems low because sturgeon feed on a wide variety of species and in a wide variety of habitats.

Limited information on the thermal tolerances of Atlantic sturgeon is available. Atlantic sturgeon have been observed in water temperatures above 30°C in the south (see Damon-Randall *et al.* 2010). In the laboratory, juvenile Atlantic sturgeon showed negative behavioral and bioenergetics responses (related to food consumption and metabolism) after prolonged exposure to temperatures greater than 28°C (82.4°F) (Niklitschek 2001). Tolerance to temperatures is thought to increase with age and body size (Ziegweid *et al.* 2008 and Jenkins *et al.* 1993), however, no information on the lethal thermal maximum or stressful temperatures for subadult or adult Atlantic sturgeon is available. Shortnose sturgeon, have been documented in the lab to experience mortality at temperatures of 33.7°C (92.66°F) or greater and are thought to experience stress at temperatures above 28°C. For purposes of considering thermal tolerances, we consider Atlantic sturgeon to be a reasonable surrogate for shortnose sturgeon given similar geographic distribution and known biological similarities.

Mean monthly ambient temperatures in the Chesapeake Bay range from 2-26°C[7]. As explained above, available predictions estimate an increase in ambient water temperature in the Bay of up to 3.5°C over the duration of the proposed action. This could result in shifts in the distribution of sturgeon out of certain areas during the warmer months. Information from southern river systems suggests that during peak summer heat, sturgeon are most likely to be found in deep water areas where temperatures are coolest. Thus, we could expect that over time, sturgeon would shift out of shallow habitats on the warmest days. This could result in reduced foraging opportunities if sturgeon were foraging in shallow waters; however if sufficient amounts of deep water habitat were available and suitable forage was present in those areas, there may be no negative impacts of this habitat shift. While some areas of the Chesapeake Bay are hypoxic during the summer months, this condition is not common in the action area; therefore, it is unlikely that the increase in surface temperature would result in an increase in hypoxic conditions in the action area.

As described above, over the long term, global climate change may affect Atlantic sturgeon by affecting the location of the salt wedge, distribution of prey, water temperature and water quality.

[7] Information obtained from www.nodc.noaa.gov/dsdt/cwtg/satl.html; last accessed 7-25-12.

However, there is significant uncertainty, due to a lack of scientific data, on the degree to which these effects may be experienced and the degree to which Atlantic sturgeon will be able to successfully adapt to any such changes. Any activities occurring within and outside the action area that contribute to global climate change are also expected to affect Atlantic sturgeon in the action area. While we can make some predictions on the likely effects of climate change on these species, without modeling and additional scientific data these predictions remain speculative. Additionally, these predictions do not take into account the adaptive capacity of these species which may allow them to deal with change better than predicted.

### 7.5 Effects of Climate Change in the Action Area on Sea Turtles

As there is significant uncertainty in the rate and timing of change as well as the effect of any changes that may be experienced in the action area due to climate change, it is difficult to predict the impact of these changes on sea turtles; however, we have considered the available information to consider likely impacts to these species in the action area.

Sea turtles are most likely to be affected by climate change due to increasing sand temperatures at nesting beaches which in turn would result in increased female: male sex ratio among hatchlings, sea level rise which could result in a reduction in available nesting beach habitat, increased risk of nest inundation, changes in the abundance and distribution of forage species which could result in changes in the foraging behavior and distribution of sea turtle species, and changes in water temperature which could possibly lead to a northward shift in their range.



Over the time period considered in this Opinion, sea surface temperatures are expected to rise up to 3.5°C in the Chesapeake Bay. It is unknown if that is enough of a change to contribute to shifts in the range or distribution of sea turtles. Theoretically, we expect that as waters in the action area warm, more sea turtles could be present or sea turtles could be present for longer periods of time. However, if temperature affected the distribution of sea turtle forage in a way that decreased forage in the action area, sea turtles may be less likely to occur in the action area. The nesting range of some sea turtle species may shift northward. Nesting in Virginia is relatively rare, but a small number of loggerhead nests are laid on Virginia Beach and other ocean facing beaches each year. The maximum number of nests laid in Virginia in a particular year was nine. As of the end of July 2012, seven loggerhead nests have been recorded and one Kemp's ridley nest (at Dam Neck); the first time a Kemp's ridley nest has ever been documented in Virginia and the furthest north this species has ever been documented to nest. It is important to consider that in order for nesting to be successful in the mid-Atlantic, fall and winter temperatures need to be warm enough to support the successful rearing of eggs and sea temperatures must be warm enough for hatchlings to survive when they enter the water. Predicted increases in water temperatures between now and 2062 are not great enough to allow successful rearing of sea turtle eggs in the action area or the survival of hatchlings that enter the water outside of the summer months. Therefore, it is unlikely that over the time period considered here, that there would be an increase in nesting activity in the action area or that hatchlings would be present in the action area.

We have considered whether the disposal of sand at Sandbridge Beach, Virginia Beach and Ft. Story would impact sea turtles. As noted above, there is the potential for a northward shift in nesting by sea turtles. Given existing nesting locations and the duration of time considered in this Opinion (50 years), it seems extremely unlikely that the range of leatherback or Kemp's ridley sea turtle nesting would shift enough so that nesting would occur on additional beaches in the Chesapeake Bay. The furthest north that leatherbacks nest is southeastern Florida. Kemp's ridleys only nest in Mexico. It is more likely that any shift in nesting to Chesapeake Bay beaches would be from loggerheads and/or green sea turtles (which normally nest as far north as North Carolina). The disposal of material at Sandbridge Beach, Virginia Beach and Ft. Story is meant to stabilize and restore eroding habitats and maintain existing beach. None of the activity is likely to reduce the suitability of these beaches for potential future nesting.

## 8.0 EFFECTS OF THE ACTION

This section of the 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). We have not identified any interdependent or interrelated actions. Because there is no critical habitat in the action area, there are no effects to critical habitat to consider in this Opinion.

This Opinion examines the likely effects (direct and indirect) of the proposed action on five DPSs of Atlantic sturgeon and four species of sea turtles and their habitat in the action area within the context of the species current status, the environmental baseline and cumulative effects. As explained in the Description of the Action, the action under consideration in this Opinion is the continued use of sand borrow areas for beach nourishment and hurricane protection as well as maintenance of federal navigation channels over the fifty-year life of these projects (i.e., through 2062). Additionally, we consider the effects of the use of dredged material disposal sites (onshore and offshore) as well as the CIEE.

The effects of dredging on listed species will be different depending on the type of dredge used. As such, the following discussion of effects of dredging will be organized by dredge type. Below, the discussion will consider the effects of dredging, including the risk of entrainment or capture of Atlantic sturgeon and sea turtles. We also consider effects of dredging and disposal on water quality, including turbidity/suspended sediment. Last, there is a discussion of other effects that are not specific to the type of equipment used. This includes effects on prey and foraging, changes in the characteristics of the dredged area and effects of dredge vessel traffic.

### 8.1 Hopper Dredge

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

A hopper dredge removes material from the bottom of the channel in relatively thin layers, usually 2-12 inches, depending upon the density and cohesiveness of the dredged material. Pumps located within the hull, but sometimes mounted on the drag arm, create a region of low pressure around the dragheads and force water and sediment up the drag arm and into the hopper. The more closely the draghead is maintained in contact with the sediment, the more efficient the dredging providing sufficient water is available to slurry the sediments (i.e. the greater the concentration of slurried sediment pumped into the hopper). Hopper dredges can efficiently dredge non-cohesive sands and more cohesive silts and low density clay. Draghead types may consist of IHC and California type dragheads.

California type dragheads sit flatter in the sediment than the IHC configuration which is more upright. Individual draghead designs (i.e. dimensions, structural reinforcing/configuration) vary between dredging contractors and hopper vessels. Port openings on the bottom of dragheads also vary between contractors and draghead design. Generally speaking the port geometry is typically rectangular or square with minimum openings of ten inch by ten inch or twelve inch by twelve inch or some rectangular variation.

Industry and government hopper dredges are equipped with various power and pump configurations and may differ in hopper capacity with different dredging capabilities. An engineering analysis of the known hydraulic characteristics of the pump and pipeline system on the USACE hopper dredge “Essayons” (i.e. a 6,423 cy hopper dredge) indicates an operational flow rate of forty cubic feet per second with a flow velocity of eleven feet per second at the draghead port openings. The estimated force exerted on a one-foot diameter turtle (i.e. one foot diameter disc shaped object) at the pump operational point in this system was estimated to be twenty-eight pounds of suction or drag force on the object at the port opening of the draghead.

Dredging is typically parallel to the centerline or axis of the channel. Under certain conditions, a waffle or crisscross pattern may be utilized to minimize trenching or during clean-up dredging operations to remove ridges and produce a more level channel bottom. This movement up and down the channel while dredging is called trailing and may be accomplished at speeds of 1-3 knots, depending on the shoaling, sediment characteristics, sea conditions, and numerous other factors. In the hopper, the slurry mixture of the sediment and water is managed by a weir system to settle out the dredged material solids and overflow the supernatant water. When an economic load is achieved, the vessel suspends dredging, the drag arms are raised, and the dredge travels to the designated placement site. Because dredging stops during the trip to the placement site, the overall efficiency of the hopper dredge is dependent on the distance between the dredging location and placement sites; the more distant to the placement site, the less efficient the dredging operation resulting in longer contract periods to accomplish the work.

Sea turtle deflectors utilized on hopper dredges are rigid V-shaped attachments on the front of the dragheads and are designed and intended to plow the sediment in front of the draghead. The plowing action creates a sand wave that rolls in front of the deflector. The propagated sand wave is intended to shed the turtle away from the deflector and out of the path of the draghead. The effectiveness of the rigid deflector design and its ability to reduce entrainment was studied by the USACE through model and field testing during the 1980s and early 1990s. The deflectors are most effective when operating on a uniform or flat bottom. However, the deflector effectiveness may be diminished when significant ridges and troughs are present that prevent the deflector from plowing and maintaining the sand wave and the dragheads from maintaining firm contact with the channel bottom.

### *8.1.1 Entrainment in Hopper Dredges – Sea Turtles*

As outlined above, sea turtles are likely to occur in Chesapeake Bay from April through mid-November each year with the largest numbers present from June through October of any year. The majority of sea turtles in the Chesapeake bay are juvenile loggerheads; however, adult loggerheads, juvenile Kemp's ridley, adult and juvenile leatherback and adult green sea turtles have also been documented in the area. The Chesapeake Bay is an important foraging area for sea turtles and an important developmental habitat for juvenile sea turtles, particularly loggerheads.

Loggerhead, Kemp's ridley and green sea turtles are vulnerable to entrainment in the draghead of the hopper dredge. Given their large size, leatherback sea turtles are not vulnerable to entrainment. As reported by USACE, no leatherback sea turtles have been entrained in hopper dredge operations operating along the U.S. Atlantic coast (USACE Sea Turtle Warehouse, 2012). 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 seasonally in the Bay.

Sea turtles become entrained in hopper dredges as the draghead moves along the bottom. Entrainment occurs when sea turtles do not or cannot escape from the suction of the dredge. Sea turtles can also be crushed on the bottom by the moving draghead. Mortality 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. Turtles can also 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 USACE 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. Increased risk of entrainment in these conditions may also be related to reduced effectiveness of the turtle deflector when operating on uneven terrain.

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. Since 1981, 77 loggerhead sea turtles have been taken by hopper dredge operations in the Port Canaveral Ship Channel, Florida. 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. Sea turtle brumation has not been documented in the Chesapeake Bay.

*8.1.1.1 Background Information on Entrainment of Sea Turtles in Hopper Dredges*

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 USACE South Atlantic Division (SAD; i.e., south of the Virginia/North Carolina border) are more common than in the USACE North Atlantic Division (NAD; Virginia-Maine) presumably due to the greater abundance of turtles in these waters and the greater frequency of hopper dredge operations. For example, in the USACE 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 USACE NAD began in 1994. Through May 2012, 74 sea turtles deaths (see Table 8) related to hopper dredge activities have been recorded in waters north of the North Carolina/Virginia border (USACE Sea Turtle Database[8]); 64 of these turtles have been entrained in dredges operating in Chesapeake Bay.

Before 1994, 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. 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 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.



Table 8. Sea Turtle Takes in USACE NAD Dredging Operations

| **Project Location** | **Year of Operation** | **Cubic Yardage Removed** | **Observed Takes** |
|---|---|---|---|
| Cape Henry Channel | 2012 | 1,190,004 | 1 loggerhead |
| York Spit | 2012 | 145,332 | 1 Loggerhead |
| Thimble Shoal Channel | 2009 | 473,900 | 3 Loggerheads |
| York Spit | 2007 | 608,000 | 1 Kemp's Ridley |
| Cape Henry | 2006 | 447,238 | 3 Loggerheads |

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

| | | | |
|---|---|---|---|
| Thimble Shoal Channel | 2006 | 300,000 | 1 loggerhead |
| Delaware Bay | 2005 | 50,000 | 2 Loggerheads |
| Thimble Shoal Channel | 2003 | 1,828,312 | 7 Loggerheads<br>1 Kemp's ridley<br>1 unknown |
| Cape Henry | 2002 | 1,407,814 | 6 Loggerheads<br>1 Kemp's ridley<br>1 green |
| VA Beach Hurricane Protection Project (Cape Henry) | 2002 | 1,407,814 | 1 Loggerhead |
| York Spit Channel | 2002 | 911,406 | 8 Loggerheads<br>1 Kemp's ridley |
| Cape Henry | 2001 | 1,641,140 | 2 loggerheads<br>1 Kemp's ridley |
| VA Beach Hurricane Protection Project (Thimble Shoals) | 2001 | 4,000,000 | 5 loggerheads<br>1 unknown |
| Thimble Shoal Channel | 2000 | 831,761 | 2 loggerheads<br>1 unknown |
| York River Entrance Channel | 1998 | 672,536 | 6 loggerheads |
| Atlantic Coast of NJ | 1997 | 1,000,000 | 1 Loggerhead |
| Thimble Shoal Channel | 1996 | 529,301 | 1 loggerhead |
| Delaware Bay | 1995 | 218,151 | 1 Loggerhead |
| Cape Henry | 1994 | 552,671 | 4 loggerheads<br>1 unknown |
| York Spit Channel | 1994 | 61,299 | 4 loggerheads |
| Delaware Bay | 1994 | NA | 1 Loggerhead |
| Cape May NJ | 1993 | NA | 1 Loggerhead |
| Off Ocean City MD | 1992 | 1,592,262 | 3 Loggerheads |
| | | | ***TOTAL = 74 Turtles*** |

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 (i.e., prior to 1995), 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 USACE 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 USACE 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 USACE'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.

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. 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 above in the examples of sea turtle takes. 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; in contrast, 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.

We have compiled a dataset representing all of the hopper dredge projects in the Norfolk District that have reported the cubic yardage removed as well as the number of takes observed. The table below includes records for all projects in the Norfolk District since 1994 and indicates the volume of material removed during “sea turtle season” (i.e., April - November).

**Table 9.** Projects in Norfolk District since 1994.

| Project Location | Dredging Dates | CY of Material Removed | % during sea turtle season | Volume Removed during turtle season | total sea turtles | log | KR | green | unknown |
|---|---|---|---|---|---|---|---|---|---|
| Cape Henry Channel | 1/29/12 - 4/12/12 | 1,190,004 | 0.162 | 192,780.65 | 1 | 1 | 0 | 0 | 0 |
| York Spit | 3/1/12 - 3/8/12, 4/3/12 - 4/5/2012 | 145,332 | 0.200 | 29,066.40 | 1 | 1 | 0 | 0 | 0 |
| Cape Henry Channel | 2/9/11- 5/10/11 | 957,996 | 0.444 | 425,350.22 | 0 | 0 | 0 | 0 | 0 |
| York Spit | 1/9/11- 4/24/11 | 1,503,517 | 0.153 | 230,038.10 | 0 | 0 | 0 | 0 | 0 |
| Thimble Shoals | 12/19/10- 2/27/11; 4/19/11- 4/21/11 | 368,104 | 0.000 | - | 0 | 0 | 0 | 0 | 0 |
| Thimble Shoals | 4/4/09- 5/20/09 | 370,412 | 1.000 | 370,412.00 | 3 | 3 | 0 | 0 | 0 |
| York Spit | 6/18/07- 7/03/07; 7/13/07- 08/05/07 | 415,626 | 1.000 | 415,626.00 | 1 | 0 | 1 | 0 | 0 |
| Atlantic Ocean Channel (Deepening) | 12/24/05- 04/8/06; 4/16/06- 4/19/06 | 1,185,436 | 0.109 | 129,212.52 | 0 | 0 | 0 | 0 | 0 |
| Cape Henry Channel | 6/15/06- 7/21/06 | 447,238 | 1.000 | 447,238.00 | 3 | 3 | 0 | 0 | 0 |
| Thimble Shoal | 6/13/06- | 419,624 | 1.000 | 419,624.00 | 1 | 1 | 0 | 0 | 0 |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Channel | 6/30/06; 7/10/06-7/27/06 | | | | | | | | |
| York Spit Channel | 04/01/04-04/06/04; 5/23/04-5/28/04 | 93,665 | 1.000 | 93,665.00 | 0 | 0 | 0 | 0 | 0 |
| Thimble Shoal Channel | 4/5/04-4/20/04; 4/30/04-5/01/04; 5/29/04-6/16/04 | 426,588 | 1.000 | 426,588.00 | 0 | 0 | 0 | 0 | 0 |
| York River Entrance Channel | 9/9/03-9/11/03; 10/17/03-11/30/03 | 268,641 | 1.000 | 268,641.00 | 0 | 0 | 0 | 0 | 0 |
| Sandbridge Beach | 05/1/03-5/25/03 | 1,500,000 | 1.000 | 1,500,000.00 | 0 | 0 | 0 | 0 | 0 |
| Thimble Shoal Channel (VA Beach) | 8/24/03-12/28/03 | 1,300,223 | 0.778 | 1,011,573.49 | 9 | 7 | 1 | 0 | 1 |
| Cape Henry Channel | 4/12/02-8/19/02; 10/21/02-11/02/02 | 2,449,285 | 1.000 | 2,449,285.00 | 8 | 6 | 1 | 1 | 0 |
| York Spit Channel | 8/20/02-10/21/02; 11/03/02-11/05/02 | 978,846 | 1.000 | 978,846.00 | 9 | 8 | 1 | 0 | 0 |
| Cape Henry Channel | 09/17/01-01/14/02 | 1,641,140 | 0.622 | 1,020,789.08 | 3 | 2 | 1 | 0 | 0 |
| VA Beach Hurricane | 6/26/01-11/30/01 | 4,000,000 | 1.000 | 4,000,000.00 | 6 | 5 | 0 | 0 | 1 |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Protection (Thimble Shoal Channel) | | | | | | | | | |
| Cape Henry Channel | 04/08/00-06/02/00 | 541,037 | 1.000 | 541,037.00 | 0 | 0 | 0 | 0 | 0 |
| Thimble Shoal Channel | 6/22/00-7/31/00; 8/13/00-9/19/00; 12/16/99-1/23/00 | 1,370,316 | 0.667 | 914,000.77 | 3 | 2 | 0 | 0 | 1 |
| Cape Henry Channel | 1/5/98-3/25/98 | 1,169,639 | 0.000 | - | 0 | 0 | 0 | 0 | 0 |
| York River Entrance Channel | 8/22/98-11/03/98 | 853,743 | 1.000 | 853,743.00 | 6 | 6 | 0 | 0 | 0 |
| York Spit Channel | 3/26/98-5/31/98 | 371,200 | 0.924 | 342,988.80 | 0 | 0 | 0 | 0 | 0 |
| Cape Henry Channel | 1/05/98-3/25/98 | 1,169,639 | 0.000 | - | 0 | 0 | 0 | 0 | 0 |
| Thimble Shoal Channel | 05/07/96-06/03/96 | 282,431 | 1.000 | 282,431.00 | 1 | 1 | 0 | 0 | 0 |
| Cape Henry Channel | 02/19/95-5/16/95 | 534,362 | 0.409 | 218,554.06 | | | | | |
| Cape Henry Channel | 4/11/94-5/12/94; 5/27/94-6/20/94 | 739,642 | 1.000 | 739,642.00 | 5 | 4 | 0 | 0 | 1 |
| York Spit Channel | 6/21/94-6/28/94 | 141,434 | 1.000 | 141,434.00 | 4 | 4 | 0 | 0 | 0 |
| | | | **TOTAL:** | **18,442,566** | ***64*** | **54** | **5** | **1** | **4** |



*8.1.1.2 Predicted Entrainment in Proposed Hopper Dredging*

Based on the data in Table 9, we calculate that an average of one sea turtle is entrained for approximately every 300,000 cy removed (18,442,566 CY removed April – November divided by 64 sea turtles). 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 April to November time frame. Based on these calculations, we expect that for any hopper dredging project in any of the channels or borrow areas considered in this Opinion during the time of year when sea turtles are likely to be present, one sea turtle is likely to be entrained for every 300,000 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.

Of the 64 entrained sea turtles, 60 have been identifiable to species; 54 were loggerheads, 5 Kemp's ridley and 1 green. Overall, of those identified to species, 90% were loggerheads, 8% Kemp's ridley and 2% green. 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 entrainment in Virginia dredging operations is a reflection of the low numbers of green sea turtles that occur in waters north of North Carolina.

Based on the above information, it is reasonable to expect that one sea turtle is likely to be injured or killed for approximately every 300,000 cy of material removed from the channels and borrow areas considered in this Opinion when dredging is carried out between April and November, and that 90% will be loggerheads, 8% will be Kemp's ridley and 2% will be green. Because sea turtles do not occur in the action area from December – March, we do not expect any entrainment during these months. 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), we anticipate the following levels of entrainment during hopper dredge activities:

| **Project** | **Total Volume over 50 years (cubic yards)** | **Number of Interactions over 50 years** | | | |
|---|---|---|---|---|---|
| | | **Total Sea Turtles** | **Loggerhead** | **Kemp's ridley** | **green** |
| Baltimore Harbor Entrance Channels | 64,500,000 | 215 | 194 | 17 | 4 |
| York River Entrance Channel | 6,500,000 | 22 | 20 | 2 | 0 |
| Hampton Roads (TS and AOC) | 50,300,000 | 168 | 151 | 13 | 3 |

| | | | | | |
|---|---|---|---|---|---|
| Virginia Beach Hurricane Project (TSS and AO borrow areas) | 4,400,000 | 15 | 13 | 1* | 1* |
| Sandbridge Shoal | 12,500,000 | 42 | 38 | 3 | 1 |
| | | **TOTAL:** | **415** | **37** | **10** |

*1 Kemp's ridley or green

*8.1.3 Hopper Dredge Entrainment – Atlantic Sturgeon*

Atlantic sturgeon are vulnerable to entrainment in hopper dredges. Entrainment is defined as the direct uptake of aquatic organisms by the suction field generated at the draghead. As explained above, since 1994, endangered species observers have been present for at least a portion of all hopper dredging done during the April – November time frame in the action area. Only two entrained Atlantic sturgeon have been documented during any hopper dredge activity in the action area, both in YSC in April 2011. Additionally, during sea turtle relocation trawling conducted in the fall of 2003 in conjunction with the 50-foot deepening of the inbound element of the Thimble Shoal Channel, 14 Atlantic sturgeon were captured by the trawler and released live in and around the channel; no incidental takes of Atlantic sturgeon by hopper dredge were observed during this period.

Entrainment of Atlantic sturgeon during hopper dredging operations in Federal navigation channels appears to be relatively rare. The USACE has documented a total of 35 incidents of sturgeon entrainment or capture of sturgeon species (all sturgeon species) on monitored projects for all types of dredge plant (mechanical, hydraulic pipeline, and hopper dredge). Twenty of the 35 documented observations were Atlantic sturgeon entrained by hopper dredge plants. A table presenting the observed sturgeon entrained or captured on monitored USACE projects between 1990 and March 2012 is presented as Appendix C. USACE-Norfolk District and Baltimore District hopper dredging projects have been monitored in the Chesapeake Bay from 1994 to present. During this period, observers have been present during the removal of more than 18 million cubic yards of dredged material from the channels considered in this consultation (see Table 9 above) with only two documented entrainments of Atlantic sturgeon.

Hydraulic dredges operate for prolonged periods underwater, with minimal disturbance, but generate continuous flow fields of suction forces while dredging. Entrainment is believed to occur primarily when the draghead is not in firm contact with the channel bottom, so the potential exist that sturgeon feeding or resting on or near the bottom may be vulnerable to entrainment. Additionally, the size and flow rates produced by the suction power of the dredge, the condition of the channel being dredged, and the method of operation of the dredge and draghead all relate to the potential of the dredge to entrain Atlantic sturgeon (Reine and Clarke, 1998). These parameters also govern the ability of the dredge to entrain other species of fish, sea turtles, and shellfish.

Inactive

Another factor influencing potential entrainment is based upon the swimming stamina and size of the individual fish at risk (Boysen and Hoover, 2009). Swimming stamina is positively correlated with total fish length. Entrainment of larger sturgeon is less likely due to the increased swimming performance and the relatively small size of the draghead opening. Juvenile entrainment is possible depending on the location of the dredging operations and the time of year in which the dredging occurs. Typically major concerns of juvenile entrainment relate to fish below 200 mm (Hoover et al., 2005; Boysen and Hoover, 2009). Juvenile sturgeon are not powerful swimmers and they are prone to bottom-holding behaviors, which make them vulnerable to entrainment when in close proximity to dragheads (Hoover et al., 2011).

On a hopper dredge, it is possible to monitor entrainment because the dredged material is retained on the vessels as opposed to the direct placement of dredged material both overboard or in confined disposal facilities by a hydraulic pipeline dredge. A hopper dredge contains screened inflow cages from which an observer can inspect recently dredged contents. Typically, the observer inspection is performed at the completion of each load while the vessel is transiting to the authorized placement area and does not impact production of the dredging operations.

In the fall of 2003, the Norfolk District captured fourteen Atlantic sturgeon during sea turtle relocation trawling activities supporting hopper dredging operations in Thimble Shoals Channel in the Chesapeake Bay. The Atlantic sturgeon were captured in the immediate vicinity of the dredging operation with no entrainment observed by NMFS approved observers onboard the hopper dredge before, during or after the relocation trawling where Atlantic sturgeon were captured.

Given the large size of adults (greater than 150cm) and the size of the openings on the dragheads, adult Atlantic sturgeon are unlikely to be vulnerable to entrainment. USACE reports that from 1990-2012, 37 confirmed interactions with sturgeon occurred during dredge operations (see Appendix C). Of these, 22 were reported as Atlantic sturgeon (20 individuals; two individuals were observed in 2 separate pieces), with 19 of these entrained in hopper dredges. Of the entrained Atlantic sturgeon for which size is available, all were subadults (larger than 50cm but less than 150cm). Information on these interactions is presented in Table 10. Most of these interactions occurred within rivers and harbors.



**Table 10. USACE Atlantic Sturgeon Entrainment Records from Hopper Dredge Operations 1990-2012**

| Project Location | Corps Division/District * | Month/Year Interaction Observed | Cubic Yards Removed | Observed** Entrainment |
|---|---|---|---|---|
| Winyah Bay, Georgetown (SC) | SAD/SAC | Oct-90 | 517,032 | 1 |
| Savannah Harbor (GA) | SAD/SAS | Jan-94 | 2,202,800 | 1 |
| Savannah Harbor | SAD/SAS | Dec-94 | 2,239,800 | 1 |
| Wilmington Harbor, Cape Fear River (NC) | SAD/SAW | Sep-98 | 196,400 | 1 |

| | | | | |
|---|---|---|---|---|
| Charleston Harbor (SC) | SAD/SAC | Mar-00 | 5,627,386 | 1 |
| Brunswick Harbor (GA) | SAD/SAS | 2-Feb | 1,459,630 | 1 |
| Charleston Harbor | SAD/SAC | 4-Jan | 1,449,234 | 1 |
| Brunswick Harbor | SAD/SAS | 5-Mar | 966,000 | 1 |
| Brunswick Harbor | SAD/SAS | 6-Dec | 1,198,571 | 1 |
| Savannah Entrance Channel | SAD/SAS | 7-Nov | 973,463 | 1 |
| Sandy Hook Channel (NJ) | NAD/NANY | 8-Aug | 23,500 | 1 |
| Savannah Entrance Channel | SAD/SAS | 9-Mar | 261,780 | 1 |
| Brunswick Entrance Channel | SAD/SAS | 10-Feb | 1,728,339 | 3 |
| Wilmington Harbor | SAD/SAW | 10-Dec | 857,726 | 1 |
| York Spit (VA) | NAD/NAN | 11-Apr | 1,630,713 | 2 |
| Charleston Harbor | SAD/SAC | 12-Mar | 1,100,000 | 1 |
| | | **Total** | **22,432,374** | **19** |

* SAD= South Atlantic Division; NAD= North Atlantic Division; SAC=Charleston District; SAS=Savannah District; SAW=Wilmington District; NANY=New York District; NAN=Norfolk District.



** Records based on sea turtle observer reports which record listed species entrained as well as all other organisms entrained during dredge operations.

In general, entrainment of large mobile animals, such as Atlantic sturgeon, is relatively rare. Several factors are thought to contribute to the likelihood of entrainment. In areas where animals are present in high density, the risk of an interaction is greater because more animals are exposed to the potential for entrainment. The risk of entrainment is likely to be higher in areas where the movements of animals are restricted (e.g., in narrow rivers or confined bays) where there is limited opportunity for animals to move away from the dredge than in unconfined areas such as wide rivers or open bays. The hopper dredge draghead operates on the bottom and is typically at least partially buried in the sediment. Sturgeon are benthic feeders and are often found at or near the bottom while foraging or while moving within rivers.

The only instances of observed Atlantic sturgeon entrainment in hopper dredges in the NMFS Northeast Region are two sturgeon entrained at York Spit, VA in 2011 (both were killed), one live Atlantic sturgeon entrained in Sandy Hook, NJ in 2008 and one dead Atlantic sturgeon entrained in Ambrose Channel, NY in 2012. As described in the discussion of sea turtles above, many other hopper dredge projects have occurred in NMFS Northeast Region; nearly all of which overlap with times and areas where Atlantic sturgeon are known to be present. Because observers have been present on these dredges and we expect that any interactions with Atlantic sturgeon would have been reported to us, the interaction rate between hopper dredges and Atlantic sturgeon seems to be very low (1 Atlantic sturgeon for every 9 mcy removed for the action area, just considering the volume of material removed when observers were present). Even just considering the projects listed in Table 10, where entrainment was recorded, we calculate an entrainment rate of one Atlantic sturgeon for approximately every 1.2 million cy of material removed. If we consider all projects in the action area where observers were present (see table 9) as well as projects outside the action area where interactions with Atlantic sturgeon were recorded (see table 10), we calculate an entrainment rate of 1 Atlantic sturgeon for every 2 mcy removed.

The entrainment estimate generated above using all projects in the Chesapeake Bay where observers have been present plus all projects in rivers and bays where entrained Atlantic sturgeon have been observed is an overestimate because it does not consider other projects outside the action area where no entrainment occurred. However, at this time, it is the best available estimate of entrainment rates for Atlantic sturgeon and hopper dredges. Just using the projects within the Chesapeake Bay (table 9) is likely to be an underestimate because there has only been observer coverage between April and November and Atlantic sturgeon may be present year round.

Based on the above information, we expect one Atlantic sturgeon to be entrained for approximately every two mcy of material removed with a hopper dredge. Given the size of adult Atlantic sturgeon (greater than 150cm) and the size of observed entrained sturgeon (less than 150cm), we do not anticipate the entrainment of any adult Atlantic sturgeon. Given the location of the channels and borrow areas to be dredged, only subadults and adults will be present; therefore, we anticipate that all entrained Atlantic sturgeon will be subadults less than 150cm in size.

There is evidence that some Atlantic sturgeon, particularly juveniles and small subadults, could be entrained in the dredge and survive. 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 Atlantic sturgeon entrained in the hopper dredge are likely to be killed. Based on the NEFOP mixed-stock analysis, we have determined that Atlantic sturgeon in the action area likely originate from the five DPSs at the following frequencies: NYB 49%; South Atlantic 20%; Chesapeake Bay 14%; Gulf of Maine 11%; and Carolina 4%; we anticipate that entrained Atlantic sturgeon will occur at similar frequencies.

**Table 11.** Expected Entrainment of Atlantic sturgeon in hopper dredges

| Project | Total Volume over 50 year period | Number of Interactions over 50 years | | | | | |
|---|---|---|---|---|---|---|---|
| | | **Total Atlantic sturgeon** | **NYB DPS** | **SA DPS** | **CB DPS** | **GOM DPS** | **Carolina DPS** |
| Baltimore Harbor Entrance Channels | 64,500,000 | 32 | 16 | 6 | 5 | 4 | 1 |
| York River Entrance Channel | 6,500,000 | 3 | 2 | 1* | 1* | 1* | 1* |
| Thimble Shoals and Atlantic Ocean Channel | 50,300,000 | 25 | 12 | 5 | 4 | 3 | 1 |
| Virginia Beach Hurricane Project (TSS and AO borrow areas) | 4,400,000 | 2 | 1 | 1* | 1* | 1* | 1* |
| Sandbridge Shoal | 12,500,000 | 6 | 3 | 1 | 1 | 1** | 1** |
| | | **Total:** | **34** | **14** | **10** | **8** | **3** |

*1 SA, CB, GOM or Carolina DPS Atlantic sturgeon
**1 GOM or Carolina DPS Atlantic sturgeon

### *8.1.4 Interactions with the Sediment Plume- Hopper Dredge*

Physical and biological impairments to the water column can occur from increases in turbidity which can alter light penetration. The proposed dredging will cause temporary increases in turbidity and suspension of sediments during dredging operations. As a result, the increase in turbidity can impact primary productivity and respiration of organisms within the project area. The re-suspension of sediments from dredging and dredged material placement can prevent or reduce gas-water exchanges in the gills of fish (Germano and Cary, 2005; Clarke and Wilber, 2000). The amount of impact that this can have on a species is dependent on the sensitivity of that species. This increase in turbidity can also impact prey species' predator avoidance response ability due to the decreased clarity in the water column.

Increased suspended sediment resulting from dredging can also reduce dissolved oxygen. Low dissolved oxygen conditions can be generated by the dredging operations from the resuspension of sediments and the biochemical oxygen demand of the surrounding water (Johnston, 1981). This can be particularly important during the summer months when water temperatures are warmer and less capable of holding dissolved oxygen. Dredging during the warmer months can exacerbate low dissolved oxygen conditions (Hatin et al., 2007*a*).

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 (USACE 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. In 2001, a study was done in the Delaware River 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.

Overall, water quality impacts are anticipated to be minor and temporary in nature. Once dredging operations are complete the project area will soon return to ambient conditions due to the dilution or re-deposition of suspended sediments along with the strong littoral currents of the Chesapeake Bay and Atlantic Ocean.

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 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 sturgeon most vulnerable to increased sediment are eggs and non-mobile larvae which are subject to burial and suffocation. As noted above, because of the distance of the projects from the spawning grounds, no Atlantic sturgeon eggs and/or larvae will be present in the action area. Any Atlantic sturgeon in the action area during dredging would be capable of avoiding any sediment plume by swimming around it. Laboratory studies (Niklitschek 2001 and Secor and Niklitschek 2001) have demonstrated shortnose and Atlantic 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 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 Atlantic sturgeon between foraging areas and/or concentration areas during any phase of dredging or otherwise negatively affect sturgeon in the action area.

## 8.2 Hydraulic Cutterhead Dredge

Hydraulic pipeline dredges tend to be more efficient than the hopper style dredges because the pipeline conveys sand directly to the placement site. However, hydraulic pipeline dredges are not well-adapted to work in environments with high wave energy. Most pipeline dredges have a cutterhead on the suction end. A cutterhead is a mechanical device that has rotating blades or teeth to break up or loosen the bottom material so that it can be sucked through the dredge. Some cutterheads are rugged enough to break up rock for removal. Pipeline dredges are mounted (fastened) to barges and are not usually self-powered, but are towed to the dredging site and secured in place by special anchor piling, called spuds. To move the dredge,the operator's raises and lowers opposite spuds to crab crawl the dredge along at a much slower pace than hopper style dredges and are subsequently less maneuverable. A hydraulic pipeline dredge removes material by controlling the dragline on which the suction cutterhead is attached. This style of dredge works more efficiently when it can move slowly and remove deeper materials as it moves along using the spuds. Material is directly mixed with water as it is sucked into the pipeline and hydraulically pumped and sent directly to the spoil disposal site. This makes this style dredge more efficient that a hopper style dredge that is required to move to a pump-out site to dispose of material. The suction is created by hydraulic pumps either located on board or in route along the pipeline acting as a booster and creates the same low pressure around the drag heads as a hopper dredge to force the material along the pipeline. As with the hopper style dredge, the more closely the cutterhead is maintained in contact with the sediment, the more efficient the dredging.

Sea turtles are not known to be vulnerable to entrainment in cutterhead dredges. This is thought to be due to the size of sea turtles and their swimming ability that allows them to escape the intake velocity near a cutterhead. There are no records of any sea turtles being entrained in cutterhead dredges in the Chesapeake Bay or anywhere else. Based on the available information, we do not anticipate any entrainment of sea turtles any time a cutterhead dredge is used.

### *8.2.1 Available Information on the Risk of Entrainment of Sturgeon in Cutterhead Dredge*

As noted above, a cutterhead dredge operates with the dredge head buried in the sediment; however, a flow field is produced by the suction of the operating dredge head. The amount of suction produced is dependent on linear flow rates inside the pipe and the pipe diameter (Clausner and Jones 2004). High flow rates and larger pipes create greater suction velocities and wider flow fields. The suction produced decreases exponentially with distance from the dredge head (Boysen and Hoover 2009). 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; rather, observers work at the disposal site to inspect material.

It is generally assumed that sturgeon are mobile enough to avoid the suction of an oncoming cutterhead dredge and that any sturgeon (with the exception of eggs and immobile larvae) 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 in the upper Delaware River. The dead sturgeon were found on the side of the spoil area into which the hydraulic pipeline dredge was pumping. An assessment of the condition of the fish indicated that the fish were likely 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 of the Delaware River 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: January 6, January 12, and January 13. Dredging was being conducted in the Kinkora and Florence ranges at this time which also overlaps with the shortnose sturgeon overwintering area. 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, USACE 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. Monitoring of dredge disposal areas used for deepening of the Delaware River with a cutterhead dredge has occurred. Dredging in Reach C occurred from March – August 2010 with 3,594,963 cy of material removed with a cutterhead dredge. Dredging in Reach B occurred in November and December 2011, with 1,100,000 cy of material removed with a cutterhead dredge. In both cases, the dredge disposal area was inspected daily for the presence of sturgeon. No sturgeon were detected.

In an attempt to understand the behavior of sturgeon while dredging is ongoing, the USACE worked with sturgeon researchers to track the movements of tagged Atlantic and shortnose sturgeon while cutterhead dredge operations were ongoing in Reach B (ERC 2011). The movements of acoustically tagged sturgeon were monitored using both passive and active methods. Passive monitoring was performed using 14 VEMCO VR2 and VR2W single-channel receivers, deployed through the study area. These receivers are part of a network that was established and cooperatively maintained by Environmental Research and Consulting, Inc. (ERC), Delaware State University (DSU), and the Delaware Department of Natural Resources and Environmental Control (DNREC). Nineteen tagged Atlantic sturgeon and three tagged shortnose sturgeon (all juveniles) were in the study area during the time dredging was ongoing. Eleven of the 19 juvenile Atlantic sturgeon detected during this study remained upriver of the dredging area and showed high fidelity to the Marcus Hook anchorage. Three of the juvenile sturgeon detected during this study (Atlantic sturgeons 13417, 1769; shortnose sturgeon 58626) appeared to have moved through Reach B when the dredge was working. The patterns and rates of movement of these fish indicated nothing to suggest that their behavior was affected by dredge operation. The other sturgeon that were detected in the lower portion of the study area either moved through the area before or after the dredging period (Atlantic sturgeons 2053, 2054), moved through Reach B when the dredge was shut down (Atlantic sturgeons 1774, 58628, 58629), or moved through the channel on the east side of Cherry Island Flats (shortnose sturgeon 2090, Atlantic sturgeon 2091) opposite the main navigation channel. It is unknown whether some of these fish chose behaviors (routes or timing of movement) that kept them from the immediate vicinity of the operating dredge. In the report, Brundage speculates that this could be to avoid the noisy area near the dredge but also states that on the other hand, the movements of the sturgeon reported here relative to dredge operation could simply have been coincidence.



A similar study was carried out in the James River (Virginia) (Cameron 2012). Dredging occurred with a cutterhead dredge between January 30 and February 19, 2009 with 166,545 cy of material removed over 417.6 hours of active dredge time. Six subadult Atlantic sturgeon (77.5 – 100 cm length) were caught, tagged with passive and active acoustic tags, and released at the dredge site. The study concluded that: tagged fish showed no signs of impeded up- or downriver movement due to the physical presence of the dredge; fish were actively tracked freely moving past the dredge during full production mode; fish showed no signs of avoidance response (e.g., due to noise generated by the dredge) as indicated by the amount of time spent in close proximity to the dredge after release (3.5 – 21.5 hours); and, tagged fish showed no evidence of attraction to the dredge.

Several scientific studies have been undertaken to understand the ability of sturgeon to avoid cutterhead dredges. Hoover *et al.* (2011) demonstrated the swimming performance of juvenile lake sturgeon and pallid sturgeon (12 – 17.3 cm FL) in laboratory evaluations. The authors compared swimming behaviors and abilities in water velocities ranging from 10 to 90 cm/second (0.33-3.0 feet per second). Based on the known intake velocities of several sizes of cutterhead dredges. At distances more than 1.5 meters from the dredges, water velocities were negligible (10 cm/s). The authors conclude that in order for a sturgeon to be entrained in a dredge, the fish would need to be almost on top of the drag head and be unaffected by associated disturbance (e.g., turbidity and noise). The authors also conclude that juvenile sturgeon are only at risk of entrainment in a cutterhead dredge if they are in close proximity, less than 1 meter, to the cutterhead.

Boysen and Hoover (2009) assessed the probability of entrainment of juvenile white sturgeon by evaluating swimming performance of young of the year fish (8-10 cm TL). The authors determined that within 1.0 meter of an operating dredge head, all fish would escape when the pipe was 61 cm (2 feet) or smaller. Fish larger than 9.3 cm (about 4 inches) would be able to avoid the intake when the pipe was as large as 66 cm (2.2 feet). The authors concluded that regardless of fish size or pipe size, fish are only at risk of entrainment within a radius of 1.5 – 2 meters of the dredge head; beyond that distance, velocities decrease to less than 1 foot per second.

Clarke (2011) reports that a cutterhead dredge with a suction pipe diameter of 36" (larger than the one to be used for this project) has an intake velocity of approximately 95 cm/s at a distance of 1 meter from the dredge head and that the velocity reduces to approximately 40cm/s at a distance of 1.5 meters, 25cm/s at a distance of 2.0 meters and less than 10cm/s at a distance of 3.0 meters. Clarke also reports on swim tunnel performance tests conducted on juvenile and subadult Atlantic, white and lake sturgeon. He concludes that there is a risk of sturgeon entrainment only within 1 meter of a cutterhead dredge head with a 36" pipe diameter and suction of 4.6m/second.



### *8.2.2 Predicted Entrainment of Atlantic sturgeon in a cutterhead dredge*

The risk of an individual 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 or ocean bottom in the immediate vicinity of the intake). None of the dredging is proposed in areas where Atlantic sturgeon are known to form aggregations. An individual would need to be in the immediate area where the dredge is operating to be entrained (i.e., within 1 meter of the dredge head). The overall risk of entrainment is low. It is likely that the nearly all Atlantic sturgeon in the action area will never encounter the dredge as they would not occur within 1 meter of the dredge. Information from the tracking studies in the James and Delaware river supports these assessments of risk, as none of the tagged sturgeon were attracted to or entrained in the operating dredges.

The entrainment of five sturgeon in the upper Delaware River indicates that entrainment of sturgeon in cutterhead dredges is possible. However, there are several factors that may increase the risk of entrainment in that area of the river as compared to the areas where cutterhead dredging will occur for the deepening. All five entrainments occurred during the winter months in an area where shortnose sturgeon are known to concentrate in dense aggregations; sturgeon in these aggregations rest on the bottom and exhibit little movement and may be slow to respond to stimuli such as an oncoming dredge. Additionally, the area where dredging was occurring is fairly narrow and constricted which may limit the ability of sturgeon to avoid the oncoming dredge. These conditions are not present in any of the areas where a cutterhead dredge will be used.

Because the only entrainment of Atlantic or shortnose sturgeon in cutterhead dredges in the United States has been the five shortnose sturgeon found at the disposal site in the upper Delaware River it is difficult to predict the number of Atlantic sturgeon that are likely to be entrained during cutterhead dredging in the action area. Based on the available information presented here, entrainment in a cutterhead dredge is likely to be rare, and would only occur if a sturgeon was within 1 meter of the dredge head. However, because we know that entrainment is possible, we expect that over the 50 year period considered here, some entrainment with a cutterhead dredge will occur. Based on the predicted rarity of the entrainment event, we expect that no more than one Atlantic sturgeon will be entrained each year that a cutterhead dredge is used for dredging in one of the channels discussed herein; this expected amount of entrainment is inclusive of the use of a cutterhead dredge in Norfolk Harbor and the CIEE expansion. Due to the suction, travel through up to several miles of pipe and any residency period in the disposal area, all entrained Atlantic sturgeon are expected to be killed.

Based on the mixed stock analysis, it is likely that the entrained Atlantic sturgeon will originate from the New York Bight DPS but could also originate from the Gulf of Maine, Chesapeake Bay or South Atlantic DPS. Given the mixed stock percentages presented above and an estimate of no more than one mortality per year, we expect the following mortality of Atlantic sturgeon in cutterhead dredges:

| **Number of Atlantic Sturgeon over 50 year Period** | **DPS** |
|---|---|
| 25 | New York Bight |
| 10 | South Atlantic |
| 8 | Chesapeake Bay |
| 5 | Gulf of Maine |
| 2 | Carolina |



### *8.2.3 Interactions with the Sediment Plume*

The increased turbidity and suspended sediments related to the dredging and placement activities are anticipated to have short term, temporary impacts to water quality. Placement of sand at the designated beach nourishment site will be via hydraulic pipeline. Sand will be deposited directly on the beach and graded to profile. Fine particles that may be present in the sand will be transported and dispersed in the swash zone.

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 USACE, 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).

The life stages of sturgeon most vulnerable to increased sediment are eggs and non-mobile larvae which are subject to burial and suffocation. As noted above, no sturgeon eggs and/or larvae will be present in the action area. Subadult and adult Atlantic sturgeon are frequently found in turbid water and would be capable of avoiding any sediment plume by swimming higher in the water column. All sturgeon in the action area would be sufficiently mobile to avoid any sediment plume. Therefore, any Atlantic sturgeon in the action area during dredging would be capable of avoiding any sediment plume by swimming around it.

### 8.3 Mechanical Dredge

Mechanical dredging will be used in association with CIEE and in some of the Norfolk Harbor Channels. Bucket dredges are relatively stationary. While operating, the dredge swings slowly in an arc across the channel cut as material is excavated. This is accomplished by pivoting the dredge on vertical pilings called spuds that are alternately raised and lowered from the stern corners of the dredge. Cables to anchors set roughly perpendicular to the forward section of the dredge are used to shift the lateral position of the digging area. Periodically, as the cut advances, the anchors are reset. Bucket dredging entails lowering the open bucket through the water column, closing the bucket after impact on the bottom, lifting the bucket up through the water column, and emptying the bucket into a barge. An environmental clamshell dredge differs from traditional dredging buckets by having an outer covering that seals when the bucket is closed. Water passes through its top moveable vents as it submerges, thereby reducing turbidity. Once it lifts off the bottom and closes, the covering seals over the bucket and minimizes overspill as the dredge bucket moves back up through the water column. Aquatic species can be captured in dredge buckets and may be injured or killed from entrapment in the bucket or burial in sediment during dredging and/or when sediment is deposited into the dredge scow. Fish captured and emptied out of the bucket could suffer stress or injury, which could also lead to mortality.

### *8.3.1 Impacts to Sea Turtles*
No sea turtles have been captured in mechanical dredges in the action area. The USACE has no records of any sea turtles being captured in mechanical dredges anywhere. As such, we do not anticipate any capture of sea turtles during any mechanical dredging considered here.

### *8.3.2 Capture of Atlantic sturgeon in the dredge bucket*
In rare occurrences 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; because of that we do not know if the lack of observations is a result of fish not being captured at other projects or that captures occur but are not observed. Captures of two shortnose and one Atlantic sturgeon have been documented at the Bath Iron Works (BIW) facility in the Kennebec River, Maine. It is unknown if these observations are the result of a unique situation in this river or whether interactions have occurred elsewhere but have just been undocumented. Observer coverage at dredging operations at BIW has been 100% for approximately 15 years and three observations of captured sturgeon have been documented. Dredging occurs every one to two years at this location. An Atlantic sturgeon was killed in the Cape Fear River in a bucket and barge operation (NMFS 1998).



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. For example, dredging in the BIW sinking basin prior to 2003 resulted in no interactions with shortnose sturgeon but one shortnose sturgeon was killed by the clamshell dredge in the last hour of the last day of dredging of a dredge event running from April 7 to April 30, 2003. An additional shortnose sturgeon was captured in this area in 2009, but none were captured between 2003 and 2009 or 2009-2011. Based on all available evidence, the risk of capture in a mechanical dredge is low due to the slow speed at which the bucket moves and the relatively small area of the bottom it interacts with at any one time. Atlantic sturgeon are highly mobile and it is anticipated that they will be able to avoid the dredge bucket in nearly all instances.

Based on the occurrence of Atlantic 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 sturgeon will be captured by mechanical dredges working at CIEE or the Norfolk Harbor channels. Due to the relatively low level of risk that an individual Atlantic sturgeon would be captured in the slow moving dredge bucket, no more than one Atlantic sturgeon is likely to be captured during dredging at CIEE and no more than one during dredging in the Norfolk Harbor channels.

Atlantic sturgeon captured in the 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 (in 2003 and 2009), one Atlantic (in 2001)), one of the shortnose sturgeon was killed. This fish was killed during the last hour of a 24-hour a day dredging operation that had been ongoing for approximately four weeks. This fish suffered from a large laceration, likely experienced due to contact with the dredge bucket. Of the other two fish, both were observed alive in the dredge scow and were released, with no visible external injuries. Assuming that the risk of mortality once captured is similar across dredging projects, we expect a similar mortality in the action area as has been observed at BIW. Therefore, we expect no more than one of the two captured Atlantic sturgeon to be injured or killed during dredging operations. Injury or mortality could result from contact with the dredge bucket or through suffocation due to burial in the scow. The dead Atlantic sturgeon could originate from any of the five DPSs.

### 8.4 On Shore Dredged Material Disposal

We have considered whether the disposal of sand at Sandbridge Beach, Virginia Beach and Ft. Story would impact sea turtles. Limited loggerhead sea turtle nesting (less than 10 nests per year) occurs on Virginia Beach; no nesting is known to occur on Sandbridge Beach or at Ft. Story. However, as noted above, there is the potential for a northward shift in nesting by sea turtles. The disposal of material at these beaches is meant to stabilize and restoring eroding habitats and maintain existing beach. None of the activity is likely to reduce the suitability of these beaches for potential future nesting.

As indicated above, all material removed by cutterhead dredge will be disposed of at a beach location. When a cutterhead dredge is used, the material is piped directly from the intake to an onshore 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 ocean bottom. While the presence of the pipe will cause a small amount of benthic habitat to be unavailable to sturgeon and sea turtles, the extremely small area affected will cause any effects to be insignificant and discountable. 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 (USACE 1983). For this project, the USACE has reported that because the dredged material is clean sand, the material will settle out within minutes and any sediment plume will be localized and temporary. Any sea turtles or sturgeon in the vicinity of the beach disposal sites during disposal may temporarily avoid the disposal area; however, as any effects to movements will be small and temporary, these effects will be insignificant. Similar effects of suspended sediment and turbidity will be experienced at the ocean disposal sites; as such, effects to sturgeon and sea turtles will be insignificant and discountable. Effects of disposal on prey resources are considered in section 7.5.

## 8.5 Use of Offshore/Ocean Dredged Material Disposal Sites

The use of offshore dredged material disposal sites can affect sea turtles and sturgeon by: exposing them to increased levels of turbidity and suspended sediments; increasing the potential for exposure to contaminants; affecting benthic resources; and, increasing vessel traffic in the area. Vessel traffic is discussed in Section 8.8. Other impacts are discussed here.

### *8.5.1 Turbidity and Suspended Sediments*

Dredged material placement operations at the ocean disposal sites are anticipated to have localized and temporary impacts to water quality. Dredged material designated for placement at these sites will be transported to the ocean placement site via bottom dump scow or split hull barges. Upon release from the barge, dredged material will enter the water column as a dense fluid plume, which will descend vertically. The dense fluid plume will descend to the bottom at a high velocity, leaving behind a low-density turbidity cloud, which will contain a small amount of total solids and settle within a few hours (USACE, 2010a). This temporary increase in turbidity in the water column when dredged material is released will cause short-term impacts that may include lower levels of dissolved oxygen for a few hours following material placement at the immediate site. In the BAs, USACE notes that dredged material placement at the ocean disposal sites will have temporary and localized impacts to water quality but will meet applicable marine water quality criteria and the limiting permissible concentration for the liquid phase and suspended phase dredged material (USACE, 2010).

During the discharge of sediment at offshore disposal sites, suspended sediment levels have been reported as high as 500.0 mg/l within 250 feet of the disposal vessel and decreasing to background levels (i.e., 15.0-100.0 mg/l depending on location and sea conditions) within 1,000-6,500 feet (USACE 1983). Total suspended solids near the center of the dredged material placement plume body have been observed to reach near background levels in 35 to 45 minutes (Battele 1994 in USACE and USEPA 2009).

TSS is most likely to affect sea turtles and Atlantic sturgeon if a plume causes a barrier to normal behaviors or if sediment settles on the bottom and affects benthic prey. As sea turtles and Atlantic sturgeon are highly mobile, individuals are likely to be able to avoid any sediment plume that is present and any effect on their movements or behavior is likely to be insignificant due to the small, temporary disruption of normal movements that may result from avoiding the sediment plume.

### *8.5.2 Contaminants*

In order to be eligible for ocean disposal, material must meet stringent criteria as required by the Clean Water Act and Section 103 of the Marine Protection, Research, and Sanctuaries Act of 1972 (as described in the EPA/USACE joint testing guidelines, available at http://water.epa.gov/type/oceb/oceandumping/dredgedmaterial/upload/gbook.pdf; last accessed May 10, 2012). By law and regulation, the significant adverse effects of dredged material disposal activities must be contained within the designated or selected disposal site and even those impacts must not degrade the area's overall ecological health. All dredged material disposal sites, including the ones considered here, are required to have and are managed under a dredged material monitoring and management plan that assesses the health and well-being of the site and surrounding environment. Monitoring of the disposal site is a part of this plan, which is designed to ensure that any degradation of resources or alteration in seafloor characteristics are identified and results in actions by permitting agencies (USEPA 2004).

The testing of dredged material is overseen by EPA and the USACE. Sediments are tested for possible contamination prior to any planned dredging to ensure that proposed dredging and the dredge material disposal are conducted in a way that minimizes the potential pathways for contaminant exposure. EPA and the USACE have jointly developed comprehensive testing procedures, which may include physical, chemical and biological tests, to evaluate dredged material placed into ocean waters.

Laboratory and evaluation methods that apply to dredged material proposed for ocean disposal in accordance with the Marine Protection, Research and Sanctuaries Act (MPRSA) are published in the 1991 USEPA/USACE guidance document entitled "Ecological Evaluation for Dredged Material Proposed for Ocean Disposal in the Marine Environment." An overview of the Dredged Material Testing Framework is contained in EPA's Ocean Dumping Program Update (1996). As described by EPA, "the acute toxicity of a sediment is determined by quantifying the mortality of appropriately sensitive organisms that are put into contact with the sediment, under either field or laboratory conditions, for a specified period." Also, bioacummulation is described as, "the accumulation of contaminants in the tissues of organisms through any route, including respiration, ingestion, or direct contact with contaminated sediment or water" (EPA 1996). The regulations require that bioaccumulation be considered as part of the environmental evaluation of dredged material proposed for ocean dumping. This consideration involves predicting whether there will be a cause-and-effect relationship between an animal's presence in the area influenced by the dredged material and an environmentally important elevation of its tissue content or body burden of contaminants above that in similar animals not influenced by the disposal of the dredged material."



In order for the dredged material to be disposed of at an in-water disposal site, it must be tested in accordance with the USACE and EPA procedures for suitability. Material that can be disposed of at the disposal site cannot be acutely toxic to any aquatic species. Further, the material must not present a risk of bioaccumulation; that is, even if it is not acutely toxic, it must not increase the potential for bioaccumulation of toxins in higher trophic level species that may prey upon benthic organisms present at the disposal site. In the BAs, USACE reports that water column bioassay testing of dredged material from the areas considered in this Opinion, using sensitive benchmark water column species were conducted in accordance with Section 103 of the Marine Protection, Research, and Sanctuary Act (MPRSA). Test results have shown that the discharge of dredged material at designated placement sites complies with the limiting permissible concentration (LPC) defined in Section 103 of the MPRSA and is not acutely toxic to sensitive benchmark organisms and no unacceptable adverse effects were observed from the liquid phase or liquid and particulate phase of the dredged material. The high flushing rate (due to the water exchange and tidal fluctuations) of the Chesapeake Bay and Atlantic Ocean is anticipated to minimize potential dredging plumes and cause them to be more quickly dispersed, minimizing long term impacts to water quality.

For purposes of this consultation, we consider that sediment that is suitable for ocean disposal would not be toxic to marine life and would not be likely to cause adverse effects to sea turtles, Atlantic sturgeon or their prey. Because the material to be disposed will be tested to ensure it is not acutely toxic and will not increase the risk of bioaccumulation of toxins or contaminants in any marine species, effects to sea turtles and Atlantic sturgeon will be insignificant and discountable.

### *8.5.3 Effects to the Benthic Environment*

Disposal operations can also affect foraging animals by burying benthic prey. Direct impacts to fish or other mobile species during placement of the dredged material would be expected to be minimal due to the small contact footprint of the fluidized sediments as they leave the barge (typically 50 foot by 100 foot). Given the small area impacted by each disposal event, mobile species are expected to be able to avoid the falling sediment and would not be subject to burial. The only species that are likely to be buried are immobile benthic organisms. Sea grasses and macroalgae that green sea turtles forage on are not present at the dispsosal sites. The species that leatherback sea turtles forage on are mobile and not likely to be vulnerable to burial. Some species of mollusks and gastropods that loggerheads and Atlantic sturgeon feed on have limited mobility and could be buried during disposal operations.

The loss of potential benthic prey species would be minimized spatially and temporally through use of a grid system for the placement of dredged material. Some buried animals will be able to unbury themselves. Areas where dredged material will be placed are expected to be recolonized by individuals from nearby similar habitats. Because the characteristics of the sediment from the project would be similar to those in and around the disposal sites, benthic invertebrates would be expected to quickly recolonize the cells used for the placement of this material. Thus, any reduction in benthic prey at the disposal site will be temporary and limited to the small area where dredged material will be placed. Green and leatherback sea turtles will not have any reduction in prey. The potential loss of prey for loggerhead and Kemp's ridley sea turtles will be extremely small, as only a fraction of the benthic species that loggerheads and Kemp's ridleys prey on will be affected, and those losses will occur in a very small area. Effects to foraging loggerhead and Kemp's ridley sea turtles will be insignificant.

The temporary localized increase in sediment loading within the water column at the dredging and placement area (NODS) has the potential to directly impact demersal species, such as the Atlantic sturgeon. Deposition of suspended sediments may induce impacts to demersal eggs and larvae through deposition and or smothering, especially in the dredging and placement areas (Johnston, 1981). There are no anticipated impacts to Atlantic sturgeon eggs and/or larvae because the project site and placement site are not located within known spawning grounds of the sturgeon and consist of soft marine clay substrate in marine waters. Although other demersal species may be impacted initially, long-term impacts are not anticipated after dredging operations cease. The high flushing rate, small area of impact during actual dredging will minimize water quality impacts to non-motile demersal organisms.

Some of the more common impacts to fish and their habitats include destruction of benthic communities, loss of prey species, and temporary impacts to water quality. As referenced in the Essential Fish Habitat Assessment for Gloucester Harbor, Massachusetts (Maguire Group Inc. 2001), the extent of the impact depends on hydrologic processes, sediment texture and composition, chemical content of the sediment and pore water matrices, and the behavior or life stages of the species. The new work dredging and fill activities may have minor affect the sturgeon through temporary and local impacts to water quality, including potential decreases in dissolved oxygen concentrations and minimal and localized increases in turbidity and sediment loads.

## 8.6 Craney Island Eastward Expansion

Dredged material removal and fill activities at the CIEE project site will permanently convert approximately 522-acres of subaqueous benthic habitat in the footprint of the containment cell to uplands. As reported in the BA, an assessment of the benthic habitat conducted for the project using the Benthic Index of Biotic Integrity (B-IBI) indicates much of the existing benthic habitat within the project site is degraded (USACE, 2006a). The proposed activities will temporarily disrupt the benthic community processes in the access channel and wharf dredging areas and permanently effect benthic processes in the footprint of the containment cell and marine terminal. New work dredging and fill activities will result in the permanent loss of the benthic community in the footprint of the new containment cell and result in a conversion of shallow water benthic habitat to a deep-water benthic habitat with similar sediment characteristics (access channels and wharf access area) potentially altering the benthic species composition at the site based on bathymetry preferences. Future maintenance dredging events in the access channels and wharf access area will temporarily and locally disrupt the benthic community through removal of shoaled material and result in periodic re-colonization of the channel and wharf area. Here, we consider the permanent loss of the benthic substrate. Other effects of the CIEE (dredging, turbidity, etc.) are considered in other sections of this Opinion.

As noted in Section 2.6, we previously determined that the CIEE was not likely to adversely affect listed sea turtles. Green sea turtles feed primarily on seagrasses (Bjorndal 1997) while loggerhead and Kemp's ridleys feed primarily on crustaceans and mollusks. The USACE has indicated that there is a total absence of submerged aquatic vegetation (SAV) at the site of the proposed expansion. The lack of SAV eliminates the potential for this site to be used by foraging green sea turtles. Kemp's ridley's also typically forage near SAV beds (Musick and Limpus 1997). The USACE has also indicated that sampling at the proposed expansion site has demonstrated that the presence of crustaceans and mollusks is rare. As such, this area is not likely to be used by foraging loggerhead and Kemp's ridleys. Leatherbacks are unlikely to be present in the near shore waters of the CIEE. Given the degraded nature of this habitat, the loss of benthic habitat that will result from the conversion to uplands, will be insignificant to listed sea turtles.

Atlantic sturgeon are likely to forage nearly anywhere where suitable benthic resources are present. However, given the nature of the habitats in the CIEE area (i.e., no SAV, degraded benthic communities), it is unlikely that this area is used by foraging Atlantic sturgeon. As such, the loss of future benthic foraging opportunities that will result from the conversion of this habitat to uplands, will be insignificant.

## 8.7 Effects on Benthic Resources and Foraging

### *8.7.1 Effects to Sea Turtles*

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 action area 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.

Of the listed species found in the action area, loggerhead and Kemp's ridley sea turtles 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) As noted above, suitable sea turtle forage items occur in some of the areas to be dredged. As preferred sea turtle and sturgeon foraging items are present and depths are suitable for use by sea turtles, 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, there is likely to be some entrainment of sea turtle prey items.

Previous studies in the upper Chesapeake Bay have demonstrated rapid recovery and resettlement by benthic biota and similar biomass and species diversity to pre-dredging conditions (Johnston, 1981; Diaz, 1994). Similar studies in the lower portions of the Chesapeake Bay produced rapid resettlement of dredging and placement areas by infauna (Sherk, 1972). McCauley et al. (1977) observed that while infauna populations declined significantly after dredging, infauna at dredging and placement areas recovered to pre-dredging conditions within 28 and 14 days, respectively. Therefore, the direct and indirect impacts to benthic communities are anticipated to be minimal. Rapid recovery and resettlement of benthic species is expected.

Based on this analysis, while there will be a small reduction in sea turtle prey due to dredging, these effects will be insignificant to foraging loggerhead and Kemp's ridley sea turtles. No effects to the prey base of green or leatherback sea turtles are anticipated.

### *8.7.2 Effects to Atlantic sturgeon*

Atlantic sturgeon feed on a variety of benthic invertebrates. The proposed dredging is likely to entrain and kill at least some of these potential forage items. Given the limited mobility of most benthic invertebrates that sturgeon feed on, most are unlikely to be able to actively avoid the dredge. As noted above, recovery of the benthic community is expected to be rapid. Also as explained above for sea turtles, the area dredged in any particular year is a very small percentage of the available foraging habitat in the action area. Because effects to benthic prey will be limited to the area immediately surrounding the dredged area, the potential for disruption in foraging is low.

### 8.8 Dredge and Disposal Vessel Traffic

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. Sea turtles have been documented with injuries consistent with vessel interactions. 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 the potential risk for interaction with vessels. The addition of one to two slow moving vessels in the action area have an insignificant effect on the risk of interactions between sea turtles and vessels in the action area.

Information regarding the risk of vessel strikes to Atlantic sturgeon is discussed in the Status of the Species and Environmental Baseline sections above. As explained there, we have limited information on vessel strikes and many variables likely affect the potential for vessel strikes in a given area. Assuming that the risk of vessel strike increases with an increase in vessel traffic, we have considered whether an increase in vessel traffic in the action area during dredging and disposal (one to two slow moving vessels per day) would increase the risk of vessel strike for Atlantic sturgeon in this area. Given the large volume of traffic in the action area and the wide variability in traffic in any given day, the increase in traffic of one to two vessels per day is negligible and the increased risk to Atlantic sturgeon is insignificant.

### 8.9 Unexploded Ordinance and Munitions of Concern

The United States Army Environmental Command (USAEC) defines unexploded ordnance (UXO) or munitions of explosive concern (MEC) as military munitions that have been (1) primed, fused, armed or otherwise prepared for action; (2) fired, dropped, launched, projected, or placed in such a manner to constitute a hazard to operations, installations, personnel, or material, and (3) remain unexploded either by malfunction, design, or any other case. UXO/MEC comes in many shapes and sizes, may be completely visible or partially or completely buried, and may be easy or virtually impossible to recognize as a military munition. UXO/MEC can be found in the ocean. UXO/MEC may look like a bullet or bomb, or be in many pieces, but even small pieces of
UXO/MEC can be dangerous. If disturbed, (touched, picked up, played with, kicked, thrown, etc.) UXO/MEC may explode without warning, resulting in serious injury or even death. Sandbridge Shoal borrow area occurs in an area associated with past and current military activities and has produced UXO/MEC during dredging operations.

The presence of UXO in dredged material presents two unique challenges. First, it poses a potential explosive safety hazard to dredging or observer personnel and potential damage to equipment and vessel. Second, any subsequent beneficial use of dredged material must also address the possibility of the presence of UXO and/or its removal.

The presence of UXO was documented during the previous Sandbridge Hurricane Protection Projects constructed in 2002 and 2007. Over 100 UXO were recovered during dredging operations and were transported to and properly disposed of at an undisclosed naval installation. Recent dredging of the Cape Henry Channel, documented UXO/MEC in the observer cages on April 15, 2011 and May 8, 2011. On April 1, 2006, the Dredge Padre Island operated by the Great Lakes Dredge & Dock Company was conducting maintenance dredging activities in the Atlantic Ocean Channel (AOC) when it suffered a ruptured dredge clean out section and severed drag head as a result of an explosion presumed to be from an ordnance device that was pumped into the draghead and associated lines. Unexploded ordnance had been previously retrieved from the draghead on three different occasions in February 2006. During the last dredging cycle of the AOC in February 2011, it was documented that UXO/MEC was encountered four times, mostly 5-inch shells, two of which were determined to be live ordnance. A UXO/MEC device also is presumed to be the cause of an explosion on a hydraulic cutter-head dredge conducting maintenance dredging in Norfolk Harbor in April 2005 rupturing the primary pump casing on the dredge. The Coast Guard rendered assistance to the dredge plant to provide additional pump-out capacity for the incoming water and stabilize the plant. Fortunately, in most incidents ordnance has not detonated and has been safely removed or jettisoned from the vessel.

As a safety precaution, in any area where UXO may be encountered (including some if not all portions of Sandbridge Shoal), the USACE will install special intake screening to be permanently placed over the drag head or cutterhead to effectively prevent any UXO from entering the dredge and/or being subsequently placed within the associated placement site. Additionally, USACE will install screening at the point where the material is discharged onto the beach. Special intake screening for UXO/MEC will be specified and installed to prevent entrainment of any material greater than 1-1/4 inches in diameter. Typical allowable openings specified by USACE-Norfolk District are 1-1/4 inches x 6 inches. While use of this screening poses challenges for monitoring interactions with listed species (see section 11 below), its use is not expected to change the entrainment rates calculated above. That is because, while it may prevent turtles or sturgeon from entering the intake pipes, it does not change the way the dredge operates or the suction power at the intake. So, while sea turtles or sturgeon may be less likely to be sucked through the dredge plant (as this could be prevented by the small size of the intakes as caused by the screening), the risk of an interaction does not change.



### 8.10 Bed Leveling Devices

Bed-leveling is often associated with hopper dredging (and other types of dredging) operations. Bed-levelers redistribute sediments, rather than removing them. Plows, I-beams, or other seabed-leveling mechanical dredging devices are used to lower high spots left in channel bottoms and dredged material deposition areas by hopper dredges or other type dredges. Leveling devices typically weigh about 30 to 50 tons, are fixed with cables to a derrick mounted on a barge pushed or pulled by a tugboat at about one to two knots.

We have considered the potential for sea turtles to be crushed as the leveling device passes over a turtle which fails to move or is not pushed out of the way by the sediment wedge “wave” generated by and pushed ahead of the device. Sea turtles at Brunswick Harbor, Georgia, may have been crushed and killed in 2003 by bed-leveling which commenced after the hopper dredge finished its work in a particular area. Brunswick Harbor is a site where sea turtles captured by relocation trawlers sometimes show evidence of brumating (over-wintering) in the muddy channel bottom, which could explain why, if they were in fact crushed, they failed to react quickly enough to avoid the bed-leveler.

USACE has engaged in efforts to design bed leveler devices that are more likely to push sea turtles out of the way (much like a deflector on a hopper dredge); it is thought that this would reduce any potential for crushing. The available information on bed leveling and sea turtles indicates that crushing is extremely unlikely outside of areas where sea turtles are brumating. Brumation is not known to occur in the action area. Additionally, the proposed modifications (i.e., integrated deflector configurations) to traditional bed-levelers are expected to further reduce the potential for impacts to sea turtles.

Subadult and adult Atlantic sturgeon are likely to be able to avoid being crushed by a bed-leveler. These fish are highly mobile. The low rate of entrainment of this species in any type of dredge suggests an ability to avoid interactions with dredge gear, including bed levelers. No reports of injured or dead sturgeon have been reported in association with any bed leveling activities. As such, we do not anticipate any Atlantic sturgeon to be injured or killed if a bed leveler is used.

### 8.11 Effects of relocation trawling as required by the Incidental Take Statement

In the Incidental Take Statement accompanying this BO (see Section 11), consistent with past Opinions considering dredging in these channels and borrow areas, we have determined that relocation trawling is necessary and appropriate when certain conditions are met to minimize the number of sea turtles captured and killed during dredging operations. The effects of relocation trawling on listed species in the action area are outlined below.

Relocation trawling is undertaken with the goal of moving sea turtles out of the area being dredged and placing them in area outside of the dredge area. There is evidence to suggest that relocation trawling can be effective at minimizing dredge interactions when the density of sea turtles in the dredge area is high. Relocation trawling has occurred occasionally in the Chesapeake Bay. Research is currently ongoing by the USACE to determine if "captureless" trawling can be as effective or more effective at displacing sea turtles from the path of the dredge. This technique uses an open bag that is thought to displace turtles from the path of the dredge without the stress of capturing the turtles and relocating them. Preliminary information available from use of captureless trawling in association with dredging activities in the Southeastern U.S. shows promise. However, the unintentional mortality of sea turtles during this type of trawling suggests that great care needs to be taken to ensure that the trawl is fishing properly. Relocation trawling can also capture species other than sea turtles. Atlantic sturgeon have been captured in relocation trawling activities in the action area.

Relocation trawling will be required if two sea turtles are entrained in one 24-hour period, or four sea turtles are entrained in a two month period, or in other circumstances where entrainment indicates that the density of sea turtles in the action area is high and would result in entrainment at a higher rate than predicted.

#### *8.11.1 Past Relocation Trawling in the Action Area*

Relocation trawling occurred in the action area in 2001, 2002 and 2003. No relocation trawling has occurred since the Fall of 2003. Relocation trawling occurred in Thimble Shoal Channel from September 6 to October 17, 2001. Twelve turtles (9 loggerheads and 3 Kemp's ridleys) were caught and released during this time period. Trawling in the Cape Henry Channel was conducted from October 13 to November 12, 2001, for 12 hours per day and with 15-30 minute tow times. Four turtles (three loggerheads and one green) were caught in water temperatures ranging from approximately 15.5 to 19°C. The turtles were relocated approximately four miles off the Virginia coast.

In 2002, several incidents of relocation trawling were initiated in Cape Henry and York Spit Channels as a result of triggering a term and condition from the January 2002 BO. From May 26 to June 6, trawling was conducted in Cape Henry, and two loggerheads were captured (in 174 30-minute tows). From September 20-25, trawling was performed in York Spit and no turtles were captured (in 103 30-minute tows). No turtles were taken by the dredge during this time. From October 10 to November 3, trawling was conducted in York Spit and Cape Henry Channels (in whichever channel the dredge was operating) with 15-30 minute tow times for 12 hours a day. Fifteen turtles were relocated (11 loggerheads, 3 Kemp's ridleys, and 1 green), and an additional Kemp's ridley turtle was found dead in the trawl. During the October to November trawling period, 5 turtles were captured by the dredge, but 2 of these incidents involved decomposed turtle parts (i.e., cause of death determined not to be related to the current dredging operations).

Relocation trawling also occurred in Thimble Shoals in 2003. Trawling occurred September 15 and 16 (20 30-minute tows, no turtles), September 20 – 22 (31 30-minute tows, 1 loggerhead) and from September 30 – October 22 (234 30-minute tows, 16 loggerheads and 5 Kemp's ridleys) and November 10 – November 28 (2 loggerheads, 1 Kemp's ridley). A total of 25 turtles were relocated during this time period. During this period of relocation trawling, fourteen Atlantic sturgeon were captured and released alive within and nearby the channel.

The maximum number of turtles relocated in one year was 25 live uninjured turtles in 2003 (September 15-16, 20-22, September 30-October 22 and November 10-28). Only one mortality has been observed. The only incidence of Atlantic sturgeon capture in relocation trawling was in the fall of 2003 with 14 individuals captured.

### *8.11.2 Effects of Relocation Trawling on Sea Turtles*

Relocation trawling conducted in association with dredging activities is specifically targeting sea turtles and as such, we expect sea turtles to be captured in the trawls. It is difficult to determine the magnitude, or the frequency, of these interactions, but potential capture levels can be estimated by previous capture rates from Virginia relocation trawling.

The maximum number of turtles caught in one year was 25, with the maximum in one month being 15. As it cannot be foreseen as to whether relocation trawling will occur in any given year or month, this anticipated capture level for relocation trawling associated with this project has been estimated with the assumption that trawling could occur every month whenever sea turtles are present and dredging occurs. Relocation trawling could therefore occur any time from April 1 to November 30 when the dredge is operating. Considering that a maximum of 15 turtles have been captured in one month of relocation trawling, if trawling occurred for all eight months that sea turtles were present, a maximum of 120 sea turtles could be captured annually during relocation trawling. We recognize that because relocation trawling is not likely to be required for every project, and even when required is unlikely to occur continuously for an 8-month period, this annual estimate is likely higher than the number of relocation captures that would occur in a typical year. However, this is our best assessment of the maximum number of turtles that would be captured during relocation trawling in any given year. Most of the captured sea turtles are likely to be loggerheads; however, we expect that some will be Kemp's ridley and greens. Of the 59 sea turtles captured during past relocation trawling, 44 were loggerheads, 13

Kemp's ridleys and 2 greens. We expect future relocation trawling to capture these species in a similar ratio (75% loggerhead, 22% Kemp's ridley and 3% green). No leatherback sea turtles are anticipated to be captured during relocation trawling due to the rarity of this species in the area and the lack of documented captures during other relocation trawling operations in the action area.

With an estimate of 25 captures per year for fifty year and the ratio of species noted above, we expect the following total number of captures over 50-years:

| Species | Number of Captures |
|---|---|
| Loggerhead | 937 |
| Kemp's Ridley | 275 |
| Green | 38 |

The relocation trawling capture estimation uses the best available information, but makes several assumptions. First, this estimation assumes that turtle distribution in the action area is not variable by month. The number used for the calculations were determined by a fall trawling event, and it is possible that turtle and/or sturgeon abundance in the action area will be higher or lower in the spring and summer. Second, this estimation assumes that turtle and sturgeon distribution will be relatively constant over the years. Relocation trawling has been conducted in Virginia only three years, and this limited amount of data was used to generate this estimated take level (e.g., one year of data noting the maximum number of turtles taken). This take estimation was based upon the best available data, but it is possible that turtle distribution may increase or decrease in future years, changing the number of turtles taken in the trawl from what was anticipated. Third, the estimated capture rate was generated under the assumption that relocation trawling would be conducted for 12 hours/day as it has in the past. If the frequency of trawling is increased beyond 12 hours/day, more turtles could be taken (e.g., if trawling is completed 24 hours/day, the capture rates could double); however, the RPM requires tows to occur for 12 hours/day, not 24. Fourth, this assumes that trawling will need to be completed each week that dredging occurs and that all dredging will be conducted during the April to November time frame. It is highly unlikely that this will occur, as the term and condition requiring trawling may not be triggered for every project or dredging may not need to be completed during the entire "turtle season", so this take level represents a maximum amount, or worst case scenario. Finally, this estimation assumes that different trawl companies and trawlers do not have any variation in turtle catch rates. This take level was generated with one company's trawl data, and if a different vessel is more or less successful at catching turtles, the anticipated take amount would be different. However, the standardized trawling protocol is required of all relocation trawling activities, so it is unlikely that the various trawl companies would have significantly different capture rates.



Relocation trawling moves animals out of their preferred environment, which may result in additional stress on the animal. While the effects of this relocation are not fully known or quantifiable, if the sea turtle is not injured or its swimming ability impaired, it is likely that the turtle could find other suitable foraging habitat or move to its desired location. Typically sea turtles are relocated at least 3 miles from the capture location. Some turtles captured during relocation trawling operations return to the dredge site and are subsequently recaptured. The likelihood of recapture may be related to where the animal was relocated, relocation distance, duration of dredging projects, and an individual turtle's preferences or site fidelity. In Canaveral Channel in the early 1980s toward the end of a 90-day dredging project, about 25-33% of the turtles caught in a given day were recaptures of turtles previously relocated in the project. Relocation sites were 5 miles north, 5 miles south, and 5 miles east of the channel. One of those turtles was caught and relocated on 7 different occasions. One was caught and removed one night and taken again on the following night. Some turtles appear to return to the area regardless of where they are moved, while others are never seen again (E-mails, C. Oravetz to E. Hawk, T. Henwood to E. Hawk, September 27, 2002). In any event, relocating animals out of the channels may subject them to stress and require the turtles to undergo extra effort to migrate back to their intended habitat.

Sea turtles forcibly submerged in any type of restrictive gear can eventually suffer fatal consequences from prolonged anoxia and/or seawater infiltration of the lung (Lutcavage *et al.*1997). A study examining the relationship between tow time and sea turtle mortality in the shrimp trawl fishery showed that mortality was strongly dependent on trawling duration, with the proportion of dead or comatose sea turtles rising from 0% for the first 50 minutes of capture to 70% after 90 minutes of capture (Henwood and Stuntz 1987). However, metabolic changes that can impair a sea turtle's ability to function can occur within minutes of a forced submergence. While most voluntary dives appear to be aerobic, showing little if any increases in blood lactate and only minor changes in acid-base status, the story is quite different in forcibly submerged sea turtles, where oxygen stores are rapidly consumed, anaerobic glycolysis is activated, and acid-base balance is disturbed, sometimes to lethal levels (Lutcavage and Lutz 1997). Forced submergence of Kemp's ridley sea turtles in shrimp trawls resulted in an acid-base imbalance after just a few minutes (times that were within the normal dive times for the species) (Stabenau *et al.*1991). Conversely, recovery times for acid-base levels to return to normal may be prolonged. Henwood and Stuntz (1987) found that it took as long as 20 hours for the acid-base levels of loggerhead sea turtles to return to normal after capture in shrimp trawls for less than 30 minutes. This effect is expected to be worse for sea turtles that are recaptured before metabolic levels have returned to normal.

Following the recommendations of the NRC to reexamine the association between tow times and sea turtle deaths, the data set used by Henwood and Stuntz (1987) was updated and re-analyzed (Epperly *et al.*2002; Sasso and Epperly 2006). Seasonal differences in the likelihood of mortality for sea turtles caught in trawl gear were apparent. For example, the observed mortality exceeded 1% after 10 minutes of towing in the winter (defined in Sasso and Epperly (2006) as the months of December-February), while the observed mortality did not exceed 1% until after 50 minutes in the summer (defined as March-November; Sasso and Epperly 2006). In general, tows of short duration (<10 minutes) in either season have little effect on the likelihood of mortality for sea turtles caught in the trawl gear and would likely achieve a negligible mortality rate (defined by the NRC as <1%). Intermediate tow times (10-200 minutes in summer and 10-150 minutes in winter) result in a rapid escalation of mortality, and eventually reach a plateau of high mortality, but will not equal 100%, as a sea turtle caught within the last hour of a long tow will likely survive (Epperly *et al.*2002; Sasso and Epperly 2006). However, in both seasons, a rapid escalation in the mortality rate did not occur until after 50 minutes (Sasso and Epperly

2006) as had been found by Henwood and Stuntz (1987). Although the data used in the reanalysis were specific to bottom otter trawl gear in the U.S. south Atlantic and Gulf of Mexico shrimp fisheries, the authors considered the findings to be applicable to the impacts of forced submergence in general (Sasso and Epperly 2006).

Sea turtle behaviors may influence the likelihood of them being captured in bottom trawl gear. Video footage recorded by the NMFS, Southeast Fisheries Science Center (SEFSC), Pascagoula Laboratory indicated that sea turtles will keep swimming in front of an advancing shrimp trawl, rather than deviating to the side, until they become fatigued and are caught by the trawl or the trawl is hauled up (NMFS 2002a). Sea turtles have also been observed to dive to the bottom and hunker down when alarmed by loud noise or gear (Memo to the File, L. Lankshear, December 4, 2007), which could place them in the path of bottom gear such as a bottom otter trawl. With respect to oceanographic features, a review of the data associated with the 11 sea turtles captured by the scallop dredge fishery in 2001 concluded that the sea turtles appeared to have been near the shelf/slope front (D. Mountain, pers. comm.).

Tows for relocation trawling will be less than 30 minutes in duration. Based on the analysis by Sasso and Epperly (2006) and Epperly *et al.*(2002) as well as information on captured sea turtles from past NJ trawl surveys, the NEAMAP and NEFSC trawl surveys, as well as the NEFSC FSB observer program, a 30-minute tow time for the trawl gear to be used will likely eliminate the risk of death from forced submergence for sea turtles caught in the trawl gear.

During spring and fall bottom otter trawl surveys conducted by the NEFSC from 1963-2009, a total of 71 loggerhead sea turtles were observed captured. Only one of the 71 loggerheads suffered injuries (cracks to the carapace) causing death (Wendy Teas, SEFSC, pers. comm. to Linda Despres, NEFSC, 2007). All others were alive and returned to the water unharmed. The one leatherback sea turtle captured in the NEFSC trawl survey was released alive and uninjured. NEFSC trawl survey tows are approximately 30 minutes in duration. All sea turtles captured in the NEAMAP surveys as well as the NJ trawl surveys have also been released alive and uninjured.

Only one mortality of a sea turtle during relocation trawling has been recorded in the action area. On November 3, 2002, during relocation trawling conducted in York Spit Channel (with 15-30 minute tows), a dead Kemp's ridley sea turtle was recovered (REMSA 2002). The fresh dead turtle was bleeding with wounds to the head. VMSM conducted a necropsy and concluded that the animal appeared to be a healthy, fresh dead juvenile Kemp's ridley with the only noted abnormalities to the head. This suggests that the cause of death could have been trawl related. Mortality of sea turtles during relocation trawling is expected to be very rare. As such, we anticipate that during each year that relocation trawling occurs, no more than 1 sea turtle will be seriously injured or killed. We expect mortalties to occur in proportion to the ratio of species captured. Therefore we expect 75% of the mortalities to be loggerheads, 22% to be Kemp's ridleys and 3% to be greens. As such, we expect the following mortalities during relocation trawling over the 50-year period considered here: 37 loggerheads, 11 Kemp's ridleys, and 2 greens.

### *8.11.3 Effects of Relocation Trawling on Atlantic sturgeon*

The capture of Atlantic sturgeon in otter trawls used for commercial fisheries is well documented (see for example, Stein *et al.*2004 and ASMFC 2007). Atlantic sturgeon are also captured incidentally in trawls used for scientific studies. Atlantic sturgeon can occur in the action area year round. While it is possible that relocation trawling may be beneficial in removing these fish from the channels being dredged, we have no information to determine if it is reasonable to expect this to occur. Relocation trawling occurred in 2001, 2002 and 2003; however, Atlantic sturgeon were captured during only one of these relocation trawl events. Fourteen Atlantic sturgeon were captured during relocation trawling in November 2003.

Because Atlantic sturgeon are known to be vulnerable to capture in trawls and Atlantic sturgeon have been captured during past relocation trawling in the action area, it is reasonable to expect that Atlantic sturgeon will be captured during future relocation trawling events. Based on past events, we expect that no more than 14 Atlantic sturgeon are likely to be captured in any year that relocation trawling is required. We expect the Atlantic sturgeon that will be captured to consist of individuals from the five DPSs at the following frequencies: NYB 49%; South Atlantic 20%; Chesapeake Bay 14%; Gulf of Maine 11%; and Carolina 4%.

The short duration of the tow and careful handling of any sturgeon once on deck is likely to result in a low potential for mortality. None of the 14 Atlantic sturgeon captured in past relocation trawling had any evidence of injury or mortality. We reviewed results of short-tow trawl surveys (i.e., 20-30 minute tow time surveys carried out by NEFSC, VIMS (NEAMAP), and the States of New Jersey and Connecticut). None of the more than six hundred Atlantic sturgeon captured during these trawl surveys have been injured or killed. Based on this information, we expect that all Atlantic sturgeon captured during relocation trawling will be alive and will be released uninjured.

### *8.11.4 Summary of Effects of Relocation Trawling*

Relocation trawling is only required when the risk of entrainment of sea turtles is higher than normal and is undertaken to minimize the potential for injury and mortality of sea turtles in the dredge. The short tow times and relocation of turtles away from the active dredge site have the goal of benefiting sea turtles. As noted above, there is the potential for some stress and a very low potential for injury or mortality. We have estimated the following maximum annual levels of capture and mortality due to relocation trawling:

| **Species** | **Number Captured Per Year** | **Number of Mortalities per Year** | **Number Captured over 50 year period** | **Number of Mortalities over 50 year period** |
|---|---|---|---|---|
| ***Sea Turtles*** | ***25 total*** | ***1*** | ***1,250*** | ***50*** |
| Loggerhead | 19 | 1* | 937 | 37 |
| Kemp's Ridley | 5 | 1* | 275 | 11 |
| Green | 1 | 1* | 38 | 2 |
| Leatherback | 0 | 0 | 0 | 0 |
| ***Atlantic*** | ***14 total*** | ***0*** | ***700 total*** | ***0*** |

| | | | | |
|---|---|---|---|---|
| ***sturgeon*** | | | | |
| NYB DPS | ≤ 7 | 0 | ≤350 | 0 |
| SA DPS | ≤ 3 | 0 | ≤150 | 0 |
| CB DPS | ≤ 2 | 0 | ≤100 | 0 |
| GOM DPS | ≤ 2 | 0 | ≤100 | 0 |
| Carolina DPS | ≤ 1 | 0 | ≤50 | 0 |

*1 loggerhead, Kemp's ridley or green annually

We expect that one turtle (either a loggerhead, Kemp's ridley, or green turtle) may be killed during relocation trawling activities each dredge cycle. In addition, a number of sea turtles (loggerheads, Kemp's ridley and green) are likely to be captured during relocation trawling and released uninjured. While this action may temporarily disrupt normal foraging and migratory behaviors, these displaced turtles are likely to rapidly resume normal behaviors. As such, the capture and displacement of live, uninjured sea turtles is not likely to have any significant effect on sea turtles in the Chesapeake Bay or the species as a whole. NMFS has also required that any live sea turtles captured during the relocation trawling be weighed and measured. While this requirement will cause additional handling of these individuals and may cause stress, this is likely to be temporary and there are no known lasting effects of taking these measurements. As such, the weighing and measuring of live, uninjured sea turtles is not likely to have any significant effect on sea turtles in the Chesapeake Bay or the species as a whole.

At this time, we have only preliminary information regarding the potential for captureless trawling to successfully minimize entrainment of sea turtles during dredging. Potential benefits to this trawling method are that the trawler can operate closer to the dredge, and therefore potentially intercept animals in the immediate pathway to the dredge; there may be less "down time" for the trawler as it does not need to stop operating every 30 minutes to haul in the trawl, handle and relocate animals, which means that the trawl is operating for a greater percentage of time, and there may be less stress and potential for injury to animals "caught" in the trawl. Potential disadvantages are that by merely disturbing animals off the bottom and not moving them outside the area being dredged, the "relocation" may be less effective and because the animals are not being brought on board the trawl vessel there is no means to monitor the number of turtles encountered so it would be difficult to gauge the success of the trawling operation (other than in any reduction in entrainment). As such, at this time, we expect that future relocation trawling will use a traditional capture methodology. If in the future the USACE proposes to use captureless relocation trawling in the action area, we will review the proposal to determine if it will: (1) achieve the same expected reduction in sea turtle entrainment as traditional relocation trawling, and (2), if it is likely to cause any effects to sea turtles or sturgeon not considered in this Opinion. If we determine that captureless trawling is at least as effective as traditional relocation trawling and that it will not cause any effects to sea turtles or sturgeon not considered in this Opinion, no further consultation is likely to be necessary and the proposed "captureless" trawling will be considered to be within the scope of this consultation.

## 9.0 CUMULATIVE EFFECTS

Cumulative effects, as defined in 50 CFR § 402.02, are those effects of future State or private activities, not involving Federal activities, which are reasonably certain to occur within the action area. Future Federal actions are not considered in the definition of "cumulative effects."

Actions carried out or regulated by the State of Virginia within the action area that may affect sea turtles and Atlantic sturgeon include the authorization of state fisheries and the regulation of dredged material discharges through CWA Section 401-certification and point and non-point source pollution through the National Pollutant Discharge Elimination System. We are not aware of any local or private actions that are reasonably certain to occur in the action area that may affect listed species. It is important to note that the definition of "cumulative effects" in the section 7 regulations is not the same as the NEPA definition of cumulative effects[9].

Future recreational and commercial fishing activities in state waters may take shortnose and Atlantic sturgeon. Information on interactions with sea turtles and Atlantic sturgeon for state fisheries operating in the action area is summarized in the Environmental Baseline section above, and it is not clear to what extent these future activities would affect listed species differently than the current state fishery activities described in the Status of the Species/Environmental Baseline sections. However, this Opinion assumes effects in the future would be similar to those in the past and are, therefore, reflected in the anticipated trends described in the status of the species/environmental baseline sections.

*State NPDES Permits* – Virginia has been delegated authority to issue NPDES permits by the EPA. These permits authorize the discharge of pollutants in the action area. Permitees include municipalities for sewage treatment plants and other industrial users. The states will continue to authorize the discharge of pollutants through the SPDES permits. However, this Opinion assumes effects in the future would be similar to those in the past and are therefore reflected in the anticipated trends described in the status of the species/environmental baseline section.



## 10.0 INTEGRATION AND SYNTHESIS OF EFFECTS

In the effects analysis outlined above, NMFS considered potential effects from continued dredging in several channels and borrow areas in the Chesapeake Bay and near its entrance as well as the CIEE. These effects include: (1) dredging with mechanical, cutterhead and hopper dredges; (2) bed leveling; and, (3) physical alteration of the action area including disruption of benthic communities. In addition to these categories of effects, NMFS considered the potential for collisions between listed species and project vessels. We anticipate the mortality of loggerhead, Kemp's ridley and green sea turtles and Atlantic sturgeon from the five DPSs. Mortality of sea turtles will result from entrainment in hopper dredges operating in the Bay and as a result of relocation trawling. Mortality of Atlantic sturgeon will occur from entrainment in hopper and/or cutterhead dredges and capture in mechanical dredges. As explained in the "Effects of the Action" section, effects of the dredging and disposal on habitat and benthic resources will be insignificant and discountable. We do not anticipate any take of sea turtles or Atlantic sturgeon due to any of the other effects including vessel traffic and dredge disposal.

We have determined that the proposed action is likely to result in the following levels of capture and mortality over the 50-year life of these projects:

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[9] Cumulative effects are defined for NEPA as "the impact on the environment, which results from the incremental impact of the action when added to other past, present, and reasonably foreseeable future actions regardless of what agency (Federal or non-Federal) or person undertakes such other actions. Cumulative impacts can result from individually minor but collectively significant actions taking place over a period of time."

| Species | Non-lethal Capture | Mortality |
|---|---|---|
| NWA DPS of Loggerhead sea turtle | 937 | 452 (415 in hopper dredge; 37 in trawl) |
| Kemp's ridley sea turtle | 275 | 48 (37 in hopper dredge; 11 in trawl) |
| Green sea turtle | 38 | 11 (9 in hopper dredge; 2 in trawl) |
| NYB DPS of Atlantic sturgeon | 350 | 60 (34 hopper, 25 cutterhead, 1 mechanical) |
| SA DPS of Atlantic sturgeon | 150 | 25 (14 hopper, 10 cutterhead, 1 mechanical) |
| CB DPS of Atlantic sturgeon | 100 | 19 (10 hopper, 8 cutterhead, 1 mechanical) |
| GOM DPS of Atlantic sturgeon | 100 | 14 (8 hopper, 5 cutterhead, 1 mechanical) |
| Carolina DPS of Atlantic sturgeon | 50 | 6 (3 hopper, 2 cutterhead, 1 mechanical) |

In the discussion below, we consider whether the effects of the proposed actions reasonably would be expected, directly or indirectly, to reduce appreciably the likelihood of both the survival and recovery of the listed species in the wild by reducing the reproduction, numbers, or distribution of the listed species that will be adversely affected by the action. The purpose of this analysis is to determine whether the proposed actions, in the context established by the status of the species, environmental baseline, and cumulative effects, would jeopardize the continued existence of any listed species. In the NMFS/USFWS Section 7 Handbook, for the purposes of determining jeopardy, survival is defined as:

> "the species' persistence as listed or as a recovery unit, beyond the conditions leading to its endangerment, with sufficient resilience to allow for the potential recovery from endangerment. Said in another way, survival is the condition in which a species continues to exist into the future while retaining the potential for recovery. This condition is characterized by a species with a sufficient population, represented by all necessary age classes, genetic heterogeneity, and number of sexually mature individuals producing viable offspring, which exists in an environment providing all requirements for completion of the species' entire life cycle, including reproduction, sustenance, and shelter."

Recovery is defined as, "improvement in the status of listed species to the point at which listing is no longer appropriate under the criteria set out in Section 4(a)(1) of the Act." We summarize below the status of the species and consider whether the proposed action will result in reductions in reproduction, numbers or distribution of these species and then consider whether any reductions in reproduction, numbers or distribution resulting from the proposed action would reduce appreciably the likelihood of both the survival and recovery of these species, as those terms are defined for purposes of the Endangered Species Act.

## 10.1 Atlantic sturgeon

As explained above, the proposed actions are likely to result in the mortality of a total of 124 Atlantic sturgeon from the Gulf of Maine, New York Bight, Chesapeake Bay, South Atlantic and Carolina DPSs over the 50 year project life. Based on the proposed dredge schedule and known maintenance and nourishment needs, in a typical year we expect that no more than two Atlantic sturgeon would be entrained. We expect that the Atlantic sturgeon killed will be subadults. We do not anticipate the mortality of any early life stages or juveniles because the high salinities in the action area preclude these life stages from being present. We do not anticipate any mortality of adults because these fish are large enough to avoid entrainment in the dredge. The proposed action is also likely to result in the capture of up to 700 Atlantic sturgeon during sea turtle relocation trawling; these captures could be subadults or adults. No mortality due to capture in relocation trawling is anticipated. All other effects to Atlantic sturgeon, including effects to habitat and prey due to dredging and dredge material disposal, will be insignificant and discountable.

### *10.1.1 Determination of DPS Composition*

We have considered the best available information to determine from which DPSs individuals that will be affected by the proposed actions are likely to have originated. Using mixed stock analysis explained above, we have determined that Atlantic sturgeon in the action area likely originate from the five DPSs at the following frequencies: NYB 49%; South Atlantic 20%;Chesapeake Bay 14%; Gulf of Maine 11%; and Carolina 4%.

### *10.1.2 Gulf of Maine DPS*

We expect that 11% of the Atlantic sturgeon in the action area will originate from the GOM DPS. The GOM DPS has been listed as threatened. While Atlantic sturgeon occur in several rivers in the GOM DPS, recent spawning has only been documented in the Kennebec; spawning is suspected to also occur in the Androscoggin river. No estimate of the number of Atlantic sturgeon in any river or for any life stage or the total population is available although the ASSRT stated that there were likely less than 300 spawners per year. GOM origin Atlantic sturgeon are affected by numerous sources of human induced mortality and habitat disturbance throughout the riverine and marine portions of their range. While there are some indications that the status of the GOM DPS may be improving, there is currently not enough information to establish a trend for any life stage or for the DPS as a whole. Over the 50-year period considered here, we anticipate the mortality of up to 14 subadult GOM DPS Atlantic sturgeon and the non-lethal capture of up to 100 subadult and adult GOM DPS Atlantic sturgeon.

Capture during relocation trawling will temporarily prevent captured sturgeon from carrying out normal behaviors such as foraging and migrating. However, these behaviors are expected to resume as soon as the fish are returned to the water. The capture of live Atlantic sturgeon is not likely to reduce the numbers of GOM DPS Atlantic sturgeon. Similarly, as the capture of live GOM DPS Atlantic sturgeon will not affect the fitness of any individual, no effects to reproduction are anticipated. The capture of live GOM DPS Atlantic sturgeon is also not likely to affect the distribution of GOM DPS Atlantic sturgeon throughout their range. As any effects to individual GOM DPS Atlantic sturgeon captured during relocation trawling and temporarily removed from the water will be minor and temporary there are not anticipated to be any population level impacts.

While overall we anticipate the death of 14 subadult Atlantic sturgeon from the GOM DPS over a 50-year period, we do not anticipate that there would be a loss of more than 1 GOM DPS subadult in any year. Here, we consider the effect of the loss of a total of these subadults on the reproduction, numbers and distribution of the GOM DPS.

The reproductive potential of the GOM DPS will not be affected in any way other than through a reduction in numbers of individuals. The loss of a total of 14 subadults, with no more than one per year, would have the effect of reducing the amount of potential reproduction as any dead GOM DPS Atlantic sturgeon would have no potential for future reproduction. However, this small reduction in potential future spawners is expected to result in an extremely small reduction in the number of eggs laid or larvae produced in future years and similarly, an extremely small effect on the strength of subsequent year classes. Even considering the potential future spawners that would be produced by the individual that would be killed as a result of the proposed action, any effect to future year classes is anticipated to be extremely small and would not change the status of this species. Reproductive potential of Atlantic sturgeon captured during relocation trawling is not expected to be affected in any way. Additionally, we have determined that any impacts to behavior will be minor and temporary and that there will not be any delay or disruption of any normal behavior including spawning; there will also be no reduction in individual fitness or any future reduction in numbers of individuals. The proposed actions will also not affect the spawning grounds within the rivers where GOM DPS fish spawn. The actions will also not create any barrier to pre-spawning sturgeon accessing the overwintering sites or the spawning grounds used by GOM DPS fish.



Because we do not have a population estimate for the GOM DPS, it is difficult to evaluate the effect of the mortality caused by these actions on the species. However, because the proposed actions will result in the loss of only one individual per year, with a total of no more than 14, it is unlikely that these deaths will have a detectable effect on the numbers and population trend of the GOM DPS.

The proposed actions are not likely to reduce distribution because the actions will not impede Atlantic sturgeon from accessing any seasonal concentration areas, including foraging areas within the action area that may be used by GOM DPS subadults or adults. Further, the actions are not expected to reduce the river by river distribution of Atlantic sturgeon. Any effects to distribution will be minor and temporary and limited to the temporary avoidance of the area where suspended sediment levels are high.

Based on the information provided above, the death of up to 14 GOM DPS Atlantic sturgeon over the next 50 years, will not appreciably reduce the likelihood of survival of the GOM DPS (*i.e.*, it will not decrease the likelihood that the species will continue to persist into the future with sufficient resilience to allow for the potential recovery from endangerment). The action will not affect GOM DPS Atlantic sturgeon in a way that prevents the species from having a sufficient population, represented by all necessary age classes, genetic heterogeneity, and number of sexually mature individuals producing viable offspring, and it will not result in effects to the environment which would prevent Atlantic sturgeon from completing their entire life cycle, including reproduction, sustenance, and shelter. This is the case because: (1) the death of one subadult GOM DPS Atlantic sturgeon in any year and the total loss of 14 subadults will not change the status or trends of the species as a whole; (3) the loss of 14 subadult GOM DPS Atlantic sturgeon is not likely to have an effect on the levels of genetic heterogeneity in the population; (4) the loss of 14 subadult GOM DPS Atlantic sturgeon over a 50 year period is likely to have such a small effect on reproductive output that the loss of this individual will not change the status or trends of the species; (5) the actions will have only a minor and temporary effect on the distribution of GOM DPS Atlantic sturgeon in the action area and no effect on the distribution of the species throughout its range; and, (6) the actions will have no effect on the ability of GOM DPS Atlantic sturgeon to shelter and only an insignificant effect on any foraging GOM DPS Atlantic sturgeon.

In certain instances, an action that does not appreciably reduce the likelihood of a species' survival might affect its likelihood of recovery or the rate at which recovery is expected to occur. As explained above, we have determined that the proposed actions will not appreciably reduce the likelihood that the GOM DPS will survive in the wild. Here, we consider the potential for the actions to reduce the likelihood of recovery. As noted above, recovery is defined as the improvement in status such that listing is no longer appropriate. Thus, we have considered whether the proposed actions will affect the likelihood that the GOM DPS can rebuild to a point where listing is no longer appropriate. No Recovery Plan for the GOM DPS has been published. The Recovery Plan will outline the steps necessary for recovery and the demographic criteria which once attained would allow the species to be delisted. We know that in general, to recover, a species must have a sustained positive trend over time and an increase in population. To allow those things to happen, a species must have enough habitat in suitable condition that allows all normal life functions to occur (i.e., spawning, foraging, resting) and have access to enough food. Here, we consider whether this proposed actions will affect the population size and/or trend in a way that would affect the likelihood of recovery.

The proposed actions are 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 GOM DPS Atlantic sturgeon and since it will not affect the overall distribution of GOM DPS Atlantic sturgeon. Any effects to habitat will be insignificant and discountable and will not affect the ability of Atlantic sturgeon to carry out any necessary behaviors or functions. Any impacts to available forage will also be insignificant. The proposed actions will result in an extremely small amount of mortality annually (one individual) and a subsequent small reduction in future reproductive output. For these reasons, it is not expected to affect the persistence of the GOM DPS of Atlantic sturgeon. These actions will not change the status or trend of the GOM DPS of Atlantic sturgeon. The very small reduction in numbers and future reproduction resulting from the proposed actions will not reduce the likelihood of improvement in the status of the GOM DPS of Atlantic sturgeon. The effects of the proposed actions will not delay the recovery timeline or otherwise decrease the likelihood of recovery. The effects of the proposed actions will also not reduce the likelihood that the status of the species can improve to the point where it is recovered and could be delisted. Therefore, the proposed actions will not appreciably reduce the likelihood that the GOM DPS of Atlantic sturgeon can be brought to the point at which they are no longer listed as threatened. Based on the analysis presented herein, the proposed actions are not likely to appreciably reduce the survival and recovery of this species.

Despite the threats faced by individual GOM DPS Atlantic sturgeon inside and outside of the action area, the proposed actions will not increase the vulnerability of individual sturgeon to these additional threats and exposure to ongoing threats will not increase susceptibility to effects related to the proposed actions. We have considered the effects of the proposed action in light of cumulative effects explained above, including climate change, and have concluded that even in light of the ongoing impacts of these activities and conditions; the conclusions reached above do not change. Based on the analysis presented herein, the proposed actions, resulting in the mortality of 14 subadult GOM DPS Atlantic sturgeon over 50 years, are not likely to appreciably reduce the survival and recovery of this species.

### *10.1.3 New York Bight DPS*

The NYB DPS has been listed as endangered. While Atlantic sturgeon occur in several rivers in the NYB DPS, recent spawning has only been documented in the Delaware and Hudson rivers. As noted above, we expect all Atlantic sturgeon impinged at Indian Point will originate from the Hudson River. There is limited information on the demographics of the Hudson River population of Atlantic sturgeon. An annual mean estimate of 863 mature adults (596 males and 267 females) was calculated for the Hudson River based on fishery-dependent data collected from 1985-1995 (Kahnle *et al.* 2007).

No data on abundance of juveniles are available prior to the 1970s; however, catch depletion analysis estimated conservatively that 6,000-6,800 females contributed to the spawning stock during the late 1800s (Secor 2002, Kahnle *et al*. 2005). Two estimates of immature Atlantic sturgeon have been calculated for the Hudson River population, one for the 1976 year class and one for the 1994 year class. Dovel and Berggren (1983) marked immature fish from 1976-1978. Estimates for the 1976 year class at age were approximately 25,000 individuals. Dovel and Berggren estimated that in 1976 there were approximately 100,000 juvenile (non-migrant) Atlantic sturgeon from approximately 6 year classes, excluding young of year.

In October of 1994, the NYDEC stocked 4,929 marked age-0 Atlantic sturgeon, provided by a USFWS hatchery, into the Hudson Estuary at Newburgh Bay. These fish were reared from Hudson River brood stock. In 1995, Cornell University sampling crews collected 15 stocked and 14 wild age-1 Atlantic sturgeon (Peterson *et al*. 2000). A Petersen mark-recapture population estimate from these data suggests that there were 9,529 (95% CI = 1,916 – 10,473) age-0 Atlantic sturgeon in the estuary in 1994. Since 4,929 were stocked, 4,600 fish were of wild origin, assuming equal survival for both hatchery and wild fish and that stocking mortality for hatchery fish was zero.

Information on trends for Atlantic sturgeon in the Hudson River are available from a number of long term surveys. From July to November during 1982-1990 and 1993, the NYSDEC sampled the abundance of juvenile fish in Haverstraw Bay and the Tappan Zee Bay. The CPUE of immature Atlantic sturgeon was 0.269 in 1982 and declined to zero by 1990. This study has not been carried out since this time.

The Long River Survey (LRS) samples ichthyoplankton river-wide from the George Washington Bridge (rkm 19) to Troy (rkm 246) using a stratified random design (CONED 1997). These data, which are collected from May-July, provide an annual index of juvenile Atlantic sturgeon in the

Hudson River estuary since 1974. The Fall Juvenile Survey (FJS), conducted from July – October by the utilities, calculates an annual index of the number of fish captured per haul. Between 1974 and 1984, the shoals in the entire river (rkm 19-246) were sampled by epibenthic sled; in 1985 the gear was changed to a three-meter beam trawl. While neither of these studies were designed to catch sturgeon, given their consistent implementation over time they provide indications of trends in abundance, particularly over long time series. When examining CPUE, these studies suggest a sharp decline in the number of young Atlantic sturgeon in the early 1990s. While the amount of interannual variability makes it difficult to detect short term trends, a five year running average of CPUE from the FJS indicates a slowly increasing trend since about 1996. Interestingly, that is when the in-river fishery for Atlantic sturgeon closed. While that fishery was not targeting juveniles, a reduction in the number of adult mortalities would be expected to result in increased recruitment and increases in the number of young Atlantic sturgeon in the river. There also could have been bycatch of juveniles that would have suffered some mortality.

In 2000, the NYSDEC created a sturgeon juvenile survey program to supplement the utilities' survey; however, funds were cut in 2000, and the USFWS was contracted in 2003 to continue the program. In 2003 – 2005, 579 juveniles were collected (N = 122, 208, and 289, respectively) (Sweka et al. 2006). Pectoral spine analysis showed they ranged from 1 – 8 years of age, with the majority being ages 2 – 6. There has not been enough data collected to use this information to detect a trend, but at least during the 2003-2005 period, the number of juveniles collected increased each year which could be indicative of an increasing trend for juveniles.



NYB DPS origin Atlantic sturgeon are affected by numerous sources of human induced mortality and habitat disturbance throughout the riverine and marine portions of their range. The largest single source of mortality appears to be capture as bycatch in commercial fisheries operating in the marine environment. A bycatch estimate provided by NEFSC indicates that approximately 376 Atlantic sturgeon die as a result of bycatch each year. Mixed stock analysis from the NMFS NEFOP indicates that 49% of these individuals are likely to originate from the NYB and 91% of those likely originate from the Hudson River, for a total of approximately 167 adult and subadult mortalities annually. Because juveniles do not leave the river, they are not impacted by fisheries occurring in Federal waters. Bycatch and mortality also occur in state fisheries; however, the primary fishery that impacted juvenile sturgeon (shad), has now been closed and there is no indication that it will reopen soon. NYB DPS Atlantic sturgeon are killed as a result of anthropogenic activities in the Hudson River and other rivers; sources of potential mortality include vessel strikes and entrainment in dredges. As noted above, we expect the mortality of two Atlantic sturgeon as a result of the Tappan Zee Bridge replacement project; it is possible that these individuals could originate from the Hudson River. There could also be the loss of a small number of juveniles at other water intakes in the River including the Danskammer and Roseton plants.

We expect that 49% of the Atlantic sturgeon in the action area originate from the NYB DPS. Capture during relocation trawling will temporarily prevent captured sturgeon from carrying out normal behaviors such as foraging and migrating. However, these behaviors are expected to resume as soon as the fish are returned to the water. The capture of live Atlantic sturgeon is not likely to reduce the numbers of NYB DPS Atlantic sturgeon. Similarly, as the capture of live NYB DPS Atlantic sturgeon will not affect the fitness of any individual, no effects to reproduction are anticipated. The capture of live NYB DPS Atlantic sturgeon is also not likely to affect the distribution of NYB DPS Atlantic sturgeon throughout their range. As any effects to individual NYB DPS Atlantic sturgeon captured during relocation trawling and temporarily removed from the water will be minor and temporary there are not anticipated to be any population level impacts.

While overall we anticipate the death of 60 subadult Atlantic sturgeon from the NYB DPS over a 50-year period, we do not anticipate that there would be a loss of more than 1 NYB DPS subadult in most years and never more than 2 NYB DPS Atlantic sturgeon killed per year. Here, we consider the effect of the loss of these subadults on the reproduction, numbers and distribution of the NYB DPS.

Any New York Bight DPS subadults could originate from the Delaware or Hudson river. We have limited information from which to determine the percentage of NYB DPS fish in the Delaware River that are likely to originate from the Delaware vs. the Hudson river. Given the sizes of the two populations, the worst case scenario is that all 60 NYB fish that are killed are Delaware River fish (rather than some Delaware River, some Hudson River); however, that appears to be unlikely. Individual assignments of NYB DPS Atlantic sturgeon that have undergone genetic testing indicates that in the oceanic environment, approximately 91% of NYB individuals originate from the Hudson River. This is likely due to the greater number of Hudson River origin Atlantic sturgeon than Delaware River Atlantic sturgeon. Thus, of the 60 NYB Atlantic sturgeon likely to be killed, five are likely to originate from the Delaware River and 55 from the Hudson River.

Some Delaware River fish have a unique genetic haplotype (the A5 haplotype); however, whether there is any evolutionary significance or fitness benefit provided by this genetic makeup is unknown. Genetic evidence indicates that while spawning continued to occur in the Delaware River and in some cases Delaware River origin fish can be distinguished genetically from Hudson River origin fish, there is free interchange between the two rivers. This relationship is recognized by the listing of the New York Bight DPS as a whole and not separate listings of a theoretical Hudson River DPS and Delaware River DPS. Thus, while we can consider the loss of Delaware River fish on the Delaware River population and the loss of Hudson River fish on the Hudson River population, it is more appropriate, because of the interchange of individuals between these two populations, to consider the effects of these mortalities on the New York Bight DPS as a whole.



While overall we anticipate the death of 60 subadult Atlantic sturgeon from the NYB DPS over a 50-year period, we do not anticipate that there would be a loss of more than 2 NYB DPS subadult per year. The mortality of 2 subadult Atlantic sturgeon from the NYB DPS each year represents a very small percentage of subadult population (*i.e.*, approximately 0.08% of the population, just considering the minimum estimated number of subadults; the percentage would be much less if the number of YOY, juveniles and adults was considered). While the death of these subadult Atlantic sturgeon will reduce the number of NYB DPS Atlantic sturgeon compared to the number that would have been present absent the proposed actions, it is not likely that this reduction in numbers will change the status of this species as this loss represents a very small percentage of the subadult population and an even smaller percentage of the overall population of the DPS (juveniles, subadults and adults combined). Even when converting these fish to adult equivalents[10] (using a conversion rate of 0.48 considering the adult equivalent), and assuming no growth in the adult population, the annual mortality of 1 subadult represents an extremely small percentage of the adult population (approximately 0.11%).

Because there will be no loss of adults, the reproductive potential of the NYB DPS will not be affected in any way other than through a reduction in numbers of individual future spawners. The loss of 60 subadults over a 50-year period would have the effect of reducing the amount of potential reproduction as any dead NYB DPS Atlantic sturgeon would have no potential for future reproduction. This small reduction in potential future spawners is expected to result in an extremely small reduction in the number of eggs laid or larvae produced in future years and similarly, an extremely small effect on the strength of subsequent year classes. Even considering the potential future spawners that would be produced by the individual that would be killed as a result of the proposed actions, any effect to future year classes is anticipated to be extremely small and would not change the status of this species. The proposed actions will also not affect the spawning grounds within the Hudson River or Delaware River where NYB DPS fish spawn. There will be no effects to spawning adults and therefore no reduction in individual fitness or any future reduction in spawning by these individuals.

The proposed actions is not likely to reduce distribution because the actions will not impede NYB DPS Atlantic sturgeon from accessing any seasonal concentration areas, including foraging, spawning or overwintering grounds in the Delaware or Hudson River or elsewhere. Any effects to distribution will be minor and temporary and limited to the temporary avoidance of the area immediately surrounding an active dredge.

Based on the information provided above, the death of up to 60 NYB DPS Atlantic sturgeon over the 50 year period considered here, will not appreciably reduce the likelihood of survival of the New York Bight DPS (*i.e.*, it will not decrease the likelihood that the species will continue to persist into the future with sufficient resilience to allow for the potential recovery from endangerment). The actions will not affect NYB DPS Atlantic sturgeon in a way that prevents the species from having a sufficient population, represented by all necessary age classes, genetic heterogeneity, and number of sexually mature individuals producing viable offspring, and it will not result in effects to the environment which would prevent Atlantic sturgeon from completing their entire life cycle, including reproduction, sustenance, and shelter. This is the case because: (1) the death of these subadult NYB DPS Atlantic sturgeon over a 50-year period represents an extremely small percentage of the species as a whole; (2) the death of these subadult NYB DPS Atlantic sturgeon will not change the status or trends of the species as a whole; (3) the loss of these subadult NYB DPS Atlantic sturgeon is not likely to have an effect on the levels of genetic heterogeneity in the population; (4) the loss of these subadult NYB DPS Atlantic sturgeon is likely to have such a small effect on reproductive output that the loss of these individuals will not change the status or trends of the species; (5) the actions will have only a minor and temporary effect on the distribution of NYB DPS Atlantic sturgeon in the action area and no effect on the distribution of the species throughout its range; and, (6) the actions will have no effect on the ability of NYB DPS Atlantic sturgeon to shelter and only an insignificant effect on individual



[10] The "adult equivalent" rate converts a number of subadults to adult equivalents (the number of subadults that would, through natural mortality, live to be adults; for Atlantic sturgeon, this is calculated as 0.48).

foraging NYB DPS Atlantic sturgeon.

In certain instances, an action that does not appreciably reduce the likelihood of a species' survival might affect its likelihood of recovery or the rate at which recovery is expected to occur. As explained above, we have determined that the proposed actions will not appreciably reduce the likelihood that the NYB DPS will survive in the wild. Here, we consider the potential for the actions to reduce the likelihood of recovery. As noted above, recovery is defined as the improvement in status such that listing is no longer appropriate. Thus, we have considered whether the proposed actions will affect the likelihood that the NYB DPS can rebuild to a point where listing is no longer appropriate. No Recovery Plan for the NYB DPS has been published. The Recovery Plan will outline the steps necessary for recovery and the demographic criteria which once attained would allow the species to be delisted. We know that in general, to recover, a species must have a sustained positive trend over time and an increase in population. To allow those things to happen, a species must have enough habitat in suitable condition that allows all normal life functions to occur (i.e., spawning, foraging, resting) and have access to enough food. Here, we consider whether these proposed actions will affect the population size and/or trend in a way that would affect the likelihood of recovery.

The proposed actions are 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 NYB DPS Atlantic sturgeon and since it will not affect the overall distribution of NYB DPS Atlantic sturgeon. Any effects to habitat will be insignificant and discountable and will not affect the ability of Atlantic sturgeon to carry out any necessary behaviors or functions. Any impacts to available forage will also be insignificant. The proposed actions will result in a small amount of mortality (no more than two individuals per year) and a subsequent small reduction in future reproductive output. For these reasons, it is not expected to affect the persistence of the NYB DPS of Atlantic sturgeon. These actions will not change the status or trend of the NYB DPS of Atlantic sturgeon. The very small reduction in numbers and future reproduction resulting from the proposed actions will not reduce the likelihood of improvement in the status of the NYB DPS of Atlantic sturgeon. The effects of the proposed actions will not delay the recovery timeline or otherwise decrease the likelihood of recovery. The effects of the proposed actions will also not reduce the likelihood that the status of the species can improve to the point where it is recovered and could be delisted. Therefore, the proposed actions will not appreciably reduce the likelihood that the NYB DPS of Atlantic sturgeon can be brought to the point at which they are no longer listed as threatened. Based on the analysis presented herein, the proposed actions are not likely to appreciably reduce the survival and recovery of this species.

Despite the threats faced by individual NYB DPS Atlantic sturgeon inside and outside of the action area, the proposed actions will not increase the vulnerability of individual sturgeon to these additional threats and exposure to ongoing threats will not increase susceptibility to effects related to the proposed actions. Based on the analysis presented herein, the proposed actions, resulting in the mortality of up to 60 subadult NYB DPS Atlantic sturgeon over 50 years, is not likely to appreciably reduce the survival and recovery of this species.

#### *10.1.4 Chesapeake Bay DPS*

We expect that 14% of the Atlantic sturgeon in the action area will originate from the CB DPS. The CB DPS has been listed as endangered. While Atlantic sturgeon occur in several rivers in the CB DPS, recent spawning has only been documented in the James River. Chesapeake Bay DPS origin Atlantic sturgeon are affected by numerous sources of human induced mortality and habitat disturbance throughout the riverine and marine portions of their range. There is currently not enough information to establish a trend for any life stage, for the James River spawning population or for the DPS as a whole. Over the 50-year period considered here, we anticipate the mortality of up to 19 subadult CB DPS Atlantic sturgeon and the non-lethal capture of up to 100 subadult and adult CB DPS Atlantic sturgeon.

Capture during relocation trawling will temporarily prevent captured sturgeon from carrying out normal behaviors such as foraging and migrating. However, these behaviors are expected to resume as soon as the fish are returned to the water. The capture of live Atlantic sturgeon is not likely to reduce the numbers of CB DPS Atlantic sturgeon. Similarly, as the capture of live CB DPS Atlantic sturgeon will not affect the fitness of any individual, no effects to reproduction are anticipated. The capture of live CB DPS Atlantic sturgeon is also not likely to affect the distribution of CB DPS Atlantic sturgeon throughout their range. As any effects to individual CB DPS Atlantic sturgeon captured during relocation trawling and temporarily removed from the water will be minor and temporary there are not anticipated to be any population level impacts.

While overall we anticipate the death of 19 subadult Atlantic sturgeon from the CB DPS over a 50-year period, we do not anticipate that there would be a loss of more than 1 CB DPS subadult in any year. Here, we consider the effect of the loss of a total of these subadults on the reproduction, numbers and distribution of the CB DPS.

While overall we anticipate the death of eighteen subadult Atlantic sturgeon from the CB DPS over a 50-year period, we do not anticipate that there would be a loss of more than 1 CB DPS subadult per year. The reproductive potential of the CB DPS will not be affected in any way other than through a reduction in numbers of individuals. The loss of a total of 19 subadults, with no more than one per year, would have the effect of reducing the amount of potential reproduction as any dead CB DPS Atlantic sturgeon would have no potential for future reproduction. However, this small reduction in potential future spawners is expected to result in an extremely small reduction in the number of eggs laid or larvae produced in future years and similarly, an extremely small effect on the strength of subsequent year classes. Even considering the potential future spawners that would be produced by the individual that would be killed as a result of the proposed actions, any effect to future year classes is anticipated to be extremely small and would not change the status of this species. Reproductive potential of other captured or injured individuals is not expected to be affected in any way. Additionally, we have determined that any impacts to behavior will be minor and temporary and that there will not be any delay or disruption of any normal behavior including spawning; there will also be no reduction in individual fitness or any future reduction in numbers of individuals. The proposed actions will also not affect the spawning grounds within the rivers where CB DPS fish spawn. The actions will also not create any barrier to pre-spawning sturgeon accessing the overwintering sites or the spawning grounds used by CB DPS fish.

Because we do not have a population estimate for the CB DPS, it is difficult to evaluate the effect of the mortality caused by these actions on the species. However, because the proposed action will result in the loss of only one individual per year, with a total of no more than 19, it is unlikely that these deaths will have a detectable effect on the numbers and population trend of the CB DPS.

The proposed actions are not likely to reduce distribution because the actions will not impede Atlantic sturgeon from accessing any seasonal concentration areas, including foraging areas within the action area that may be used by CB DPS subadults or adults. Further, the actions are not expected to reduce the river by river distribution of Atlantic sturgeon. Any effects to distribution will be minor and temporary and limited to the temporary avoidance of the area where suspended sediment levels are high.

Based on the information provided above, the death of up to 19 CB DPS Atlantic sturgeon over the next 50 years, will not appreciably reduce the likelihood of survival of the CB DPS (*i.e.*, it will not decrease the likelihood that the species will continue to persist into the future with sufficient resilience to allow for the potential recovery from endangerment). The actions will not affect CB DPS Atlantic sturgeon in a way that prevents the species from having a sufficient population, represented by all necessary age classes, genetic heterogeneity, and number of sexually mature individuals producing viable offspring, and it will not result in effects to the environment which would prevent Atlantic sturgeon from completing their entire life cycle, including reproduction, sustenance, and shelter. This is the case because: (1) the death of one subadult CB DPS Atlantic sturgeon in any year and the total loss of 19 subadults will not change the status or trends of the species as a whole; (3) the loss of 19 subadult CB DPS Atlantic sturgeon is not likely to have an effect on the levels of genetic heterogeneity in the population; (4) the loss of 19 subadult CB DPS Atlantic sturgeon over a 50 year period is likely to have such a small effect on reproductive output that the loss of this individual will not change the status or trends of the species; (5) the actions will have only a minor and temporary effect on the distribution of CB DPS Atlantic sturgeon in the action area and no effect on the distribution of the species throughout its range; and, (6) the actions will have no effect on the ability of CB DPS Atlantic sturgeon to shelter and only an insignificant effect on any foraging CB DPS Atlantic sturgeon.



In certain instances, an action that does not appreciably reduce the likelihood of a species' survival might affect its likelihood of recovery or the rate at which recovery is expected to occur. As explained above, we have determined that the proposed actions will not appreciably reduce the likelihood that the CB DPS will survive in the wild. Here, we consider the potential for the actions to reduce the likelihood of recovery. As noted above, recovery is defined as the improvement in status such that listing is no longer appropriate. Thus, we have considered whether the proposed actions will affect the likelihood that the CB DPS can rebuild to a point where listing is no longer appropriate. No Recovery Plan for the CB DPS has been published. The Recovery Plan will outline the steps necessary for recovery and the demographic criteria which once attained would allow the species to be delisted. We know that in general, to recover, a species must have a sustained positive trend over time and an increase in population. To allow those things to happen, a species must have enough habitat in suitable condition that allows all normal life functions to occur (i.e., spawning, foraging, resting) and have access to enough food. Here, we consider whether this proposed actions will affect the population size and/or trend in a way that would affect the likelihood of recovery.

The proposed actions are 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 CB DPS Atlantic sturgeon and since it will not affect the overall distribution of CB DPS Atlantic sturgeon. Any effects to habitat will be insignificant and discountable and will not affect the ability of Atlantic sturgeon to carry out any necessary behaviors or functions. Any impacts to available forage will also be insignificant. The proposed actions will result in an extremely small amount of mortality (on average, less than one individual per year) and a subsequent small reduction in future reproductive output. For these reasons, it is not expected to affect the persistence of the CB DPS of Atlantic sturgeon. These actions will not change the status or trend of the CB DPS of Atlantic sturgeon. The very small reduction in numbers and future reproduction resulting from the proposed actions will not reduce the likelihood of improvement in the status of the CB DPS of Atlantic sturgeon. The effects of the proposed actions will not delay the recovery timeline or otherwise decrease the likelihood of recovery. The effects of the proposed actions will also not reduce the likelihood that the status of the species can improve to the point where it is recovered and could be delisted. Therefore, the proposed actions will not appreciably reduce the likelihood that the CB DPS of Atlantic sturgeon can be brought to the point at which they are no longer listed as threatened. Based on the analysis presented herein, the proposed actions, are not likely to appreciably reduce the survival and recovery of this species.

Despite the threats faced by individual CB DPS Atlantic sturgeon inside and outside of the action area, the proposed actions will not increase the vulnerability of individual sturgeon to these additional threats and exposure to ongoing threats will not increase susceptibility to effects related to the proposed actions. We have considered the effects of the proposed actions in light of cumulative effects explained above, including climate change, and have concluded that even in light of the ongoing impacts of these activities and conditions; the conclusions reached above do not change. Based on the analysis presented herein, the proposed actions, resulting in the mortality of 19 subadult CB DPS Atlantic sturgeon over 50 years, is not likely to appreciably reduce the survival and recovery of this species.



### *10.1.5 Carolina DPS*

We expect that 4% of the Atlantic sturgeon in the action area will originate from the CA DPS. Individuals originating from the CA DPS are likely to occur in the action area. The CA DPS is listed as endangered. The CA DPS consists of Atlantic sturgeon originating from at least five rivers where spawning is still thought to occur. Carolina DPS origin Atlantic sturgeon are affected by numerous sources of human induced mortality and habitat disturbance throughout the riverine and marine portions of their range. There is currently not enough information to establish a trend for any life stage, for any of the spawning populations or for the DPS as a whole. Over the 50-year period considered here, we anticipate the mortality of up to 6 subadult CA DPS Atlantic sturgeon and the non-lethal capture of up to 50 subadult and adult CA DPS Atlantic sturgeon.

Capture during relocation trawling will temporarily prevent captured sturgeon from carrying out normal behaviors such as foraging and migrating. However, these behaviors are expected to resume as soon as the fish are returned to the water. The capture of live Atlantic sturgeon is not likely to reduce the numbers of CA DPS Atlantic sturgeon. Similarly, as the capture of live CA DPS Atlantic sturgeon will not affect the fitness of any individual, no effects to reproduction are anticipated. The capture of live CA DPS Atlantic sturgeon is also not likely to affect the distribution of CA DPS Atlantic sturgeon throughout their range. As any effects to individual CA DPS Atlantic sturgeon captured during relocation trawling and temporarily removed from the water will be minor and temporary there are not anticipated to be any population level impacts.

While overall we anticipate the death of 6 subadult Atlantic sturgeon from the CA DPS over a 50-year period, we do not anticipate that there would be a loss of more than 1 CA DPS subadult in any year. Here, we consider the effect of the loss of a total of these subadults on the reproduction, numbers and distribution of the CA DPS.

The reproductive potential of the CA DPS will not be affected in any way other than through a reduction in numbers of individuals. The loss of a total of 6 subadults, with no more than one per year, would have the effect of reducing the amount of potential reproduction as any dead CA DPS Atlantic sturgeon would have no potential for future reproduction. However, this small reduction in potential future spawners is expected to result in an extremely small reduction in the number of eggs laid or larvae produced in future years and similarly, an extremely small effect on the strength of subsequent year classes. Even considering the potential future spawners that would be produced by the individual that would be killed as a result of the proposed actions, any effect to future year classes is anticipated to be extremely small and would not change the status of this species. Reproductive potential of other captured or injured individuals is not expected to be affected in any way. Additionally, we have determined that any impacts to behavior will be minor and temporary and that there will not be any delay or disruption of any normal behavior including spawning; there will also be no reduction in individual fitness or any future reduction in numbers of individuals. The proposed actions will also not affect the spawning grounds within the rivers where CA DPS fish spawn. The actions will also not create any barrier to pre-spawning sturgeon accessing the overwintering sites or the spawning grounds used by CA DPS fish.



Because we do not have a population estimate for the CA DPS, it is difficult to evaluate the effect of the mortality caused by these actions on the species. However, because the proposed actions will result in the loss of only one individual per year, with a total of no more than 6, it is unlikely that these deaths will have a detectable effect on the numbers and population trend of the CA DPS.

The proposed actions are not likely to reduce distribution because the actions will not impede Atlantic sturgeon from accessing any seasonal concentration areas, including foraging areas within the action area that may be used by CA DPS subadults or adults. Further, the actions are not expected to reduce the river by river distribution of Atlantic sturgeon. Any effects to distribution will be minor and temporary and limited to the temporary avoidance of the area where suspended sediment levels around the dredge are high.

Based on the information provided above, the death of up to 6 CA DPS Atlantic sturgeon over the next 50 years, will not appreciably reduce the likelihood of survival of the CA DPS (*i.e.*, it will not decrease the likelihood that the species will continue to persist into the future with sufficient resilience to allow for the potential recovery from endangerment). The actions will not affect CA DPS Atlantic sturgeon in a way that prevents the species from having a sufficient population, represented by all necessary age classes, genetic heterogeneity, and number of sexually mature individuals producing viable offspring, and it will not result in effects to the environment which would prevent Atlantic sturgeon from completing their entire life cycle, including reproduction, sustenance, and shelter. This is the case because: (1) the death of one subadult CA DPS Atlantic sturgeon in any year and the total loss of 6 subadults will not change the status or trends of the species as a whole; (3) the loss of 6 subadult CA DPS Atlantic sturgeon is not likely to have an effect on the levels of genetic heterogeneity in the population; (4) the loss of 6 subadult CA DPS Atlantic sturgeon over a 50 year period is likely to have such a small effect on reproductive output that the loss of this individual will not change the status or trends of the species; (5) the actions will have only a minor and temporary effect on the distribution of CA DPS Atlantic sturgeon in the action area and no effect on the distribution of the species throughout its range; and, (6) the actions will have no effect on the ability of CA DPS Atlantic sturgeon to shelter and only an insignificant effect on any foraging CA DPS Atlantic sturgeon.

In certain instances, an action that does not appreciably reduce the likelihood of a species' survival might affect its likelihood of recovery or the rate at which recovery is expected to occur. As explained above, we have determined that the proposed actions will not appreciably reduce the likelihood that the CA DPS will survive in the wild. Here, we consider the potential for the actions to reduce the likelihood of recovery. As noted above, recovery is defined as the improvement in status such that listing is no longer appropriate. Thus, we have considered whether the proposed actions will affect the likelihood that the CA DPS can rebuild to a point where listing is no longer appropriate. No Recovery Plan for the CA DPS has been published. The Recovery Plan will outline the steps necessary for recovery and the demographic criteria which once attained would allow the species to be delisted. We know that in general, to recover, a species must have a sustained positive trend over time and an increase in population. To allow those things to happen, a species must have enough habitat in suitable condition that allows all normal life functions to occur (i.e., spawning, foraging, resting) and have access to enough food. Here, we consider whether this proposed actions will affect the population size and/or trend in a way that would affect the likelihood of recovery.

The proposed actions 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 CA DPS Atlantic sturgeon and since it will not affect the overall distribution of CA DPS Atlantic sturgeon. Any effects to habitat will be insignificant and discountable and will not affect the ability of Atlantic sturgeon to carry out any necessary behaviors or functions. Any impacts to available forage will also be insignificant. The proposed actions will result in an extremely small amount of mortality (six individuals over 50 years) and a subsequent small reduction in future reproductive output. For these reasons, it is not expected to affect the persistence of the CA DPS of Atlantic sturgeon. This actions will not change the status or trend of the CA DPS of Atlantic sturgeon. The very small reduction in numbers and future reproduction resulting from the proposed actions will not reduce the likelihood of improvement in the status of the CA DPS of Atlantic sturgeon. The effects of the proposed actions will not delay the recovery timeline or otherwise decrease the likelihood of recovery. The effects of the proposed actions will also not reduce the likelihood that the status of the species can improve to the point where it is recovered and could be delisted.

Therefore, the proposed actions will not appreciably reduce the likelihood that the CA DPS of Atlantic sturgeon can be brought to the point at which they are no longer listed as threatened. Based on the analysis presented herein, the proposed actions, is not likely to appreciably reduce the survival and recovery of this species.

Despite the threats faced by individual CA DPS Atlantic sturgeon inside and outside of the action area, the proposed actions will not increase the vulnerability of individual sturgeon to these additional threats and exposure to ongoing threats will not increase susceptibility to effects related to the proposed actions. We have considered the effects of the proposed actions in light of cumulative effects explained above, including climate change, and have concluded that even in light of the ongoing impacts of these activities and conditions; the conclusions reached above do not change. Based on the analysis presented herein, the proposed actions, resulting in the mortality of six subadult CA DPS Atlantic sturgeon over 50 years, is not likely to appreciably reduce the survival and recovery of this species.

***10.1.6 South Atlantic DPS***

We expect that 20% of the Atlantic sturgeon in the action area will originate from the SA DPS. The SA DPS is listed as endangered. The SA DPS consists of Atlantic sturgeon originating from at least six rivers where spawning is still thought to occur. Schueller and Peterson (2006) estimate that there were 343 adults spawning in the Altamaha River, GA in 2004 and 2005. This represents a percentage of the total adult population for the Altamaha River. Males spawn every 1-5 years and females spawn every 2-5 years; thus, the total Altamaha River adult population, assuming a 2:1 ratio of males: females as seen on the Hudson River, could range from 457 - 1,715. Spawning occurs in at least five other rivers in this DPS, thus the number of Atlantic sturgeon in the Altamaha River population is only a portion of the total DPS. No estimate of the number of Atlantic sturgeon in any of the other spawning rivers or for the DPS as a whole is available. Information from commercial fisheries bycatch indicates that the ratio of subadults to adults in the ocean may be 3:1. This suggests that there could be three times as many subadults as adults in the DPS. Using the estimate of Altamaha River adults, we could estimate 1,371-5,145 Altamaha River origin adults. Over the 50-year period considered here, we anticipate the mortality of up to 25 subadult SA DPS Atlantic sturgeon and the non-lethal capture of up to 150 subadult and adult SA DPS Atlantic sturgeon.



Capture during relocation trawling will temporarily prevent captured sturgeon from carrying out normal behaviors such as foraging and migrating. However, these behaviors are expected to resume as soon as the fish are returned to the water. The capture of live Atlantic sturgeon is not likely to reduce the numbers of SA DPS Atlantic sturgeon. Similarly, as the capture of live SA DPS Atlantic sturgeon will not affect the fitness of any individual, no effects to reproduction are anticipated. The capture of live SA DPS Atlantic sturgeon is also not likely to affect the distribution of SA DPS Atlantic sturgeon throughout their range. As any effects to individual SA DPS Atlantic sturgeon captured during relocation trawling and temporarily removed from the water will be minor and temporary there are not anticipated to be any population level impacts.

While overall we anticipate the death of 25 subadult Atlantic sturgeon from the SA DPS over a 50-year period, we do not anticipate that there would be a loss of more than 1 SA DPS subadult in any year. Here, we consider the effect of the loss of a total of these subadults on the reproduction, numbers and distribution of the SA DPS. At this time we do not have sufficient genetic information to determine what percentage of SA DPS sturgeon encountered in the action area are likely to originate from each of the six spawning rivers.

The reproductive potential of the SA DPS will not be affected in any way other than through a reduction in numbers of individuals. The loss of a total of 25 subadults, with no more than one per year, would have the effect of reducing the amount of potential reproduction as any dead SA DPS Atlantic sturgeon would have no potential for future reproduction. However, this small reduction in potential future spawners is expected to result in an extremely small reduction in the number of eggs laid or larvae produced in future years and similarly, an extremely small effect on the strength of subsequent year classes. Even considering the potential future spawners that would be produced by the individual that would be killed as a result of the proposed actions, any effect to future year classes is anticipated to be extremely small and would not change the status of this species. Reproductive potential of other captured or injured individuals is not expected to be affected in any way. Additionally, we have determined that any impacts to behavior will be minor and temporary and that there will not be any delay or disruption of any normal behavior including spawning; there will also be no reduction in individual fitness or any future reduction in numbers of individuals. The proposed actions will also not affect the spawning grounds within the rivers where SA DPS fish spawn. The actions will also not create any barrier to pre-spawning sturgeon accessing the overwintering sites or the spawning grounds used by SA DPS fish.

Because we do not have a population estimate for the SA DPS, it is difficult to evaluate the effect of the mortality caused by this actions on the species. However, because the proposed actions will result in the loss of only one individual per year, with a total of no more than 25, it is unlikely that these deaths will have a detectable effect on the numbers and population trend of the SA DPS.

The proposed actions are not likely to reduce distribution because the actions will not impede Atlantic sturgeon from accessing any seasonal concentration areas, including foraging areas within the actions area that may be used by SA DPS subadults or adults. Further, the actions are not expected to reduce the river by river distribution of Atlantic sturgeon. Any effects to distribution will be minor and temporary and limited to the temporary avoidance of the area where suspended sediment levels are high.

Based on the information provided above, the death of up to 25 SA DPS Atlantic sturgeon over the next 50 years, will not appreciably reduce the likelihood of survival of the SA DPS (*i.e.*, it will not decrease the likelihood that the species will continue to persist into the future with sufficient resilience to allow for the potential recovery from endangerment). The actions will not affect SA DPS Atlantic sturgeon in a way that prevents the species from having a sufficient population, represented by all necessary age classes, genetic heterogeneity, and number of sexually mature individuals producing viable offspring, and it will not result in effects to the environment which would prevent Atlantic sturgeon from completing their entire life cycle, including reproduction, sustenance, and shelter. This is the case because: (1) the death of one subadult CB DPS Atlantic sturgeon in any year and the total loss of 25 subadults will not change the status or trends of the species as a whole; (3) the loss of 25 subadult SA DPS Atlantic sturgeon is not likely to have an effect on the levels of genetic heterogeneity in the population; (4) the loss of 25 subadult SA DPS Atlantic sturgeon over a 50 year period is likely to have such a small effect on reproductive output that the loss of this individual will not change the status or trends of the species; (5) the actions will have only a minor and temporary effect on the distribution of SA DPS Atlantic sturgeon in the action area and no effect on the distribution of the species throughout its range; and, (6) the actions will have no effect on the ability of SA DPS Atlantic sturgeon to shelter and only an insignificant effect on individual foraging SA DPS Atlantic sturgeon.

In certain instances, an action that does not appreciably reduce the likelihood of a species' survival might affect its likelihood of recovery or the rate at which recovery is expected to occur. As explained above, we have determined that the proposed actions will not appreciably reduce the likelihood that the SA DPS will survive in the wild. Here, we consider the potential for the actions to reduce the likelihood of recovery. As noted above, recovery is defined as the improvement in status such that listing is no longer appropriate. Thus, we have considered whether the proposed actions will affect the likelihood that the SA DPS can rebuild to a point where listing is no longer appropriate. No Recovery Plan for the SA DPS has been published. The Recovery Plan will outline the steps necessary for recovery and the demographic criteria which once attained would allow the species to be delisted. We know that in general, to recover, a species must have a sustained positive trend over time and an increase in population. To allow those things to happen, a species must have enough habitat in suitable condition that allows all normal life functions to occur (i.e., spawning, foraging, resting) and have access to enough food. Here, we consider whether these proposed actions will affect the population size and/or trend in a way that would affect the likelihood of recovery.

The proposed actions are 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 SA DPS Atlantic sturgeon and since it will not affect the overall distribution of SA DPS Atlantic sturgeon. Any effects to habitat will be insignificant and discountable and will not affect the ability of Atlantic sturgeon to carry out any necessary behaviors or functions. Any impacts to available forage will also be insignificant. The proposed actions will result in an extremely small amount of mortality (on average, less than one individual per year) and a subsequent small reduction in future reproductive output. For these reasons, it is not expected to affect the persistence of the SA DPS of Atlantic sturgeon. These actions will not change the status or trend of the SA DPS of Atlantic sturgeon. The very small reduction in numbers and future reproduction resulting from the proposed actions will not reduce the likelihood of improvement in the status of the SA DPS of Atlantic sturgeon. The effects of the proposed actions will not delay the recovery timeline or otherwise decrease the likelihood of recovery. The effects of the proposed actions will also not reduce the likelihood that the status of the species can improve to the point where it is recovered and could be delisted. Therefore, the proposed actions will not appreciably reduce the likelihood that the SA DPS of Atlantic sturgeon can be brought to the point at which they are no longer listed as threatened. Based on the analysis presented herein, the proposed actions, are not likely to appreciably reduce the survival and recovery of this species.

Despite the threats faced by individual SA DPS Atlantic sturgeon inside and outside of the action area, the proposed actions will not increase the vulnerability of individual sturgeon to these additional threats and exposure to ongoing threats will not increase susceptibility to effects related to the proposed actions. We have considered the effects of the proposed actions in light of cumulative effects explained above, including climate change, and have concluded that even in light of the ongoing impacts of these activities and conditions; the conclusions reached above do not change. Based on the analysis presented herein, the proposed actions, resulting in the mortality of 25 subadult SA DPS Atlantic sturgeon over 50 years, is not likely to appreciably reduce the survival and recovery of this species.

### 10.2 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 Coast 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 sea turtles are considered endangered wherever they occur in U.S. waters. Green sea 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). As is also the case with the other sea 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 three 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 exceeds 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 numbers 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 1970s 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 1980s 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 actions must, ultimately, be considered at the species level for section 7 consultations. 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. 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).

As described in the Status of the Species, Environmental Baseline and Cumulative Effects sections above, green sea turtles in the action area continue to be affected by multiple anthropogenic impacts including bycatch in commercial and recreational fisheries, habitat alteration and other factors that result in mortality of individuals at all life stages.

In the "Effects of the Action" section above, we determined that green sea turtles could be entrained in a hopper dredge operating in any of the channels or borrow areas considered in this consultation and could also be captured and killed during relocation trawling. We have estimated that the proposed actions are likely to result in the mortality of 11 green sea turtles and the non-lethal capture of 38 green sea turtles over the 50 year project life. We determined that all other effects of these actions on this species will be insignificant and discountable. While this estimate is based on the best available information, it is likely that this is an overestimate of the number of green sea turtles that will be encountered during hopper dredging because it: (1) assumes that all dredging will occur in the April – November time period when sea turtles are present in the action area; and, (2) that any dredging that could occur with a hopper or cutterhead dredge, occurs with a hopper dredge. The number of mortalities would be less than 11 if some of the dredging occurred between December and March and if more of it was carried out with a cutterhead dredge, both of which are likely to occur. No mortalities of green sea turtles are expected whenever a cutterhead dredge. No green turtles are present in the action area from December – March, therefore, hopper dredging that occurs during this time of year will not result in the mortality of any green sea turtles.



Based on the proposed dredge schedule and known maintenance and nourishment needs, in a typical year during the initial construction period, approximately 1 million cubic yards of material will be removed from the channels and borrow areas considered here; in the worst case, if all channels and borrow areas were dredged in one year, up to 5 million cubic yards of material could be removed. However, it is extremely unlikely that this would happen given the cost of such an operation and the limited number of dredges that are available for this kind of work. Therefore, in a typical year, we expect that no more than 1 green sea turtle would be entrained. All other effects to greens, including effects to habitat and prey due to dredging and dredge disposal, will be insignificant and discountable.

The lethal removal of 11 green sea turtles from the action area over a fifty year period would reduce the number of green sea turtles as compared to the number of green sea turtles 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 the species 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 lethal removal of one green sea turtle in a particular year and a total of 11 over 50 years, whether males or females, immature or mature animals, would reduce the number of green sea turtles as compared to the number of green that would have been present in the absence of the proposed actions assuming all other variables remained the same; the loss of one green sea turtles represents a very small percentage of the species as a whole. Even compared to the number of nesting females (17,000-37,000), which represent only a portion of the number of greens worldwide, the mortality of 11 greens represents less than 0.07% of the nesting population. The loss of these sea turtles would be expected to reduce the reproduction of green sea turtles as compared to the reproductive output of green sea turtles in the absence of the proposed action. As described in the "Status of the Species" section above, we consider the trend for green sea turtles to be stable. However, as explained below, the death of these green sea turtles will not appreciably reduce the likelihood of survival for the species for the following reasons.

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 greens because: the species is widely geographically distributed, it is not known to have low levels of genetic diversity, there are several thousand individuals in the population and the number of greens is likely to be increasing and at worst is stable. These actions are not likely to reduce distribution of greens because the actions will not impede greens from accessing foraging grounds or cause more than a temporary disruption to other migratory behaviors.



Based on the information provided above, the death of 11 green sea turtles over 50 years will not appreciably reduce the likelihood of survival (i.e., it will not decrease the likelihood that the species will continue to persist into the future with sufficient resilience to allow for the potential recovery from endangerment). The actions will not affect green sea turtles in a way that prevents the species from having a sufficient population, represented by all necessary age classes, genetic heterogeneity, and number of sexually mature individuals producing viable offspring and it will not result in effects to the environment which would prevent green sea turtles from completing their entire life cycle, including reproduction, sustenance, and shelter. This is the case because: (1) the species' nesting trend is increasing; (2) the death of 11 green sea turtles represents an extremely small percentage of the species as a whole; (3) the loss of 11 green sea turtles will not change the status or trends of the species as a whole; (4) the loss of 11 green sea turtles is not likely to have an effect on the levels of genetic heterogeneity in the population; (5) the loss of 11 green sea turtles is likely to have an undetectable effect on reproductive output of the species as a whole; (6) the actions will have no effect on the distribution of greens in the action area or throughout its range; and (7) the actions will have no effect on the ability of green sea turtles to shelter and only an insignificant effect on individual foraging green sea turtles.

In certain instances, an action may not appreciably reduce the likelihood of a species survival (persistence) but may affect its likelihood of recovery or the rate at which recovery is expected to occur. As explained above, we have determined that the proposed actions will not appreciably reduce the likelihood that green sea turtles will survive in the wild. Here, we consider the potential for the actions to reduce the likelihood of recovery. As noted above, recovery is defined as the improvement in status such that listing is no longer appropriate. Thus, we have considered whether the proposed actions will affect the likelihood that the species can rebuild to a point where listing is no longer appropriate. A Recovery Plan for Green sea turtles was published by NMFS and USFWS in 1991. The plan outlines the steps necessary for recovery and the criteria which, once met, would ensure recovery. In order to be delisted, green sea turtles must experience sustained population growth, as measured in the number of nests laid per year, over time. Additionally, "priority one" recovery tasks must be achieved and nesting habitat must be protected (through public ownership of nesting beaches) and stage class mortality must be reduced. Here, we consider whether this proposed actions will affect the population size and/or trend in a way that would affect the likelihood of recovery.

The proposed actions will not appreciably reduce the likelihood of survival of green sea turtles. 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 green sea turtles in any geographic area and since it will not affect the overall distribution of green sea turtles other than to cause minor temporary adjustments in movements in the action area. As explained above, the proposed actions are likely to result in the mortality of a total of 11 green sea turtles, with the loss of no more than one per year; however, as explained above, the loss of these individuals over this time period is not expected to affect the persistence of green sea turtles or the species trend. The actions will not affect nesting habitat and will have only an extremely small effect on mortality. The effects of the proposed actions will not hasten the extinction timeline or otherwise increase the danger of extinction; further, the actions will not prevent the species from growing in a way that leads to recovery and the actions will not change the rate at which recovery can occur. This is the case because while the actions may result in a small reduction in the number of greens and a small reduction in the amount of potential reproduction due to the loss of one individual, these effects will be undetectable over the long-term and the actions is not expected to have long term impacts on the future growth of the population or its potential for recovery. Therefore, based on the analysis presented above, the proposed actions will not appreciably reduce the likelihood that green sea turtles can be brought to the point at which they are no longer listed as endangered or threatened.

Despite the threats faced by individual green sea turtles inside and outside of the action area, the proposed actions will not increase the vulnerability of individual sea turtles to these additional threats and exposure to ongoing threats will not increase susceptibility to effects related to the proposed actions. We have considered the effects of the proposed actions in light of cumulative effects explained above, including climate change, and has concluded that even in light of the ongoing impacts of these activities and conditions; the conclusions reached above do not change. Based on the analysis presented herein, the proposed actions, resulting in the mortality of 11 green sea turtles over 50 years, is not likely to appreciably reduce the survival and recovery of this species.

### 10.3 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 leatherback sea turtles are likely to be entrained in any dredge operating during any of the projects considered here and this species is not likely to be involved in any collision with a project vessel. No leatherback sea turtles are likely to be captured during relocation trawling. As all effects to leatherback sea turtles from the proposed actions are likely to be insignificant or discountable, these actions are not likely to adversely affect this species.

### 10.4 Kemp's ridley sea turtles

In the "Effects of the Action" section above, we determined that Kemp's ridley sea turtles could be entrained in a hopper dredge operating in any of the channels or borrow areas considered in this consultation and could also be captured and killed during relocation trawling. We have estimated that the proposed actions are likely to result in the mortality of 48 Kemp's ridley sea turtles and the non-lethal capture of 275 Kemp's ridley sea turtles over the 50 year project life. We determined that all other effects of the actions on this species will be insignificant and discountable. While this estimate is based on the best available information, it is likely that this is an overestimate of the number of Kemp's ridley sea turtles that will be encountered during hopper dredging because it: (1) assumes that all dredging will occur in the April – November time period when sea turtles are present in the action area; and, (2) that any dredging that could occur with a hopper or cutterhead dredge, occurs with a hopper dredge. The number of mortalities would be less than 48 if some of the dredging occurred between December and March and if any of it was carried out with a cutterhead dredge, both of which are likely to occur. No mortalities of sea turtles are expected whenever a cutterhead dredge is used; no sea turtles are present in the action area from December – March, therefore, hopper dredging that occurs during this time of year will not result in the mortality of any 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 Kemp's ridleys is a single stretch of beach near Rancho Nuevo, Tamaulipas, Mexico (Carr 1963; USFWS and NMFS 1992; NMFS and USFWS 2007c).

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 turtle 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 (Meylan 1982; Ross 1996; Zurita *et al.* 2003; Hawkes *et al.* 2005; letter to J. Lecky, NMFS Office of Protected Resources, from N. Thompson, NMFS Northeast Fisheries Science Center, December 4, 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 ridleys suggests that this species is in the early stages of recovery (NMFS and USFWS 2007b). Nest count data indicate increased nesting and increased numbers of nesting females in the population. NMFS also takes into account a number of recent conservation actions including the protection of females, nests, and hatchlings on nesting beaches since the 1960s and the enhancement of survival in marine habitats through the implementation of TEDs in the early 1990s and a decrease in the amount of shrimping off the coast of Tamaulipas and in the Gulf of Mexico in general (NMFS and USFWS 2007b). We expect this increasing trend to continue over the time period considered in this Opinion.

The mortality of 48 Kemp's ridleys over a 50 year time period represents a very small percentage of the Kemp's ridleys worldwide. Even taking into account just nesting females, the death of 48 Kemp's ridley represents less than 0.8% of the population; considering that there is not likely to be more than 1 mortality of a Kemp's ridley per year, the annual impact is less than 0.014% of the population. While the death of 48 Kemp's ridley will reduce the number of Kemp's ridleys compared to the number that would have been present absent the proposed actions, it is not likely that this reduction in numbers will change the status of this species or its stable to increasing trend as this loss represents a very small percentage of the population. Reproductive potential of Kemp's ridleys is not expected to be affected in any other way other than through a reduction in numbers of individuals.

A reduction in the number of Kemp's ridleys would have the effect of reducing the amount of potential reproduction as any dead Kemp's ridleys would have no potential for future reproduction. In 2006, the most recent year for which data is available, there were an estimated 7-8,000 nesting females. While the species is thought to be female biased, there are likely to be several thousand adult males as well. Given the number of nesting adults, it is unlikely that the loss of 1 Kemp's ridley per year or 48 over 50 years would affect the success of nesting in any year. Additionally, this small reduction in potential nesters is expected to result in a small reduction in the number of eggs laid or hatchlings produced in future years and similarly, a very small effect on the strength of subsequent year classes. Even considering the potential future nesters that would be produced by the individuals that would be killed as a result of the proposed actions, any effect to future year classes is anticipated to be very small and would not change the stable to increasing trend of this species. Additionally, the proposed actions will not affect nesting beaches in any way or disrupt migratory movements in a way that hinders access to nesting beaches or otherwise delays nesting.



The proposed actions are not likely to reduce distribution because the actions will not impede Kemp's ridleys from accessing foraging grounds or cause more than a temporary disruption to other migratory behaviors. Additionally, given the small percentage of the species that will be killed as a result of the proposed actions, there is not likely to be any loss of unique genetic haplotypes and no loss of genetic diversity.

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.

Based on the information provided above, the death of 48 Kemp's ridley sea turtles over the next 50 years will not appreciably reduce the likelihood of survival (i.e., it will not decrease the likelihood that the species will continue to persist into the future with sufficient resilience to allow for the potential recovery from endangerment). The actions will not affect Kemp's ridleys in a way that prevents the species from having a sufficient population, represented by all necessary age classes, genetic heterogeneity, and number of sexually mature individuals producing viable offspring and it will not result in effects to the environment which would prevent Kemp's ridleys from completing their entire life cycle, including reproduction, sustenance, and shelter. This is the case because: (1) the species' nesting trend is increasing; (2) the death of 48 Kemp's ridleys represents an extremely small percentage of the species as a whole; (3) the death of 48 Kemp's ridleys will not change the status or trends of the species as a whole; (4) the loss of these Kemp's ridleys is not likely to have an effect on the levels of genetic heterogeneity in the population; (5) the loss of these Kemp's ridleys is likely to have such a small effect on reproductive output that the loss of these individuals will not change the status or trends of the species; (5) the actions will have only a minor and temporary effect on the distribution of Kemp's ridleys in the action area and no effect on the distribution of the species throughout its range; and, (6) the actions will have no effect on the ability of Kemp's ridleys to shelter and only an insignificant effect on individual foraging Kemp's ridleys.

In certain instances, an action may not appreciably reduce the likelihood of a species survival (persistence) but may affect its likelihood of recovery or the rate at which recovery is expected to occur. As explained above, we have determined that the proposed actions will not appreciably reduce the likelihood that green sea turtles will survive in the wild. Here, we consider the potential for the actions to reduce the likelihood of recovery. As noted above, recovery is defined as the improvement in status such that listing is no longer appropriate. Thus, we have considered whether the proposed actions will affect the likelihood that Kemp's ridleys can rebuild to a point where listing is no longer appropriate. In 2011, NMFS and the USFWS issued a recovery plan for Kemp's ridleys (NMFS and USFWS 2011). The plan includes a list of criteria necessary for recovery. These include:

1. An increase in the population size, specifically in relation to nesting females[11];
2. An increase in the recruitment of hatchlings[12];
3. An increase in the number of nests at the nesting beaches;
4. Preservation and maintenance of nesting beaches (i.e. Rancho Nuevo, Tepehuajes, and Playa Dos); and,
5. Maintenance of sufficient foraging, migratory, and inter-nesting habitat.

[11] A population of at least 10,000 nesting females in a season (as measured by clutch frequency per female per season) distributed at the primary nesting beaches in Mexico (Rancho Nuevo, Tepehuajes, and Playa Dos) is attained in order for downlisting to occur; an average of 40,000 nesting females per season over a 6-year period by 2024 for delisting to occur

[12] Recruitment of at least 300,000 hatchlings to the marine environment per season at the three primary nesting beaches in Mexico (Rancho Nuevo, Tepehuajes, and Playa Dos).

Kemp's ridleys have an increasing trend; as explained above, the loss of one Kemp's ridley per year during the proposed actions will not affect the population trend. The number of Kemp's ridleys likely to die as a result of the proposed actions is an extremely small percentage of the species. This loss will not affect the likelihood that the population will reach the size necessary for recovery or the rate at which recovery will occur. As such, the proposed actions will not affect the likelihood that criteria one, two or three will be achieved or the timeline on which they will be achieved. The action area does not include nesting beaches; therefore, the proposed actions will have no effect on the likelihood that recovery criteria four will be met. All effects to habitat will be insignificant and discountable; therefore, the proposed actions will have no effect on the likelihood that criteria five will be met.

The effects of the proposed actions will not hasten the extinction timeline or otherwise increase the danger of extinction. Further, the actions will not prevent the species from growing in a way that leads to recovery and the actions will not change the rate at which recovery can occur. This is the case because while the actions may result in a small reduction in the number of Kemp's ridleys and a small reduction in the amount of potential reproduction due to the average loss of one individual per year, these effects will be undetectable over the long-term and the actions are not expected to have long term impacts on the future growth of the population or its potential for recovery. Therefore, based on the analysis presented above, the proposed actions 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.

Despite the threats faced by individual Kemp's ridley sea turtles inside and outside of the actions area, the proposed actions will not increase the vulnerability of individual sea turtles to these additional threats and exposure to ongoing threats will not increase susceptibility to effects related to the proposed actions. We have considered the effects of the proposed actions in light of cumulative effects explained above, including climate change, and have concluded that even in light of the ongoing impacts of these activities and conditions; the conclusions reached above do not change. Based on the analysis presented herein, the proposed actions, resulting in the mortality of one Kemp's ridley sea turtle per year, is not likely to appreciably reduce the survival and recovery of this species.



### 10.5 Northwest Atlantic DPS of Loggerhead sea turtles

In the "Effects of the Action" section above, we determined that loggerheads could be entrained in a hopper dredge operating in any of the channels or borrow areas considered in this consultation. We have estimated that, over the 50-year period considered here, the proposed actions are likely to result in the mortality of 452 NWA DPS loggerhead sea turtles and the non-lethal capture of 937 loggerheads. We determined that all other effects of the action on this species will be insignificant and discountable. While this estimate is based on the best available information, it is likely that this is an overestimate of the number of loggerhead sea turtles that will be encountered during hopper dredging because it: (1) assumes that all dredging will occur in the April – November time period when sea turtles are present in the action area; and, (2) that any dredging that could occur with a hopper or cutterhead dredge, occurs with a hopper dredge. The number of mortalities would be less than 452 if some of the dredging occurred between December and March and if any of it was carried out with a cutterhead dredge, both of which are likely to occur. No mortalities of sea turtles are expected whenever a cutterhead dredge is used.

No sea turtles are present in the action area from December – March, therefore, hopper dredging that occurs during this time of year will not result in the mortality of any loggerhead sea turtles.

The Northwest Atlantic DPS of loggerhead sea turtles is listed as "threatened" under the ESA. 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 2008). There are many natural and anthropogenic factors affecting the survival of loggerheads prior to their reaching maturity as well as for those adults who have reached maturity. As described in the Status of the Species, Environmental Baseline and Cumulative Effects sections above, loggerhead sea turtles in the action area continue to be affected by multiple anthropogenic impacts including bycatch in commercial and recreational fisheries, habitat alteration, dredging, power plant intakes and other factors that result in mortality of individuals at all life stages. Negative impacts causing death of various age classes occur both on land and in the water. 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.

The SEFSC (2009) estimated the number of adult females in the NWA DPS at 30,000, and if a 1:1 adult sex ratio is assumed, the result is 60,000 adults in this DPS. Based on the reviews of nesting data, as well as information on population abundance and trends, NMFS and USFWS determined in the September 2011 listing rule that the NWA DPS should be listed as threatened. They found that an endangered status for the NWA DPS was not warranted given the large size of the nesting population, the overall nesting population remains widespread, the trend for the nesting population appears to be stabilizing, and substantial conservation efforts are underway to address threats. This stable trend is expected to continue over the time period considered in this Opinion.

As stated above, we expect the lethal entrainment of 452 loggerheads over the 50-year time period considered here; with an average mortality rate of approximately 9 loggerheads per year. The lethal removal of up to 452 loggerhead sea turtles from the action area over this time period 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 2008 recovery plan compiled the most recent information on the 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 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. However, the 2008 recovery plan indicates that the Yucatán nesting aggregation has at least 1,000 nesting females annually. It should be noted here, that the above numbers only include nesting females (*i.e.*, do not include non-nesting adult females, adult males, or juvenile males or females in the population).

Although limited information is available on the genetic makeup of loggerheads in an area as extensive as the action area, it is likely that loggerheads in the action area originate from several, if not all of the recovery units. Genetic analysis of samples collected from immature loggerheads captured in pound nets in the Pamlico-Albemarle Estuarine Complex in North Carolina between 1995-1997 indicated that 80% of the juveniles and sub-adults utilizing the foraging habitat originated from the south Florida nesting stock, 12% from the northern nesting stock, 6% from the Yucatán nesting stock, and 2% from other rookeries (including the Florida Panhandle, Dry Tortugas, Brazil, Greece, and Turkey nesting stocks) (Bass *et al*. 2004). In a separate study, genetic analysis of samples collected from loggerheads from Massachusetts to Florida also found that all five western Atlantic loggerhead stocks were represented (Bowen *et al.* 2004). However, earlier studies by Rankin-Baransky *et al*. (2001) and Witzell *et al*. (2002) indicated that only a few nesting stocks were represented along the U.S. Atlantic coast: south Florida (59% and 69% of the loggerheads sampled, respectively), northern (25% and 10%, respectively), and Mexico (16% and 20%, respectively). Most recently, Haas *et al.* (2008) found that 89% of the loggerheads captured in the U.S. Atlantic scallop fishery from 1996-2005 originated from the south Florida nesting stock, 4% were from the Mexican stock, 3% were from the northern (northeast Florida to North Carolina) stock, 1% were from the northwest Florida stock, and 0% were from the Dry Tortugas stock. The remaining 3% of loggerheads sampled were attributed to nesting stocks in Greece. However, a re-analysis of loggerhead genetics data by the Atlantic Loggerhead TEWG has found that it is unlikely that U.S. fishing fleets are interacting with the Mediterranean DPS (Peter Dutton, NMFS, pers. comm.) and that loggerheads from Greek nesting stocks are unlikely to occur in the action area.



The previously defined loggerhead nesting stocks do not share the exact delineations of the recovery units identified in the 2008 recovery plan. However, the PFRU encompasses the south Florida stock, the NRU is roughly equivalent to the northern nesting stock, the northwest Florida stock is included in the NGMRU, the Mexico stock is included in the GCRU, and the DTRU encompasses the Dry Tortugas stock. Based on the genetic analysis presented in Haas *et al.* (2008), which is the most recent and one of the most comprehensive (in terms of the area from which samples were acquired) of the loggerhead genetics studies referenced above, the vast majority of the loggerheads in the action area are likely to originate from the PFRU (90%), with the remainder originating from the NRU (3%), GCRU (5%), NGMRU (1.5%), and DTRU (0.5%). Therefore, we expect that 407 of the loggerheads will be from the PFRU, 14 from the NRU, 27 from the GCRU, 7 from the NGMRU, and 2 from the DTRU. The best available information indicates that the proportion of the interactions from each recovery unit are consistent with the relative sizes of the recovery units, and we conclude, based on the available evidence, that none of the recovery units will be disproportionately impacted by the proposed actions. Thus, genetic heterogeneity should be maintained in the species even in the face of this level of mortality resulting from the proposed actions.

The loss of 407 loggerheads over a 50-year period (approximately 8 per year) 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 number of nesting females), the annual average loss of up to 8 individuals would represent approximately 0.06% of the population. Similarly, the loss of no more than 1 loggerhead from the NRU for 14 of the 50 years represents an extremely small percentage of the recovery unit. Even if the total population was limited to 1,272 sea turtles (the number of nesting females), the loss of 1 individual in a given year would represent approximately 0.3% of the population. The loss of no more than 1 loggerhead for 27 of the 50 years from the GCRU, which is expected to support at least 1,000 nesting females, represents less than 0.1% of the population, even just considering the number of adult nesting females, which is only a fraction of the total population. The loss of no more than 1 loggerhead for 7 of the 50 years from the NGMRU, represents a very small percentage of the population, even just considering the number of adult nesting females, which is only a fraction of the total population. The loss of no more than 1 loggerhead for 2 of the 50 years from the DTRU, which is expected to support at least 60 nesting females, represents a very small percentage of the population, even just considering the number of adult nesting females, which is only a fraction of the total population and an even smaller percentage of the DPS as a whole.

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. The impact of these losses is even less when considering that these losses will occur over a span of 50 years. Considering the extremely small percentage of the populations that will be killed, it is unlikely that these deaths 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.

All of the loggerheads that are expected to be killed will be juveniles. Thus, any effects on reproduction are limited to the loss of these individuals on their year class and the loss of future reproductive potential. Given the number of nesting adults in each of these populations, it is unlikely that the expected loss of loggerheads would affect the success of nesting in any year. Additionally, this small reduction in potential nesters is expected to result in a small reduction in the number of eggs laid or hatchlings produced in future years and similarly, a very small effect on the strength of subsequent year classes. Even considering the potential future nesters that would be produced by the individuals that would be killed as a result of the proposed actions, any effect to future year classes is anticipated to be very small and would not change the stable trend of this species. Additionally, the proposed actions will not affect nesting beaches in any way or disrupt migratory movements in a way that hinders access to nesting beaches or otherwise delays nesting.

The proposed action is not likely to reduce distribution because the actions will not impede loggerheads from accessing foraging grounds or cause more than a temporary disruption to other migratory behaviors. Additionally, given the small percentage of the species that will be killed as a result of the deepening and maintenance, there is not likely to be any loss of unique genetic haplotypes and no loss of genetic diversity.

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 loggerheads 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 loggerheads is likely to be stable or increasing over the time period considered here.

Based on the information provided above, the death of up to 452 loggerheads over the next 50 years will not appreciably reduce the likelihood of survival (i.e., it will not decrease the likelihood that the species will continue to persist into the future with sufficient resilience to allow for the potential recovery from endangerment). The actions will not affect loggerheads in a way that prevents the species from having a sufficient population, represented by all necessary age classes, genetic heterogeneity, and number of sexually mature individuals producing viable offspring and it will not result in effects to the environment which would prevent loggerheads from completing their entire life cycle, including reproduction, sustenance, and shelter. This is the case because: (1) the species' nesting trend is stabilizing; (2) the death of these loggerheads represents an extremely small percentage of the species as a whole; (3) the death of these loggerheads will not change the status or trends of the species as a whole; (4) the loss of these loggerheads is not likely to have an effect on the levels of genetic heterogeneity in the population; (5) the loss of these loggerheads is likely to have such a small effect on reproductive output that the loss of these individuals will not change the status or trends of the species; (5) the actions will have only a minor and temporary effect on the distribution of loggerheads in the action area and no effect on the distribution of the species throughout its range; and, (6) the actions will have no effect on the ability of loggerheads to shelter and only an insignificant effect on individual foraging loggerheads.



In certain instances, an action may not appreciably reduce the likelihood of a species survival (persistence) but may affect its likelihood of recovery or the rate at which recovery is expected to occur. As explained above, we have determined that the proposed actions will not appreciably reduce the likelihood that loggerhead sea turtles will survive in the wild. Here, we consider the potential for the actions to reduce the likelihood of recovery. As noted above, recovery is defined as the improvement in status such that listing is no longer appropriate. Thus, we have considered whether the proposed actions will affect the likelihood that the NWA DPS of loggerheads can rebuild to a point where listing is no longer appropriate. In 2008, NMFS and the USFWS issued a recovery plan for the Northwest Atlantic population of loggerheads (NMFS and USFWS 2008). The plan includes demographic recovery criteria as well as a list of tasks that must be accomplished. Demographic recovery criteria are included for each of the five recovery units. These criteria focus on sustained increases in the number of nests laid and the number of nesting females in each recovery unit, an increase in abundance on foraging grounds, and ensuring that trends in neritic strandings are not increasing at a rate greater than trends in in-water abundance. The recovery tasks focus on protecting habitats, minimizing and managing predation and disease, and minimizing anthropogenic mortalities.

Loggerheads have an increasing trend; as explained above, the loss of 452 loggerheads over 50-years as a result of the proposed actions will not affect the population trend. The number of loggerheads likely to die as a result of the proposed actions is an extremely small percentage of any recovery unit or the DPS as a whole. This loss will not affect the likelihood that the population will reach the size necessary for recovery or the rate at which recovery will occur. As such, the proposed actions will not affect the likelihood that the demographic criteria will be achieved or the timeline on which they will be achieved. The action area does not include nesting beaches; all effects to habitat will be insignificant and discountable; therefore, the proposed actions will have no effect on the likelihood that habitat based recovery criteria will be achieved. The proposed actions will also not affect the ability of any of the recovery tasks to be accomplished.

The effects of the proposed actions will not hasten the extinction timeline or otherwise increase the danger of extinction; further, the actions will not prevent the species from growing in a way that leads to recovery and the actions will not change the rate at which recovery can occur.

In summary, the effects of the proposed actions will not hasten the extinction timeline or otherwise increase the danger of extinction; further, the actions will not prevent the species from growing in a way that leads to recovery and the actions will not change the rate at which recovery can occur. This is the case because while the actions may result in a small reduction in the number of loggerheads and a small reduction in the amount of potential reproduction due to the loss of these individuals, these effects will be undetectable over the long-term and the actions are not expected to have long term impacts on the future growth of the population or its potential for recovery. Therefore, based on the analysis presented above, the proposed actions 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.

Despite the threats faced by individual loggerhead sea turtles inside and outside of the action area, the proposed actions will not increase the vulnerability of individual sea turtles to these additional threats and exposure to ongoing threats will not increase susceptibility to effects related to the proposed actions. We have considered the effects of the proposed actions in light of other threats, including climate change, and have concluded that even in light of the ongoing impacts of these activities and conditions, the conclusions reached above do not change. Based on the analysis presented herein, the proposed actions are not likely to appreciably reduce the survival and recovery of the NWA DPS of loggerhead sea turtles.



## 11.0 CONCLUSION

After reviewing the best available information on the status of endangered and threatened species under our 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 any DPS of Atlantic sturgeon, Kemp's ridley or green sea turtles or the Northwest Atlantic DPS of loggerhead sea turtles and is not likely to adversely affect leatherback sea turtles. Because no critical habitat is designated in the action area, none will be affected by the proposed action.

## 12.0 INCIDENTAL TAKE STATEMENT

Section 9 of the ESA prohibits the take of endangered species of fish and wildlife. "Fish and wildlife" is defined in the ESA "as any member of the animal kingdom, including without limitation any mammal, fish, bird (including any migratory, non-migratory, or endangered bird for which protection is also afforded by treaty or other international agreement), amphibian, reptile, mollusk, crustacean, arthropod or other invertebrate, and includes any part, product, egg, or offspring thereof, or the dead body or parts thereof." 16 U.S.C. 1532(8). "Take" is defined as to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture or collect, or to attempt to engage in any such conduct. Harm is further defined by NMFS to include any act which actually kills or injures fish or wildlife. Such an act may include significant habitat modification or degradation that actually kills or injures fish or wildlife by significantly impairing essential behavioral patterns including breeding, spawning, rearing, migrating, feeding, or sheltering. Incidental take is defined as take that is incidental to, and not the purpose of, the carrying out of an otherwise lawful activity. "Otherwise lawful activities" are those actions that meet all State and Federal legal requirements except for the prohibition against taking in ESA Section 9 (51 FR 19936, June 3, 1986), which would include any state endangered species laws or regulations. Section 9(g) makes it unlawful for any person "to attempt to commit, solicit another to commit, or cause to be committed, any offense defined [in the ESA.]" 16 U.S.C. 1538(g). See also 16 U.S.C. 1532(13)(definition of "person"). Under the terms of section 7(b)(4) and section 7(o)(2), taking that is incidental to and not intended as part of the agency action is not considered to be prohibited under the ESA provided that such taking is in compliance with the terms and conditions of this Incidental Take Statement.

The measures described below are non-discretionary, and must be undertaken by USACE so that they become binding conditions for the exemption in section 7(o)(2) to apply. USACE has a continuing duty to regulate the activity covered by this Incidental Take Statement. If USACE (1) fails to assume and implement the terms and conditions or (2) fails to require any contractors to adhere to the terms and conditions of the Incidental Take Statement through enforceable terms that are added contracts or other documents as appropriate, the protective coverage of section 7(o)(2) may lapse. In order to monitor the impact of incidental take, USACE must report the progress of the action and its impact on the species to us as specified in the Incidental Take Statement [50 CFR §402.14(i)(3)] (See U.S. Fish and Wildlife Service and National Marine Fisheries Service's Joint Endangered Species Act Section 7 Consultation Handbook (1998) at 4-49).

## 12.1 Amount or Extent of Incidental Take

The proposed dredging project has the potential to directly affect green, loggerhead and Kemp's ridley sea turtles, and individuals from the New York Bight, Gulf of Maine, Chesapeake Bay, South Atlantic and Carolina DPSs of Atlantic sturgeon which may become entrained in the dredge. These interactions are likely to cause mortality. This level of take is expected to occur over the entire 50 year period and is not likely to jeopardize the continued existence of listed species. While we have completed one Biological Opinion, the actions considered here consist of five independent actions carried out by the USACE and their contractors. As such, at the request of USACE, we have organized the ITS for dredging by project.

This ITS exempts the following incidental take over the 50 year period:

| Species | Non-lethal Capture | Mortality |
|---|---|---|
| NWA DPS of Loggerhead sea turtle | 937 | 452 |
| Kemp's ridley sea turtle | 275 | 48 |
| Green sea turtle | 38 | 11 |
| NYB DPS of Atlantic sturgeon | 350 | 60 |
| SA DPS of Atlantic sturgeon | 150 | 25 |
| CB DPS of Atlantic sturgeon | 100 | 19 |
| GOM DPS of Atlantic sturgeon | 100 | 14 |
| Carolina DPS of Atlantic sturgeon | 50 | 6 |

The tables below illustrate our expectations of where these takes will occur:

### *Hopper Dredging*

| Project | Total Volume | Number of Interactions over 50 years | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | **Total Sea Turtles** | **Loggerhead** | **Kemp's ridley** | **green** | **Total Atlantic sturgeon** | **NYB DPS** | **SA DPS** | **CB DPS** | **GOM DPS** | **Carolina DPS** |
| Baltimore Harbor Entrance Channels | 64.5 MCY | 215 | 194 | 17 | 4 | 32 | 16 | 6 | 5 | 4 | 1 |
| York River Entrance Channel | 6.5 MCY | 22 | 20 | 2 | 0 | 3 | 2 | 1* | 1* | 1* | 1* |
| Hampton Roads (TS and AOC) | 14.5 MCY | 168 | 151 | 13 | 3 | 25 | 12 | 5 | 4 | 3 | 1 |

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Virginia Beach Hurricane Project (TSS and AO borrow areas) | 10 MCY | 15 | 13 | 1** | 1** | 2 | 1 | 1* | 1* | 1* | 1* |
| Sandbridge Shoal | 12.5 MCY | 42 | 38 | 3 | 1 | 6 | 3 | 1 | 1 | 1*** | 1*** |
| | | | | | | | | | | | |

*1 CB, GOM or Carolina DPS Atlantic sturgeon
** 1 Kemp's ridley or green sea turtle
***1 GOM or Carolina DPS Atlantic sturgeon

### *Cutterhead Dredging*

| **DPS** | **Number of Atlantic Sturgeon over 50 year Period** |
|---|---|
| New York Bight | 25 |
| South Atlantic | 10 |
| Chesapeake Bay | 8 |
| Gulf of Maine | 5 |
| Carolina | 2 |

### *Mechanical Dredging*

One Atlantic sturgeon (any DPS) at CIEE and one (any DPS) in Norfolk Harbor

### *Relocation Trawling*

| **Species** | **Number Captured over 50 year period** | **Number of Mortalities over 50 year period** |
|---|---|---|
| ***Sea Turtles*** | ***1,250*** | ***50*** |
| Loggerhead | 938 | 37 |
| Kemp's Ridley | 275 | 11 |
| Green | 37 | 2 |
| Leatherback | 0 | 0 |
| ***Atlantic sturgeon*** | ***700 total*** | ***0*** |
| NYB DPS | ≤350 | 0 |
| SA DPS | ≤150 | 0 |
| CB DPS | ≤100 | 0 |
| GOM DPS | ≤100 | 0 |
| Carolina DPS | ≤50 | 0 |

When a hopper dredge is used, NMFS-approved endangered species observers are typically required on board the dredge to monitor for the entrainment of sea turtles and sturgeon. The endangered species observer program has been in place on hopper dredges since 1994 and is effective at monitoring take during hopper dredge operations. The use of observers relies on screening placed on the draghead being large enough to allow large sized pieces of biological material to pass through and be caught in cages that retain material that is then inspected by the observer. When UXO screening is in place on the draghead, the size of material that can pass through the dredge is significantly smaller, making detection by an observer extremely unlikely. As described in the Description of the Action, due to safety concerns, USACE is likely to require UXO screening for dredges working on Sandbridge Shoal. It is likely that only internal soft tissue (e.g., intestine) or small, fragmented, external parts (e.g., pieces of shell) of the crushed/impinged animal would be entrained. These parts are extremely unlikely to be detected by ESA observers, and if detected, are likely to be too small to be identifiable as a particular species (pers. comm. Chris Slay, Coast Wise Consulting, Inc.; Trish Bargo, East Coast Observers, Inc.; April 4, 2012).

Additionally, animals may impinge on the UXO screens. Animals impinged on the UXO screen may free or dislodge themselves from the screen once the suction of the dredge has been turned off. Animals that free themselves may suffer severe injuries that may result in death. As the entire interaction occurs underwater, it would not be observed by an on-board observer. As such, in these cases, we have determined that it is not reasonable and appropriate to require endangered species observers on the dredge. As there is no practical way for on board endangered species observers to monitor the impingement/entrainment of listed species during hopper dredging operations with UXO screening in place, we explored several alternatives, for monitoring the interactions as described below.

The USACE and NMFS considered the following alternatives to (1) monitor take of listed species during hopper dredge operations with UXO screening in place or (2) modify the activity to eliminate the potential for take, thereby eliminating the need to monitor take.

1. Install a camera near the draghead: A camera installed on a draghead would allow users at the surface to observe underwater interactions. However, there are technical challenges to using video, including visibility due to water clarity and available light, improper focus, inappropriate camera angle, and the range of the viewing field. The use of video would require additional resources, and it is unlikely that it would be effective for monitoring this type of dredge work. For these dredges, turbidity levels (i.e., up to 450 mg/l) near the draghead while dredging operations are underway are too high to visually detect any animal impinged on or within the vicinity of the draghead. Therefore, this is not a reasonable and appropriate means to monitor take.

2. Use of sonar/fish finder: Sonar can be used to detect animals within the water and within the vicinity of the dredge. However, studies would need to take place to establish the signatures of sea turtles and sturgeon so that they could be readily identified electronically; this information is not currently available. As such, at this time, sonar alone could not indicate the take of an individual animal or identify the species

potentially being taken. As such, the use of such devices would not be reasonable or appropriate for monitoring take.

3. Placement of observers on the shoreline: Observers placed on the shoreline may be able to detect stranded animals either in the water or on the shore. However, animals may not strand in the direct vicinity of the operation. Injured or deceased animal may not float to the surface immediately (i.e., it may take days for this to occur) or may drift far from the incident where injury occurred. Therefore, an injured or deceased stranded animal often cannot be definitively attributed to a specific action. As such, this is not a reasonable and appropriate means to monitor take.

4. Relocation trawling: While relocation could reduce the number of sea turtles and Atlantic sturgeon in the area being dredged and therefore minimize take, using relocation trawling would not serve to monitor the number of animals affected during dredging. Additionally, while relocation trawling can minimize the number of animals in the area to be dredged and minimize the potential for take, it does not eliminate the potential for take. Therefore, we could not require relocation trawling and assume that no interactions with the dredge would occur. Therefore, while this is a good method to minimize hopper dredge takes it is not a reasonable and appropriate means to monitor take.

5. Time of year restriction: If there was a time of year when no listed species were likely to occur in the action area, dredging could be scheduled to occur in that time of year. This would eliminate the potential for take and negate the need for monitoring. However, because Atlantic sturgeon occur in the action area year round and safety and navigational concerns require dredging year-round, this is not practicable.

6. Use of alternate dredge types: The use of a mechanical dredge would eliminate the potential for sea turtle takes and would greatly reduce the number of Atlantic sturgeon takes; similar benefits could be obtained by requiring the use of a cutterhead dredge. However, the USACE chooses the type of dredge based on practical and technological constraints, including water depth, oceanic conditions, vessel traffic and maneuverability, substrate type and distance to the disposal area. Therefore, while use of alternate dredge types may minimize take, it is not practicable to require that mechanical or cutterhead dredges be used in all instances.



Both agencies agreed that none of these methods would serve to eliminate the potential for take or were reasonable or appropriate for monitoring take. In situations where individual takes cannot be observed, a proxy must be considered. This proxy must be rationally connected to the taking and provide an obvious threshold of exempted take that, if exceeded, provides a basis for reinitiating consultation. As explained in section 8.0 of this Opinion, the estimated number of sea turtles and Atlantic sturgeon to be adversely affected by this action is related to the volume of material removed via dredge, the time of year and the duration of dredging activity.

Therefore, the volume of material removed from the action area can serve as a proxy for monitoring actual take. As explained in the Effects of the Action, one sea turtle is entrained for every 300,000 cy of material dredged; one Atlantic sturgeon is entrained for every 2 mcy. This estimate provides a proxy for monitoring the amount of incidental take during hopper and cutterhead dredging operations when UXO screening is in place and direct observations of impingements cannot occur. This will be used as the primary method of determining whether incidental take has occurred; that is, we will consider that one sea turtle (Kemp's ridley or loggerhead) has been taken for every 300,000 cubic yards material removed during hopper dredging operations. Similarly, we will consider that one subadult Atlantic sturgeon has been taken for every 2.0 million cubic yards of material removed during hopper dredging operations or each time that a cutterhead dredge is used. In addition, there is a possibility that a sea turtle or an Atlantic sturgeon may remain impinged on UXO screens after the suction has been turned off. These animals can be visually observed, via a lookout, when the draghead is lifted above the water. Animals documented on the draghead by the lookout will be considered a take and this monitoring will be considered as a part of the monitoring of the actual take level. Similarly, should we receive any reports of injured or killed sea turtles or sturgeon in the area (i.e., via the STSSN) and necropsy documents that interactions with the hopper dredge operating during this project was the cause of death, we will consider those animals to be taken by this action.

As soon as the estimated number of sea turtles are observed or believed to be taken (e.g., if the total was six turtles: five takes via proxy or one observed impinged and four via proxy, etc.), any additional entrainment of a sea turtle will be considered to exceed the exempted level of take. We expect exceedance of the exempted amount of take to be unlikely given the conservative assumptions made in calculating this estimate, particularly the assumption that all hopper dredging would occur between April and November when it is much more likely that some, if not all dredging will occur outside of this time of year. Lookouts will be present on the vessel and volumes of material removed will be continuously monitored during hopper dredge operations. Therefore, take levels can be detected and assessed early in the project and, if needed, consultation can be reinitiated.

If a cutterhead dredge is used without UXO screening, inspectors will visually inspect the area where sand is being placed; this is expected to detect any Atlantic sturgeon entrained in the cutterhead dredge.

### 12.2 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 Applicable for All Dredge Activities***

1. NMFS must be contacted prior to the commencement of dredging and again upon completion of the dredging activity.

2. All dredges must be operated in a manner that will reduce the risk of interactions with sea turtles.

3. All (alive or dead) Atlantic sturgeon must have a fin clip taken for genetic analysis. This sample must be transferred to NMFS.

4. All dead loggerhead sea turtles must have a sample for genetic analysis. This sample must be transferred to NMFS.

5. Any dead sturgeon must be transferred to NMFS or an appropriately permitted research facility NMFS will identify so that a necropsy can be undertaken to attempt to determine the cause of death. Sturgeon should be held in cold storage.

6. Any dead sea turtles must be held until proper disposal procedures can be discussed with NMFS. Turtles should be held in cold storage.

7. All sturgeon and turtle captures, injuries or mortalities associated with any dredging activity and any sturgeon and sea turtle sightings in the action area must be reported to NMFS within 24 hours.

8. The ACOE shall implement measures that would reduce the number of sea turtles in the dredging channel so that the possibility of entrainment would be minimized.

***RPMs Applicable for all hopper dredges***

9. The USACE shall ensure that all 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.

***RPMs Applicable when UXO screening is not in place on a hopper dredge***

10. For all hopper dredge operations where UXO screening is not in place, a NMFS-approved observer must be present on board the hopper dredge any time it is operating. The USACE 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.

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

***RPMs Applicable when UXO screening is in place on a hopper dredge***

12. The USACE shall ensure that for all dredge operations where UXO screening is in place, a lookout/bridge watch, knowledgeable in listed species identification, will be present on board the hopper dredge at all times to inspect the draghead each time it is removed from the water.

***RPMs Applicable when UXO screening is in place on a hopper or cutterhead dredge***

13. For all hopper or cutterhead dredge operations where UXO screening is in place, USACE shall provide monthly reports to NMFS regarding the status of dredging and interactions or observations of listed species.

***RPMs Applicable when UXO screening is not in place on a cutterhead dredge***

Prior to finalizing contract specifications and initiating contract solicitation processes for new cutterhead dredging projects scheduled for calendar year 2013, the USACE must work with NMFS to develop monitoring plans for cutterhead dredges and/or dredged material disposal sites.

***RPMs Applicable during Mechanical Dredging***

14. A lookout/bridge watch must be present to observe all mechanical dredging activities where dredged material will be deposited to monitor for any capture of sturgeon.

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

### 12.3 Terms and conditions

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

1. To implement RPM #1, the USACE 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 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 USACE with any updated contact information or reporting forms.

2. To implement RPM #2, 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.

3. To implement RPM #3, the USACE must ensure that fin clips are taken (according to the procedure outlined in Appendix D) of any sturgeon captured during the project and that the fin clips are sent to NMFS for genetic analysis. Fin clips must be taken prior to preservation of other fish parts or whole bodies.

4. To implement RPM #4, if a dead loggerhead sea turtle is taken in dredging or relocation trawling operations, a genetic sample must be taken following the procedure outlined in Appendix E.

5. To implement RPM #5, in the event of any lethal takes of Atlantic 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 F (sturgeon salvage form) must be completed and submitted to NMFS.

6. To implement RPM #6, in the event of any lethal takes of sea turtles, any dead specimens or body parts must be photographed, measured, and preserved (refrigerate or freeze) until disposal procedures are discussed with NMFS.

7. To implement RPM #6, 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 USACE anticipates that they will not be counted towards the ITS) must be frozen and transported to a nearby stranding or rehabilitation facility for review. USACE 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 G) 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.

8. To implement RPM #7, the USACE must contact NMFS within 24 hours of any interactions with sturgeon or sea turtles, including non-lethal and lethal takes. NMFS will provide updated contact information when alerted of the start of dredging activity. Until alerted otherwise, the USACE should provide reports by e-mail (julie.crocker@noaa.gov) or phone (978) 282-8480 or the Section 7 Coordinator by phone (978)281-9328 or fax 978-281-9394). Take information should also be reported by e-mail to: incidental.take@noaa.gov.

9. To implement RPM #7, the USACE must photograph and measure any 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 G) must be completed and submitted to NMFS **within 24 hours** by fax (978-281-9394) or e-mail (incidental.take@noaa.gov).

10. To implement RPM #7, any time that take is greater than the estimated level of take for a particular project (e.g. annual estimate for a channel or borrow area based on the volume of material removed), USACE must immediately contact NMFS to review the situation. At that time, USACE will discuss with NMFS whether any new management measures could be implemented to prevent the total incidental take level from being exceeded and will work with NMFS to determine whether the level of take during that year represents new information revealing effects of the action that may not have been previously considered.

11. To implement RPM #7, the USACE 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).

12. To implement RPM#8, sea turtle relocation trawling must be initiated following the take of two (2) turtles (any species) in a 24-hour time period or four (4) turtles within a two month period, or in other circumstances that NMFS deems appropriate. Such circumstances include a large number of cumulative takes during the project (e.g., ½ of the anticipated incidental take level for the channel being dredged based on volume to be removed that dredge cycle), or other evidence indicating that protected species presence

is high. All trawls must follow the standard protocol described in Appendix H. The trawling and relocation survey must be initiated within 24 hours of the incidental take or the ACOE must suspend dredging operations until such trawling can be initiated. Trawling must continue for at least 5 consecutive days, unless precluded by inclement weather, after which NMFS may continue or suspend the survey. After the trawling survey is completed, the NMFS and ACOE shall immediately discuss the results of the trawling to determine if additional measures are needed to relocate turtles found in the channel.

13. To implement RPM #8, the results of each turtle take from the relocation trawl trawling survey must be recorded on the Sea Turtle Relocation Trawling Data Report (Appendix I), or a similar form including the same information. The preliminary results of the trawling survey must be submitted to NMFS immediately after the survey is completed so that NMFS can determine if additional trawling is warranted. A final report summarizing the results of the trawling and any takes of listed species must be submitted to NMFS within 30 working days of completion of the trawling survey.

14. To implement RPM #9, all hopper dredges must be equipped with the rigid deflector draghead as designed by the USACE 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.



15. To implement RPM #10, the USACE 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 J.

16. To implement RPM #10, when UXO screening is not in place, observer coverage on hopper dredges 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 USACE must ensure that USACE 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 J). No observers can be deployed to the dredge site until USACE has written confirmation from NMFS that they have met the qualifications to be a "NMFS-approved observer" as outlined in Appendix J. If substitute observers are required during dredging operations, USACE must ensure that NMFS approval is obtained before those observers are deployed on dredges.

17. To implement RPM #10, the USACE shall require of the dredge operator that, when the observer is off watch, the cage shall not be opened unless it is clogged. The USACE 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.

18. To implement RPM #11, the procedures for handling live sea turtles must be followed in the unlikely event that a sea turtle survives entrainment in the dredge (Appendix K). Any live sturgeon must be photographed, weighed and measured if possible, and released immediately overboard while the dredge is not operating.

19. To implement RPM #12, the lookout will inspect the draghead for impinged sea turtles or Atlantic sturgeon each time it is brought up from completing a dredge cycle. Should a sea turtle or Atlantic sturgeon be found impinged on the draghead, the incident should be recorded (Appendix G) and NMFS contacted.

20. To implement RPM #13, USACE will provide NMFS reports every 30 days, via email (Julie.Crocker@noaa.gov and incidental.take@noaa.gov) recording the days that dredging occurred, summaries of the bridge watch reports on draghead inspection, the volume of material removed during the previous 30 day period and any observations of listed species.

21. To implement RPM #14, USACE will schedule a meeting with NMFS prior to finalizing contract specifications and initiating contract solicitation processes for new cutterhead dredging projects scheduled for calendar year 2013 to determine the scope of a monitoring plan. This monitoring plan must be agreed to by NMFS prior to initiation of contracting processes and must be implemented in all subsequent cutterhead dredge contracts, unless modified by agreement of USACE and NMFS. The goal of the monitoring plan will be to accurately determine entrainment of Atlantic sturgeon in future cutterhead dredging projects when no UXO screening is in place.

22. To implement RPM#15, for mechanical dredging USACE must require a lookout to watch for captured sturgeon in the dredge bucket and to monitor the scow/hopper for sturgeon. Any interactions with sturgeon must be reported to NMFS as required by RPM #5.

23. To implement RPM #16, any sturgeon observed in the dredge scow/hopper during mechanical dredging operations must be removed with a net and, if alive, returned to the water away from the dredge site.



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 us informed of when and where dredging activities are taking place and will require USACE to report any take in a reasonable amount of time, as well as implement measures to monitor for entrainment during dredging. USACE 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. We have determined that all 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 represent only a minor change to the action as proposed by the USACE.

## 13.0 CONSERVATION RECOMMENDATIONS

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

(1) To the extent practicable, the USACE should avoid dredging in the spring (March-May) and fall (September – November) when listed species are most likely to occur in the action area.

(2) The USACE should conduct studies in conjunction with cutterhead dredging where disposal occurs on the beach to assess the potential for improved screening to: (1) establish the type and size of biological material that may be entrained in the cutterhead dredge, and (2) verify that monitoring the disposal site without screening is providing an accurate assessment of entrained material.

(3) The USACE should support studies to determine the effectiveness of using a sea turtle deflector to minimize the potential entrainment of sturgeon during hopper dredging.

(4) The USACE should explore alternative means for monitoring for interactions with listed species when UXO screening is in place including exploring the potential for video or other electronic monitoring.



## 14.0 REINITIATION OF CONSULTATION

This concludes formal consultation on the proposed action. 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.

As noted in Section 2.0, in the future, reinitiation of consultation may be necessary (see 50 CFR§

402.16). Depending on the circumstances associated with the cause for reinitiation, it may not be necessary to reinitiate consultation for all of the actions considered here. For example, if a new species is listed that may be affected by dredging activities, it would likely be necessary to reinitiate consultation on all of the activities considered here. However, if the cause for reinitiation has effects that are limited to one action (for example, a change in dredge type, dredge volume or disposal area), reinitiation of consultation on only that action would be necessary. We expect that determinations about the scope of any future reinitiation(s) will be made in cooperation between the USACE and us.

## 15.0 LITERATURE CITED


Allen PJ, Nicholl M, Cole S, Vlazny A, Cech JJ Jr. 2006. Growth of larval to juvenile green sturgeon in elevated temperature regimes. Trans Am Fish Soc 135:89–96

Anchor Environmental. 2003. Literature review of effects of resuspended sediments due to dredging. June. 140pp.

Andrews, H.V., and K. Shanker. 2002. A significant population of leatherback turtles in the Indian Ocean. Kachhapa 6:19.

Andrews, H.V., S. Krishnan, and P. Biswas. 2002. Leatherback nesting in the Andaman and Nicobar Islands. Kachhapa 6:15-18.

Antonelis, G.A., J.D. Baker, T.C. Johanos, R.C. Braun and A.L. Harting. 2006. Hawaiian monk seal (Monachus schauinslandi): status and conservation issues. Atoll Research Bulletin 543: 75-101

ASMFC (Atlantic States Marine Fisheries Commission). 2002. Amendment 4 to the Interstate Fishery Management Plan for weakfish. Fishery Management Report No. 39. Washington, D.C.: Atlantic States Marine Fisheries Commission.

ASMFC (Atlantic States Marine Fisheries Commission). 2009. Atlantic Sturgeon. In: Atlantic Coast Diadromous Fish Habitat: A review of utilization, threats, recommendations for conservation and research needs. Habitat Management Series No. 9. Pp. 195-253.

ASSRT (Atlantic Sturgeon Status Review Team). 2007. Status review of Atlantic sturgeon (Acipenser oxyrinchus oxyrinchus). National Marine Fisheries Service. February 23, 2007. 188 pp.

Attrill, M.J., J. Wright, and M. Edwards. 2007. Climate-related increases in jellyfish frequency suggest a more gelatinous future for the North Sea. Limnology and Oceanography 52:480-485.

Avens, L., J.C. Taylor, L.R. Goshe, T.T. Jones, and M. Hastings. 2009. Use of skeletochronological analysis to estimate the age of leatherback sea turtles Dermochelys coriacea in the western North Atlantic. Endangered Species Research 8:165-177.

Ayers, M.A. et al. 1994. Sensitivity of Water Resources in the Delaware River Basin to Climate Variability and Change. USGS Water Supply Paper 2422. 21 pp.

Bain, M. B. 1997. Atlantic and shortnose sturgeons of the Hudson River: Common and Divergent Life History Attributes. Environmental Biology of Fishes 48: 347-358.

Bain, M., K. Arend, N. Haley, S. Hayes, J. Knight, S. Nack, D. Peterson, and M. Walsh. 1998a. Sturgeon of the Hudson River: Final Report on 1993-1996 Research. Prepared for The Hudson River Foundation by the Department of Natural Resources, Cornell University, Ithaca, New York.

Bain, M.B., N. Haley, D. Peterson, J. R. Waldman, and K. Arend. 2000. Harvest and habitats of Atlantic sturgeon Acipenser oxyrinchus Mitchill, 1815, in the Hudson River Estuary: Lessons for Sturgeon Conservation. Instituto Espanol de Oceanografia. Boletin 16: 43-53.

Bain, Mark B., N. Haley, D. L. Peterson, K. K Arend, K. E. Mills, P. J. Sulivan. 2007. Recovery of a US Endangered Fish. PLoS ONE 2(1): e168. doi:10.1371/journal.pone.0000168

Bain, Mark B., N. Haley, D. L. Peterson, K. K. Arend, K. E. Mills, P. J. Sullivan. 2000. Annual meeting of American fisheries Society. EPRI-AFS Symposium: Biology, Management and Protection of Sturgeon. St. Louis, MO. 23-24 August 2000.

Baker, J.D., C.L. Littnan, and D.W. Johnston. 2006. Potential effects of sea level rise on the terrestrial habitats of endangered and endemic megafauna in the Northwestern Hawaiian Islands. Endangered Species Research 2:21-30.

Balazs, G.H. 1982. Growth rates of immature green turtles in the Hawaiian Archipelago, p. 117-125. In K.A. Bjorndal (ed.), Biology and Conservation of Sea Turtles. Smithsonian Institution Press, Washington, D.C.

Balazs, G.H. 1985. Impact of ocean debris on marine turtles: entanglement and ingestion. U.S. Department of Commerce, NOAA Tech. Memo. NMFS-SWFSC-54:387-429.

Baldwin, R., G.R. Hughes, and R.T. Prince. 2003. Loggerhead turtles in the Indian Ocean. Pages 218-232. In: A.B. Bolten and B.E. Witherington (eds.) Loggerhead Sea Turtles. Smithsonian Books, Washington, D.C. 319 pp.

Bartol, S.M., J.A. Musick, and M.L. Lenhardt. 1999. Auditory evoked potentials of the loggerhead sea turtle (Caretta caretta). Copeia, 3: 836-840.

Bass, A.L., S.P. Epperly, and J. Braun-McNeill. 2004. Multi-year analysis of stock composition of a loggerhead turtle (Caretta caretta) foraging habitat using maximum likelihood and Bayesian methods. Conservation Genetics 5:783-796.

Bath, D.W., J.M. O'Conner, J.B. Albert and L.G. Arvidson. 1981. Development and identification of larval Atlantic sturgeon (Acipenser oxyrinchus) and shortnose sturgeon (A. brevirostrum) from the Hudson River estuary, New York. Copeia 1981:711-717.

Beamesderfer, Raymond C.P. and Ruth A. Farr. 1997. Alternatives for the protection and restoration of sturgeons and their habitat. Environmental Biology of Fishes 48: 407-417.

Belanger, S.E., J.L. Farris, D.S. Cherry, and J. Cairns, Jr. 1985. Sediment preference of the freshwater Asiatic clam, Corbicula fluminea. The Nautilus 99(2-3):66-73.

Berlin, W.H., R.J. Hesselberg, and M.J. Mac. 1981. Chlorinated hydrocarbons as a factor in the reproduction and survival of lake trout (Salvelinus namaycush) in Lake Michigan. Technical Paper 105 of the U.S. Fish and Wildlife Service, 42 pages.

Bigelow, H.B. and W.C. Schroeder. 1953. Sea Sturgeon. In: Fishes of the Gulf of Maine. Fishery Bulletin 74. Fishery Bulletin of the Fish and Wildlife Service, vol. 53.

Bilkovic, D.M, Angstadt, K. and D. Stanhope. 2009. Atlantic Sturgeon Spawning Habitat on the James River, Virginia: Final Report to NOAA/NMFS Chesapeake Bay Office. Virginia Institute of Marine Science, Gloucester Point, Virginia.

Birstein, V.J., Bemis, W.E. and J.R. Waldman. 1997. The threatened status of acipenseriform species: a summary. Environmental Biology of Fishes 48: 427-435.

Bjork, M., F. Short, E. McLeod, and S. Beers. 2008. Managing seagrasses for resilience to climate change. IUCN, Gland.

Bjorndal, K.A. 1997. Foraging ecology and nutrition of sea turtles. Pages 199-233 In: Lutz, P.L. and J.A. Musick, eds., The Biology of Sea Turtles. CRC Press, New York. 432 pp.

Blalock, H.N., and J.J. Herod. 1999. A comparative study of stream habitat and substrate utilized by Corbicula flumineain the New River, Florida. Florida Scientist 62:145-151.

Blumenthal, J.M., J.L. Solomon, C.D. Bell, T.J. Austin, G. Ebanks-Petrie, M.S. Coyne, A.C. Broderick, and B.J. Godley. 2006. Satellite tracking highlights the need for international cooperation in marine turtle management. Endangered Species Research 2:51-61.

Bolten, A.B. 2003. Variation in sea turtle life history patterns: neritic vs. oceanic developmental stages. Pages 243-257 in P.L. Lutz, J.A. Musick, and J. Wyneken, eds. The Biology of Sea Turtles, Vol. 2. Boca Raton, Florida: CRC Press.

Bolten, A.B., J.A. Wetherall, G.H. Balazs, and S.G. Pooley (compilers). 1996. Status of marine turtles in the Pacific Ocean relevant to incidental take in the Hawaii-based pelagic longline fishery. U.S. Dept. of Commerce, NOAA Technical Memorandum, NOAA-TM-NOAA Fisheries SWFSC-230.

Bolten, A.B., K.A. Bjorndal, H.R. Martins, T. Dellinger, M.J. Biscoito, S.E. Encalada, and B.W. Bowen. 1998. Transatlantic developmental migrations of loggerhead sea turtles demonstrated by mtDNA sequence analysis. Ecological Applications 8(1):1-7.

Boreman, J. 1997. Sensitivity of North American sturgeons and paddlefish to fishing mortality. Environmental Biology of Fishes 48: 399-405.

Borodin, N. 1925. Biological observations on the Atlantic sturgeon, Acipenser sturio.Transactions of the American Fisheries Society 55: 184-190.

Boulon, R., Jr. 2000. Trends in sea turtle strandings, U.S. Virgin Islands: 1982 to 1997. U.S. Department of Commerce, NOAA Technical Memorandum NMFS-SEFSC-436:261-263.

Bowen, B.W. 2003. What is a loggerhead turtle? The genetic perspective. Pages 7-27 in A.B. Bolten and B.E. Witherington, (eds). Loggerhead Sea Turtles. Washington, D.C.: Smithsonian Press.

Bowen, B.W. , A. L. Bass, S. Chow, M. Bostrom, K. A.Bjorndal, A. B. Bolten, T. Okuyama, B. M. Bolker, S.Epperley, E. Lacasella, D. Shaver, M. Dodd, S. R. Hopkins-Murphy, J. A. Musick, M. Swingle, K. Rankin-Baransky, W. Teas, W. N. Witzell, and P. H. Dutton. 1992. Natal homing in juvenile loggerhead turtles (Caretta caretta). Molecular Ecology (2004) 13: 3797-3808.

Bowen, B.W., A.L. Bass, L. Soares, and R.J. Toonen. 2005. Conservation implications of complex population structure: lessons from the loggerhead turtle (Caretta caretta). Molecular Ecology 14:2389-2402.

Bowen, B.W., and S.A. Karl. 2007. Population genetics and phylogeography of sea turtles. Molecular Ecology 16:4886-4907.

Boysen, K. A. and Hoover, J. J. (2009), Swimming performance of juvenile white sturgeon (Acipenser transmontanus): training and the probability of entrainment due to dredging. Journal of Applied Ichthyology, 25: 54–59.

Braun, J., and S.P. Epperly. 1996. Aerial surveys for sea turtles in southern Georgia waters, June 1991. Gulf of Mexico Science 1996(1):39-44.

Braun-McNeill, J. , C.R. Sasso, S.P.Epperly, C. Rivero. 2008. Feasibility of using sea surface temperature imagery to mitigate cheloniid sea turtle–fishery interactions off the coast of northeastern USA. Endangered Species Research: Vol. 5: 257–266, 2008.

Braun-McNeill, J., and S.P. Epperly. 2004. Spatial and temporal distribution of sea turtles in the western North Atlantic and the U.S. Gulf of Mexico from Marine Recreational Fishery Statistics Survey (MRFSS). Marine Fisheries Review 64(4):50-56.

Brewer, K., M. Gallagher, P. Regos, P. Isert, and J. Hall. 1993. Kuvlum #1 Exploration Prospect: Site Specific Monitoring Program, Final Report. Prepared by Coastal Offshore Pacific Corporation, Walnut Creek, CA, for ARCO Alaska, Inc., Anchorage, AK. 80pp.

Brodeur, R.D., C.E. Mills, J.E. Overland, G.E. Walters, and J.D. Schumacher. 1999. Evidence for a substantial increase in gelatinous zooplankton in the Bering Sea, with possible links to climate change. Fisheries Oceanography 8(4):296-306.

Brown, J.J. and G.W. Murphy. 2010. Atlantic sturgeon vessel strike mortalities in the Delaware River. Fisheries 3 5(2):7 2-83.

Brundage, H. 1986. Radio tracking studies of shortnose sturgeon in the Delaware River for the Merrill Creek Reservoir Project, 1985 Progress Report. V.J. Schuler Associates, Inc.

Brundage, H.M. and J. C. O'Herron. 2009. Investigations of juvenile shortnose and Atlantic sturgeons in the lower tidal Delaware River. Bull. N.J. Acad. Sci. 54(2), pp1-8.Weber, RG. 2001. Preconstruction Horeshoe Crab Egg Density Monitoring and Habitat Availability at Kelly Island, Port Mahon and Broadkill Beach Study Areas, Delaware. Submitted to the USACE Philadelphia District. Available at: http://www.nap.usace.army.mil/cenap-pl/b10.pdf

Brundage, H.M. and R.E. Meadows. 1982. The Atlantic sturgeon in the Delaware River estuary.Fisheries Bulletin 80:337-343.

Brundage, H.M., III and R.E. Meadows. 1982a. Occurrence of the endangered shortnose sturgeon, Acipenser brevirostrum, in the Delaware River estuary. Estuaries 5:203-208.

Bryant, L.P. 2008. Governor's Commission on Climate Change. Final Report: A Climate Change Action Plan. Virginia Department of Environmental Quality.

Burlas, M., G. L Ray, & D. Clarke. 2001. The New York District's Biological Monitoring Program for the Atlantic Coast of New Jersey, Asbury Park to Manasquan Section Beach Erosion Control Project. Final Report. U.S. Army Engineer District, New York and U.S. Army Engineer Research and Development Center, Waterways Experiment Station.

Burton, W. 1993. Effects of bucket dredging on water quality in the Delaware River and the potential for effects on fisheries resources. Prepared by Versar, Inc. for the Delaware Basin Fish and Wildlife Management Cooperative, unpublished report. 30 pp.

Burton, W.H. 1994. Assessment of the Effects of Construction of a Natural Gas Pipeline on American Shad and Smallmouth Bass Juveniles in the Delaware River. Prepared by Versar, Inc.for Transcontinental Gas Pipe Line Corporation.

Bushnoe, T. M., Musick, J.A. and D.S. Ha. 2005. Essential spawning and nursery habitat of Atlantic sturgeon (*Acipenser oxyrinchus*) in Virginia. Provided by Jack Musick, Virginia Institute of Marine Science, Gloucester Point, Virginia.

Caillouet, C., C.T. Fontaine, S.A. Manzella-Tirpak, and T.D. Williams. 1995. Growth of head-started Kemp's ridley sea turtles (Lepidochelys kempi) following release. Chelonian Conservation and Biology. 1(3):231-234.

Cameron, P., J. Berg, V. Dethlefsen, and H. Von Westernhagen. 1992. Developmental defects in pelagic embryos of several flatfish species in the southern north-sea. Netherlands Journal of Sea Research 29: 239-256.

Cameron, S. 2012. "Assessing the Impacts of Channel Dredging on Atlantic Sturgeon Movement and Behavior". Presented to the Virginia Atlantic Sturgeon Partnership Meeting. Charles City, Virginia. March 19, 2012.

Carlson, D.M., and K.W. Simpson. 1987. Gut contents of juvenile shortnose sturgeon in the upper Hudson estuary. Copeia 1987:796-802

Caron, F., D. Hatin, and R. Fortin. 2002. Biological characteristics of adult Atlantic sturgeon (Acipenser oxyrinchus) in the Saint Lawrence River estuary and the effectiveness of management rules. Journal of Applied Ichthyology 18: 580-585.

Carr, A.R. 1963. Pan specific reproductive convergence in Lepidochelys kempi. Ergebn. Biol. 26: 298-303.

Carreras, C., S. Pont, F. Maffucci, M. Pascual, A. Barceló, F. Bentivegna, L. Cardona, F. Alegre, M. SanFélix, G. Fernández, and A. Aguilar. 2006. Genetic structuring of immature loggerhead sea turtles (Caretta caretta) in the Mediterranean Sea reflects water circulation patterns. Marine Biology 149:1269-1279.

Casale, P., P. Nicolosi, D. Freggi, M. Turchetto, and R. Argano. 2003. Leatherback turtles (Dermochelys coriacea) in Italy and in the Mediterranean basin. Herpetological Journal 13: 135-139.

Castroviejo, J., J.B. Juste, J.P. Del Val, R. Castelo, and R. Gil. 1994. Diversity and status of sea turtle species in the Gulf of Guinea islands. Biodiversity and Conservation 3: 828-836.

Cetacean and Turtle Assessment Program (CeTAP). 1982. Final report of the cetacean and turtle assessment program, University of Rhode Island, to Bureau of Land Management, U.S. Department of the Interior. Ref. No. AA551-CT8-48. 568 pp.

Chan, E.H., and H.C. Liew. 1996. Decline of the leatherback population in Terengganu, Malaysia, 1956-1995. Chelonian Conservation and Biology 2(2): 192-203.

Chevalier, J., X. Desbois, and M. Girondot. 1999. The reason for the decline of leatherback turtles (Dermochelys coriacea) in French Guiana: a hypothesis p.79-88. In Miaud, C. and R. Guyétant (eds.), Current Studies in Herpetology, Proceedings of the ninth ordinary general meeting of the Societas Europea Herpetologica, 25-29 August 1998 Le Bourget du Lac, France.

Church, J., J.M. Gregory, P. Huybrechts, M. Kuhn, K. Lambeck, M.T. Nhuan, D. Qin, P.L. Woodworth. 2001. Changes in sea level. In: Houghton, J.T., Y. Ding, D.J. Griggs, M. Noguer, P.J. Vander Linden, X. Dai, K. Maskell, C.A. Johnson CA (eds.) Climate change 2001: the scientific basis. Contribution of Working Group I to the Third Assessment Report of the Intergovernmental Panel on Climate Change. Cambridge University Press, Cambridge, p 639–694

Clarke, D. 2011. Sturgeon Protection. Presented to the Dredged Material Assessment and Management Seminar 24-26 May, 2011 Jacksonville, FL

Clarke, D. G., and Wilber, D. H. 2000. Assessment of potential impacts of dredging operations due to sediment resuspension. DOER Technical Notes Collection. U.S. Army Engineer Research and Development Center, Vicksburg, MS.

Clausner, J.; Jones, D., 2004: Prediction of flow fields near the intakes of hydraulic dredges. Web based tool. Dredging Operation and Environmental Research (DOER) Program. U.S. Army Engineer Research and Development Center, Vicksburg, MS. Available at: http://el.erdc.usace.army.mil/dots/doer/flowfields/dtb350.html

Cliffton, K., D.O. Cornejo, and R.S. Felger. 1982. Sea turtles of the Pacific coast of Mexico. Pages 199-209 in K.A. Bjorndal, ed. Biology and Conservation of Sea Turtles. Washington, D.C.: Smithsonian Institution Press.

Colligan, M., Collins, M., Hecht, A., Hendrix, M., Kahnle, A., Laney, W., St. Pierre, R., Santos, R., and Squiers, T. 1998. Status Review of Atlantic sturgeon *(Acipenser oxyrinchus oxyrinchus).* U.S. Department of the Interior and U.S. Department of Commerce.

Collins, M. R., and T. I. J. Smith. 1997. Distribution of shortnose and Atlantic sturgeons in South Carolina. North American Journal of Fisheries Management 17: 995-1000.

Collins, M. R., S. G. Rogers, and T. I. J. Smith. 1996. Bycatch of sturgeons along the Southern Atlantic Coast of the USA. North American Journal of Fisheries Management 16: 24-29.

Collins, M.R., T.I.J. Smith, W.C. Post, and O. Pashuk. 2000. Habitat Utilization and Biological Characteristics of Adult Atlantic Sturgeon in Two South Carolina Rivers. Transactions of the American Fisheries Society 129: 982–988.

Conant, T.A., P.H. Dutton, T. Eguchi, S.P. Epperly, C.C. Fahy, M.H. Godfrey, S.L. MacPherson, E.E. Possardt, B.A. Schroeder, J.A. Seminoff, M.L. Snover, C.M. Upite, and B.E. Witherington. 2009. Loggerhead sea turtle (Caretta caretta) 2009 status review under the U.S. Endangered Species Act. Report of the Loggerhead Biological Review Team to the National Marine Fisheries Service, August 2009. 222 pp.

Coutant, C.C., 1987. Thermal preference: when does an asset become a liability? Environmental Biology of Fishes 18:161-172.

Coyne, M. and A.M. Landry, Jr. 2007. Population sex ratios and its impact on population models. In: Plotkin, P.T. (editor). Biology and Conservation of Ridley Sea Turtles. Johns Hopkins University Press, Baltimore, Maryland. p. 191-211.

Coyne, M.S. 2000. Population Sex Ratio of the Kemp's Ridley Sea Turtle (Lepidochelys kempii): Problems in Population Modeling. PhD Thesis, Texas A&M University. 136pp.

Crance, J. H. 1987. Habitat suitability index curves for anadromous fishes. In: Common Strategies of Anadromous and Catadromous Fishes, M. J. Dadswell (ed.). Bethesda, Maryland, American Fisheries Society. Symposium 1: 554.

Dadswell, M. 2006. A review of the status of Atlantic sturgeon in Canada, with comparisons to populations in the United States and Europe. Fisheries 31: 218-229.

Damon-Randall, K. et al. 2010. Atlantic sturgeon research techniques. NOAA Technical Memorandum NMFS-NE-215. Available at: http://www.nero.noaa.gov/prot_res/atlsturgeon/tm215.pdf

Damon-Randall, K., M. Colligan, and J. Crocker. 2012. Composition of Atlantic Sturgeon in Rivers, Estuaries, and in Marine Waters. National Marine Fisheries Service, NERO, Unpublished Report. 32 pages.

Daniels, R.C., T.W. White, and K.K. Chapman. 1993. Sea-level rise: destruction of threatened and endangered species habitat in South Carolina. Environmental Management 17(3):373-385.

Davenport, J. 1997. Temperature and the life-history strategies of sea turtles. Journal of Thermal Biology 22(6):479-488.

Davenport, J., and G.H. Balazs. 1991. ‘Fiery bodies’ – Are pyrosomas an important component of the diet of leatherback turtles? British Herpetological Society Bulletin 37: 33-38.

Dees, L. T. 1961. Sturgeons. United States Department of the Interior Fish and Wildlife Service, Bureau of Commercial Fisheries, Washington, D.C.

DFO (Fisheries and Oceans Canada). 2011. Atlantic sturgeon and shortnose sturgeon. Fisheries and Oceans Canada, Maritimes Region. Summary Report. U.S. Sturgeon Workshop, Alexandria, VA, 8-10 February, 2011. 11pp.

Diaz, R.J. 1994. Response of tidal freshwater macrobenthos to sediment disturbance. Hydrobiologia 278: 201-212.

Dodd, C.K. 1988. Synopsis of the biological data on the loggerhead sea turtle Caretta caretta (Linnaeus 1758). U.S. Fish and Wildlife Service Biological Report 88(14):1-110.

Dodd, M. 2003. Northern Recovery Unit - Nesting Female Abundance and Population Trends. Presentation to the Atlantic Loggerhead Sea Turtle Recovery Team, April 2003.

Doughty, R.W. 1984. Sea turtles in Texas: A forgotten commerce. Southwestern Historical Quarterly. pp. 43-70.

Dovel, W. L. and T. J. Berggren. 1983. Atlantic sturgeon of the Hudson River Estuary, New York. New York Fish and Game Journal 30: 140-172.

Dovel, W.J. 1978. The Biology and management of shortnose and Atlantic sturgeons of the Hudson River. Performance report for the period April 1, to September 30, 1978. Submitted to N.Y. State Department of Environmental Conservation.

Dovel, W.J. 1979. Biology and management of shortnose and Atlantic sturgeon of the Hudson River. New York State Department of Environmental Conservation, AFS9-R, Albany.

Duarte, C.M. 2002. The future of seagrass meadows. Environmental Conservation 29:192-206.

Dunton, K.J., A. Jordaan, K.A. McKown, D.O. Conover, and M.J. Frisk. 2010. Abundance and distribution of Atlantic sturgeon (Acipenser oxyrinchus oxyrinchus) within the Northwest Atlantic Ocean, determined from five fishery-independent surveys. Fishery Bulletin 108:450-465.

Durbin, E, G. Teegarden, R. Campbell, A. Cembella, M.F. Baumgartner, B.R. Mate. 2002. North Atlantic right whales, Eubalaena glacialis, exposed to Paralytic Shellfish Poisoning (PSP) toxins via a zooplankton vector, Calanus finmarchicus. Harmful Algae 1: 243-251.

Dutton, P.H., B.W. Bowen, D.W. Owens, A. Barragan, and S.K. Davis. 1999. Global phylogeography of the leatherback turtle (Dermochelys coriacea). Journal of Zoology 248: 397-409.

Dutton, P.H., C. Hitipeuw, M. Zein, S.R. Benson, G. Petro, J. Pita, V. Rei, L. Ambio, and J. Bakarbessy. 2007. Status and genetic structure of nesting populations of leatherback turtles (Dermochelys coriacea) in the Western Pacific. Chelonian Conservation and Biology 6(1):47-53.

Dwyer, F. James, Douglas K. Hardesty, Christopher G. Ingersoll, James L. Kunz, and David W. Whites. 2000. Assessing contaminant sensitivity of American shad, Atlantic sturgeon, and shortnose sturgeon. Final Report. U.S. Geological Survey. Columbia Environmental Research Center, 4200 New Have Road, Columbia, Missouri.

Dwyer, K.L., C.E. Ryder, and R. Prescott. 2002. Anthropogenic mortality of leatherback sea turtles in Massachusetts waters. Poster presentation for the 2002 Northeast Stranding Network Symposium.

Eckert, S.A. 1999. Global distribution of juvenile leatherback turtles. Hubbs Sea World Research Institute Technical Report 99-294.

Eckert, S.A. and J. Lien. 1999. Recommendations for eliminating incidental capture and mortality of leatherback sea turtles, Dermochelys coriacea, by commercial fisheries in Trinidad and Tobago. A report to the Wider Caribbean Sea Turtle Conservation Network (WIDECAST). Hubbs-Sea World Research Institute Technical Report No. 2000-310, 7 pp.

Eckert, S.A., D. Bagley, S. Kubis, L. Ehrhart, C. Johnson, K. Stewart, and D. DeFreese. 2006. Internesting and postnesting movements of foraging habitats of leatherback sea turtles (Dermochelys coriacea) nesting in Florida. Chel. Cons. Biol. 5(2): 239-248.

Ehrhart, L.M., D.A. Bagley, and W.E. Redfoot. 2003. Loggerhead turtles in the Atlantic Ocean: geographic distribution, abundance, and population status. Pages 157-174 in A.B. Bolten and B.E. Witherington, eds. Loggerhead Sea Turtles. Washington, D.C.: Smithsonian Institution Press.

Ehrhart. L.M., W.E. Redfoot, and D.A. Bagley. 2007. Marine turtles of the central region of the Indian River Lagoon System, Florida. Florida Scientist 70(4): 415-434.

Encyclopedia Britannica. 2010. Neritic Zone. Accessed 12 January 2010. http://www.britannica.com/eb/article-9055318.

Environmental Protection Agency (EPA). 1986. Quality Criteria for Water. EPA 440/5-86-001.

Epperly, S., L. Avens, L. Garrison, T. Henwood, W. Hoggard, J. Mitchell, J. Nance, J. Poffenberger, C. Sasso, E. Scott-Denton, and C. Yeung. 2002. Analysis of sea turtle bycatch in the commercial shrimp fisheries if southeast U.S. waters and the Gulf of Mexico. U.S. Department of Commerce, NOAA Tech. Memo. NMFS-SEFSC-490, 88pp.

Epperly, S.P. 2003. Fisheries-related mortality and turtle excluder devices. In: P.L. Lutz, J.A.

Epperly, S.P. and J. Braun-McNeill. 2002. The use of AVHRR imagery and the management of sea turtle interactions in the Mid-Atlantic Bight. National Marine Fisheries Service, Southeast Fisheries Science Center, Miami, FL. 8pp.

Epperly, S.P., and W.G. Teas. 2002. Turtle Excluder Devices - Are the escape openings large enough? Fishery Bulletin 100:466-474.

Epperly, S.P., J. Braun, A.J. Chester, F.A. Cross, J.V. Merriner and P.A. Tester. 1995b. Winter distribution of sea turtles in the vicinity of Cape Hatteras and their interactions with the summer flounder trawl fishery. Bull. of Marine Sci. 56(2): 547-568.

Epperly, S.P., J. Braun, and A. Veishlow. 1995c. Sea turtles in North Carolina waters. Conservation Biology 9(2):384-394.

Epperly, S.P., J. Braun, and A.J. Chester. 1995a. Aerial surveys for sea turtles in North Carolina inshore waters. Fishery Bulletin 93:254-261.

Epperly, S.P., J. Braun-McNeill, and P.M. Richards. 2007. Trends in catch rates of sea turtles in North Carolina, USA. Endangered Species Research 3: 283-293.

ERC (Environmental Research and Consulting, Inc.) 2012. Acoustic telemetry study of the movements of juvenile sturgeons in reach B of the Delaware River during dredging operations. Prepared for the US Army Corps of Engineers. 38 pp.

ERC, Inc. (Environmental Research and Consulting, Inc.). 2002. Contaminant analysis of tissues from two shortnose sturgeon (Acipenser brevirostrum) collected in the Delaware River. Prepared for National Marine Fisheries Service. 16 pp. + appendices.

ERC, Inc. (Environmental Research and Consulting, Inc.). 2007. Preliminary acoustic tracking study of juvenile shortnose sturgeon and Atlantic sturgeon in the Delaware River. May 2006 through March 2007. Prepared for NOAA Fisheries. 9 pp.

Erickson, D. L., A. Kahnle, M. J. Millard, E. A. Mora, M. Bryja, A. Higgs, J. Mohler, M. DuFour, G. Kenney, J. Sweka, and E. K. Pikitch. 2011. Use of pop-up satellite archival tags to identify oceanic-migratory patterns for adult Atlantic Sturgeon, Acipenser oxyrinchus oxyrinchus Mitchell, 1815. J. Appl. Ichthyol. 27: 356–365.

Ernst, C.H. and R.W. Barbour. 1972. Turtles of the United States. Univ. Press of Kentucky, Lexington. 347 pp.

Eyler, S., M. Mangold, and S. Minkkinen. 2004. Atlantic coast sturgeon tagging database. USFWS, Maryland Fishery Resources Office. Summary Report. 60 pp.

Eyler, Sheila M., Jorgen E. Skjeveland, Michael F. Mangold, and Stuart A. Welsh. 2000. Distribution of Sturgeons in Candidate Open Water Dredged Material Placement Sites in the Potomac River (1998-2000). U.S. Fish and Wildlife Service, Annapolis, MD. 26 pp.

Fernandes, S.J. 2008. Population demography, distribution, and movement patterns of Atlantic and shortnose sturgeons in the Penobscot River estuary, Maine. University of Maine. Masters thesis. 88 pp.

Ferreira, M.B., M. Garcia, and A. Al-Kiyumi. 2003. Human and natural threats to the green turtles, Chelonia mydas, at Ra's al Hadd turtle reserve, Arabian Sea, Sultanate of Oman. Page 142 in J.A. Seminoff, compiler. Proceedings of the Twenty-Second Annual Symposium on Sea Turtle Biology and Conservation. NOAA Technical Memorandum NMFS-SEFSC-503.

Finkbeiner, E.M., B.P. Wallace, J.E. Moore, R.L. Lewison, L.B. Crowder, and A.J. Read. 2011. Cumulative estimates of sea turtle bycatch and mortality in USA fisheries between 1990 and 2007. Biological Conservation 144(11): 2719-2727.

Fish, M.R., I.M. Cote, J.A. Gill, A.P. Jones, S. Renshoff, and A.R. Watkinson. 2005. Predicting the impact of sea-level rise on Caribbean sea turtle nesting habitat. Conservation Biology 19:482-491.

Flournoy, P.H., S.G. Rogers, and P.S. Crawford. 1992. Restoration of shortnose sturgeon in the Altamaha River, Georgia. Final Report to the U.S. Fish and Wildlife Service, Atlanta, Georgia.

Fox, D.A. and M.W. Breece. 2010. Atlantic sturgeon (Acipenser oxyrinchus oxyrinchus) in the New York Bight DPS: Identification of critical habitat and rates of interbasin exchange; Final Report Submitted to NOAA (Award NA08NMF4050611). 62 p.

FPL (Florida Power and Light Company) and Quantum Resources. 2005. Florida Power and Light Company, St. Lucie Plant Annual Environmental Operating Report, 2002. 57 pp.

Frazer, N.B., and L.M. Ehrhart. 1985. Preliminary growth models for green, Chelonia mydas, and loggerhead, Caretta caretta, turtles in the wild. Copeia 1985: 73-79.

Fritts, T.H. 1982. Plastic bags in the intestinal tracts of leatherback marine turtles. Herpetological Review 13(3): 72-73.2003. 9pp.

Gagosian, R.B. 2003. Abrupt climate change: should we be worried? Prepared for a panel on abrupt climate change at the World Economic Forum, Davos, Switzerland, January 27,

Garner, J.A, and S.A. Garner. 2007. Tagging and nesting research of leatherback sea turtles (Dermochelys coriacea) on Sandy Point St. Croix, U.S. Virgin Islands. Annual Report to U.S. Fish and Wildlife Service. WIMARCS Publication.

Garrison, L.P., and L. Stokes. 2012. Estimated bycatch of marine mammals and sea turtles in the U.S. Atlantic pelagic longline fleet during 2010. NOAA Technical Memorandum NMFS-SEFSC-624:1-53.

GCRP (U.S. Global Change Research Program). 2009. Global Climate Change Impacts in the United States.http://www.globalchange.gov/usimpacts

Geoghegan, P., M.T. Mattson and R.G Keppel. 1992. Distribution of shortnose sturgeon in the Hudson River, 1984-1988. IN Estuarine Research in the 1980s, C. Lavett Smith, Editor. Hudson River Environmental Society, Seventh symposium on Hudson River ecology. State University of New York Press, Albany NY, USA.

George, R.H. 1997. Health Problems and Diseases of Sea Turtles. Pages 363-386 in P.L. Lutz and J.A. Musick, eds. The Biology of Sea Turtles. Boca Raton, Florida: CRC Press.

Germano, J. D., and Cary, D. 2005. "Rates and effects of sedimentation in the context of dredging and dredged material placement," *DOER Technical Notes Collection* (ERDC TN-DOER-E19), U.S. Army Engineer Research and Development Center, Vicksburg, MS.

GHD. 2005. Port of Hay Point Apron Areas and Departure Path Capital Dredging: Draft EIS. GHD Pty Ltd.

Giesy, J.P., J. Newsted, and D.L. Garling. 1986. Relationships between chlorinated hydrocarbon concentrations and rearing mortality of chinook salmon (Oncorhynchus tshawytscha) eggs from Lake Michigan. Journal of Great Lakes Research 12(1):82-98.

Gilbert, C.R. 1989. Atlantic and shortnose sturgeons. United States Department of Interior Biological Report 82, 28 pages.

Girondot, M. and J. Fretey. 1996. Leatherback turtles, Dermochelys coriacea, nesting in French Guiana 1978-1995. Chelonian Conserv Biol 2: 204–208.

Girondot, M., M.H. Godfrey, L. Ponge, and P. Rivalan. 2007. Modeling approaches to quantify leatherback nesting trends in French Guiana and Suriname. Chelonian Conservation and Biology 6(1): 37-46.

Glen, F. and N. Mrosovsky. 2004. Antigua revisited: the impact of climate change on sand and nest temperatures at a hawksbill turtle (Eretmochelys imbricata) nesting beach. Global Change Biology 10:2036-2045.

Glen, F., A.C. Broderick, B.J. Godley, and G.C. Hays. 2003. Incubation environment affects phenotype of naturally incubated green turtle hatchlings. Journal of the Marine Biological Association of the United Kingdom 83(5): 1183-1186.

GMFMC (Gulf of Mexico Fishery Management Council). 2007. Amendment 27 to the Reef Fish FMP and Amendment 14 to the Shrimp FMP to end overfishing and rebuild the red snapper stock. Tampa, Florida: Gulf of Mexico Fishery Management Council. 490 pp. with appendices.

Goff, G.P. and J.Lien. 1988. Atlantic leatherback turtle, Dermochelys coriacea, in cold water off Newfoundland and Labrador. Can. Field Nat. 102(1):1-5.

Goldenberg, S.B., C.W. Landsea, A.M. Mestas-Nunez, W.M. Gray. 2001. The recent increase in Atlantic hurricane activity: causes and implications. Science 293:474–479

Gottfried, P.K., and J.A. Osborne. 1982. Distribution, abundance and size of Corbicula manilensis (Philippi) in a spring-fed central Florida stream. Florida Scientist 45(3):178-188.

Graff, D. 1995. Nesting and hunting survey of the turtles of the island of S□o Tomé. Progress Report July 1995, ECOFAC Componente de S□o Tomé e Príncipe, 33 pp.

Greene CH, Pershing AJ, Cronin TM and Ceci N. 2008. Arctic climate change and its impacts on the ecology of the North Atlantic. Ecology 89:S24-S38.

Greene, K. 2002. Beach Nourishment: A Review of the Biological and Physical Impacts. Atlantic States Marine Fisheries Commission (ASMFC) Habitat Management Series #7. 179 pp.

Greene, R.J. Jr. 1987. Characteristics of oil industry dredge and drilling sounds in the Beaufort Sea. Journal of Acoustical Society of America 82: 1315-1324.

Grunwald, C., J. Stabile, J.R. Waldman, R. Gross, and I. Wirgin. 2002. Population genetics of shortnose sturgeon (Acipenser brevirostrum) based on mitochondrial DNA control region sequences. Molecular Ecology 11: 000-000.

Guerra-Garcia, J.M. and J. C. Garcia-Gomez. 2006. Recolonization of defaunated sediments: Fine versus gross sand and dredging versus experimental trays. Estuarine Coastal and Shelf Science 68 (1-2): 328-342

Guilbard, F., J. Munro, P. Dumont, D. Hatin, and R. Fortin. 2007. Feeding ecology of Atlantic sturgeon and Lake sturgeon co-occurring in the St. Lawrence Estuarine Transition Zone. American Fisheries Society Symposium. 56: 85-104.

Haley, N. 1996. Juvenile sturgeon use in the Hudson River Estuary. Master's thesis. University of Massachusetts, Amhearst, MA, USA.

Hamann, M., C.J. Limpus, and M.A. Read. 2007. Chapter 15 Vulnerability of marine reptiles in the Great Barrier Reef to climate change. In: Johnson JE, Marshall PA (eds) Climate change and the Great Barrier Reef: a vulnerability assessment, Great Barrier Reef Marine Park Authority and Australia Greenhouse Office, Hobart, p 465–496.

Hansen, P.D. 1985. Chlorinated hydrocarbons and hatching success in Baltic herring spring spawners. Marine Environmental Research 15:59-76.

Hatase, H., M. Kinoshita, T. Bando, N. Kamezaki, K. Sato, Y. Matsuzawa, K. Goto, K . Omuta, Y. Nakashima, H. Takeshita, and W. Sakamoto. 2002. Population structure of loggerhead turtles, Caretta caretta, nesting in Japan: Bottlenecks on the Pacific population. Marine Biology 141:299-305.

Hatin, D., R. Fortin, and F. Caron. 2002. Movements and aggregation areas of adult Atlantic sturgeon (Acipenser oxyrinchus) in the St. Lawrence River estuary, Québec, Canada. Journal of Applied Ichthyology 18: 586-594.

Hatin, D., Lachance, S., D. Fournier. 2007*a*. Effect of Dredged Sediment Deposition on use by Atlantic Sturgeon and Lake Sturgeon at an Open-water Disposal Site in the St. Lawrence Estuarine Transition Zone. American Fisheries Society Symposium 56:235-255.

Hatin, D., J. Munro, F. Caron, and R. D. Simons. 2007. Movements, home range size, and habitat use and selection of early juvenile Atlantic sturgeon in the St. Lawrence estuarine transition zone. Pp. 129-155 in J. Munro, D. Hatin, J.E. Hightower, K. McKown, K.L. Sulak,A.W. Kahnle, and F. Caron (eds.) Anadromous sturgeon: habitat, threats, and management.Ammerican Fisheries Society Symposium 56, Bethesda, MD 215 pp.

Hawkes, L. A. Broderick, M. Godfrey and B. Godley. 2005. Status of nesting loggerhead turtles, Caretta caretta, at Bald Head Island (North Carolina, USA) after 24 years of intensive monitoring and conservation. Oryx. 39(1): 65-72.

Hawkes, L.A., A.C. Broderick, M.H. Godfrey, and B.J. Godley. 2007. Investigating the potential impacts of climate change on a marine turtle population. Global Change Biology 13: 1-10.

Hawkes, L.A., A.C. Broderick, M.H. Godfrey, and B.J. Godley. 2009. Climate change and marine turtles. Endangered Species Research 7:137-154.

Hawkes, L.A., A.C. Broderick, M.S. Coyne, M.H. Godfrey, L.-F. Lopez-Jurado, P. Lopez-Suarez, S.E. Merino, N. Varo-Cruz, and B.J. Godley. 2006. Phenotypically linked dichotomy in sea turtle foraging requires multiple conservation approaches. Current Biology 16: 990-995.

Hays, G.C., A.C. Broderick, F. Glen, B.J. Godley, J.D.R. Houghton, and J.D. Metcalfe. 2002. Water temperature and internesting intervals for loggerhead (Caretta caretta) and green (Chelonia mydas) sea turtles. Journal of Thermal Biology 27: 429-432.

Heppell, S.S., D.T. Crouse, L.B. Crowder, S.P. Epperly, W. Gabriel, T. Henwood, R. Marquez, and N.B. Thompson. 2005. A population model to estimate recovery time, population size, and management impacts on Kemp's ridley sea turtles. Chelonian Conservation and Biology 4(4):767-773.

Hildebrand, H. 1982. A historical review of the status of sea turtle populations in the western Gulf of Mexico, P. 447-453. In K.A. Bjorndal (ed.), Biology and conservation of sea turtles. Smithsonian Institution Press, Washington, D.C.

Hilterman, M.L. and E. Goverse. 2004. Annual report of the 2003 leatherback turtle research and monitoring project in Suriname. World Wildlife Fund - Guianas Forests and Environmental Conservation Project (WWF-GFECP) Technical Report of the Netherlands Committee for IUCN (NC-IUCN), Amsterdam, the Netherlands, 21p.

Hirth, H.F. 1971. Synopsis of biological data on the green sea turtle, Chelonia mydas. FAO Fisheries Synopsis No. 85: 1-77.

Hirth, H.F. 1997. Synopsis of the biological data of the green turtle, Chelonia mydas (Linnaeus 1758). USFWS Biological Report 97(1): 1-120.

Holland, B.F., Jr. and G.F. Yelverton. 1973. Distribution and biological studies of anadromous fishes offshore North Carolina. North Carolina Department of Natural and Economic Resources, Division of Commercial and Sports Fisheries, Morehead City. Special Scientific Report 24:1-132.

Hoover, J.J., Boysen, K.A., Beard, J.A., and H. Smith. 2011. Assessing the risk of entrainment by cutterhead dredges to juvenile lake sturgeon (*Acipenser fulvescens*) and juvenile pallid sturgeon (*Scaphirhynchus albus*). Journal of Applied Ichthyology 27:369-375.

Hoover, J.J., Killgore, K.J., Clarke, D.G., Smith, H., Turnage, A., and Beard, J. 2005. Paddlefish and sturgeon entrainment by dredges: Swimming performance as an indicator of risk. DOER Technical Notes Collection (ERDC-TN-DOER-E22), U.S. Army Engineer Research and Development Center, Vicksburg, MS.

Hulin, V., and J.M. Guillon. 2007. Female philopatry in a heterogenous environment: ordinary conditions leading to extraordinary ESS sex ratios. BMC Evolutionary Biology 7:13

Hulme, P.E. 2005. Adapting to climate change: is there scope for ecological management in the face of global threat? Journal of Applied Ecology 43: 617-627.IPCC (Intergovernmental Panel on Climate Change) 2007. Fourth Assessment Report. Valencia, Spain.

Innis, C., C. Merigo, K. Dodge, M. Tlusty, M. Dodge, B. Sharp, A. Myers, A. McIntosh, D. Wunn, C. Perkins, T.H. Herdt, T. Norton, and M. Lutcavage. 2010. Health Evaluation of Leatherback Turtles (Dermochelys coriacea) in the Northwestern Atlantic During Direct Capture and Fisheries Gear Disentanglement. Chelonian Conservation and Biology, 9(2):205-222.

Intergovernmental Panel on Climate Change (IPCC). 2007a. Climate Change 2007 – Impacts, Adaptation and Vulnerability. Contribution of Working Group II to the Fourth Assessment Report of the IPCC. IPCC, Geneva.

Intergovernmental Panel on Climate Change (IPCC). 2007b. Climate Change 2007 - The Physical Science Basis. Contribution of Working Group I to the Fourth Assessment Report of the IPCC. IPCC, Geneva.

Intergovernmental Panel on Climate Change. 2007. Summary for Policymakers. In Solomon, S., D. Qin, M. Manning, Z. Chen, M. Marquis, K.B. Averyt, M. Tignor and H.L. Miller (editors). Climate Change 2007: The Physical Science Basis. Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change. Cambridge University Press, Cambridge, United Kingdom, and New York, New York, USA.

James, M.C., C.A. Ottensmeyer, and R.A. Myers. 2005b. Identification of high-use habitat and threats to leatherback sea turtles in northern waters: new directions for conservation. Ecol. Lett. 8: 195-201.

James, M.C., R.A. Myers, and C.A. Ottenmeyer. 2005a. Behaviour of leatherback sea turtles, Dermochelys coriacea, during the migratory cycle. Proc. R. Soc. B, 272: 1547-1555.

Jenkins, W.E., T.I.J. Smith, L.D. Heyward, and D.M. Knott. 1993. Tolerance of shortnose sturgeon, Acipenser brevirostrum, juveniles to different salinity and dissolved oxygen concentrations. Proceedings of the Southeast Association of Fish and Wildlife Agencies, Atlanta, Georgia.

Johnson, and P.J. Eliazar (Compilers) Proceedings of the Fourteenth Annual Symposium on Sea Turtle Biology and Conservation. NOAA Technical Memorandum NMFS-SEFSC-351, 323 pp.

Johnson, J. H., D. S. Dropkin, B. E. Warkentine, J. W. Rachlin, and W. D. Andrews. 1997. Food habits of Atlantic sturgeon off the central New Jersey coast. Transactions of the American Fisheries Society 126: 166-170.

Johnson, M. P. & P.L. Tyack. 2003. A digital acoustic recording tag for measuring the response of wild marine mammals to sound. IEEE J. Oceanic Engng 28: 3–12.

Johnston Jr., S.A. 1981. Estuarine Dredge and Fill Activities: A Review of Impacts. Environmental Management 5(5): 427-440.

Jones A.R., W. Gladstone, N.J. Hacking. 2007. Australian sandy beach ecosystems and climate change: ecology and management. Aust Zool 34:190–202

Kahnle, A.W., K.A. Hattala, K.A. McKown. 2007. Status of Atlantic sturgeon of the Hudson River Estuary, New York, USA. American Fisheries Society Symposium. 56:347-363.

Kasparek, M., B.J. Godley, and A.C. Broderick. 2001. Nesting of the green turtle, Chelonia mydas, in the Mediterranean: a review of status and conservation needs. Zoology in the Middle East 24: 45-74.

Keevin, Thomas M. and Hempen, G. L. 1997. The Environmental Effects of Underwater Explosions with Methods to Mitigate Impacts. U. S. Army Corps of Engineers, St. Louis District.

Kreeger, D., J. Adkins, P. Cole, R. Najjar, D. Velinsky, P. Conolly, and J. Kraeuter. May 2010. Climate Change and the Delaware Estuary: Three Case Studies in Vulnerability Assessment and Adaptation Planning. Partnership for the Delaware Estuary, PDE Report No. 10-01. 1 –117 pp.

Kelle, L., N. Gratiot, I. Nolibos, J. Therese, R. Wongsopawiro, and B. DeThoisy. 2007. Monitoring of nesting leatherback turtles (Dermochelys coriacea): contribution of remote-sensing for real time assessment of beach coverage in French Guiana. Chelonian Conserv Biol 6: 142–149.

Ketten, D.R. and S.M. Bartol. (2005). Functional Measures of Sea Turtle Hearing. ONR Award No: N00014-02-1-0510.

Kieffer and Kynard in review [book to be published by AFS]. Kieffer, M. C., and B. Kynard. In review. Pre-spawning and non-spawning spring migrations, spawning, and effects of hydroelectric dam operation and river regulation on spawning of Connecticut River shortnose sturgeon.

Kieffer, M.C. and B. Kynard. 1993. Annual movements of shortnose and Atlantic sturgeons in the Merrimack River, Massachusetts. Transactions of the American Fisheries Society 1221: 1088-1103.

Kocan, R.M., M.B. Matta, and S. Salazar. 1993. A laboratory evaluation of Connecticut River coal tar toxicity to shortnose sturgeon (Acipenser brevirostrum) embryos and larvae. Final Report to the National Oceanic and Atmospheric Administration, Seattle, Washington.

Kuller, Z. 1999. Current status and conservation of marine turtles on the Mediterranean coast of Israel. Marine Turtle Newsletter 86: 3-5.

Kynard, B. and M. Horgan. 2002. Ontogenetic behavior and migration of Atlantic sturgeon, Acipenser oxyrinchus oxyrinchus, and shortnose sturgeon, A. brevirostrum, with notes on social behavior. Environmental Behavior of Fishes 63: 137-150.

LaCasella, E.L., P.H. Dutton, and S.P. Epperly. 2005. Genetic stock composition of loggerheads (Caretta caretta) encountered in the Atlantic northeast distant (NED) longline fishery using additional mtDNA analysis. Pages 302-303 in Frick M., A. Panagopoulou, A.F. Rees, and K. Williams (compilers). Book of Abstracts of the Twenty-sixth Annual Symposium on Sea Turtle Biology and Conservation. International Sea Turtle Society, Athens, Greece.

Lageux, C.J., C. Campbell, L.H. Herbst, A.R. Knowlton and B. Weigle. 1998. Demography of marine turtles harvested by Miskitu Indians of Atlantic Nicaragua. U.S. Department of Commerce, NOAA Technical Memorandum NMFS-SEFSC-412: 90.

Lalli, C.M. and T.R. Parsons. 1997. Biological oceanography: An introduction – 2nd Edition.Pages 1-13. Butterworth-Heinemann Publications. 335 pp.

Laney, R.W., J.E. Hightower, B.R. Versak, M.F. Mangold, W.W. Cole Jr., and S.E. Winslow.2007. Distribution, habitat use, and size of Atlantic sturgeon captured during cooperative winter tagging cruises, 1988–2006. Pages 167-182. In: J. Munro, D. Hatin, J. E. Hightower, K. McKown, K. J. Sulak, A. W. Kahnle, and F. Caron, (editors), Anadromous sturgeons: habi-tats, threats, and management. Am. Fish. Soc. Symp. 56, Bethesda, MD.

Larson, K. and Moehl, C. 1990. "Fish entrainment by dredges in Grays Harbor, Washington". Effects of dredging on anadromous Pacific Coast fishes. C.A. Simenstad ed., Washington Sea Grant Program, University of Washington, Seattle. 102-12 pp.

LaSalle, M.W. 1990. Physical and chemical alterations associated with dredging. C.A. Simenstad editor. Proceedings of the workshop on the effects of dredging on anadromous Pacific coast fishes. Washington Sea Grant Program, Seattle. 1-12 pp.

Laurent, L., J. Lescure, L. Excoffier, B. Bowen, M. Domingo, M. Hadjichristophorou, L. Kornaraki, and G. Trabuchet. 1993. Genetic studies of relationships between Mediterranean and Atlantic populations of loggerhead turtle Caretta caretta with a mitochondrial marker. Comptes Rendus de l'Academie des Sciences (Paris), Sciences de la Vie/Life Sciences 316:1233-1239.

Laurent, L., P. Casale, M.N. Bradai, B.J. Godley, G. Gerosa, A.C. Broderick, W. Schroth, B. Schierwater, A.M. Levy, D. Freggi, E.M. Abd El-Mawla, D.A. Hadoud, H.E. Gomati, M. Domingo, M. Hadjichristophorou, L. Kornaraki, F. Demirayak, and C. Gautier. 1998. Molecular resolution of the marine turtle stock composition in fishery bycatch: A case study in the Mediterranean. Molecular Ecology 7: 1529-1542.

Leland, J. G., III. 1968. A survey of the sturgeon fishery of South Carolina. Bears Bluff Labs. No. 47, 27 pp.

Lewison, R.L., L.B. Crowder, and D.J. Shaver. 2003. The impact of turtle excluder devices and fisheries closures on loggerhead and Kemp's ridley strandings in the western Gulf of Mexico. Conservation Biology 17(4): 1089-1097.

Lewison, R.L., S.A. Freeman, and L.B. Crowder. 2004. Quantifying the effects of fisheries on threatened species: the impact of pelagic longlines on loggerhead and leatherback sea turtles. Ecology Letters. 7: 221-231.

Limpus, C.J. and D.J. Limpus. 2000. Mangroves in the diet of Chelonia mydas in Queensland, Australia. Mar Turtle Newsl 89: 13–15.

Limpus, C.J. and D.J. Limpus. 2003. Loggerhead turtles in the equatorial Pacific and southern Pacific Ocean: A species in decline. In: Bolten, A.B., and B.E. Witherington (eds.), Loggerhead Sea Turtles. Smithsonian Institution.

Longwell, A.C., S. Chang, A. Hebert, J. Hughes and D. Perry. 1992. Pollution and developmental abnormalities of Atlantic fishes. Environmental Biology of Fishes 35:1- 21.

Lutcavage, M.E. and P. Plotkin, B. Witherington, and P.L. Lutz. 1997. Human impacts on sea turtle survival, p.387-409. In P.L. Lutz and J.A. Musick, (eds.), The Biology of Sea Turtles, CRC Press, Boca Raton, Florida. 432pp.

Lutcavage, M.E. and P.L. Lutz. 1997. Diving Physiology. Pp. 277-296 in The Biology of Sea Turtles. P.L. Lutz and J.A. Musick (Eds). CRC Press.

Mac, M.J., and C.C. Edsall. 1991. Environmental contaminants and the reproductive success of lake trout in the Great Lakes: An epidemiological approach. Journal of Toxicology and Environmental Health 33:375-394.

MacLeod, C.D. 2009. Global climate change, range changes and potential implications for the conservation of marine cetaceans: a review and synthesis. Endang Species Res 7: 125-136.

Magnuson, J.J., J.A. Bjorndal, W.D. DuPaul, G.L. Graham, D.W. Owens, C.H. Peterson, P.C.H. Prichard, J.I. Richardson, G.E. Saul, and C.W. West. 1990. Decline of Sea Turtles: Causes and Prevention. Committee on Sea Turtle Conservation , Board of Environmental Studies and Toxicology, Board on Biology, Commission of Life Sciences, National Research Council, National Academy Press, Washington, D.C. 259 pp.

Maier, P. P., A. L. Segars, M. D. Arendt, J. D. Whitaker, B. W. Stender, L. Parker, R. Vendetti, D. W. Owens, J. Quattro, and S. R. Murphy. 2004. Development of an index of sea turtle abundance based on in-water sampling with trawl gear. Final report to the National Marine Fisheries Service. 86 pp.

Mangin, E. 1964. Croissance en Longueur de Trois Esturgeons d'Amerique du Nord: Acipenser oxyrhynchus, Mitchill, Acipenser fulvescens, Rafinesque, et Acipenser brevirostris LeSueur. Verh. Int. Ver. Limnology 15: 968-974.

Mansfield, K. L. 2006. Sources of mortality, movements, and behavior of sea turtles in Virginia. Chapter 5. Sea turtle population estimates in Virginia. pp.193-240. Ph.D. dissertation. School of Marine Science, College of William and Mary.

Mansfield, K.L., V.S. Saba, J.A. Keinath, and J.A. Musick. 2009. Satellite tracking reveals a dichotomy in migration strategies among juvenile loggerhead turtles in the Northwest Atlantic. Marine Biology 156:2555–2570.

Marcano, L.A. and J.J. Alio-M. 2000. Incidental capture of sea turtles by the industrial shrimping fleet off northwestern Venezuela. U.S. department of Commerce, NOAA Technical Memorandum NMFS-SEFSC-436:107.

Marcano, L.A. and J.J. Alio-M. 2000. Incidental capture of sea turtles by the industrial shrimping fleet off northwestern Venezuela. U.S. department of Commerce, NOAA Technical Memorandum NMFS-SEFSC-436:107.

Margaritoulis, D., R. Argano, I. Baran, F. Bentivegna, M.N. Bradai, J.A. Camiñas, P. Casale, G. De Metrio, A. Demetropoulos, G. Gerosa, B.J. Godley, D.A. Haddoud, J. Houghton, L. Laurent, and B. Lazar. 2003. Loggerhead turtles in the Mediterranean Sea: Present knowledge and conservation perspectives. Pages 175-198. In: A.B. Bolten and B.E. Witherington (eds.) Loggerhead Sea Turtles. Smithsonian Books, Washington, D.C. 319 pp.

Márquez, M.R., A. Villanueva O., and M. Sánchez P. 1982. The population of the Kemp’s ridley sea turtle in the Gulf of Mexico – Lepidochelys kempii. In: K.A. Bjorndal (editor), Biology and Conservation of Sea Turtles. Washington, D.C. Smithsonian Institute Press. p. 159-164.

Márquez, R. 1990. FAO Species Catalogue, Vol. 11. Sea turtles of the world, an annotated and illustrated catalogue of sea turtle species known to date. FAO Fisheries Synopsis, 125. 81pp.

Martin, R.E. 1996. Storm impacts on loggerhead turtle reproductive success. Mar Turtle Newsl 73:10–12.

Mayfield RB, Cech JJ Jr. 2004. Temperature effects on green sturgeon bioenergetics. Trans Am Fish Soc 133:961–970

Mazaris A.D., G. Mastinos, J.D. Pantis. 2009. Evaluating the impacts of coastal squeeze on sea turtle nesting. Ocean Coast Manag 52:139–145.

McCauley, J.E., Parr, R.A. and D. R. Hancock. 1977. Benthic Infauna and Maintenance Dredging: A Case Study. Water Research 11: 233-242.

McClellan, C.M., and A.J. Read. 2007. Complexity and variation in loggerhead sea turtle life history. Biology Letters 3: 592-594.

McCord, J.W., M.R. Collins, W.C. Post, and T.J. Smith. 2007. Attempts to develop an index of abundance for age-1 Atlantic sturgeon in South Carolina, USA. Am. Fisheries Society Symposium 56: 397-403.

McEnroe, M., and J.J. Cech. 1987. Osmoregulation in white sturgeon: life history aspects.American Fisheries Society Symposium 1:191-196.

McMahon, C.R., and G.C. Hays. 2006. Thermal niche, large-scale movements and implications of climate change for a critically endangered marine vertebrate. Global Change Biology 12:1330-1338.

Meylan, A. 1982. Estimation of population size in sea turtles. In: K.A. Bjorndal (ed.) Biology and Conservation of Sea Turtles. Smithsonian Inst. Press, Wash. D.C. p 135-138.

Meylan, A., B. Schroeder, and A. Mosier. 1995. Sea turtle nesting activity in the state of Florida. Fla. Mar. Res. Publ. 52: 1-51.

Meylan, A., B.E. Witherington, B. Brost, R. Rivero, and P.S. Kubilis. 2006. Sea turtle nesting in Florida, USA: Assessments of abundance and trends for regionally significant populations of Caretta, Chelonia, and Dermochelys. pp 306-307. In: M. Frick, A. Panagopoulou, A. Rees, and K. Williams (compilers). 26th Annual Symposium on Sea Turtle Biology and Conservation Book of Abstracts.

Mitchell, G.H., R.D. Kenney, A.M. Farak, and R.J. Campbell. 2003. Evaluation of occurrence of endangered and threatened marine species in naval ship trial areas and transit lanes in the Gulf of Maine and offshore of Georges Bank. NUWC-NPT Technical Memo 02-121A. March 2003. 113 pp.

Mohler, J. W. 2003. Culture manual for the Atlantic sturgeon, Acipenser oxyrinchus oxyrinchus. U.S. Fish and Wildlife Service, Hadley, Massachusetts. 70 pp.

Monzón-Argüello, C., A. Marco., C. Rico, C. Carreras, P. Calabuig, and L.F. López-Jurado. 2006. Transatlantic migration of juvenile loggerhead turtles (Caretta caretta): magnetic latitudinal influence. Page 106 in Frick M., A. Panagopoulou, A.F. Rees, and K. Williams (compilers). Book of Abstracts of the Twenty-sixth Annual Symposium on Sea Turtle Biology and Conservation. International Sea Turtle Society, Athens, Greece.

Morgan, R.P., V.J. Rasin and L.A. Noe. 1973. Effects of Suspended Sediments on the Development of Eggs and Larvae of Striped Bass and White Perch. Natural resources Institute, Chesapeake Biological Laboratory, U of Maryland, Center for Environmental and Estuarine Studies. 20 pp.

Morreale, S.J. and E.A. Standora. 1990. Occurrence, movement, and behavior of the Kemp's ridley and other sea turtles in New York waters. Annual report for the NYSDEC, Return A Gift To Wildlife Program, April 1989 - April 1990.

Morreale, S.J. and E.A. Standora. 1998. Early life stage ecology of sea turtles in northeastern U.S. waters. U.S. Dep. Commer. NOAA Tech. Mem. NOAA Fisheries-SEFSC-413, 49 pp.

Morreale, S.J., and E.A. Standora. 1993. Occurrence, movement, and behavior of the Kemp's ridley and other sea turtles in New York waters. Okeanos Ocean Research Foundation Final Report April 1988-March 1993. 70 pp.

Morreale, S.J., C.F. Smith, K. Durham, R.A. DiGiovanni, Jr., and A.A. Aguirre. 2005. Assessing health, status, and trends in northeastern sea turtle populations. Interim report - Sept. 2002 - Nov. 2004. Gloucester, Massachusetts: National Marine Fisheries Service.

Moser, M.L. and S.W. Ross. 1995. Habitat use and movements of shortnose and Atlantic sturgeons in the lower Cape Fear River, North Carolina. Transactions of the American Fisheries Society 124:225-234.

Moser, Mary. 1999. Cape Fear River Blast Mitigation Tests: Results of Caged Fish Necropsies,Final Report to CZR, Inc. under Contract to US Army Corps of Engineers, Wilmington District.

Mrosovsky, N. 1981. Plastic jellyfish. Marine Turtle Newsletter 17: 5-6.

Mrosovsky, N., G.D. Ryan, M.C. James. 2009. Leatherback turtles: The menace of plastic. Marine Pollution Bulletin 58: 287-289.

Munro, J. 2007. Anadromous sturgeons: Habitats, threats, and management - synthesis and summary. Am. Fisheries Society Symposium 56: 1-15.

Murawski, S.A. and A.L. Pacheco. 1977. Biological and fisheries data on Atlantic sturgeon, Acipenser oxyrhynchus (Mitchill). National Marine Fisheries Service Technical Series Report 10: 1-69.

Murdoch, P. S., J. S. Baron, and T. L. Miller. 2000. Potential effects of climate change on surface-water quality in North America. JAWRA Journal of the American Water Resources Association, 36: 347–366.

Murphy, T.M. and S.R. Hopkins. 1984. Aerial and ground surveys of marine turtle nesting beaches in the southeast region. United States Final Report to NMFS-SEFSC. 73pp.

Murphy, T.M., S.R. Murphy, D.B. Griffin, and C. P. Hope. 2006. Recent occurrence, spatial distribution and temporal variability of leatherback turtles (Dermochelys coriacea) in nearshore waters of South Carolina, USA. Chel. Cons. Biol. 5(2): 216-224.

Murray, K.T. 2004. Bycatch of sea turtles in the Mid-Atlantic sea scallop (Placopecten magellanicus) dredge fishery during 2003. NEFSC Reference Document 04-11; 25 pp.

Murray, K.T. 2006. Estimated average annual bycatch of loggerhead sea turtles (Caretta caretta) in U.S. Mid-Atlantic bottom otter trawl gear, 1996-2004. NEFSC Reference Document 06-19; 26 pp.

Murray, K.T. 2007. Estimated bycatch of loggerhead sea turtles (Caretta caretta) in U.S. Mid-Atlantic scallop trawl gear, 2004-2005, and in sea scallop dredge gear, 2005. NEFSC Reference Document 07-04; 30 pp.

Murray, K.T. 2008. Estimated average annual bycatch of loggerhead sea turtles (Caretta caretta) in U.S. Mid-Atlantic bottom otter trawl gear, 1996-2004 (2nd edition). NEFSC Reference Document 08-20; 32 pp.

Murray, K.T. 2009a. Characteristics and magnitude of sea turtle bycatch in US mid-Atlantic gillnet gear. Endangered Species Research 8:211-224.

Murray, K.T. 2009b. Proration of estimated bycatch of loggerhead sea turtles in U.S. Mid-Atlantic sink gillnet gear to vessel trip report landed catch, 2002-2006. NEFSC Reference Document 09-19; 7 pp.

Murray, K.T. 2011. Sea turtle bycatch in the U.S. sea scallop (Placopecten magellanicus) dredge fishery, 2001–2008. Fish Res. 107:137-146.

Musick, and J. Wyneken (editors). The Biology of Sea Turtles Vol. II, CRC Press, Boca Raton, Florida. p. 339-353.

Musick, J.A. and C.J. Limpus. 1997. Habitat utilization and migration in juvenile sea turtles. Pp. 137-164 In: Lutz, P.L., and J.A. Musick, eds., The Biology of Sea Turtles. CRC Press, New York. 432 pp.

NAST (National Assessment Synthesis Team). 2000. Climate Change Impacts on the United States: The Potential Consequences of Climate Variability and Change, US Global Change Research Program, Washington DC, 2000.

NAST (National Assessment Synthesis Team). 2008. Climate Change Impacts on the United States: The Potential Consequences of Climate Variability and Change, US Global Change Research Program, Washington DC, 2000 http://www.usgcrp.gov/usgcrp/Library/nationalassessment/1IntroA.pdf

National Research Council (NRC). 1990. Decline of the Sea Turtles: Causes and Prevention. Committee on Sea Turtle Conservation. Natl. Academy Press, Washington, D.C. 259 pp.

Nicholls, R.J. 1998. Coastal vulnerability assessment for sea level rise: evaluation and selection of methodologies for implementation. Technical Report R098002, Caribbean Planning for Adaption to Global Climate Change (CPACC) Project. Available at: www.cpacc.org.

Niklitschek, J. E. 2001. Bioenergetics modeling and assessment of suitable habitat for juvenile Atlantic and shortnose sturgeons (Acipenser oxyrinchus and A. brevirostrum) in the Chesapeake Bay. Dissertation. University of Maryland at College Park, College Park.

NMFS (National Marine Fisheries Service) and USFWS (U.S. Fish and Wildlife Service). 1991. Recovery plan for U.S. population of Atlantic green turtle Chelonia mydas. Washington, D.C.: National Marine Fisheries Service. 58 pp.

NMFS (National Marine Fisheries Service) and USFWS (U.S. Fish and Wildlife Service). 1992. Recovery plan for leatherback turtles Dermochelys coriacea in the U.S. Caribbean, Atlantic, and Gulf of Mexico. Washington, D.C.: National Marine Fisheries Service. 65 pp.

NMFS (National Marine Fisheries Service) and USFWS (U.S. Fish and Wildlife Service). 1995. Status reviews for sea turtles listed under the Endangered Species Act of 1973. Silver Spring, Maryland: National Marine Fisheries Service. 139 pp.

NMFS (National Marine Fisheries Service) and USFWS (U.S. Fish and Wildlife Service). 1998a. Recovery Plan for U.S. Pacific Populations of the Leatherback Turtle (Dermochelys coriacea). Silver Spring, Maryland: National Marine Fisheries Service. 65 pp.

NMFS (National Marine Fisheries Service) and USFWS (U.S. Fish and Wildlife Service). 1998b. Recovery Plan for U.S. Pacific Populations of the Green Turtle (Chelonia mydas). Silver Spring, Maryland: National Marine Fisheries Service. 84 pp.

NMFS (National Marine Fisheries Service) and USFWS (U.S. Fish and Wildlife Service). 2007a. Loggerhead sea turtle (Caretta caretta) 5 year review: summary and evaluation. National Marine Fisheries Service, Silver Spring, Maryland. 65 pp.

NMFS (National Marine Fisheries Service) and USFWS (U.S. Fish and Wildlife Service). 2007b. Leatherback sea turtle (Dermochelys coriacea) 5 year review: summary and evaluation. Silver Spring, Maryland: National Marine Fisheries Service. 79 pp.

NMFS (National Marine Fisheries Service) and USFWS (U.S. Fish and Wildlife Service). 2007c. Kemp's ridley sea turtle (Lepidochelys kempii) 5 year review: summary and evaluation. Silver Spring, Maryland: National Marine Fisheries Service. 50 pp.

NMFS (National Marine Fisheries Service) and USFWS (U.S. Fish and Wildlife Service). 2007d. Green sea turtle (Chelonia mydas) 5 year review: summary and evaluation. Silver Spring, Maryland: National Marine Fisheries Service. 102 pp.

NMFS (National Marine Fisheries Service) and USFWS (U.S. Fish and Wildlife Service). 2008. Recovery plan for the Northwest Atlantic population of the loggerhead turtle (Caretta caretta), Second revision. Washington, D.C.: National Marine Fisheries Service. 325 pp.

NMFS (National Marine Fisheries Service) NEFSC (Northeast Fisheries Science Center). 2011. Preliminary summer 2010 regional abundance estimate of loggerhead turtles (Caretta caretta) in northwestern Atlantic Ocean continental shelf waters. US Dept Commerce, Northeast Fisheries Science Center Reference Document 11-03; 33 pp.

NMFS (National Marine Fisheries Service), USFWS (U.S. Fish and Wildlife Service), and SEMARNAT. 2011. Bi-National Recovery Plan for the Kemp's Ridley Sea Turtle (Lepidochelys kempii), Second Revision. National Marine Fisheries Service. Silver Spring, Maryland 156 pp. + appendices.

NMFS (National Marine Fisheries Service). 2002. Endangered Species Act Section 7 Consultation on Shrimp Trawling in the Southeastern United States, under the Sea Turtle Conservation Regulations and as Managed by the Fishery Management Plans for Shrimp in the South Atlantic and Gulf of Mexico. Biological Opinion. December 2, 2002.

NMFS (National Marine Fisheries Service). 2004. Endangered Species Act Section 7 Consultation on the Proposed Regulatory Amendments to the Fisheries Management Plan for the Pelagic Fisheries of the Western Pacific. Biological Opinion. February 23, 2004.

NMFS (National Marine Fisheries Service). 2004. Endangered Species Act Section 7 Reinitiated Consultation on the Continued Authorization of the Atlantic Pelagic Longline Fishery under the Fishery Management Plan for Atlantic Tunas, Swordfish, and Sharks (HMS FMP). Biological Opinion. June 1, 2004.

NMFS (National Marine Fisheries Service). 2006. Endangered Species Act Section 7 Consultation on the Proposed Renewal of an Operating Licsense for the Oyster Creek Nuclear Generating Station, Barnegat Bay, New Jersey. Biological Opinion. November 22, 2006.

NMFS (National Marine Fisheries Service). 2008b. Summary Report of the Workshop on Interactions Between Sea Turtles and Vertical Lines in Fixed-Gear Fisheries. M.L. Schwartz (ed.), Rhode Island Sea Grant, Narragansett, Rhode Island. 54 pp.

NMFS (National Marine Fisheries Service). 2011. Biennial Report to Congress on the Recovery Program for Threatened and Endangered Species, October 1, 2008 – September 30, 2010. Washington, D.C.: National Marine Fisheries Service. 194 pp.

NMFS (National Marine Fisheries Service). 2012. Reinitiation of Endangered Species Act (ESA) Section 7 Consultation on the Continued Implementation of the Sea Turtle Conservation Regulations, as Proposed to Be Amended, and the Continued Authorization of the Southeast U.S. Shrimp Fisheries in Federal Waters under the Magnuson-Stevens Act. Biological Opinion. May 8, 2012.

NMFS and USFWS. 1992. Recovery plan for leatherback turtles in the U.S. Caribbean, Atlantic, and Gulf of Mexico. National Marine Fisheries Service, Washington, D.C. 65 pp.

NMFS and USFWS. 1995. Status reviews for sea turtles listed under the Endangered Species Act of 1973. National Marine Fisheries Service, Silver Spring, Maryland. 139 pp.

NMFS and USFWS. 1998b. Recovery Plan for the U.S. Pacific Population of the Leatherback Turtle (Dermochelys coriacea). National Marine Fisheries Service, Silver Spring, Maryland.

NMFS and USFWS. 2007b. Leatherback sea turtle (Dermochelys coriacea) 5 year review: summary and evaluation. National Marine Fisheries Service, Silver Spring, Maryland. 79 pp.

NMFS SEFSC (Southeast Fisheries Science Center). 2009. An assessment of loggerhead sea turtles to estimate impacts of mortality reductions on population dynamics. NMFS SEFSC Contribution PRD-08/09-14. 45 pp.

NMFS Southeast Fisheries Science Center. 2001. Stock assessments of loggerheads and leatherback sea turtles and an assessment of the impact of the pelagic longline fishery on the loggerhead and leatherback sea turtles of the Western North Atlantic. U.S. Department of Commerce, National Marine Fisheries Service, Miami, FL, SEFSC Contribution PRD-00/01-08; Parts I-III and Appendices I-IV. NOAA Tech. Memo NMFS-SEFSC-455, 343 pp.

NMFS. 1998. Recovery plan for the shortnose sturgeon (Acipenser brevirostrum). Prepared by the Shortnose Sturgeon Recovery Team for the National Marine Fisheries Service, Silver Spring, Maryland 104 pp.

NRC (National Research Council). 1990. Decline of the Sea Turtles: Causes and Prevention. Washington, D.C.: National Academy Press. 259 pp.

NYHS (New York Historical Society as cited by Dovel as Mitchell. S. 1811). 1809. Volume1. Collections of the New-York Historical Society for the year 1809.

NYSDEC (New York State Department of Environmental Conservation). 2003. "Final Environmental Impact Statement Concerning the Applications to Renew New York State Pollutant Discharge Elimination System (SPDES) Permits for the Roseton 1 and 2 Bowline 1 and 2 and IP2 and IP3 2 and 3 Steam Electric Generating Stations, Orange, Rockland and Westchester Counties" (Hudson River Power Plants FEIS). June 25, 2003.

O'Herron, J.C. and R.W. Hastings. 1985. A Study of the Shortnose Sturgeon (Acipenser brevirostrum) population in the upper tidal Delaware River: Assessment of impacts of maintenance dredging (Post- dredging study of Duck Island and Perriwig ranges), Draft final report. Prepared for the U.S. Army Corps of Engineers, Philadelphia District by the Center for Coastal and Environmental Studies, Rutgers, the State University of New Jersey, New Brunswick, NJ.

Palka , D. 2000. Abundance and distribution of sea turtles estimated from data collected during cetacean surveys. In: Bjorndal, K.A. and A.B. Bolten. Proceedings of a workshop on assessing abundance and trends for in-water sea turtle populations. U.S. Dep. Commer. NOAA Tech. Mem. NMFS-SEFSC-445, 83pp.

Palmer M.A., C.A. Reidy, C. Nilsson, M. Florke, J. Alcamo, P.S. Lake, and N. Bond. 2008. Climate change and the world's river basins: anticipating management options. Frontiers in Ecology and the Environment 6:81-89.

Parmesan, C., and G. Yohe. 2003. A globally coherent fingerprint of climate change impacts across natural systems. Nature 421:37-42.

Pearce, A.F. 2001. Contrasting population structure of the loggerhead turtle (Caretta caretta) using mitochondrial and nuclear DNA markers. Master's thesis, University of Florida.

Pearce, A.F. and B.W. Bowen. 2001. Final report: Identification of loggerhead (Caretta caretta) stock structure in the southeastern United States and adjacent regions using nuclear DNA markers. Project number T-99-SEC-04. Submitted to the National Marine Fisheries Service, May 7, 2001. 79 pp.

Pike, D.A. and J.C. Stiner. 2007. Sea turtle species vary in their susceptibility to tropical cyclones. Oecologia 153: 471–478.

Pike, D.A., R.L. Antworth, and J.C. Stiner. 2006. Earlier nesting contributes to shorter nesting seasons for the loggerhead sea turtle, Caretta caretta. Journal of Herpetology 40(1): 91-94.

Pikitch, E.K., P. Doukakis, L. Lauck, P. Chakrabarty, and D.L. Erickson. 2005. Status, trends and management of sturgeon and paddlefish fisheries. Fish and Fisheries 6: 233–265.

Pisces Conservation Ltd. 2008. The status of fish populations and ecology of the Hudson River. Prepared by R.M. Seaby and P.A. Henderson. http://www.riverkeeper.org/wp-content/uploads/2009/06/Status-of-Fish-in-the-Hudson-Pisces.pdf

Plaziat, J.C., and P.G.E.F. Augustinius. 2004. Evolution of progradation/ erosion along the French Guiana mangrove coast: a comparison of mapped shorelines since the 18th century with Holocene data. Mar Geol 208: 127–143.

Polis, D.F., S.L. Kupferman, and K. Szekielda. 1973. Physical oceanography. Delaware Bay Report Series, Vol. 4. University of Delaware, Newark, DE.

Pritchard, P.C.H. 1982. Nesting of the leatherback turtle, Dermochelys coriacea, in Pacific, Mexico, with a new estimate of the world population status. Copeia 1982: 741-747.

Pritchard, P.C.H. 2002. Global status of sea turtles: An overview. Document INF-001 prepared for the Inter-American Convention for the Protection and Conservation of Sea Turtles, First Conference of the Parties (COP1IAC), First part August 6-8, 2002.

Prusty, G., S. Dash, and M.P. Singh. 2007. Spatio-temporal analysis of multi-date IRS imageries for turtle habitat dynamics characterisation at Gahirmatha coast, India. Int J Remote Sens 28: 871–883

Rahmstorf, S. 1997. Risk of sea-change in the Atlantic. Nature 388: 825–826.

Rahmstorf, S. 1999. Shifting seas in the greenhouse? Nature 399: 523–524.

Rankin-Baransky, K., C.J. Williams, A.L. Bass, B.W. Bowen, and J.R. Spotila. 2001. Origin of loggerhead turtles stranded in the northeastern United States as determined by mitochondrial DNA analysis. Journal of Herpetology 35(4):638-646.

Rebel, T.P. 1974. Sea turtles and the turtle industry of the West Indies, Florida and the Gulf of Mexico. Univ. Miami Press, Coral Gables, Florida.

Rees, A.F., A. Saad, and M. Jony. 2005. Marine turtle nesting survey, Syria 2004: discovery of a "major" green turtle nesting area. Page 38 in Book of Abstracts of the Second Mediterranean Conference on Marine Turtles. Antalya, Turkey, 4-7 May 2005.

Reine, K., and Clarke, D. 1998. Entrainment by hydraulic dredges–A review of potential impacts. Technical Note DOER-E1. U.S. Army Engineer Research and Development Center, Vicksburg, MS.

Revelles, M., C. Carreras, L. Cardona, A. Marco, F. Bentivegna, J.J. Castillo, G. de Martino, J.L. Mons, M.B. Smith, C. Rico, M. Pascual, and A. Aguilar. 2007. Evidence for an asymmetrical size exchange of loggerhead sea turtles between the Mediterranean and the Atlantic through the Straits of Gibraltar. Journal of Experimental Marine Biology and Ecology 349:261-271.

Rhoads, D.C. and J.D. Germano. 1982. Characterization of Benthic Processes Using Sediment Profile Imaging: an Efficient Method of Remote Ecological Monitoring on the Seafloor (REMOTS System). Marine Ecology Process Series 8:115-128

Richardson A.J., A. Bakun, G.C. Hays, and M.J. Gibbons. 2009. The jellyfish joyride: causes, consequences and management responses to a more gelatinous future. Trends in Ecology and Evolution 24:312-322.

Ridgway, S.H., E.G. Weaver, J.G. McCormick, J. Palin, and J.H. Anderson. 1969. Hearing in the Giant Sea Turtle, Chelonia mydas. Proceedings of the National Academy of Sciences 64(3): 884-890.

Rivalan, P., P.H. Dutton, E. Baudry, S.E. Roden, and M. Girondot. 2005. Demographic scenario inferred from genetic data in leatherback turtles nesting in French Guiana and Suriname. Biol Conserv 1: 1–9.

Robinson, M.M., H.J. Dowsett, and M.A. Chandler. 2008. Pliocene role in assessing future climate impacts. Eos, Transactions of the American Geophysical Union 89(49):501-502.

Rochard, E., M. Lepage, and L. Meauzé. Identification et caractérisation de l'aire de répartition marine de l'esturgeon éuropeen Acipenser sturio a partir de déclarations de captures. 1997. Aquat. Living. Resour. 10: 101-109.

Rogers, S.G., and W. Weber. 1995b. Status and restoration of Atlantic and shortnose sturgeons in Georgia. Final Report to the National Marine Fisheries Service, Southeast Regional Office, St. Petersburg, Florida.

Rosenthal, H. and D. F. Alderdice. 1976. Sublethal effects of environmental stressors, natural and pollutional, on marine fish eggs and larvae. Journal of the Fisheries Research Board of Canada 33: 2047-2065.

Ross, J.P. 1996. Caution urged in the interpretation of trends at nesting beaches. Marine Turtle Newsletter 74: 9-10.

Ross. J.P. 2005. Hurricane effects on nesting Caretta caretta. Mar Turtle Newsl 108:13–14.

Ruben, H.J, and S.J. Morreale. 1999. Draft Biological Assessment for Sea Turtles in New York and New Jersey Harbor Complex. Unpublished Biological Assessment submitted to National Marine Fisheries Service.

Ruelle, R. and C. Henry. 1992. Organochlorine compounds in pallid sturgeon. Contaminant

Ruelle, R. and C. Henry. 1994. Life history observations and contaminant evaluation of pallid sturgeon. Final Report U.S. Fish and Wildlife Service, Fish and Wildlife Enhancement, South Dakota Field Office, 420 South Garfield Avenue, Suite 400, Pierre, South Dakota 57501-5408.

Ruelle, R., and K.D. Keenlyne. 1993. Contaminants in Missouri River pallid sturgeon. Bull. Environ. Contam. Toxicol. 50: 898-906.

Sarti Martinez, L., A.R. Barragan, D.G. Munoz, N. Garcia, P. Huerta, and F. Vargas. 2007. Conservation and biology of the leatherback turtle in the Mexican Pacific. Chelonian Conservation and Biology 6(1): 70-78.

Sarti, L., S. Eckert, P. Dutton, A. Barragán, and N. García. 2000. The current situation of the leatherback population on the Pacific coast of Mexico and central America, abundance and distribution of the nestings: an update. Pages 85-87 In: H. Kalb and T. Wibbels, compilers. Proceedings of the Nineteenth Annual Symposium on Sea Turtle Conservation and Biology. NOAA Technical Memorandum NMFS-SEFSC-443.

Sarti, L., S.A. Eckert, N. Garcia, and A.R. Barragan. 1996. Decline of the world's largest nesting assemblage of leatherback turtles. Marine Turtle Newsletter 74: 2-5.

Savoy, T. 2007. Prey eaten by Atlantic sturgeon in Connecticut waters. Am. Fisheries Society Symposium 56: 157-165.

Savoy, T., and D. Pacileo. 2003. Movements and important habitats of subadult Atlantic sturgeon in Connecticut waters. Transactions of the American Fisheries Society. 132: 1-8.

Schmid, J.R., and W.N. Witzell. 1997. Age and growth of wild Kemp's ridley turtles (Lepidochelys kempi): cumulative results of tagging studies in Florida. Chelonian Conservation and Biology 2(4): 532-537.

Schubel, J.R., H.H. Carter, R.E. Wilson, W.M. Wise, M.G. Heaton, and M.G. Gross. 1978. Field investigations of the nature, degree, and extent of turbidity generated by open-water pipeline disposal operations. Technical Report D-78-30; U.S. Army Engineer Waterways Experiment Station, Vicksburg, Miss., 245 pp.

Schueller, P. and D.L. Peterson. 2006. Population status and spawning movements of Atlantic sturgeon in the Altamaha River, Georgia. Presentation to the 14th American Fisheries Society Southern Division Meeting, San Antonio, February 8-12th, 2006.

Schultz, J.P. 1975. Sea turtles nesting in Surinam. Zoologische Verhandelingen (Leiden), Number 143: 172 pp.

Scott, W. B., and M. C. Scott. 1988. Atlantic fishes of Canada. Canadian Bulletin of Fisheries and Aquatic Science No. 219. pp. 68-71.

Scott, W.B. and E.J. Crossman. 1973. Freshwater fishes of Canada. Fisheries Research Board of Canada. Bulletin 184. pp. 80-82.

Seaturtle.org. Sea turtle tracking database. Available at http://www.seaturtle.org.

Secor, D. H. 2002. Atlantic sturgeon fisheries and stock abundances during the late nineteenth century. Pages 89-98 In: W. Van Winkle, P. J. Anders, D. H. Secor, and D. A. Dixon,(editors), Biology, management, and protection of North American sturgeon. American Fisheries Society Symposium 28, Bethesda, Maryland.

Secor, D.H. and J.R. Waldman. 1999. Historical abundance of Delaware Bay Atlantic sturgeon and potential rate of recovery. American Fisheries Society Symposium 23: 203-

Secor, D.J. and E.J. Niklitschek. 2002. Sensitivity of sturgeons to environmental hypoxia: A review of physiological and ecological evidence, p. 61-78 In: R.V. Thurston (Ed.) Fish Physiology, Toxicology, and Water Quality. Proceedings of the Sixth International Symposium, La Paz, MX, 22-26 Jan. 2001. U.S. Environmental Protection Agency Office of Research and Development, Ecosystems Research Division, Athens, GA. EPA/600/R-02/097. 372 pp.

Sella, I. 1982. Sea turtles in the Eastern Mediterranean and Northern Red Sea. Pages 417-423 in K.A. Bjorndal, ed. Biology and Conservation of Sea Turtles. Washington, D.C.: Smithsonian Institution Press.

Seminoff, J.A. 2004. Chelonia mydas. In 2007 IUCN Red List of Threatened Species. Accessed 31 July 2009. http://www.iucnredlist.org/search/details.php/4615/summ.

Shamblin, B.M. 2007. Population structure of loggerhead sea turtles (Caretta caretta) nesting in the southeastern United States inferred from mitochondrial DNA sequences and microsatellite loci. Master's thesis, University of Georgia. 59 pp.

Sherk, J.A. J.M. O'Connor and D.A. Neumann. 1975. Effects of suspended and deposited sediments on estuarine environments. In: Estuarine Research Vol. II. Geology and Engineering. L.E. Cronin (editor). New York: Academic Press, Inc.

Sherk, J.A. 1972. Current Status of the Knowledge of the Biological Effects of Suspended and Deposited Sediments in Chesapeake Bay. Chesapeake Science, vol. 13, Supplement: Biota of the Chesapeake Bay pp. S137-S144.

Sherk, J.A. 1971. Effects of suspended and deposited sediments on estuarine organisms. Chesapeake Biological Laboratory, University of Maryland. Contribution No. 443.

Shirey, C., C. C. Martin, and E. D. Stetzar. 1999. Atlantic sturgeon abundance and movement in the lower Delaware River. DE Division of Fish and Wildlife, Dover, DE, USA. Final Report to the National Marine Fisheries Service, Northeast Region, State, Federal & Constituent Programs Office. Project No. AFC-9, Grant No. NA86FA0315. 34 pp.

Shoop, C.R. 1987. The Sea Turtles. Pages 357-358 in R.H. Backus and D.W. Bourne, eds. Georges Bank. Cambridge, Massachusetts: MIT Press.

Shoop, C.R. and R.D. Kenney. 1992. Seasonal distributions and abundances of loggerhead and leatherback sea turtles in waters of the northeastern United States. Herpetological Monographs 6: 43-67.

Short, F.T. and H.A. Neckles. 1999. The effects of global climate change on seagrasses. Aquat Bot 63: 169–196.

Simpson, P.C. 2008. Movements and habitat use of Delaware River Atlantic sturgeon. Master Thesis, Delaware State University, Dover, DE 128 p.

Skjeveland, Jorgen E., Stuart A. Welsh, Michael F. Mangold, Sheila M. Eyler, and Seaberry Nachbar. 2000. A Report of Investigations and Research on Atlantic and Shortnose Sturgeon in Maryland Waters of the Chesapeake bay (1996-2000). U.S. Fish and Wildlife Service, Annapolis, MD. 44 pp.

Slay, C.K. and J.I. Richardson. 1988. King's Bay, Georgia: Dredging and Turtles. Schroeder, B.A. (compiler). Proceedings of the eighth annual conference on sea turtle biology and conservation. NOAA Technical Memorandum NMFS-SEFC-214, pp. 109-111.

Smith, Hugh M. and Barton A. Bean. 1899. List of fishes known to inhabit the waters of the District of Columbia and vicinity. Prepared for the United States Fish Commission. Washington Government Printing Office, Washington, D.C.

Smith, T. I. J., D. E. Marchette, and G. F. Ulrich. 1984. The Atlantic sturgeon fishery in South

Smith, T. I. J., E. K. Dingley, and D. E. Marchette. 1980. Induced spawning and culture of Atlantic sturgeon. Progressive Fish-Culturist 42: 147-151.

Smith, T.I.J. 1985. The fishery, biology, and management of Atlantic sturgeon, Acipenser oxyrhynchus, in North America. Environmental Biology of Fishes 14(1): 61-72.

Smith, T.I.J. and J.P. Clugston. 1997. Status and management of Atlantic sturgeon, Acipenser oxyrinchus, in North America. Environmental Biology of Fishes 48: 335-346.

Smith, T.I.J., D.E. Marchette and R.A. Smiley. 1982. Life history, ecology, culture and management of Atlantic sturgeon, Acipenser oxyrhynchus oxyrhynchus, Mitchill, in South Carolina. South Carolina Wildlife Marine Resources. Resources Department, Final Report to U.S. Fish and Wildlife Service Project AFS-9. 75 pp.

Snover, M.L., A.A. Hohn, L.B. Crowder, and S.S. Heppell. 2007. Age and growth in Kemp's ridley sea turtles: evidence from mark-recapture and skeletochronology. Pages 89-106 in P.T.

Plotkin, ed. Biology and Conservation of Ridley Sea Turtles. Baltimore, Maryland: Johns Hopkins University Press.

Snyder, D.E. 1988. Description and identification of shortnose and Atlantic sturgeon larvae. American Fisheries Society Symposium 5:7-30.

South Carolina Department of Natural Resources. 2007. Examination of Local Movement and Migratory Behavior of Sea Turtles during spring and summer along the Atlantic coast off the southeastern United States. Unpublished report submitted to NMFS as required by ESA Permit 1540. 45 pp.

Spells, A. 1998. Atlantic sturgeon population evaluation utilizing a fishery dependent reward program in Virginia's major western shore tributaries to the Chesapeake Bay. U.S. Fish and Wildlife Service, Charles City, Virginia.

Spotila, J.R., A.E. Dunham, A.J. Leslie, A.C. Steyermark, P.T. Plotkin and F.V. Paladino. 1996. Worldwide population decline of Dermochelys coriacea: are leatherback turtles going extinct? Chelonian Conservation and Biology 2: 209-222.

Spotila, J.R., R.D. Reina, A.C. Steyermark, P.T. Plotkin, and F.V. Paladino. 2000. Pacific leatherback turtles face extinction. Nature 405(6786):529-530.

Squiers, T. And M. Robillard. 1997. Preliminary report on the location of overwintering sites for shortnose sturgeon in the estuarial complex of the Kennebec River during the winter of 1996/1997. Unpublished report, submitted to the Maine Department of Transportation.

Squiers, T., L. Flagg, and M. Smith. 1982. American shad enhancement and status of sturgeon stocks in selected Maine waters. Completion report, Project AFC-20.

Stein, A.B., K.D. Friedland, and M. Sutherland. 2004. Atlantic sturgeon marine bycatch and mortality on the continental shelf of the Northeast United States. North American Journal of Fisheries Management 24: 171-183.

Stephens, S.H., and J. Alvarado-Bremer. 2003. Preliminary information on the effective population size of the Kemp's ridley (Lepidochelys kempii) sea turtle. Page 250 In: J.A. Seminoff, compiler. Proceedings of the Twenty-Second Annual Symposium on Sea Biology and Conservation. NOAA Technical Memorandum NMFS-SEFSC-503.

Stetzar, E. J. 2002. Population Characterization of Sea Turtles that Seasonally Inhabit the Delaware Estuary. Master of Science thesis, Delaware State University, Dover, Delaware. 136pp.

Stevenson, J. T., and D. H. Secor. 1999. Age determination and growth of Hudson River Atlantic sturgeon, Acipenser oxyrinchus. Fishery Bulletin 97: 153-166.

Stewart, K., C. Johnson, and M.H. Godfrey. 2007. The minimum size of leatherbacks at reproductive maturity, with a review of sizes for nesting females from the Indian, Atlantic and Pacific Ocean basins. Herp. Journal 17:123-128.

Stewart, K., M. Sims, A. Meylan, B. Witherington, B. Brost, and L.B. Crowder. 2011. Leatherback nests increasing significantly in Florida, USA; trends assessed over 30 years using multilevel modeling. Ecological Applications, 21(1): 263–273.

Stocker, T.F. and A. Schmittner. 1997. Influence of CO2 emission rates on the stability of the thermohaline circulation. Nature 388: 862–865.

Suárez, A. 1999. Preliminary data on sea turtle harvest in the Kai Archipelago, Indonesia. Abstract, 2nd ASEAN Symposium and Workshop on Sea Turtle Biology and Conservation, July 15-17, 1999, Sabah, Malaysia.

Suárez, A., P.H. Dutton, and J. Bakarbessy. 2000. Leatherback (Dermochelys coriacea) nesting on the North Vogelkop Coast of Irian Jaya, Indonesia. Page 260 in H.J. Kalb and T. Wibbels, compilers. Proceedings of the Nineteenth Annual Symposium on Sea Turtle Biology and Conservation. NOAA Technical Memorandum NMFS-SEFSC-443.

Taub, S.H. 1990. Interstate fishery management plan for Atlantic sturgeon. Fisheries Management Report No. 17. Atlantic States Marine Fisheries Commission, Washington, D.C. 73 pp.

Taubert, B.D. 1980b. Biology of shortnose sturgeon (Acipenser brevirostrum) in the Holyoke Pool, Connecticut River, Massachusetts. Ph.D. Thesis, University of Massachusetts, Amherst, 136 p.

Taubert, B.D., and M.J. Dadswell. 1980. Description of some larval shortnose sturgeon (Acipenser brevirostrum) from the Holyoke Pool, Connecticut River, Massachusetts, USA, and the Saint John River, New Brunswick, Canada. Canadian Journal of Zoology 58:1125-1128.

Taylor, A.C. 1990. The hopper dredge. In: Dickerson, D.D. and D.A. Nelson (Comps.); Proceedings of the National Workshop of Methods to Minimize Dredging Impacts on Sea Turtles, 11-12 May 1988, Jacksonville, Florida. Miscellaneous Paper EL-90-5. Department of the Army, U.S. Army Engineer Waterways Experiment Station, Vicksburg, MS. February, 1990. Pp. 59-63.

Teleki, G.C. and A.J. Chamberlain. 1978. Acute Effects of Underwater Construction Blasting in Fishes in Long Point Bay, Lake Erie. J. Fish. Res. Board Can. 35: 1191-1198.

TEWG (Turtle Expert Working Group). 1998. An assessment of the Kemp's ridley (Lepidochelys kempii) and loggerhead (Caretta caretta) sea turtle populations in the Western North Atlantic. NOAA Technical Memorandum NMFS-SEFSC-409:1-96.

TEWG (Turtle Expert Working Group). 2000. Assessment update for the Kemp's ridley and loggerhead sea turtle populations in the western North Atlantic. NOAA Technical Memorandum NMFS-SEFSC-444:1-115.

TEWG (Turtle Expert Working Group). 2007. An assessment of the leatherback turtle population in the Atlantic Ocean. NOAA Technical Memorandum NMFS-SEFSC-555:1-116.

TEWG (Turtle Expert Working Group). 2009. An assessment of the loggerhead turtle population in the Western North Atlantic Ocean. NOAA Technical Memorandum NMFS-SEFSC-575:1-131.

TEWG. 2000. Assessment update for the Kemp's ridley and loggerhead sea turtle populations in the western North Atlantic. U.S. Dep. Commer. NOAA Tech. Mem. NMFS-SEFSC-444, 115 pp.

TEWG. 2007. An assessment of the leatherback turtle population in the Atlantic Ocean. NOAA Technical Memorandum NMFS-SEFSC-555, 116 pp.

TEWG. 2009. An assessment of the loggerhead turtle population in the Western North Atlantic Ocean. NOAA Technical Memorandum NMFS-SEFSC-575: 1-131.

Titus, J.G. and V.K. Narayanan. 1995. The probability of sea level rise. U.S. Environmental Protection Agency EPA 230-R-95-008. 184 pp.

Turtle Expert Working Group (TEWG). 1998. An assessment of the Kemp's ridley (Lepidochelys kempii) and loggerhead (Caretta caretta) sea turtle populations in the Western North Atlantic. NOAA Technical Memorandum NOAA Fisheries-SEFSC-409. 96 pp.

Tynan, C.T. and D.P. DeMaster. 1997. Observations and predictions of Arctic climatic change: potential effects on marine mammals. Arctic 50: 308-322.

U.S. Army Corps of Engineers (USACE). 2006. Biological Assessment for Research and Compilation of Baseline Data for the Use of Bed-leveling Devices at Port of Palm Beach, Palm Beach County, Florida. Prepared for USACE-Jacksonville District. March.

U.S. Army Corps of Engineers (USACE). 1994. Beach Erosion Control and Hurricane Protection Study, Virginia Beach, Virginia- General Reevaluation Report, Main Report, Environmental Assessment , and Appendices. Norfolk District.

U.S. Army Corps of Engineers (USACE), Nofrolk District. 2012. Supplemental Biological Assessment for the Potential Impacts to Atlantic Sturgeon (Acipenser oxyrinchus oxyrinchus) Resulting from Beach Nourishment Activities at Sandbridge Beach Utitizing the Sandbridge Shoal Borrow Areas. Submitted to NMFS Northeast Regional Office, April 2012. Norfolk, Virginia. 39 pp.

U.S. Army Corps of Engineers (USACE), Savannah District. 2004. Biological Assessment of Threatened and Endangered Species for Brunswick Harbor Deepening Modification to Allow Use of Bed-leveling Mechanical Dredging, Glynn County, Georgia. July.

U.S. Fish and Wildlife Service (USFWS). 1997. Synopsis of the biological data on the green turtle, Chelonia mydas (Linnaeus 1758). Biological Report 97(1). U.S. Fish and Wildlife Service, Washington, D.C. 120 pp.

Uhler, P.R. and O. Lugger. 1876. List of fishes of Maryland. Rept. Comm. Fish. MD. 1876: 67-176.

USACE Environmental Laboratory. Sea Turtle Data Warehouse. Available at http://el.erdc.usace.army.mil/seaturtles/index.cfm.

USDOI (United States Department of Interior). 1973. Threatened wildlife of the United States. Shortnose sturgeon. Office of Endangered Species and International Activities, Bureau of Sport Fisheries and Wildlife, Washington, D.C. Resource Publication 114 (Revised Resource Publication 34).

USFWS (U.S. Fish and Wildlife Service) and NMFS (National Marine Fisheries Service). 1992. Recovery plan for the Kemp's ridley sea turtle (Lepidochelys kempü). Original. St. Petersburg, Florida: National Marine Fisheries Service. 40 pp.

USFWS and NMFS. 1992. Recovery plan for the Kemp’s ridley sea turtle (Lepidochelys kempii). NMFS, St. Petersburg, Florida.hatching. Curr Biol 17: R590.

Van Den Avyle, M. J. 1984. Species profile: Life histories and environmental requirements of coastal fishes and invertebrates (South Atlantic): Atlantic sturgeon. U.S. Fish and Wildlife Service Report No. FWS/OBS-82/11.25, and U. S. Army Corps of Engineers Report No. TR EL-82-4, Washington, D.C.

Van Eenennaam, J.P., and S.I. Doroshov. 1998. Effects of age and body size on gonadal development of Atlantic sturgeon. Journal of Fish Biology 53: 624-637.

Van Eenennaam, J.P., S.I. Doroshov, G.P. Moberg, J.G. Watson, D.S. Moore and J. Linares. 1996. Reproductive conditions of the Atlantic sturgeon (Acipenser oxyrhynchus) in the Hudson River. Estuaries 19: 769-777.

Van Houtan, K.S. and J.M. Halley. 2011. Long-Term Climate Forcing in Loggerhead Sea Turtle Nesting. PLoS ONE 6(4): e19043. doi:10.1371/journal.pone.0019043.

Van Houton, K.S. and O.L. Bass. 2007. Stormy oceans are associated with declines in sea turtle

Varanasi, U. 1992. Chemical contaminants and their effects on living marine resources. pp. 59-71. in: R. H. Stroud (ed.) Stemming the Tide of Coastqal Fish Habitat Loss. Proceedings of the Symposium on Conservation of Fish Habitat, Baltimore, Maryland. Marine Recreational Fisheries Number 14. National Coalition for Marine Conservation, Inc., Savannah Georgia.

Vinyard, L. and W.J. O’Brien. 1976. Effects of light and turbidity on the reactive distance of bluegill (Lepomis macrochirus) J. Fish. Res. Board Can. 33: 2845-2849.

Vladykov, V.D. and J.R. Greeley. 1963. Order Acipenseroidea. Pages 24-60 in Fishes of the Western North Atlantic. Memoir Sears Foundation for Marine Research 1(Part III). xxi + 630 pp.

Von Westernhagen, H., H. Rosenthal, V. Dethlefsen, W. Ernst, U. Harms, and P.D. Hansen. 1981. Bioaccumulating substances and reproductive success in Baltic flounder Platichthys flesus. Aquatic Toxicology 1:85-99.

Waldman JR, Grunwald C, Stabile J, Wirgin I. 2002. Impacts of life history and biogeography on genetic stock structure in Atlantic Sturgeon, Acipenser oxyrinchus oxyrinchus, Gulf sturgeon A. oxyrinchus desotoi, and shortnose sturgeon, A.brevirostrum. J Appl Ichthyol 18:509-518

Waldman, J.R., J.T. Hart, and I.I. Wirgin. 1996. Stock composition of the New York Bight Atlantic sturgeon fishery based on analysis of mitochondrial DNA. Transactions of the American Fisheries Society 125: 364-371.

Wallace, B.P., S.S. Heppell, R.L. Lewison, S. Kelez, and L.B. Crowder. 2008. Impacts of fisheries bycatch on loggerhead turtles worldwide inferred from reproductive value analyses. J Appl Ecol 45:1076-1085.

Walsh, M.G., M.B. Bain, T. Squires, J.R. Walman, and Isaac Wirgin. 2001. Morphological and genetic variation among shortnose sturgeon Acipenser brevirostrum from adjacent and distant rivers. Estuaries Vol. 24, No. 1, p. 41-48. February 2001.

Waluda, C.M., P.G. Rodhouse, G.P. Podesta, P.N. Trathan, and G.J. Pierce. 2001. Surface oceanography of the inferred hatching grounds of Illex argentinus (Cephalopoda: Ommastrephidae) and influences on recruitment variability. Marine Biology 139: 671-679.

Warden, M. and K. Bisack 2010. Analysis of Loggerhead Sea Turtle Bycatch in Mid-Atlantic Bottom Trawl Fisheries to Support the Draft Environmental Impact Statement for Sea Turtle Conservation and Recovery in Relation to Atlantic and Gulf of Mexico Bottom Trawl Fisheries. NOAA NMFS NEFSC Ref. Doc.010. 13 pp.

Warden, M.L. 2011a. Modeling loggerhead sea turtle (Caretta caretta) interactions with US Mid-Atlantic bottom trawl gear for fish and scallops, 2005-2008. Biological Conservation 144:2202-2212.

Warden, M.L. 2011b. Proration of loggerhead sea turtle (Caretta caretta) interactions in U.S. Mid-Atlantic bottom otter trawls for fish and scallops, 2005-2008, by managed species landed. U.S. Department of Commerce, Northeast Fisheries Science Centter Reference Document 11-04. 8 p.

Waters, Thomas F. 1995. Sediment in Streams. American Fisheries Society Monograph 7. American Fisheries Society, Bethesda, MD. Pages 95-96.

Webster, P.J., G.J. Holland, J.A. Curry, H.R. Chang. 2005. Changes in tropical cyclone number, duration, and intensity in a warming environment. Science 309:1844–1846.

Wehrell, S. 2005. A survey of the groundfish caught by the summer trawl fishery in Minas Basin and Scots Bay. Honours Thesis. Department of Biology, Acadia University, Wolfville, Canada.

Weishampel, J.F., D.A. Bagley, and L.M. Ehrhart. 2004. Earlier nesting by loggerhead sea turtles following sea surface warming. Global Change Biology 10: 1424-1427.

Welsh, S. A., S. M. Eyler, M. F. Mangold, and A. J. Spells. 2002. Capture locations and growth rates of Atlantic sturgeon in the Chesapeake Bay. Pages 183-194 In: W. Van Winkle, P. J.Anders, D. H. Secor, and D. A. Dixon, (editors), Biology, management, and protection of North American sturgeon. American Fisheries Society Symposium 28, Bethesda,Maryland.

Welsh, Stuart A., Michael F. Mangold, Jorgen E. Skjeveland, and Albert J. Spells. 2002. Distribution and Movement of Shortnose Sturgeon (Acipenser brevirostrum) in the Chesapeake Bay. Estuaries Vol. 25 No. 1: 101-104.

Wibbels, T. 2003. Critical approaches to sex determination in sea turtle biology and conservation. In: P. Lutz et al. (editors), Biology of Sea Turtles, Vol 2. CRC Press Boca Raton. p. 103-134.

Wilber, D.H., D.G. Clarke & M.H. Burlas. (2006). Suspended sediment concentrations associated with a beach nourishment project on the northern coast of New Jersey. Journal of Coastal Research 22(5): 1035 – 1042.

Wilber, Dara H. and Douglas C. Clarke. 2001. Biological Effects of Suspended Sediments: A review of suspended sediment impacts on fish and shellfish with relation to dredging activities in estuaries. North American Journal of Fisheries Woodland, R. J. 2005. Age, growth, and recruitment of Hudson River shortnose sturgeon (Acipenser brevirostrum). Master's thesis. University of Maryland, College Park.

Wirgin, I. and T.L. King. 2011. Mixed stock analysis of Atlantic sturgeon from coastal locales and a non-spawning river. Presentation of the 2011 Sturgeon Workshop, Alexandria, VA, February 8-10.

Wirgin, I., Grunwald, C., Carlson, E., Stabile, J., Peterson, D.L. and J. Waldman. 2005. Range-wide population structure of shortnose sturgeon Acipenser brevirostrum based on sequence analysis of mitochondrial DNA control region. Estuaries 28:406-21.

Witherington, B., P. Kubilis, B. Brost, and A. Meylan. 2009. Decreasing annual nest counts in a globally important loggerhead sea turtle population. Ecological Applications 19: 30-54.

Witt, M.J., A.C. Broderick, D.J. Johns, C. Martin, R. Penrose, M.S. Hoogmoed, and B.J. Godley. 2007. Prey landscapes help identify potential foraging habitats for leatherback turtles in the NE Atlantic. Marine Ecology Progress Series 337: 231-243.

Witt, M.J., A.C. Broderick, M. Coyne, A. Formia and others. 2008. Satellite tracking highlights difficulties in the design of effective protected areas for critically endangered leatherback turtles Dermochelys coriacea during the inter-nesting period. Oryx 42: 296–300.

Witzell, W.N. 2002. Immature Atlantic loggerhead turtles (Caretta caretta): suggested changes to the life history model. Herpetological Review 33(4): 266-269.

Witzell, W.N., A.L. Bass, M.J. Bresette, D.A. Singewald, and J.C. Gorham. 2002. Origin of immature loggerhead sea turtles (Caretta caretta) at Hutchinson Island, Florida: evidence from mtDNA markers. Fish. Bull. 100:624-631.

Woodland, R.J. and D. H. Secor. 2007. Year-class strength and recovery of endangered shortnose sturgeon in the Hudson River, New York. Transaction of the American Fisheries Society 136:72-81.

Wynne, K. and M. Schwartz. 1999. Guide to marine mammals and turtles of the U.S. Atlantic and Gulf of Mexico. Rhode Island Sea Grant, Narragansett, Rhode Island. 114 pp.

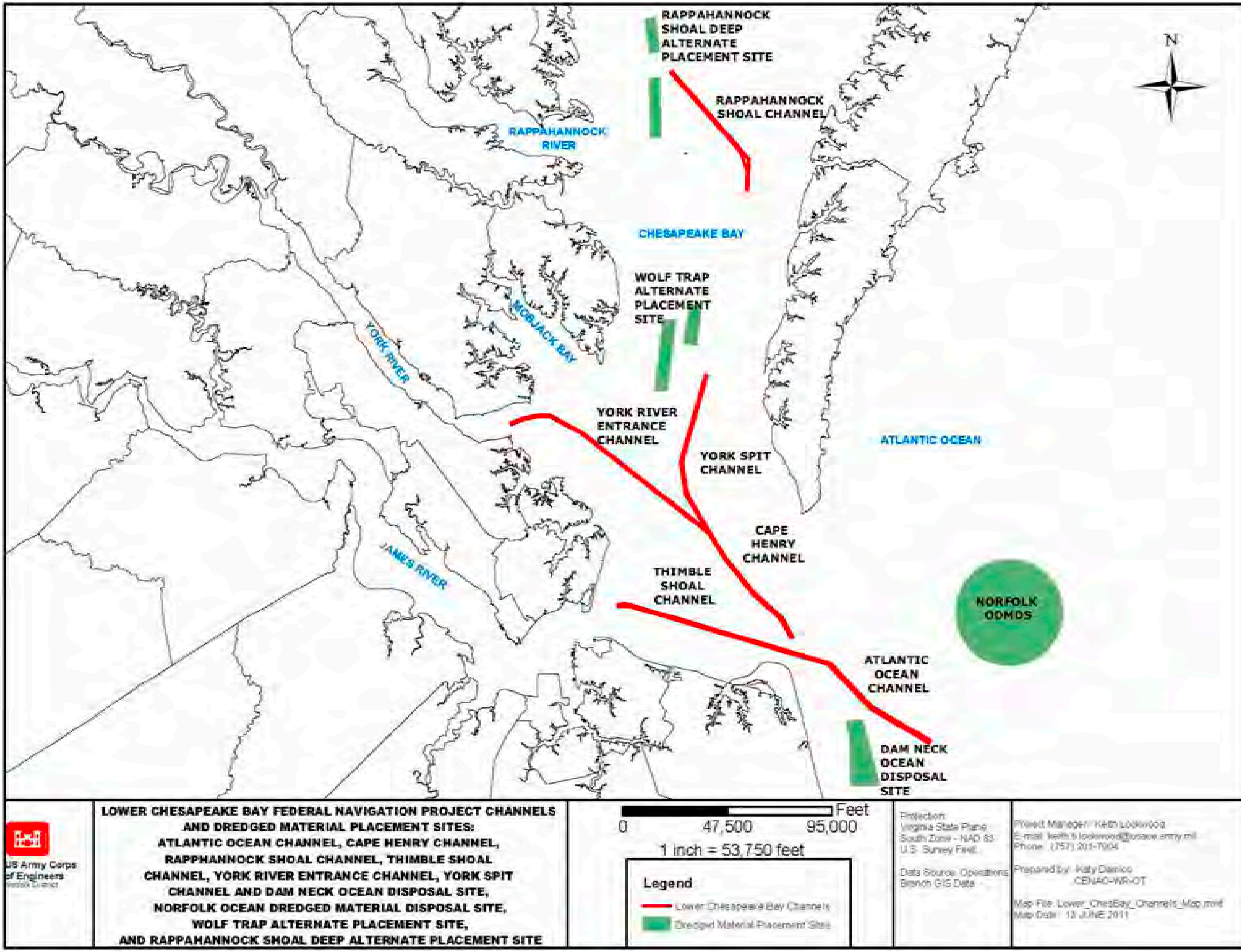
Young, J. R., T. B. Hoff, W. P. Dey, and J. G. Hoff. 1998. Management recommendations for a Hudson River Atlantic sturgeon fishery based on an age-structured population model. Fisheries Research in the Hudson River. State of University of New York Press, Albany, New York. pp. 353.

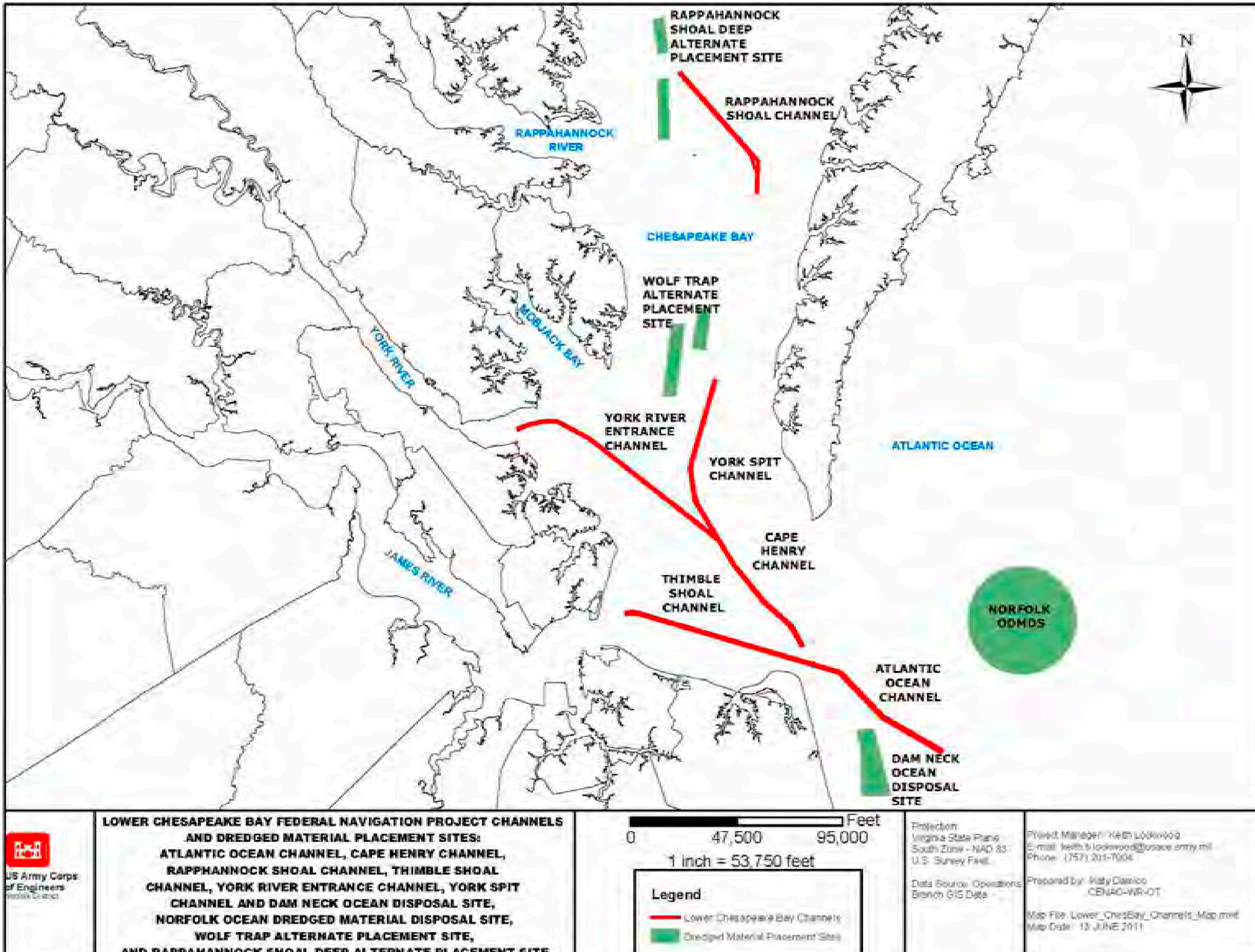
Ziegeweid, J.R., C.A. Jennings, and D.L. Peterson. 2008a. Thermal maxima for juvenile shortnose sturgeon acclimated to different temperatures. Environmental Biology of Fish 3: 299-307.

Ziegeweid, J.R., C.A. Jennings, D.L. Peterson and M.C. Black. 2008b. Effects of salinity, temperature, and weight on the survival of young-of-year shortnose sturgeon. Transactions of the American Fisheries Society 137:1490-1499.

Zug, G.R., and J.F. Parham. 1996. Age and growth in leatherback turtles, Dermochelys coriacea: a skeletochronological analysis. Chelonian Conservation and Biology 2(2): 244-249.

Zurita, J.C., R. Herrera, A. Arenas, M.E. Torres, C. Calderon, L. Gomez, J.C. Alvarado, and R. Villavicencio. 2003. Nesting loggerhead and green sea turtles in Quintana Roo, Mexico. Pp. 125-127. In: J.A. Seminoff (compiler). Proceedings of the Twenty-Second Annual Symposium on Sea Turtle Biology and Conservation. NOAA Tech. Memo. NMFS-SEFSC-503, 308 p.


RAPPAHANNOCK SHOAL DEEP ALTERNATE PLACEMENT SITE
RAPPAHANNOCK SHOAL CHANNEL
RAPPAHANNOCK RIVER
CHESAPEAKE BAY
WOLF TRAP ALTERNATE PLACEMENT SITE
MOBJACK BAY
YORK RIVER
YORK RIVER ENTRANCE CHANNEL
YORK SPIT CHANNEL
ATLANTIC OCEAN
CAPE HENRY CHANNEL
THIMBLE SHOAL CHANNEL
JAMES RIVER
NORFOLK ODMDS
ATLANTIC OCEAN CHANNEL
DAM NECK OCEAN DISPOSAL SITE
N
US Army Corps of Engineers
LOWER CHESAPEAKE BAY FEDERAL NAVIGATION PROJECT CHANNELS AND DREDGED MATERIAL PLACEMENT SITES: ATLANTIC OCEAN CHANNEL, CAPE HENRY CHANNEL, RAPPHANNOCK SHOAL CHANNEL, THIMBLE SHOAL CHANNEL, YORK RIVER ENTRANCE CHANNEL, YORK SPIT CHANNEL AND DAM NECK OCEAN DISPOSAL SITE, NORFOLK OCEAN DREDGED MATERIAL DISPOSAL SITE, WOLF TRAP ALTERNATE PLACEMENT SITE, AND RAPPAHANNOCK SHOAL DEEP ALTERNATE PLACEMENT SITE
0 47,500 95,000 Feet
1 inch = 53,750 feet
Legend
Lower Chesapeake Bay Channels
Dredged Material Placement Sites
Projection: Virginia State Plane South Zone - NAD 83 U.S. Survey Feet
Data Source: Operations Branch GIS Data
Project Manager: Keith Lockwood
Phone: (757) 201-7004
Prepared by: Katy Damico CENAO-WR-OT
Map File: Lower_ChesBay_Channels_Map.mxd
Map Date: 13 JUNE 2011




US Army Corps of Engineers
Norfolk District

**LOWER CHESAPEAKE BAY FEDERAL NAVIGATION PROJECT CHANNELS AND DREDGED MATERIAL PLACEMENT SITES: ATLANTIC OCEAN CHANNEL, CAPE HENRY CHANNEL, RAPPHANNOCK SHOAL CHANNEL, THIMBLE SHOAL CHANNEL, YORK RIVER ENTRANCE CHANNEL, YORK SPIT CHANNEL AND DAM NECK OCEAN DISPOSAL SITE, NORFOLK OCEAN DREDGED MATERIAL DISPOSAL SITE, WOLF TRAP ALTERNATE PLACEMENT SITE, AND RAPPAHANNOCK SHOAL DEEP ALTERNATE PLACEMENT SITE**

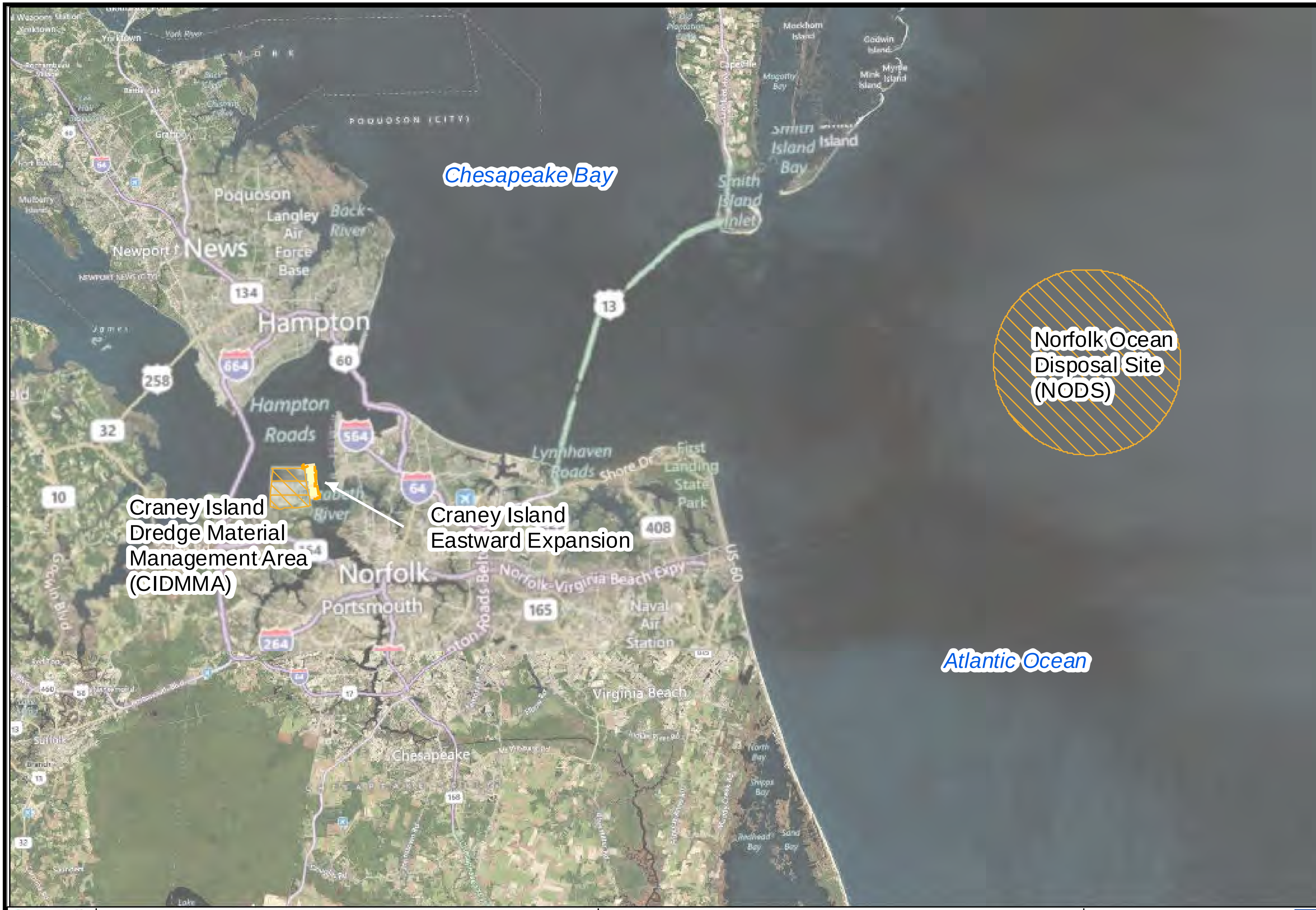
Projection:
Virginia State Plane
South Zone - NAD 83
U.S. Survey Feet

Data Source: Operations Branch GIS Data

Project Manager: Keith Lockwood
E-mail: keith.b.lockwood@usace.army.mil
Phone: (757) 201-7004

Prepared by: Katy Damico
CENAO-WR-OT

Map File: Lower_ChesBay_Channels_Map.mxd
Map Date: 13 JUNE 2011




US Army Corps of Engineers
Norfolk District

# Craney Island Eastward Expansion

Federal Navigation Channel
Eastward Expansion Dike Area
Eastward Expansion Fill Area
Access Channels
Berthing Area
Dredge Material Placement Area

PM: Mike Anderson
michael.a.anderson@usace.army.mil
Map: CIEE Stage2A_EPA_Permit.mxd
Developed By: Jeff Swallow
Date of Map: 07/23/2012
0 500 1,000 2,000 Feet


US Army Corps of Engineers
Norfolk District

# Craney Island Eastward Expansion

Federal Navigation Channel
Eastward Expansion Dike Area
Eastward Expansion Fill Area
Access Channel
Wharf Access Area
Dredge Material Placement Area

PM: Mike Anderson
michael.a.anderson@usace.army.mil
Map: CIEE Stage2A_EPA_Permit.mxd
Developed By: Jeff Swallow/Karin Dridge
Date of Map: 07/30/2012

0 1,000 2,000 4,000 Feet


# Federal Navigation Channels and Anchorages Serving the Port of Hampton Roads

0 1 2 Miles

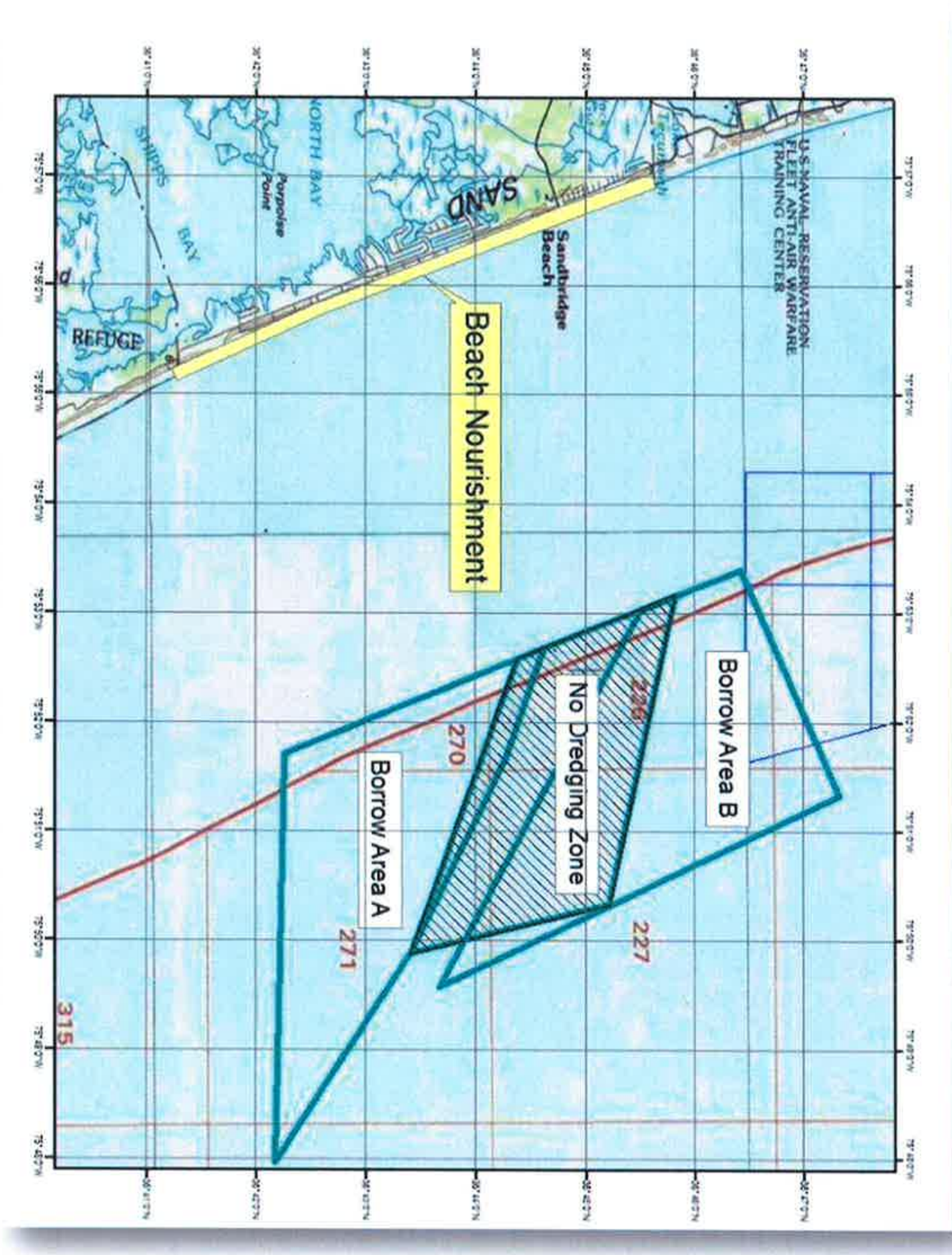
PM: Steve Powell
Map: NorfolkHarborSturgeon.mxd
Developed By: Jeff Swallow
Date of Map: 07/10/2012


# Dredge Material Placement Areas Serving the Port of Hampton Roads

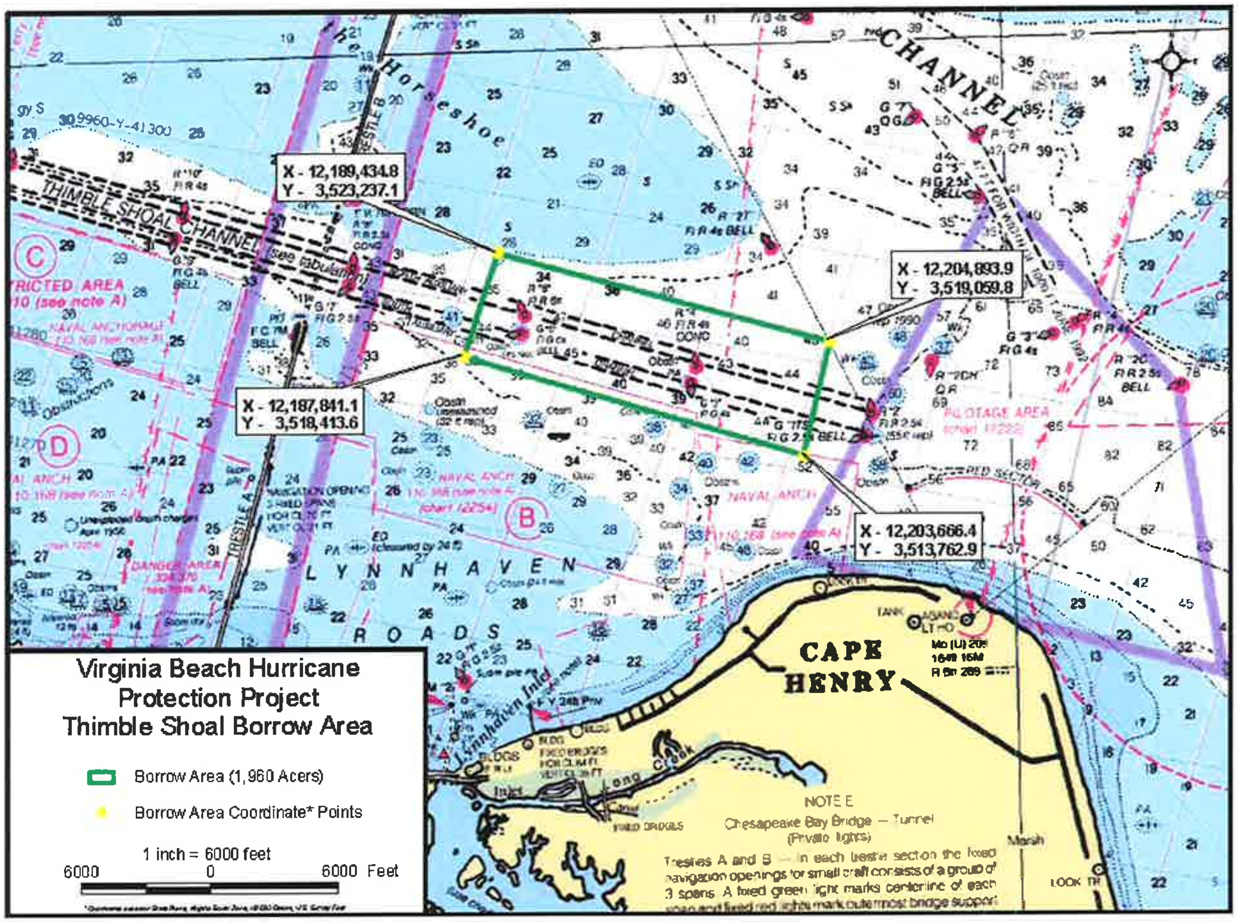
0 4 8 Miles

PM: Steve Powell
Map: NorfolkHarborSturgeon.mxd
Developed By: Jeff Swallow
Date of Map: 07/10/2012

## Appendix A

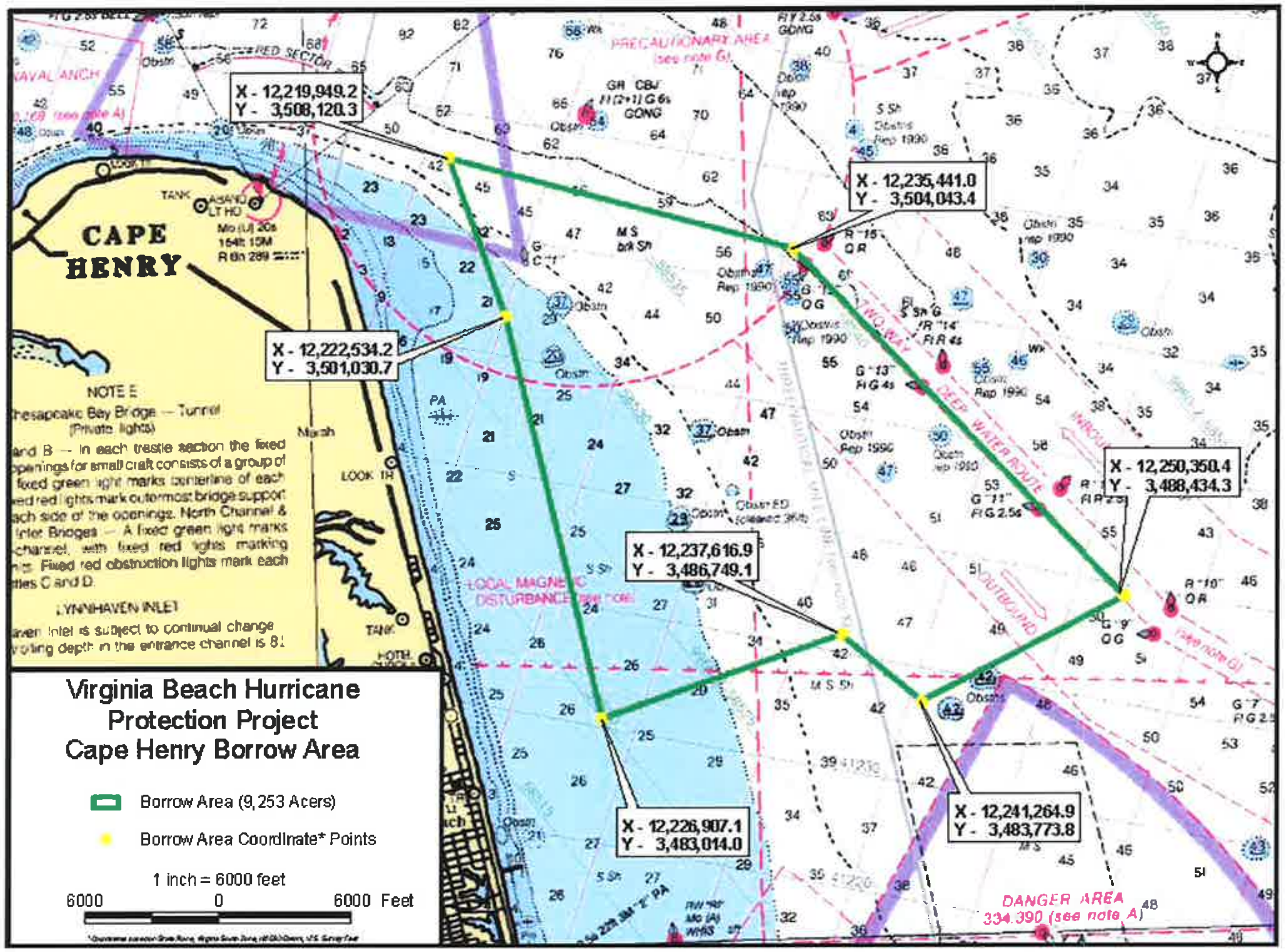

Beach Nourishment
Borrow Area A
Borrow Area B
No Dredging Zone
Sandbridge Beach
U.S. NAVAL RESERVATION
FLEET ANTI-AIR WARFARE
TRAINING CENTER
NORTH BAY
Porpoise Point
SAND
REFUGE
270
271
227
315

Appendix A

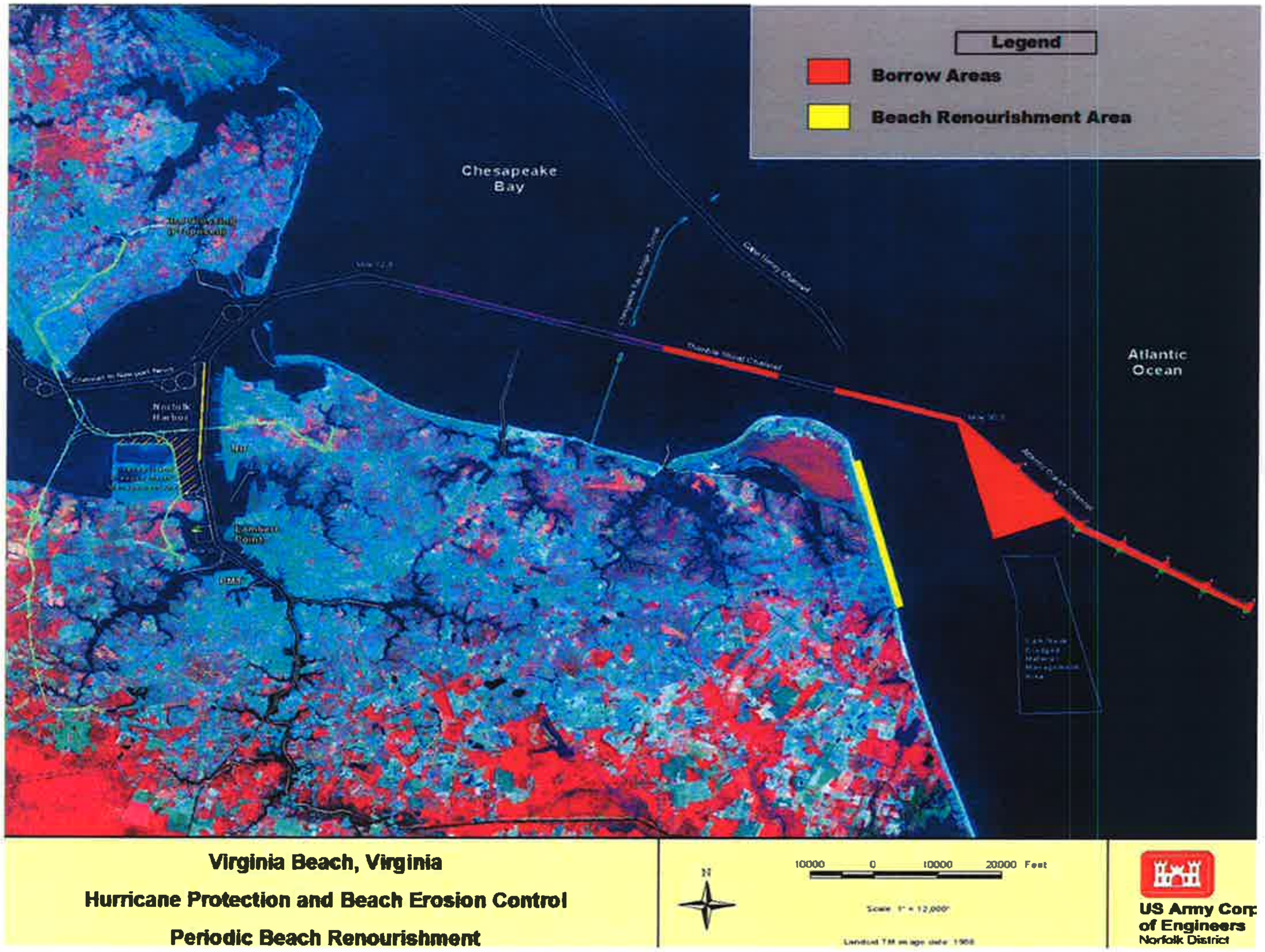


Virginia Beach Hurricane Protection Project Thimble Shoal Borrow Area
Borrow Area (1,960 Acres)
Borrow Area Coordinate* Points
1 inch = 6000 feet
6000 0 6000 Feet
X - 12,189,434.8 Y - 3,523,237.1
X - 12,204,893.9 Y - 3,519,059.8
X - 12,187,841.1 Y - 3,518,413.6
X - 12,203,666.4 Y - 3,513,762.9
THIMBLE SHOAL CHANNEL
CHANNEL
The Horseshoe
LYNNHAVEN ROADS
CAPE HENRY
NAVAL ANCH
PILOTAGE AREA
DANGER AREA
TRESTLE A
TRESTLE B
Lynnhaven Inlet
Long Creek
NOTE E
Chesapeake Bay Bridge – Tunnel (Private lights)

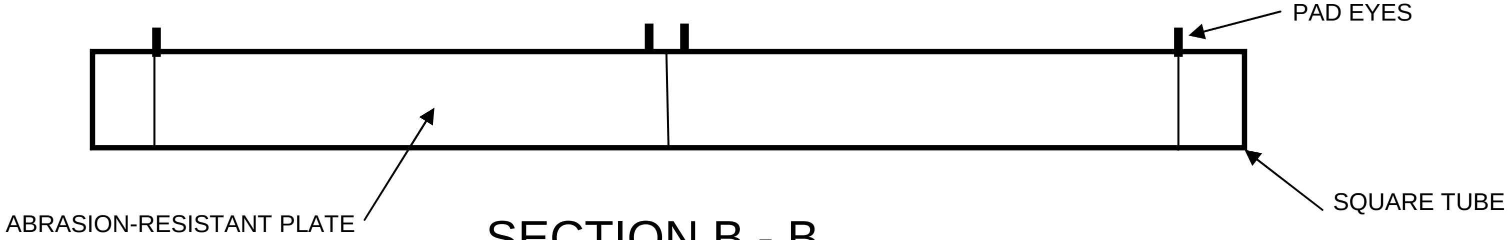
Appendix B


Virginia Beach Hurricane Protection Project
Cape Henry Borrow Area
Borrow Area (9,253 Acres)
Borrow Area Coordinate* Points
1 inch = 6000 feet
6000 0 6000 Feet
X - 12,219,949.2 Y - 3,508,120.3
X - 12,235,441.0 Y - 3,504,043.4
X - 12,222,534.2 Y - 3,501,030.7
X - 12,250,350.4 Y - 3,488,434.3
X - 12,237,616.9 Y - 3,486,749.1
X - 12,226,907.1 Y - 3,483,014.0
X - 12,241,264.9 Y - 3,483,773.8
CAPE HENRY
NOTE E
LYNNHAVEN INLET
PRECAUTIONARY AREA
LOCAL MAGNETIC DISTURBANCE
DANGER AREA 334.390 (see note A)

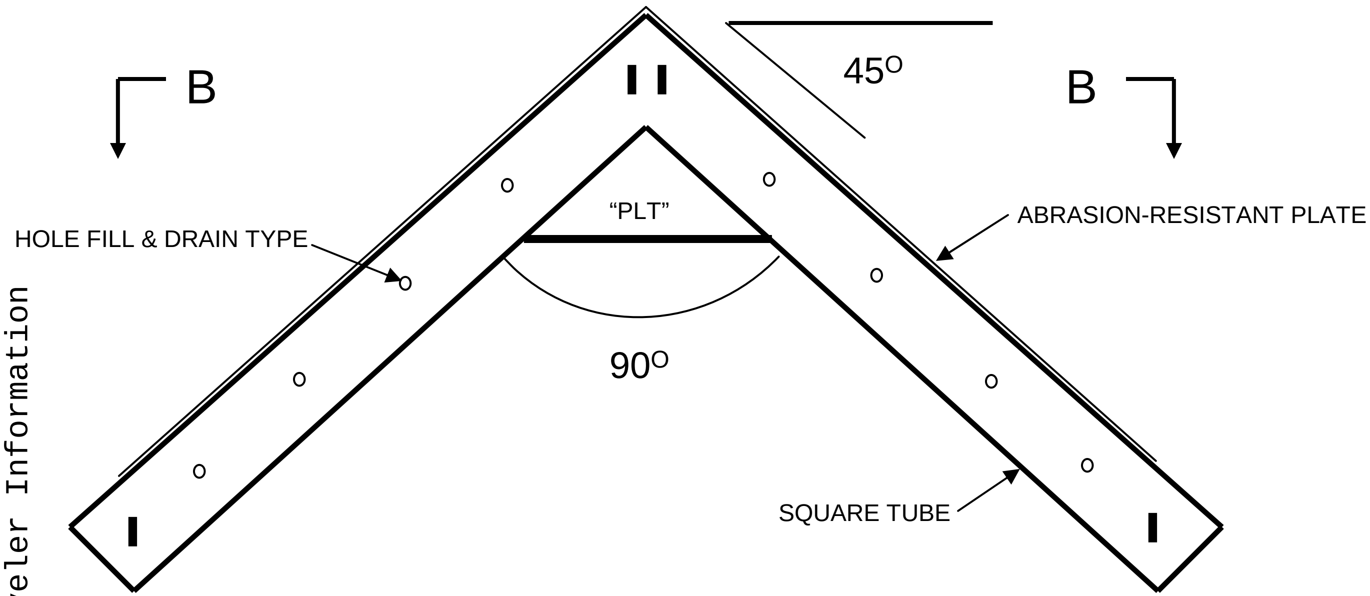
Appendix C



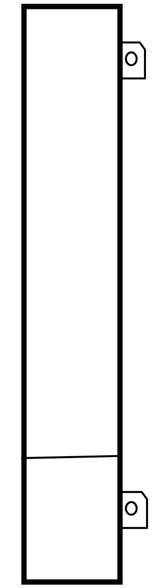
Legend
Borrow Areas
Beach Renourishment Area
Chesapeake Bay
Atlantic Ocean
Norfolk Harbor
Virginia Beach, Virginia
Hurricane Protection and Beach Erosion Control
Periodic Beach Renourishment
N
10000 0 10000 20000 Feet
US Army Corp of Engineers
Norfolk District




SECTION B - B



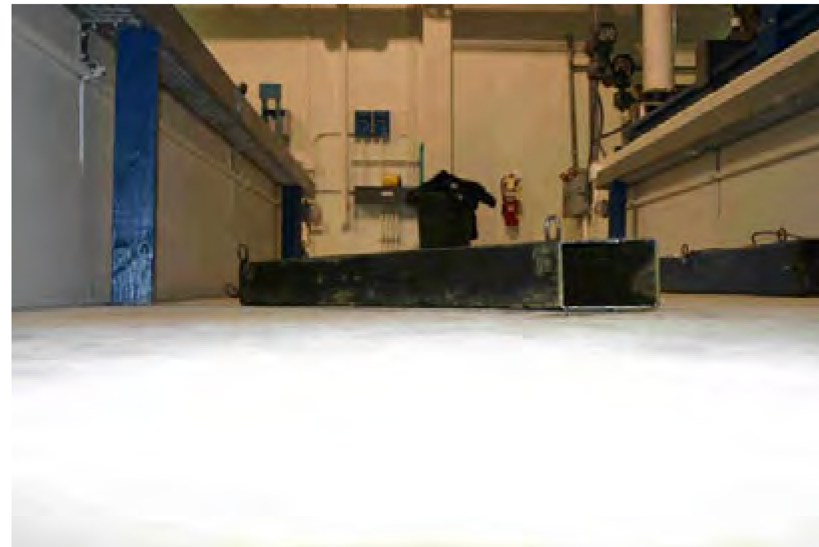

PLAN VIEW

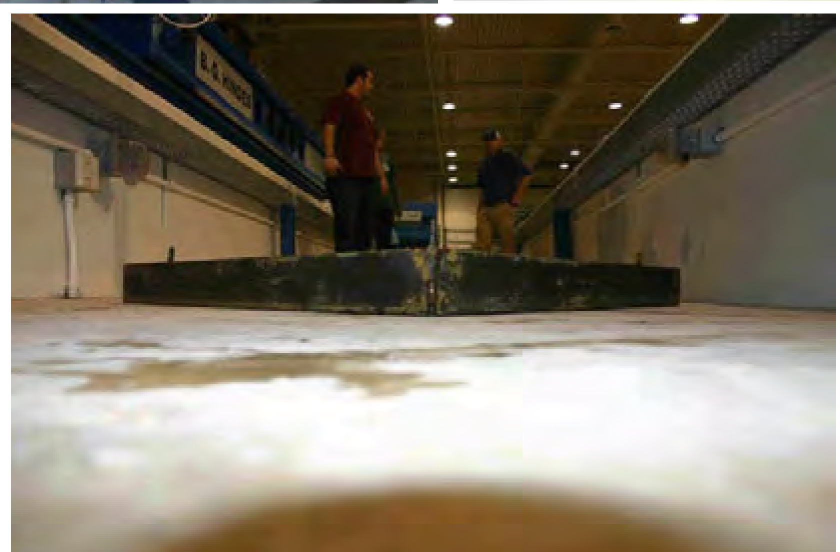


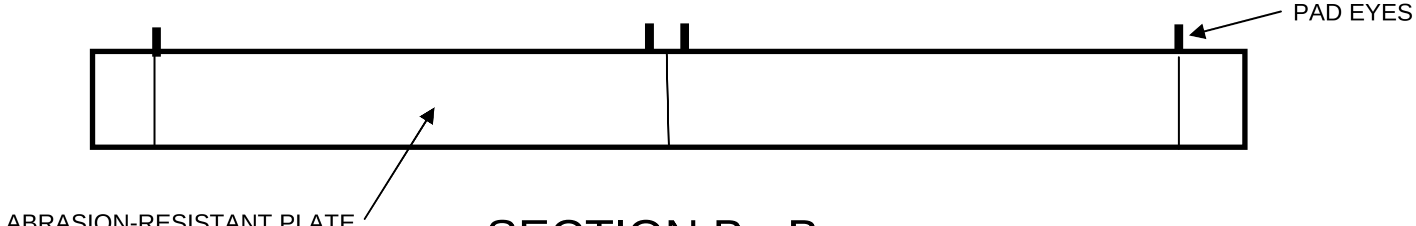
LEFT SIDE VIEW

**90 DEGREE BED LEVELER**
**CONCEPTUAL DESIGN**

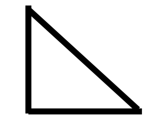
# 90 DEGREE BED LEVELER MODEL PHOTOGRAPHS



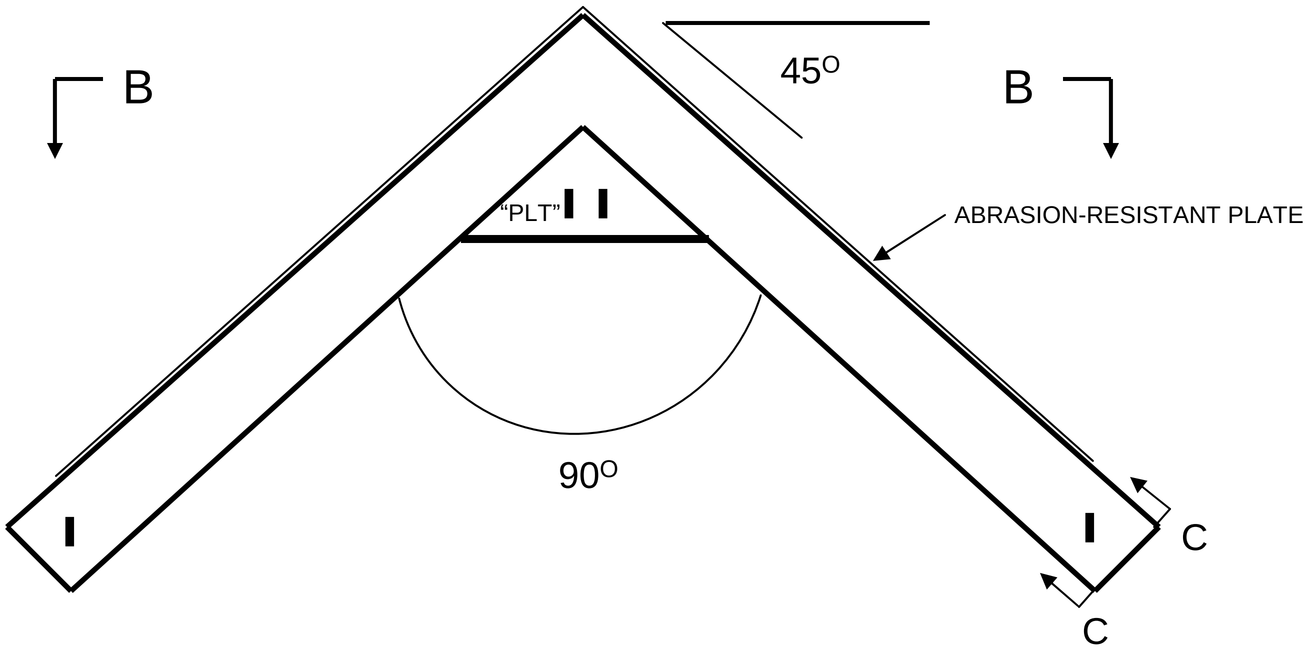




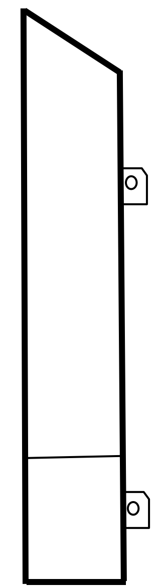

SECTION B - B



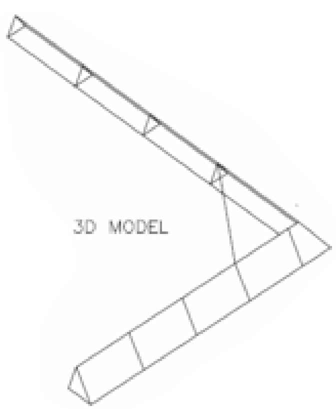
SECTION C-C




PLAN VIEW



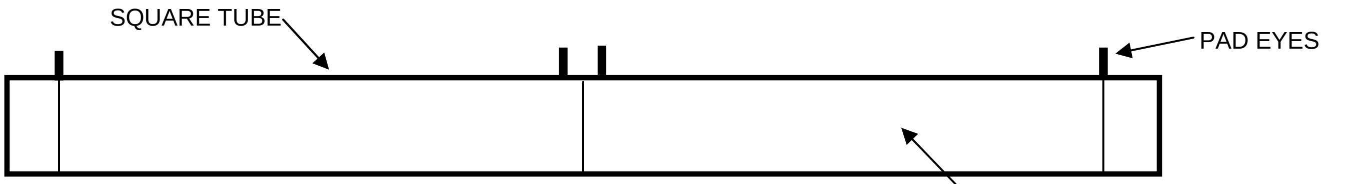
LEFT SIDE VIEW




**90 DEGREE RAKED BED LEVELER**
**CONCEPTUAL DESIGN**

# 90 DEGREE RAKED BED LEVELER MODEL PHOTOGRAPHS



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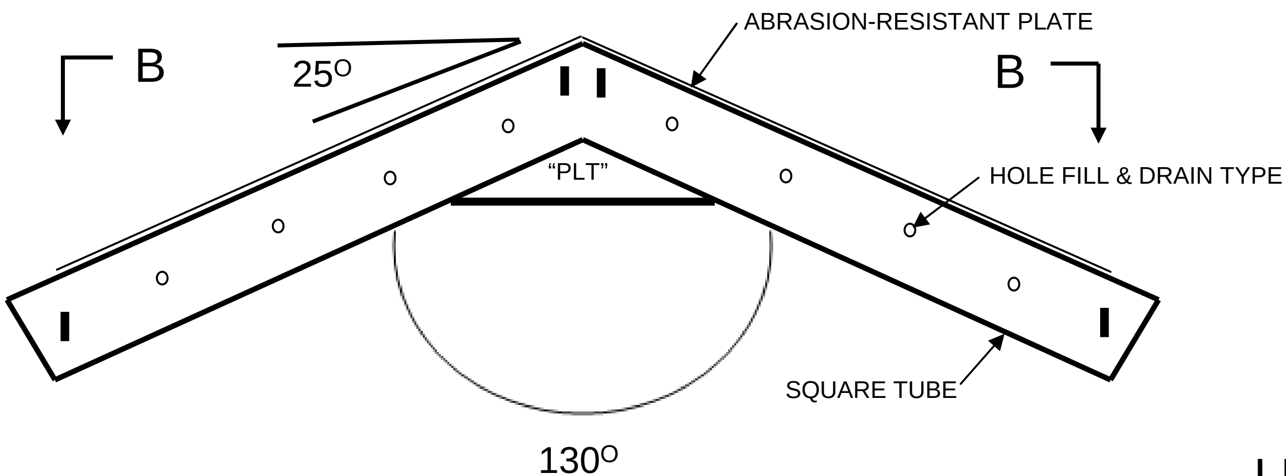
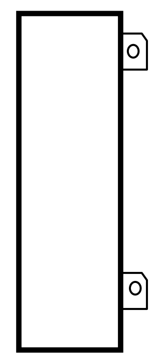


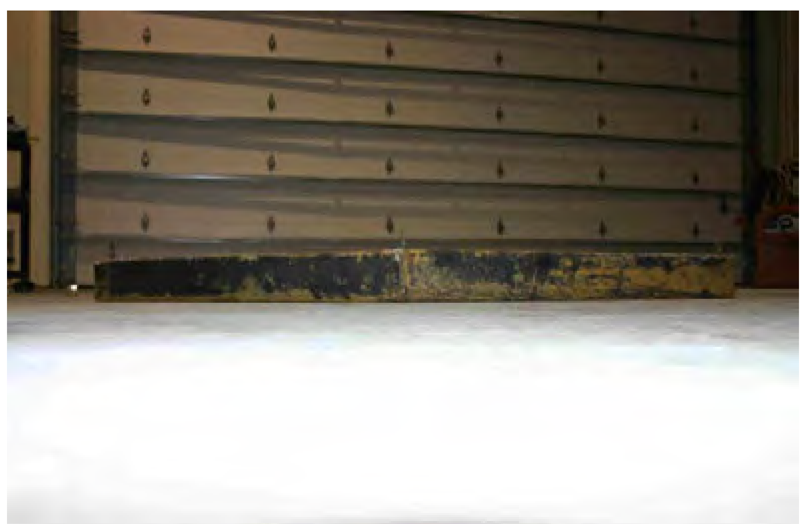

PLAN VIEW

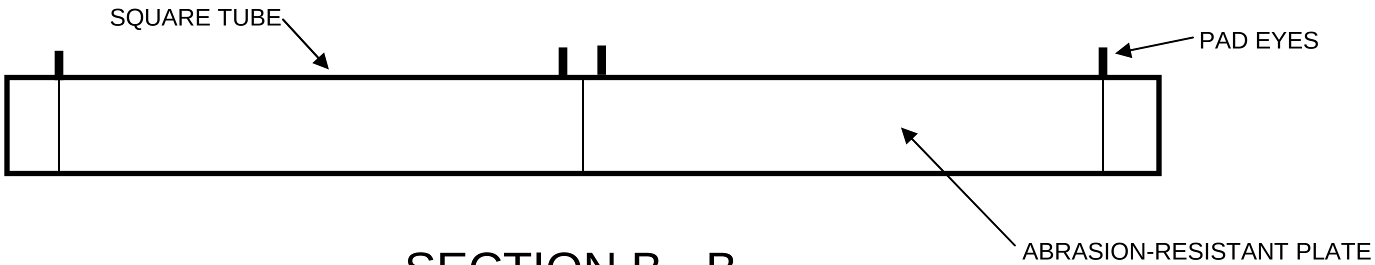


LEFT SIDE VIEW

# 130 DEGREE BED LEVELER CONCEPTUAL DESIGN

# 130 DEGREE BED LEVELER MODEL PHOTOGRAPHS



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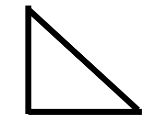
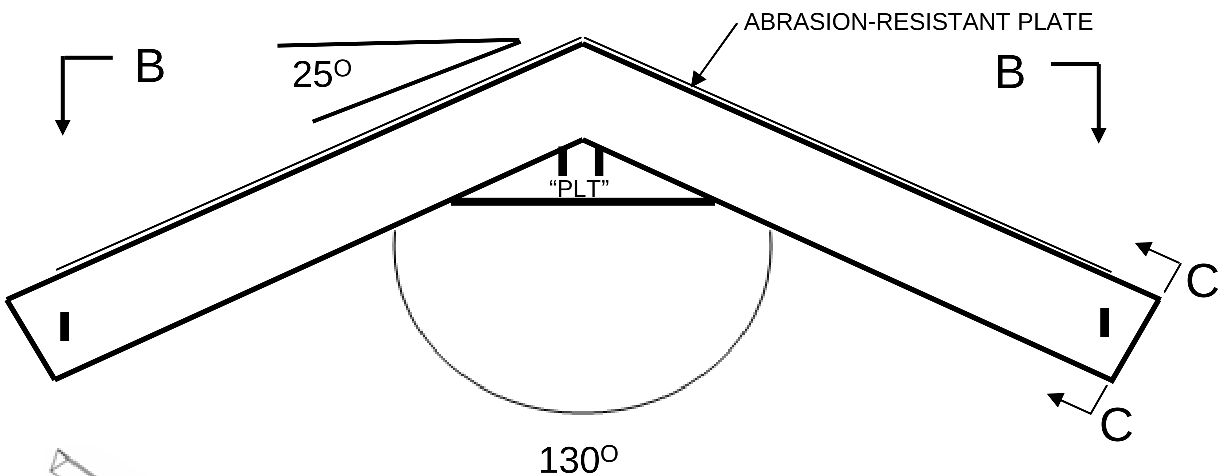
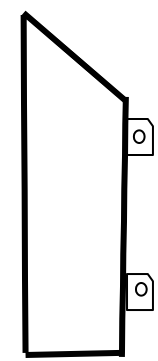


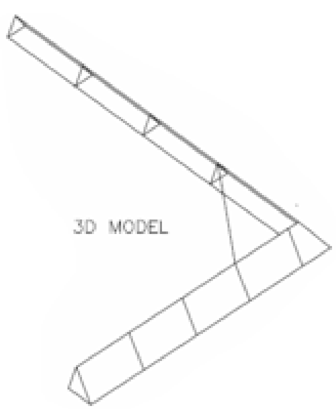
SECTION C-C




PLAN VIEW



LEFT SIDE VIEW




**130 DEGREE RAKED BED LEVELER**
**CONCEPTUAL DESIGN**

Appendix C.
Historical Take Records of Sturgeon

## Sturgeon Take Records from Dredging Operations 1990 - Mar 2012

| Take # | Date | Corps District | Location | Sp | Dredge Type/ Name | Status | Specimen Description | Notes | Photos | Documentation |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 30 Oct 90 | SAC | Winyah Bay Georgetown | A | H *Ouchita* | Dead | ~69cm, rear half | Overflow Screening | N | Chris Slay pers com<br>Observer report<br>DACW 60-90-C-0067 |
| 2 | 15 Jan 94 | SAS | Savannah Harbor | A | H *RN Weeks* | NA | NA | Found by Turtle observer | No | Steve Calver pers com 14 Jun 05<br>Observer load sheet and final rpt<br>#DACW21-93-C-0072 |
| 3 | 07 Dec 94 | SAS | Savannah Harbor | A | H *Dodge Island* | Live released | 71cm, whole fish | Starboard Skimmer Screening | Yes We have efile | Chris Slay pers com<br>Observer report |
| 4 | 07 Dec 94 Different Load | SAS | Savannah Harbor | A | H *Dodge Island* | Dead | 77.5cm, whole fish | Starboard Skimmer Screening | Yes We have efile | Chris Slay pers com<br>Observer report |
| 5 | Feb 96 | NAP | Delaware River Newbold Island | S | P *Ozark* | Dead | 83cm, female w/eggs | In DMA Money Island | | NMFS memo for record<br>From Laurie Silva 19 Apr 96 |
| 6 | Feb 96 | NAP | Delaware River Newbold Island | S | P *Ozark* | Dead | 63cm, mature male | In DMA Money Island | | NMFS memo for record<br>From Laurie Silva<br>19 Apr 96 |
| 7 | 06 Jan 98 | NAP | Delaware River Kinkora Range | S | P *??* | Dead | Either 657mm or 573mm **???** | In DMA Money Island | Y Not e-file | Memo for file 20 Jan 98<br>From Greg Wacik NAP |
| 8 | 12 Jan 98 | NAP | Delaware River Florence Range | S | P *??* | Dead | Either 657mm or 573mm **???** | In DMA Money Island | Y Not e-file | Memo for file 20 Jan 98<br>From Greg Wacik NAP |
| 9 | 13 Jan 98 | NAP | Delaware River Florence Range | S | P *??* | Dead | Either 657mm or 573mm **???** | In DMA Money Island | Y Not e-file | Memo for file 20 Jan 98<br>From Greg Wacik NAP |
| 10 | 7 Sep 98 | SAW | Wilmington Har Cape Fear River | A | H *McFarland* | Dead | Head only (1 ft long) | In turtle Inflow screen | | Observer incident report<br>Pers com Bill Adams- SAW 26 Jul 04 |
| 11 | 01 Mar 00 | SAC | Charleston Harbor | A | H *Stuyvesant* | Dead | Missing head and tail | Main Overflow Screening | No | Chris Slay pers com<br>Observer reporting forms |
| 12 | 12 Apr 00 | SAC | Charleston Harbor | A | H *Stuyvesant* | Dead | 71.6cm, whole fish | Starboard Overflow screening | No | Chris Slay pers com<br>Observer reporting forms |
| 13 | 03 Dec 00 | SAW | Wilmington Har MOTSU | A | C *New York* | Dead | 82.5cm, whole fish decomposing | In bucket | Y Not e-file Payonk? ? | Chris Slay pers com<br>Phil Payonk pers com<br>30 Jul 04<br>Bill Adams pers com<br>28 Jul 04<br>#DACW54-00-C-0013 |

## Sturgeon Take Records from Dredging Operations 1990 - Mar 2012

| Take # | Date | Corps District | Location | Sp | Dredge Type/ Name | Status | Specimen Description | Notes | Photos | Documentation |
|---|---|---|---|---|---|---|---|---|---|---|
| 14 | 24 Feb 01 | SAS | Brunswick Harbor | A | H<br>*RN Weeks* | Dead | Head only | Just mentions take on all forms, no other info. | No | Daily and Weekly Reports, Load sheet. |
| 15 | 19 Jun 01 | NAE | Kennebec River<br>Bath Iron Works | A | C *??* | Live released | | Put in scow, released unharmed | | Julie Crocker NMFS pers com 19 Jul 04<br>2003 Chesapeake BA, Section 7.2<br>Normandeau Associates, Inc 2001 |
| 16 | 30 Apr 03 | NAE | Kennebec River<br>Bath Iron Works | S | C<br>Reed and Reed dredge company | Dead | Fish nearly cut in half | | Y<br>We have e-file | Julie Crocker NMFS pers com 19 Jul 04<br>2003 Chesapeake BA, Section 7.2<br>Normandeau Associates, Inc 2001 |
| 17 | 6 Oct 03 | NAE | Kennebec River<br>Doubling Point | S | H<br>*Padre Island* | Dead | 38.1inches | In hopper | Y<br>We have e-file | Observer incident report<br>Kennebec River BA Jul 04<br>Memo for Commander, from Bill Kavanaugh, 1 Jul 04<br>Bill Kavanaugh pers com 15 Jul 04<br>Julie Crocker pers com 19 Jul 04 |
| 18 | 6 Oct 03 | NAE | Kennebec River<br>Doubling Point | S | H<br>*Padre Island* | Dead | 37.0 inches | In hopper<br>Did not dive<br>Probably died | Y<br>We have e-file | Observer incident report<br>Kennebec River BA Jul 04<br>Memo for Commander, from Bill Kavanaugh, 1 Jul 04<br>Bill Kavanaugh pers com 15 Jul 04<br>Julie Crocker pers com 19 Jul 04 |
| 19 | 6 Oct 03 | NAE | Kennebec River<br>Doubling Point | S | H<br>*Padre Island* | Live | Swam away | In hopper | Y<br>We have e-file | Observer incident report<br>Kennebec River BA Jul 04<br>Memo for Commander, from Bill Kavanaugh, 1 Jul 04<br>Bill Kavanaugh pers com 15 Jul 04<br>Julie Crocker pers com 19 Jul 04 |

## Sturgeon Take Records from Dredging Operations 1990 - Mar 2012

| Take # | Date | Corps District | Location | Sp | Dredge Type/ Name | Status | Specimen Description | Notes | Photos | Documentation |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | |
| 20 | 06 Oct 03 | NAE | Kennebec River Doubling Point | S | H *Padre Island* | Dead | Found alive | In hopper | Y We have e-file | Observer incident report Kennebec River BA Jul 04 Memo for Commander, from Bill Kavanaugh, 1 Jul 04 Bill Kavanaugh pers com 15 Jul 04 Julie Crocker pers com 19 Jul 04 |
| 21 | 08 Oct 03 | NAE | Kennebec River Doubling Point | S | H *Padre Island* | Live | Good condition | In hopper | Y We have e-file | Observer incident report Kennebec River BA Jul 04 Memo for Commander, from Bill Kavanaugh, 1 Jul 04 Bill Kavanaugh pers com 15 Jul 04 Julie Crocker pers com 19 Jul 04 |
| 22 | 07 Jan 04 | SAC | Charleston Harbor | A | H *Manhattan Island* | Live | Whole fish 49 inches total length May have died later when released | Found by Coastwise turtle observers | Yes (We Have e-file) | Robert Chappell pers com 28 Jun 04 Observer daily report 7 Jan 04 |
| 23 | 13 Dec 04 | SAM | Gulfport Harbor Channel | G | H *Bayport* | Dead | Trunk of fish 59.5cm | Found by turtle observers | | Observer incident report Susan Rees pers com 7 Jan 05 |
| 24a | 28 Dec 04 | SAM | Mobile Bar Channel | G | H *Padre Island* | Dead | Trunk of fish 2 ft, 1inch | Found by Turtle observers | Yes (We Have e-file) | Observer incident report Susan Rees pers com 7 Jan 05 #W91278-04-C-0049 |
| 24b | 01 Jan 05 | SAM | Mobile Bar Channel | G | H *Padre Island* | Dead | Head only of fish 22.5cm | 2nd part of take on 28 Dec 04 | Yes taken But we Have not received | Observer incident report Susan Rees pers com 7 Jan 05 #W91278-04-C-0049 |
| 25 | 2 Mar 05 | SAS | Brunswick Harbor | A | H *RN Weeks* | Dead | Posterior section only 60 cm section w/tail | Found by turtle observer | Yes (We Have e-file) | Chris Slay pers com 7 Jun 05 Steve Calver pers com 14 Jun 05 |
| 26 | 26 Dec 06 | SAS | Brunswick | A | H *Newport* | Dead | Head only | Caught in port screen and | Black and | Incident and load report |

## Sturgeon Take Records from Dredging Operations 1990 - Mar 2012

| Take # | Date | Corps District | Location | Sp | Dredge Type/ Name | Status | Specimen Description | Notes | Photos | Documentation |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | turtle part caught in starboard screen | White | |
| 27 | 17 Jan 07 | SAS | Savannah Entrance Channel | A | H *Glenn Edwards* | Dead | Whole fish, FL 104 cm | Fresh Dead, 60 Horseshoe crab in with load | Coastwise took photo | Incident and Load report |
| 28 | 2 Mar 09 | SAS | Savannah Entrance Channel | A | H *Dodge Island* | Dead | Total Length 111 cm | Fresh Dead, found in starboard aft inflow box, load #42 | | Incident, Load and Daily report |
| 29 | 6 Feb 10 | SAS | Brunswick Entrance Channel | A | H *Glenn Edwards* | Dead | No measurements | Fore screen contents, Load #19 with 12 Horseshoe crab | | No incident report, just listed on load sheet and daily summary |
| 30 | 7 Feb 10 | SAS | Brunswick Entrance Channel | A | H *Glenn Edwards* | Dead | No measurements | Fore screen contents, Load #25 with 20 Horseshoe crab | | No incident report, just listed on load sheet and daily summary |
| 31 | 2 Feb 10 | SAS | Brunswick Entrance Channel | A | H *Bayport* | Dead | No measurements, head to mid body in load #193 and mid body to tail recovered in load #194. | Stbd screen contents, load #193 and overflow screen in #194, | | No incident report, just listed on load sheet and daily summary |
| 32 | 7 Dec 10 | SAW | Wilmington Harbor | A | H Terrapin Island | Dead | Whole fish, FL 61 cm | Fresh Dead, water temp 12 C, air 2 C, load 6 | Coastwise took photo | Incident and Load report |
| 33 | 10 Apr 11 | NAO | York Spit Channel | A | H Terrapin Island | Dead | Total Length 24.5” in, Fork Length 13.5”, Middle of anus to Anal Fin 3.8” | During Clean up. Torn in half, only posterior from pectoral region to tail, no head. Fins and tail torn but complete | | Hopper daily report from, QCR, e-mail, incident report, daily report, load sheets |

## Sturgeon Take Records from Dredging Operations 1990 - Mar 2012

| Take # | Date | Corps District | Location | Sp | Dredge Type/ Name | Status | Specimen Description | Notes | Photos | Documentation |
|---|---|---|---|---|---|---|---|---|---|---|
| 34 | 11Apr 11 | NAO | York Spit Channel | A | H Liberty Island | Dead | | During cleanup. Another piece taken on 4/13/11 matches perfectly. | Y | E-mail |
| 35 | 14 Mar 12 | SAC | Charleston Harbor Channel | A | H Glenn Edwards | Dead | Fresh dead, body part 26"-30" long X 13" width, no head or tail | Load 129 (0024-0345) found in starboard draghead, during cleanup mode. Given to South Carolina DNR | Yes | E-mail, load sheet, incident report |
| NT | 25 May 05 | NAO | York Spit Channel | ? | H *McFarland* | Dead | Approx. 2 ft estimate from photos | Too decomposed to identify | Yes (We Have e-file) | Observer final report, REMSA 2004 |
| NDNEF | 26 Jun 96 | NAN | East Rock Away Long Island | ? | H Dodge Island | Dead | (~3'), couldn't identify and doesn't mention condition (fresh or dead already)? Chris Starbird. | Load sheet states Carp or sturgeon | No | Load sheet, Daily and Weekly Summary mentions. No way to confirm. |
| NDNEF | About 98 | SAW | Wilmington Har Cape Fear River | A | P *??* | Dead | | | | NMFS 1998 Shortnose Recovery Plan p. 53 |
| NDNEF | About 98 | SAW | Wilmington Har Cape Fear River | A | C | Dead | | | | NMFS 1998 Shortnose Recovery Plan p. 53 |
| NDNEF | About 98 | SAJ or SAS | Kings Bay | A | H *??* | Dead | | | | NMFS 1998 Shortnose Recovery Plan p. 52 Chris Slay pers com |

Sp=sturgeon species
A=Atlantic sturgeon (*Acipenser oxyrhynchus oxyrhynchus*)
S=Shortnose sturgeon (*Acipenser brevirostrum*)
G=Gulf sturgeon (*Acipenser oxyrhynchus desotoi*)
NT = Non-take incident by dredge
SAC=Charleston

SAW=Wilmington
SAS=Savannah
SAJ=Jacksonville
SAM=Mobile
NAE=New England
NAO=Norfolk
NAN=New York
NAP=Philadelphia
H=Hopper
P=Hydraulic Cutterhead pipeline
C=Mechanical clamshell or bucket, bucket and barge
DMA=Dredged material disposal area
NDNEF=No documentation, no evidence found to confirm citation

## APPENDIX D

### Procedure for obtaining fin clips from sturgeon for genetic analysis

***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

a. Prior to sending the sample, contact Russ Bohl at NMFS Northeast Regional Office (978-282-8493) to report that a sample is being sent and to discuss proper shipping procedures.

**APPENDIX E**
**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**

# STURGE~~ON~~ SALVAGE FORM

For use in documenting dead sturgeon in the wild under ESA permit no. 1614 (version 05-16-2012)

**INVESTIGATORS'S CONTACT INFORMATION**

Name: First ______________ Last ____________________

Agency Affiliation ______________ Email ____________________

Address ______________________________________________

______________________________________________

Area code/Phone number ______________________________

UNIQUE IDENTIFIER (Assigned by NMFS)

DATE REPORTED:

Month ☐☐ Day☐☐ Year 20☐☐

DATE EXAMINED:

Month ☐☐ Day☐☐ Year 20☐☐

**SPECIES: (check one)**

- ☐ shortnose sturgeon
- ☐ Atlantic sturgeon
- ☐ Unidentified *Acipenser* species

*Check "Unidentified" if uncertain* .
See reverse side of this form for aid in identification.

**LOCATION FOUND:** ☐Offshore (Atlantic or Gulf beach) ☐Inshore (bay, river, sound, inlet, etc)

River/Body of Water______________ City____________________ State ____

Descriptive location (be specific)________________________________________

______________________________________________

______________________________________________

Latitude ______________N (Dec. Degrees) Longitude ______________ W (Dec. Degrees)

**CARCASS CONDITION at time examined: (check one)**

- ☐ 1 = Fresh dead
- ☐ 2 = Moderately decomposed
- ☐ 3 = Severely decomposed
- ☐ 4 = Dried carcass
- ☐ 5 = Skeletal, scutes & cartilage

**SEX:**

- ☐ Undetermined
- ☐ Female ☐ Male

How was sex determined?

- ☐ Necropsy
- ☐ Eggs/milt present when pressed
- ☐ Borescope

**MEASUREMENTS:** **Circle unit**

Fork length ________ cm / in

Total length ________ cm / in

Length ☐ actual ☐ estimate

Mouth width (inside lips, see reverse side) ________ cm / in

Interorbital width (see reverse side) ________ cm / in

Weight ☐ actual ☐ estimate ________ kg / lb

**TAGS PRESENT?** Examined for external tags including fin clips? ☐ Yes ☐ No Scanned for PIT tags? ☐ Yes ☐ No

| Tag # | Tag Type | Location of tag on carcass |
|---|---|---|
| | | |
| | | |

**CARCASS DISPOSITION: (check one or more)**

- ☐1 = Left where found
- ☐2 = Buried
- ☐3 = Collected for necropsy/salvage
- ☐4 = Frozen for later examination
- ☐5 = Other (describe) ____________________

**Carcass Necropsied?**

☐Yes ☐No

Date Necropsied:____________

Necropsy Lead:

____________________

**PHOTODOCUMENTATION:**

Photos/vide taken? ☐ Yes ☐ No

Disposition of Photos/Video:__________

______________________________

______________________________

**SAMPLES COLLECTED?** ☐ Yes ☐ No

| Sample | How preserved | Disposition (person, affiliation, use) |
|---|---|---|
| | | |
| | | |
| | | |
| | | |
| | | |
| | | |
| | | |
| | | |

Comments:

______________________________________________

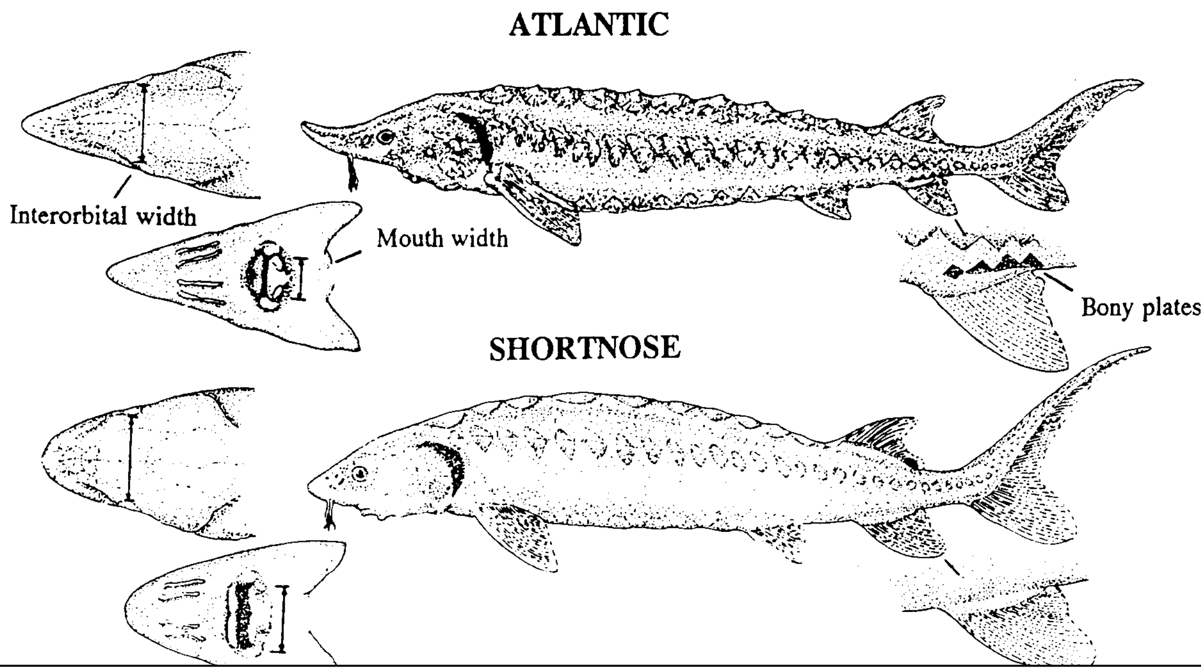
______________________________________________

______________________________________________

Distinguishing Characteristics of Atlantic and Shortnose Sturgeon (version 07-20-2009)

| Characteristic | Atlantic Sturgeon, *Acipenser oxyrinchus* | Shortnose Sturgeon, *Acipenser brevirostrum* |
|---|---|---|
| Maximum length | > 9 feet/ 274 cm | 4 feet/ 122 cm |
| Mouth | Football shaped and small. Width inside lips < 55% of bony interorbital width | Wide and oval in shape. Width inside lips > 62% of bony interorbital width |
| *Pre-anal plates | Paired plates posterior to the rectum & anterior to the anal fin. | 1-3 pre-anal plates almost always occurring as median structures (occurring singly) |
| Plates along the anal fin | Rhombic, bony plates found along the lateral base of the anal fin (see diagram below) | No plates along the base of anal fin |
| Habitat/Range | Anadromous; spawn in freshwater but primarily lead a marine existence | Freshwater amphidromous; found primarily in fresh water but does make some coastal migrations |

* From Vecsei and Peterson, 2004




Describe any wounds / abnormalities (note tar or oil, gear or debris entanglement, propeller damage, etc.). **Please note if no wounds / abnormalities are found.**

________________________________________

________________________________________

________________________________________

________________________________________

________________________________________

Data Access Policy: Upon written request, information submitted to National Marine Fisheries Service (NOAA Fisheries) on this form will be released to the requestor provided that the requestor credit the collector of the information and NOAA Fisheries. NOAA Fisheries will notify the collector that these data have been requested and the intent of their use.

**Submit completed forms (within 30 days of date of investigation) to**: **Northeast Region Contacts** – Shortnose Sturgeon Recovery Coordinator (Jessica Pruden, Jessica.Pruden@noaa.gov, 978-282-8482) or Atlantic Sturgeon Recovery Coordinator (Lynn Lankshear, Lynn.Lankshear@noaa.gov, 978-282-8473); **Southeast Region Contacts**- Shortnose Sturgeon Recovery Coordinator (Stephania Bolden, Stephania.Bolden@noaa.gov, 727-824-5312) or Atlantic Sturgeon Recovery Coordinator (Kelly Shotts, Kelly.Shotts@noaa.gov, 727-551-5603).

**APPENDIX G**
**INCIDENTAL TAKE REPORT**

**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/ Sturgeon Mortality*)

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

Observer's Name: __________________________________________________
Observer's Signature: ______________________________________________

| Species | # of Sightings | # of Animals | Comments |
|---|---|---|---|
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**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)
_______________________________________________________________________________
_______________________________________________________________________________
_______________________________________________________________________________

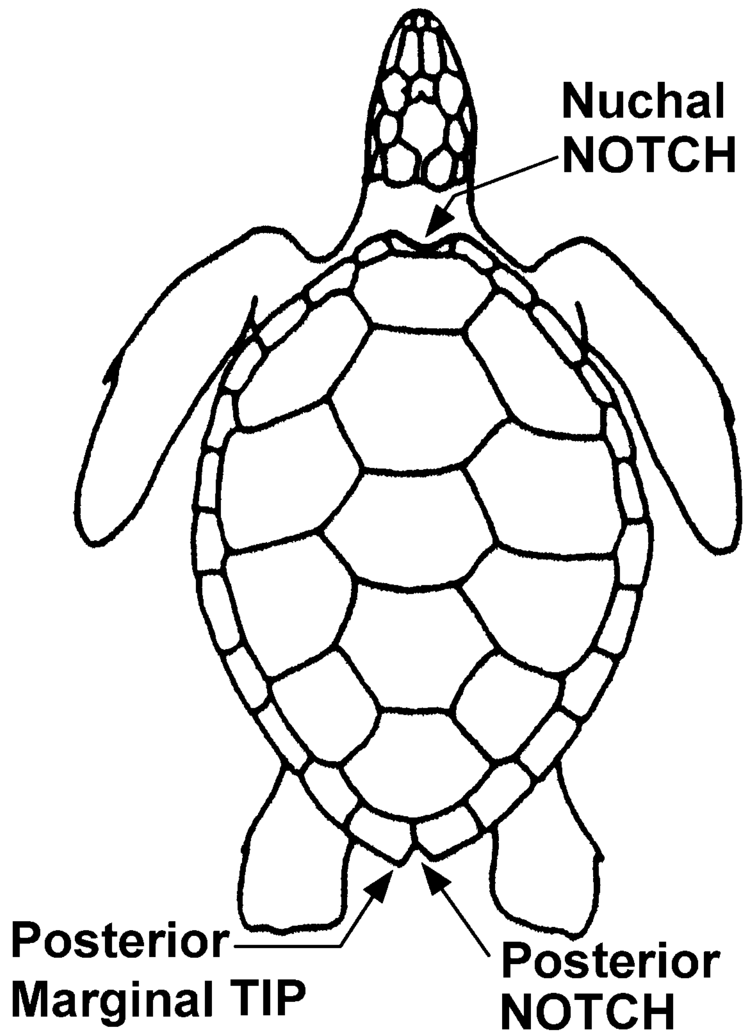
Turtle Decomposed: NO SLIGHTLY MODERATELY SEVERELY

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:

**Incident Report of Sturgeon Take**

*Photographs should be taken and the following information should be collected from all sturgeon (alive and dead)*

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___________________________________________________________
_________________________________________________________________________

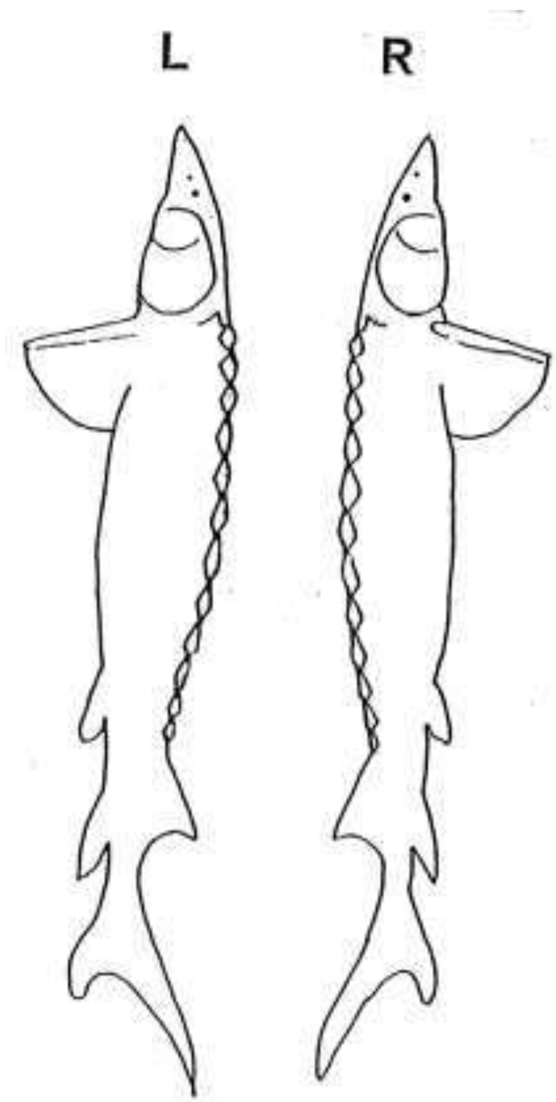
Water temp: Surface ________________ Below midwater (if known) _______________

**Species Information**: *(please designate cm/m or inches.)*
Fork length (or total length) _____________________ Weight ______________________

Condition of specimen/description of animal
_________________________________________________________________________
_________________________________________________________________________
_________________________________________________________________________
_________________________________________________________________________

Fish Decomposed: NO SLIGHTLY MODERATELY SEVERELY
Fish 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_____________________

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




Description of fish condition:

## APPENDIX H

### Sea Turtle Trawling and Relocation Guidelines

(as derived from ACOE South Atlantic Division protocol)

Note that: In this BO, NMFS has determined that relocation trawling is necessary to minimize the take of sea turtles in dredging operations. NMFS has also determined that handling and measuring as outlined in the ITS is necessary to monitor the take of sea turtles. Additionally, NMFS has determined that genetic sampling of dead sea turtles is necessary to monitor take. However, external or internal sampling procedures (e.g., flipper tagging, PIT tagging, blood letting, skin tag sampling, laparoscopies, gastric lavages, mounting satellite or radio transmitters, genetics sampling, etc.) performed on live sea turtles are not permitted under this BO unless the observer holds a valid sea turtle research permit (obtained pursuant to section 10 of the ESA, from the NMFS' Office of Protected Resources, Permits Division) authorizing sampling, either as the permit holder, or as designated agent of the permit holder.

**Sea turtle trawling procedures**

1. Trawling shall be conducted under the supervision of a biologist approved by the NMFS. A letter stating that NMFS has approved the supervising biologist must be obtained prior to the commencement of trawling.

2. Sea turtles captured pursuant to relocation trawling shall be handled in a manner designed to ensure their safety and viability, and shall be released over the side of the vessel, away from the propeller, and only after ensuring that the vessel's propeller is in the neutral, or disengaged, position (i.e., not rotating). Captured turtles shall be kept moist, and shaded whenever possible, until they are released. Resuscitation guidelines are included in part in Appendix C.

3. Any turtles captured during the survey shall be measured in accordance with standard biological sampling procedures prior to release, and weighed when possible. Sampling data shall be recorded on the Sea Turtle Relocation Report (Appendix E).

4. Turtles shall be kept no longer than 12 hours prior to release and shall be released at least 3 miles away from the dredge site (if it can be done safely, turtles may be transferred onto another vessel for transport to the release area to enable the relocation trawler or relative abundance trawler to keep sweeping the dredge site without interruption).

7. The trawler will be equipped with two 60-foot nets constructed from 8-inch mesh (stretch) fitted with mud rollers and flats as specified in the Turtle Trawl Nets Specifications. Paired net tows will be made for 10 to 12 hours per day or night. Trawling will be conducted with the tidal flow using repetitive 15-30 minute (total time) tows in the channel. Tows will be made in the center, green and red sides of the channel such that the total width of the channel bottom is sampled. Positions at the beginning and end of each tow will be determined from GPS Positioning equipment. Trawl speeds shall not exceed 3.5 knots. Tow speed will be recorded at the approximate midpoint of each tow.

7. Methods and equipment will be standardized including data sheets, nets, trawling direction to tide, length of station, length of tow, and number of tows per station. Water temperature measurements will be taken at the water surface each day using a laboratory thermometer. Data on each tow, including weather conditions, air temperature, wind velocity and direction, sea state-wave height, and precipitation, will be recorded on the Sea Turtle Trawling Report.

8. Before trawling begins, the necessary state permits for trawling in Virginia state waters must be obtained from the appropriate party (e.g., State of Virginia, Virginia Marine Resources Commission).

## Turtle Trawl Nets Specifications

**DESIGN:** 4 seam, 4 legged, 2 bridal trawl net
**WEBBING:** 4 inch bar, 8 inch stretch
top - 36 gauge twisted nylon dipped
side - 36 gauge twisted nylon dipped
bottom - 84 gauge braided nylon dipped
**NET LENGTH:** 60 ft from cork line to cod end
**BODY TAPER:** 2 to 1
**WING END HEIGHT:** 6 ft
**CENTER HEIGHT:** Dependent on depth of trawl 14 to 18 ft
**COD END:** Length 50 meshes x 4" = 16.7 ft
Webbing 2 inch bar, 4 inch stretch, 84 gauge braid nylon dipped, 80 meshes around, 40 rigged meshes with 1/4 x 2 inch choker rings, 1 each ½ x 4 inch at end
cod end cover - none
chaffing gear - none
**HEAD ROPE:** 60 ft ½ inch combination rope (braid nylon with stainless cable center)
**FOOT ROPE:** 65 ft ½ inch combination rope
**LEG LINE:** top - 6 ft, bottom 6 - ft
**FLOATS:** size - tuna floats (football style), diameter - 7 inch length - 9 inch, number - 12 each, spacing - center on top net 2 inches apart
**MUD ROLLERS:** size 5 inch diameter 5.5 inch length, number - 22 each, spacing - 3 ft attached with 3/8 inch polypropelene rope (replaced with snap on rollers when broken)
**TICKLER CHAINS:** NONE (discontinued- but previously used 1/4 inch x 74 ft galvanized chain)
**WEIGHT:** 20 ft of 1/4 inch galvanized chain on each wing, 40 ft per net looped and tied
**DOOR SIZE:** 7 ft x 40 inches (or 8 ft x 40 inches), Shoe - 1 inch x 6 inch, bridles - 3/8 inch high test chain
**CABLE LENGTH** (bridle length, total): 7/16 inch x 240-300 ft varies with bottom conditions
**FLOAT BALL:** none
**LAZY LINES:** 1 inch nylon
**PICKUP LINES:** 3/8 inch polypropelene
**WHIP LINES:** 1 inch nylon

**APPENDIX I**
**RELOCATION TRAWLING REPORT**

**Part 1 - Sea Turtle Relocation Report**

(*Note that any other reporting form submitted for turtles taken in trawling activities related to maintenance dredging should include the following information*.)

Channel: ________________________________ Date: ___________________________
Tow #:_________________________________ Net (circle): Port Starboard
Day of trawling effort (e.g., 3rd day) __________ Hour of trawling effort (that day) __________
Water depth__________________________ Water temperature ______________________
Other environmental conditions_______________________________________________
Describe capture location (include state, county, lat and long): ___________________________
______________________________________________________________________________
Describe capture method and/or type of gear in use when turtle was caught:_________________
______________________________________________________________________________

**Species Information**: *(please designate cm/m or inches.)*
Species _____________________________ Weight (kg or lbs)___________________________
Sex (circle): Male Female Unknown How was sex determined? ___________________
Straight carapace length ________________ Straight carapace width _____________________
Curved carapace length ________________ Curved carapace width ______________________
Plastron length _______________________ Plastron width _____________________________
Tail length ___________________________ Head width _______________________________
Condition of specimen/description of animal__________________________________________
______________________________________________________________________________

**Existing Flipper Tag Information**
Left ______________________________ Right ___________________________________
PIT Tag # _________________________________

**Miscellaneous:**
Genetic biopsy taken: YES NO
Photos Taken: YES NO Is this a Recapture: YES NO

**Turtle Release Information:**
Date ___________________________ Time _______________________________
Lat ____________________________ Long _______________________________
State ___________________________ County _____________________________

**Remarks:** (note if turtle was involved with tar or oil, gear or debris entanglement, wounds or mutilations, propellor damage, papillomas, old tag locations, etc.)
______________________________________________________________________________
______________________________________________________________________________

Part 2-

**Sturgeon Relocation Form**

Channel: _________________________________ Date: ____________________________

Tow #:___________________________________ Net (circle): Port Starboard

Day of trawling effort (e.g., 3rd day) __________ Hour of trawling effort (that day) __________

Water depth___________________________ Water temperature ______________________

Other environmental conditions______________________________________________________

Describe capture location (include state, county, lat and long): ____________________________

________________________________________________________________________________

Describe capture method and/or type of gear in use when turtle was caught:_________________

________________________________________________________________________________

**Species Information**: *(please designate cm/m or inches.)*

Species ______________________________ Weight (kg or lbs)____________________________

Length (TL) ________________ Length (FL) _____________________

Condition of specimen/description of animal_____________________________________________

________________________________________________________________________________

**Existing Tag Information**

PIT Tag # __________________________________

**Other Tags: ___________________________________________________________**

**Miscellaneous:**

Fin clip taken: YES NO

Photos Taken: YES NO Is this a Recapture: YES NO

**Release Information:**

Date ____________________________ Time ________________________________

Lat _____________________________ Long ________________________________

State ___________________________ County ______________________________

**Remarks:** (note if fish was involved with tar or oil, gear or debris entanglement, wounds or mutilations, propellor damage, old tag locations, etc.)

________________________________________________________________________________

________________________________________________________________________________

# APPENDIX J

## 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. Baskets/screening will allow for better monitoring by observers of the dredged material intake for sea turtles, sturgeon 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 and sturgeon 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

Observers are required at times and locations outlined in the ITS. 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), NMFS Protected Resources Division must be contacted by phone (978-281-9328) or e-mail (incidental.take@noaa.gov) within 24 hours of the take. An incident report for sea turtle/shortnose sturgeon take (Appendix D) shall also be completed by the observer and sent via FAX (978) 281-9394 or e-mail (incidental.take@noaa.gov) 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 (incidental.take@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 D):

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 sturgeon (alive or dead, decomposed or fresh) or turtle or shortnose sturgeon parts are taken incidental to the project(s), NMFS Protected Resources must be contacted within 24 hours of the take (phone: 978-281-9328 or e-mail (incidental.take@noaa.gov). All whole dead sea turtles or sturgeon, or turtle or shortnose sturgeon parts, must be photographed and described in detail on the Incident Report of Sea Turtle Mortality (Appendix D). The photographs and reports should be submitted by email (incidental.take@noaa.gov) or mail (Attn: Section 7 Coodinator, 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. Disposition of dead sea turtles/ 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.

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 C). 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) 282-8470) 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 K**

## 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.*

**Dead sea turtles**

The procedures for handling dead sea turtles and parts are described in Appendix D.

**Live sea turtles**

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

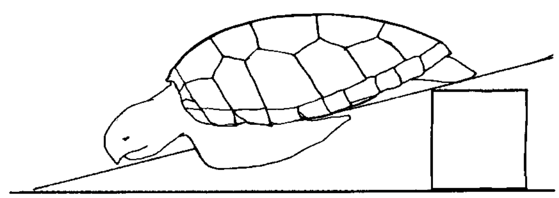
- **If the turtle is actively moving**, it should be retained onboard until evaluated for injuries by a permitted rehabilitation facility. Due to the potential for internal injuries associated with hopper entrainment, it is necessary to transport the live turtle to the nearest rehabilitation facility 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 866-755-6622 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, 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/rehabilitation contacts**

**NMFS Stranding Hotline**: 866-755-6622 or NERStranding.staff@noaa.gov

**Virginia State Coordinator: Sea Turtle Stranding and Salvage Network**

Mark Swingle (Co-Coordinator, James River South and VA Eastern Shore)

Virginia Aquarium Stranding Program
717 General Booth Boulevard
Virginia Beach, VA 23451
Office: 757-437-6022; Fax: -4976
Stranding Hotline: 757-437-6159
mswingle@vbgov.com