NATIONAL MARINE FISHERIES SERVICE
ENDANGERED SPECIES ACT SECTION 7 CONSULTATION
BIOLOGICAL OPINION

Agency: United States Army Corps of Engineers, Norfolk District

Activity: James River Federal Navigation Project: Tribell Shoal Channel to Richmond Harbor in Surry, James City, Prince George, Charles City, Henrico, and Chesterfield Counties and the Cities of Richmond and Hopewell, Virginia
(F/NER/2012/01183)
GARFO-2012-00013

Conducted by: National Marine Fisheries Service
Northeast Regional Office

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Approved by: [signature] for John Bullard

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1.0 INTRODUCTION

This constitutes the biological opinion (Opinion) of NOAA's National Marine Fisheries Service (NMFS) on the effects of the United States Army Corps of Engineers, Norfolk District (the Corps) proposed James River Federal Navigation Project (the Project) on threatened and endangered species in accordance with section 7 of the Endangered Species Act (ESA) of 1973, as amended (16 U.S.C. 1531 et seq.). This Opinion is based on information provided in the Biological Assessment (BA) for the Corps' James River Federal Navigation Project, correspondence with the Corps, and other sources of information. A complete administrative record of this consultation will be kept on file at the NMFS Northeast Regional Office. Formal consultation was initiated on May 16, 2012.

2.0 CONSULTATION HISTORY

The James River Federal Navigation Project was authorized by the Rivers and Harbors Act of July 5, 1884, and later modified by the Rivers and Harbors Act of June 13, 1902; March 3, 1905; July 3, 1930; August 26, 1937; March 2, 1945; May 17, 1950; and October 23, 1962. Historically there was an increased need for a safer and more efficient shipping corridor between the Atlantic coast of Virginia and the port of Richmond, Virginia.

In June 2011, the Corps informed NMFS that it was preparing a BA for the proposed James River Federal Navigation project. At that time, the Atlantic sturgeon (*Acipenser oxyrinchus oxyrinchus*) listing had not been finalized, and the Corps wanted to enter into Conference with NMFS on this project. NMFS suggested that the Corps wait until the listing was finalized (Atlantic sturgeon final listing date of February 6, 2012) before entering into formal section 7 consultation that would result in a Biological Opinion and an associated Incidental Take Statement, because we did not expect the project to result in jeopardy. In March, 2012, NMFS received a final BA from the Corps detailing the proposed ongoing maintenance dredging project within the Federal Navigation channel. NMFS provided comments on the BA, requesting additional information and analysis. On April 11, 2012, a revised final BA was received by NMFS. All additional information was received via email on May 16, 2012. NMFS initiated formal consultation on May 16, 2012.

3.0 DESCRIPTION OF THE PROPOSED ACTION

3.1. 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 nine shoals along the James River Federal Navigation as well as an area extending 1000 feet in all directions from the area to be dredged to account for the sediment plume generated during dredging activities. Based on analysis of hydraulic dredging activities (ACOE,1983), increased sediment levels are likely to be present for no more than 1,150-feet downstream of the dredge area. As such, the action area is the area within the James River in the federal channel and all overboard dredge material disposal areas associated with the James River Federal Navigation project located within a 1,150-foot radius from the dredge and placement footprints. This area will encompass all of the effects of the proposed project.

Each overboard dredge disposal area runs the approximate linear length as the shoal it is located adjacent to. Underwater sounds generated from dredging are typically low in intensity and frequency, with estimated source sound pressure levels ranging between 168 to 186 dB peak re 1μPa at 1 meter below the surface. Studies indicate that sounds attributed to the cutterhead dredge operations were virtually undetectable at 500 meters (1,640 feet) from the source (Clarke *et al.*, 2003).

Dredging will occur in the following nine areas: Tribell Shoal, Goose Hill Shoal, Dancing Point-Swann Point Shoal, Jordan Point-Harrison Bar-Windmill Point Shoal, City Point Shoal, Richmond Deepwater Terminal to Hopewell Shoal, Richmond Deepwater Terminal Shoal (turning basin), Richmond Harbor to Richmond Deepwater Terminal Shoal, and Richmond Harbor. The James River Federal Navigation Channel is divided into three segments: lower, middle, and upper, and the channel is maintained at 350 feet wide. The lower portion of the Federal Navigation channel extends from river mile 0 (at the mouth of the river) to river mile 26 near Hog Island. The lower segment of the James River includes Tribell Shoal (total area of approximately 0.45 square miles), located east of Hog Island. Tribell Shoal is regularly maintained and overboard placement for this site is located 1,500-2,000 feet (measured from centerline of placement area to the channel) east and landward of the Federal Navigation channel. The overboard placement site is approximately 24,000 linear feet long by 1,500 feet wide, which equates to an area of 36,000,000 square feet (1.3 square miles). The lower segment of the river includes the city of Newport News, and the counties of Isle of Wight, James City, and Surry.

The middle segment of the James River Federal Navigation channel is located between river mile 27 and river mile 69. The following shoals are contained within this segment: Goose Hill, Dancing Point-Swann Point, Jordan Point-Harrison Bar-Windmill Point, and City Point. Goose Hill Shoal is located between Hog Point (river mile 27) and Jamestown Island (river mile 30) (total area of approximately 0.38 square miles) and the overboard placement area is located 2,000 feet south and east of the channel. The overboard placement site is approximately 24,000 feet long by 1,500 feet wide, equating to a total area of 36,000,000 square feet (1.3 square miles). Dancing Point-Swann Point Shoal (total area of approximately 0.53 square miles) is located between Swann Point (river mile 35) and Dancing Point (river mile 42), with overboard dredge material placement approximately 1,250-2,000 feet south of the Federal channel. Dredged material will be placed at two overboard placement sites adjacent to this shoal. The eastern site measures approximately 11,000 feet long by 1,500 feet wide, which equates to an area of

16,500,000 square feet (0.6 square miles) and the western site measures approximately 10,000 feet long by 1,500 feet wide, equating to an area of 15,000,000 square feet (0.5 square miles). A distance of approximately 7,500 feet is located between the two sites. Jordan Point-Harrison Bar-Windmill Point (total area of approximately 0.56 square miles) is located between Windmill Point (river mile 55) and Jordan Point (river mile 65), and the overboard placement area is located 1,500 feet north of the channel, as two separate placement sites. The eastern site is approximately 5,000 feet long by 2,000 feet wide (total area of 10,000,000 square feet or 0.4 square miles), and the western site measures approximately 5,000 feet long by 1,600 feet wide (total area of 8,000,000 square feet or 0.3 square miles), and is located approximately 4,500 feet away from the eastern site. City Point shoal (total area of approximately 0.15 square miles) is located between City Point (river mile 65) and Eppes Island (river mile 69), and dredged material will be placed 2,000-2,600 feet north of the channel at a site that measures approximately 8,000 feet long by 1,500 feet wide, equating to an area of 12,000,000 square feet (0.4 square miles). The middle portion of the James River is located in the following counties: Surry, Prince George, James City, and Charles City. The city of Hopewell, Virginia is also located along this portion of the river.

The upper segment of the Federal Navigation channel is located between river mile 70 and river mile 90 and encompasses the following shoals: Richmond Deepwater Terminal to Hopewell Shoal channel (river mile 70), Richmond Deepwater Terminal Turning Basin (river mile 85), and Richmond Harbor to Richmond Deepwater Terminal (river mile 90). The dredged area equates to approximately 1.3 square miles. All material dredged in the upper portion of the Federal Navigation channel will be disposed of at appropriate upland disposal sites.

3.2 Physical Characteristics of the Action Area

The James River is formed by the junction of the Cowpasture and Jackson Rivers in the Appalachian Mountains at Iron Gate in western Virginia. The river flows easterly 340 miles to Hampton Roads at Newport News, Virginia. The James River drains approximately 10,102 square miles, which equates to one quarter of Virginia's land area (Bushnoe, 2005). The tidal freshwater of the river extends from the fall line in Richmond to the mouth of the Chickahominy River (Musick, 2005). The fall zone area is characterized by rapids and granite outcrops, and large potholes have been scoured out in the bedrock channel on the south side of Belle Island (http://web.wm.edu/geology/virginia/rivers/james.html). As the river flows south, the area is characterized by sedimentary outcroppings. At Hopewell, the Appomattox River flows into the James River. At this point, the James River transitions into a relatively wide estuary (0.6-1.9 miles in width).

The project area includes the navigation channel from Hampton Roads, Virginia to the Richmond locks, a distance of over 90 miles. The dredging areas within a given shoal will vary from year to year depending on needs, but the overall footprint of the channel and overboard placement areas will remain constant. Hydrographic surveys and information collected by river pilots are analyzed to assess which shoals or portions thereof need dredging and the timeframe in which it should be completed.

Several factors influence the frequency at which dredging takes place at any given shoal including precipitation, soil erosion and run-off, development in upper portions of the watershed, etc. The congressional authorization allows for a -35 foot deep MLLW channel, with 3:1 horizontal to vertical sideslopes. The channel is allowed to be dredged to -28 feet MLLW. Cross sectional analyses demonstrate that approximately eight to ten feet of sediment may accumulate in the channel between dredge cycles. The sediment grain size at each of the nine shoals varies from coarse sand to silty-clays. The lower river shoals are characterized by silt/clay material, whereas areas in the middle river and upper river tend to comprise more coarse grained material including fine, medium and coarse sands.

3.3 Description of the Action

The proposed project includes the ongoing maintenance dredging of the James River Federal Navigation channel to accommodate deep-draft vessels. The James River serves as an important commercial shipping corridor for vessels traveling to the port of Richmond, Virginia from coastal Virginia, but shoals have a tendency to form along the channel, necessitating maintenance dredging activities. The duration of dredging and the amount of material removed from each shoal, and the dredging frequency of each shoal depends on a number of factors including environmental conditions, shoal location, length of time since the last dredge cycle, time of year restrictions, weather, emergencies, funding, and other factors.

Federal Navigation Channel

The project authorizes the maintenance of a 300 feet wide and 35 feet deep channel running from Hampton Roads to Richmond Deepwater Terminal, Virginia, a distance of 86.1 miles via three cut-off channels in the upper section of the river. This entire portion of the channel includes a mooring 35 feet deep, 180-200 feet wide, and 2,100 feet long at Hopewell; and a turning basin 35 feet deep, 825 feet wide, and 2,770 feet long at the Terminal. A continuation of the channel runs from the Deepwater Terminal to the Richmond lock a distance of 4.7 miles at 18 feet deep and 200 feet long, with a turning basin at the lock measuring 18 feet deep, 200 feet wide and 600 feet long. All depths are measured at mean lower low water (MLLW). The project description also includes reference to the construction of spur and training dikes; however, this language was included from a previous project description and is not included in the current action. Overall, the James River Navigation Project provides approximately 90 miles of deep draft navigation from Hampton Roads, Virginia to Richmond, Virginia.

Cutterhead Dredging and Overboard Placement

Hydraulic cutterhead dredging is the preferred dredging method on the James River, and will used for maintenance dredging activities. In the event of a shoaling emergency, another type of dredge may be used. 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. Cutterhead dredges on the James River are usually small with a maximum pipe diameter of 36 inches; however, recent dredging history on the James River indicates that pipe diameters range between 18-20 inches. Cutterhead dredging agitates and mixes the sediments into a slurry which is hydraulically pumped to the dredged material placement area. Cutterhead dredging in the James River does not require the usage of Unexploded Ordinance (UXO) screening on the draghead. The James River is not located in or near known UXO areas, and there is no history of encountering UXO. As a result, no UXO screening will be included in dredging operations.

In the case of the Federal Navigation channel dredging, the dredge slurry will be pumped to the appropriate overboard placement areas adjacent to the shoals along the channel, or in the case of the upper river segment, to the upland disposal sites. Factors that may determine where dredged material is placed include: distance of the dredging site to the placement site (pumping distance), availability of authorized placements sites, cost, topography and dimensions of the channel, and avoidance of environmentally sensitive or restricted areas. The approximate placement areas for this action have been configured and located, as detailed previously. The Corps proposes to place all dredged material along the centerline of each placement area in a uniform thickness. Dredged material will settle naturally and spread across the placement areas that have been outlined in the schematic drawings. Typically, all impacts of dredging and disposal activities are contained within 1,150 feet of the particular site. In addition to the actual dredge sites and placement areas, an additional 1,150 feet will be used in this Opinion to represent the maximum extent of where projects impacts may occur as a result of dredging and disposal activities.

Table 1 details the average dredging frequencies and volumes for each shoal. These averages serve as the estimates for future dredging activities. This Opinion covers dredging and disposal operations for 50-years. An approximate total of 1-1.5 million cubic yards of material is estimated to be removed from the channel per year. Over the 50-year span of the action, this equates to a total removal of approximately 50 to 75 million cubic yards of material.

Location	**Average Dredge Volume (cys)**	**Dredging Frequency**
Tribell Shoal	256,127	1.5-3 years
Goose Hill Shoal	353,021	2-3 years
Dancing Point-Swann Point Shoal	484,059	Semi-annual
Jordan Point-Harrison Bar-Windmill Point Shoal	372,915	1-3 years
City Point Shoal	137,977	10-15 years
Richmond Deepwater Terminal to Hopewell Shoal	243,151	1-3 years
Richmond Deepwater Terminal Shoal	143,151	1-3 years

Richmond Harbor to Richmond Deepwater Terminal Shoal	**	**
Richmond Harbor Shoal	97,068	2-8 years

Table 1. Average maintenance dredge cycle frequency and average dredged quantity in cubic yards (cys).

3.4 Implementation Schedule

As stated, the indefinite dredging project life is currently 50-years. In the lower James River, dredging will occur between June 15th and February 15th of any given year. The rest of the river (middle and upper James River) allows dredging from June 30th to February 15th of any given year.

A typical dredging cycle on the James River will not exceed several weeks for the entire cycle or a few days per shoaled area. The duration of dredging activities is governed by several factors, some of which include the amount of shoaled material in the channel, size and type of dredge, and distance to placement area. Small cutterhead dredges with pipe diameters ranging between 18 to 36 inches will be used to move material from the channel to the dredged material placement sites in the lower and middle rivers. Average dredge volumes range between 97,068 and 484,059 cubic yards and average distances from the toe of the channel to overboard dredge material placement sites range from 1,250 to 2,600 feet.

3.5 Mitigation Measures

Throughout the proposed action, the Corps will implement measures to minimize any potential effects of dredging to listed species throughout the proposed project. The following are the mitigation measures the Corps will implement as part of the proposed action:

1. The Corps will implement Best Management Practices to minimize water quality effects that may result from several features related to dredging (dredge pipe diameter, swing speed and vertical thickness of the cut).

2. The Corps will use a small diameter (18-20-inch, maximum 36-inch) cutterhead dredge to minimize the risk of entrainment.

3. The Corps is required to monitor dissolved oxygen levels from July 1st to October 31st during dredging activities.

4. Time of year restrictions are in effect in the lower James River from February 15th to

June 15th and in the rest of the river from February 15th to June 30th to protect anadromous fish during migration and spawning periods.

5. Maintenance dredging activities will minimize impacts to water quality to the maximum extent practicable by usage of a diffuser secured at the end of the dredge pipe for overboard placement activities to minimize turbidity and sediment re-suspension.

6. Any ESA species sightings will be reported to NMFS' Protected Resources Division. Contact information is included in Section 11.2, Terms and Conditions.

4.0 SPECIES THAT ARE NOT LIKELY TO BE ADVERSELY AFFECTED BY THE PROPOSED ACTION

Sea turtles occur in the Virginia portion of the Chesapeake Bay and the very lower estuarine extent of the James River. Shortnose sturgeon are not known to occur in Virginia waters or in habitat that may be affected by the proposed action, and as such all effects to shortnose sturgeon are discountable, and thus not discussed further. While listed whales occur seasonally off the Atlantic coast of Virginia, no listed whales are known to occur in the action area. As such, no whale species will be further discussed in this Opinion. The following species are not likely to be adversely affected by the proposed action, but may occur near the action area. Our analysis of insignificant and/or discountable effects for the four species of sea turtles follows.

Sea Turtles

Northwest Distinct Population Segment (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]

4.1 *Presence of Sea Turtles near the Action Area*

Sea turtles are expected to be in the Chesapeake Bay during warmer months, typically from May through late November, with the highest concentrations of sea turtles present from June – October. The sea turtles in these waters are typically small juveniles with the most abundant species being the loggerhead sea turtle followed by the Kemp's ridley sea turtle. Green sea turtles and leatherback sea turtles also occur, albeit less frequently, in the Chesapeake Bay during the May – November time period.

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[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.

Several studies have examined the seasonal distribution of sea turtles in the mid-Atlantic, including Maryland and Virginia. Sea turtles begin appearing in nearshore habitats of the mid-Atlantic as water temperatures rise to greater than 11°C during the spring and then remain in the region throughout the warmer months (Morrealle and Standora, 2005). As temperatures decline in the fall (usually beginning the first week of November), sea turtles tend to leave their coastal habitats and join a larger contingent of other turtles migrating southward to overwinter in southern waters. Consequently, by the end of November, listed sea turtles have left the waters of the Chesapeake Bay (Shoop and Kenney, 1992; Musick and Limpus, 1997; Morrealle and Standora, 2005).

Sea turtles are exposed to a number of threats in the marine environment including fisheries interactions. Sea turtles entangled in fishing gear generally have a reduced ability to feed, dive, and surface to breathe or perform any other behavior essential to survival (Balazs, 1985). 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. In addition to fishery interactions, sea turtles may be susceptible to injury/mortality by dredge operations, oil and gas exploration, from vessel strikes, and from marine pollution.

Northwest Atlantic DPS of Loggerhead Sea Turtle
The Northwest Atlantic DPS of loggerhead sea turtle uses a wide range of habitats including open ocean, continental shelves, bays, lagoons, and estuaries (NMFS and USFWS, 1995). Loggerheads are the most abundant species of sea turtle in U.S. waters, commonly occurring throughout the inner continental shelf of the Atlantic seaboard from Florida through Cape Cod, Massachusetts.

Aerial surveys of loggerhead turtles north of Cape Hatteras indicate that they are most common in waters from 72 to 161 feet deep but they can range from the beach to waters beyond the continental shelf (Shoop and Kenney, 1992). The presence of loggerhead turtles in the action area is also influenced by water temperature; water temperatures of ≥11° C are generally favorable to sea turtles. Loggerhead sea turtles originating from the Northwestern Atlantic nesting aggregations are believed to lead a pelagic existence in the North Atlantic Gyre for as long as 7-12 years before settling into benthic environments where they opportunistically forage on crustaceans and mollusks (Wynne and Schwartz, 1999). Recent studies demonstrate that rather than making discrete developmental shifts from oceanic to neritic environments, 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).

Aerial surveys conducted in the Virginia Chesapeake Bay during the 1980s, as well as in 2001-2004, and a comparison of the median densities between the two periods suggests a three-fold reduction of turtles in the lower Chesapeake Bay since the 1980s (Mansfield, 2006). Based on the 2001-2004 aerial surveys and assuming constant sightability, total mean abundances for the entire Virginia Chesapeake Bay were between 2,850 and 5,479 sea turtles (Mansfield, 2006). While this estimate does not separate out species, loggerheads are the most abundant turtle in the Bay. Approximately 95% of the loggerheads in the Chesapeake Bay are juveniles (Musick and Limpus, 1997). 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).

Kemp's Ridley Sea Turtle

The Kemp's ridley is one of the least abundant sea turtle species in the world. 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 (USFWS and NMFS 1992).

Studies indicate that sub-adult Kemp's ridleys stay in shallow, warm, nearshore waters in the northern Gulf of Mexico until cooling waters force them offshore or south along the Florida coast (Renaud, NOAA Fisheries Galveston Laboratory, pers. comm.). Juvenile Kemp's ridleys use northeastern and mid-Atlantic coastal waters of the U.S. as primary developmental habitat during summer months, with shallow coastal embayments serving as important foraging grounds. Kemp's ridleys found in mid-Atlantic waters are primarily post-pelagic juveniles averaging 40 cm in carapace length, and weighing less than 20 kilograms (Terwilliger and Musick, 1995). Next to loggerheads, they are the second most abundant sea turtle in mid-Atlantic waters, arriving in these areas during late May and June (Keinath *et al.*, 1987; Musick and Limpus, 1997). The annual abundance of juvenile Kemp's ridley sea turtles in the Chesapeake Bay has been estimated to be 211 to 1,083 turtles (Musick and Limpus, 1997), but abundance may be lower now given the turtle density declines reported in Mansfield (2006).

In the Chesapeake Bay, Kemp's ridleys frequently forage in shallow embayments, particularly in areas supporting submerged aquatic vegetation that contain their preferred forage species (Lutcavage and Musick, 1985; Bellmund *et al.*, 1987; Keinath *et al.*, 1987; Musick and Limpus, 1997). Post-pelagic ridleys feed primarily on crabs, with mollusks, shrimp, and fish consumed less frequently (Bjorndal, 1997). From telemetry studies, Morreale and Standora (1994) determined that Kemp's ridleys are sub-surface animals that frequently swim to the bottom while diving. The generalized dive profile showed that the turtles spend 56% of their time in the upper third of the water column, 12% in mid-water, and 32% on the bottom. In water shallower than 15 m (50 feet), the turtles dive to depth, but spend a considerable portion of their time in the upper portion of the water column. In contrast, turtles in deeper water dive to depth, spending as much as 50% of the dive on the bottom. Kemp's ridleys migrate to more southerly waters from September to November (Keinath *et al.*, 1987; Musick and Limpus, 1997). Cold-stunning poses a threat to individuals that do not begin migrating with the drop in temperatures.

Leatherback Sea Turtle

The leatherback is the largest living sea turtle and ranges farther than any other sea turtle species, exhibiting broad thermal tolerances (NMFS and USFWS, 1995). Leatherbacks are frequently thought of as a pelagic species that feed on cnidarians (medusae, siphonophores) and tunicates (*e.g.*, salps, pyrosomas) in oceanic habitats (Rebel, 1974; Davenport and Balazs, 1991), but 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).

Leatherbacks are a long lived species (> 30 years). Based on a review of all sightings of leatherback sea turtles of <145 cm curved carapace length (CCL), Eckert (1999) found that leatherback juveniles remain in waters warmer than 26° C until they exceed 100 cm CCL. 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.*, 2005).

Leatherback populations have declined worldwide. The population was estimated to number approximately 115,000 adult females in 1980 and only 34,500 by 1995 (Spotila *et al.*,1996). The decline can be attributed to many factors including interactions with fishing gear, as well as intense exploitation of the eggs (Ross, 1979). The most recent population size estimate for the North Atlantic alone is a range of 34,000-94,000 adult leatherbacks (TEWG, 2007). Leatherbacks seem to be the most vulnerable to entanglement in fishing gear, specifically pot/trap fisheries. This susceptibility may be the result of their body type (large size, long pectoral flippers, and lack of a hard shell), and their attraction to gelatinous organisms and algae that collect on buoys and buoy lines at or near the surface. Leatherbacks have been documented entangled in crab pot gear in the Virginia Chesapeake Bay (e.g., 3 instances in 2002 alone). Additionally, an estimated 6,363 leatherback sea turtles were caught by the U.S. Atlantic tuna and swordfish longline fisheries between 1992-1999, of which 88 were released dead (NMFS SEFSC, 2001). Leatherbacks are typically foul hooked (*i.e.*, on the flipper or shoulder area) by longline gear rather than mouth or throat hooked like loggerheads.

Green Sea Turtle
Green turtles are the largest chelonid (hard-shelled) sea turtle, with an average adult carapace length of 91 cm SCL (straight carapace length) and weight of 150 kilograms. Green turtles are distributed circumglobally. In the Northwestern Atlantic, this species ranges from Massachusetts to Argentina, including the Gulf of Mexico and the Caribbean (Wynne and Schwartz, 1999). Green sea turtles use mid-Atlantic and northern areas of the western Atlantic Ocean as important summer developmental habitat. Limited information is available regarding the occurrence of green turtles in the Chesapeake Bay, although they are presumably present in lower numbers than loggerheads and Kemp's ridleys. Like loggerheads and Kemp's ridleys, green sea turtles that use northern waters during the summer must return to warmer waters when water temperatures drop, or face the risk of cold-stunning. Cold-stunning of green turtles occurs in southern areas, as well (i.e., Indian River, Florida), as these natural mortality events are dependent on water temperatures and not solely geographic location.

After moving from nesting sites, the remaining portion of the green turtle's life is spent on the foraging and breeding grounds. Pelagic juveniles are assumed to be omnivorous, but with a strong tendency toward carnivory during early life stages. At approximately 20 to 25 cm carapace length, juveniles leave pelagic habitats and enter benthic foraging areas, shifting to a chiefly herbivorous diet (Bjorndal, 1997). Green turtles appear to prefer marine grasses and algae in shallow bays, lagoons and reefs (Rebel 1974), but also consume jellyfish, salps, and sponges. The summer developmental habitat for green turtles encompasses estuarine and coastal waters of Chesapeake Bay (Musick and Limpus, 1997). Stranding reports indicate that between an average of 200-400 green turtles strand annually along the Eastern U.S. coast from a variety of causes, most of which are unknown (STSSN, unpublished data).

4.2 Effects of the Proposed Action

Although sea turtles are present in the Virginia portion of the Chesapeake Bay and the lower James River near Hampton Roads and Portsmouth, Virginia (NMFS NEFSC, 2012), the action area is not known to support sea turtle foraging or provide summer habitat for any species of sea turtle known to occur in the Chesapeake Bay. Additionally, the proposed action is not expected to impact sea turtle habitat in the lower James River near the confluence of the Chesapeake Bay or in Chesapeake Bay, itself.

The lower James River near the confluence of Chesapeake Bay supports marine and estuarine habitat similar to the mainstem of the Chesapeake Bay (i.e., similar salinity, tidal flushing, shellfish habitat, etc.). Restrictions on pound net fisheries in this portion of the river and the Bay are in place to provide protection for listed sea turtles. The first shoal proposed for dredging along the federal channel, Tribell Shoal, is located approximately 20 miles upstream for the confluence of the river and the Bay, where sea turtles may forage. Areas upstream of the confluence of the river and the Bay rapidly decrease in salinity. The area near Tribell Shoal has salinity that ranges between 2.6 and 5.0 ppt (http://www.pnas.org/content/108/15/6193/F1.large.jpg). This salinity range does not support sea turtle habitat or their forage base. The primary forage base for sea turtles includes whelks, crabs, and other shellfish and benthic invertebrates for loggerheads and Kemp's ridleys; sea grasses and marine algae for green sea turtles, and cnidarians, salps, jellyfish and tunicates for leatherback sea turtles. Forage items are estuarine/marine organisms that inhabitat areas with salinities higher than those found near Tribell Shoal, which is the furthest downstream shoal in the action area. Therefore, high quality forage habitat is not located in the action area. As such, listed sea turtles are not expected to be, swimming, foraging, or resting in the vicinity of the action area and all effects to sea turtles in the action area are discountable.

Additionally, adverse effects to sea turtles and their habitat downstream of the action area are not expected to occur. All dredging and disposal activities, which would potentially increase turbidity and suspended sediment near the action area, will be conducted in such a manner as to reduce the re-suspension of sediments (i.e. usage of baffle plates on the dredge head, etc.). Increased sedimentation may affect sea turtle forage species if they are present within the range of sediment plumes generated by dredging activities. However, based on analysis of hydraulic dredging activities (ACOE, 1983), increased sediment levels are likely to be present for no more than 1,150-feet downstream of the dredge area, and in this case, the associated adjacent overboard dredged material disposal areas. Since Tribell Shoal is the lowest shoal of the project, and is located approximately 20 miles upstream of the James River/Chesapeake Bay confluence, the effects of dredging and disposal activities are not expected to impact sea turtles. All effects will be discountable.

5.0 LISTED SPECIES IN THE ACTION AREA

Five distinct population segments (DPSs) of Atlantic sturgeon are known to occur in the Chesapeake Bay and James River, and unlike the four species of sea turtle, may be affected by the action. No critical habitat has been designated within the action area; so critical habitat will not be affected by this action.

5.1 Status of Affected Species

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

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
Carolina DPS of Atlantic sturgeon	Endangered
South Atlantic 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.

5.2 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[2] (77 FR

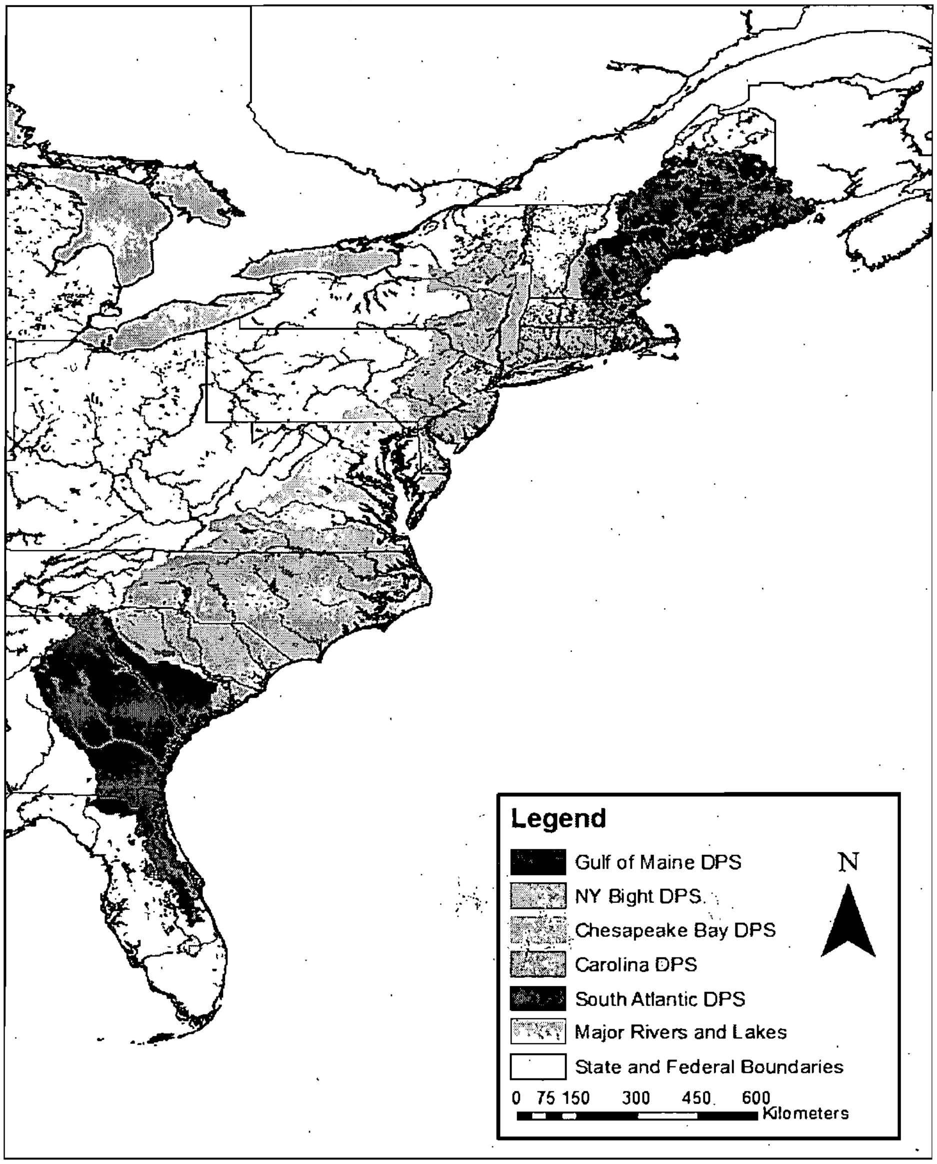
2 To be considered for listing under the ESA, a group of organisms must constitute a "species." A "species" is defined in section 3 of the ESA to include "any subspecies of fish or wildlife or plants, and any distinct population segment of any species of vertebrate fish or wildlife which interbreeds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

5880 and 77 FR 5914). These are: the Gulf of Maine (GOM), New York Bight (NYB), Chesapeake Bay (CB), Carolina (CA), and South Atlantic (SA) 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 1. Map Depicting the Boundaries of the five Atlantic sturgeon DPSs



5.2.1 Atlantic sturgeon life history

Atlantic sturgeon are long-lived (approximately 60 years), late maturing, estuarine dependent, anadromous[3] 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 2012).

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 2. 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 sub-adult 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). Juvenile Atlantic sturgeon feed on aquatic insects, insect larvae, and other invertebrates (Bigelow and

3 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 FAQ's, available at http://www.nefsc.noaa.gov/faq/fishfaq1a.html, modified June 16, 2011)

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 juvenile 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 sub-adults (Holland and Yelverton, 1973; Dovel and Berggen, 1983; Waldman *et al.*, 1996; Dadswell, 2006; ASSRT, 2007).

After emigration from the natal estuary, sub-adults 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 nearshore 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.

5.2.2 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 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. However, only eggs and larvae from the Chesapeake Bay DPS are expected in the James River.

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).

5.2.3 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/Androscoggin Complex, 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). Thus, there are substantial gaps in the range between Atlantic sturgeon spawning rivers amongst northern and mid-Atlantic states which could make re-colonization 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, sub-adults, 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).

5.2.4 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 19th and 20th 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 sub-adults 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 one of the primary threats faced by all five 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. We have a similar estimate from the Southeast Region based on the shrimp and highly migratory species fisheries. We 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%.

5.3 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/Androscoggin River complex, 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. 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 sub-adult 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 bycatch has been prohibited since 1998. Nevertheless, mortalities associated with bycatch in fisheries prosecuted in state and federal waters still occur. In the marine range, Gulf of Maine DPS Atlantic sturgeon are incidentally captured in federal and state managed fisheries, reducing survivorship of sub-adult and adult Atlantic sturgeon (Stein *et al.*, 2004; ASMFC 2007). As explained above, we have estimates of the number of sub-adults 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 DPS have navigation channels that are maintained by dredging. Dredging outside of Federal channels and in-water construction occurs throughout the Gulf of Maine DPS. 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 however, 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 sub-adult 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 two rivers (Kennebec and Androscoggin) and possibly in a third. 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.

5.4 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 1800's 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. All available data on abundance of juvenile Atlantic sturgeon in the Hudson River Estuary indicate a substantial drop in production of young since the mid 1970's (Kahnle *et al.*, 1998). A decline appeared to occur in the mid to late 1970's followed by a secondary drop in the late 1980's (Kahnle *et al.*, 1998; Sweka *et al.*, 2007; ASMFC, 2010). Catch-per-unit-effort data suggests that recruitment has remained depressed relative to catches of juvenile Atlantic sturgeon in the estuary during the mid-late 1980's (Sweka *et al.*, 2007; ASMFC, 2010). In examining the CPUE data from 1985-2007, there are significant fluctuations during this time. There appears to be a decline in the number of juveniles between the late 1980s and early 1990s and while the CPUE is generally higher in the 2000s as compared to the 1990s, given the significant annual fluctuation, it is difficult to discern any trend. Despite the CPUEs from 2000-2007 being generally higher than those from 1990-1999, they are significantly lower than in the late 1980s. There is currently not enough information regarding any life stage to establish a trend for the Hudson River population.

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 sub-adult 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 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. 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.

5.5 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 sub-adults (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 sub-adults 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.

5.6 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 3). 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 3. 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. Prior 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. Atlantic sturgeon are more sensitive to bycatch mortality 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. Based on these life history traits, Boreman (1997) calculated that Atlantic sturgeon can only withstand the annual loss of up to 5 percent of their population to bycatch mortality without suffering population declines. Mortality rates of Atlantic sturgeon taken as bycatch in various types of fishing gear range between 0 and 51 percent, with the greatest mortality occurring in sturgeon caught by sink gillnets. Atlantic sturgeon are particularly vulnerable to being caught in sink gillnets, therefore fisheries using this type of gear account for a high percentage of Atlantic sturgeon bycatch. 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 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. Their late age at maturity provides more opportunities for individual Atlantic sturgeon to be removed from the population before reproducing. 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 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. 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 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.

5.7 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 4). 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 Population	Data
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 4. 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 sub-adults 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. Their late age at maturity provides more opportunities for individual Atlantic sturgeon to be removed from the population before reproducing. 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.

5.8 Atlantic sturgeon in the Action Area

Habitat Usage

Adults

Based on the best available information, Atlantic sturgeon originating from any of five DPSs could occur in the James River; however, the Chesapeake Bay DPS spawns in upstream reaches of the river. The 340 mile long James River is Virginia's largest river and the largest tributary to the Chesapeake Bay (Bushnoe *et al.*, 2005). Tidal waters extend from the mouth, west to Richmond, VA, at the river's fall line (Bushnoe *et al.*, 2005). Based on modeling work using features associated with spawning habitat (e.g., suitable substrate), Bushnoe *et al.* (2005) concluded that the Turkey Island oxbow and the James Neck oxbow were potential spawning sites for Atlantic sturgeon in the James River. Early life stages (ELS) would be expected to be present in these spawning habitats, as ELS habitat tends to be restricted to spawning areas and regions slightly downstream. The James River, from the mouth to the potential spawning regions, comprises approximately 206 square miles.

Environmental cues, such as temperature, dissolved oxygen, and salinity appear to play a strong role in use of the James River by adult, presumably Chesapeake Bay DPS, Atlantic sturgeon (Hager *et al.*, 2011). Captive and field based studies have indicated that fish actively select habitats to maximize their energetic budge (Niklitschek and Secor, 2005; Hager, 2004). Adult sturgeon enter the river in spring when water temperatures are around 17° C, and occur from river mile 18 to river mile 67 before departing from the river in June when water temperatures are around 24° C (Hager *et al.*, 2011). A tracking array on the James River was configured to obtain migration and movement data. The array consists of two receivers that detect individually tagged fish as they pass through the array. Tracking data for 2010 demonstrated an aggregation of sturgeon in freshwater areas at river mile 48, suggesting the possibility of suitable spawning habitat in this area (Hager *et al.*, 2011).

Adult sturgeon appear to be absent from the James River for most of the summer until late August when tagged fish are once again detected in the river (Hager *et al.*, 2011). During the late summer-early fall residency (August-October), fish ascend the river rapidly and aggregate in upriver sites between river mile 48 and the fall line near Richmond, VA; possibly in response to physiologically stressful conditions (e.g., low dissolved oxygen and elevated water temperature) in the lower James River and Chesapeake Bay (Hager *et al.*, 2011). The confluence of the James and Appomattox Rivers is a preferred area. As temperature declines in late September or early October, adults disperse through downriver sites and begin to move out of the river (Hager *et al.*, 2011). By November, adults occupy only lower river sites (Hager *et al.*, 2011). By December, adults are undetected on the tracking array and, thus, are presumed to be out of the river (Hager *et al.*, 2011).

The spawning season for Chesapeake Bay DPS Atlantic sturgeon is April–May based on historical and current evidence that includes: (1) records of large harvests near the mouth of the Chesapeake Bay and in the lower James River in April; (2) incidental observations of adult-sized carcasses and incidental capture of adult-sized live fish in April; (3) detection of sonically tagged sturgeon in current scientific studies; and, (4) capture of a large female sturgeon in spawning condition within the James River in April 2011 (Hildebrand and Schroeder, 1928; Vladykov and Greeley, 1963; Bushnoe *et al.*, 2005; ASSRT; 2007; Blakenship, 2011a). James River fish are thought to spawn in temperatures similar to the Delaware River fish, which has been determined to range from 12.8°C to 18.3°C (Ryder, 1888). However, spawning in temperatures as high as 21°C to 26°C have been recorded. Capture of another large female in post-spawning condition within the James River in September 2011 suggests the possibility of a second late-summer spawning run (Balazik, unpublished data). However, further analyses are needed to confirm whether fall spawning is occurring in the James River.

Sub-adults
Sub-adult Atlantic sturgeon inhabit the fresh water portions of natal river for at least the first year of their life before migrating out to sea (Secor *et al.*, 2000). In the James River, sub-adults occupy a diverse depth range while searching for suitable habitat. Although adults also exhibit a range in depth preference, their movement between depths is not as pronounced as it is with sub-adults (Hager *et al.*, 2011). The peak sub-adult population occurs during late May/early June when water temperatures reach 26°C in the James River. The population of sub-adult sturgeon typically decreases as temperatures warm, and sub-adults presumably seek thermal refuge during the summer months, which are also characterized by low dissolved oxygen levels (Hager *et al.*, 2011) As temperatures cool in September and October, another population spike occurs as sub-adults become more prevalent in the river again. As the river temperatures decrease in October (below 20°C), sub-adults move downstream, and a portion of tagged fish have been found over-wintering in the lower river downstream of Hog Island in deep waters. Sub-adults have also been recorded migrating to offshore deep holes near the North Carolina banks where adult fish have also been recorded. (Hager *et al.*, 2011). Fish typically reside in these areas until April.

Nearby Threats

Numerous threats to Atlantic sturgeon from any DPS exist in the James River and the Chesapeake Bay. Impacts on water quality that may directly or indirectly affect individuals through direct contact with pollutants or shifts in forage base due to pollutants. Additionally, pound net fisheries that occur in the lower James Rivera and Chesapeake Bay may pose a threat to Atlantic sturgeon through entanglement or collisions with vessels.

Nutrient loading and the effects of low dissolved oxygen has been problematic throughout the Chesapeake Bay and its tributaries. Although pollutant inputs from the James River and Atlantic sturgeon were not analyzed in the 2012 Chesapeake Bay Dissolved Oxygen Biological Opinion by NMFS, the effects of water quality issues resulting from low dissolved oxygen levels may threaten Atlantic sturgeon natal to the James River as they move through Chesapeake Bay. Fish from other DPSs, that use habitat in the James River, may also be affected by degraded water quality resulting from nutrient enrichment. High water temperatures and low dissolved oxygen create physiological stress for Atlantic sturgeon and refugia may be difficult to find while improvements in water quality are made throughout the Bay. The limitation of refugia and appropriate habitat due to low dissolved oxygen may create detrimental effects to Atlantic sturgeon that use the James River.

Pound net fisheries are prevalent in the lower James River and typically may pose a threat to sea turtles in that region. However, the chance of entanglement in a pound net is possible for foraging Atlantic sturgeon, and an increase in vessel strike risk may increase in these regions of the lower James River near the confluence with the Bay where these fisheries are active.

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, vessel and fishery operations, water quality/pollution, 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 vessel operations and gear associated with federally-permitted fisheries on threatened and endangered species in the action area. Each of those consultations sought to develop ways of reducing the probability of adverse impacts of the action on listed species. Additionally, NMFS has consulted on dredging and construction projects authorized by the USACE. Formal consultations completed in the action area are summarized below.

Scientific Research Permits
The incidental capture of 273 Atlantic sturgeon in the lower James River has been reported via the USFWS Atlantic Sturgeon Reward Program (Spells, 1998). As a result of techniques

associated with this program, these sturgeon have been subjected to capturing, handling, tagging, and genetic sampling. No injuries or mortalities of Atlantic sturgeon were reported via this program. This program has been discontinued due to the fishery dependent nature of the program which precluded fish from the freshwater portions of the river being included in the sampling.

The USFWS Cooperative Atlantic Tagging Database is still ongoing. Between 1997 and 2010, approximately 1150 Atlantic sturgeon were tagged in the James River. Similar to the Reward program, because of techniques associated with this program, these sturgeon have also been subjected to capturing, handling, tagging, and genetic sampling.

Vessel Operations

Potential adverse effects from federal vessel operations in the action area of this consultation include operations of the U.S. Navy (USN) and the U.S. Coast Guard (USCG), which maintain the largest federal vessel fleets, the EPA, the National Oceanic and Atmospheric Administration (NOAA), and the ACOE. NMFS has conducted formal consultations with the USCG, the USN, and is currently in early phases of consultation with the other federal agencies on their vessel operations (e.g., NOAA research vessels). 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. Several ship strikes have been observed in the James River. Five sturgeon were reported to have been struck by commercial vessels within the river in 2005 (ASSRT, 2007). Locations, such as the James River, that support large ports and have relatively narrow waterways seem to be more prone to vessel strikes.

Dredging

Maintenance dredging of federal navigation channels can adversely affect listed species. Dredging in the Chesapeake Bay has occurred in the past and will continue in the future. Ongoing dredging projects that have been the subject of Section 7 consultation include the US Navy's Dam Neck Annex beach renourishment project and numerous projects permitted by the ACOE including the Thimble Shoal Federal Navigation Channel project, the Atlantic Ocean Channel Federal Navigation Channel Project, and the Cape Henry Channel, York Spit Channel, York River Entrance Channel, and Rappahannock Shoal Channel project. Several sea turtles have been taken by dredges associated with these projects. Hopper dredging in the action area has resulted in the mortality of a number of sea turtles, most of which were loggerheads. No shortnose sturgeon or Atlantic sturgeon have been reported taken in association with these projects; however, Atlantic sturgeon are known to become entrained in hopper dredges. A large sturgeon was captured in a pre-dredge relocation trawl for the Thimble Shoals project in October, 2003; however, it is unknown if this was a shortnose or Atlantic sturgeon.

6.2 Non-Federally Regulated Actions

Private and Commercial Vessel Operations

Private and commercial vessels, including fishing vessels, operating in the action area of this consultation also have the potential to interact with listed species. The James River has a high volume of commercial vessels that move between the Atlantic coast of Virginia and the port of Richmond, Virginia. Vessel strikes may occur as a result of this high volume.

Listed species may also be affected by fuel oil spills resulting from vessel accidents. Fuel oil spills could affect animals directly or indirectly through the food chain. Fuel spills involving fishing vessels are common events. However, these spills typically involve small amounts of material that are unlikely to adversely affect listed species. Larger oil spills may result from accidents, although these events would be rare and involve small areas. No direct adverse effects on listed Atlantic sturgeon resulting from fishing vessel fuel spills have been documented.

An unknown number of private recreational boaters frequent coastal waters and river waters; some of these are engaged in sport fishing activities. These activities have the potential to result in lethal (through entanglement or boat strike) or non-lethal (through harassment) takes of listed species. Effects of harassment or disturbance which may be caused by such vessel activities are currently unknown; however, no conclusive detrimental effects have been demonstrated.

Non-Federally Regulated Fishery Operations
Very little is known about the level of interactions with listed species in fisheries that operate strictly in state waters. However, depending on the fishery in question, many state permit holders also hold federal licenses; therefore, section 7 consultations on federal actions in those fisheries address some state-water activity.

6.3 Other Potential Sources of Impacts in the Action Area

Sources of human-induced mortality, injury, and/or harassment of Atlantic sturgeon in the action area that are reasonably certain to occur in the future include incidental takes in state-regulated fishing activities, vessel collisions, and pollution. While the combination of these activities may affect any of the DPSs of Atlantic sturgeon, preventing or slowing the species' recovery, the magnitude of these effects is currently unknown. A number of anthropogenic activities have likely directly or indirectly affected listed species in the action area of this consultation. These potential sources of impacts include previous dredging projects, pollution, water quality/pollution. However, the impacts from these activities are difficult to measure. Where possible, conservation actions are being implemented to monitor or study impacts from these sources.

Pollution and Water Quality
Excessive turbidity due to coastal development and/or construction sites could influence foraging ability. Atlantic sturgeon may be affected by water quality or increased suspended sediments directly through contact with sensitive structures such as gills or indirectly by decreases in habitat suitability for listed species hindering their capability to forage and/or for their foraging items to exist. Eventually they will tend to leave or avoid these less desirable areas (Ruben and

Morreale 1999). Degraded water quality may also affect the development of eggs and larvae and/or affect spawning fish as they move upstream to suitable spawning habitat. Point source discharges (i.e., municipal wastewater, industrial or power plant cooling water or wastewater) and compounds associated with discharges (i.e., metals, dioxins, dissolved solids, phenols, and hydrocarbons) contribute to poor water quality and may also impact the health of sturgeon populations. The compounds associated with discharges can alter the pH or receiving waters, which may lead to mortality, changes in fish behavior, deformations, and reduced egg production and survival.

Sources of contamination in the action area include atmospheric loading of pollutants, stormwater runoff from coastal development, groundwater discharges, industrial development, and debris and materials from dredging activities. Noise pollution has primarily been raised as a concern for marine mammals but may be a concern for other marine organisms, including Atlantic sturgeon. Acoustic impacts can include temporary or permanent injury, habitat exclusion, habituation, and disruption of other normal behavior patterns. As described above, global warming is likely to negatively affect Atlantic sturgeon, especially in southern systems. To the extent that air pollution, for example from the combustion of fossil fuels by vessels, contributes to global warming, then it is also expected to negatively affect Atlantic sturgeon.

As noted previously, private and commercial vessels operate within the action area. Listed species may be affected by fuel oil spills resulting from vessel accidents. Fuel oil spills could affect animals directly or indirectly through the food chain. Fuel spills involving fishing vessels are common events. However, these spills typically involve small amounts of material that are unlikely to adversely affect listed species.

Larger oil spills may also occur as a result of accidents. A prime example of this is the Deepwater Horizon oil spill that occurred on April 20, 2010. As the effects of this disaster are still ongoing, and information on the number of strandings, deaths, and recoveries of listed species are still being recorded, the effects of the oil spill on listed species will remain unknown at this time.

7.0 GLOBAL 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 and how Atlantic sturgeon may be affected by those predicted environmental changes over the life of the proposed action. Climate change is relevant to the Status of the Species and Environmental Baseline sections of this Opinion; rather than include partial discussion in several sections of this Opinion, we are synthesizing this information into one discussion. Effects of the proposed action that are relevant to climate change are included in the Effects of the Action section below (section 7.0 below).

7.1 Background Information on Predicted Climate Change

The global mean temperature has risen 0.76°C (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 (IPCC, 2007) 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, 2007); these trends are most apparent over the past few decades.

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, 2007). 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, 2007). The NAO impacts climate variability throughout the northern hemisphere (IPCC, 2007). 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, 2007). 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, 2007). There is evidence that the NADW has already freshened significantly (IPCC, 2007). 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 50-year life of the action on coastal and marine resources on smaller geographic scales, such as the James 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. Additional information on potential effects of climate change specific to the action area is discussed below. 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 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.

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°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 Atlantic Sturgeon Specific Information on Climate Change

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 affect 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

Climate change may affect the ecology of Chesapeake Bay and its tributaries, such as the James River, in a number of ways including further depression of dissolved oxygen levels, increased temperatures, decreases in oysters, eelgrass and crab species, and increases in cnidarians such as jellyfish (Mulholland, 2010). 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 CO_2 concentration, sea level, temperature, precipitation, and storm frequency and intensity and that scientists have detected significant warming and sea-level-rise trends during the 20th century in the Chesapeake Bay. Climate change scenarios for CO_2 emissions examined by STAC suggest that the region is likely to experience significant changes in climatic conditions throughout the 21st century including increases in CO_2 concentrations, sea level rise of 0.7 to 1.6 meters, and water temperature increasing by up to 2° to 6°C. 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 rise in 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.

As a tributary of the Chesapeake Bay, the physical structure of the James River could be altered because of climate change and sea level rise. The Center for Coastal Research at the Virginia Institute of Marine Science (VIMS) indicates that several changes in coastal features may occur along the James River such as shifts in shallow subtidal and tidal marsh habitat (inundation), and shifts in submerged aquatic vegetation (SAV) (http://ccrm.vims.edu/research/climate_change/jmsph.html).

Additionally, salinity shifts, with increasing saline conditions in areas that were once brackish or fresh (Najjar *et al.*, 2010), may occur. The James River is largely tidal fresh water habitat, and this could represent a significant change in habitat type and availability, especially for anadromous fish using the river. Shifts in salinity regimes may also alter the current biotic assemblages using the river, and the movement of saline dependent species into areas further upstream may occur.

Rice *et al.* (2010) evaluated the effects of potential sea-level rise in the York and James Rivers. The models measured the effects of 30 cm, 50 cm, and 100 cm sea-level rises by 2100. The Three-Dimensional Hydrodynamic-Eutrophication Model (HEM-3D) was used to simulate tide, current and salinity for the Chesapeake Bay in order to facilitate the simulation of these same parameters for both rivers. The results of the model demonstrated that in all scenarios, a rise in salinity would be detected in these largely freshwater tidal rivers for much of the year. The effects of increased salinity would create larger issues in areas where estuarine stratification is greater (i.e. the James River). Clough and Larson (2010) ran a similar model, Sea Level Affecting Marshes Model (SLAMM 6) to examine the potential for marsh inundation at the James River National Wildlife Refuge. Using the model, they were able to predict that sea level may rise anywhere between 30-40 cm by 2062 and 40-70 cm by 2100.

6.4 Effects of Climate Change in the Action Area on 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 and the likely impacts to sturgeon in the action area. The proposed action under consideration of maintenance dredging is projected to occur over 50 years. As such, we consider the likely effects of climate change during the period from now until 2062.

Over time, the most likely effect to Atlantic sturgeon would be if sea level rise was great enough to consistently shift the salt wedge further upstream, restricting the range of juvenile sturgeon thus potentially affecting the development of ELS. Habitat that is suitable for spawning is known to be present upstream of the areas that are thought to be used by Atlantic sturgeon suggesting that there may be some capacity for spawning to shift further upstream to remain ahead of the saltwedge. Because the vast majority of the James River is currently fresh/brackish even in the lower reaches, it is unlikely that the saltwedge would shift far enough upstream to result in a significant restriction of spawning or nursery habitat. The available habitat for juvenile sturgeon could decrease over time; however, even if the saltwedge shifted several miles upstream, it seems unlikely that the decrease in available habitat would have a significant effect on juvenile sturgeon, because currently the river is almost entirely brackish and fresh, and suitable habitat areas are widely available.

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 river. There could be shifts in the timing of spawning. Presumably, if water temperatures warm earlier in the spring, and 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 alone, or combined, 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.

Salinity shifts could also alter forage species distribution throughout the James River. But as mentioned above, the varied diet of Atlantic sturgeon is unlikely to be affected by these shifts. However, additional competition from marine/salt tolerant species that move into the river with salinity shifts may present increased competition for food resources, or may increase predation threat on ELS in nursery habitat, if shifts have occurred far enough upstream. This is difficult to predict based on climate model accuracy, which does not allow an accurate prediction of how far upstream the saltwedge may move (Rice *et al.*, 2010).

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 wild. However, 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 sub-adult or adult Atlantic sturgeon is available.

Mean monthly ambient temperatures in the James River range from 11-34°C from April – November, with temperatures lower than 11°C from December-March (USGS data). No estimates of a predicted rise in water temperatures for the James River is available. A predicted increase in water temperature of 3-4°C within 100 years is predicted in the Hudson River. If we assume that a similar rate of change or greater would be experienced in the James River, we would expect an increase of approximately 2-3°C between now and 2062. This could result in temperatures approaching the preferred temperature limit of Atlantic sturgeon (28°C) on more days and/or in across larger areas. Shifts in the distribution of sturgeon out of certain areas during the warmer months could occur. 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.

Over the long term, global climate change may affect Atlantic sturgeon by affecting the location of the saltwedge, distribution of prey, water temperature and water quality. 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 more easily than predicted.

8.0 EFFECTS OF THE ACTION

This section of an Opinion assesses the direct and indirect effects of the proposed action on threatened and endangered species or critical habitat, together with the effects of other activities that are interrelated or interdependent (50 CFR §402.02). Indirect effects are those that are caused later in time, but are still reasonably certain to occur. Interrelated actions are those that are part of a larger action and depend upon the larger action for their justification. Interdependent actions are those that have no independent utility apart from the action under consideration (50 CFR §402.02). We have not identified any interdependent or interrelated actions. This Opinion examines the likely effects (direct and indirect) of the proposed action on the five DPSs of Atlantic sturgeon in the action area and their habitat within the context of the species current status, the environmental baseline and cumulative effects. As explained in the Description of the Action, the action under consideration in this Opinion is the ongoing maintenance dredging of the James River Federal Navigation Channel, at nine separate shoals, which will continue to be dredged for 50-years. The action also includes overboard placement of dredged material in the lower and middle James River, and upland disposal in the upper James River.

8.1 Effects of Dredging Operations

As explained in the Description of the Action section above, over the 50-year life of the project, a hydraulic cutterhead dredge will be used for all maintenance dredging of all nine shoal areas along the federal navigation channel in the James River. Below, the effects of cutterhead dredging on threatened and endangered species will be considered. Effects of the proposed dredging include (1) entrainment and impingement; (2) alteration of Atlantic sturgeon prey and foraging behavior due to dredging; (3) suspended sediment associated with dredging operations;

(4) underwater noise generated during dredging operations; and (5) the potential for interactions between project vessels and individual Atlantic sturgeon.

8.1.1 Available Information on the Risk of Entrainment and Impingement of Sturgeon in Cutterhead Dredge

Table 6 describes the approximated schedule and dredge volume for the ongoing maintenance activities associated with the project. All dredging is proposed to occur with a cutterhead dredge, except in an emergency situation where any available dredge may be used.

Location	Average Dredge Volume (cys)	Dredging Frequency
Tribell Shoal	256,127	1.5-3 years
Goose Hill Shoal	353,021	2-3 years
Dancing Point-Swann Point Shoal	484,059	Semi-annual
Jordan Point-Harrison Bar-Windmill Point Shoal	372,915	1-3 years
City Point Shoal	137,977	10-15 years
Richmond Deepwater Terminal to Hopewell Shoal	243,151	1-3 years
Richmond Deepwater Terminal Shoal	143,151	1-3 years
Richmond Harbor to Richmond Deepwater Terminal Shoal	**	**
Richmond Harbor Shoal	97,068	2-8 years

Table 5. Average maintenance dredge cycle frequency and average dredged quantity in cubic yards (cys).

Maintenance of the existing 35-foot deep (dredged to -28 feet MLW) channel occurs routinely with dredging accomplished with a cutterhead dredge. Hopper and mechanical dredging are only used under emergency situations, where shoaling has inhibited safe navigation of the channel. The 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). The pipe diameters for cutterhead dredges on the James River range from 18 to 20 inches; maximum pipe diameter is 36-inches. High flow rates and larger pipes create greater suction velocities and wider flow fields; however, flow-fields still remain confined to small areas (Clarke, 2011). Additionally, suction decreases exponentially with distance from the dredge head (Boysen and Hoover 2009). In the lower and middle James River, dredged material is pumped onboard and then placed at overboard placement sites within 1,250 to 2,600 feet of the channel. At the upper river shoals, material is pumped directly from the dredged area to an upland 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 in situations where this is an option.

It is assumed that sturgeon are mobile enough to avoid the suction of an oncoming cutterhead dredge and that any sturgeon in the vicinity of such an operation would be able to avoid the intake and escape. However, in mid-March 1996, two shortnose sturgeon were found in a dredge discharge pool on Money Island, near Newbold Island in the Delaware River. The dead sturgeon were found on the side of the spill area into which the hydraulic pipeline dredge was pumping. An assessment of the condition of the fish indicated that the fish were 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.

In an attempt to understand the behavior of sturgeon while dredging is ongoing, the Corps worked with sturgeon researchers to track the movements of tagged Atlantic and shortnose sturgeon while cutterhead dredge operations were ongoing in the Delaware River (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 throughout 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 dredging sites 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 of the dredge project 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 2011). Dredging occurred with a cutterhead dredge between January 30 and February 19, 2009 with 166,545 cubic yards of material removed over 417.6 hours of active dredge time. Six sub-adult 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 drag heads.

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 inches (the maximum size that could be used) 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 40 cm/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 sub-adult 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-inch pipe diameter and suction of 4.6 m/second. The maximum pipe diameter for dredging on this project is 36 inches, with 18-20 inch diameter pipes used more often.

The risk of an individual Atlantic sturgeon being entrained in a cutterhead dredge is difficult to calculate. While a large area overall will be dredged, the dredge operates in an extremely small area at any given time (i.e., the river bottom in the immediate vicinity of the intake). As Atlantic sturgeon are well distributed throughout the action area and an individual would need to be in the immediate area where the dredge is operating to be entrained (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 Rivers 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 James River maintenance project. 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.

An approximate total of 1-1.5 million cubic yards of material is estimated to be removed from the channel per year. Over the 50-year span of the action, this equates to a total removal of approximately 50 to 75 million cubic yards of material. 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 maintenance activities. Based on the available information, 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, with a maximum diameter of 36 inches. This risk is lowered as the diameter of the pipeline decreases, and a sturgeon would need to be closer to a smaller pipeline and the suction velocity would have to be significantly greater to cause entrainment (Clarke, 2011). The maximum dredge head diameter on this project is 36 inches, and 18-20 inch dredge heads more commonly used in the James River. This determination applies to life stages of sturgeon that are likely to be in the action area during the time of year when dredging will occur, including young-of the year, juvenile, sub-adult and adult Atlantic sturgeon. ELS are not expected in the action area. Entrainment of all stages of Atlantic sturgeon, including ELS, if they were to occur within the action area, is made less likely by the time of year restrictions: February 15th -June 15th in the lower James and February 15th to June 30th in the upper portions of the river. Spawning occurs just upstream of the action area between March and April. By the time dredging would be allowed to occur, eggs will have hatched and larvae (if still present) and juvenile Atlantic sturgeon will have swimming abilities that will allow them to move out of the way of the dredge, if spawning occurred within the action area.

Dredging in the upper extent of the James River at Richmond Harbor occurs once every 2-8 years on average, and this area is also located downstream of potential spawning and rearing sites. Sub-adults and adult sturgeon may use the river throughout the year. Since we know that entrainment is possible, we expect that over the duration of maintenance activities over a 50-year time period, some entrainment will occur. Based on the action's total estimated dredge volumes, estimated frequency, and cutterhead dredge size, as well as the predicted rarity of entrainment in cutterhead dredges, we expected that no more than one Atlantic sturgeon will be entrained per year by cutterhead dredging. This equates to a total of 50 Atlantic sturgeon over the 50-year life of the project. The entrained sturgeon could be young-of-the-year, juvenile or sub-adult. Adults are not expected to be entrained in the 18-20-inch, or even a maximum 36-inch, pipeline, based on flow field data by Clark (2011). Based on the mixed stock analysis, it is likely that the entrained young-of-the-year, juvenile, or sub-adult Atlantic sturgeon will originate from the Chesapeake Bay DPS with sub-adults also originating from the Gulf of Maine, New York Bight, Carolina, or South Atlantic DPS. Adult Atlantic sturgeon are not expected to be entrained due to their size.

Due to the suction, travel through the pipe to upland disposal sites, and any residency period in the disposal area, all entrained Atlantic sturgeon are expected to be killed. Entrained Atlantic sturgeon that are deposited at overboard placement areas may be injured but mortality is not necessarily expected due to the close proximity of the disposal areas (within 2,600 feet, maximum).

8.1.2. Interactions with the Sediment Plume

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

As reported by the Corps, 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) total suspended solids (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, and would dissipate within several hours. 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 580 mg/L to 700,000 mg/L depending on species. Sublethal effects have been observed at substantially lower turbidity levels. For example, prey consumption was significantly lower for striped bass larvae tested at concentrations of 200 and 500 mg/L compared to larvae exposed to 0 and 75 mg/L (Breitburg, 1988 in Burton, 1993). Studies with striped bass adults showed that pre-spawners did not avoid concentrations of 954 to 1,920 mg/L to reach spawning sites (Summerfelt and Moiser, 1976 and Combs, 1979 in Burton, 1993). While there have been no directed studies on the effects of TSS on Atlantic sturgeon, the similar species, shortnose sturgeon, are often documented in turbid water and Dadswell (1984) reports that sturgeon are more active under lowered light conditions, such as those in turbid waters. Additionally, Atlantic sturgeon are known to frequent the salt front of rivers, which are characterized by turbid waters.

The life stages of sturgeon most vulnerable to increased sediment are eggs and non-mobile larvae which are subject to burial and suffocation. Although dredging occurs in upstream areas of the James River, soft-sediment shoal habitat is inconsistent with spawning habitat in the James River, which is characterized by exposed bedrock areas upstream of Richmond. Bushnoe *et al.* (2005) concluded that the Turkey Island oxbow and the James Neck oxbow were potential spawning sites for Atlantic sturgeon in the James River. These areas are located more than 1,150 feet upstream from the Richmond Harbor shoal, which is the furthest upstream shoal proposed for maintenance dredging activities. Furthermore, dredging activities are restricted between February 15th and June 30th in the upper James River. Dredging is scheduled to begin on July 1st, and at that time of year, Atlantic sturgeon spawned that year (March/April/May) would be at least two-three months old and would be mobile; these fish are no longer considered larvae, but are young-of-the-year (see Table 2 above). However, since potential spawning sites and associated rearing grounds are located upstream from Richmond Harbor, it is unlikely that any effects from a dredge plume would be realized at the spawning and rearing grounds. Juvenile, sub-adult 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. Additionally, according to monitoring at Dancing Point-Swann Point shoal, dissolved oxygen levels are relatively high (above 5 mg/L) throughout the year, which is suitable for Atlantic sturgeon. Significant dredging-induced reductions in dissolved oxygen are not expected over the course of the 50-year action. Any reductions in dissolved oxygen will be temporary as dredging occurs, and as turbidity subsides, dissolved oxygen levels will return to baseline levels. In conclusion, all sturgeon in the action area at this time of year would be sufficiently mobile to avoid any sediment plume or reductions in dissolved oxygen, occurring in isolated instances. Therefore, any Atlantic sturgeon in the action area during dredging would be capable of avoiding any sediment plume or low dissolved oxygen regions by swimming around them, and any effects would be insignificant.

8.1.3 Alteration of foraging habitat

Atlantic sturgeon feed on a variety of benthic invertebrates throughout the James River. The proposed dredging is likely to entrain and kill at least some of these potential forage items, such as shellfish, benthic worms, or other benthic invertebrates within the river system. Given the limited mobility of most benthic invertebrates that sturgeon feed on, most are unlikely to be able to actively avoid the dredge. However, the shoal areas possess actively shifting sediments, and are dredged regularly and have been for many years. Similarly, the overboard placement areas are continuously disturbed during maintenance activities. In benthic habitats such as these, colonization and re-colonization tend to be slower than non-dredged areas and produce suboptimal forage species (O'Herron and Hastings, 1985). As a result, it is unlikely that Atlantic sturgeon regularly forage in the shoal areas. Atlantic sturgeon are known to forage opportunistically in shallow areas where prey are available, including shellfish beds, and over mud flats supporting benthic worms and other organisms. These preferred foraging areas are not consistent with the shoaled areas within the regularly maintained federal channel. However, since the time between dredging does vary from 1-10 years at specific shoals, if adequate recolonization occurs in those areas between dredging events, there is no reason that Atlantic sturgeon could not forage in those areas opportunistically if prey items were available.

Furthermore, the proportion of benthic habitat disturbed during dredging activities is small compared with the 90 miles of river included in the action area, where Atlantic sturgeon may frequent. From the mouth of the James River to the potential spawning areas, the James River includes approximately 207 square miles of riverine habitat. The total area of disturbed benthic habitat in the dredge footprint equates to approximately 3.37 square miles throughout the entire action area, which represents a small portion (1.6%) of the available sturgeon habitat in the James River.

8.1.4 Vessel Strikes

Documented cases of collisions between dredges and listed species are rare; however, Atlantic sturgeon have been involved in other vessel strikes in the James River. Information regarding the risk of vessel strikes to Atlantic sturgeon is discussed above in the Status of the Species and Environmental Baseline sections. As explained, 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 on the river 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.

8.1.5 Dredge Noise

An interagency work group (including USFWS and NMFS), has reviewed the best available scientific information and developed criteria for assessing the potential of pile driving activities to cause direct physical injury to fish (i.e., injury or "harm" in terms of the ESA) (Fisheries Hydroacoustic Working Group (FHWG) 2008). The workgroup established dual sound criteria for injury, measured 10 meters away from the pile, of 206 dB peak and 187 dB accumulated sound exposure level (SEL) (183 dB SEL for fish less than 2 grams). While this work group is based on the US west coast, species similar to Atlantic sturgeon were considered in developing this guidance (green sturgeon and Pacific salmon) and as these species are biologically similar to the species being considered herein, it is reasonable to use the criteria developed by the FHWG.

The FHWG has not yet provided criteria for sound levels that would affect the behavior of fish and, therefore, might be considered to cause fish to experience behavioral modifications, such as avoidance. However, sound pressure levels in excess of 150 dB RMS can cause temporary behavioral changes, such as elicitation of a startle response, disruption of feeding, or avoidance of an area (Hastings, 2002). NMFS and USFWS have previously used the 150 dB RMS level when determining whether pile driving activities lead to harassment of Pacific salmon. Although more research is needed, there are several studies that support this as a conservative threshold for behavioral effects. Observations by Feist *et al.* (1992) suggest sound levels greater than 150 dB may disrupt normal migratory behavior of salmon and steelhead. They observed that salmonids respond by avoiding the area of greatest sound levels and attempt to swim along the opposite side of the channel or along the shoreline furthest away from the active pile driving operation. Turnpenny *et al.* (1994) and Wysocki *et al.* (2007) documented that salmonids exposed to noise levels up to 150 dB RMS did not exhibit signs of stress. Given these studies, 150 dB RMS is a conservative estimate of what sound levels might result in behavioral modifications, such as avoidance, by Atlantic sturgeon. Specific studies that examine the effects of dredge noise on listed species have not been conducted, and as such, the previous represents the best available information.

The amount of noise generated by hydraulic cutterhead dredges relates to the size and type of dredging equipment used, the specifications, any modifications to the equipment, operational methods, and the geomorphology and suspended sediment loads at the site (Reine *et al.*, 2012). Generally, noise generated by dredges are considered continuous and low in frequency (i.e., no rapid rise times and below 1000 Hertz (Hz)) (CEDA, 2011). The estimated sound pressure levels may range between 168 to 186 dB peak re 1μPa at one meter below the surface. However, the vast majority of sound from cutterhead dredges occur between 70 Hz and 1,000 Hz, and peak sound pressures tended to range between 100 to 110 dB peak re 1μPa (Clarke *et al.*, 2002). Clarke *et al.* (2002) recorded sounds of a 10,000 horsepower, 24 inch cutterhead dredge during maintenance dredging activities in the Mississippi River. The study indicates that dredge sounds were muted by other noises in the aquatic environment, and that sounds attributed to the cutterhead dredge operations were virtually undetectable at 500 meters (1,640 feet) from the source (Clarke et al., 2002).

The exact size and specifications of the cutterhead dredge in the action area will vary from year to year, but the absolute maximum dredge size is 36 inches, and more often ranges between 18 to 20 inches, which would proportionately be expected to produce less noise. The peak sounds produced by cutterhead dredges is lower than the injury threshold for Atlantic sturgeon (206 dBPeak and 187 dB accumulated sound exposure level (SEL) (183 dB SEL for fish less than 2 grams). However, the loudest dredge noises are still within the harassment range of approximately 150 dB RMS. Since dredging will occur during the time of year when all life stages of Atlantic sturgeon are mobile, it is likely that individuals will move away from areas if noise above the 150 dB RMS harassment level is present. Since studies on cutterhead dredges with 24 inch dredge heads indicate that the vast majority of sound pressure levels ranged between 100 to 110 dB, it is reasonably likely to expect that dredges with 18 to 20 inch dredge heads (predicted to be used most often on this project) will likely also produce sound pressure levels in this range the majority of the time. This decibel range is below the range of harassment or injury for Atlantic sturgeon and as such, all effects will be insignificant.

8.1.6 Fuel Oil Spills

Fuel oil spills could occur from the dredge or any other vessels involved with the project. A fuel oil spill would be an unintended, unpredictable event. Marine animals are known to be negatively impacted by exposure to oil and other petroleum products. Without an estimate of the amount of fuel oil released it is difficult to predict the likely effects on listed species. No accidental spills of diesel fuel are expected during dredging operations; however, if such an incident does occur, implementation of the USCG-approved safety response plans or procedures to prevent and minimize any impacts associated with a spill will be implemented by all personnel to ensure a rapid response to any spill. As the effects of a possible spill are likely to be localized and temporary, any effects would be discountable. Additionally, should a response be required by the United States Environmental Protection Agency or the USCG, there would be an opportunity for NMFS to conduct a consultation with the lead Federal agency on the oil spill response.

8.2 Effects of Dredged Material Disposal

As explained in the Description of the Action section above, over the 50-year life of the project, a hydraulic cutterhead dredge will dispose of dredged material at designated overboard placement sites in the lower and middle James River and at appropriate upland disposal sites in the upper James River. Below, the effects dredge material disposal will be considered on Atlantic sturgeon. Effects of the dredge material placement include (1) suspended sediment associated with disposal activities; and, (2) alteration of Atlantic sturgeon prey and foraging behavior.

8.2.1 Interactions with the Sediment Plume

The dredging contractor is required to place sediment at overboard placement sites evenly along the centerline of the designated dredged material placement site. As each shoal is dredged, the discharge pipe is moved along the centerline of the disposal area to achieve this even distribution of material and to ensure that sediments do not mound up or become concentrated in one area. Bathymetric observations of the dredged material placement sites over several dredge cycles indicate that the depths and extents of the dredged material placement sites do not change significantly. This is may be in part due to natural river dynamics and sediment transport in the James River between dredge cycles.

Several plume tracking studies have been conducted in the James River at Goose Hill Shoal Channel (March, 2005) and Tribell Shoal (February, 2010). All studies were performed with a baffle plate installed at the end of the discharge pipe at the overboard discharge area, similar to how disposal activities will be conducted for this project. Sediment types vary at these two shoals even though they are adjacent to one another. At Tribell shoal, 88-92% of sediments consisted of silty-clays, while at Goose Hill shoal, 74% of the material was a clay/silty-clay mix and 26% was fine to coarse sand, silty-sand, and clayey-sand (Reine *et al.*, 2010 in progress). The study at Goose Hills shoal determined that small to medium plumes (246 to 328 feet wide) dissipated within 656 feet of the pipe (Olney *et al.*, 2005). The total suspended solids measured 400 to 550 mg/L at 65-165 feet from the discharge point. The maximum width of the Tribell shoal plume measured less than 246 feet) and at distances of 328 feet or more from the overboard placement discharge pipe, the suspended sediment plume was not detectable (Reine *et al.*, 2010 in progress). The shoals in the lower and middle part of the James tend to contain more silty sediments than the shoals in the upper James. Coarser materials are not re-suspended to the same extent that fine materials are and it is reasonable to expect that plumes would cover less area in the upper reaches of the river.

Similar to plumes created as a direct result of dredging (within 1,150 feet of dredge area), plumes generated as a result of disposal are likely to pose similar minimal threats to Atlantic sturgeon. Based on these studies, the extent of these disposal plumes should be of lesser magnitude than the dredging plumes. Again, because of time of year restrictions and the prospective size of Atlantic sturgeon in the river at the time of dredging and disposal activities, it is reasonably likely that all sturgeon in the action area at this time of year 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, and any effects would be insignificant.

8.2.2 Alteration of foraging habitat

As discussed previously, Atlantic sturgeon feed on a variety of benthic organisms. The overboard placement areas are regularly disturbed during disposal activities and are not likely to provide high quality forage habitat since organisms may not have enough time to re-colonize effectively between dredge cycles, which may vary from semi-annually for some shoals, to once every 10-15 years for other shoals. This type of habitat is inconsistent with Atlantic sturgeon foraging habitat (i.e. shellfish beds, mud flats, areas with of benthic worms/organisms). As evidenced in bathymetric surveys of the disposal areas, the depth and extent of these areas changes little, so it is reasonable to assume that natural riverine processes and sediment transport may also add to the disturbance regime at the placement areas.

And again, the proportion of benthic habitat disturbed during disposal activities is small compared with the 90 miles of river included in the action area, where Atlantic sturgeon may frequent. From the mouth of the James River to the potential spawning areas, the James River includes approximately 207 square miles of riverine habitat. The total area of disturbed benthic habitat in the disposal footprint equates to approximately 4.27 square miles throughout the entire action area, which represents a small portion (2%) of the potential forage habitat in the James River.

8.3 Effects of Emergency Dredging

Under certain emergency situations where shoaling has inhibited the safe navigation of the federal channel, it may be necessary to dredge at varying intervals and at other times of year than expected. The Corps anticipates using hydraulic cutterhead dredges for all emergency dredging activities. Shoaling emergencies occur, on average, once every five years. Although emergency shoaling situations may occur during time-of year restrictions, the usage of a cutterhead dredge will reduce any probability of impingement or entrainment of juvenile, sub-adult and adult Atlantic sturgeon, as explained for all maintenance dredging activities. Additionally, dredging is not expected to occur in known spawning areas, and as such,all effects will be insignificant.

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 Commonwealth of Virginia within the action area that may affect Atlantic sturgeon include the authorization of state fisheries and the regulation of point and non-point source pollution through the National Pollutant Discharge Elimination System. As such, sources of human-induced mortality or harassment of Atlantic sturgeon in the action area include incidental takes in state-regulated fishing activities, private/commercial vessel collisions, and pollution. The combination of these activities may potentially affect any DPS of Atlantic sturgeon that may use the James River, preventing or slowing the recovery process. Natural predation and disease may also factor into the recovery process.

Future commercial fishing activities in state waters may affect Atlantic sturgeon in a number of ways—through entanglement/entrainment in gear, etc. However, it is not clear to what extent these future activities would affect Atlantic sturgeon differently than the current state fishery activities described in the Environmental Baseline section. The Atlantic Coastal Cooperative Statistics Program (ACCSP) and the NMFS sea turtle/fishery strategy are expected to provide information on takes of protected species in state fisheries and systematically collect fishing effort data, which will be useful in monitoring impacts of the fisheries. Currently, fisheries for largemouth bass, commercial pound net fisheries, and crab fisheries exist in the James River. NMFS expects these state water fisheries to continue in the future, and as such, the potential for interactions with Atlantic sturgeon will also continue.

The Commonwealth of Virginia has been delegated authority to issue National Pollutant Discharge Elimination System (NPDES) permits by the EPA. These permits authorize the discharge of pollutants in the action area. Permittees include municipalities for sewage treatment plants and other industrial users. The states will continue to authorize the discharge of pollutants through the State Pollutant Discharge Elimination System (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.

Excessive turbidity due to coastal development and/or construction sites could also influence Atlantic sturgeon survival and recovery. Additional sources of contamination in the action area include atmospheric loading of pollutants, stormwater runoff from coastal development, groundwater discharges, and industrial development. Chemical contamination may have an effect on Atlantic sturgeon reproduction and survival. While dependent upon environmental stewardship and clean up efforts, impacts from marine pollution, excessive turbidity, and chemical contamination on marine resources and the Virginia coastal ecosystem are expected to continue in the future.

10.0 INTEGRATION AND SYNTHESIS OF EFFECTS

In the effects analysis outlined above, NMFS considered potential effects from the following sources: (1) dredging, via cutterhead dredges; (2) placement of dredge material at overboard dredge disposal sites (3) physical alteration of the action area including disruption of benthic communities and changes in turbidity levels in the action area resulting from dredging and disposal activities; (4) dredge noise and resultant increases in underwater noise levels; (5) increase in vessel strike probability; and (6) increase in the potential of fuel oil spills.

We anticipate the mortality of 50 Atlantic sturgeon from any of the five DPSs from entrainment in cutterhead dredges over the 50-year action period. As explained in the "Effects of the Action" section, effects of maintenance dredging and disposal activities on habitat and benthic resources will be insignificant and discountable. We do not anticipate any take of Atlantic sturgeon due to any of the other effects including vessel traffic dredge disposal, or by increased noise or probability of fuel spills.

In the discussion below, we consider whether the effects of the proposed action reasonably would be expected, directly or indirectly, to reduce appreciably the likelihood of both the survival and recovery of Atlantic sturgeon 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 action, in the context established by the status of the species, environmental baseline, and cumulative effects, would jeopardize the continued existence of Atlantic sturgeon. 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 Atlantic sturgeon 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 federal ESA.

10.1 Atlantic sturgeon

As explained above, the proposed action is likely to result in the mortality of a total of 50 Atlantic sturgeon from the Gulf of Maine, New York Bight, Chesapeake Bay, Carolina and South Atlantic DPSs during the 50-years of maintenance dredging. We expect that there will be no more than one mortality per year. We expect that the Atlantic sturgeon killed will be young-of-the year, juveniles or sub-adults. Adult Atlantic sturgeon are too large to be impinged or entrained by a cutterhead dredge. All other effects to Atlantic sturgeon, including effects to habitat and prey due to dredging and dredge disposal, will be insignificant and discountable.

10.1.1 Determination of DPS Composition

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%. Given these percentages, it is most likely that the entrained Atlantic sturgeon would originate from the New York Bight DPS but it is possible it could originate from any of the five DPSs.

10.2 Gulf of Maine DPS

Individuals originating from the GOM DPS are likely to occur in the action area. 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 and the Androscoggin River (which shares an estuary with the Kennebec). No total population estimates are available for the GOM DPS, and there are currently no published population estimates for for any single life stage either. We expect that 11% of the Atlantic sturgeon in the action area will originate from the GOM DPS. 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. We anticipate the mortality of no more than one subadult Atlantic sturgeon per year (50 total over the 50-year duration of the action) during the activity described in this Opinion. As noted above, we do not have an estimate of the number of subadult Atlantic sturgeon in the GOM DPS, the number of adults or the size of the GOM DPS as a whole. Here, we consider the effect of the loss of one subadult 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 one subadult 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, because this action will result in the death of only one individual, 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. 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 action will also not affect the spawning grounds within the rivers where GOM DPS fish spawn. The action 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 this action on the species. However, because the proposed action will result in the loss of only one individual, it is unlikely that this death will have a detectable effect on the numbers and population trend of the GOM DPS.

The proposed action is not likely to reduce distribution because the action 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 action is 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 no more than one GOM DPS Atlantic sturgeon, 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 will not change the status or trends of the species as a whole; (3) the loss of one 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 one subadult GOM DPS Atlantic sturgeon 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 action 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 action will have no effect on the ability of GOM DPS Atlantic sturgeon to shelter and only an insignificant effect on individual 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 action will not appreciably reduce the likelihood that the GOM DPS will survive in the wild. Here, we consider the potential for the action 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 action 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 an adequate forage base. Here, we consider whether this proposed action will affect the population size and/or trend in a way that would affect the likelihood of recovery.

The proposed action 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 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 action will result in an extremely small amount of mortality (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. This action 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 action will not reduce the likelihood of improvement in the status of the GOM DPS of Atlantic sturgeon. The effects of the proposed action will not delay the recovery timeline or otherwise decrease the likelihood of recovery. The effects of the proposed action 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 action 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 action, is 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, and as a result of the action, the proposed action will not increase the vulnerability of individualsturgeon to these additional threats and exposure to ongoing threats will not increase susceptibility to effects related to the proposed action. 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 action, resulting in the mortality of one subadult GOM DPS Atlantic sturgeon, is not likely to appreciably reduce the survival and recovery of this species.

10.3 New York Bight DPS

Individuals originating from the NYB DPS are likely to occur in the action area. 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. We expect that 49% of the Atlantic sturgeon in the action area will originate from the NYB DPS. 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. There is currently not enough information to establish a trend for any life stage, for the Hudson or Delaware River spawning populations or for the DPS as a whole.

We have estimated that the proposed maintenance activities over 50 years will result in the mortality of 50 Atlantic sturgeon, with one originating from the NYB DPS. No mortality of adults is anticipated; thus, there will be no loss of Delaware or Hudson River origin adults. NYB origin eggs, larvae, and juveniles would not be present in the James River. Here, we consider the effects of the mortality of one sub-adult NYB DPS Atlantic sturgeon over the 50-year time period. Any New York Bight DPS sub-adults could originate from the Delaware or Hudson River and move into the James River. There is currently not enough information to establish a trend for any life stage, for the Hudson or Delaware River spawning populations or for the DPS as a whole. 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.

The mortality of one sub-adult Atlantic sturgeon from the NYB DPS over a 50-year period represents a very small percentage of the sub-adult population. While the death of one sub-adult Atlantic sturgeon will reduce the number of NYB DPS Atlantic sturgeon compared to the number that would have been present absent the proposed action, it is not likely that this reduction in numbers will change the status of this species as this loss represents a very small percentage of the sub-adult population. Even when converting this one sub-adult to an adult equivalent[4] (using a conversion rate of 0.48 considering the adult equivalent), and assuming no growth in the adult population, this one mortality represent an extremely small percentage of the adult population. The effect of this loss is even smaller when considering that this mortality will occur over a 50-year period. The loss of one fish per year over a 50-year time period represents an even smaller proportion of the total sub-adult and adult NYB DPS population.

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 one sub-adult 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 action, any effect to future year classes is anticipated to be extremely small and would not change the status of this species. The proposed action will also not affect the spawning grounds within the Hudson River where most NYB DPS fish spawn, or in the Delaware River, where additional spawning may occur. We have also determined that dredging will not result in any delay or disruption in any normal behavior including movements of adults from the ocean to the in-river

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

spawning grounds. 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 action is not likely to reduce distribution because the action 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 in the James River.

Based on the information provided above, the loss of up to one 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 action 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 one sub-adult NYB DPS Atlantic sturgeon over a 50-year period represents an extremely small percentage of the species as a whole; (2) the death of one sub-adult NYB DPS Atlantic sturgeon will not change the status or trends of the species as a whole; (3) the loss of these sub-adult 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 sub-adult 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 action 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 action will have no effect on the ability of NYB DPS Atlantic sturgeon to shelter and only an insignificant effect on individual 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 action will not appreciably reduce the likelihood that the NYB DPS will survive in the wild. Here, we consider the potential for the action 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 action 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 this proposed action will affect the population size and/or trend in a way that would affect the likelihood of recovery.

The proposed action 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 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 action will result in an extremely small amount of mortality (one individual) 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. This action 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 action will not reduce the likelihood of improvement in the status of the NYB DPS of Atlantic sturgeon. The effects of the proposed action will not delay the recovery timeline or otherwise decrease the likelihood of recovery. The effects of the proposed action 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 action 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 action, is 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 action 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 action. Based on the analysis presented herein, the proposed action, resulting in the mortality of up to one subadult NYB DPS Atlantic sturgeon, is not likely to appreciably reduce the survival and recovery of this species.

10.4 Chesapeake Bay DPS

Individuals originating from the CB DPS are likely to occur in the action area. 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. No estimates of the number of spawning adults, the DPS as a whole or any life stage have been reported. We expect that 14% of the Atlantic sturgeon in the action area will originate from the CB DPS; however, under a worst case scenario, we could expect that 100% of fish originate from this DPS. 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. Here, we consider the effect of the loss of 50 juveniles or subadults over 50 years on the reproduction, numbers and distribution of the CB DPS.

We anticipate the mortality of 50 Atlantic sturgeon over the 50-year period considered here, with 50 likely to originate from the CB DPS (worst-case scenario). Because we do not anticipate the mortality of any adults, and sub-adults represent the best available data for all other life stages, we consider here the effects to the CB DPS from the loss of 50 sub-adults (>500mm TL <1,500 mm TL) or juveniles over the 50-year time period.

The death of 50 juvenile or sub-adult Atlantic sturgeon from the CB DPS over a 50-year period (less than one per year) represents a small loss of juvenile or sub-adults from the CB DPS over the life of the action. 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 50 juvenile or sub-adults over 50 years 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. 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 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 action will also not affect the spawning grounds within the rivers where CB DPS fish spawn because spawning grounds are located upstream from the action area. The action will also not create any barrier to pre-spawning sturgeon accessing the overwintering sites or the spawning grounds used by CB DPS fish.

The proposed action is not likely to reduce distribution because the action will not impede Atlantic sturgeon from accessing any seasonal concentration areas, including foraging areas within the Delaware River that may be used by CB DPS sub-adults or adults. Further, the action is 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 immediate area where dredging is occurring.

Based on the information provided above, the death of no more than 50 CB DPS Atlantic sturgeon (as a worst-case scenario) over a 50-year period resulting from the proposed maintenance dredging 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 action 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 50 juvenile or sub-adult CB DPS Atlantic sturgeon over a 50-year period represents an extremely small percentage of the species as a whole; (2) the death of 50 juvenile or sub-adult CB DPS Atlantic sturgeon will not change the status or trends of the species as a whole; (3) the loss of these juvenile or sub-adult CB DPS Atlantic sturgeon is not likely to have an effect on the levels of genetic heterogeneity in the population; (4) the loss of these juvenile or sub-adult CB DPS Atlantic sturgeon 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 action 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 action will have no effect on the ability of CB DPS Atlantic sturgeon to shelter and only an insignificant effect on individual 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 action will not appreciably reduce the likelihood that the CB DPS will survive in the wild. Here, we consider the potential for the action 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 action 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 action will affect the population size and/or trend in a way that would affect the likelihood of recovery.

The proposed action 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 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 action will result in an extremely small amount of mortality (one individual) 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. This action 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 action will not reduce the likelihood of improvement in the status of the CB DPS of Atlantic sturgeon. The effects of the proposed action will not delay the recovery timeline or otherwise decrease the likelihood of recovery. The effects of the proposed action 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 action 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 action, is 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 action 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 action. 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 action, resulting in the mortality of 46 juvenile or subadult CB DPS Atlantic sturgeon, is not likely to appreciably reduce the survival and recovery of this species.

10.5 Carolina 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 six rivers where spawning is still thought to occur. There are no estimates of the size of the CA DPS. The ASSRT estimated that there were fewer than 300 spawning adults in each of the five spawning rivers. We expect that 4% of the Atlantic sturgeon in the action area will originate from the Carolina DPS. 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. Here, we consider the effect of the loss of one subadult 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 this subadult 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. 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. 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; there will also be no reduction in individual fitness or any future reduction in numbers of individuals. The proposed action will also not affect the spawning grounds within the rivers where CA DPS fish spawn. The action 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 this action on the species. However, because the proposed action will result in the loss of only one individual, it is unlikely that this death will have a detectable effect on the numbers and population trend of the CB DPS.

The proposed action is not likely to reduce distribution because the action 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 action is 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 immediate area where dredging is occurring.

Based on the analysis provided above, the death of no more than one CA DPS Atlantic sturgeon 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 action 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 loss of one subadult CA DPS Atlantic sturgeon represents an extremely small percentage of the species as a whole; (2) the loss of one subadult CA DPS Atlantic sturgeon will not change the status or trends of the species as a whole; (3) the loss of one 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 one subadult CA DPS Atlantic sturgeon 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 action 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 action will have no effect on the ability of CA DPS Atlantic sturgeon to shelter and only an insignificant effect on individual 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 action will not appreciably reduce the likelihood that the CA DPS will survive in the wild. Here, we consider the potential for the action 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 action 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 action will affect the population size and/or trend in a way that would affect the likelihood of recovery.

The proposed action 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 action will result in an extremely small amount of mortality (one individual) 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 action 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 action will not reduce the likelihood of improvement in the status of the CA DPS of Atlantic sturgeon. The effects of the proposed action will not delay the recovery timeline or otherwise decrease the likelihood of recovery. The effects of the proposed action 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 action 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 action, 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 action 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 action. 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 action, resulting in the mortality of one subadult CA DPS Atlantic sturgeon, is not likely to appreciably reduce the survival and recovery of this species.

10.6 South Atlantic DPS

Individuals originating from the SA DPS are likely to occur in the action area. 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. 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). There are no reported population estimates for any spawning rivers or the DPS as a whole.

We expect that 20% of the Atlantic sturgeon in the action area will originate from the SA DPS. Most of these fish are expected to be sub-adults, with few adults from the SA DPS expected to be present in the James River. South Atlantic 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.

We anticipate the mortality of 50 Atlantic sturgeon over the 50-year period considered here, with one likely to originate from the SA DPS. Because we do not anticipate the mortality of any adults, we consider here the effects to the SA DPS from the loss of one sub-adult (>500mm TL <1,500 mm TL) over the 50-year time period. The death of one sub-adult Atlantic sturgeon from the SA DPS over a 50-year period represents a very small percentage of the sub-adult population. While the death of one sub-adult Atlantic sturgeon will reduce the number of SA DPS Atlantic sturgeon compared to the number that would have been present absent the proposed action, it is not likely that this reduction in numbers will change the status of this species as this loss represents a very small percentage of the sub-adult population. Even when converting this fish to an adult equivalent[5] (using a conversion rate of 0.48), and assuming no growth in the adult population, this mortality represent a very small percentage of the adult population. The effect of this loss is even smaller when considering that these mortalities will occur over a 50-year period, with no more than one occurring in any one year. The loss of one fish over a 50-year time period represents an even smaller proportion of the total sub-adult and adult SA DPS population.

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 one sub-adults 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. This small reduction in a potential future spawner 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. 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; there will also be no reduction in individual fitness or any future reduction in numbers of individuals.

The proposed action will also not affect the spawning grounds within the rivers where SA DPS fish spawn. The action will also not create any barrier to pre-spawning sturgeon accessing the overwintering sites or the spawning grounds used by SA DPS fish.

The proposed action is not likely to reduce distribution because the action will not impede Atlantic sturgeon from accessing any seasonal concentration areas, including foraging areas within the JamesRiver that may be used by SA DPS sub-adults or adults. Further, the action is not expected to reduce the river by river distribution of Atlantic sturgeon. Any effects to

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

distribution will be minor and temporary and limited to the temporary avoidance of the immediate area where dredging is occurring.

Based on the information provided above, the death of no more than one SA DPS Atlantic sturgeon over a 50-year period resulting from maintenance dredging 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 action 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 sub-adult SA DPS Atlantic sturgeon over a 50-year period represents an extremely small percentage of the species as a whole; (2) the loss of one sub-adult SA DPS Atlantic sturgeon will not change the status or trends of the species as a whole; (3) the loss of this sub-adult SA DPS Atlantic sturgeon is not likely to have an effect on the levels of genetic heterogeneity in the population; (4) the loss of this sub-adult SA DPS Atlantic sturgeon 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 action 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 action 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 action will not appreciably reduce the likelihood that the SA DPS will survive in the wild. Here, we consider the potential for the action 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 action 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 this proposed action will affect the population size and/or trend in a way that would affect the likelihood of recovery.

The proposed action 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 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 action will result in an extremely small amount of mortality (one individual) 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. This action 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 action will not reduce the likelihood of improvement in the status of the SA DPS of Atlantic sturgeon. The effects of the proposed action will not delay the recovery timeline or otherwise decrease the likelihood of recovery. The effects of the proposed action 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 action 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 action, is 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 action 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 action. 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 action, resulting in the mortality of one subadult SA DPS Atlantic sturgeon, is not likely to appreciably reduce the survival and recovery of this species.

11.0 CONCLUSION

After reviewing the best available information on the status of endangered and threatened species under NMFS jurisdiction, the environmental baseline for the action area, the effects of the action, and the cumulative effects, it is NMFS' biological opinion that the proposed action may adversely affect but is not likely to jeopardize the continued existence of any DPS of Atlantic sturgeon.

12.0 INCIDENTAL TAKE STATEMENT

The proposed dredging project has the potential to directly affect Atlantic sturgeon individuals from the New York Bight, Gulf of Maine, Chesapeake Bay, Carolina, and South Atlantic DPSs, causing them to become entrained in the cutterhead dredge. These interactions are likely to cause mortality. Take may occur any time during the 50-year period of maintenance dredging of the federal navigation channel of the James River. The following 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.

This ITS exempts the following lethal take over 50 years:

- 1 Gulf of Maine DPS Atlantic sturgeon.
- 1 New York Bight DPS Atlantic sturgeon;
- 50 Chesapeake Bay DPS Atlantic sturgeon;
- 1 Carolina DPS Atlantic sturgeon; and,
- 1 South Atlantic DPS Atlantic sturgeon,

We expect that one sturgeon will be killed per year during the 50-year maintenance period, with a total exempted take of 50 sturgeon over the 50-year time frame. One Gulf of Maine DPS, one New York Bight DPS, 50 Chesapeake Bay DPS, one Carolina DPS, and one South Atlantic DPS Atlantic sturgeon will be sub-adults. Juveniles or sub-adults from the Chesapeake Bay DPS could be taken as well. No take of any adult Atlantic sturgeon is anticipated.

12.1 Reasonable and Prudent Measures

NMFS believes the following reasonable and prudent measures are necessary and appropriate to minimize and monitor impacts of incidental take resulting from the proposed action:

RPMs related to Cutterhead Dredging Activities

1. NMFS must be contacted prior to the commencement of dredging and again upon completion of the dredging activity. This applies to all maintenance dredging activities.

2. For cutterhead dredging with upland disposal, an inspector, with sufficient training to identify sturgeon, must be present at the upland disposal site to conduct daily inspections for biological materials, including Atlantic sturgeon or sturgeon parts (see Appendix A). The inspection schedule and procedures must be sufficient to ensure a high likelihood of documenting entrained sturgeon and must involve inspections of ponded areas and inspections at the area where water is discharged from the upland disposal site.

3. A diffuser will be used on cutterhead dredges and a maximum pipeline diameter of 36 inches will be used for the entire duration of this project. Pipelines between 18-20 inches will be used as often as possible.

4. The ACOE shall ensure that all measures are taken to protect any sturgeon that survive entrainment.

5. All maintenance dredging activities must adhere to time-of-year restrictions: February 15^{th} to June 15^{th} in the lower James River, and February 15^{th} to June 30^{th} in the middle and upper James River.

RPMs for all aspects of the project

6. All Atlantic sturgeon captured must have a fin clip taken for genetic analysis. This sample must be transferred to NMFS.

7. All Atlantic sturgeon that are captured during the project must be scanned for the presence of Passive Integrated Transponder (PIT) tags. Tag numbers must be recorded and reported to NMFS.

8. 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.

9. All sturgeon captures, injuries or mortalities associated with all maintenance activities and any sturgeon sightings in the action area must be reported to NMFS within 24 hours.

12.2 Terms and conditions

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

1. To implement RPM #1, the Corps must contact NMFS (Chris Vaccaro by email (christine.vaccaro@noaa.gov)or phone (978)-281-9167) or (978)-281-9328 within 3 days of the commencement of each maintenance 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 the Corps with any updated contact information or reporting forms.

2. To implement RPM #2, for cutterhead dredging, the Corps must require inspections at the upland disposal area at least four times a day in order to document any fish entrained in the dredge, including Atlantic sturgeon or their parts. The Corps must provide training in Atlantic sturgeon identification to inspectors/personnel working at the upland dredged disposal site (Appendix A). Species identification must be verified by an expert.

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

4. To implement RPM #6, the ACOE must ensure that fin clips are taken (according to the procedure outlined in Appendix C) 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.

5. To implement RPM #7, all collected sturgeon must be inspected for a PIT tag with an appropriate PIT tag reader. Any tag numbers must be recorded and reported to NMFS.

6. To implement RPM #8, 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 D(sturgeon salvage form) must be completed and submitted to NMFS.

7. To implement RPM #9, the Corps must contact NMFS within 24 hours of any interactions with Atlantic sturgeon including non-lethal and lethal takes. NMFS will provide contact information annually when alerted of the start of dredging activity. Until alerted otherwise, the Corps should contact Chris Vaccaro:: by email (christine.vaccaro@noaa.gov) or phone (978) 281-9167 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.

8. To implement RPM #8, the ACOE must photograph and measure any Atlantic sturgeon observed during project operations (including whole sturgeon or body parts observed at the disposal location or on board the dredge, hopper or scow) and the corresponding form (Appendix B) must be completed and submitted to NMFS **within 24 hours** by fax (978-281-9394) or e-mail (incidental.take@noaa.gov).

9. To implement RPM #9, any time a take occurs the Corps must immediately contact NMFS to review the situation. At that time, the Corps must provide NMFS with information on the amount of material dredged thus far and the amount remaining to be dredged during that cycle. It should be noted that the take of 50 sturgeon over the 50-year maintenance dredging period is exempted. On average one take is expected per year, but this may vary and may be reviewed on a case-by-case basis. The Corps should 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 this take represents new information revealing effects of the action that may not have been previously considered.

10. To implement RPM #9, the Corps must submit a final annual report summarizing the results of all dredging activities occurring in that calendar year and any takes of listed species to NMFS within 30 working days of the completion of each dredging year (by mail to the attention of the Section 7 Coordinator, NMFS Protected Resources Division, 55 Great Republic Drive, Gloucester, MA 01930).

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 Corps consider the following Conservation Recommendations:

(1) To the extent practicable, the ACOE should avoid emergency dredging during times of year when Atlantic sturgeon sensitive life stages are likely to be present. These life stages may include larvae and young-of-the year that drift downstream of spawning grounds into the action area.

(2) Population information on certain life stages of Atlantic sturgeon is still sparse for this river system. The Corps should continue to support studies to evaluate habitat and the use of the river, in general, by all life stages in the James River and/or Atlantic sturgeon aggregation areas.

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

(4) The Corps should coordinate and oversee studies at the upland dredged material disposal areas 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.

(5) The Corps should coordinate and oversee the development of a program to monitor the movement of acoustically tagged Atlantic sturgeon during the dredging operations

14.0 REINITIATION OF CONSULTATION

This concludes formal consultation on the Corps' James River Federal Navigation project. As provided in 50 CFR 402.16, reinitiation of formal consultation is required where discretionary federal agency involvement or control over the action has been retained (or is authorized by law) and if: (1) the amount or extent of incidental take is exceeded; (2) a new species is listed or critical habitat designated that may be affected by the action; (3) the agency action is subsequently modified in a manner that causes an effect to the listed species or critical habitat not considered in this opinion; or (4) new information reveals effects of the action that may affect listed species or critical habitat in a manner or to an extent not previously considered. If the amount or extent of incidental take is exceeded, the Corps must immediately request reinitiation of formal consultation.

15.0 LITERATURE CITED

Army Corps of Engineers. 1983. Dredging and Dredged Material Disposal. U.S. Dept. Army. Engineer Manual 1110-2-5025.

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.

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.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.

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.

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.

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. dissertation. School of Marine Science, College of William and Mary.

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.

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

Bushnoe, T.M., Musick, J.A., and D.S. Ha. 2005. Essential spawning and nursery habitat of Atlantic sturgeon (*Acipenser oxyrinchus oxyrinchus*) in Virginia. VIMS Special Scientific Report #145: 44 pp.

Borodin, N. 1925. Biological observations on the Atlantic sturgeon, *Acipenser sturio*.

Transactions of the American Fisheries Society 55: 184-190.

Cameron, S. 2011. Atlantic sturgeon and the James River: a status review. U.S. Army Corps of Engineers.

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.

CEDA (2011). "Underwater sound in relation to dredging". Central Dredging Association Position Paper, Prepared by the CEDA Working Group on Underwater Sound under the remit of the CEDA Environment Commission. Available at:www.dredgingtoday.org/news_details.asp.

Clarke, D., C. Dickerson, and K. Reine. 2003. Characterization of underwater sounds produced by dredges. *In* Proceedings of the Third Specialty Conference on Dredging and Dredged Material Disposal, May 5-8, 2002, Orlando, Florida.

Clarke, D. 2011. Sturgeon Protection. Dredged Material Assessment and Management Seminar. U.S. Army Corps of Engineers.

Clough, J.S., and E.C. Larson. 2010. Application of Sea-Level Rise Affecting Marshes Model (SLAMM 6) to James River NWR. U.S. Fish and Wildlife Service.

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.

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.

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.

Dadswell, M. J., B. D. Taubert, T. S. Squiers, D. Marchette, and J. Buckley. 1984. Synopsis of Biological Data on Shortnose Sturgeon, *Acipenser brevirostrum*, LeSuer 1818.

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.* 2012a. Composition of Atlantic sturgeon in rivers, estuaries and marine waters. March 2012. Report from the August 10-11, 2011 workshop on the distribution of

Atlantic sturgeon in the Northeast. US Dept of Commerce. 32pp. NMFS NERO Protected Resources Division.Available from: NMFS NERO PRD, 55 Great Republic Drive, Gloucester, MA 01930.

Damon-Randall, K. 2012b. Memorandum to the Record regarding population estimates for Atlantic sturgeon. March 7, 2012. 8 pp.

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.

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.

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.

Eckert, S.A. 1999. Global distribution of juvenile leatherback turtles. Hubbs Sea World Research Institute Technical Report 99-294.

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.

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.

Eyler, S., M. Mangold, and S. Minkkinen. 2004. Atlantic coast sturgeon tagging database. USFWS, Maryland Fishery Resources Office. Summary Report. 60 pp.

Gilbert, C.R. 1989. Atlantic and shortnose sturgeons. United States Department of Interior Biological Report 82, 28 pp.

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.

Hager, C. 2011. Atlantic sturgeon review: Gather data on reproducing subpopulation of Atlantic sturgeon in the James River. Contract EA133F10CN0317.

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.

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.

Holland, B.F., Jr., and G.F. Yelverton. 1973. Distribution and biological studies of anadromous fishes offshore North Carolina. Division of Commercial and Sports Fisheries, North Carolina Dept. of Natural and Economic Resources, Special Scientific Report No. 24. 130pp.

Intergovernmental Panel on Climate Change (IPCC). 2007. Summary for Policymakers. Cambridge University Press, Cambridge.

James, M.C., R.A. Myers, and C.A. Ottenmeyer. 2005a. Behavior of leatherback sea turtles, *Dermochelys coriacea*, during the migratory cycle. Proc. R. Soc. B, 272: 1547-1555.

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. Letters. 8: 195-201.

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.

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.

Kennebec River Resource Management Plan. 1993. Kennebec River resource management plan: balancing hydropower generation and other uses. Final Report to the Maine State Planning Office, Augusta, ME. 196 pp.

Kuo, A.Y. and B.J. Neilson. 1987. Hypoxia and salinity in Virginia estuaries. Estuarines. 10(4): 277-283.

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.

Kynard, B., M. Horgan, M. Kieffer, and D. Seibel. 2000. Habitat used by shortnose sturgeon in two Massachusetts rivers, with notes on estuarine Atlantic sturgeon: A hierarchical approach. Transactions of the American Fisheries Society 129: 487-503.

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: habitats, threats, and management. Am. Fish. Soc. Symp. 56, Bethesda, MD.

Leland, J. G., III. 1968. A survey of the sturgeon fishery of South Carolina. Bears Bluff Labs. No. 47, 27 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.

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.

Mohler, J. W. 2003. Culture manual for the Atlantic sturgeon, *Acipenser oxyrinchus oxyrinchus*. U.S. Fish and Wildlife Service, Hadley, Massachusetts. 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.

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.

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.

Musick, J.A. 2005. Essential Fish Habitat of Atlantic sturgeon in the southern Chesapeake Bay. Report to NOAA/NMFS. VIMS Special Scientific Report.

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.

Najjar, R.G., Pyke, C.R., Adams, M.B., Breitburg, D., Hershner, C., Kemp, M., Howarth, R., Mulholland, M., Paolisso, M., Secor, D., Sellner, K., Wardop, D., Wood, R. 2010. Potential climate-change impacts on the Chesapeake Bay. Estuarine, Coastal and Shelf Science. 86: 1-20.

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

NMFS Southeast Fisheries Science Center (SEFSC). 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 Northeast Fishery Science Center (NEFSC) 2012. The Cost-effectiveness of Gear Research Relative to a Closure: Pound Nets and Sea Turtles as an Example. US Dept Commer, Northeast Fish Sci Cent Ref Doc. 12-01; 25 p. Available from: National Marine Fisheries Service, 166 Water Street, Woods Hole, MA 02543-1026, or online at http://www.nefsc.noaa.gov/nefsc/publications/.

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. 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.

Olney, J.E., Watkins, B.E., Aunins, A.W., and D. Clarke. 2005. Assessing the Impacts of Channel Dredging on the Migratory Behavior of American shad (*Alosa sapidissima*). U.S Army Corps of Engineers, Engineer Research and Development Center, and the College of William and Mary, Virginia Institute of Marine Science.

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.

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.

Reine, K.J., Clarke, D., and C. Dickerson. 2010 (in progress). Suspended sediment plumes associated with open-water placement of dredged material in the Tribell Shoal reach of the James River, Virginia. U.S Army Corps of Engineers, Engineer Research and Development Center, Vicksburg, MS.

Reine, K.J., Clarke, D., and C. Dickerson. 2012. Characterization of Underwater Sounds Produced by a Hydraulic Cutterhead Dredge Fracturing Limestone Rock. DOER Technical Note Collection, TN-DOER-XXX, U.S. Army Engineer Research and Development Center, Vicksburg, MS. 17pp.

Rice. K.C., Shen, J., and B. Hong. 2010. Simulated changes in salinity in the York and James River estuaries, southeastern Virginia, USA, from projected sea-level rise in the Chesapeake Bay. American Geophysical Union, Fall Meeting.

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.

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 sub-adult Atlantic sturgeon in Connecticut waters. Transactions of the American Fisheries Society. 132: 1-8.

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.

Scott, W.B. and E.J. Crossman. 1973. Freshwater fishes of Canada. Fisheries Research Board of Canada. Bulletin 184. pp. 80-82.

Scott, W. B., and M. C. Scott. 1988. Atlantic fishes of Canada. Canadian Bulletin of Fisheries and Aquatic Science No. 219. pp. 68-71.

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: 203-216.

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. 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.

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., D. E. Marchette, and G. F. Ulrich. 1984. The Atlantic sturgeon fishery in South Carolina. North American Journal of Fisheries Management 4: 167-176.

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.

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. and J.P. Clugston. 1997. Status and management of Atlantic sturgeon, *Acipenser oxyrinchus*, in North America. Environmental Biology of Fishes 48: 335-346.

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 *Demochelys coriacea*: Are Leatherback Turtles Going Extinct? Chelonian Conservation and Biology 2(2): 209-222.

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.

Stevenson, J. T., and D. H. Secor. 1999. Age determination and growth of Hudson River Atlantic sturgeon, *Acipenser oxyrinchus*. Fishery Bulletin 97: 153-166.

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.

TEWG. 2007. An assessment of the leatherback turtle population in the Atlantic Ocean. NOAA Technical Memorandum NMFS-SEFSC-555, 116 pp.

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., 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 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.

Vladykov, V.D. and J.R. Greeley. 1963. Order Acipenseroidei. In: Fishes of Western North Atlantic. Sears Foundation. Marine Research, Yale Univ. 1 630 pp.

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.

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.

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.

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.

Witzell, W.N. 2002. Immature Atlantic loggerhead turtles (*Caretta caretta*): suggested changes to the life history model. Herpetological Review 33(4): 266-269.

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.

APPENDIX A

Preferred Inspector Qualifications

A. Basic Requirement

An upland disposal inspector must have the demonstrated ability to identify Atlantic sturgeon must be placed at the upland disposal sites; starting immediately upon project commencement to monitor for the presence of listed species and/or parts being taken or present in the vicinity of dredge operations. An inspector should be able to:

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

B. Duty Cycle

A trained observer must be at the upland disposal site during all disposal activities until the project is completed. Inspectors shall provide the required inspection coverage to provide 100% coverage of all dredge-cycles.

C. Inspection of Dredge Spoils at Disposal Site

If any whole sturgeon (alive or dead) or sturgeon parts are taken incidental to the project(s), NMFS must be contacted **within 24 hours** of the take (phone: 978-281-9328 or email (incidental.take@noaa.gov). An incident report for sturgeon take shall also be completed by the observer and sent to NMFS 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. Every incidental take (alive or dead, decomposed or fresh) must be photographed. A final report including all completed load sheets, photographs, and relevant incident reports are to be submitted to the attention of the Section 7 Coordinator, NMFS Protected Resources Division, 55 Great Republic Drive, Gloucester, MA 01930.

D. Disposition of Parts

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

APPENDIX B
ENDANGERED SPECIES OBSERVER FORM
James River Federal Navigation Project

Daily Report

Date: ______________________________
Geographic Site:____
Location: Lat/Long ____________________ Vessel Name __________________________

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

Condition of screening apparatus: ____
____
____

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

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

Observer's Name: ____
Observer's Signature: ____

Species	# of Sightings	# of Animals	Comments

Incident Report of 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 ____________________

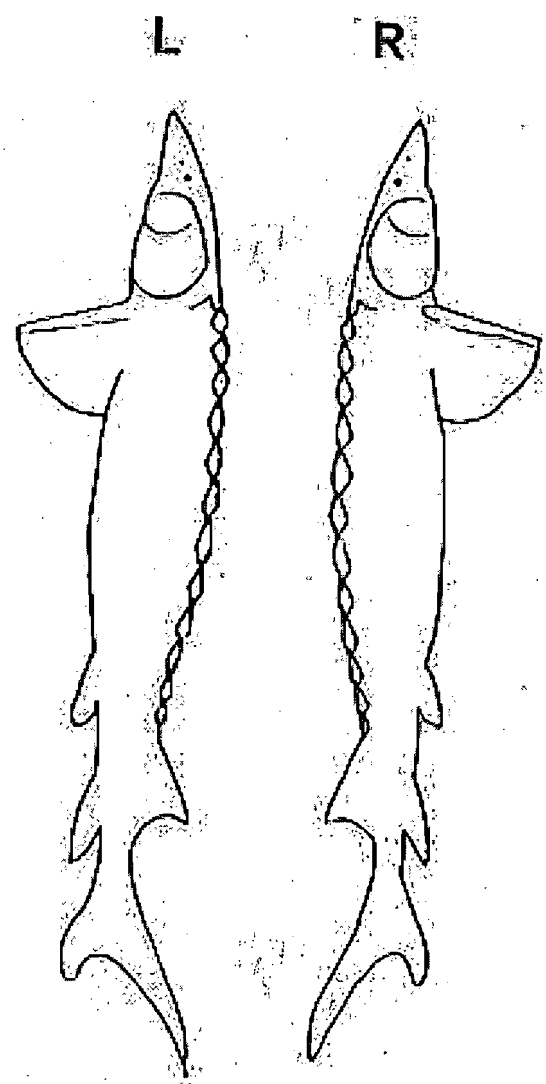
Condition of specimen/description of animal

____
____
____
____

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 C

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 D

Attach Salvage Forms

Appendix D

STURGEON 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:

____

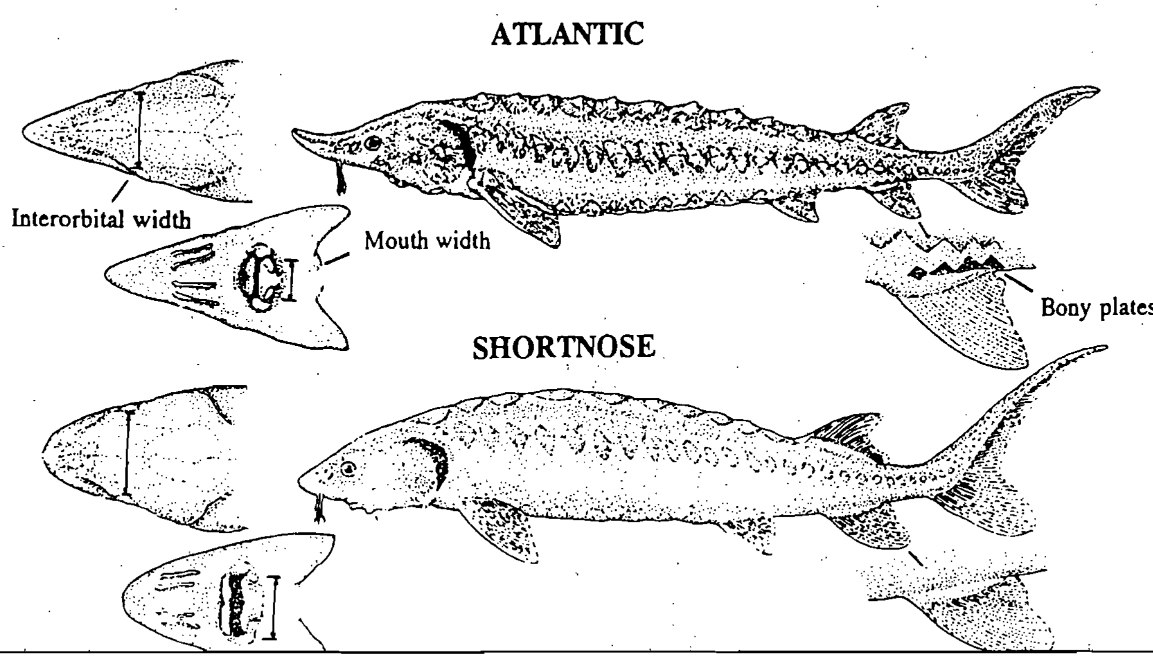
____

____

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).