NATIONAL MARINE FISHERIES SERVICE
ENDANGERED SPECIES ACT
BIOLOGICAL OPINION

Agency: Army Corps of Engineers (USACE), Norfolk District

Activity Considered: James River Federal Navigation Project
NER-2018-15090
GARFO- 2018-00105

Conducted by: National Marine Fisheries Service
Greater Atlantic Regional Fisheries Office

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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 (James River FNP) 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 FNP, correspondence with the Corps, and other sources of information. A complete administrative record of this consultation will be kept on file at the NMFS Greater Atlantic Regional Office. Formal consultation was initiated on September 20, 2018.

2.0 PROJECT HISTORY

The James River FNP 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 coastal Virginia and the port of Richmond, Virginia, and the FNP was begun to satisfy that need.

In June 2011, you informed us that you were preparing a BA for the proposed James River FNP. At that time, the listing of five Distinct Population Segments (DPSs) of Atlantic sturgeon (*Acipenser oxyrinchus oxyrinchus*) had been proposed. Although you asked to enter into Conference with us on the project, because the proposed action was not likely to jeopardize the continued existence of a proposed species or adversely modify critical habitat, conference was not necessary. Additionally, in order to promote efficiency in our interagency process, we suggested waiting until the listing was final (Atlantic sturgeon final listing date of February 6, 2012) before entering into formal section 7 consultation (resulting in a Biological Opinion and an associated Incidental Take Statement (ITS)). In March, 2012, we received your BA detailing the proposed ongoing maintenance dredging within the Federal Navigation channel, and associated disposal activities at nearby overboard and upland sites within the James River. We provided comments on the BA, requesting additional information and analysis. On April 11, 2012, a revised BA was received by NMFS. All additional information was received via email on May 16, 2012. NMFS initiated formal consultation on May 16, 2012. We issued the Biological Opinion on September 24, 2012, concluding the section 7 consultation for the duration of the action until 2062.

On August, 17, 2017, we published a final rule (50 CFR Part 226), effective September 18, 2017, designating critical habitat for all five Atlantic sturgeon DPSs. Under Section 7(a)(2) of the ESA, Federal agencies are required to ensure that any action they fund, authorize, or carry out is not likely to destroy or adversely modify designated critical habitat. Additionally, new information about Atlantic sturgeon fall spawning, juvenile presence, and vessel traffic in the James River had become available. During discussions between December, 2017 and early spring 2018, we notified you that consultation should be reinitiated, and we subsequently received a draft BA from you on June 13, 2018. After working cooperatively with us, you submitted an updated BA for the James River FNP as part of the reinitiation process for formal consultation under Section 7 of the ESA on August 30, 2018. Your BA includes an analysis of effects that considers new biological information related to Atlantic sturgeon fall spawning, juvenile presence, and critical habitat, as well as an analysis of vessel traffic that utilize the James River navigation channel as a result of its maintenance. The BA also updates the previous analysis from 2012 with the currently best available information for the species and project elements considered in 2012, where applicable. We received your final complete and adequate version of the BA on September 20, 2018. Consultation was reinitiated on September 20, 2018.

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 the areas where effects of dredging and disposal activities as well as the area transited by all project-related vessels, and vessels using the James River FNP as a result of the action (i.e., regular ship traffic within the navigation channel) will occur. The action area also encompasses all underwater areas where all effects of increased suspended sediment from dredging and disposal will occur.

Specifically, you have indicated that the action area begins at Craney Island (RM 5/RKM 8), continues through the beginning of the Federal navigation channel (RM 12/RKM 19), and up through the end of the Federal Navigation Channel from RM 90/RKM 145, to Bosher's Dam (RM 99/RKM 159) within the James River in Virginia. The action area includes 94 river miles (151 river km) of the James River. Project vessels (dredges/barges) typically navigate within the channel during active dredging. However, these vessels and tender vessels may leave the immediate vicinity of the channel for crew transfers, offloading, etc.; and the exact locations of are unknown. Additionally, pipelines will be used to transport dredged material to placement sites in river and at upland disposal sites, and their routes may vary within the river. Also, turbidity plumes are stochastic and their physical boundaries and extent of effects reach beyond dredging and disposal footprints. In order to fully consider the direct effects of the action, and indirect effects (i.e., those that may occur later in time and are reasonably certain to occur) to listed species from exposure to the action, you have calculated the action area to include 188.5 square miles of the James River from RM 5 (RKM 8) to Bosher's Dam (RM 99, RKM 159). This action area includes all direct, indirect, and interrelated/interdependent effects of dredging, material placement, turbidity plumes, and vessel transit routes.

Your vessel traffic analysis (discussed in this Opinion in section 3.2.5) indicates that regular maintenance of the federal navigation channel supports the baseline level of 35,000 vessel trips per year between the mouth of the James River and Richmond, VA (Table 4). Any vessels that enter the Port of Norfolk or Hampton Roads must travel through the Thimble Shoal and Newport News channel from the confluence of the Chesapeake Bay to the beginning of the James River federal navigation channel at RM 12. Because the maintenance dredging of the Thimble Shoal and Newport News channels and associated vessel traffic within these channels are already analyzed under a separate USACE authorization (Biological Opinion for the Chesapeake Bay Entrance Channels, 2018), the portion of the James River between the confluence of Chesapeake Bay and RM 5 (Craney Island) is not included in the action area considered in this Biological Opinion. Therefore, the effects of the James River FNP are confined to the 188.5 square miles within the James River from RM 5 to RM 99 (94 river miles).

3.1.1 Geography of the Action Area

The navigation channel within the action area is divided into three segments: lower, middle, and upper for the purposes of this consultation. While the entire Federal Navigation Channel, and all areas where disposal, increased suspended sediments, and vessel traffic occur as already noted, are included within the action area, active maintenance dredging is limited to the following shoals: 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. Rock Landing Shoal in the lower James River is not proposed for dredging. If dredging were to be proposed at this shoal again, effects of this modification to the action would need to be analyzed to determine if re-initiation of consultation was required. Disposal occurs at nearby overboard placement areas in the lower and middle segments of the action area, and will be placed at upland sites in the upper segment via pipeline. The total action area is approximately 188.5 square miles; however the total maintained channel area (approximate sum area of all shoals, which may vary seasonally according the USACE) has been calculated by us at 2.9 square miles (1.5% of the total action area). Overboard placement area totals are estimated by us at 6.1 square miles (3.2% of the total action area). As such, active dredging and overboard disposal occur in 4.7% of the action area.

The lower portion of the action area (lower segment of the river) extends from RM 5 (RKM 8) downriver of the I-664 crossing near the mouth of the river to RM 26 (RKM 42) near Hog Island. The lower segment of the James River includes Tribell Shoal (total shoal area approximately 0.28 square miles), located just east of Hog Island between RM 22 and 26 (RKM 35 and 42; Figure 1). Tribell Shoal is regularly maintained, with an approximate cycle time of 1-3 years between dredging events. The overboard placement area for Tribell Shoal is approximately 1,500 – 2,000 feet east and landward of the Federal Navigation Channel, and is 1.09 square miles. The lower segment of the James River includes the city of Newport News and the counties of Isle of Wight, James City, and Surry.

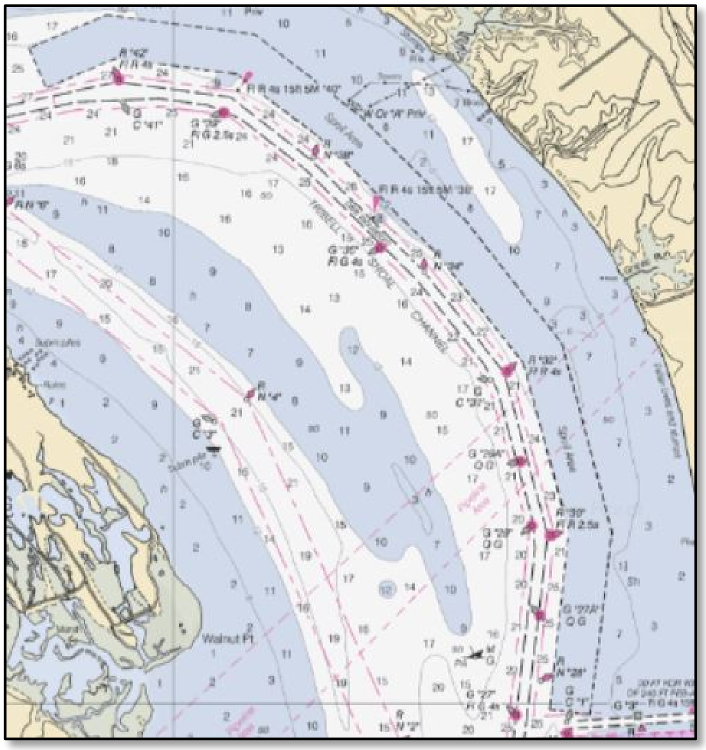


Figure 1. Tribell Shoal and overboard placement area.

The middle segment of the James River Federal Navigation Channel is located between RM 27 (RKM 43) and RM 72 (RKM 116) and includes the following shoals: Goose Hill, Dancing Point-Swann Point, Jordan Point-Harrison Bar-Windmill Point, and City Point. Goose Hill Shoal channel is located between Hog Point (RM 27, RKM 43) and Jamestown Island (RM 32, RKM 51; Figure 2) and comprises 0.32 square miles. The overboard placement area, located 2,000 feet south and east of the channel, is approximately 1.94 square miles in size. Dancing Point-Swann Point Shoal channel is located between Swann Point (RM 38; RKM 61) and Dancing Point (RM 45, RKM 72; Figure 3) and measures 0.43 square miles with overboard dredged material placement approximately 1,250 – 2,000 feet south of the Federal channel in two placement sites that are approximately 7,500 feet apart. The disposal areas total 2.18 square miles. Jordan Point-Harrison Bar-Windmill Point is located between Windmill Point (RM 59, RKM 95) and Jordan Point (RM 68, RKM 109; Figure 4), and comprises 0.50 square miles of shoal. The overboard placement area is located 1,500 feet north of the channel as two separate placement sites that are approximately 4,500 feet apart. The total area for disposal is 0.67 square miles. City Point Shoal is located between City Point and Eppes Island (RM 69 to 71, RKM 111 to 114; Figure 5), measuring 0.13 square miles, and dredged material will be placed 2,000 – 2,600 feet north of the channel at a 0.23 square mile disposal site. The middle portion of the James River is located within the counties of: Surry, Prince George, James City, Charles City, and the city of Hopewell, Virginia.

The upper segment of the James River Federal Navigation Project is located between RM 73 (RKM 116) and RM 99 (RKM 159) and includes the following shoals: Richmond Deepwater

Terminal to Hopewell (RM 73, RKM 117) Shoal channel (0.98 square miles) (Figure 6), Richmond Deepwater Terminal Turning Basin (RM 84, RKM 135; Figure 7) (0.05 square miles), and Richmond Harbor to Richmond Deepwater Terminal (RM 89; RKM 143) (0.17) and Richmond Harbor (0.004 square miles) (Figures 7 and 8). All material dredged in the upper portion of the Federal Navigation Channel will be placed at appropriate confined upland placement sites.

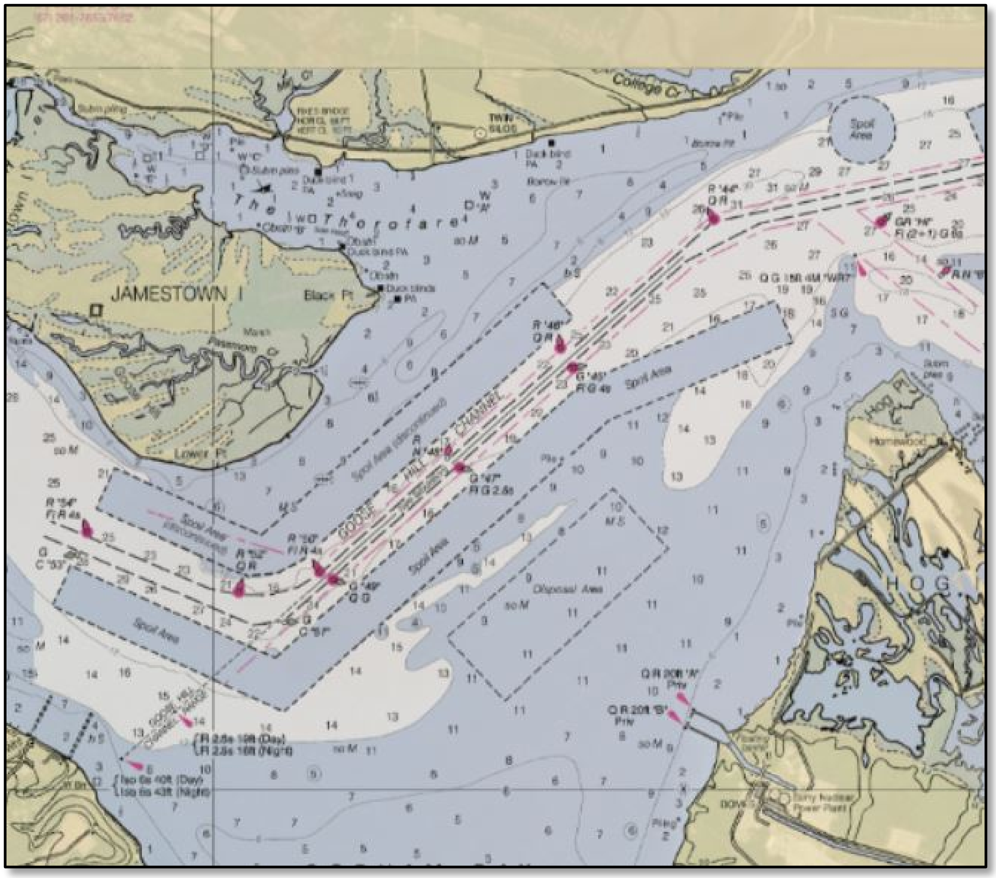


Figure 2. Goose Hill Shoal and overboard placement areas.

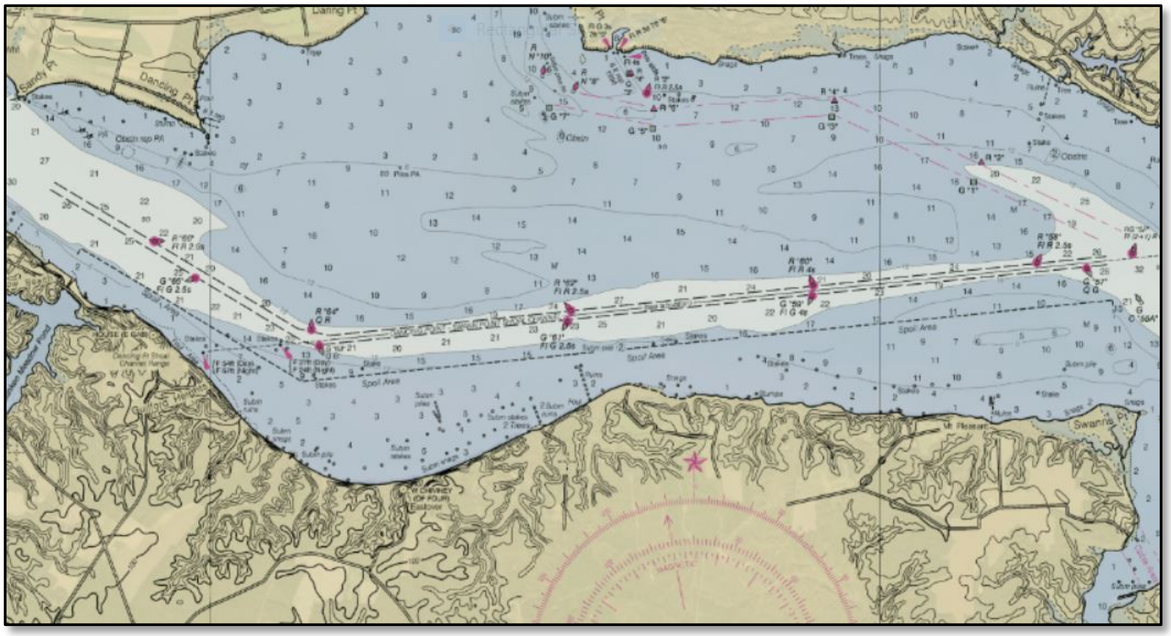


Figure 3. Dancing Point – Swann Point Shoal and overboard placement area.

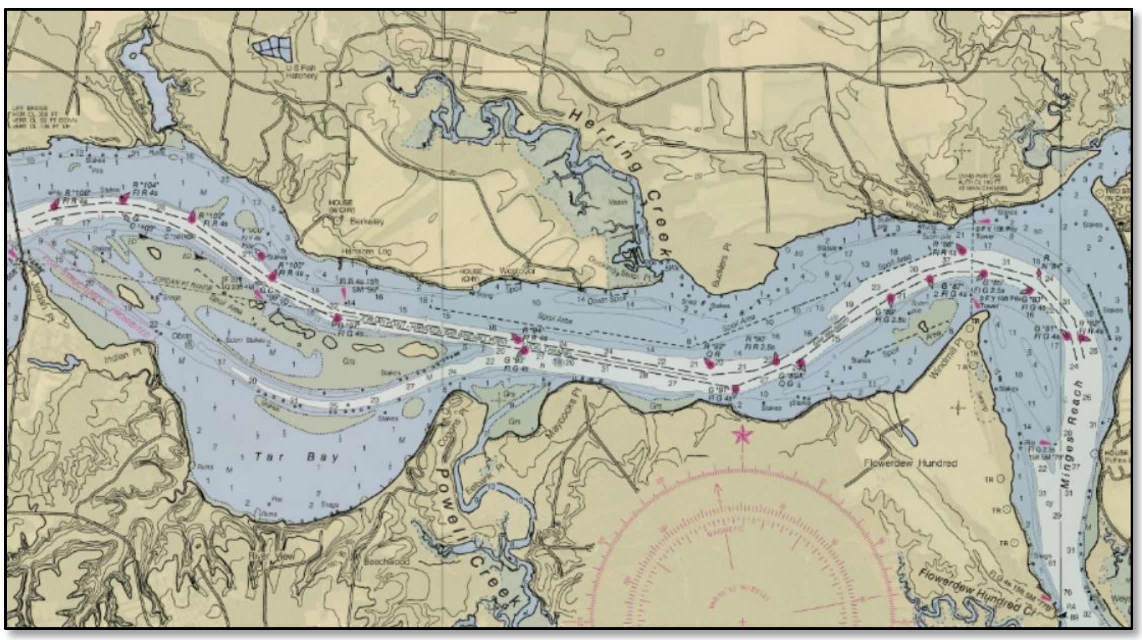


Figure 4. Jordan Point-Harrison Bar-Windmill Point and overboard placement areas.

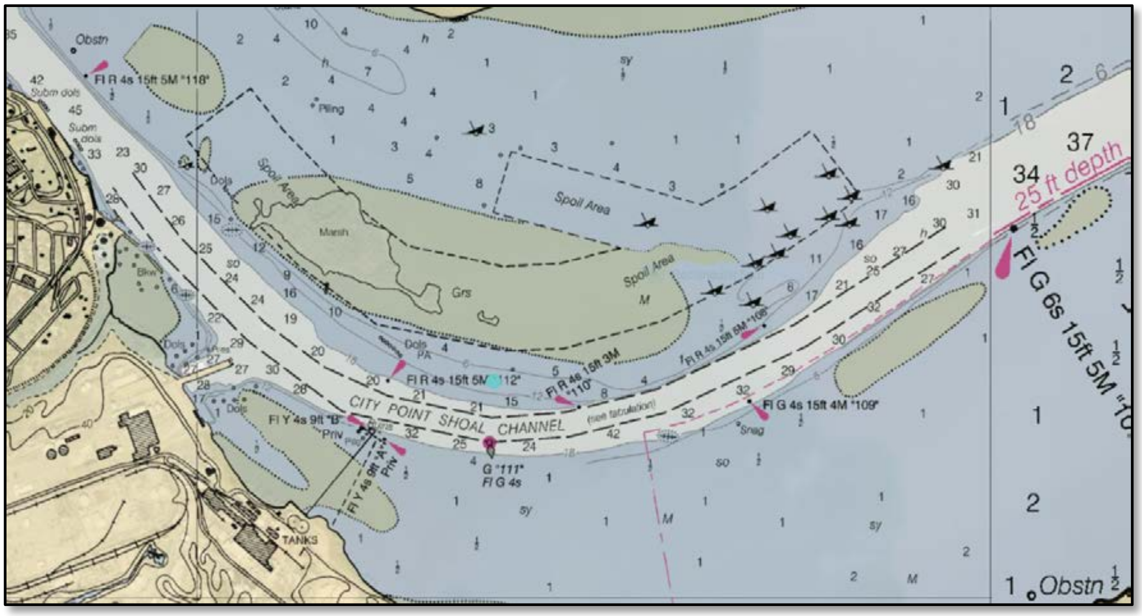


Figure 5. City Point Shoal and overboard placement area.

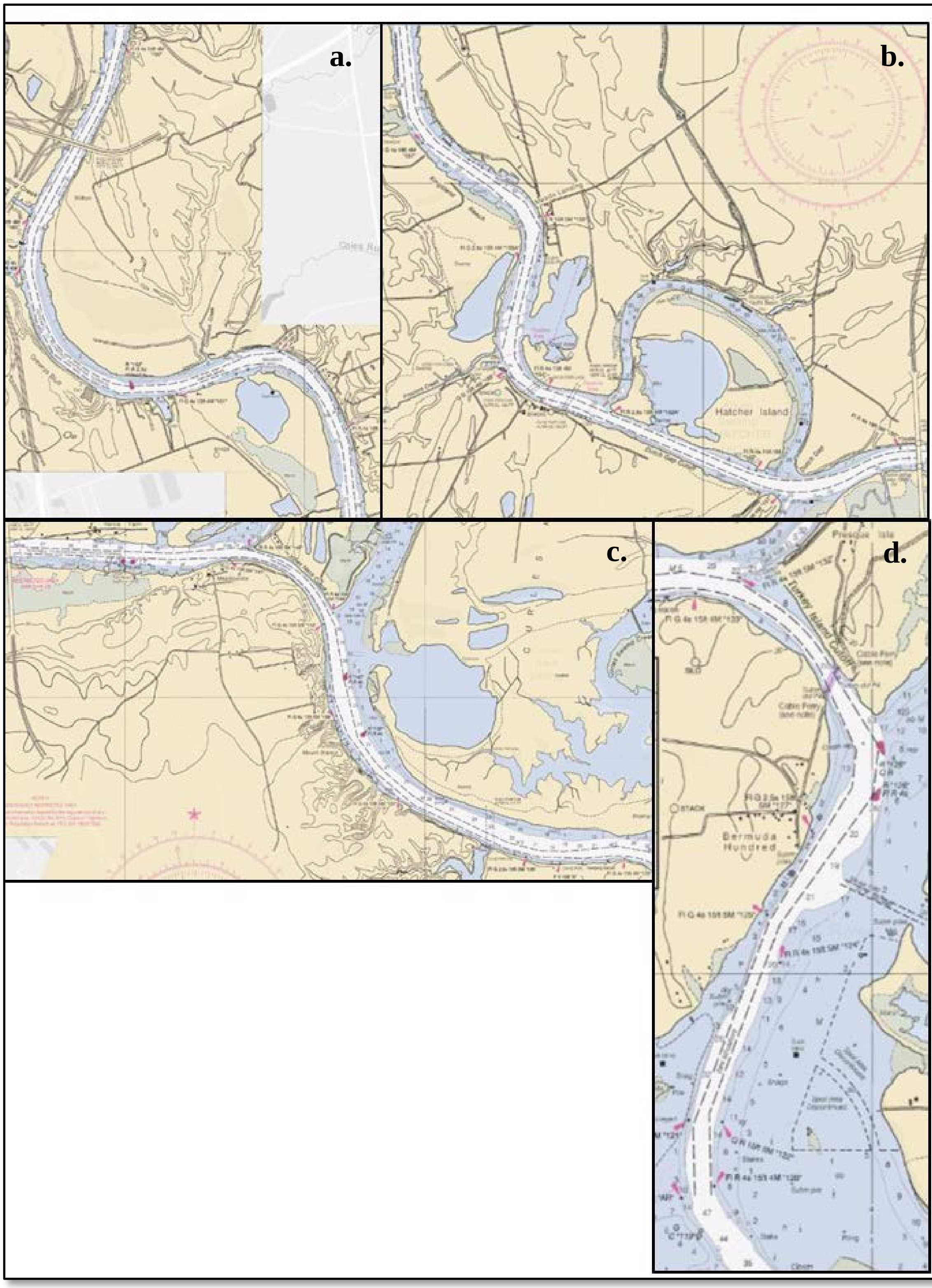
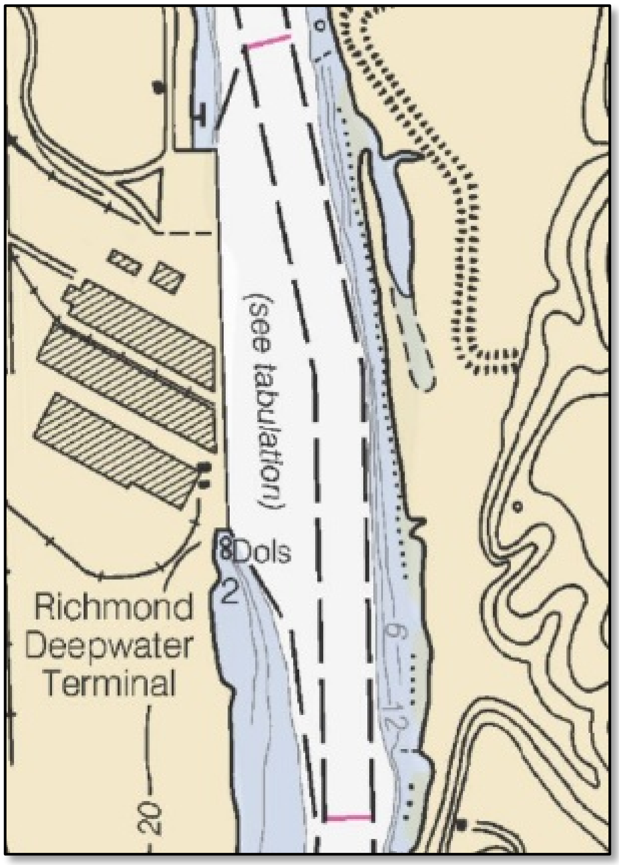


Figure 6. Richmond Deep Water Terminal to Hopewell Shoal, from upstream (a) to downstream (d).



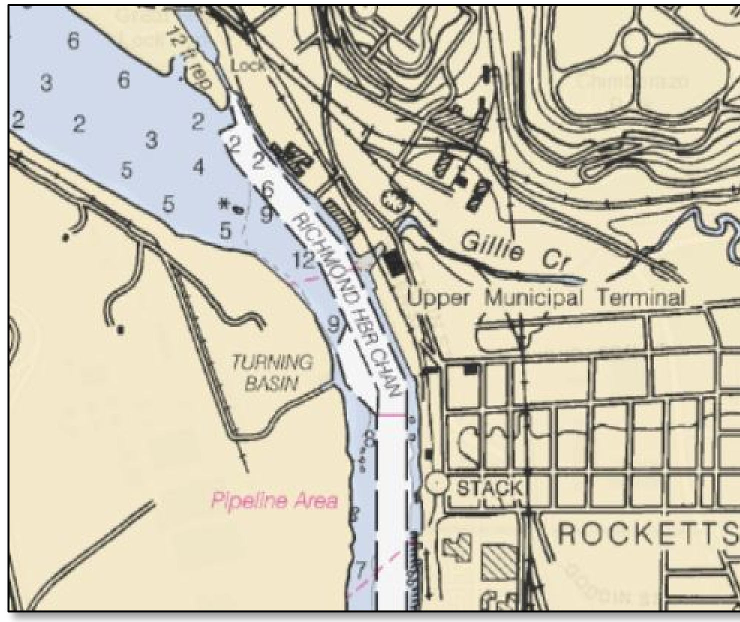


Figure 7. Richmond Deep Water Terminal and Richmond Harbor

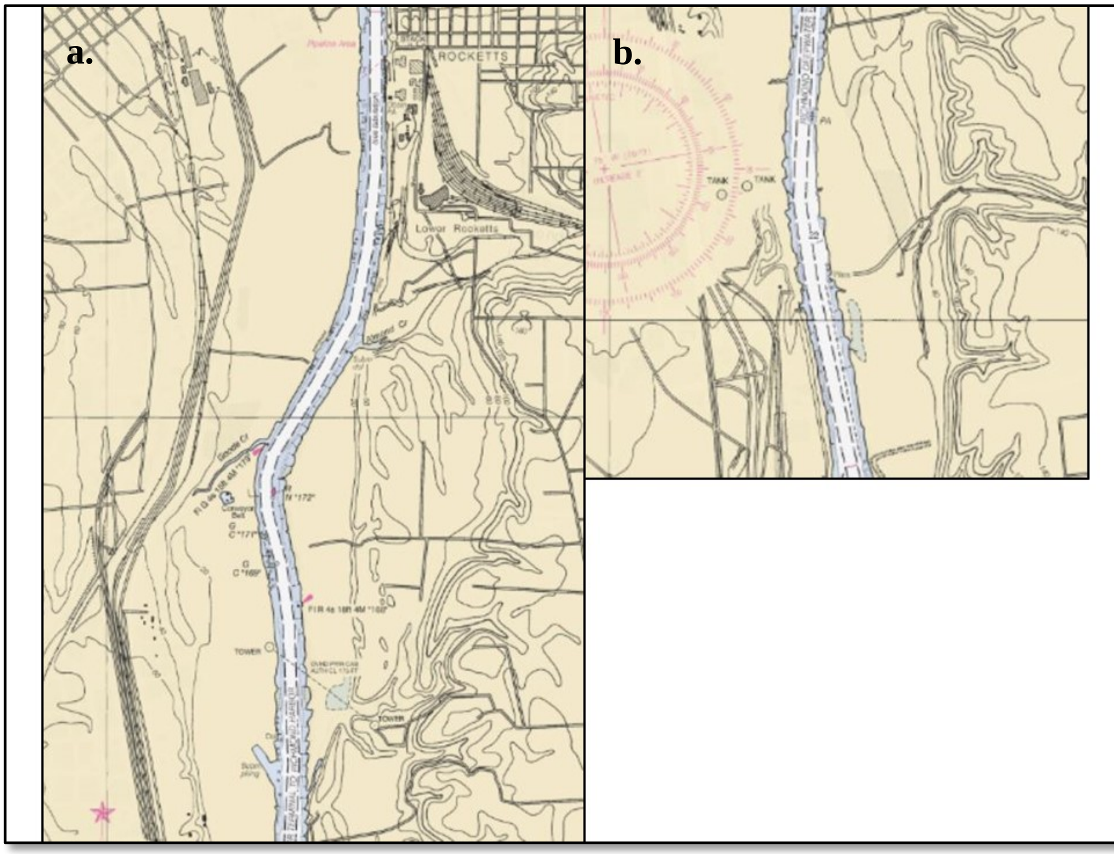


Figure 8. Richmond Deepwater Terminal Shoal from upstream (a) to downstream (b)

3.1.2 Physical Characteristics and Habitat in Action Area

The James River is a relatively shallow river with an average depth of 12 feet at mean low water, but depths may vary due to shallow flats and deep holes (-100 feet MLLW) throughout the action area. Salinity increases from close to 0 ppt at the head of the river to an average range of 18 – 21 ppt at the mouth in the summer (see Figure 9 below). The daily flushing rate of the river averages nearly 6,000 million gallons per day (MGD) (http://www.virginiaplaces.org/watersheds/waterstats.html). Large freshwater discharges in the spring may decrease salinity downriver all the way to Tribell Shoal at RM 22-26. Salinity in the middle segment of the action area ranges from approximately 5 to 14 ppt, but may be as low as 0.5 ppt depending on the position of the salt front. Salinity levels in the river are dynamic, and the salt front[1] is defined by a lower concentration of 0.25 ppt. Although the salt front can move up and downstream depending on seasonal conditions, generally speaking, in the summer and

1 The salt front in an estuary is the line between brackish water and freshwater. The location of the salt front changes with the tide cycle and the season. Daily, as the tide in the ocean rises, it brings saltier ocean water into the estuary and pushing the salt front further up the river estuary. As the tide recedes, the salt front occurs further downriver. Seasonally, higher freshwater flow (e.g., in the spring) pushes the salt front further downriver in the estuary. During times of less freshwater input (e.g., during the summer), the salt front is further upriver in the estuary.

fall, RM 47 is a reasonable approximation of the salt front location given the lack of real time data. (Chesapeake Bay Program). In the action area, RM 47 is located within the middle segment of the action area.

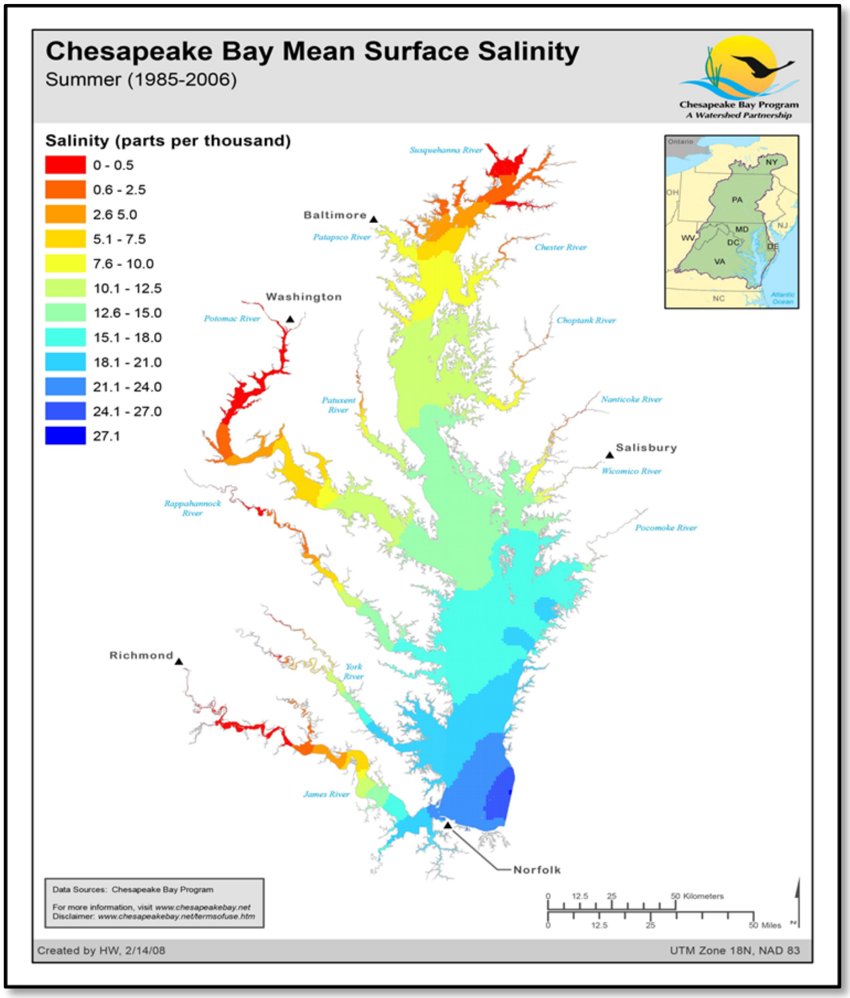


Figure 9. Mean surface salinity (ppt) in Chesapeake Bay and its tributaries.

Dissolved oxygen (DO) concentrations in the James River follow seasonal patterns and are dependent on physical and biological factors. Dissolved oxygen levels are highest in the winter, when oxygen demand is lower, and lowest in the summer, when freshwater discharge is low and both salinity and temperature are increased.

Sediment from the James River is naturally sorted as the river flows from the headwaters in the mountains down to its confluence with Chesapeake Bay. As the river flows downstream, the coarser, heavier, sandy sediments settle out of the water column first while lighter, finer grained silts travel further downstream and settle out closer to the mouth of the river. Therefore, the grain size and distribution of sediment types correspond directly with location along the downstream gradient of the river. Sediments near Richmond, in the upper portion of the river, are predominantly sand, but further downstream, closer to the mouth of the river, sediments are primarily silt and clay. Only soft sediments consisting of sand and silts/clay are found within the shoaling areas of the James River navigation channel, according to past sampling events.

Specifically, in the lower James River, Tribell Shoal consists of predominantly fine soft sediments (2% sand and 98% clay/silt). In the middle James River, shoals are composed of 27% sand and 73% silt/clay on average. Shoals in the upper James River tend to be coarser grained soft sediments consisting of 74% sand and 26% clay/silt, on average. Detailed grain size distributions for each shoal are presented in Table 1. In a study by Bilkovic (2009), results indicate that approximately 20% of the surveyed bottom in the upper river, (Richmond to Turkey Island Cutoff) consists of hard bottom, including rock, gravel, and cobble, and salinity is between 0 and 0.5 ppt. Recent surveys by the ACOE, of the maintained shoals, have indicated that while there is a very small proportion of gravel (1-2% of samples) (note: gravel is typically larger than 4.75 mm, and most of the sediment was 0.6 mm size on average (sand)) in two shoals (Richmond Deepwater Terminal to Hopewell and Richmond Deepwater Terminal), these sediments represent the underlying channel substrate captured in core sampling that obtained material from strata below the dredging prism. These deeper substrate sediments are not currently dredged during maintenance activities, nor are they exposed as a result of maintenance dredging. Finer shoal material (sands) overlay the deep channel sediments (upper 1-3.5 feet that are dredged on average during maintenance activities). Because the samples that included 1-2% of gravel, were determined to be sediment underlying the depth to which the shoals will be dredged during maintenance, no gravel or other hard bottom habitat, that could provide potential spawning habitat, is currently exposed for spawning activities, nor will this type of habitat be dredged. Generally speaking, throughout the action area, sediments sampled from the Federal Navigation Channel are smaller (average of 0.6 mm) than the sediment size required for spawning (>30 mm) (Holton and Walsh 1995). Except for the deep layer gravel underlying the maintained, soft-sediment shoals, hard bottom is not present in the maintained shoaling areas of the channel likely due to historic modifications performed from 1843 to 1937 that removed most of the hard substrate in the channel (USACE BA, 2018), and thus spawning habitat is not present within the shoaled areas proposed for dredging.

Table 1. Average sediment grain size distribution (according to the Unified Soil Classification System) for shoals in the James River taken from sediment cores.

James River Channel Shoal Name	**Avg. Grain Size Distribution of Sediment from James River Channel Shoals**			
	% Gravel (>4.75mm)	**% Sand (0.075-4.75mm)**	**% Silt (9-75 µm)**	**% Clay (<9 µm)**
Tribell Shoal	**0**	**2**	**46**	**52**
Goose Hill Shoal	**0**	**6**	**44**	**50**
Dancing Point – Swann Point Shoal	**0**	**2**	**71**	**27**
Jordan Point – Harrison Bar – Windmill Point Shoal	**0**	**9**	**61**	**30**
City Point Shoal	**0**	**91**	**6**	**3**
Richmond Deepwater Terminal to Hopewell	**1**	**74**	**16**	**9**
Richmond Deepwater Terminal	**2**	**70**	**19**	**9**

Foraging habitat and prey species in the action area are similar to those in other rivers discharging into lower Chesapeake Bay, such as the York River, where similar sediment characteristics to the James River (soft mud and sand) supports aquatic vegetation and oyster shells/cultch with a diverse assemblage of organisms, including polychaetes, crabs, clams, and mussels, among others (as reviewed in Gillet and Schaffner 2009). Additional benthic studies in the James River have demonstrated a strong correlation between salinity and benthic community diversity (as reviewed in Diaz and Schaffner 1990), where low diversity in saline waters increases to higher diversity in freshwater (Attrill 2002). As such, this information suggests that the river supports a wide array of benthic community types.

3.1.2.1 Shoal-Specific Habitat Characteristics in the Action Area

The geography of the James River plays a role in how and where shoals form. Shoals tend to have slower water flows and/or loss of hydraulic gradients. Because of this, sediments stagnate and accumulate in these areas (USACE 2000, Friedrichs 2009). Portions of the river with swift currents are typically characterized by higher rates of sediment transport through the area, which may expose underlying river bottom sediments (i.e., boulder or cobble), while lighter, fine materials are washed downstream.

Lower Segment

Tribell Shoal is located in a wide section of the James River between Jamestown Island and Mulberry Island and is characterized by broad shallows on either side of the channel. The sediment of Tribell Shoals is composed of approximately 92% brown-gray silty clay, 7% clayey silty sand, and 1% sandy clay (Holton et al. 2000b). The benthic prey community supported by this shoal includes bivalves, crustaceans, and polychaetes that are tolerant to mesohaline waters.

Middle Segment

Goose Hill Shoal is an area dominated by sediment accretion rather than erosion and consists of approximately 74% silty clay substrate and 26% fine to coarse sand, silty sand, clayey sand, clayey silt, sandy silt, and organic peat (Holton et al. 2000a). Dancing Point – Swann Point Shoal consists of approximately 87% sandy clay or silty clay, with 13% fine sand, silty sand, or clayey sand (Holton et al. 2002b). The Jordan Point – Harrison Bar – Windmill Point (JPWP) Shoal includes a wider variety of sediment types with some shell and organic matter (peat) distributed within the sediment. The dominant substrate types for this shoal are silty sands (31.6%) and silty clays (26.3%), while the remaining material is an equal assemblage of sand, clayey silt, and clay, with a small amount of sandy silty clay, clayey sand, and peat (Holton et al. 2003). The sediment at City Point Shoal is composed of 50.5% fine sand, 16.2% silty sand or clayey sand, 30.3% clays, and 3% silts (Holton et al. 2002a). There is a sediment grain size gradient in City Point Shoal, with coarser sediments in the upriver portion of the shoal and a decrease in grain size moving toward the downriver portion of the shoal. City Point Shoal contains some areas of naturally deep water of up to -43 feet MLLW. The benthic prey community in the middle segment of the action area consists of bivalves, crustaceans, and polychaetes that are tolerant to oligohaline to mesohaline waters.

Upper Segment

On average, approximately 74% of the total sediment from the Richmond Deepwater Terminal to Hopewell Shoal consists of medium and fine grained sands, with medium grained sand as the dominant sediment type. The remaining 26% of sediment type includes a mix of silts and clays (24.4%) and approximately 1.6% gravel above the salt wedge (WS&E, Ltd. 2004, USACE 2005, USACE 2010). There is no hard bottom or cobble habitat within the shoals proposed for dredging. The Richmond Deepwater Terminal Shoal, which includes the Port of Richmond, the berthing area, and the turning basin, consists predominantly of fine grained sand (approximately 79%) (WS&E, Ltd. 2004). Upriver of the Richmond Deepwater Terminal Shoal, the sediments consist of 75 - 90% fine to medium grained sands, with less than 8% coarse grained sand. The majority of the remaining is silt (7 - 15%), with some gravel (1-2%) and clay (<6%). As mentioned, during sampling efforts in the actual shoals in the upper river segment, no hard bottom or cobble habitat was sampled except for the 1-2% gravel in the core samples which was determined, during sampling, to be underlying sediments that are neither dredged nor exposed during maintenance dredging activities. The benthic prey community supported by shoals in the upper James River includes bivalves, crustaceans, and polychaetes that are tolerant to oligohaline waters.

3.1.2.2 Overboard Placement Area Habitat

Overboard placement areas are generally shallow (0 to -20 feet MLLW) with soft-sediment bottoms. Compared to regularly dredged shoals within the Federal navigation channel, overboard placement areas are low energy and relatively stable, though physical attributes of the general area near the shoal are similar (water flow, hydraulic gradients, salinity, sediment transport rates). Benthic prey communities supported by overboard placement areas support bivalves, crustaceans, and polychaetes that are tolerant to similar salinities as those found in nearby shoals.

3.2 Proposed Action

3.2.1 Scope of the Action

The James River FNP is necessary to maintain the navigation channel within the river from Craney Island to Richmond, VA. Approximately 1 to 1.5 million cubic yards (MCY) of shoaled sediments will be removed annually from the James River navigation channel via maintenance dredging with hydraulic cutterhead dredges. The volume of dredged material removed from each shoal will vary depending on shoaling rates and frequency of dredging. The estimated volumes of material removed from each shoal and average dredging cycle frequencies are presented in Table 2. Shoaled portions of the channel may be dredged to authorized maximum allowable depths of -28 feet MLLW where applicable. This depth includes required depths, paid allowable depths, and non-pay depths. Regular dredging activities are subject to the availability of federal funding over the next 44 years until 2062.

Table 2. Estimated average maintenance dredging volumes (cubic yards, CY) and dredging cycle frequencies.

Location	Average CY Dredged	Dredging Frequency	Area (square miles)	Depth of Channel (MLLW) (feet)	Dates of Last Dredging
Tribell Shoal	250,000	1.5-3 years	0.28	25 (authorized up to -35)	12/6/17-1/11/18
Goose Hill Shoal	338,000	2-3 years	0.32	25 (authorized up to -35)	1/10/17-2/14/17
Dancing Point-Swann Point Shoal	471,000	2 x a year	0.43	25 (authorized up to -35)	1/12/18-2/7/18
Jordan Point-Harrison Bar-Windmill Point Shoal	339,000	1-3 years	0.50	25 (authorized up to -35)	1/29/15-2/1/15
City Point Shoal	138,000	10-15 years	0.13	25 (authorized up to -35)	1/8/01-1/27/01
Richmond Deepwater Terminal to Hopewell Shoal	243,000	1-3 years	0.98	25 (authorized up to -35)	10/9/11-1/7/12
Richmond Deepwater Terminal Shoal	146,000	1-3 years	0.05	25 (authorized up to -35)	10/22/2016 – 11/21/2016
Richmond Harbor to Richmond Deepwater Terminal Shoal	**	**	0.17	18 (authorized to -18)	4/7/1949 – 6/3/1949
Richmond Harbor Shoal	97,000	2-8 years	0.004	18 (authorized to -18)	4/7/1949-6/3/1949

** Richmond Harbor to Richmond Deepwater Terminal Shoal is naturally deep water (-18 to -27 feet MLLW) and has not been dredged in recent years because commercial usage has not justified maintenance of this shoal. However, this channel may be dredged in the future if usage patterns or shoaling conditions change.

3.2.2 Dredging

Hydraulic cutterhead dredges are used for maintenance dredging in the James River. A cutterhead dredge is essentially a barge hull with a moveable rotating cutter apparatus surrounding the intake of a suction pipe (Taylor 1990). By combining mechanical cutting action with hydraulic suction, the hydraulic cutterhead dredge has the capability of efficiently dredging a wide range of material, including clay, silt, sand, and gravel. These dredges are capable of pumping certain types of material through as much as 5 – 6 miles of pipeline, although up to 3 miles is more typical. The dredge plant uses spud configurations to "walk" up the channel while dredging and typically advances several hundred feet per day depending on site conditions. The dredge plant is mobilized to dredging locations under assistance of tender vessels.

Hydraulic cutterhead dredges used on the James River are generally small, with a typical pipe diameter of approximately 16 – 20 inches, though a maximum width of 36 inches is possible. The average bank height, or the height of the dredge cut, varies from shoal to shoal. The bank height is also influenced by the amount of sediment that has accreted, the sediment load volume and rate in the James River, and the time between each dredging cycle. In general, the average bank height ranges from approximately 1 feet to 3.5 feet. In general cutterhead dredge plumes range to approximately 1,000 feet radius predominantly within the bottom 6 feet of the water column (USACE 1983). Increased levels of total suspended solids (TSS) ranges from 11.5 to 282 mg/l with highest concentrations closest to the dredge head and dissipation occurring rapidly with distance (Nightingale and Simenstad 2001).

In lower Chesapeake Bay, several Federal navigation channels are located within areas of previous and current military activities, and unexploded ordinances (UXO) have been encountered. In contrast to some of the lower Chesapeake Bay channels, the James River FNP is not located in or near an area of concern for UXO, there is no history of UXO usage or presence, and as such, there is no reason to believe that any UXO will be encountered during the proposed action. Because of this, no UXO screening will be used on the cutterhead dredging equipment for this action.

3.2.3 Disposal Activities

All dredged material from the James River FNP will be placed overboard in adjacent sediment placement areas to channel shoals or in nearby diked upland sites along the shoreline of the river. Diked upland sites have no pathways to effects back into the James River (i.e., contaminants or turbidity). Table 3 summarizes disposal activities for each shoal along the length of the James River. Overboard placement areas are generally shallow (0 – 20 feet deep) with soft-sediment bottoms and are adjacent to maintained shoals. An energy-dissipating device, such as a baffle plate or diffuser, will be installed on the end of the discharge pipe and discharges occur a minimum of 3 feet below the water surface at authorized overboard placement areas to help minimize turbidity. A submerged or combination floating/submerged pipeline will transport dredged material to confined upland placement areas. Disposal activities occur concurrently with dredging at the same frequencies and during the same time frames.

Two tracking studies in the James River (USACE at Goose Hill Shoal 2005 and Tribell Shoal 2010) have presented varying turbidity levels in placement areas based on sediment grain size. All studies were performed with a baffle plate installed at the end of the discharge pipe at the overboard placement area, to mimic how disposal activities are conducted for the action. Although these two shoals are adjacent to each other, sediment types vary. At Tribell Shoal sediments are very silty, while Goose Hill Shoal has more sand present. The study at Goose Hill Shoal determined that small to medium plumes (246 – 328 feet wide) dissipated within 656 feet of the pipe (Holton et al. 2000). The TSS measured 400 to 550 mg/l at a distance of 65 to 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). The shoals in the lower and middle part of the James River tend to contain more silty sediments than shoals in the upper James River. Coarser materials are not re-suspended to the same extent that fine materials are, so it is reasonable to expect that plumes would cover less area in the upper reaches of the river compared with the lower river.

The USACE has also initiated near-field and far-field fate modeling of overboard dredged material placement operations in the middle James River at Dancing Point – Swann Point Shoal Channel. Modeling suggests that 2 - 7% of the total solids remain in suspension from overboard placement operations. The near-field source area impacted by suspended sediments involves an area contained to a distance of approximately 1,000 feet downstream with a horizontal spread of approximately 262 feet (Lackey, pers. comm.). The mass fraction remaining in the water column after 5 hours was estimated to be 1.5% of the total solids or a TSS concentration ranging from 40 to 100 mg/l depending on the meteorological and hydrodynamic conditions. Far-field modeling of the middle James River at Dancing Point – Swann Point Shoal Channel indicates the maximum depth of deposited material outside of the authorized placement area was 0.5 cm (Lackey, pers. comm.). Using the best available information in order to conservatively estimate turbidity impacts from disposal activities, we assume the worst case scenario of plumes extending a maximum of 1,000 feet downstream, with a horizontal spread of up to 300 feet from discharge pipes, and up to 0.5 cm of accumulated material may temporarily be present during disposal activities before natural flushing in the river washes sediment downstream.

Table 3. Approximate area of overboard and confined upland placement areas.

Location	Placement Area Type	Placement Area (square miles)	Water Depth (MLLW) (feet)
Tribell Shoal	Overboard	1.09	-8 to-20
Goose Hill Shoal	Overboard	1.94	-10 to -20
Dancing Point-Swann Point Shoal	Overboard	2.18	-3 to -18
Jordan Point-Harrison Bar-Windmill Point Shoal	Overboard	0.67	-7 to -14
City Point Shoal	Overboard	0.23	0 to -5
Turkey Island Cut-off CDF	Upland	0.04	NA
Jones Neck CDF	Upland	0.06	NA
Hatcher Island CDF	Upland	0.02	NA
Willis Road CDF	Upland	0.04	NA
Richmond Deepwater Terminal CDF	Upland	0.08	NA
Richmond Harbor CDF	Upland	0.05	NA

3.2.4 Vessel Traffic

For most dredging events the dredging contract requires one work barge, 2-3 tender vessels, and a survey vessel. The tender vessels mobilize the dredge plant to the dredging locations, and typically maintain speeds of 3 – 5 knots. Once at the dredging site, the dredge plant uses spud configurations to "walk" up the channel while dredging, and typically advances several hundred feet per day depending on site conditions. More than one shoal may be dredged under a single contract, but dredging is sequenced by priority based on navigation concerns, shoaling rates, etc., and only one shoal is dredged at a time. The dredging contract period, itself, depends on funding, availability, dredging needs, and dredge plant availability. Dredging may occur up to 7 days per week, and dredges are typically actively dredging 18 of every 24-hour period. Dredging may last between 14 to 60 days. See Table 2.

3.2.5 Interrelated and Interdependent Vessel Traffic

Interrelated activities are defined as those that are part of the proposed action and depend on the proposed action for their justification. An interdependent activity is defined as an activity that has no independent utility apart from the action. The usage of the James River navigation channel by non-project related vessel traffic is interdependent and interrelated to the proposed maintenance dredging of the channels, as described above.

Commercial, fishing, and recreational vessels use the channels regularly. The total number of trips of all vessel types with drafts of 1 – 38 feet using the James River from the mouth, at Hampton Roads, to Richmond from 2012 – 2016 remained relatively stable at approximately 35,000 (Table 4). The analysis of vessel trips includes areas of the James River near Hampton Roads and the port of Norfolk that are not part of the action area for the James River FNP (See Section 3.1). The action area for the James River FNP begins at RM 5 at Craney Island, but vessel activity in the lower James River, included in the vessel traffic data analysis section of the BA, is covered by the 2018 Biological Opinion on the Chesapeake Bay Entrance Channels, and thus is not included in the action area for this project, as previously discussed. The vessel analysis indicates that deep draft tanker and cargo vessels with 40+ foot drafts do not pass Craney Island into the James River navigation channel (Figures 10 and 11). An average of four cargo and tanker vessels with over 30 foot drafts passed into the federal navigation channel annually from 2012 to 2016, and an average of 44 vessels with drafts between 20 and 30 feet passed annually during that same time frame (Table 5). The majority of the trips reported in the James River were made by vessels with drafts <10 feet (mean = 34,573), with vessels between 10 and 20 foot drafts making an average of 232 trips per year (Table 5). The data also indicates that most of the reported trips were made by self-propelled dry cargo vessels (Table 6).

Table 4. Annual trip reports in the James River from the mouth to Richmond from 2012 through 2016, including upbound, downbound, and total trips. (Data Source: Waterborne Commerce Statistics Center)

Trips	2012	2013	2014	2015	2016
Upbound	18,156	17,157	17,637	16,556	17,477
Downbound	18,149	17,476	17,583	16,574	17,501
Total	36,305	34,633	35,220	33,130	34,978

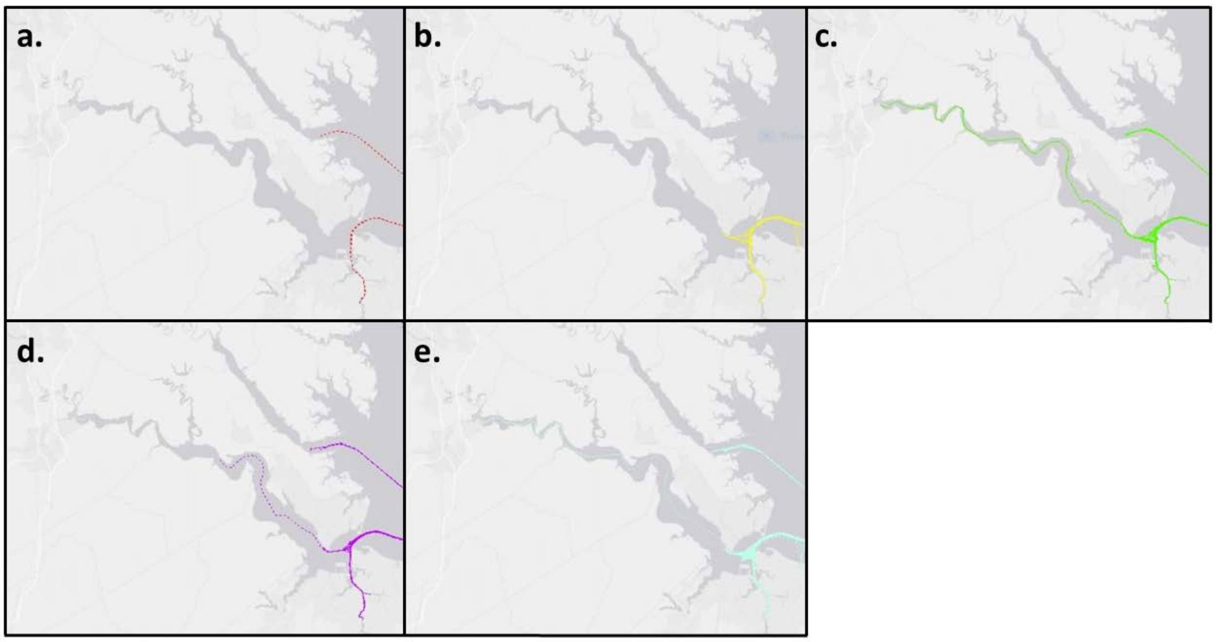


Figure 10. Traffic of tanker vessels in the James River with drafts: a) ≥ 45, b) ≥40 and <45, c) ≥35 and <40, d) ≥30 and <35, and e) <30 feet.

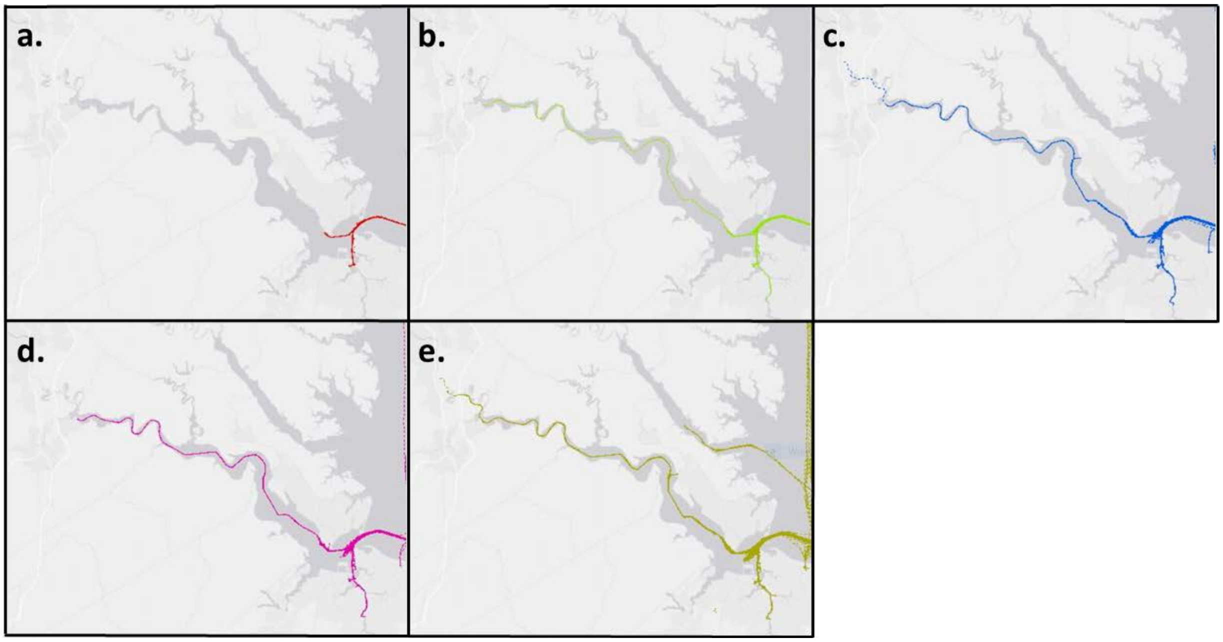


Figure 11. Traffic of cargo vessels in the James River with drafts: a) ≥ 45, b) ≥40 and <45, c) ≥35 and <40, d) ≥30 and <35, and e) <30 feet.

Table 5. Total annual trip reports from 2012 through 2016 by vessel draft. (Data Source: Waterborne Commerce Statistics Center)

Draft (feet)	2012	2013	2014	2015	2016
≤10	35998	34278	34954	32876	34759
>10 - ≤20	263	310	216	210	164
>20 - ≤30	44	43	48	39	47
>30	0	2	2	5	8

Table 6. Total annual trips by vessel type from 2012 through 2016. (Data Source: Waterborne Commerce Statistics Center)

Vessel type	2012	2013	2014	2015	2016
Self-propelled dry cargo	33643	32449	32502	30987	32816
Self-propelled tanker	4	2	10	12	9
Self-propelled towboat	959	661	787	606	348
Non-self-propelled dry cargo	1471	1257	1576	1220	1229
Non-self-propelled tanker	228	264	345	305	276

Although there was a slight increase in the number of trips made by deeper draft vessels (between 30 and 40 feet) in the James River from 2012 through 2016 (0 in 2012, 2 in 2013, and 8 in 2016), this is not directly correlated to continued maintenance dredging activities in the James River navigation channel, where proposed dredging depths and activities have remained stable over many years, with no proposed channel deepening or widening. Because some smaller vessels have been retired in recent years and replaced by larger vessels (Port Authority pers comm.with USACE) that may be used more diversely and efficiently (i.e., options to carry large loads *or* smaller capacity loads when needed), the increase in larger vessel usage may not be related to a greater need for deeper draft tankers, but rather indicative of versatile usage of available vessels to transport goods to Richmond.

In conclusion, the total number of trips reported in the James River has been relatively stable at approximately 35,000 trips per year from 2012 through 2016. As such, the continued maintenance of the James River navigation channel is not expected to increase vessel usage of the channel above baseline levels for the duration of the action (until 2062) nor can it be correlated to any changes in the size of vessels using the channel.

3.2.6 Maintenance Dredging and Disposal Timelines

Maintenance dredging in the James River typically occurs from July 1 to February 14 in any given year. The duration of dredging in each shoal may vary from days to several weeks to months depending on the volume of material that needs removal and funding constraints at the time of dredging. Historically, maintenance dredging has also occurred outside the time of year restrictions for anadromous fishes, which is currently from February 15 through June 30, in the James River above the Route 17 crossing, during emergency shoaling events. If emergency dredging is necessary, reinitiation of consultation may be required. The time of year restriction of February 15 through June 30 overlaps with migrating Atlantic sturgeon moving upstream for spring spawning, which typically may occur between March and June, with larvae present through July, thus limiting the chance of effects to spring spawned early life stages (ELS). This time of year also overlaps with fall spawning adults moving into the lower James River to stage, as well as with sub-adults, and juvenile fish. Although state resource agencies are recommending a new time of year restriction for in-stream work above the Route 17 crossing for fall spawning and migration (August 1 through November 15, with larvae potentially present through December), this restriction has not been observed by dredging operations in the Federal channel because you say this would impede the ability of the USACE to maintain safe navigation in the James River. Because juveniles sturgeon are expected within the river year round, and subadults, adults, and early life stages spawned in the fall will be present during dredging operations, the USACE has proposed a combination of time of year restrictions and best management practices will be used to minimize effects to the species present within the James River.

3.2.7 Best Management Practices

A number of Best Management Practices (BMPs) have been proposed as part of the action to minimize effects to listed species.

- NMFS will be contacted three days prior to the commencement of any dredging operations to ensure all appropriate reporting forms will be used and to notify NMFS about the beginning and ending of dredging operations for each contract.

- To minimize the risk of entrainment during dredging operations, small diameter (16 – 20 inch, maximum 36 inch) cutterheads will be used for the maintenance dredging of the channels. No hopper dredges are proposed for usage.
- Dissolved oxygen levels will be monitored in the upper James River from July 1st through October 31st during dredging activities. If ambient DO concentrations fall below 5 mg/l, the Virginia Department of Environmental Quality (VADEQ) will be notified. If ambient DO concentrations fall below 4 mg/l, dredging will be suspended until DO concentrations rise above 5 mg/l. Monitoring is not required by VADEQ during November through June 30 based on prior data showing that DO levels remain above 5 mg/l.
- Time of year restrictions are currently observed to the maximum extent practicable through state coordination with the Coastal Zone Management Act (CZMA) approved Coastal Program. Restrictions protecting anadromous fishes during migration and spawning periods are from February 15 through June 30 at this time.
- To minimize impacts to water quality to the maximum extent practicable, maintenance dredging activities will use an energy-dissipating device (e.g., baffle plate or diffuser) secured at the end of the dredge pipe for overboard placement activities with discharge occurring a minimum of 3 feet below the water surface to minimize turbidity and sediment resuspension from dredged material discharge operations.
- Any incidental takes of ESA species by dredging operations within the action area will be reported to NMFS' Protected Resources Division within 24 hours and will follow all protocols put forth in the Biological Opinion, including all Reasonable and Prudent Measures (RPMs) and Terms and Conditions (T&C). Any sturgeon captures, injuries, or mortalities associated with maintenance activities must be reported to NMFS' Protected Resources Division within 24 hours.

4.0 STATUS OF LISTED SPECIES AND CRITICAL HABITAT IN THE ACTION AREA

Several species listed under our jurisdiction occur in the action area for this consultation. While listed whales occur seasonally off the coast of Virginia and occasional transient right whales and fin whales have been documented within Chesapeake Bay, no ESA listed whales are known to occur in the action area. As such, no whale species will be further discussed in this Opinion.

We have determined that the action being considered in this biological opinion may affect the following endangered or threatened species and critical habitat under our 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
South Atlantic DPS of Atlantic sturgeon	Endangered
Carolina DPS of Atlantic sturgeon	Endangered

We have also determined that the proposed action being considered in this Opinion is not likely to adversely affect the following species: Northwest Atlantic (NWA) DPS[2] of Loggerhead sea turtles (*Caretta caretta*), Kemp's Ridley sea turtles (*Lepidochelys kempii*), North Atlantic (NA) DPS[3] of Green sea turtle (*Chelonia mydas*), hawksbill sea turtles (*Eretmochelys imbricata*), leatherback sea turtles (*Dermochelys coriacea*), or shortnose sturgeon (*Acipenser brevirostrum*), all of which, except Loggerhead and Green sea turtles (threatened), are listed as endangered under the ESA. We have also determined that the proposed action being considered in this Opinion is not likely to adversely affect the James River Unit of the designated critical habitat for the Chesapeake Bay DPS of Atlantic sturgeon. The following discussions are our rationale for these determinations.

4.1 Species and Critical Habitat Not Likely to be Adversely Affected by the Proposed Action

4.1.1 Sea Turtles

Sea turtles are expected to be in the Chesapeake Bay during warmer months, typically from April through late November, with the highest concentrations of sea turtles present from June – October. The sea turtles in Virginia waters are typically small juveniles with the most abundant species being the NWA DPS of loggerhead sea turtle followed closely by the Kemp's ridley sea turtles. Loggerhead turtles are primarily carnivorous and graze on mollusks and crustaceans, whereas Kemp's ridley are omnivorous but feed on swimming crabs and other crustaceans, predominantly. The NA DPS of green sea turtles are present and leatherback sea turtles also occur, albeit less frequently, in the Chesapeake Bay during the same timeframe. Juvenile green sea turtles tend to be carnivorous, but more mature individuals also consume vascular sea grass. Green sea turtles transition as adults to fully herbivorous and graze on marine grasses and algae. Conversely, the leatherback sea turtle is a specialized feeder preying primarily upon jellyfish. Hawksbill sea turtles are rarely found as far north as the action area. Detailed information concerning the individual species life histories, distributions and biological requirements for each species of sea turtle can be found on the NOAA office of Protected Resources webpage at http://www.nmfs.noaa.gov/pr/species/turtles/index.html and is incorporated here by reference.

4.1.1.1 Sea Turtle Presence in the Action Area

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), and may also occur in lower portions of the action area, which begins at RM 5 in the James River. While the lower James River near the confluence of Chesapeake Bay supports marine and estuarine habitat similar to the mainstem Chesapeake Bay (i.e., similar salinity (Figure 9), tidal flushing, shellfish habitat, etc.), the action area (at RM 5), supports salinities of approximately 21 to 24 ppt, and at Tribell Shoal (the furthest downstream shoal to be dredged at approximately RM 22) has salinities that range between 5-10 ppt (Figure 9). The bank-to-bank width in this section of the

[1] NWA DPS = Northwest Atlantic DPS, the only loggerhead sea turtle DPS expected to occur in the action area.
[2] The North Atlantic DPS is the only green sea turtle DPS expected to occur in the action area.

James River varies from approximately 3 to 6 miles. Because of this rapid decline in salinity, the primary forage base for sea turtles, including 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, become less abundant than they are in predominantly marine habitats. As such, we assume sea turtles are transient in the action area, opportunistically foraging and resting where appropriate forage and habitat exist in the lower portion of the James River.

4.1.1.2 Effects of the Action on Sea Turtles

Sea turtles in the action area can be exposed to effects of the proposed action including vessel traffic and increased turbidity/suspended sediment (which may affect prey). Sea turtles can also be exposed to dredging activities in the lower portion of the James River at Tribell Shoal if they move upstream to opportunistically forage near the shoal during maintenance dredging operations.

Hydraulic cutterhead dredges are used on the James River and are generally small, with a typical pipe diameter of approximately 16 – 20 inches (maximum 36 inches). A cutterhead dredge operates with the dredge head buried in the sediment; however, a flow field is produced by the suction of the operating dredge head. The amount of suction produced is dependent on linear flow rates inside the pipe and the pipe diameter (Clausner and Jones 2004). High flow rates and larger pipes create greater suction velocities and wider flow fields. The suction produced decreases exponentially with distance from the dredge head (Boysen and Hoover 2009). With a cutterhead dredge, material is pumped directly from the dredged area to a disposal site.

Sea turtles are not known to be vulnerable to entrainment in cutterhead dredges. Because of their size and swimming ability, they may escape the intake velocity near a cutterhead dredge while it is in operation. There are no records of any sea turtles being entrained in cutterhead dredges in the Chesapeake Bay or anywhere else at this time. Based on the available information, we do not anticipate any entrainment of sea turtles from cutterhead dredge operation in the action area, and thus any effects are extremely unlikely to occur and are discountable.

Suspended sediments from dredging and disposal are most likely to affect sea turtles if a plume causes a barrier to normal behaviors (e.g., migration, resting, or foraging). As sea turtles are highly mobile, individuals present in the action area are likely to avoid any sediment plumes that are temporary, discrete, and localized in nature. Since sediment plumes related to dredging and disposal will only temporarily occupy small portions of the action area, any minor and short-lived disruption of normal patterns of sea turtle movement or behavior that result from avoidance of the sediment plumes are expected to be so small they cannot be meaningfully measured or detected. Additionally, because dredging and disposal disrupt benthic habitat where sea turtles may opportunistically forage, both activities can indirectly affect sea turtles by altering the existing biotic assemblages in the action area and reducing prey availability. Prey items for sea turtles vary and include sessile infaunal organisms and sea grasses, as well as mobile crustaceans, etc. Previous studies in the upper Chesapeake Bay demonstrated rapid recovery and resettlement by benthic biota and similar biomass and species diversity to pre-dredging conditions within several seasons (Johnston 1981; Diaz 1994). Similar studies in the lower portions of the Chesapeake Bay produced rapid resettlement of dredging and placement areas by infauna (Sherk 1972). McCauley et al. (1977) observed that, while infaunal populations declined significantly immediately after dredging, infauna at dredging and placement areas recovered to pre-dredging and placement site conditions within 28 and 14 days, respectively. Based on this information effects to benthic communities are anticipated to be short term, and rapid recovery and resettlement of benthic species is expected.

Additionally, the only dredging and placement area in the action area where sea turtles are likely to be present at is Tribell Shoal (located between RM 22 and 26, with salinities of 5-10 ppt). Based on salinity values, preferred foraging items, listed above, within the actual dredge and disposal footprints is likely of low quantity. Although sea turtles could travel further upstream, the next shoal is in even lower salinity waters (2-5 ppt) where preferred prey will be even scarcer. The shoal and placement areas at Tribell shoal represent 0.28 square miles and 1.09 square miles for dredging and disposal, respectively, within a 21 mile long portion of the action area (RM 5 to RM 26), varying between 3 and 6 miles wide. Based on this analysis, while there will be a small reduction in sea turtle prey due to dredging and disposal in the lower James River, any effects to foraging sea turtles will be too small to be meaningfully measured, detected, or evaluated and are, therefore, insignificant. Because leatherback sea turtles feed primarily on pelagic jellyfish, no impacts to their prey base is expected from benthic habitat disturbance via dredging and disposal.

Although little is known about how sea turtles react to vessel traffic, it is generally assumed that turtles are more likely to avoid injury from slower-moving vessels than fast moving ones, since the turtle has more time to maneuver and move out of the way of impact. Dredges maintain speeds between 3 and 5 knots within the action area, and while on site, the dredge spuds into the substrate to “walk up” the dredge cut at even slower speeds. Tender vessels and crew boats may also be in the action area (total of 5 vessels, inclusive of dredge, per maintenance dredging event). These vessels tend to be smaller than the dredge. Shoals are not concurrently dredged, and as such, only one dredge vessel and associated vessels are added temporarily, at a time, to the baseline vessel traffic within the action area while project activities occur for several days to months. Vessel traffic in the action area is high to begin with, and as previously discussed in Section 3.2.5, continued maintenance of the federal navigation channel will not cause increased vessel traffic above baseline levels. The USACE has conservatively estimated that 5 vessels per shoal (approximately four times per year) are added temporarily to the baseline in the action area as a result of the James River FNP, before their subsequent removal from the baseline again. These 5 vessels (over approximately four events) will make trips that represent a very small proportion of the 35,000 vessel trips per year that travel the James River with no permanent increase or shift in traffic patterns due to their temporary and intermittent nature. As such, the addition of these vessels to the baseline has an insignificant effect on the risk of interactions between sea turtles and vessels in the action area.

4.1.2 Shortnose Sturgeon

Shortnose sturgeon are benthic fish that occur in large coastal rivers of eastern North America. They range from as far south as the St. Johns River, Florida (possibly extirpated from this system) to as far north as the Minas Basin, Nova Scotia, Canada. The species is anadromous in the southern portion of its range (i.e., south of Chesapeake Bay), while some northern populations may be amphidromous. In Chesapeake Bay, shortnose sturgeon have most often been found in Maryland waters of the mainstem bay and tidal tributaries such as the Susquehanna, Potomac, and Rappahannock Rivers (Spells 1998; Litwiler 2001; Kynard et al. 2007, 2009; SSSRT 2010). Spells (1998), Skjeveland et al. (2000), and Welsh et al. (2002) all reported one capture each of adult shortnose sturgeon in the Rappahannock River. Documented recent use of Virginia waters of Chesapeake Bay is currently limited to two individual shortnose sturgeon: one captured in 2016 (Balazik, 2017) and a second sturgeon (a confirmed gravid female) caught in 2018 in the James River (Balazik, pers comm).

These captures of adults are the only records of shortnose sturgeon in the Virginia portion of the Chesapeake Bay at this time. Given that the species has historically been observed in the Maryland waters of the upper Chesapeake Bay and the proposed action occurs wholly within the James River where only two adult fish have been observed, the best available information indicates that shortnose sturgeon are rare transients in the James River and further, the action area does not serve as any type of aggregation or overwintering area, as far as can be understood from existing data. That said, if transient adult shortnose sturgeon are present during dredging and disposal activities, they are not subject to impingement or entrainment in cutterhead dredges, because similar to adult Atlantic sturgeon (discussed later in this Opinion) and sea turtles, their size and swimming ability allow them to escape the intake velocity of cutterhead dredges (Clarke 2011). Because of this, direct effects to transient adult shortnose sturgeon from cutterhead dredging are extremely unlikely to occur and are therefore discountable.

Additionally, turbidity effects to adults, if present, are extremely unlikely to occur, as turbidity levels related to dredging and disposal are estimated to be between 11 and 550 mg/l, which ranges below the levels that may elicit a reaction in adult fish (580 to 1,000 mg/l; Burton 1993), such as shortnose sturgeon. All direct effects of turbidity are therefore discountable. While some temporary loss and effects to benthic foraging habitat may occur, no permanent changes in habitat type are expected, and only a small portion of benthic habitat will be disturbed at any one time, since dredging of shoals is not completed concurrently. Furthermore, a total of 4.7% of the action area will experience habitat effects from dredging, disposal, and the associated turbidity, leaving over 95% of the action area available for opportunistic foraging. As such, any effects to shortnose sturgeon by way of habitat disturbance will be too small to be meaningfully detected and all effects are insignificant.

As discussed above in the section on sea turtles, tender vessels and crew boats may be in the action area in addition to the dredge (total of 5 vessels, inclusive of dredge, per maintenance event) during each maintenance dredging event. These vessels tend to be smaller than the dredge. Shoals are not concurrently dredged, and as such, only one dredge vessel and associated vessels are added temporarily, at a time, to the baseline vessel traffic within the action area while project activities occur for several days to weeks to months. Vessel traffic in the action area is high to begin with, and as previously discussed in Section 3.2.5, continued maintenance of the federal navigation channel will not cause an increase in vessel traffic above baseline levels. The USACE has conservatively estimated that 5 vessels per shoal (approximately four times per year) are added temporarily to the baseline in the action area as a result of the James River FNP, before their subsequent removal from the baseline again. These 5 vessels (over approximately four events) will make trips that represent a very small proportion of the 35,000 vessel trips per year that travel the James River with no permanent increase or shift in traffic patterns due to their temporary and intermittent nature. As such, the addition of these vessels to the baseline has an insignificant effect on the risk of interactions between adult shortnose sturgeon and vessels in the action area.

4.1.3 Atlantic Sturgeon Critical Habitat

On August 17, 2017, we issued a final rule to designate critical habitat for the threatened Gulf of Maine DPS of Atlantic sturgeon, the endangered New York Bight DPS of Atlantic sturgeon, the endangered Chesapeake Bay DPS of Atlantic sturgeon, the endangered Carolina DPS of Atlantic sturgeon, and the endangered South Atlantic DPS of Atlantic sturgeon (82 FR 39160).
The rule became effective on September 18, 2017. The conservation objective identified in the final rule for the designation is to increase the abundance of each DPS by facilitating increased successful reproduction and recruitment to the marine environment. We designated five critical habitat units to achieve this objective for the Chesapeake Bay DPS: (1) Potomac River from the Little Falls Dam downstream to where the main stem river discharges at its mouth into the Chesapeake Bay; (2) Rappahannock River from the U.S. Highway 1 Bridge, downstream to where the river discharges at its mouth into Chesapeake Bay; (3) York River from its confluence with the Mattaponi and Pamunkey rivers downstream to where the main stem river discharges at its mouth into Chesapeake Bay as well as the waters of the Mattaponi River from its confluence with the York River and upstream to the Virginia State Route 360 Brige of the Mattaponi River, and waters of the Pamunkey River from its confluence with the York River and upstream to the Nelson's Bridge Road Route 615 crossing of the Pamunkey River; (4) James River from Boshers Dam downstream to where the main stem river discharges at its mouth into Chesapeake Bay at Hampton Roads; and (5) Nanticoke River from the Maryland State Route 313 Bridge crossing near Sharptown, MD to where the main stem discharges at its mouth into Chesapeake Bay as well as Marshyhope Creek from its confluence with the Nanticoke River and upriver to the Maryland State Route 318 Bridge crossing near Federalsburg, MD. In total, these designations encompass approximately 773 kilometers (480 miles) of aquatic habitat.

The action area overlaps with the James River Critical Habitat Unit (Figure 12). This critical habitat unit has been calculated in GIS at approximately 166 square miles, which spans almost the entire size of the action area (188.5 square miles). As identified in the final rule, the physical and biological features (PBFs) that are essential to the conservation of the species and that may require special management considerations or protection are:

1) Hard bottom substrate (e.g., rock, cobble, gravel, limestone, boulder, etc.) in low salinity waters (i.e., 0.0 to 0.5 parts per thousand (ppt) range) for settlement of fertilized eggs, refuge, growth, and development of early life stages;
2) Aquatic habitat with a gradual downstream salinity gradient of 0.5 up to as high as 30 ppt and soft substrate (e.g., sand, mud) between the river mouth and spawning sites for juvenile foraging and physiological development;
3) Water of appropriate depth and absent physical barriers to passage (e.g., locks, dams, thermal plumes, turbidity, sound, reservoirs, gear, etc.) between the river mouth and spawning sites necessary to support:
   (i) Unimpeded movement of adults to and from spawning sites;
   (ii) Seasonal and physiologically dependent movement of juvenile Atlantic sturgeon to appropriate salinity zones within the river estuary; and
   (iii) Staging, resting, or holding of subadults or spawning condition adults.

   Water depths in main river channels must also be deep enough (e.g., at least 1.2 m) to ensure continuous flow in the main channel at all times when any sturgeon life stage would be in the river.

4) Water, between the river mouth and spawning sites, especially in the bottom meter of the water column, with the temperature, salinity, and oxygen values that, combined, support:
   (i) Spawning;
   (ii) Annual and interannual adult, subadult, larval, and juvenile survival; and
   (iii) Larval, juvenile, and subadult growth, development, and recruitment (*e.g.*,13 °C to 26 °C for spawning habitat and no more than 30 °C for juvenile rearing habitat, and 6 milligrams per liter (mg/L) dissolved oxygen (DO) or greater for juvenile rearing habitat).

As discussed in the description of the action, the James River has been divided into lower, middle, and upper segments for the purposes of dredging schedules and analysis in this Opinion. All four PBFs are located in the action area; however we have also determined which PBFs are present within each segment. The lower segment (RM 5-RM 26) is characterized by silty bottoms and salinity ranges between 5 and 24 ppt, thus early life stages are not present due to their need for fresh (0-0.5 ppt) waters. As such, PBF 1 is absent in this segment of the action area, but PBFs 2, 3, and 4 are present. The middle segment of the action area runs from RM 27-RM 72 and is characterized by a mix of sand and silty soft sediment benthic habitat with low salinities ranging from 0.5 to 14 ppt. Although spawning habitat has not been identified in the channel or placement areas, based on benthic analyses discussed in section 3.1.2 and 3.1.2.1, suitable spring spawning habitat is thought to exist in the James River between RM 56 and 60 (inclusive of the middle segment of the action area), and fall spawning habitat between RM 65 and 96 (GARFO Tables) (inclusive of middle and upper segment), where appropriate hard bottom habitat is located. Because hard bottom habitat has been identified in the portion of the river that constitutes the middle segment, all four PBFs are present because of the mix of both hard and soft benthic habitat types, as well as freshwater, and salinity gradients from 0.5 ppt and above. The upper segment of the action area runs from RM 73-RM 99 and is characterized by low salinity (0-0.5 ppt) and sandy substrates. Hard bottom substrate has not been identified in the dredge footprints within the channel (Section 3.1.2.1) and all disposal is limited to upland sites. However, this segment of the river overlaps with potential fall spawning habitat in areas where hard substrate has been identified in the Turkey Island Cutoff to Richmond span of the James River (inclusive of the upper segment defined for this action) (Bilkovic 2009). Because of the lack of a salinity gradient with levels between 0.5 and 30 ppt, PBF 2 is not present, but PBF 1, 3, and 4 have been identified within this segment of the action area.

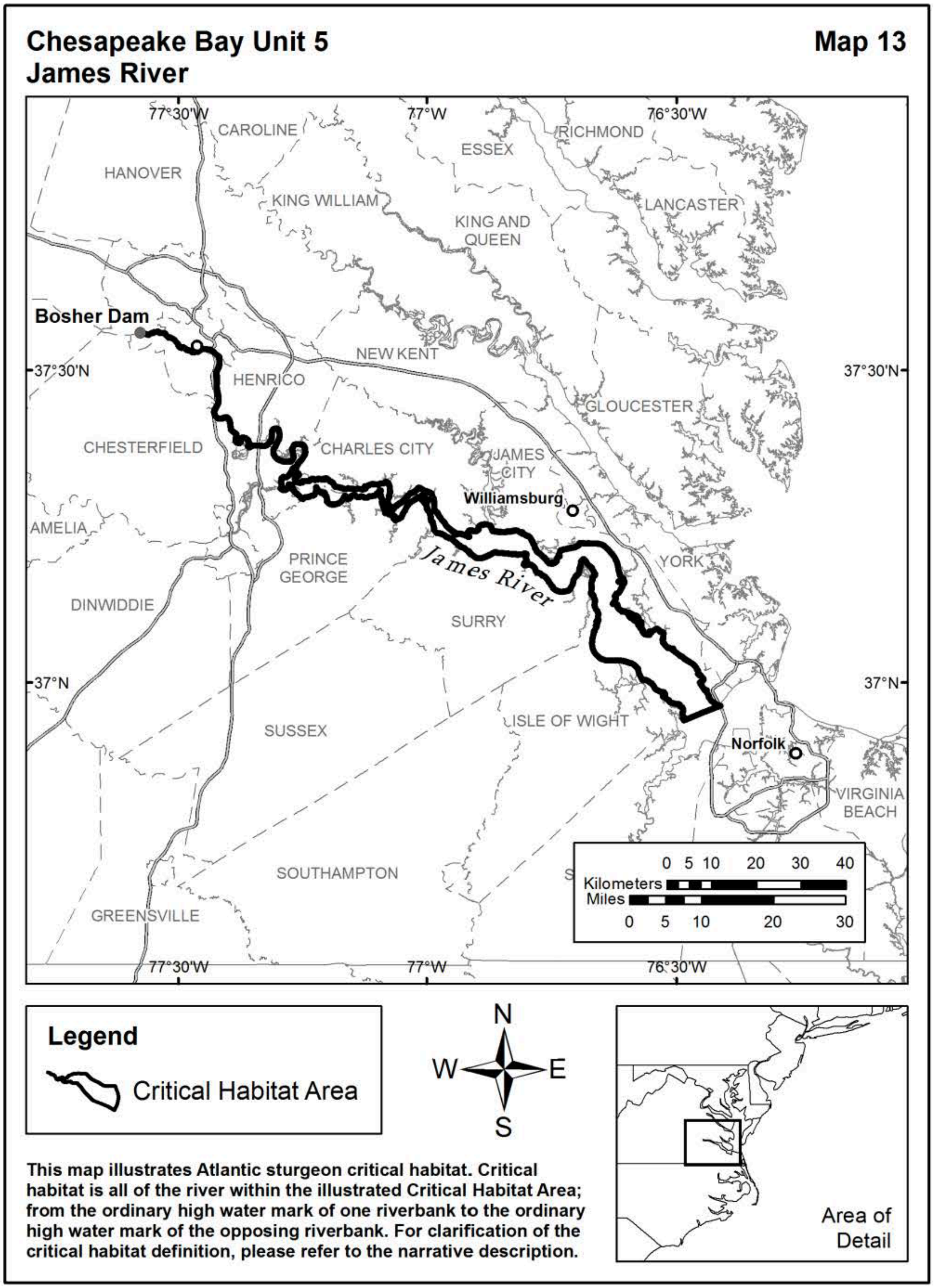


Figure 12. Critical habitat designation for the Chesapeake Bay DPS of Atlantic sturgeon within the James River (NOAA 2017).

We have analyzed the potential impacts of the proposed action on this designated critical habitat, inclusive of the four PBFs present that have been deemed essential to the conservation of the species and which may require special management considerations or protections. For each PBF, we identify those activities that may affect the PBF. For each feature that may be affected by the action, we then determine whether any effects to the feature are adverse, insignificant, discountable, or entirely beneficial. In making this determination, we consider the action's potential to affect how each PBF supports Atlantic sturgeon's conservation needs in the action area. Part of this analysis is consideration of whether the action will have effects on the ability of Atlantic sturgeon to access the feature, temporarily or permanently, and consideration of the effect of the action on the action area's ability to develop the feature over time. We have determined that the effects to these PBFs from the proposed action will be insignificant or discountable for the following reasons.

PBF 1: Hard bottom substrate in low salinity waters for the development of eggs and larvae

In considering effects to PBF 1, we consider whether the proposed action will have any effect on areas of hard bottom substrate, including rock, cobble, gravel, limestone, and boulder in low salinity waters, which are needed for adult Atlantic sturgeon to successfully spawn, and necessary for the survival and recruitment of eggs and yolk-sac larvae. Within the action area, PBF 1 is present within the middle and upper segments of the river within the action area between approximately RM 56 and 96, where spring and fall spawning is thought to occur based on river flow, appropriate salinity levels, and presence of hard bottom habitat (GARFO tables). Salinity levels in the river are dynamic, and the salt front[4] is defined by a lower concentration (0.25 ppt) than the salinity cutoff level between PBF 1 and 2 (0.5 ppt). Although the salt front can move up and downstream depending on seasonal conditions, generally speaking, in the summer and fall, RM 47 is a reasonable approximation of the salt front location given the lack of real time data and the very small difference we would expect between the area where salinity is 0.5 ppt and 0.25 ppt. In the action area, RM 47 is located within the middle segment of the action area, thus, where hard bottom habitat is present in waters between 0 and 0.5 ppt salinity, PBF 1 is present.

The James River navigation channel is proposed for maintenance dredging, but not deepening. Only 1 to 3.5 feet of material will be removed on an intermittent basis according to natural shoaling events in the river, where the channel is maintained at -25 feet and authorized to -35 feet. Ross et al. (2015) stated that dredging in the Delaware River (i.e., increased depth to -45 feet) has not significantly influenced long-term salinity trends (statistical models did not detect a significant salinity trend in the area following completed deepening), and as such we do not

4 The salt front in an estuary is the line between brackish water and freshwater. The location of the salt front changes with the tide cycle and the season. Daily, as the tide in the ocean rises, it brings saltier ocean water into the estuary and pushing the salt front further up the river estuary. As the tide recedes, the salt front occurs further downriver. Seasonally, higher freshwater flow (e.g., in the spring) pushes the salt front further downriver in the estuary. During times of less freshwater input (e.g., during the summer), the salt front is further upriver in the estuary.

expect salinity regimes to change in the James because of maintenance dredging. While we do expect salt water intrusion further into the James River over time due to climate change, the relative effects of dredging on salinity levels and location (spatial and temporal), in addition to baseline conditions, will be too small to be meaningfully measured or detected, and we expect low salinity waters to remain available for spawning sturgeon and early life stages (ELS) now and in the future.

According to Bilkovic et al. (2009), approximately 20% of the surveyed bottom habitat in the upper and middle James River segments of the action area, from Richmond downstream to the Turkey Island Cutoff (~RM 66), is hard bottom. However, based on the information presented in 3.1.2 characterizing shoals in the middle and upper segments of the action area where spawning may occur, the dredging and disposal areas do not contain any hard bottom substrate to support spawning. As such, no direct removal of hard bottom habitat supporting potential spawning will occur. Increased levels of suspended sediments as a result of dredging, disposal, or vessel traffic may temporarily occur in nearby areas (up to 1,000 feet from dredge cuts and 300 feet from overboard placement areas), and those areas may or may not contain hard bottom substrate. At this time, we do not know the exact locations of hard bottom habitat in the vicinity of the dredging and disposal areas. The USACE has indicated in their near and far field studies within the James River between 2005 and 2010 (discussed in the BA), within five hours of dredging only 1.5% of sediment remained suspended within 1,000 feet of the dredging areas, and 2-7% of solids remained downstream of the overboard placement areas. This information indicates that sediments flush out of the system relatively quickly even though shoal areas tend to have slower rates of water flow or loss of hydraulic gradients, causing sediments to stagnate and accumulate (USACE 2000, Friedrichs 2009). Generally speaking, portions of the river with swift currents and high hydraulic gradients are typically characterized by higher rates of sediment transport through the area, moving lighter, fine materials downstream, and exposing underlying, heavier river bottom sediments (i.e., gravel, boulder or cobble). In the James River, where shoals and adjacent overboard placement areas are located, flushing is occurring according to the studies by the USACE; however the very presence of shoals indicates these areas tend to trap sediments. Additionally, no evidence of significant hydraulic shifts in river flow contained within the localized shoaling and overboard placement sites exists based on the USACE studies examining TSS. The natural river morphology and flow dictates whether hard bottom habitat is maintained as clear and open. As such the presence of hard bottom habitat in the immediate vicinity (up to 1,000 feet away) of the shoaling sites is unlikely.

Regardless, because soft sediment typically scours around hard cobble substrate (hard substrate provides 3-dimensional relief for sediments to drift around), sediments are unlikely to stick to these surfaces if present. With an average flushing rate in the James River of close to 6,000 mgd, a substantial amount of sediment is moved daily in some portions of the river. In other areas of the river (i.e., shoals), sediment moves at a relative slower rate or is trapped, hence the formation of the shoal. Downstream of these shoals, flows may again move unobstructed, which maintains the high flushing rate in the river. During dredging operations, the channel is being cleared of obstructions (i.e. accumulated sediments), and the overall high flushing rate of the James River minimizes and quickly disperses finer grained sediments from dredging and disposal plumes downstream (Clarke and Wilber 2000). This decreases long-term impacts to the benthos in any habitat, including hard bottom (if present) located near dredging and disposal areas, if present. Following this logic, any sedimentation caused by vessels would also be temporary and localized. Thus, the effects of increased turbidity are short-lived, intermittent, and may only temporarily affect the hard bottom habitat, supporting early life stages, if present within the reach of turbidity plumes from dredging or disposal. The action will not prevent the feature from developing over time for the same reasons. In conclusion, any effects to the value of PBF 1 to the conservation of the species in the action area would be too small to be detected, and are therefore insignificant.

PBF 2: Transitional salinity zone with soft substrate for juvenile foraging and physiological development

In considering effects to PBF 2, we consider whether the proposed action will have any effect on soft substrate habitat used for juvenile foraging and physiological development, located within transitional salinity zones (0.5 to 30 ppt) between spawning sites and the river mouth. In order to successfully complete their physiological development, Atlantic sturgeon must have access to a gradual gradient of salinity from freshwater to saltwater. Atlantic sturgeon move along this gradient as their tolerance to increased salinity develops with age. PBF 2 is ubiquitous throughout the middle and lower segments of the James River below the salt front, which is located at approximately RM 47. We have calculated that the action area overlaps with approximately 127 square miles of PBF 2 in the James River critical habitat unit (Figure 13).

Dredging and in-water disposal within shoals and adjacent placement areas will temporarily disturb the soft substrate component of PBF 2 in the action area. PBF 2 spans roughly 127 square miles within the action area, but only a total of 1.03 square miles will be disturbed in the shoaled areas via dredging, and 5.21 square miles by disposal activities, on an intermittent basis, in non-contiguous habitat. We do not anticipate that the dredging and disposal will result in a permanent change in the type of substrate. However, dredging and disposal footprints will result in temporary reductions in the availability of benthic habitat, and the forage base contained therein, for a total dredge and disposal footprint of 6.24 square miles of PBF 2 within the 127 square miles of PBF 2 that overlaps with the action area. These areas may be disturbed for 18 out of 24 hours, for between 14 and 60 days, on an average of every 1 to 3 years, non-concurrently (i.e., only one shoal is dredged at a time). Dredging will temporarily remove sturgeon foraging habitat and may entrain prey, and placement areas will be covered with sediments via disposal activities and benthic prey may be temporarily buried and some proportion of prey may suffocate. This may temporarily reduce to the value of PBF to the conservation of the species in these affected areas. Additionally, dredging and disposal activities will temporarily create turbidity plumes. Habitat adjacent to dredging and disposal areas may be impacted by sedimentation from the nearfield turbidity plumes. Cutterhead dredging is expected to create plumes 1,000 feet from the dredge and to produce turbidity levels of 282 mg/l maximum, which is below the threshold of 390 mg/l found to negatively impact benthic communities (EPA, 1986). Thus, any effects to PBF 2 from turbidity outside the dredge footprint are extremely unlikely to occur and are discountable. However, for disposal activities turbidity levels of up to 550 mg/l may be experienced at placement sites for approximately 1,000 feet downstream, and 300 feet to either side of the disposal area. Because of this, some benthic prey resources may be temporarily buried within the action area, outside of the disposal footprint, during disposal activities. As such, juvenile sturgeon may suffer a small and temporary loss of small portions of PBF 2 in the action area. We have conservatively added these affected adjacent habitat areas to the total disposal area impact, and we expect 6.56 square miles of PBF 2 may be affected by disposal activities (inclusive of direct impacts within the placement areas and turbidity plumes based on disposal area dimensions). In total, 7.59 square miles of non-contiguous PBF 2 may be temporarily, and periodically, impacted by maintenance dredging and disposal activities (6% of PBF 2 in the action area).

Figure 13. PBF 2 in the James River Critical Habitat Unit (127 square miles).

Studies in the lower portions of Chesapeake Bay demonstrated rapid resettlement of dredging and placement areas by mobile infauna (Sherk 1972) and McCauley et al. (1977) observed that, while infauna populations declined significantly after dredging, infauna at dredging and placement areas recovered to pre-dredging conditions within 28 and 14 days, respectively. Other studies demonstrate that full recovery may occur between one and 11 months (Wilbur and Clark 2007); however full faunal recovery of habitat where mobile infaunal and epifaunal organisms are dominant, is not necessary in order for PBF 2 to be valuable to the conservation of the species . As brief disturbance regimes related to dredging and disposal cease, motile organisms immediately begin to move into newly created open habitat from nearby areas, and the habitat will function to provide opportunistic forage, as affected areas of PBF 2 regain their full value to the conservation of the species.

Additionally it is worth noting that the high average daily flushing rate in the James River (approximately 6,000 mgd) will move a portion of sediments deposited at disposal areas downstream toward the Chesapeake Bay, potentially limiting the depth of burial at placement sites. There is a range of variation in recovery times, but because the non-contigous shoals are not dredged concurrently and are also dredged intermittently (averaging 1-3 years in the action area overlapping with PBF 2), most areas dredged in one cycle are expected to fully recover their value for juvenile foraging before being dredged or disposed at again (full recovery to pre-disturbance state occurring in one to 11 months). During the interim, sturgeon will be able to access and transit through the area and use it for other aspects of their development, and continue to forage throughout the entire action area where PBF 2 is present and ubiquitous, including areas flanking the dredge cut on the other side of the channel opposite of disposal areas in similar depths. Based on this reasoning, non-contiguous areas of PBF 2 will be temporarily affected by maintenance dredging and disposal on a smaller scale than the total 6% of the available feature, representing the maximum total spatial extent that will be affected by the proposed action. The maximum total spatial extent of the soft substrate component of PBF2 does not reflect the temporal and periodic nature of the dredging and disposal activities. Because of this, impacts to PBF 2 from maintenance activities are likely to be considerably smaller at any instantaneous point in time, because shoals are not dredged concurrently.

Soft substrate within the James River federal navigation channel may be disturbed on a daily basis by vessel traffic, which may impact the quality of forage habitat provided by the channel. Channel areas requiring maintenance dredging are particularly vulnerable to disturbance from vessels, for as sediments build up (which occurs over time after dredging in shoaling areas where hydraulic gradients are lower relative to surrounding areas, allowing the trapping of materials), they can be close enough to the keels and propellers of large vessels to be a navigation hazard. Given the dynamic nature of the substrates that form these channels, the impacts of natural factors that lead to the accumulation of sediments in these channels (i.e., lower flows and lower hydraulic gradients than surrounding areas), and the disturbance of at least the top layer of sediment when large ships pass overhead, these areas may not support the same abundance of benthic resources as other portions of the action area that overlaps with PBF 2 (the James River outside of the channels, where the disturbance regime is not as frequent). However, given that Atlantic sturgeon opportunistically forage on a variety of benthic invertebrates, (soft sediment benthic organisms tend to be mobile via swimming/burrowing), it is not entirely clear what impact the disturbance regime has on the ability of these shoaled areas to support the foraging and development of juvenile Atlantic sturgeon. While we do not have fine scale information on sturgeon forage items or sturgeon distribution that we could use to make a conclusive determination about foraging in the channel versus outside the channel, it is reasonable to assume that areas outside the channel that are not subject to disturbance as frequently are more likely to support abundant forage species. Accordingly, the value of PBF 2 outside the channel is greater to the conservation of the species. When taken in context of disposal activities that occur outside the channels, 5.2% of non-contiguous portions of the action area overlapping with

PBF 2, where areas are likely to support suitable forage habitat, will be temporarily disturbed on an average of 1-3 years. When these non-contiguous areas are not being disturbed, as discussed previously, benthic organisms will repopulate the substrate and once again provide suitable foraging habitat, limiting long-term impacts to the value of PBF 2 to the conservation of the species.

Lastly, and similar to PBF 1, we do not expect dredging and disposal to impact salinity levels, to an extent that would influence the movement or seasonal location of the salt front. Accordingly, the salinity gradient component of PBF 2 would continue to perform its function to facilitate the physiological development of juveniles.

In conclusion, the dredging and disposal, including turbidity plumes, in the action area of up to 7.59 non-contiguous square miles will affect benthic habitat and forage, sporadically and intermittently, throughout the life of the action, by removal of sediment in the shoals, and through burial of organisms in placement areas. These activities may limit a portion of PBF 2's ability to permanently improve in value in the future. The intermittent removal of substrates to maintain the channel depth, and disposal of materials in designated disposal areas, may affect the availability of forage species while those areas are recolonized by benthic invertebrates that juvenile Atlantic sturgeon would otherwise feed on. However, the area will continue to consist of soft bottom substrate, with no permanent alteration of habitat type, thus preserving the soft-sediment habitat available for benthic forage to inhabit along the appropriate salinity gradient. In addition, the total dredging and disposal footprints represent a small (up to approximately 6% of the James River critical habitat unit potentially supporting PBF 2) and non-contiguous (in space and time) portions of the available soft bottom substrate within the subset of the action area that overlaps with PBF 2. Additionally, it is reasonable to assume that the value of PBF 2 outside the shoaling channel regions is greater to the conservation of the species (5.2% of this subset of the action area that will be temporarily affected by disposal activities). Furthermore, non-contiguous areas of PBF 2 will not be impacted at the same times during dredging and disposal events, as dredging of individual shoals is not performed concurrently. Finally, high flushing rates of the James River (average of approximately 6,000 mgd) will disperse elevated TSS and move a portion of temporarily increased sediment loads away from placement sites, limiting the depth of burial of mobile organisms that will readily repopulate newly placed sediment following the cessation of disturbance in the action area. Considering these factors, the function of PBF 2 in the action area, even if dredging and disposal activities did not occur, the effects of temporarily and intermittently disturbing this small amount of ubiquitous soft-sediment habitat on juvenile foraging or physiological development, will be so small that they cannot be meaningfully measured, evaluated, or detected. Therefore, any effects on the value of PBF 2 in the action area to the conservation of the species are insignificant.

PBF 3: Water absent physical barriers to passage between the river mouth and spawning sites

In considering effects to PBF 3, we consider whether the proposed action will have any effect on water of appropriate depth and absent physical barriers to passage (e.g., locks, dams, thermal plumes, turbidity, sound, reservoirs, gear, etc.) between the river mouth and spawning sites necessary to support: unimpeded movements of adults to and from spawning sites; seasonal and physiologically dependent movement of juvenile Atlantic sturgeon to appropriate salinity zones within the river estuary, and; staging, resting, or holding of subadults or spawning condition adults. We also consider whether the proposed action will affect water depth or water flow, because if water is too shallow it can be a barrier to sturgeon movements, and an alteration in water flow could similarly impact the movements of sturgeon in the river. PBF 3 is located throughout the entire action area.

Unlike some southern rivers, given the extent of tidal flow, geomorphology and naturally deep depths of the James River, it is not vulnerable to natural reductions in water flow or water depth that can result in barriers to sturgeon movements; also, we are not aware of any impacts from this action that reduce water depth or water flow in a way that impact sturgeon movements. We are not aware of any barriers to passage for Atlantic sturgeon in the James River; that is, we do not know of any structures or conditions that prevent sturgeon from moving up or downstream within the river. There are areas in the James River critical habitat unit where sturgeon movements are affected by water quality (e.g., thermal plumes discharged from power plant outfalls) and noise (e.g., during pile driving at ongoing in-water construction projects); however, impacts on movements are normally temporary and/or intermittent and best available data suggests there is always a zone of passage through the affected river reach.

A study conducted in the James River by Reine et al. (2012) found no evidence that would suggest that the presence of an active dredge, and its turbidity plumes, represented a physical barrier to sturgeon movement. Similarly, dredging and disposal, and all associated plumes, within the James River navigation channel will not create physical barriers within the river that will impede Atlantic sturgeon movements or use of the river. Even during times of active dredging and disposal, Atlantic sturgeon can still access and use the surrounding portions of the channel and disposal sites within the action area. While some studies indicate that Atlantic sturgeon tend to avoid areas of active dredging (Hatin et al. 2007), other studies (Reine et al. 2012) state that Atlantic sturgeon showed neither attraction to nor avoidance of active dredging activities. Moser and Ross (1993) found that both shortnose and Atlantic sturgeon occupied both undisturbed and regularly dredged areas during concurrent dredging operations with no negative impact. A study by Cameron (2012) showed that sturgeon exhibited no signs of impeded movement up or downriver due to the physical presence of a dredge. Fish were actively tracked freely moving past the dredge during full production mode and 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). In addition, tagged fish showed no evidence of attraction to the dredge. Brundage (personal communication with USACE, 2017) has noted reduced catches in the Marcus Hook Anchorage in the Delaware River when hydraulic dredging was occurring in the adjacent navigation channel. It is not known, however, if the noise produced by pumping the dredged material through the pipeline was causing an avoidance response or if the physical presence of the pipeline and general disturbance of the area may have also contributed to the sturgeon moving away. Additionally, turbidity plumes will be intermittent, temporary, and will not occupy the width of the river. Turbidity levels related to dredging and disposal are estimated to be between 11 and 550 mg/l, which ranges below the levels that may elicit a reaction in Atlantic sturgeon (580 to 1,000 mg/l; Burton 1993), further limiting the ability for a plume to cause a barrier to passage.

In sum, the proposed action may have temporary effects on PBF 3 by creating temporary in-water stressors from project activities (i.e., presence of dredge and turbidity plumes related to dredging and disposal, presence of vessels); however, none of the proposed activities will be barriers to the movement of any life stage of Atlantic sturgeon. Based on our assessment, these impediments to movement are extremely unlikely to affect the value of PBF 3 to the conservation of the species in the action area; that is, it is extremely unlikely that the habitat alterations will create barriers that will affect the movement of Atlantic sturgeon in the action area generally, nor will the action affect the ability of the feature to develop over time. Specifically, it is extremely unlikely that the habitat alterations will impede the movement of adults to and from spawning sites or the seasonal and physiologically dependent movement of juvenile Atlantic sturgeon to appropriate salinity zones within the river estuary or impede the staging, resting, or holding of subadults or spawning condition adults in the present or future; therefore, the effects are discountable.

PBF 4: Water with the temperature, salinity, and oxygen values that, combined, provide for DO values that support successful reproduction and recruitment and are within the temperature range that supports the habitat function

In considering effects to PBF 4, we consider whether the proposed action will have any effect on water quality, between the river mouth and spawning sites, especially in the bottom meter (3.3 feet) of the water column with the temperature, salinity, and oxygen values that, combined, support: spawning; annual and interannual adult, subadult, larval, and juvenile survival; and larval, juvenile, and subadult growth, development, and recruitment. As defined, water quality factors of temperature, salinity and DO are interrelated environmental variables, and in a river system such as the James, are constantly changing from influences of the tide, weather, season, etc. PBF 4 is located throughout the action area.

As previously discussed in PBF 1 and referenced in PBF 2, salinity regimes in the James River are variable, and many factors may influence it, including stream flow, ocean salinity, sea level, wind stress, and human activities (e.g., dredging activities). However, as evidenced by the Ross et al. (2015) study in the Delaware River, salinity levels did not significantly change as a result of dredging or deepening. No deepening is proposed as part of the action and only 1 to 3.5 feet of material will be removed from the -25 to -28 foot deep channel, intermittently. And as discussed, even though salt water intrusion further into the James River may occur over time due to climate change, dredging and disposal effects on the salinity baseline will be too small to be meaningfully measured or detected.

Similarly, because dredging and disposal activities will only have minor effects on overall depth within the action area, the action will not alter temperature regimes in the James River either. With the very small shifts in depths over the entire action area that supports PBF 4, impacts to temperature as a result of the action will be too small to be meaningfully measured or detected. For DO, the only pathway for the proposed dredging to impact levels is through increased suspended sediments and turbidity. Sediments suspended during dredging may have minor, temporary, localized effects on DO levels, but we expect sediment to settle out of the water column within an hour, thus limiting exposure, and any effects that would possibly impact the value of the feature for any life stage of Atlantic sturgeon. Because the effects of the action to water quality are sporadic and intermittent, the action will not affect the ability of the feature to develop over time. To summarize, we expect the effects of dredging in the action area on the value of PBF 4 to the conservation of the species to be too small to be meaningfully measured or detected, and are therefore, insignificant.

4.2 Species Likely to Be Adversely Affected by the Action: Atlantic Sturgeon

4.2.1 Status ofAtlantic Sturgeon

Species description

Atlantic sturgeon occupy ocean waters and associated bays, estuaries, and coastal river systems from Hamilton Inlet, Labrador, Canada, to Cape Canaveral, Florida (Stein *et al*. 2004a) (Figure 14). Atlantic sturgeon are listed as five DPSs under the ESA.

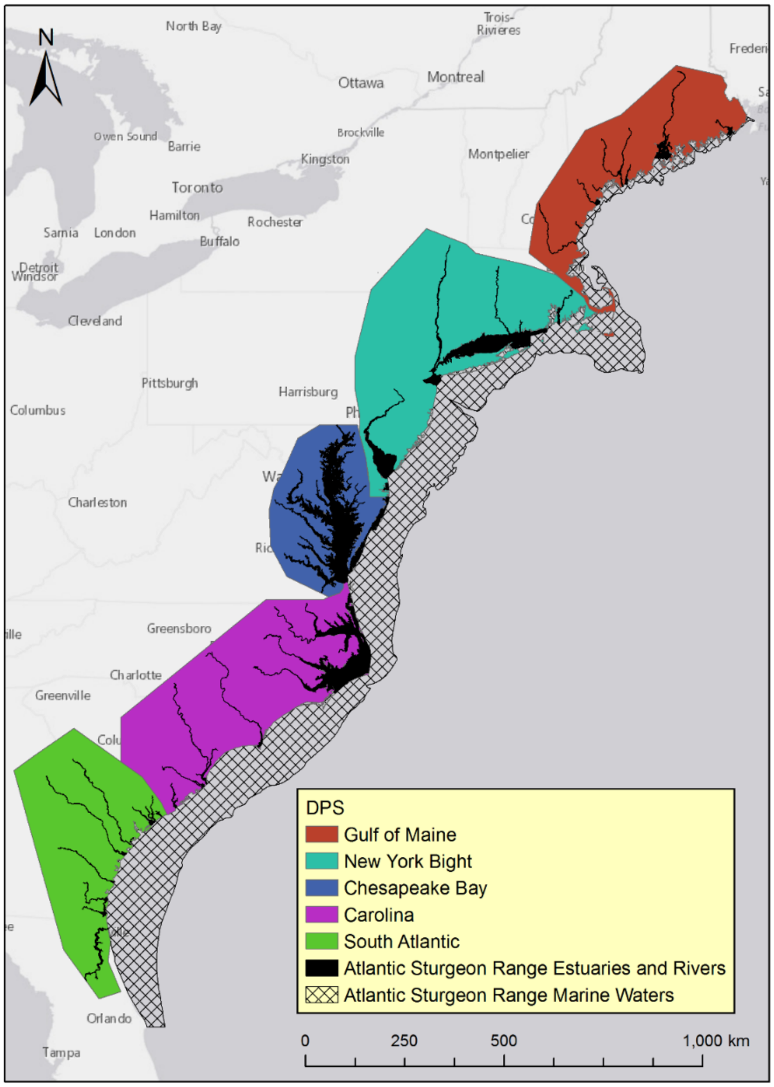
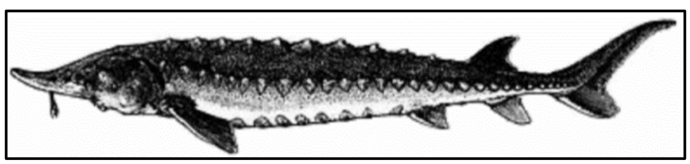


Figure 14. Map Depicting the 5 Atlantic Sturgeon DPSs



The Atlantic sturgeon is a long-lived, late maturing, anadromous species. Atlantic sturgeon attain lengths of up to approximately 14 feet, and weights of more than 800 pounds (Figure 10). They are bluish black or olive brown dorsally with paler sides and a white ventral surface and have five major rows of dermal scutes (Colette and Klein-MacPhee 2002). Five DPSs were listed under the ESA on February 6, 2012. The Gulf of Maine DPS was listed as threatened, and the New York Bight, Chesapeake Bay, Carolina, and South Atlantic DPSs were listed as endangered (Table 7).

Table 7. Atlantic sturgeon information bar provides species' Latin name, common name and current Federal Register notice of listing status, designated critical habitat, Distinct Population Segment, recent status review, and recovery plan.

Species	Common Name	Distinct Population Segment	ESA Status	Recent Review Year	Listing	Recovery Plan	Critical Habitat
Acipenser oxyrinchus oxyrinchus	Atlantic Sturgeon	Gulf of Maine (GOM)	Threatened	2007	77 FR 5880	No	82 FR 39160
Acipenser oxyrinchus oxyrinchus	Atlantic Sturgeon	New York Bight (NYB)	Endangered	2007	77 FR 5880	No	82 FR 39160
Acipenser oxyrinchus oxyrinchus	Atlantic Sturgeon	Chesapeake Bay (CB)	Endangered	2007	77 FR 5880	No	82 FR 39160
Acipenser oxyrinchus oxyrinchus	Atlantic Sturgeon	Carolina	Endangered	2007	77 FR 5914	No	82 FR 39160
Acipenser oxyrinchus oxyrinchus	Atlantic Sturgeon	South Atlantic (SA)	Endangered	2007	77 FR 5914	No	82 FR 39160

Life history

Atlantic sturgeon size at sexual maturity varies with latitude with individuals reaching maturity in the Saint Lawrence River at 22 to 34 years (Scott and Crossman 1973). Atlantic sturgeon spawn in freshwater, but spend most of their adult life in the marine environment. Spawning adults generally migrate upriver in May through July in Canadian systems (Murawski and Pacheco 1977; Smith 1985; Bain 1997; Smith and Clugston 1997; Caron *et al*. 2002). Atlantic sturgeon spawning is believed to occur in flowing water between the salt front and fall line of large rivers at depths of three to 27 meters (Borodin 1925; Leland 1968; Scott and Crossman 1973; Crance 1987; Bain *et al*. 2000). Atlantic sturgeon likely do not spawn every year; spawning intervals range from one to five years for males (Smith 1985; Collins *et al*. 2000; Caron *et al*. 2002) and two to five years for females (Vladykov and Greeley 1963; Van Eenennaam *et al*. 1996; Stevenson and Secor 2000).

Sturgeon eggs are highly adhesive and are deposited on the bottom substrate, usually on hard surfaces (Gilbert 1989; Smith and Clugston 1997) between the salt front and fall line of large rivers (Borodin 1925; Scott and Crossman 1973; Crance 1987; Bain *et al*. 2000). Following spawning in northern rivers, males may remain in the river or lower estuary until the fall; females typically exit the rivers within four to six weeks (Savoy and Pacileo 2003). Hatching occurs approximately 94 to 140 hours after egg deposition at temperatures of 20 and 18 degrees Celsius, respectively (Theodore *et al*. 1980). The yolk sac larval stage is completed in about eight to 12 days, during which time larvae move downstream to rearing grounds over a six to 12 day period (Kynard and Horgan 2002). Juvenile sturgeon continue to move further downstream into waters ranging from zero to up to ten parts per thousand salinity. Older juveniles are more tolerant of higher salinities as juveniles typically spend two to five years in freshwater before eventually becoming coastal residents as sub-adults (Smith 1985; Boreman 1997; Schueller and Peterson 2010).

Upon reaching the subadult phase, individuals may move to coastal and estuarine habitats (Murawski and Pacheco 1977; Dovel and Berggren 1983; Smith 1985; Stevenson 1997). Tagging and genetic data indicate that subadult and adult Atlantic sturgeon may travel widely once they emigrate from rivers. Despite extensive mixing in coastal waters, Atlantic sturgeon exhibit high fidelity to their natal rivers (King *et al*. 2001; Waldman *et al*. 2002; Grunwald *et al*. 2008). Because of high natal river fidelity, it appears that most rivers support independent populations (Waldman and Wirgin 1998; Wirgin *et al*. 2000, 2002; King *et al*. 2001; Grunwald *et al*. 2008). Atlantic sturgeon feed primarily on polychaetes, isopods, American sand lances and amphipods in the marine environment, while in fresh water they feed on oligochaetes, gammarids, mollusks, insects, and chironomids (Moser and Ross 1995; Johnson *et al*. 1997; Guilbard *et al*. 2007; Savoy 2007; Novak *et al*. 2017).

Population dynamics

The following is a discussion of the species' population and its variance over time. This section includes: abundance, population growth rate, genetic diversity, and distribution as it relates to Atlantic sturgeon.

Abundance

Historically, the Gulf of Maine DPS likely supported more than 10,000 spawning adults. The current abundance is estimated to be one to two orders of magnitude smaller than historical levels (Secor *et* al. 2002; ASSRT 2007).

The New York Bight, ranging from the Delmarva Peninsula to Cape Cod, historically supported four or more spawning populations. Currently, this DPS only supports two spawning populations, the Delaware and Hudson River, although new information demonstrates that the Connecticut River may support spawning as well. Numbers of Atlantic sturgeon in the New York Bight DPS are extremely low compared to historical levels and have remained so for the past 100 years. The spawning populations of this DPS are thought to be one to two orders of magnitude below historical levels.

Historically the Delaware River is believed to have supported around 180,000 individuals (Secor 2002). In 2007, NMFS status review estimated that the population had declined to fewer than 300 individuals. In 2014, Hale *et al*. (2016) estimated that 3,656 (95% CI = 1,935-33,041) early juveniles (age zero to one) utilized the Delaware River estuary as a nursery. Based on commercial fishery landings from the mid-1980s to the mid-1990s, the total abundance of adult Hudson River Atlantic sturgeon was estimated to be 870 individuals (Kahnle *et* al. 2007). Based on the juvenile assessments from (Peterson 2000), the Hudson River suffered a series of recruitment failures, which triggered the ASMFC fishing moratorium in 1998 to allow the populations to recover.

There are no current abundance estimates for the Chesapeake Bay DPS. Historically, Atlantic sturgeon were common throughout the Chesapeake Bay and its tributaries (Kahnle *et al*. 1998; Bushnoe *et al*. 2005). At the time of listing, the James River was the only known spawning river for the Chesapeake Bay DPS (ASSRT 2007; Balazik *et al*. 2012a). Since the listing, spawning has been confirmed to occur in the Pamunkey River, a tributary of the York River (Hager *et al*. 2014; Kahn *et al*. 2014) and is suspected to be occurring in Marshyhope Creek, a tributary of the Nanticoke River. The historical and contemporary accounts of Atlantic sturgeon in the York, Rappahannock, Susquehanna, and Potomac Rivers (ASSRT 2007), as well as the presence of the features necessary to support reproduction and recruitment in this river indicate that there is the potential for spawning to occur.

The Carolina DPS spawning populations are estimated to be at less than 3% of their historic levels. Prior to 1890, there were estimated to be 7,000 to 10,500 adult female Atlantic sturgeon in North Carolina and approximately 8,000 adult females in South Carolina. Currently, the existing spawning populations in each of the rivers in the Carolina DPS are thought to have less than 300 adults spawning each year.

The South Atlantic DPS historically supported eight spawning populations ranging from the St. Johns River, Florida to the Ashepoo, Combahee, and Edisto Rivers Basin in South Carolina. Currently, this DPS supports five extant spawning populations. Of these populations, the Altamaha is believed to support the largest number of spawning adults. The current abundance of the Altamaha population is suspected to be less than 6% of historical abundance, extrapolated from the 1890s commercial landings (Secor 2002). Few captures have been documented in other populations within this DPS and are suspected to be less than 1% of their historic abundance (less than 300 spawning adults).

Stock Assessments

The ASMFC released a new benchmark stock assessment for Atlantic sturgeon in October 2017 (ASMFC 2017a). The assessment used both fishery-dependent and fishery-independent data, as well as biological and life history information. Fishery-dependent data came from commercial fisheries that formerly targeted Atlantic sturgeon (before the moratorium), as well as fisheries that catch sturgeon incidentally. Fishery-independent data were collected from scientific research and survey programs.

At the coastwide and DPS levels, the stock assessment concluded that Atlantic sturgeon are depleted relative to historical levels. The low abundance of Atlantic sturgeon is not due solely to effects of historic commercial fishing, so the ‘depleted’ status was used instead of ‘overfished.’ This status reflects the array of variables preventing Atlantic sturgeon recovery (e.g., bycatch, habitat loss, and ship strikes).

As described in the Assessment Overview, Table 12 shows “the stock status determination for the coastwide stock and DPSs based on mortality estimates and biomass/abundance status relative to historic levels, and the terminal year (i.e., the last year of available data) of indices relative to the start of the moratorium as determined by the ARIMA[5] analysis."

Table 8. Stock status determination for the coastwide stock and DPSs (from the ASMFC's Atlantic Sturgeon Stock Assessment Overview, October 2017)

	Mortality Status	Biomass/Abundance Status	
Population	**Probability that $Z > Z_{50\%EPR}$ 80%**	**Relative to Historical Levels**	**Average probability of terminal year of indices > 1998* value**
Coastwide	7%	Depleted	95%
Gulf of Maine	74%	Depleted	51%
New York Bight	31%	Depleted	75%
Chesapeake Bay	30%	Depleted	36%
Carolina	75%	Depleted	67%
South Atlantic	40%	Depleted	Unknown (no suitable indices)

*** For indices that started after 1998, the first year of the index was used as the reference value. EPR= Eggs Per Recruit.**

Despite the depleted status, the assessment did include signs that the coastwide index is above the 1998 value (95% chance). The Gulf of Maine, New York Bight, and Carolina DPS indices also all had a greater than 50% chance of being above their 1998 value; however, the index from the Chesapeake Bay DPS (highlighted red) only had a 36% chance of being above the 1998 value. There were no representative indices for the South Atlantic DPS. Total mortality from the tagging model was very low at the coastwide level. Small sample sizes made mortality estimates at the DPS level more difficult. The New York Bight, Chesapeake Bay, and South Atlantic DPSs all had a less than 50% chance of having a mortality rate higher than the threshold. The Gulf of Maine and Carolina DPSs (highlighted red) had 74%-75% probability of being above the mortality threshold (ASMFC 2017a).

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 action area is known to be used by Atlantic sturgeon originating from all five DPSs. We have considered the best available information from a mixed stock analysis done by Damon-Randall et al. (2013) to determine from which DPSs individuals in the action area are likely to have originated. We have determined that when looking at the entire action area within the James River, Atlantic sturgeon throughout likely originate from the five DPSs at the following frequencies: NYB 2%; SA 2%; CB 92%; GOM 2%; and Carolina 2%. Approximately 2.2% of the Atlantic sturgeon throughout the action area originate from Canadian rivers or management units. All early life stages including eggs, larvae, or juvenile fish in the action area would be from the CB DPS only.

Distribution

The Gulf of Maine DPS includes all anadromous Atlantic sturgeons that are spawned in the

5 "The ARIMA (Auto-Regressive Integrated Moving Average) model uses fishery-independent indices of abundance to estimate how likely an index value is above or below a reference value" (ASMFC 2017a).

watersheds from the Maine/Canadian border and, extending southward, all watersheds draining into the Gulf of Maine as far south as Chatham, Massachusetts (Figure 9). The geomorphology of most small coastal rivers in Maine is not sufficient to support Atlantic sturgeon spawning populations, except for the Penobscot and the estuarial complex of the Kennebec, Androscoggin, and Sheepscot rivers. Spawning still occurs in the Kennebec and Androscoggin Rivers, and may occur in the Penobscot River. Atlantic sturgeon have more recently been observed in the Saco, Presumpscot, and Charles rivers.

The natal river systems of the New York Bight DPS span from the Connecticut River south to the Delaware River (Figure 9). The Connecticut River has long been known as a seasonal aggregation area for subadult Atlantic sturgeon, and both historical and contemporary records document presence of Atlantic sturgeon in the river as far upstream as Hadley, Massachusetts (Savoy and Shake 1992; Savoy and Pacileo 2003). The upstream limit for Atlantic sturgeon on the Hudson River is the Federal Dam at the fall line, approximately river kilometer 246 (Dovel and Berggren 1983; Kahnle *et* al. 1998). In the Delaware River, there is evidence of Atlantic sturgeon presence from the mouth of the Delaware Bay to the head-of-tide at the fall line near Trenton on the New Jersey side and Morrisville on the Pennsylvania side of the River, a distance of 220 river kilometers (Breece *et al*. 2013).

The natal river systems of the Chesapeake Bay DPS span from the Susquehanna River south to the James River (Figure 9).

The natal river systems of the Carolina DPS span from the Roanoke River, North Carolina south to the Santee-Cooper system in South Carolina (Figure 9). The Carolina DPS ranges from the Santee-Cooper River to the Albemarle Sound and consists of seven extant populations; one population (the Sampit River) is believed to be extirpated.

The natal river systems of the South Atlantic DPS span from Edisto south to the St. Mary's River (Figure 9). Seventy-six Atlantic sturgeon were tagged in the Edisto River during a 2011 to 2014 telemetry study (Post *et al.* 2014). Fish entered the river between April and June and were detected in the saltwater tidal zone until water temperature decreased below 25 degrees Celcius. They then moved into the freshwater tidal area, and some fish made presumed spawning migrations in the fall around September to October. Atlantic sturgeon in the Savannah River were documented displaying similar behavior three years in a row—migrating upstream during the fall and then being absent from the system during spring and summer. Forty three Atlantic sturgeon larvae were collected in upstream locations (river kilometer 113 to 283) near presumed spawning locations (Collins and Smith 1997).

Status

Atlantic sturgeon were once present in 38 river systems and, of these, spawned in 35 of them. Individuals are currently present in 36 rivers, and spawning occurs in at least 20 of these (ASSRT 2007). The decline in abundance of Atlantic sturgeon has been attributed primarily to the large U.S. commercial fishery which existed for the Atlantic sturgeon from the 1870s through the mid 1990s. The fishery collapsed in 1901 and landings remained at between 1%-5% of the pre-collapse peak until ASMFC placed a two generation moratorium on the fishery in 1998

(ASMFC 1998a, 1998b). The majority of the populations show no signs of recovery, and new information suggests that stressors such as bycatch, ship strikes, and low DO can and do have substantial impacts on populations (ASSRT 2007). Additional threats to Atlantic sturgeon include habitat degradation from dredging, damming, and poor water quality (ASSRT 2007). Climate change related impacts on water quality (e.g., temperature, salinity, dissolved oxygen, contaminants) have the potential to impact Atlantic sturgeon populations using impacted river systems. These effects are expected to be more severe for southern portions of the U.S. range of Atlantic sturgeon (Carolina and South Atlantic DPSs). None of the spawning populations are currently large or stable enough to provide any level of certainty for continued existence of any of the DPSs.

Recovery Goals

Recovery Plans have not yet been drafted for any of the Atlantic sturgeon DPSs.

4.2.1.1 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 at least the Androscoggin, Kennebec, Merrimack, Penobscot, and Sheepscot Rivers (ASSRT, 2007). Spawning habitat is available and accessible in the Penobscot, Androscoggin, Kennebec, Merrimack, and Piscataqua (inclusive of the Cocheco and Salmon Falls rivers) rivers. Spawning has been documented in the Kennebec River. In the Androscoggin River, captures of adult Atlantic sturgeon, including a ripe male, over suitable spawning grounds during the spawning season confirm likely spawning; however Atlantic sturgeon eggs and larvae have not yet been recovered in the Androscoggin (Wippelhauser pers. comm. 2018). Despite the availability of suitable habitat and the presence of Atlantic sturgeon in the remaining rivers, there is currently no evidence spawning activity in these rivers.

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

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

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

Riverine habitat may be impacted by dredging and other in-water activities, disturbing spawning habitat and also altering the benthic forage base. Many rivers in the Gulf of Maine 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. We 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 tracking of spawning condition Atlantic sturgeon 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. Until it was breached in July 2013, the range of Atlantic sturgeon in the Penobscot River was limited by the presence of the Veazie Dam. Since the removal of the Veazie Dam and the Great Works Dam, sturgeon can now travel as far upstream as the Milford Dam. While Atlantic sturgeon are known to occur in the Penobscot River, there is no evidence of spawning currently occurring. The Essex Dam on the Merrimack River blocks access to approximately 58% of historically accessible habitat in this river. Atlantic sturgeon occur in the Merrimack River but spawning has not been documented. Like the Penobscot, it is unknown how the Essex Dam affects the likelihood of spawning occurring in this river.

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

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

Summary of the Gulf of Maine DPS

Spawning for the Gulf of Maine DPS is known to occur in two rivers (Kennebec and Androscoggin). Spawning may be occurring in other rivers, such as the 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). We have 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.

4.2.2.2 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 Taunton River (ASSRT, 2007). However, there is recent evidence that spawning may be occurring in the Connecticut River. Atlantic sturgeon that are spawned elsewhere continue to use habitats within the Connecticut and Taunton Rivers as part of their overall marine range (ASSRT, 2007; Savoy, 2007; Wirgin and King, 2011).

The abundance of the Hudson River Atlantic sturgeon riverine population prior to the onset of expanded exploitation in the 1800s is unknown but, has been conservatively estimated at 10,000 adult females (Secor, 2002). Current abundance is likely at least one order of magnitude smaller than historical levels (Secor, 2002; ASSRT, 2007; Kahnle *et al.*, 2007). As described above, an estimate of the mean annual number of mature adults (863 total; 596 males and 267 females) was calculated for the Hudson River riverine population based on fishery-dependent data collected from 1985-1995 (Kahnle *et al.*, 2007). Kahnle *et al.* (1998; 2007) also showed that the level of fishing mortality from the Hudson River Atlantic sturgeon fishery during the period of 1985-1995 exceeded the estimated sustainable level of fishing mortality for the riverine population and may have led to reduced recruitment. A decline in the abundance of young Atlantic sturgeon appeared to occur in the mid to late 1970s followed by a secondary drop in the late 1980s (Kahnle *et al.*, 1998; Sweka *et al.*, 2007; ASMFC, 2010). At the time of listing, catch-per-unit-effort (CPUE) data suggested that recruitment remained depressed relative to catches of juvenile Atlantic sturgeon in the estuary during the mid-late 1980s (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 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 low compared to the late 1980s. Standardized mean catch per net set from the NYSDEC juvenile Atlantic sturgeon survey have had a general increasing trend from 2006 – 2015, with the exception of a dip in 2013.

In addition to capture in fisheries operating in Federal waters, bycatch and mortality also occur in state fisheries; however, the primary fishery that impacted juvenile sturgeon (shad) in the Hudson River, has now been closed and there is no indication that it will reopen soon. In the Hudson River, sources of potential mortality include vessel strikes and entrainment in dredges. Individuals are also exposed to effects of bridge construction (including the replacement of the Tappan Zee Bridge). Impingement at water intakes, including the Danskammer, Roseton and Indian Point power plants also occurs. Recent information from surveys of juveniles (see above) indicates that the number of young Atlantic sturgeon in the Hudson River is increasing compared to recent years, but is still low compared to the 1970s. There is currently not enough information regarding any life stage to establish a trend for the entire Hudson River population.

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

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

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

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

Riverine habitat may be impacted by dredging and other in-water activities, disturbing spawning habitat and 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, and four fish were entrained in the Delaware River during maintenance and deepening activities in 2017 and 2018. At this time, we do not have any additional information to quantify the number of Atlantic sturgeon killed or disturbed during dredging or in-water construction projects. We are also not able to quantify any effects to habitat.

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

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. Additionally, 138 sturgeon carcasses were observed on the Hudson River and reported to the NYSDEC between 2007 and 2015. Of these, 69 are suspected of having been killed by vessel strike. Genetic analysis has not been completed on any of these individuals to date, given that the majority of Atlantic sturgeon in the Hudson River belong to the New York Bight DPS, we assume that the majority of the dead sturgeon reported to NYSDEC belonged to the New York Bight DPS. Given the time of year in which the fish were observed (predominantly May through July), it is likely that many of the adults were migrating through the river to the spawning grounds.

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. We 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.

4.2.2.3 Chesapeake Bay DPS of Atlantic sturgeon

The Chesapeake Bay (CB) DPS includes the following: all anadromous Atlantic sturgeon that spawn or 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, Virginia. The marine range of Atlantic sturgeon from the CB DPS extends from Hamilton Inlet, Labrador, Canada, to Cape Canaveral, Florida. The riverine range of the CB DPS and the adjacent portion of the marine range are shown in Figure 9. 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% 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, specifically within the Pamunkey River (a tributary of the York River) (Musick *et al.* 1994; ASSRT 2007; Greene *et al.* 2009). The recent capture of an adult sturgeon in spawning condition suggests that spawning may also occur in Marshyhope Creek, a tributary to the Nanticoke River (Bruce et al. 2016). However, conclusive evidence of current spawning is only available for the James River, where spring spawning occurs, and a study also found evidence of Atlantic sturgeon spawning in the fall (Balazik *et al.* 2012). Atlantic sturgeon that are spawned elsewhere are known to use the Chesapeake Bay (Vladykov and Greeley 1963; Wirgin *et al.* 2000; ASSRT 2007; Grunwald *et al.* 2008).

Age to maturity for CB 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 five 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 CB DPS likely falls within these values.

Several threats play a role in shaping the current status of CB 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 1998b; 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 CB 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 1998a; 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). Heavy industrial development during the 20th century in rivers inhabited by sturgeon impaired water quality and impeded these species' recovery.

Although there have been improvements in the some areas of the Bay's health, the ecosystem remains in poor condition. The EPA gave the overall health of the Bay a grade of 45% based on goals for water quality, habitats, lower food web productivity, and fish and shellfish abundance (EPA CBP 2010). This was a 6% increase from 2008. According to the EPA, the modest gain in the health score was due to a large increase in the adult blue crab population, expansion of underwater grass beds growing in the Bay's shallows, and improvements in water clarity and bottom habitat health as highlighted below:

- 12% of the Bay and its tidal tributaries met CWA standards for dissolved oxygen between 2007 and 2009, a decrease of 5% from 2006 to 2008,

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

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 2005-2007. Several of these were mature individuals. Balazik et al. (2012) found 31 carcasses in tidal freshwater regions of the James River between 2007 and 2010, and approximately 36 between 2013 and 2017 (Balazik, pers comm). 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 CB DPS on a regular basis. However, Balazik et al. estimates that current monitoring in the James River only captures approximately one third of all mortalities related to vessel interaction.

In the marine and coastal range of the CB DPS from Canada to Florida, fisheries bycatch in federally and state-managed fisheries poses a threat to the DPS, reducing survivorship of subadults and adults and potentially causing an overall reduction in the spawning population (Stein *et al.* 2004b; ASMFC TC 2007; ASSRT 2007).

Summary of the Chesapeake Bay DPS

Spawning for the CB DPS is known to occur in only the James and Pamunkey Rivers. Spawning may be occurring in other rivers, such as the York, Rappahannock, Potomac, and Nanticoke, but has not been confirmed for any of those. 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 CB DPS have been removed (e.g., directed fishing) or reduced as a result of improvements in water quality since passage of the CWA. We have estimated that there are a minimum of 8,811 CB DPS adult and subadult Atlantic sturgeon of size vulnerable to capture in U.S. Atlantic waters.

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 CB DPS of Atlantic sturgeon. Of the 35% of Atlantic sturgeon incidentally caught in the Bay of Fundy, about 1% were CB DPS fish (Wirgin *et al.* 2012). Studies have shown that Atlantic sturgeon can only sustain low levels of bycatch mortality (Boreman 1997; ASMFC TC 2007; Kahnle *et al.* 2007). The CB 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.

4.2.2.4 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. The riverine range of the Carolina DPS and the adjacent portion of the marine range are shown in Figure 9. Sturgeon are commonly captured 40 miles offshore (D. Fox, Delaware State University, 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*. 2004b, ASMFC TC 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 YOY were observed or mature adults were present in freshwater portions of a system (Table 14). 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. Fish from the Carolina DPS likely use other river systems than those listed here for their specific life functions.

Table 14. 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.

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;	Yes	age-1, potentially YOY (1980s)

River/Estuary	Spawning Population	Data
Winyah Bay		
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	

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 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, are estimated to be less than 3% of what they were historically (ASSRT 2007). We have estimated that there are a minimum of 1,356 Carolina DPS adult and subadult Atlantic sturgeon of size vulnerable to capture in U.S. Atlantic waters.

Overutilization of Atlantic sturgeon from directed fishing caused initial severe declines in Atlantic sturgeon populations in the Southeast in the mid- to late 19th century, from which they have never rebounded. Continued bycatch of Atlantic sturgeon in commercial fisheries is an ongoing impact to the Carolina DPS. More robust fishery independent data on bycatch are available for the Northeast and Mid-Atlantic than in the Southeast where high levels of bycatch underreporting are suspected.

Though there are statutory and regulatory regulations that authorize reducing the impact of dams on riverine and anadromous species, these mechanisms have proven inadequate for preventing dams from blocking access to habitat upstream and degrading habitat downstream. Water quality continues to be a problem in the Carolina DPS, even with existing controls on some pollution sources. Current regulatory regimes are not 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.).

Summary of the Status of the Carolina DPS of Atlantic Sturgeon

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 more than 60% 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 dissolved oxygen) 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 use 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 either 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 existing regulatory mechanisms, such as the moratorium on directed fisheries for Atlantic sturgeon, bycatch and habitat alterations are currently not being addressed through existing mechanisms. Further, despite NMFS's authority under the Federal Power Act to prescribe fish passage and existing controls on some pollution sources, access to habitat and improved water quality continues to be a problem. The inadequacy of regulatory mechanisms to control bycatch and habitat alterations is contributing to the status of the Carolina DPS.

4.2.2.5 South Atlantic DPS of Atlantic sturgeon

The South Atlantic (SA) 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 SA DPS extends from the Hamilton Inlet, Labrador, Canada, to Cape Canaveral, Florida. The riverine range of the SA DPS and the adjacent portion of the marine range are shown in Figure 9. Sturgeon are commonly captured 40 miles offshore (D. Fox, Delaware State University, 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.* 2004b, ASMFC TC 2007), but Atlantic sturgeon are recorded as bycatch out to 500 fathoms (900 meters).

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 YOY were observed, or mature adults were present, in freshwater portions of a system (Table 15). 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. Recent evidence shows that a small number of fish have returned to the St. Mary's River, and may use the river for spawning. 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. Fish from the SA DPS likely use other river systems than those listed here for their specific life functions.

Table 9. Major rivers, tributaries, and sounds within the range of the SA DPS and currently available data on the presence of an Atlantic sturgeon spawning population in each system.

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	Yes	
St. Johns River, FL	Extirpated	

Secor (2002) estimates that 8,000 adult females were present in South Carolina before the collapse of the fishery in 1890. However, because fish from South Carolina are included in both the Carolina and SA DPSs, it is likely that some of the historical 8,000 fish would be attributed to both the Carolina DPS and SA DPS. The sturgeon fishery had been the third largest fishery in Georgia. Reductions from the commercial fishery and ongoing threats have drastically reduced the numbers of Atlantic sturgeon within the South Atlantic DPS. We have estimated that there are a minimum of 14,911 SA DPS adult and subadult Atlantic sturgeon of size vulnerable to capture in U.S. Atlantic waters.

The directed Atlantic sturgeon fishery caused initial severe declines in southeast Atlantic sturgeon populations. Although the directed fishery is closed, bycatch in other commercial fisheries continues to impact the SA DPS. Statutory and regulatory mechanisms exist that authorize reducing the impact of dams on riverine and anadromous species such as Atlantic sturgeon, but 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 SA DPS, even with existing controls on some pollution sources. Current regulatory regimes are not 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.)

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

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 SA 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 SA DPS by modifying spawning, nursery, and foraging habitat. Habitat modifications through reductions in water quality and dissolved oxygen are also contributing to the status of the SA DPS, 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 also contributes to the SA DPSs 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 use 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 SA DPS have been ameliorated or reduced due to the existing regulatory mechanisms, such as the moratorium on directed fisheries for Atlantic sturgeon, bycatch and habitat alteration are currently not being addressed through existing mechanisms. Further, access to habitat and good water quality continues to be a problem even with NMFS's authority under the Federal Power Act to prescribe fish passage and existing controls on some pollution sources. There is a lack of regulation for some large water withdrawals, which threatens sturgeon habitat. 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 SA DPS.

5.0 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: commercial and recreational fisheries, hopper dredging operations, sand mining and beach nourishment activities, commercial shipping and other vessel activities, military operations, scientific research, projects affecting water quality and pollution, global climate change, and recovery activities associated with reducing impacts to listed species.

5.1 Federal Actions that have Undergone Section 7 Consultation

We have undertaken a number of section 7 consultations to address the effects of Federal actions on threatened and endangered species in the action area. Each of those consultations sought to develop ways to reduce the probability of adverse impacts of the action on listed species.

5.1.1 Hopper Dredging, Sand Mining, and Beach Nourishment

The construction and maintenance of Federal navigation channels, sand mining ("borrow") activities, beach nourishment, and shoreline restoration/stabilization projects have been identified as sources of Atlantic sturgeon incidental take and mortality near the action area. The majority of these projects in the action area are authorized and carried out by the U.S. Army Corps of Engineers (USACE), with a few facility-specific ones overseen by the National Aeronautics and Space Administration (NASA) and U.S. Navy. Within and near the action area, USACE projects are under the jurisdiction of the Norfolk District of the North Atlantic Division. From 1993-2017, the Norfolk District has reported few interactions between hopper dredges and Atlantic sturgeon, with just two records documenting interactions near the action area (in Virginia near the Chesapeake Bay entrance).

We have completed several ESA section 7 consultations to consider effects of these dredging, sand mining, and nourishment projects on Atlantic sturgeon that may use the action area for the James River FNP. Many of these consultations – including this one - are in the process of being reinitiated to consider effects to Atlantic sturgeon critical habitat. In our 2012 biological opinion, over the 50-year period of maintenance dredging of the James River federal navigation channel, we expected up to 50 sub-adult Atlantic sturgeon (approximately one per year) to be taken as a result of the action. In our 2012 biological opinion for the 50-year maintenance dredging of the Chesapeake Bay entrance channels and use of sand borrow areas for beach nourishment from 2012-2062, we anticipated up to 800 Atlantic sturgeon would be incidentally taken. This Biological Opinion was updated in 2018 to include incidental take for 908 Atlantic sturgeon over the life of the project. This 2018 Biological Opinion replaces the 2012.

Recently, the U.S. Navy's Dam Annex Shoreline Protection System Repairs operations and NASA's Wallops Island Shoreline Restoration/Infrastructure Protection Program were determined to cause the entrainment of up to one Atlantic sturgeon from any of the five DPSs for approximately every 9.4 million cubic yards of material removed from the borrow areas. This equated to one and two captures, respectively, from any of the five DPSs over the course of the two projects for 50 years. Three additional biological opinions (two Navy projects and one ACOE project) were also completed in 2012 to assess Atlantic sturgeon interactions in dredging operations near the action area. Takes of Atlantic sturgeon during relocation trawling activities are also included in the ACOE consultations. Relocation trawling has been successful at temporarily displacing Atlantic sturgeon from navigation channels and nearshore mining/borrow areas during periods when hopper dredging was imminent or ongoing.

5.1.2 Vessel Activity and Military Operations

Potential sources of adverse effects to Atlantic sturgeon from Federal vessel operations in or near the action area include operations of the U.S. Navy (USN) and the U.S. Coast Guard (USCG), which maintain the largest Federal fleets, as well as the Bureau of Ocean Energy Management (BOEM), Maritime Administration (MARAD), Environmental Protection Agency (EPA), NOAA, and ACOE. We have conducted formal consultations with the USN, USCG, EPA, and NOAA on their vessel-based operations. We have also conducted section 7 consultations with BOEM and MARAD on vessel traffic related to energy projects in the Greater Atlantic Region and implemented conservation measures. Through the section 7 process, where applicable, we have and will continue to establish conservation measures for all these agency vessel operations to avoid or minimize adverse effects to listed species. To date, ocean-going vessels and military activities have not been identified as significant threats to Atlantic sturgeon in the marine environment, but when vessels move into riverine systems, such as the action area, the possibility exists for interactions between vessels and sturgeon.

5.1.3 Research and Other Permitted Activities

Research activities either conducted or funded by Federal agencies within the action area may adversely affect ESA-listed sea turtles and fish, and may require a section 7 consultation. Several section 7 consultations on research activities have recently been completed, as described below.

Fish Surveys funded by the USFWS
USFWS Region 5 provides funds to 13 states and the District of Columbia under the Dingell-Johnson Sport Fish Restoration Grant program and the State Wildlife Grant Program. Vermont and West Virginia are the only two Northeast states that do not use these funds to conduct ongoing surveys in marine, estuarine or riverine waters where NMFS listed species are present. The eleven other states (Maine, New Hampshire, Massachusetts, Connecticut, Rhode Island, New York, New Jersey, Pennsylvania, Delaware, Maryland, Virginia) and the District of Columbia carry out a total of approximately 80-90 studies, mostly on an annual basis. There are several broad categories of fisheries surveys including: hook and line; beach seine; bottom trawl; fishway trap; boat electrofishing; long line; fyke net; gill net; haul seine; push net; and, backpack

electrofishing. These surveys occur in state waters (rivers, estuaries, and in nearshore ocean waters), generally from Maine through Virginia, with several studies occurring in Virginia state waters including juvenile fish trawl surveys, juvenile striped bass beach seine surveys, and the Chesapeake Bay Multispecies Monitoring and Assessment Program (ChesMMAP) surveys. These surveys have resulted in the non-lethal take of Atlantic sturgeon (seven total) since 2013.

In 2018, we completed re-initiation on the 2013 biological opinion, which bundled the twelve independent actions carried out by USFWS (i.e., awarding of each grant fund to each state is an independent action). The biological opinion provides an ITS by activity and provided a summary by state. Overall, we anticipate that the surveys described in the biological opinion, to be funded by USFWS and carried out by the states will result in the capture of up to 427 Atlantic sturgeon (no more than six lethal) over a five-year period. The only mortalities that we anticipate for Virginia state waters are three Atlantic sturgeon (originating from any of the five DPSs) during striped bass and shad gillnet surveys that may occur in portions of the action area.

Section 10(a)(1)(A) Permits

We have issued additional research permits under section 10(a)(1)(A) of the ESA, which authorizes activities for scientific purposes or to enhance the propagation or survival of the affected species. The permitted activities do not operate to the disadvantage of the species and are consistent with the purposes of the ESA, as outlined in section 2 of the Act. A total of 13 section 10(a)(1)(A) permits are currently in effect for Atlantic sturgeon, and only 3 within the action area.

Section 10(a)(1)(B) Permits

Section 10(a)(1)(B) of the ESA authorizes us, under some circumstances, to permit non-Federal parties to take otherwise prohibited fish and wildlife if such taking is "incidental to, and not the purpose of carrying out otherwise lawful activities" (50 CFR 217-222). As a condition for issuance of a permit, the permit applicant must develop a conservation plan that minimizes negative impacts to the species. There are currently no active Section 10(a)(1)(B) permits in the action area for this consultation, although on August 14, 2017, we published a notice in the Federal Register announcing the receipt of an application from Dominion Virginia Power for a section 10(a)(1)(B) permit, which is discussed in more detail below. Active permits and permit applications are posted online for all ESA-listed species as they become available at http://www.nmfs.noaa.gov/pr/permits/esa_review.htm.

5.1.4 Coal Burning Power Stations

Chesterfield Power Station – James River

The Chesterfield Power Station (CPS) is a coal-fired power plant operated by Dominion Virginia Power (Dominion). The CPS began operations in 1945 and has been operating at its current level since 1992. The station is located at RM 82 of the James River in Chesterfield, VA. The six power-generating units at CPS utilize a once-through cooling water system that withdraws water directly from the James River though five cooling water intake structures. The operation of the CPS has resulted in the take of Atlantic sturgeon. An Atlantic sturgeon presumed to be an adult based on its size (no measurements available), was impinged on “trash racks” of the CPS on October 3, 2015. The sturgeon was injured, but returned alive to the James River. Also in October 2015, two yolk-sac Atlantic sturgeon larvae were captured during entrainment sampling conducted pursuant to section 316(b) of the Clean Water Act. After the incidental take of the two larvae, Dominion suspended entrainment sampling on March 2, 2016, prior to the spring spawning of Atlantic sturgeon in the James River. On April 10, 2017, we received a complete application from Dominion requesting an Incidental Take Permit (ITP) to take Atlantic sturgeon over a 10-year period. The facility has since done entrainment studies during spring 2018 and November 2018. Dominion estimates the take of up to 846 Atlantic sturgeon per year from the Chesapeake Bay DPS due to entrainment in the CPS cooling water intakes. Dominion also estimates the take of up to two juvenile, sub-adult, or adult Atlantic sturgeon from the Chesapeake Bay DPS over a 10-year period as a result of impingement at the CPS intakes. Several changes to the plan have also been proposed and they are currently working with NMFS to address the issues.

5.2 Non-Federally Regulated Fisheries

Atlantic sturgeon may be vulnerable to capture, injury, and mortality in fisheries occurring in Virginia state waters. Information on the number of Atlantic sturgeon captured or killed in Virginia state fisheries is extremely limited and as such, efforts are currently underway to obtain more information on the numbers of these species captured and killed in state water fisheries. We are currently working with the Northeast Fisheries Observer Program (NEFOP), Atlantic States Marine Fisheries Commission (ASMFC), the Virginia Marine Resources Commission (VMRC), and the Virginia Aquarium and Marine Science Center to assess the impacts of state authorized fisheries on Atlantic sturgeon and other species. We are also currently working with Virginia on applications for ESA section 10(a)(1)(B) Incidental Take Permits to cover their fisheries; however, to date, no permit applications have been submitted. Below, we discuss the different fisheries authorized by the state of Virginia and any available information on interactions between these fisheries and Atlantic sturgeon.

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

Atlantic croaker fishery
An Atlantic croaker fishery using trawl and gillnet gear also occurs within the action area and sea turtle interactions have been observed in the fishery. Atlantic sturgeon interactions have been observed in the Atlantic croaker fishery, but a quantitative assessment of the number of Atlantic sturgeon captured in the croaker fishery is not available. A mortality rate of Atlantic sturgeon in commercial trawls has been estimated at 5%. A review of the NEFOP database indicates that from 2006-2010, 60 Atlantic sturgeon (out of a total of 726 observed interactions) were captured during observed trips where the trip target was identified as croaker. This represents a minimum number of Atlantic sturgeon captured in the croaker fishery during this time period as it only considers trips that included a NEFOP observer onboard.

Weakfish fishery

The weakfish fishery occurs in both state and Federal waters, but the majority of commercially and recreationally caught weakfish are caught in state waters (ASMFC 2002). The dominant commercial gears include gillnets, pound nets, haul seines, flynets, and trawls, with the majority of landings occurring in the fall and winter months (ASMFC 2002). Weakfish landings were dominated by the trawl fishery through the mid-1980s, after which gillnet landings began to account for most weakfish landed (ASMFC 2002). Virginia has ranked second among U.S. Atlantic states in annual landings since 1972 (ASMFC 2002).

A quantitative assessment of the number of Atlantic sturgeon captured in the weakfish fishery is not available. A mortality rate of Atlantic sturgeon in commercial trawls has been estimated at 5%. A review of the NEFOP observer database indicates that from 2006-2010, 36 Atlantic sturgeon (out of a total of 726 observed interactions) were captured during observed trips where the trip target was identified as weakfish. This represents a minimum number of Atlantic sturgeon captured in the weakfish fishery during this time period as it only considers observed trips, and most inshore fisheries are not observed. An earlier review of bycatch rates and landings for the weakfish fishery reported that the weakfish-striped bass fishery had an Atlantic sturgeon bycatch rate of 16% from 1989-2000; the weakfish-Atlantic croaker fishery had an Atlantic sturgeon bycatch rate of 0.02%, and the weakfish fishery had an Atlantic sturgeon bycatch rate of 1.0% (ASSRT 2007).

Whelk fishery

A whelk fishery using pot/trap gear is known to occur in Virginia waters of Chesapeake Bay. Whelk pots are not known to interact with Atlantic sturgeon.

Crab fisheries

Various crab fisheries, such as horseshoe crab and blue crab, also occur in Virginia state waters. Atlantic sturgeon are known to be caught in state water horseshoe crab fisheries, which currently operate in all Northeast U.S. states except New Jersey. Along the U.S. East Coast, hand, trawl, and dredge fisheries account for more than 85% of the commercial horseshoe crab landings in the bait fishery. Other methods used are gillnets, pound nets, and traps (ASMFC 2011a). State waters from Delaware to Virginia are closed to horseshoe crab harvest and landing from January 1 to June 7 (ASMFC 2011a). The majority of horseshoe crab landings in 2010 came from Massachusetts, Virginia, and Delaware. Stein *et al*. (2004) examined bycatch of Atlantic sturgeon using the NMFS sea-sampling/observer database (1989-2000) and found that the bycatch rate for horseshoe crabs was low, at 0.05%. An Atlantic sturgeon "reward program," where commercial fishermen were provided monetary rewards for reporting captures of Atlantic sturgeon in the Maryland waters of Chesapeake Bay, operated from 1996 to 2012 (Mangold *et al*. 2007).[6] The data from this program during the 11-year period of 1996-2006 show that one of 1,395 wild Atlantic sturgeon was found caught in a crab pot (Mangold *et al*. 2007).

Fish trap, seine, and channel net fisheries

No information on interactions between Atlantic sturgeon and fish traps, long haul seines, purse seines, or channel nets is currently available; however, depending on where this gear is set and

[6] The program was terminated in February 2012, with the listing of Atlantic sturgeon under the ESA.

the mesh size, the potential exists for Atlantic sturgeon to be entangled or captured in this gear.

Striped bass fishery

The striped bass fishery occurs in only in state waters, as Federal waters have been closed to the harvest and possession of striped bass since 1990, except that possession is allowed in a defined area around Block Island, Rhode Island (ASMFC 2011b). The ASMFC has managed striped bass since 1981, and provides guidance to states from Maine to North Carolina through an ISFMP. All states are required to have recreational and commercial size limits, recreational creel limits, and commercial quotas. The commercial striped bass fishery is closed in Maine, New Hampshire, and Connecticut, but open in Massachusetts (hook and line only), Rhode Island, New Jersey (hook and line only), Delaware, Maryland, Virginia, and North Carolina. Recreational striped bass fishing occurs all along the U.S. East Coast.

Several states have reported incidental catch of Atlantic sturgeon (NMFS Sturgeon Workshop 2011). Data from the Atlantic Coast Sturgeon Tagging Database (2000-2004) shows that the striped bass fishery accounted for 43% of Atlantic sturgeon recaptures (ASSRT 2007). The striped bass-weakfish fishery also had one of the highest bycatch rates of 30 directed fisheries according to NMFS Observer Program data from 1989-2000 (ASSRT 2007). However, greater rates of bycatch do not necessarily translate into high mortality rates. Other factors, such as gear, season, and soak times, may be important variables in understanding Atlantic sturgeon mortality.

State gillnet fisheries

Two 10- to 14-inch (25.6- to 35.9-centimeter) mesh gillnet fisheries, the black drum and sandbar shark gillnet fisheries, occur in Virginia state waters along the tip of the eastern shore, which is not located within the action area, but fish that use the action area may pass through. Based on gear type (i.e., gillnets), it is likely that Atlantic sturgeon would be vulnerable to capture in these fisheries. An Atlantic sturgeon "reward program" where fishermen were provided monetary rewards for reporting captures of Atlantic sturgeon, operated in the late 1990s in Virginia. The majority of reports of Atlantic sturgeon captures were in drift gillnets and pound nets. No quantitative information on the number of Atlantic sturgeon captured or killed in Virginia fisheries is currently available.

Poundnet Fishery

This fishery is managed by the states, except for regulations NMFS issued under the authority of the ESA to protect sea turtles. Atlantic sturgeon are known to become entrapped in pound nets and were routinely observed in Maryland waters, primarily through the USFWS reward program (U.S. FWS 2007). We have only anecdotal reports of Atlantic sturgeon entrapped in pound nets in Virginia.

We completed a biological opinion in 2018 on the gear regulations implemented by NMFS for the pound net fishery operating in nearshore coastal and estuarine waters of Virginia, including waters inside Chesapeake Bay. The biological opinion provides an ITS, which exempts the annual incidental take by entrapment, impingement, or entanglement of Atlantic sturgeon. Overall, we anticipate that the activities described in the biological opinion, will result in the take of up to 13 Atlantic sturgeon (one lethal).

State recreational fisheries
Atlantic sturgeon have been observed captured in hook-and-line gear, yet the number of interactions that occur annually is unknown. While most Atlantic sturgeon are likely to be released alive, we currently have no information on post-release survival. Although we do not currently have adequate information to quantify the level of take that occurs in state fisheries due to the lack of a federal nexus, we expect that take does occur and will continue to occur into the future. NMFS is currently working on a project to assess the extent of sea turtle interactions that occur in recreational fisheries of the Southeast (North Carolina to Florida) and believes that the survey platform and questionnaire may also be applicable for determining the amount of Atlantic sturgeon interactions as well.

5.3 Other Activities

5.3.1 Maritime Industry

Private and commercial vessels, including fishing vessels, operating in the action area of this consultation also have the potential to interact with Atlantic sturgeon. The effects of fishing vessels, recreational vessels, or other types of commercial vessels on ESA-listed species may involve disturbance or injury/mortality due to collisions or entanglement in anchor lines. During 2007-2010, researchers documented 31 carcasses of adult Atlantic sturgeon in the tidal freshwater portion of the James River, Virginia. Twenty-six of the carcasses had gashes from vessel propellers, and the remaining five carcasses were too decomposed to allow determination of the cause of death. The types of vessels responsible for these mortalities were not explicitly demonstrated. Most (84%) of the carcasses were found in a relatively narrow reach that was modified to increase shipping efficiency (Balazik *et al*. 2012). Listed species may also be affected by fuel oil spills resulting from vessel accidents. Fuel oil spills could affect animals through the food chain. However, these spills typically involve small amounts of material that are unlikely to adversely affect listed species. Larger oil spills may result from severe 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.

5.3.2 Pollution

Anthropogenic sources of marine pollution, while difficult to attribute to a specific Federal, state, local, or private action, may affect Atlantic sturgeon in the action area. Sources of pollutants in the action area include atmospheric loading of pollutants such as PCBs; storm water runoff from coastal towns, cities, and villages; runoff into rivers emptying into bays; groundwater discharges; wastewater and sewage treatment plant effluents; and oil spills. Nutrient loading from land-based sources, such as coastal communities and agricultural operations, is known to stimulate plankton blooms in closed or semi-closed estuarine systems. Contaminants could degrade habitat if pollution and other factors reduce the food available to Atlantic sturgeon, or may pose a threat to developing eggs, larvae, and juveniles. The effects from pollution are long term and ongoing.

5.3.3 Coastal Development

Beachfront development, lighting, and beach erosion control all are ongoing activities along the Mid- and South Atlantic coastlines of the U.S. These activities may degrade the aquatic habitat within the action area and affect various life stages of Atlantic sturgeon.

5.3.4 Vessel Traffic in the Action Area

Commercial, fishing, and recreational vessels use the channels of the James River FNP regularly. As discussed in Section 3.2.5 (data gathered from Waterborne Commerce Statistics Center and AIS), the total number of trips of all vessel types with drafts of 1 – 38 feet using the James River from the mouth, at Hampton Roads, to Richmond from 2012 – 2016 remained relatively stable at approximately 35,000. Further analysis indicates that deep draft tanker and cargo vessels with 40+ foot drafts do not pass Craney Island into the James River navigation channel, but an average of four cargo and tanker vessels with over 30 foot drafts passed into the federal navigation channel annually from 2012 to 2016, and an average of 44 vessels with drafts between 20 and 30 feet passed annually during that same time frame. The majority of the trips reported in the James River were made by vessels with drafts <10 feet (mean = 34,573), and vessels between 10 and 20 foot drafts making an average of 232 trips per year. Most of the vessels using the James River federal navigation channel are self-propelled dry cargo vessels. Because vessel trip frequency has remained relatively stable in recent years, there is no reason to expect an increase in the action area going forward, because as some vessels are added to the fleet, others are retired. That said, Atlantic sturgeon may interact with vessels in the shipping lanes of the James River if the vessels and individuals overlap in time and space.

5.3.5 Global Climate Change and Ocean Acidification

In addition to the information on climate change presented in the *Status of the Species* section for Atlantic sturgeon, the discussion below presents further background information on global climate change as well as past and projected effects of global climate change throughout the range of the ESA-listed species considered in this Opinion. Below is the available information on projected effects of climate change in the action area and how Atlantic sturgeon may be affected by those projected environmental changes. The effects are summarized on the time span of the proposed action, for which we can realistically analyze impacts, yet are discussed and considered for longer time periods when feasible.

In its Fifth Assessment Report (AR5) from 2013, the Intergovernmental Panel on Climate Change (IPCC) stated that the globally averaged combined land and ocean surface temperature data has shown a warming of 0.85°C (likely range: 0.65° to 1.06°C) over the period of 1880-2012. Similarly, the total increase between the average of the 1850-1900 period and the 2003-2012 period is 0.78°C (likely range: 0.72° to 0.85°C). On a global scale, ocean warming has been largest near the surface, with the upper 75 meters of the world's oceans having warmed by 0.11°C (likely range: 0.09° to 0.13°C) per decade over the period of 1971-2010 (IPCC 2013). The mean rate of global averaged sea level rise was 1.7 millimeters/year (likely range: 1.5 to 1.9 millimeters/year) between 1901 and 2010, 2.0 millimeters/year (likely range: 1.7 to 2.3

millimeters/year) between 1971 and 2010, and 3.2 millimeters/year (likely range: 2.8 to 3.6 millimeters/year) between 1993 and 2010.

Climate model projections exhibit a wide range of plausible scenarios for both temperature and precipitation over the next several decades. The global mean surface temperature change for the period 2016-2035 relative to 1986-2005 will likely be in the range of 0.3° to 0.7°C (medium confidence). This assessment is based on multiple lines of evidence and assumes there will be no major volcanic eruptions or secular changes in total solar irradiance. Relative to natural internal variability, near-term increases in seasonal mean and annual mean temperatures are expected to be larger in the tropics and subtropics than in mid- and high latitudes (high confidence). 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 also resulted in increased river discharge and glacial and sea-ice melting (Greene *et al.* 2008). The strongest ocean warming is projected for the surface in tropical and Northern Hemisphere subtropical regions. At greater depths, the warming will be most pronounced in the Southern Ocean (high confidence). Best estimates of ocean warming in the top 100 meters are about 0.6° to 2.0°C, and about 0.3° to 0.6°C at a depth of about 1,000 meters by the end of the 21st century (IPCC 2013).

Under Representative Concentration Pathway (RCP) 8.5, the climate change scenario where emission levels continue to rise throughout the 21st century, the projected change in global mean surface air temperature and global mean sea level rise for the mid- and late 21st century relative to the reference period of 1986-2005 is as follows. Global average surface temperatures are likely to be 2.0°C higher (likely range: 1.4° to 2.6°C) from 2046-2065 and 3.7°C higher (likely range: 2.6° to 4.8°C) from 2081-2100. Global mean sea levels are likely to be 0.30 meters higher (likely range: 0.22 to 0.38 meters) from 2046-2065 and 0.63 meters higher (likely range: 0.45 to 0.82 meters) from 2081-2100, with a rate of sea level rise during 2081-2100 of 8 to 16 millimeters/year (medium confidence). There is uncertainty about the magnitude of global sea level rise, projected to rise .30 to 1.22 meters by 2100, as it is primarily dependent on the dynamics of ice sheet melting (Melillo *et al.*, 2014).

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 (IPCC 2007; Greene *et al.* 2008). 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 2000s showed that the NAO index 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 1,000 meters deep and is deeper than anywhere in the world's oceans and is particularly evident under the Gulf Stream/North Atlantic Current system (IPCC 2007). 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 (IPCC 2007; Greene *et al.* 2008). 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 entire world (Greene *et al.* 2008).

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 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 have been most apparent over the past few decades, although this may also be due to increased research. Below, we discuss information on future impacts of climate change in the action area.

While predictions are available regarding potential effects of climate change globally, it is more difficult to assess the potential effects of climate change over the next few decades on coastal and marine resources on smaller geographic scales, such as the action area, 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 of the U.S. Warming is very likely to continue in the U.S. over the life span of the project regardless of reduction in greenhouse gases, 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 during the life of the project, and it is possible that they 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).

Expected consequences of climate change for river systems 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 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 along the U.S. Atlantic coast 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 0.2ºC per decade; and 3) a rise in sea level (NAST 2000). Sea level is expected to continue rising; during the 20th century global sea level has increased 15 to 20 centimeters. It is also important to note that ocean temperature in the U.S. Northeast Shelf and surrounding Northwest Atlantic waters have warmed faster than the global average over the last decade (Pershing *et al.* 2015). New projections for the U.S. Northeast Shelf and Northwest Atlantic Ocean suggest that this region will warm two to three times faster than the global average and thus existing projections from the IPCC may be too conservative (Saba *et al.* 2015). Hare *et al.* (2016b) provides a literature summary of other aspects of the climate system that is changing on the U.S. Northeast Shelf including a high rate of sea-level rise, as well as increases in annual precipitation and river flow, magnitude of extreme precipitation events, magnitude and frequency of floods, and dissolved CO_2.

Effects on Atlantic sturgeon in the Action Area

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. We have analyzed the available information, however, to consider likely impacts to sturgeon and their habitat in the action area. We consider here, likely effects of climate change during the life span of the project.

Atlantic sturgeon have persisted for millions of years and have experienced wide variations in global climate conditions, to which they have successfully adapted. Climate change at historical rates (thousands of years) is not thought to have been a problem for sturgeon species. However, at the current rate of global climate change, future effects to sturgeon are possible. Rising sea level may result in the salt wedge moving upstream in affected rivers. Atlantic sturgeon spawning occurs in fresh water reaches of the James River because early life stages have little to no tolerance for salinity. Similarly, juvenile sturgeon have limited tolerance to salinity and remain in waters with a salinity gradient that they adapt to over time. If the salt wedge moves further upstream, sturgeon spawning and rearing habitat could be restricted to the upper portions of the James where, as discussed previously, only 20% of surveyed habitat between Bosher's Dam (RM 99 and Turkey Island Cutoff (approximately RM 75) is suitable (i.e., hard bottom). 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 salt wedge would be limited. In the James River, Bosher's Dam would represent such an impediment. 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 the James River, spawning occurs for miles upstream of the salt wedge. It is unlikely that shifts in the location of the salt wedge 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 dissolved oxygen (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 are tolerant to 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 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.

Atlantic sturgeon in the action area are most likely to experience the effects of global climate change in warming water temperatures, which could change their range and migratory patterns. Warming temperatures predicted to occur over the next 100 years would likely result in a northward shift/extension of their range (i.e., into the St. Lawrence River, Canada) while truncating the southern distribution, thus affecting the recruitment and distribution of sturgeon rangewide. The increase in sea surface temperature over the life of the proposed action is expected to be minimal, and thus, it is unlikely that this expanded range will be observed in the near future. If any shift does occur, it is likely to be minimal and thus, it seems unlikely that this small increase in temperature will cause a significant effect to Atlantic sturgeon or a significant modification to the number of sturgeon likely to be present in the action area over the life of the proposed action. However, even a small increase in temperate can affect DO concentrations. A one degree change in temperature in Chesapeake Bay could make parts of Chesapeake Bay inaccessible to sturgeon due to decreased levels of DO (Batiuk *et al.* 2009) and projections, from global climate models representing a wide range of potential futures, suggest water temperature increases in the bay of 2-5.5°C (3.5-9°F) by the end of the 21st century.

The action area includes spawning grounds for Atlantic sturgeon, and elevated temperatures could modify cues for spawning migration, resulting in an earlier spawning season, and thus, altering the time of year sturgeon may or may not be present within the action area. This may cause an increase or decrease in the number of sturgeon present in the action area. 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 will affect the seasonal movements of sturgeon through the action area.

In addition, changes in water temperature may also alter the forage base and thus, foraging behavior of sturgeon. Any forage species that are temperature-dependent may also shift in distribution as water temperatures warm and cause a shift in the distribution of sturgeon. However, because we do not know the adaptive capacity of these species 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.

5.4 Reducing Threats to ESA-listed Species

5.4.1 Education and Outreach Activities

Education and outreach activities are considered some of the primary tools that will effectively reduce the threats to all protected species. For example, NMFS has been active in public outreach to educate fishermen about handling and resuscitation techniques for Atlantic sturgeon, and educates recreational fishermen and boaters on how to avoid interactions with these species. NMFS also has a program called "SCUTES" (Student Collaborating to Undertake Tracking Efforts for Sturgeon), which offers educational programs and activities about the movements, behaviors, and threats to sturgeon. NMFS intends to continue these outreach efforts in the action area in an attempt to reduce interactions with protected species, and to reduce the likelihood of injury to protected species when interactions do occur.

5.4.2 Salvage Program

A salvage program is in place for sturgeon. Sturgeon carcasses can provide pertinent life history data and information on new or evolving threats. Their use in scientific research studies can reduce the need to collect live sturgeon. Our Sturgeon Salvage Program is a network of individuals qualified to retrieve and/or use sturgeon carcasses and parts for scientific research and education. All carcasses and parts are retrieved opportunistically and participation in the network is voluntary.

5.4.3 Regulatory Measures for Atlantic Sturgeon

Sturgeon Recovery Planning
Several conservation actions aimed at reducing threats to Atlantic sturgeon are currently ongoing. In the near future, we will be convening a recovery team and drafting a recovery plan which will outline recovery goals and criteria and steps necessary to recover all Atlantic

sturgeon DPSs. Numerous research activities are underway for sturgeon, involving us and other Federal, state, and academic partners, to obtain more information on the distribution and abundance of sturgeon throughout their range, including in the action area. Efforts are also underway to better understand threats faced by sturgeon and ways to minimize these threats, including bycatch and water quality. Fishing gear research is underway to design fishing gear that minimizes interactions with Atlantic sturgeon while maximizing retention of targeted fish species. Several states are in the process of preparing ESA section 10 Habitat Conservation Plans aimed at minimizing the effects of state fisheries on Atlantic sturgeon.

Research Activity Guidelines
Research activities aid in the conservation of listed species by furthering our understanding of the species' life history and biological requirements. We recognize, however, that many scientific research activities involve capture and may pose some level of risk to individuals or to the species. Therefore, it is necessary for research activities to be carried out in a manner that minimizes the adverse impacts of the activities on individuals and the species while obtaining crucial information that will benefit the species. Guidelines developed by sturgeon researchers in cooperation with NMFS staff (Moser *et al.* 2000; Damon-Randall *et al.* 2010; Kahn and Mohead 2010) provide standardized research protocols that minimize the risk to sturgeon from capture, handling, and sampling. These guidelines must be followed by any entity receiving a federal permit to do research on Atlantic sturgeon.

Protections for the GOM DPS of Atlantic Sturgeon
The prohibitions listed under section 9(a)(1) of the ESA automatically apply when a species is listed as endangered but not when listed as threatened. When a species is listed as threatened, section 4(d) of the ESA requires the Secretary of Commerce (Secretary) to issue regulations, as deemed necessary and advisable, to provide for the conservation of the species. The Secretary may, with respect to any threatened species, issue regulations that prohibit any act covered under section 9(a)(1). Whether section 9(a)(1) prohibitions are necessary and advisable for a threatened species is largely dependent on the biological status of the species and the potential impacts of various activities on the species. On June 10, 2011, we proposed protective measures for the GOM DPS of Atlantic sturgeon (76 FR 34023). On November 19, 2013 we published a final rule that applied all prohibitions of section 9(a)(1) to the GOM DPS beginning on December 19, 2013 (78 FR 69310).

5.5 Summary of Available Information on Listed Species Likely to be Adversely Affected by the Proposed Action in the Action Area

The marine and estuarine range of all five Atlantic sturgeon DPSs overlaps and extends from Canada through Cape Canaveral, Florida. Based on the best available information, sub-adult and adult Atlantic sturgeon originating from any of five DPSs could occur in the action area within the James River. However, because we have determined that all life stages of Atlantic sturgeon are present in the action area (although presence may vary by location and time of year (Table 14)), all spawning adults, and early life stages (eggs, larvae, and juveniles) are from the Chesapeake Bay DPS, only. Adult Atlantic sturgeon that spawn in the fall likely stage in the summer and fall in brackish water between RM 14 and 66 (Balazik and Musick 2015). Fall spawning likely occurs between RM 65 and the fall line near Richmond (RM 96) (Balazik et al.

2012), while spring spawning likely occurs around RM 56 and 60 (Balazik and Musick 2015). Larvae rear in freshwater reaches downstream of spawning locations (ASSRT 2007), and juveniles are likely present throughout the James River year-round (Balazik et al. 2012). Because of the small, and benthic nature of early life stages, entrainment in dredges, and exposure to increased turbidity and vessel traffic may occur.

Table 10. Atlantic sturgeon presence in the James River by river segment of action area and life stage.

Location	Life Stage	Presence Timeframe
Lower Segment (RM 5 - 26)	Eggs/YSL	-
	PYSL	-
	Juvenile	Year-round
	Sub-adult	March – November
	Adult	March – November
Middle Segment (RM 27 - 72)	Eggs/YSL	Spring spawn: March – May/June (RM 56 - 60) Fall spawn: mid-August – November (RM 65 -96)
	PYSL	Spring: April – mid-July* Fall: September – December*
	Juvenile	Year-round
	Sub-adult	March – November
	Adult	March – November
Upper Segment (RM 73 – 99)	Eggs/YSL	Fall spawn: August – November
	PYSL	Fall: September – December*
	Juvenile	Year-round
	Sub-adult	March – November
	Adult	March – November

*Larvae may drift downstream of spawning areas but remain above the salt wedge, which is generally located at RM 47, although this may vary and reach further downstream during some spring seasons.

Diets of adult and subadult Atlantic sturgeon include mollusks, gastropods, amphipods, annelids, decapods, isopods, and fish such as sand lance (Bigelow and Schroeder 1953; ASSRT 2007; Guilbard *et al.* 2007; Savoy 2007). Juvenile Atlantic sturgeon feed on aquatic insects, insect larvae, and other invertebrates (Bigelow and Schroeder 1953; ASSRT 2007; Guilbard *et al.* 2007). In general, foraging occurs where suitable forage and appropriate habitat conditions are present (ASSRT 2007). Because of the benthic nature of their prey, it is likely that foraging juveniles or small-sub-adult Atlantic sturgeon could swim into and ultimately be entrapped during dredging operations in the action area. Additionally, dredging operations, through direct removal and increased turbidity may affect the quality and quantity of prey resources in the action area.

6.0 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). This Opinion examines the likely effects (direct, indirect, and interrelated/interdependent) of the proposed action on five DPSs of Atlantic sturgeon in the action area and their habitat within the context of the species status now and projected over the course of the action, the environmental baseline, and cumulative effects. As explained in the "Description of the Action" section, the action under consideration in this Opinion is the ongoing maintenance dredging and disposal to the James River navigation channel from now until 2062.

As explained in the "Description of the Proposed Action" section above, hydraulic cutterhead, dredges will be used for all maintenance dredging activities. Below, the discussion will consider the effects of dredging and disposal, including the risk of entrainment or capture, and burial/suffocation of Atlantic sturgeon. We also consider effects of dredging and disposal on water quality, including turbidity/suspended sediment, and effects of project vessel traffic. This analysis also includes effects of the action on prey, foraging, and spawning habitat.

6.1 Entrainment in Hydraulic Cutterhead Dredges

6.1.1 Available Information on the Risk of Entrainment of Atlantic Sturgeon in Cutterhead Dredges

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). High flow rates and larger pipes create greater suction velocities and wider flow fields. The suction produced decreases exponentially with distance from the dredge head (Boysen and Hoover 2009). With a cutterhead dredge, material is pumped directly from the dredged area to a disposal site. As such, there is no opportunity to monitor for biological material on board the dredge; rather, observers typically work at the disposal site to inspect material. Because all disposal in the lower and middle segments of the river are directly overboard from the dredge vessel and adjacent to the dredge cut, observers will not be able to examine the material dredged and disposed of overboard. Upland disposal only happens in the upper segment of the river and observers are required at these disposal sites.

It is generally assumed that non-larval sturgeon (i.e., juveniles, sub-adults, and adults) 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., indicating that although it is unlikely adult fish will be entrained, it is possible. An assessment of the condition of the fish indicated that the fish were likely alive and in good condition prior to entrainment and that they were both adult females. The area where dredging was occurring was a known overwintering area for shortnose sturgeon and large numbers of shortnose sturgeon were known to be concentrated in the general area. A total of 509,946 cy were dredged via cutterhead dredge between Florence and the upper end of Newbold Island during that dredge cycle. Since that time, dredging occurring in the winter months in the Newbold – Kinkora range in the Delaware River require that inspectors conduct daily inspections of the dredge spoil area in an attempt to detect the presence of any sturgeon. In January 1998, three shortnose sturgeon carcasses were discovered in the Money Island Disposal Area. The sturgeon were found on three separate dates: January 6, January 12, and January 13. Dredging was being conducted in the Kinkora and Florence ranges at this time which also overlaps with the shortnose sturgeon overwintering area. A total of 512,923 cy of material was dredged between Florence and upper Newbold Island during that dredge cycle. While it is possible that not all shortnose sturgeon killed during dredging operations were observed at the dredge disposal pool, USACE has indicated that due to flow patterns in the pool, it is expected that all large material (i.e., sturgeon, logs etc.) will move towards the edges of the pool and be readily observable.

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

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

Several scientific studies have been undertaken to understand the ability of sturgeon to avoid cutterhead dredges. Hoover *et al.* (2011) demonstrated the swimming performance of juvenile lake sturgeon and pallid sturgeon (12 – 17.3 cm FL) in laboratory evaluations. The authors compared swimming behaviors and abilities in water velocities ranging from 10 to 90 cm/second (0.33-3.0 feet per second). 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 (3.3 feet), 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 (3.3. feet) of an operating dredge head, all fish would escape when the pipe was 24 inches 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 26 inches. 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. Amaral and Sullivan (2004) reported a prolonged swimming speed of 39 cm/s (15.3 in/s) for a 16 cm sturgeon (i.e., late-stage larvae), which is consistent with Boysen and Hoover (2009). Early-stage larvae passively drift and would not be able to escape dredges by actively swimming.

Clarke (2011) reports that a cutterhead dredge with a suction pipe diameter of 36 inches (the maximum size used for this project, with more often diameters of 16 to 20 inches) 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 10 cm/s at a distance of 3.0 meters. Clarke also reports on swim tunnel performance tests conducted on juvenile and subadult Atlantic, white and lake sturgeon. He concludes that there is a risk of sturgeon entrainment only within 1 meter of a cutterhead dredge head with a 36 inchpipe diameter and suction of 4.6 m/second.

The risk of an individual sturgeon being entrained in a cutterhead dredge is difficult to calculate. While a large area overall will be dredged, the dredge operates in an extremely small area at any given time (i.e., the river 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 one 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 one meter of the dredge. Information from the tracking studies in the James and Delaware River supports these assessments of risk, as none of the tagged sturgeon were attracted to or entrained in the operating dredges.

The entrainment of five sturgeon in the upper Delaware River, and studies of earlier life stages (juveniles and post yolk sac larve (PYSL)) in proxy sturgeon species, indicates that entrainment of sturgeon in cutterhead dredges is possible. 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. These conditions are not known to occur in the James River. However, because of the length of the continued action (44 years), and the amount of dredging per year (up to 1.5 million cy of material), the possibility does exist for fish to become entrained, based on the best available information, at some point over the duration of the action. The risk of entrainment is related to size of the fish, as well as the duration and frequency of dredging events and how those events overlap with sturgeon presence in the action area. Because duration and frequency can vary, as a proxy, we can determine the level of potential entrainment of individuals using the volume of sediments removed. Based on previous dredging events in the Delaware River and precedents set in the previous biological opinion for this action among others, we have determined that one individual Atlantic sturgeon per total number of cubic yards is a reasonable proxy for take. In the case of this action, one individual per 1.5 million cy material (maximum volume removed per year) until 2062 may be taken.

6.1.2 Predicted Entrainment of Atlantic sturgeon in a Cutterhead Dredge in the Action Area

Non-larval Sturgeon

Non-larval Atlantic sturgeon (adults, sub-adults, and juveniles) are at low risk of entrainment in cutterhead dredges because a dredge head needs to be within one meter of them in order to potentially affect their ability to swim away. As studies in the Delaware and James Rivers has shown, sturgeon do not typically react to cutterhead dredge presence. Juveniles may be found throughout the river year round from the salt wedge down to the mouth; however, sub-adults are present most often below the salt front, and adults throughout the river, from March through November, and typically absent from December through February. Regular maintenance dredging in the James River occurs from July through February, thus each non-larval life stage will have overlap with the presence of periodic maintenance dredging and disposal. The smaller size of juveniles and sub-adults make them more likely than large adult Atlantic sturgeon to be at risk of entrainment, and for the purposes of the Biological Opinion, we assume that adults will not be entrained.

The entrainment of five shortnose sturgeon in the upper Delaware River indicates that entrainment of sturgeon in cutterhead dredges is possible. As mentioned, 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 this action. The season (entrainment during winter months), the behavior of the fish (overwintering in dense aggregations where they rest on the bottom and exhibit little movement and may be slow to respond to stimuli such as an oncoming dredge), and the location (fairly narrow and constricted portion of the Delaware River), may have all played a role in limiting the ability of sturgeon to avoid the oncoming dredge. Although some parts of the action area within the James River may be narrow, cutterhead dredging will not occur where fish may be aggregating (i.e., pre-spawning staging areas in the James River occur in the wide lower river, and adults leave the river in December (Balazik *et al*. 2012), and overwintering is not known to occur in dredging footprints). There is some evidence of juveniles spend their winters between RM 37 and 56 where the river is not considerably constricted in width (Balazik pers comm 2018). Additionally, anecdotal evidence of overwintering by juveniles and sub-adults occur in deep waters as opposed to shoaling areas, and specifically in a 100 foot deep hole a few miles below Tribell Shoal (near Deepwater Shoal) (approximately RM 18-20). Also, sub-adults are thought to aggregate in large numbers in the lower Chesapeake Bay outside of the James River (Balazik, pers comm. 2018). Dredging will not be occurring at Deepwater shoal or in any deep holes, but rather only in the shoaled areas of the channel that have already been identified.

Because the only entrainment of Atlantic or shortnose sturgeon in cutterhead dredges in the United States has been the five shortnose sturgeon found at the disposal site in the upper Delaware River it is difficult to predict the number of Atlantic sturgeon that are likely to be entrained during cutterhead dredging in the action area. Based on the available information presented here, entrainment in a cutterhead dredge is likely to be rare, and would only occur if a sturgeon was within one meter of the dredge head. However, because we know that entrainment is possible, we expect that over the project life considered here, some entrainment with a cutterhead dredge will occur. Based on the predicted rarity of the entrainment event, we expect that no more than one sub-adult or juvenile Atlantic sturgeon will be entrained per 1.5 million cy (no more than 1 per year) that a cutterhead dredge is used for maintenance dredging in the action area. Due to the force of the suction, travel through up to several miles of pipe, and any residency period in the disposal area, all entrained Atlantic sturgeon are expected to be killed.

Based on the mixed stock analysis, it is likely that most of the entrained sub-adult Atlantic sturgeon will originate from the Chesapeake Bay DPS but could also originate from the Gulf of Maine, New York Bight, Carolina, or South Atlantic DPS. If juvenile fish are entrained, they will be from the Chesapeake Bay DPS, only. In 2012 we used this same mixed stock analysis and determined that a total of 50 fish (1 mortality per 1.5 million cy (the estimated maximum dredge volume per year) would be taken until 2062 (assuming no more than one mortality per year). Based on the best available information discussed in this Opinion and the dredge volumes from 2012-2018 provided by the USACE, we have determined that approximately 3 subadult and/or juvenile fish have been taken during this six year timeframe. As such, going forward for the next 44 years of the action, 47 fish may be taken. Given the mixed stock percentages presented in the "Status of the Species" we expect the following mortality of Atlantic sturgeon in cutterhead dredges from 2018 until 2062:

Table 11: Expected Takes of Atlantic Sturgeon by Cutterhead Dredges

Number of Atlantic Sturgeon over the life span of the Project	DPS
1	New York Bight
1	South Atlantic
43	Chesapeake Bay
1	Gulf of Maine
1	Carolina

Effects to Post Yolk-Sac Larvae (PYSL)

Post yolk-sac larvae (PYSL) are free swimming, prefer the deepest parts of the river, may seek refuge in hard bottom substrate, and forage in soft substrates. Except for hard bottom substrate, this habitat is similar to that found in the navigation channels. Hard bottom has not been identified in any of the channel areas as discussed in section 3.1.2.1. Given the limited mobility of PYSL, especially early stage PYSL that passively drift, we expect some entrainment to occur.

Routine maintenance dredging in freshwater reaches of the action area (approximately RM 47 to RM 99) is expected to occur July 1st through February 14th of each year, which overlaps with the time of year when PYSL will be present in the action area. Conservatively, PYSL are present in the James River April through July and September through December, with August being the month after spring spawning where larvae are generally transitioning into small juveniles, and before the beginning of fall spawning which typically occurs in September. Thus overlap with dredging occurs July, September, October, November, and December of each year. Although not all shoals are dredged yearly, shoals within this stretch of the river are on a 1-3 year schedule, with some dredging being more intermittent (8-15 years).

PYSL are expected to be near the bottom of the river, either foraging over soft substrates or resting/seeking refuge within hard substrates with big enough interstitial spaces to provide cover. Given the small size of PYSL (14-37mm for Atlantics), and the intake velocity of cutterhead dredges (~4.6m/second), it is unlikely that a PYSL that is over or within substrates being removed by the dredge could avoid entrainment. Additionally, the possible size of openings in the cutterhead suction pipe (~16-20 inches, maximum of 36 inches) would not provide any screening or protection from entrainment. Cutterhead dredge operators minimize exposure of PYSL to the suction of the cutterhead intake by not turning on the suction until the cutterhead is properly seated on the bottom sediments and by doing their best to maintain contact between the dredge head and the bottom; however, if PYSL are right at the bottom or are settled into areas of cobble or gravel, this may offer little protection. Because this action does not include dredging in any portions of cobble or hard bottom habitat, only foraging or early-stage drifting PYSL are at risk for entrainment. As such, no eggs or yolk-sac larvae (YSL) will be entrained because they occur over cobble/hard-bottom substrates.

To date, monitoring of entrainment of sturgeon larvae has not occurred. There is very limited information on the risk of fish larvae to dredge entrainment generally and we are not aware of any studies on the entrainment of sturgeon larvae during dredging with the exception of one study in Russia which does not provide enough information to provide any insights on risk

(Veshchev 1981, as cited in USACE DOER 1998). We also do not have any estimates for the numbers of PYSL that may occur in the navigation channel from July and September through December. Therefore, in order to assess the impacts of dredge entrainment on PYSL we need to make a number of assumptions. First, we assume that any PYSL that are present in the areas being dredged will be entrained and that the mortality rate will be high. These are reasonable assumptions give the limited ability of PYSL to avoid the dredge intake, as well as the almost certain mortality due to suffocation or burial within the sediments at the disposal sites. Because we do not know how many PYSL will be present in the areas to be dredged we cannot determine the number that will be entrained. However, we can make a reasonable prediction of the proportion of the total PYSL in a particular year class that are likely to be entrained in a dredge. To make this prediction, and because we do not have the information to determine exactly when and where PYSL will be present at any given time, we must make assumptions about the spatial and temporal distribution of PYSL in the river. These assumptions are informed by what we know about the seasonal presence of this life stage (i.e., based on when we expect spawning to occur we can calculate the time of year when PYSL would be present in the river) and by what we know about where PYSL would occur in the river (i.e., only within freshwater, but not limited to the hard substrates where eggs and yolk-sac larvae are present).

Given this information, we assume that Atlantic sturgeon PSYL are evenly distributed temporally (i.e., across the months of July to December) and spatially (within the mainstem James River between the upstream limit of potential spawning grounds (RM 99 (Bosher's Dam)) and the salt front (RM 47)) throughout the space and time when and where this life stage can occur in the river. These are reasonable assumptions because we know that spawning is spread out over time (e.g., see tracking of spawning condition Atlantic sturgeon adults in Breece *et al.* 2013) and therefore, an entire year class will not transition from one life stage to another all at the same time, but rather over a range of time. In addition, we also know that not all spawning happens in one place (spring spawning and fall spawning events occur in different locations on the James River), which provides some distribution of early life stages throughout the action area; in addition to the fact that PYSL move away from the spawning sites, although are still restricted to freshwater (ASSRT 2007), and as such PYSL could occur anywhere throughout the tidal freshwater reach of the action area (above approximately RM 47).

We conducted an ArcGIS analysis to approximate the area of the James River from RM 47 (approximate location of the salt front above which is tidal freshwater habitat that may support spawning and larval development) to RM 99 (Bosher's Dam), and arrived at an estimated area of 49.5 square miles where PYSL may be present in July and September through December, the months that overlap with dredging activities. Assuming that an equal amount of PYSL are present in each of the eight months (April to July and September to December) when this life stage is present in the river. then PYSL would potentially be exposed to cutterhead dredging 62.5% of the time the year class is present or, alternatively, 37.5% of each year class will not be exposed to dredging effects (April, May, and June).

Annual maintenance dredging may overlap with Atlantic sturgeon PYSL in July and September through December (62.5% of the time the year class may be present), and will target shoals that are approximately a total of 1.8 square miles in size (3.6% of the total area where PYSL may be distributed). Therefore, we estimate that 2.2% (i.e., 0.625 x 0.036 = 0.022, rounded to the nearest tenth of a percent) of the Atlantic sturgeon PYSL year class will be killed due to maintenance dredging in freshwater portions of the James River from RM 47 to RM 99 each year for the duration of the action (until 2062).

It is important to note that while previous Biological Opinions issued by us for these projects have not identified or attempted to quantify the mortality of Atlantic PSYL during maintenance dredging, this is not a new threat or source of mortality. Rather, this new analysis is a reflection of having more information and an enhanced understanding of the likely risks to sturgeon from ongoing maintenance of the James River federal navigation channel.

6.1.3 Predicted Effects of Entrainment during Pipeline Priming

Both submerged and floating pipelines may be used in the proposed action to transport dredged sediment to both upland and overboard placement areas. Pipelines are submerged by pumping water into them and sinking them to the river bottom using the same suction as when the cutterhead dredge is operating in the channel. This action is discrete and takes place prior to the commencement of dredging, but may present an entrainment risk. Because the process of pumping water into the pipeline takes place in the same locations as active dredging, PYSL, juvenile, sub-adult, and adult sturgeon may be exposed to the effects of entrainment from suction force. The suction force is similar to when the cutterhead is running during operation, but the dredge is not moving. Eggs and yolk-sac larval sturgeon, located in spawning grounds over hard bottom habitat outside of the dredging areas, would not be exposed to the effects of pipeline priming. Adult Atlantic sturgeon are too large to be entrained in the pipeline priming activities, and although sub-adults and juveniles may be susceptible to entrainment during active dredging, the probability that they be entrained during a discrete pipeline priming is extremely low, because the activity is very short-lived (approximately one hour; Wood, pers comm.) and stationary, and fish would need to be within 1 meter of the draghead in order for effects to be experienced, thus any effects to these life stages are extremely unlikely to occur and discountable. Early and late-stage PYSL larvae drift or swim in the water column and are, thus, susceptible to entrainment when water is pumped into pipelines, as described above in Section 6.1.2. However, our analysis of cutterhead dredging effects is based on the areal extent of dredging, and because priming of the pipeline does not increase the dredge footprint, and only lasts for a short period of time, we do not expect additional effects beyond what has already been considered. Thus any additional effects to PYSL are extremely unlikely to occur, and discountable.

6.2 Interactions with Suspended Sediments

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

6.2.1 Cutterhead Dredging

Cutterhead dredges use suction to entrain sediment for pumping through a pipeline to a designated discharge site. Production rates vary greatly based on pump capacities and the type (size and rotational speed) of cutter used, as well as distance between the cutterhead and the substrate. Sediments are re-suspended during lateral swinging of the cutterhead as the dredge progresses forward. Modeling results of cutterhead dredging indicated that TSS concentrations above background levels would be present throughout the bottom six feet of the water column for a distance of approximately 1,000 feet (USACE 1983). Based on these analyses, elevated suspended sediment levels are expected to be present within a 1,000 foot radius of the of the cutterhead dredge. TSS concentrations associated with cutterhead dredge sediment plumes typically range from 11.5 to 282.0 mg/L with the highest levels detected adjacent to the cutterhead dredge and concentrations decreasing with greater distance from the dredge (Nightingale and Simenstad 2001).

6.2.2 Dredged Material Disposal

All dredged material from the James River FNP will be placed overboard in adjacent sediment placement areas to channel shoals (middle and lower river segments) or in nearby diked upland sites along the shoreline of the river (upper river segment). Overboard placement areas are generally shallow (0 – 20 feet deep) with soft-sediment bottoms and are adjacent to maintained shoaling portions of the channel. An energy-dissipating device, such as a baffle plate or diffuser, will be installed on the end of the discharge pipe and discharges occur a minimum of 3 feet below the water surface at authorized overboard placement areas to help minimize turbidity. A submerged or combination floating/submerged pipeline will transport dredged material to confined upland placement areas.

The best available information from studies in the James River (Lackey *et al*. 2017) indicate that turbidity levels of up to 550 mg/l may be experienced at placement sites for approximately 1,000 feet downstream, and 300 feet to either side of the disposal area.

Far-field modeling of the middle James River at Dancing Point – Swann Point Shoal Channel indicates the maximum depth of deposited material outside of the authorized placement area was 0.5 cm (Lackey, pers. comm.). Covering white perch eggs with sediment less than 0.45 mm thick did not negatively impact hatchability; however, egg development decreased when sediments were over 0.8 mm think, and 100% mortality of eggs occurred when covered with 2 mm of sediment (Morgan et al. 1983). As such, burial of eggs and larvae in hard bottom habitat could be lethal.

6.2.3 Effects of Turbidity and Suspended Sediments on Atlantic Sturgeon

Effects to Mobile Life Stages

Atlantic sturgeon adults, sub-adults, juveniles, and PYSL are all free-swimming with the ability to avoid sediment plumes when they are present. Studies of the effects of turbid water 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 TSS levels expected for all of the proposed activities (ranging from 11 mg/l to 550 mg/l) are below those shown to have adverse effect on fish (580 mg/l for the most sensitive species, with 1,000 mg/l more typical; see summary of scientific literature in Burton 1993). Dredging activities produce plumes with concentrations (11 mg/l to 282 mg/l) less than those show to affect benthic communities (390 mg/l (EPA 1986)). Near field disposal activities (up to 550 mg/l for a short duration), may pose a risk of adverse effects to benthic communities.

We expect elevated levels of TSS to settle out of the water column relatively quickly. The USACE has indicated in their near and far field studies within the James River between 2005 and 2010 (discussed in the BA), within five hours of dredging only 1.5% of sediment remained suspended within 1,000 feet of the dredging areas, and 2-7% of solids remained downstream, in the nearfield, of the overboard placement areas. Mobile prey items will likely be able to uncover themselves from any deposited sediment as the conditions in the area return to baseline conditions, while a small percentage of non-mobile prey in the near field range of disposal may be buried/suffocated. Therefore, effects to sturgeon foraging opportunities from TSS impacts to benthic communities, are largely temporary and limited to a small area (i.e., the near-field range of where disposal occurs). As mentioned, cutterhead dredging produces TSS of 11-282 mg/l and are below levels shown to affect fish or benthic communities. Disposal activities (up to 550 mg/l) also produce TSS less than those shown to affect normal fish behavior. TSS is most likely to affect mobile sturgeon (post yolk-sac larvae and older) if a plume causes a barrier to normal behaviors. However, the increase in TSS levels expected are below those shown to have adverse effects on fish, so we expect sturgeon to either swim through the plumes or make small evasive movements to avoid them. Based on the best available information, we will not be able to meaningfully detect, evaluate, or measure the effects of re-suspended sediment on sturgeon resulting from dredging activities when added to baseline conditions. Therefore, effects on mobile sturgeon are insignificant.

Effects to Non-mobile Life Stages

The life stages of sturgeon most vulnerable to increased sediment are eggs and non-mobile yolk-sac larvae which are subject to burial and suffocation while they develop in areas characterized by hard bottom habitat. Eggs and yolk-sac larvae may be present March-May/June and August through November. For this action, activities producing suspended sediments may co-occur with Atlantic sturgeon spawning and eggs and yolk-sac larvae from July through November (time when dredging occurs to when eggs and yolk-sac larvae may still be present). While we do not expect spawning or yolk sac larvae to occur within the shoals or soft substrates targeted for maintenance dredging or disposal, sediment plumes extend outside of the dredge and disposal footprint. Currently we do not know the exact locations of hard bottom habitat in the vicinity of dredging and disposal sites. But as previously discussed, we know that flushing is high within the river (6,000 mgd) and even in the shoal areas where water flow and hydraulic gradients are naturally lower, materials are flushing out, as discussed above.

Generally speaking, portions of the river with swift currents and high hydraulic gradients are characterized by high rates of sediment transport through the area, which expose underlying hard bottom sediments (i.e., gravel, boulder or cobble). As discussed in Section 4.1.3., hard bottom habitat is not likely to be present in the immediate vicinity (up to 1,000 feet away) from the shoaling sites based on USACE studies and general river morphology information for the dredging and disposal areas. We expect spawning, eggs, and yolk-sac larvae to occur over hard bottom substrate with relatively sheltered interstitial spaces amongst exposed bedrock outcrops, boulders, and large cobble. The fact that these areas have maintained exposed outcrops of bedrock, boulders, and cobbles demonstrates that they are in locations where the current and sediment transport keep them clear of soft substrate deposits, and these areas are unlikely to occur adjacent to shoal and low energy disposal areas where soft sediment is abundant. However, if sediment plumes were to drift into areas where hard bottom is exposed and potentially functioning as spawning habitat, we expect the water velocities in these areas to quickly transport any sediment from turbidity producing activities downstream before it settles on spawning habitat or harms fertilized eggs or yolk sac larvae. Therefore, adverse effects to sturgeon spawning habitat, eggs, and yolk-sac larvae are extremely unlikely, and discountable.

Tissue sampling

Although unlikely because of the nature of cutterhead dredges, genetic samples will need to be taken from any captured fish. This will be done by taking a small (1 cm^2) tissue sample, clipped with surgical scissors from a section of soft fin rays. This procedure does not appear to impair the sturgeon's ability to swim and is not thought to have any long-term adverse impact (Kahn and Mohead 2010). Many researchers, have removed tissue samples according to this same protocol reporting no adverse effects (Wydoski and Emery 1983); therefore, we do not anticipate any long-term adverse effects to the sturgeon from this activity.

6.3 Vessel Traffic

6.3.1 Project Vessels Associated with Proposed Construction Activities

Maintenance dredging activities require the use of dredge and support vessels to facilitate both dredging and disposal activities. Typically, one work barge, two to three tender vessels, and one survey vessel are required for each dredging contract in the James River. Tender vessels mobilize the dredge to dredging locations, and typically maintain speeds of 3 – 5 knots. Only one shoal is dredged at a time, so the addition of approximately 5 vessels is added to the baseline for any one dredging event. The USACE estimates this will happen approximately four times per year. No ballast water is expected to be taken on by any project vessels.

6.3.2 Effects of Vessel Traffic on Atlantic Sturgeon

Background Information on the Risk of Vessels to Atlantic Sturgeon

The factors relevant to determining the risk to Atlantic sturgeon from vessel strikes are currently unknown, but based on what is known for other species we expect they are related to size and speed of the vessels, navigational clearance (i.e., depth of water and draft of the vessel) in the area where the vessel is operating, and the behavior of sturgeon in the area (e.g., foraging, migrating, etc.). Geographic conditions (e.g. narrow channels, restrictions, etc.) may also be relevant risk factors. Large vessels have been typically implicated because of their deep draft relative to smaller vessels, which may increase the probability of vessel collision with demersal fishes like sturgeon, even in deep water (Brown and Murphy 2010). Larger vessels also draw more water through their propellers given their large size and therefore may be more likely to entrain sturgeon in the vicinity. However as documented below, sturgeon are also at risk from exposure to smaller vessels with shallower drafts, thus making vessel traffic analyses difficult.

Atlantic sturgeon interactions with vessels have been documented in the James River (Balazik *et al*. 2012a). The Balazik *et al*. (2012) study was conducted in the freshwater portion of the James River from 2007 - 2010 and 31 carcasses of adult Atlantic sturgeon were used in the study. Twenty-six of the carcasses had scars from propellers and five were too decomposed to determine the cause of death. Nearly all of the carcasses were recovered (84%) from a narrow reach of the river near Turkey Island (RM 75) that was modified to enhance shipping efficiency. Balazik *et al*. (2012) indicated that the vessel interactions were likely caused by deep draft vessels because of the benthic nature of Atlantic sturgeon based on the telemetry study. Balazik and Garman (2018) suggest that a high percentage of reports (unpublished) of dead Atlantic sturgeon may be interacting with vessels in the Thimble Shoals portion of the Chesapeake Bay which is one of the entrance channels into the James River, but not included in the action area. This area can support deep-draft vessels, and telemetry studies indicate that migrating sturgeon use the channel to enter the river system.

Miranda and Killgore (2013) estimated that the large towboats on the Mississippi River, which have a propeller diameter of eight feet, a draft of up to nine feet, and travel at approximately the same speed as tugboats (less than ten knots), kill a large number of fish by drawing them into the propellers. They indicated that shovelnose sturgeon (*Scaphirhynchus platorynchus*), a small sturgeon (~50-85 cm in length) with a similar life history to shortnose sturgeon, were being killed at a rate of 0.02 individuals per kilometer traveled by the towboats.

As the Mississippi and James River systems differ significantly, and as we do not have the data necessary to compare shovelnose sturgeon densities in the Mississippi to Atlantic sturgeon populations in the James, this estimate cannot directly be used for this analysis. We also cannot modify the rate for this analysis because we do not know (a) the difference in traffic on the Mississippi and Delaware rivers; (b) the difference in density of shovelnose sturgeon and Atlantic sturgeon; and, (c) if there are risk factors that increase or decrease the likelihood of strike in the James River. However, this information does suggest that large vessel traffic can be a major source of sturgeon mortality. In larger water bodies it is less likely that fish would be killed since they would have to be close to the propeller to be drawn in. In a relatively shallow or narrow area a big vessel with a deep draft and a large propeller would leave little space for a nearby fish to maneuver.

Although smaller vessels have a shallower draft and entrain less water, they often operate at higher speeds, which is expected to limit a sturgeon's opportunity to avoid being struck. There is evidence to suggest that small fast vessels with shallow draft are a source of vessel strike mortality on Atlantic and shortnose sturgeon. On November 5, 2008, in the Kennebec River, Maine, Maine Department of Marine Resources (MEDMR) staff observed a small (<20 foot) boat transiting a known shortnose sturgeon overwintering area at high speeds. When MEDMR approached the area after the vessel had passed, a fresh dead shortnose sturgeon was discovered. The fish was collected for necropsy, which later confirmed that the mortality was the result of a propeller wound to the right side of the mouth and gills. In another case, a 35-foot recreational vessel travelling at 33 knots on the Hudson River was reported to have struck and killed a 5.5 foot Atlantic sturgeon (NYSDEC sturgeon mortality database (9-15-14)). Additionally, Barber (2017) found correlations between channel morphology and vessel strike risk in the James River. Because risk varies depending on a number of factors, speed from smaller vessels may pose risk at similar levels as deep-draft vessels depending on the physical environment where the fish are found. Given these incidents and studies, we conclude that interactions with vessels are not limited to large, deep draft vessels.

Effects of Vessel Traffic on Atlantic Sturgeon

In summary, we estimate that as many as five project vessels (one dredge, up to three support vessels, and a survey vessel) may be used for each maintenance dredging event. These vessels will be moving slow (3-5 knots), and do not have deep drafts, thus two of the majorly theorized risk factors (draft and speed) are not present. Only one shoal is dredged at a time, so only five additional vessels, added to the baseline, would occur at a time at a rate of approximately four times per year. The vessels would only be in the water for between 14 and 60 days (based on average dredge schedules) before being removed from the baseline again.

As noted in the Environmental Baseline section (5.3.4), the number of vessel trips using vessels with drafts of 1 – 38 feet using the James River from the mouth, at Hampton Roads, to Richmond from 2012 – 2016 remained relatively stable at approximately 35,000. The analysis also indicates that deep draft tanker and cargo vessels with 40+ foot drafts do not pass Craney Island into the James River navigation channel, but an average of four cargo and tanker vessels with over 30 foot drafts passed into the federal navigation channel annually from 2012 to 2016, and an average of 44 vessels with drafts between 20 and 30 feet passed annually during that same time frame. The majority of the trips reported in the James River were made by vessels with drafts <10 feet (mean = 34,573), and vessels between 10 and 20 foot drafts making an average of 232 trips per year. Most of the vessels using the James River federal navigation channel are self-propelled dry cargo vessels.

Because there are thousands of vessel trips occurring in the action area each year, the increase in vessel traffic from periodically used project vessels is extremely small (5 vessels per event). Additionally, these vessels are slow moving, and shallow draft vessels. Accordingly, the corresponding increase in the risk of strike is very small and cannot be meaningfully measured, detected, or evaluated and therefore, effects are insignificant.

Furthermore, the maintenance dredging of the existing navigation channel will not alter the vessel traffic pattern in any substantial way according to the USACE's estimate discussed in Section 3.2.5. Therefore, any interrelated or interdependent use of the channel by vessels that operate independent of the action, will not create any additional pathways for effects. As such we do not expect maintenance to result in any increase in risk of vessel strike beyond what is considered in the environmental baseline and status of the species. Thus any effects of interrelated and interdependent vessel traffic are too small to be measured or detected, and therefore insignificant.

6.4 Habitat Impacts from Dredging and Construction Activities

Dredging involves removing the bottom material down to a specified depth (-25 to -28 feet MLLW), the benthic environment will be impacted by dredging operations. During cutterhead dredging activities, sand will be deposited overboard or at disposal facilities via pipeline. The pipe will be approximately 16 to 20 inches in diameter and laid on the river bottom in some circumstances. The presence of the pipe will cause a small amount of benthic habitat to be temporarily unavailable to sturgeon. In some cases, spawning habitat may be impacted by contact with submerged pipeline, although this would be minimized due to the limited amount of bottom substrate that would be in contact with the pipeline. Most contractors sink pipelines in high traffic areas near the channel, and allow them to float in areas away from the channel (Wood pers comm). Overboard disposal areas will be affected during sediment placement activies and may bury/suffocate existing soft-bottom habitat. No hard-bottom habitat is proposed for dredging or disposal, and thus direct habitat effects to spawning areas will not occur. However, effects to adjacent spawning habitat from elevated TSS or pipeline placement may occur.

6.4.1 Effects of Dredging on Sturgeon Habitat

Atlantic sturgeon feed on a variety of benthic invertebrates. Atlantic sturgeon prey primarily on soft bodied invertebrates such as worms (Guilbard *et al.* in Munro *et al.* 2007; Savoy in Munro *et al.* 2007). The proposed dredging will occur in the navigation channel. As explained above in the Critical Habitat Section 4.1.3, we expect the daily disturbance in the navigation channel (e.g., sedimentation from propellers/prop wash) to have some impact on the ability of these areas to support an abundant and diverse community of benthic invertebrates; however, we expect that this disturbance is more likely to disturb or displace non-mobile organisms that occur at the surface of the sediment and is less likely to impact mobile invertebrates (such as crabs) or benthic invertebrates that bury deep into the substrate (such as worms). Dredging is likely to entrain and kill at least some of these potential sturgeon forage items. Dredging is not proposed in spawning habitat. As noted in the description of the action, the TSS levels expected for proposed dredging (ranging from 11 mg/l to 282 mg/l for dredging) are below levels shown to have adverse effects on benthic communities (390 mg/L (EPA 1986). As such, the only pathway for effects to foraging habitat from dredging is from direct entrainment, or from contact of the cutterhead pipeline with the bottom habitat that will temporarily restrict sturgeon from utilizing this foraging habitat. Impacts to habitat adjacent to dredge cuts may occur via elevated TSS or pipeline placement.

Motile life stages of sturgeon may forage in the full extent of the action area, primarily over soft substrates. The combined area of dredging impacts in the action area is 2.9 square miles. This area is approximately 1.5 % of the total action area. Overboard placement areas are located within 1,250 to 2,600 feet from the federal channels, thus an additional 0.00028 square miles (maximum) (assuming a 3 foot pipe) may be impacted for each of the five shoals with overboard disposal. In the upper segment of the action area where upland disposal occurs, the river width varies from 400 to 800 feet. Material is disposed of, via in-water pipeline, at nearby diked upland sites that we can reasonably assume are less than the width of the river's distance away from the dredge footprint. Thus, these four sites total another 0.00034 square miles. When added to the area of direct impacts from dredging, 2.900064 square miles may be impacted, which is still approximately 1.5% of the action area that will be temporarily impacted. Dredged areas are expected to be recolonized by individuals from nearby similar habitats and may recover from dredging (O'Herron and Hastings 1985) in one to three years. Similar studies in the lower portions of Chesapeake Bay demonstrated rapid resettlement of dredging and placement areas by infauna (Sherk 1972) and McCauley et al. (1977) observed that, while infauna populations declined significantly after dredging, infauna at dredging and placement areas recovered to pre-dredging conditions within 28 and 14 days, respectively. Thus, any reduction in benthic prey in the dredging footprint will be temporary, and at least some foraging habitat will recover quickly. Because these shoaling areas are disturbed regularly through accumulation of sediments being trapped in the shoal, as well as through daily vessel traffic in the channel, organisms that live within the shoaled areas are likely adapted to these kind of disturbance regimes, repopulating quickly as discussed, and mobile prey will move from nearby shifting sediments into the newly dredged areas

Potential spawning habitat in the middle and upper segments of the action area will not be disturbed because dredging and disposal activities do not occur within hard bottom substrates. Additionally, spring spawning sites will not be affected by dredge and disposal plumes because dredging does not begin until July. On the other hand, fall spawning habitat, if present near dredging and disposal activities, may be temporarily disturbed by turbidity plumes and the placement of pipelines. As detailed in Section 6.2.3, the dynamics of the river make it unlikely that hard bottom habitat is exposed near shoaling and disposal areas (USACE 2000, Friedrichs 2009) because in order for hard bottom habitat to be open to support spawning, water flow needs to flush smaller grained sediment out of the area. Because shoals and disposal areas exist continuously as soft sediment habitat, river flow and hydraulic gradients differ in the two habitat types. However, if plumes do at any time overlap with hard bottom habitat, any suspended sediments would quickly flush out due to the overall high rate of water flow in the James River (6,000 mgd), and any effects to spawning habitat, or to the eggs and larvae present there, would be temporary and negligible.

In sum, impacts to foraging and spawning habitat as a result of dredging activities will be minor and temporary. Any impacts from the placement of the cutterhead dredge pipe during disposal will be short-lived and negligible, representing a very small portion of impacted benthic habitat.

While there is likely to be some permanent reduction in the amount of sturgeon prey in frequently dredged shoaling areas, as well as a temporary restriction of habitat under the cutterhead pipeline, given the limited area where benthic resources will be removed or displaced, effects on sturgeon from reductions in benthic resources in a limited area and for limited periods of time, will be too small to be meaningfully measured or detected, and are therefore insignificant. Based on the analysis of flushing rates, and shoaling nature in the river, any effects to spawning habitat from dredging activities, including pipeline placement, are extremely unlikely to occur, and discountable.

6.4.2 Effects of Disposal on Sturgeon Habitat

Disposal operations can also affect foraging animals by burying benthic prey. Direct impacts to fish or other mobile species during placement of the dredged material would be expected to be minimal due to the small contact footprint of the fluidized sediments as they leave the 16-20 inch pipe. Given the small area impacted by each disposal event, mobile species, such as crabs and deep-burrowing worms, are expected to be able to avoid the falling sediment and would not be subject to burial. The only species that are likely to be buried are immobile benthic organisms. Disposal of sediments at placement sites may produce TSS of up to 550 mg/l, which may cause adverse effects to sessile benthic communities. Approximately 6.56 square miles of disposal area impacts (including footprints and turbidity plumes associated with disposal turbidity plumes) will occur. This represents 3.5% of the action area. As discussed, dredged areas are expected to be recolonized by individuals from nearby similar habitats in 1 to 3 years or in shorter timeframes of several months. Thus, any reduction in benthic prey in the disposal area footprint will be temporary, and at least some foraging habitat will recover quickly. Areas where dredged material will be placed are expected to be recolonized by individuals from nearby similar habitats. Because the characteristics of the sediment from the dredge cuts would be similar to those in and around the disposal sites, benthic invertebrates would be expected to quickly recolonize the overboard placement area. Thus, any reduction in benthic prey at the disposal site will be temporary and limited to the small area where dredged material will be placed. Although we cannot estimate an exact sediment load related to disposal activities, an approximate, average daily flushing rate of 6,000 mgd in the James River will potentially limit the extent of impacts related to burial/suffocation, since a proportion of the sediments disposed of at placement sites will be carried downstream to the Cheseapeake Bay immediately following placement activities while sediments are still suspended.

Disposal activities will not occur in spawning areas. Potential spawning habitat is not known to be located adjacent to the placement sites, and as stated earlier herein, the presence of hard bottom habitat near shoaling and placement sites is unlikely based on river morphology and conditions that make shoaling of soft sediment possible. Also, because placement areas are adjacent to the shoals within the channel, and the shoals represent areas where the sediment accumulates, it is unlikely that exposed hard bottom habitat will be present in areas of active accumulation, based on information collected by the USACE and the river morphology. However, if suitable habitat is nearby or downstream, it may be temporarily affected by ephemeral turbidity plumes. Because any suspended sediments would quickly flush out of adjacent habitat areas due to the high rate of flushing in the James River (6,000 mgd), (hard bottom habitat is subject to scour because the cobbles and surfaces provide relief on the bottom substrate and soft sediments move around and downstream), any effects to spawning habitat, or the eggs and larvae present there would be temporary and negligible.

In sum, impacts to foraging and spawning habitat as a result of disposal activities will be minor and temporary. While there is likely to be some reduction in the amount of sturgeon prey in placement sites, effects on sturgeon from reduced prey in these small, non-contiguous areas, relative to available foraging areas in the rest of the action area, where soft-sediment foraging habitat is ubiquitous, are too small to be meaningfully measured or detected, and are insignificant. Based on the analysis of flushing rates, and shoaling nature in the river, any effects to spawning habitat from disposal activities are extremely unlikely to occur, and discountable.

7.0 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 State Pollutant Discharge Elimination System (PDES). Other than those captured in the Status of the Species and Environmental Baseline sections above, we are not aware of any local or private actions that are reasonably certain to occur in the action area that may affect listed species. It is important to note that the definition of "cumulative effects" in the section 7 regulations is not the same as the NEPA definition of cumulative effects[7].

State Water Fisheries

Future recreational and commercial fishing activities in state waters may capture, injure, or kill sturgeon. However, it is not clear to what extent these future activities would affect listed species differently than the current state fishery activities described in the *Environmental Baseline* section. Atlantic sturgeon are captured and killed in fishing gear operating in the action area; however, at this time we are not able to quantify the number of interactions that occur. 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* and *Environmental Baseline* sections.

Debris, Pollution, and Contaminants

Human activities in the action area causing marine debris and pollution are reasonably certain to continue in the future, as are impacts from them on Atlantic sturgeon. However, the level of impacts cannot be projected. Sources of contamination in the action area include atmospheric

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

loading of pollutants, stormwater runoff from coastal development, groundwater discharges, industrial development, and wastewater discharges associated with State PDES permits. Chemical contamination may have effects on listed species' reproduction and survival. Excessive turbidity due to coastal development and/or construction sites could influence sturgeon foraging or spawning ability. Marine debris (e.g., discarded fishing line or lines from boats, plastics) also has the potential to entangle ESA-listed species in the water or to be consumed by them. 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* and *Environmental Baseline* sections.

In the future, global climate change is expected to continue and may impact ESA-listed species and their habitat in the action area. As noted in the *Status of the Species* and *Environmental Baseline* sections, the likely rate of change associated with climate impacts is on a century scale, which makes the ability to discern changes in the abundance, distribution, or behavior of these species in the action area as a result of climate change impacts challenging in the short term. Additionally, the relatively small size of the action area and 44 year remainder of the action's duration, make assessing any potential impacts of climate change difficult.

8.0 INTEGRATION AND SYNTHESIS OF EFFECTS

In the effects analysis outlined above, we considered potential effects to Atlantic sturgeon from the following sources: (1) maintenance dredging of the federal navigation channel in the James River from RM 5 to RM 99 by cutterhead dredge; (2) disposal at overboard and upland disposal sites; and (3) physical alteration of the action area including effects to benthic communities in the action area. In addition to these categories of effects, we considered the potential for collisions between listed species and project vessels, and the potential effects to vessel traffic in the action area as a result of maintenance dredging. We anticipate the mortality of a small number of sub-adult Atlantic sturgeon from the five DPSs, or juveniles from the Chesapeake Bay DPS via cutterhead dredging (total of 47 until 2062, and effects to each year class of PYSL in the James River (mortality of 2.2% of year class). We do not anticipate any mortality of Atlantic sturgeon due to any of the other effects including vessel traffic, turbidity related to dredging or disposal, or habitat removal.

We have determined that the proposed action is likely to result in the following levels of capture and mortality over the life of this action:

Table 12: Total Atlantic Sturgeon Takes

Species	Lethal Take
New York Bight DPS (Sub-adult)	1
South Atlantic DPS (Sub-adult)	1
Chesapeake Bay DPS (Sub-adult, Juvenile)	43
Gulf of Maine DPS (Sub-adult)	1
Carolina DPS (Sub-adult)	1
Chesapeake Bay DPS PYSL	2.2% of each year class until 2062

**3 CB fish have already been taken between 2012-2018 based on dredge volumes.

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 Atlantic sturgeon 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 action area or result in destruction or adverse modification of critical habitat. 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." Below, for the listed species that may be affected by the proposed action, we summarize the status of the species and consider whether the proposed action will result in reductions in reproduction, numbers or distribution of Atlantic sturgeon and then we 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 Atlantic sturgeon, as those terms are defined for purposes of the Federal Endangered Species Act.

8.1 Atlantic Sturgeon Summary

As explained above, the proposed actions are likely to result in the mortality of a total of 47 Atlantic sturgeon (sub-adult) from the Gulf of Maine, New York Bight, South Atlantic, Carolina, and Chesapeake Bay (sub-adult and juvenile) DPSs over the project life (1 fish per 1.5 million cy per year for the duration of 44 years). Based on the proposed dredge schedule and known maintenance needs, in a typical year we expect that no more than one Atlantic sturgeon would be entrained. We anticipate 2.2 % of each year class of Chesapeake Bay DPS PYSL will be entrained. We do not anticipate any mortality of adults because these fish are large enough to avoid entrainment in the cutterhead dredge. All other effects to Atlantic sturgeon, including effects to habitat and prey due to dredging and dredge material disposal, as well as interaction with vessels, will be insignificant and discountable.

8.2 DPS Composition and Analysis

We have considered the best available information to determine from which DPSs individuals that will be affected by the proposed actions are likely to have originated. Using mixed stock analysis explained above, we have determined that Atlantic sturgeon in the action area likely originate from the five DPSs at the following frequencies: NYB 2% South Atlantic 2%; Chesapeake Bay 92%; Gulf of Maine 2%; and Carolina 2%. Given these percentages, we expect that that of the 47 Atlantic sturgeon likely to be killed during dredging, 1 will originate from the New York Bight DPS, 1 from the South Atlantic DPS, 43 from the Chesapeake Bay DPS, 1 from the Gulf of Maine DPS, and 1 from the Carolina DPS.

8.1.2 Gulf of Maine DPS

The GOM DPS is listed as threatened. While Atlantic sturgeon occur in several rivers in the GOM DPS, recent spawning has only been documented in the Kennebec; spawning is suspected to also occur in the Androscoggin River. No total population estimates are available for any river population or the DPS as a whole. As discussed in section 4.2.2.1, we have estimated a total of 7,455 GOM DPS adults and subadults in the ocean (1,864 adults and 5,591 subadults). This estimate is the best available at this time and represents only a percentage of the total GOM DPS population as it does not include young of the year or juveniles and does not include all adults and subadults. 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.

Based on mixed-stock analysis, we expect that 2% of the sub-adult and adult Atlantic sturgeon in the action area will originate from the GOM DPS. While some adults from the GOM DPS are expected to be present in the action area, we do not anticipate any mortality of adult Atlantic sturgeon from the GOM DPS. Over the life of the project, we anticipate the mortality of up to 1 subadult GOM DPS Atlantic sturgeon due to cutterhead dredging.

The number of subadult GOM DPS Atlantic sturgeon we expect to be killed due to the proposed action (1 between now and the conclusion of the proposed action) represents an extremely small percentage of the GOM DPS. While the death of 1 GOM DPS Atlantic sturgeon over this period will reduce the number of GOM 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 GOM DPS population of subadults and an even smaller percentage of the overall DPS as a whole. Even if there were only 5,591 subadults in the GOM DPS, the loss would represent only 0.02% of the subadults in the DPS. The percentage would be much less if we also considered the number of young of the year, juveniles, adults, and other subadults not included in the NEAMAP-based oceanic population estimate.

Because there will be no loss of adults, the reproductive potential of the GOM DPS will not be affected in any way other than through a reduction in numbers of individual future spawners as opposed to current spawners. The loss of 1 female 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. 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 loss of 1 male subadult may have less of an impact on future reproduction as other males are expected to be available to fertilize eggs in a particular year. The proposed action will also not affect the spawning grounds within the rivers where GOM DPS fish spawn.

The proposed action is not likely to reduce distribution because while sturgeon may temporarily avoid areas where dredging or disposal activities are underway, all of these changes in distribution will be temporary and limited to movements to relatively nearby areas. We do not anticipate that any impacts to habitat will impact how GOM DPS sturgeon use the action area and all impacts will be insignificant. Additionally, given the small percentage of the species that will be killed as a result of the proposed actions, there is not likely to be any loss of unique genetic haplotypes and no loss of genetic diversity

Based on the information provided above, the death of 1 sub-adult GOM DPS Atlantic sturgeon over the life of the proposed action, 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 1 subadult GOM DPS Atlantic sturgeon represents an extremely small percentage of the population of the DPS; (2) the death of 1 GOM DPS Atlantic sturgeon will not change the status or trends of the DPS as a whole; (3) the loss of 1 GOM DPS Atlantic sturgeon is not likely to have an effect on the levels of genetic heterogeneity in the population; (4) the loss of 1 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 DPS; (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 DPS 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 foraging GOM DPS Atlantic sturgeon.

In certain instances, an action that does not appreciably reduce the likelihood of a species' survival might affect its likelihood of recovery or the rate at which recovery is expected to occur. As explained above, we have determined that the proposed actions will not appreciably reduce the likelihood that the GOM DPS will survive in the wild. Here, we consider the potential for the actions to reduce the likelihood of recovery from the perspective of ESA Section 4. As noted above, recovery is defined as the improvement in status such that listing under Section 4(a) as "in danger of extinction throughout all or a significant portion of its range" (endangered) or "likely to become an endangered species within the foreseeable future throughout all or a significant portion of its range…" (threatened) is no longer warranted. Thus, we have considered whether the proposed action will appreciably reduce the likelihood that the GOM DPS of Atlantic sturgeon can rebuild to a point where it is no longer in danger of becoming endangered within the foreseeable future throughout all or a significant portion of its range.

A Recovery Plan for the GOM DPS has not yet been developed. 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 listed species must have a sustained positive trend of increasing population over time. In order for that to happen for GOM Atlantic sturgeon, individuals must have access to enough habitat in suitable condition for foraging, migrating, resting, and spawning. Conditions must be suitable for the successful development of early life stages. Mortality rates must be low enough to allow for recruitment to all age classes so that successful spawning can continue over time and over generations. For Atlantic sturgeon, habitat conditions must be suitable both in the natal river and in other rivers and estuaries where foraging by subadults and adults will occur and in the ocean where subadults and adults migrate, overwinter and forage. Habitat connectivity must also be maintained so that individuals can migrate between important habitats without delays that impact their fitness. Here, we consider whether this proposed action will affect the GOM DPS 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 GOM DPS Atlantic sturgeon to carry out any necessary behaviors or functions including spawning, migration, overwintering and foraging. Any impacts to available forage will also be insignificant. The proposed action will result in an extremely small amount of mortality over the life of the project (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 actions are not likely to appreciably reduce the survival and recovery of this species.

Despite the threats faced by individual GOM DPS Atlantic sturgeon inside and outside of the action area, the proposed 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 1 subadult GOM DPS Atlantic sturgeon over the life span of the project, is not likely to appreciably reduce the survival and recovery of this species.

8.1.3 New York Bight DPS

The NYB DPS is 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. The capture of age-0 Atlantic sturgeon in the Connecticut River indicates that spawning, at least in some years, is likely occurring in that river as well. Based on Mixed Stock Analysis, we expect that 2% of the subadult and adult Atlantic sturgeon in the action area will originate from the NYB DPS.

NYB origin Atlantic sturgeon are affected by numerous sources of human induced mortality and habitat disturbance (e.g., impingement at water intakes, dredging, bycatch in commercial and recreational fisheries, in-water construction activities, vessel traffic) throughout the riverine and marine portions of their range. As discussed in section 4.2.2.2, we have estimated a total of 34,566 NYB DPS adults and subadults in the ocean (8,642 adults and 25,925 subadults). This estimate is the best available at this time and represents only a percentage of the total NYB DPS population as it does not include young of the year or juveniles and does not include all adults and subadults. The largest single source of mortality appears to be capture as bycatch in commercial fisheries operating in the marine environment. A bycatch estimate provided by NEFSC indicates that approximately 376 Atlantic sturgeon die as a result of bycatch each year. While there are some indications that the status of the NYB 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.

Based on mixed-stock analysis, we expect that 2% of the sub-adult and adult Atlantic sturgeon in the action area will originate from the NYB DPS. While some adults from the NYB DPS are expected to be present in the action area, we do not anticipate any mortality of adult Atlantic sturgeon from the NYB DPS. Because juveniles do not leave their natal rivers, they are not impacted by the proposed action.

Over the life of the proposed action, we anticipate the mortality of up to 1 subadult NYB DPS Atlantic sturgeon. It could be killed due to entrainment in cutterhead dredges. This fish could be a subadult originating from the Delaware or Hudson River. While it is possible that entrained fish could survive, we assume here that the fish will be killed. Here, we consider the effect of the loss of this subadult on the reproduction, numbers and distribution of the NYB DPS.

Any New York Bight DPS subadults could originate from the Delaware or Hudson River. We have limited information from which to determine the percentage of NYB DPS fish in the Chesapeake Bay that are likely to originate from the Delaware vs. the Hudson River. Individual assignments of NYB DPS Atlantic sturgeon that have undergone genetic testing indicates that in the oceanic environment, approximately 91% of NYB individuals originate from the Hudson River. This is likely due to the greater number of Hudson River origin Atlantic sturgeon than Delaware River Atlantic sturgeon.

While the death of one subadult NYB DPS Atlantic sturgeon over the life of the project 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 subadult population and an even smaller percentage of the overall population of the DPS (juveniles, subadults and adults combined).

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 1 subadult over the remaining 44-year period of the action 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 or Delaware River where NYB DPS fish spawn. There will be no effects to spawning adults and therefore no reduction in individual fitness or any future reduction in spawning by these individuals.

The proposed action is not likely to reduce distribution. Although sturgeon may temporarily avoid areas where dredging or disposal activities are underway, all of these changes in distribution will be temporary and limited to movements to relatively nearby areas. We do not anticipate that any impacts to habitat will permanently impact how sturgeon use the action area. Further, the action is not expected to reduce the river by river distribution of Atlantic sturgeon. Additionally, given the small percentage of the species that will be killed as a result of the proposed action, there is not likely to be any loss of unique genetic haplotypes and no loss of genetic diversity

Based on the information provided above, the death of 1 NYB DPS Atlantic sturgeon over the project life considered here, will not appreciably reduce the likelihood of survival of the New York Bight DPS (i.e., it will not decrease the likelihood that the species will continue to persist into the future with sufficient resilience to allow for the potential recovery from endangerment). The actions will not affect NYB DPS Atlantic sturgeon in a way that prevents the species from having a sufficient population, represented by all necessary age classes, genetic heterogeneity, and number of sexually mature individuals producing viable offspring, and it will not result in effects to the environment which would prevent NYB DPS Atlantic sturgeon from completing their entire life cycle, including reproduction, sustenance, and shelter. This is the case because: (1) the death of 1 subadult NYB DPS Atlantic sturgeon represents an extremely small percentage of the population of the DPS; (2) the death of 1 subadult NYB DPS Atlantic sturgeon will not change the status or trends of the species as a whole; (3) the loss of 1 subadult NYB DPS Atlantic sturgeon is not likely to have an effect on the levels of genetic heterogeneity in the population; (4) the loss of 1 subadult NYB DPS Atlantic sturgeon is likely to have such a small effect on reproductive output that the loss of these individuals will not change the status or trends of the species; (5) the 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 actions 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. As explained above, we have determined that the proposed actions will not appreciably reduce the likelihood that the NYB DPS will survive in the wild. Here, we consider whether the action will appreciably reduce the likelihood of recovery from the perspective of ESA Section 4. As noted above, recovery is defined as the improvement in status such that listing under Section 4(a) as "in danger of extinction throughout all or a significant portion of its range" (endangered) or "likely to become an endangered species within the foreseeable future throughout all or a significant portion of its range…" (threatened) is no longer appropriate. Thus, we have considered whether the proposed action will appreciably reduce the likelihood that the NYB DPS of Atlantic sturgeon can rebuild to a point where it is no longer in danger of extinction through all or a significant part of its range.

A Recovery Plan for the NYB DPS has not yet been developed. 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 listed species must have a sustained positive trend of increasing population over time. To allow that to happen for sturgeon, individuals must have access to enough habitat in suitable condition for foraging, resting, migrating, and spawning. Conditions must be suitable for the successful development of early life stages. Mortality rates must be low enough to allow for recruitment to all age classes so that successful spawning can continue over time and over generations. For Atlantic sturgeon, habitat conditions must be suitable both in the natal river and in other rivers and estuaries where foraging by subadults and adults will occur and in the ocean where subadults and adults migrate, overwinter and forage. Habitat connectivity must also be maintained so that individuals can migrate between important habitats without delays that impact their fitness. Here, we consider whether this proposed action will affect the NYB DPS 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 NYB DPS Atlantic sturgeon to carry out any necessary behaviors or functions including foraging, resting, migrating, and spawning. Any impacts to available forage will also be insignificant. The proposed action will result in a small amount of mortality 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 actions 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 endangered. 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 1 subadult NYB DPS Atlantic sturgeon over the life span of the project, is not likely to appreciably reduce the survival and recovery of this species.

8.1.4 Chesapeake Bay DPS

The CB DPS is listed as endangered. Individuals originating from the CB DPS are likely to occur in the action area. While Atlantic sturgeon occur in several rivers in the CB DPS, recent spawning has only been documented in the James River and York River systems. Chesapeake Bay DPS origin Atlantic sturgeon are affected by numerous sources of human induced mortality and habitat disturbance (e.g., impingement at water intakes, dredging, bycatch in commercial and recreational fisheries, in-water construction activities, vessel traffic) throughout the riverine and marine portions of their range. No total population estimates are available for any river population or the DPS as a whole. As discussed in section 4.2.2.3, we have estimated a total of 8,811 CB DPS adults and subadults in the ocean (2,203 adults and 6,608 subadults). This estimate is the best available at this time and represents only a percentage of the total CB DPS population as it does not include young of the year or juveniles and does not include all adults and subadults. There is currently not enough information to establish a trend for any life stage or for the DPS as a whole.

Based on our mixed-stock analysis, we expect that 92% of the Atlantic sturgeon in the action area will originate from the CB DPS. Over the remaining duration of the action (44-years) considered here, we anticipate the mortality of up to 43 subadult and/or juvenile CB DPS Atlantic sturgeon. These sturgeon could be killed due to entrainment in a cutterhead dredge. While it is possible that entrained/entrapped fish could survive, we assume here that these fish will be killed. Additionally, we expect the annual loss of 2.2 % of post-yolk-sac larvae (PYSL) due to cutterhead dredging. Adult sturgeon are too large to be entrained in cutterhead dredges.

While overall we anticipate the death of 43 juvenile and/or subadult Atlantic sturgeon from the CB DPS over the life span of the project, we do not anticipate that there would be a loss of more than 1 CB DPS subadult or juvenile in any year. Here, we consider the effect of the loss of a total of these subadults/juveniles on the reproduction, numbers and distribution of the CB DPS.

Based on the analysis outlined in the "Effects of the Action" section above, 2.2% of PYSL will be killed annually during dredging activities within the shoals. To generate this estimate, we assumed that all Atlantic sturgeon spawning in the James River occurred between RM 47 and RM 99 within the action area, in regions where best available information has suggested spawning is likely to occur. This is a very conservative estimate, as the best available information suggests that Atlantic sturgeon spawning may occur where appropriate habitat exists in waters with salinity of 0-0.5 ppt (typically above RM 47 where the salt front is approximately located); however, substrate data to generate an estimate of spawning habitat over this larger stretch of river are not available. The only estimate is that 20% of the surveyed bottom from Turkey Island Cutoff (RM 75) to Bosher's Dam (RM 99) has suitable hard bottom habitat within that stretch of the river. The estimate of adverse effects to PYSL assumes that dredging occurs in frequently shoaling areas every year, and that all dredging is completed during the time of year when PYSL are present. While you may need to dredge these shoals every year, some may only require dredging every 3-15 years. Also, July and September through December is approximately 60% of the entire dredging window proposed for maintenance activities, which extends from July through February, so it is unlikely that all of the dredging will occur when PYSL are present.

As early life stages naturally experience high levels of mortality, due to predation and other environmental variability, the loss of a small percentage of PYSL (annually for the duration of the action) is not equivalent to the loss of a similar percentage of juveniles or adults. While these losses of early life stage sturgeon will have an effect on the number of juvenile and eventually the number of adult sturgeon in a particular year class, the reduction in size would be extremely small. As Atlantic sturgeon are long lived species, there are up to at least 30 year classes in a population at a particular time. We conclude that it is unlikely that an extremely small reduction in PYSL survival would be detectable at the DPS level.

The reproductive potential of the CB DPS will not be affected in any way other than through a reduction in numbers of individuals. The loss of a total of 43 female juvenile and subadults, with no more than one per year, and the loss of a small percentage of female PYSL (2.2%) 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. The loss of a small percentage of 2.2 % of male larvae and up to 43 male non-larval Atlantic sturgeon (could be all juveniles, all subadults, and no adults) may have less of an impact on future reproduction as other males are expected to be available to fertilize eggs in a particular year. However, this small reduction in potential future spawners is expected to result in an extremely small reduction in the number of eggs laid or larvae produced in future years and similarly, an extremely small effect on the strength of subsequent year classes. The proposed action will also not directly affect the spawning grounds within the rivers where CB DPS fish spawn, since all dredging and disposal activities do not take place in spawning habitat. All effects of elevated turbidity that may drift into spawning grounds was determined to be insignificant or discountable. The actions will also not create any barrier to pre-spawning sturgeon accessing the overwintering sites or the spawning grounds used by CB DPS fish.

Because we do not have a population estimate for the CB DPS, it is difficult to evaluate the effect of the mortality caused by these actions on the species. However, because the proposed action will result in the loss of only one individual per year, with a total of no more than 43, and up to only 2.2% of PYSL per year, it is unlikely that these deaths will have a detectable effect on the numbers and population trend of the CB DPS.

The proposed action is not likely to reduce distribution. Although sturgeon may temporarily avoid areas where dredging or disposal activities are underway, all of these changes in distribution will be temporary and limited to movements to relatively nearby areas. We do not anticipate that any impacts to habitat will permanently impact how sturgeon use the action area. Further, the action is not expected to reduce the river by river distribution of CB DPSAtlantic sturgeon. Additionally, given the small percentage of the species that will be killed as a result of the proposed action, there is not likely to be any loss of unique genetic haplotypes and no loss of genetic diversity.

Based on the information provided above, the death of up to 43 CB DPS Atlantic sturgeon and 2.2% of PYSL annually, over the life span of the project, will not appreciably reduce the likelihood of survival of the CB DPS (i.e., it will not decrease the likelihood that the species will continue to persist into the future with sufficient resilience to allow for the potential recovery from endangerment). The actions will not affect CB DPS Atlantic sturgeon in a way that prevents the species from having a sufficient population, represented by all necessary age classes, genetic heterogeneity, and number of sexually mature individuals producing viable offspring, and it will not result in effects to the environment which would prevent Atlantic sturgeon from completing their entire life cycle, including reproduction, sustenance, and shelter. This is the case because: (1) the death of one juvenile or subadult CB DPS Atlantic sturgeon in any year and the total loss of 43 juvenile and/or subadult and 2.2% of PYSL annually will not change the status or trends of the species as a whole; (2) the death of 43 juvenile and/or subadult and 2.2% of PYSL CB DPS Atlantic sturgeon annually represents and extremely small percentage of the species; (3) the loss of 43 juvenile and/or subadult and 2.2% of PYSL CB DPS Atlantic sturgeon annually is not likely to have an effect on the levels of genetic heterogeneity in the population; (4) the loss of 43 juvenile and/or subadult and 2.2% of PYSL CB DPS Atlantic sturgeon annually over the life span of the project will not result in the permanent loss of any single age class; (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 any foraging CB DPS Atlantic sturgeon.

In certain instances, an action that does not appreciably reduce the likelihood of a species' survival might affect its likelihood of recovery. As explained above, we have determined that the proposed action will not appreciably reduce the likelihood that the CB DPS of Atlantic sturgeon will survive in the wild. Here, we consider whether the action will appreciably reduce the likelihood of recovery from the perspective of ESA Section 4. As noted above, recovery is defined as the improvement in status such that listing under Section 4(a) as "in danger of extinction throughout all or a significant portion of its range" (endangered) or "likely to become an endangered species within the foreseeable future throughout all or a significant portion of its range…" (threatened) is no longer appropriate. Thus, we have considered whether the proposed action will appreciably reduce the likelihood that the CB DPS of Atlantic sturgeon shortnose sturgeon can rebuild to a point where it is no longer in danger of extinction through all or a significant part of its range.

A Recovery Plan for the CB DPS has not yet been developed. 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 listed species must have a sustained positive trend of increasing population over time. To allow that to happen for sturgeon, individuals must have access to enough habitat in suitable condition for foraging, migrating, resting, and spawning. Conditions must be suitable for the successful development of early life stages. Mortality rates must be low enough to allow for recruitment to all age classes so that successful spawning can continue over time and over generations. For Atlantic sturgeon, habitat conditions must be suitable both in the natal river and in other rivers and estuaries where foraging by subadults and adults will occur and in the ocean where subadults and adults migrate, overwinter and forage. Habitat connectivity must also be maintained so that individuals can migrate between important habitats without delays that impact their fitness. Here, we consider whether this proposed action will affect the CB DPS 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 including foraging, migrating, resting, and spawning. Any impacts to available forage will also be insignificant. The proposed action will result in an extremely small amount of mortality (on average, less than one individual per year and 2.2% of the PYSL annually) 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 endangered. 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 actions in light of cumulative effects explained above, including climate change, and have concluded that even in light of the ongoing impacts of these activities and conditions; the conclusions reached above do not change. Based on the analysis presented herein, the proposed action, resulting in the mortality of 43 juvenile and/or subadult and 2.2% of PYSL CB DPS Atlantic sturgeon annually over the life span of the project, is not likely to appreciably reduce the survival and recovery of this species.

8.1.5 Carolina DPS

We expect that 2% of the Atlantic sturgeon in the action area will originate from the CA DPS. Individuals originating from the CA DPS are likely to occur in the action area. The CA DPS is listed as endangered. The CA DPS consists of Atlantic sturgeon originating from at least five rivers where spawning is still thought to occur. Carolina DPS origin Atlantic sturgeon are affected by numerous sources of human induced mortality and habitat disturbance throughout the riverine and marine portions of their range. There is currently not enough information to establish a trend for any life stage, for any of the spawning populations or for the DPS as a whole. Over the 44-year period considered here, we anticipate the mortality of 1 subadult CA DPS Atlantic sturgeon from cutterhead dredging.

The reproductive potential of the CA DPS will not be affected in any way other than through a reduction in numbers of individuals. The loss of a total of 1 subadult, over the life span of the project, would have the effect of reducing the amount of potential reproduction as any dead CA DPS Atlantic sturgeon would have no potential for future reproduction. However, this small reduction in potential future spawners is expected to result in an extremely small reduction in the number of eggs laid or larvae produced in future years and similarly, an extremely small effect on the strength of subsequent year classes. Even considering the potential future spawners that would be produced by the individual that would be killed as a result of the proposed 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 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 CA DPS.

We do not anticipate that any impacts to habitat will permanently impact how sturgeon use the action area. Further, the action is not expected to reduce the river by river distribution of CA DPS Atlantic sturgeon. Additionally, given the small percentage of the species that will be killed as a result of the proposed action, there is not likely to be any loss of unique genetic haplotypes and no loss of genetic diversity

Based on the information provided above, the death of 1 CA DPS Atlantic sturgeon over the life of the project, 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 CA DPS Atlantic sturgeon from completing their entire life cycle, including reproduction, sustenance, and shelter. This is the case because: (1) the death of 1 subadult CA DPS Atlantic sturgeon represents and extremely small percentage of the species; (2) the death of 1 subadult CA DPS Atlantic sturgeon in any year and the total loss of 1 subadults is likely to have a small effect on reproductive output and will not change the status or trends of the species as a whole; (3) the loss of 1 subadult CA DPS Atlantic sturgeon will not have an effect on the levels of genetic heterogeneity in the population; (4) the action will have no effect on the distribution of the species throughout its range; and, (5) the action will have no effect on the ability of CA DPS Atlantic sturgeon to shelter and only an insignificant effect on any foraging CA DPS Atlantic sturgeon.

In certain instances, an action that does not appreciably reduce the likelihood of a species' survival might affect its likelihood of recovery. As explained above, we have determined that the proposed action will not appreciably reduce the likelihood that the CA DPS of Atlantic sturgeon will survive in the wild. Here, we consider whether the action will appreciably reduce the likelihood of recovery from the perspective of ESA Section 4. As noted above, recovery is defined as the improvement in status such that listing under Section 4(a) as "in danger of extinction throughout all or a significant portion of its range" (endangered) or "likely to become an endangered species within the foreseeable future throughout all or a significant portion of its range…" (threatened) is no longer appropriate. Thus, we have considered whether the proposed action will appreciably reduce the likelihood that CA DPS of Atlantic sturgeon can rebuild to a point where it is no longer in danger of extinction through all or a significant part of its range.

A Recovery Plan for the CA DPS has not yet been developed. 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 listed species must have a sustained positive trend of increasing population over time. To allow that to happen for sturgeon, individuals must have access to enough habitat in suitable condition for foraging, migrating, resting and spawning. Conditions must be suitable for the successful development of early life stages. Mortality rates must be low enough to allow for recruitment to all age classes so that successful spawning can continue over time and over generations. There must be enough suitable habitat for spawning, foraging, resting and migrations of all individuals. For Atlantic sturgeon, habitat conditions must be suitable both in the natal river and in other rivers and estuaries where foraging by subadults and adults will occur and in the ocean where subadults and adults migrate, overwinter and forage. Habitat connectivity must also be maintained so that individuals can migrate between important habitats without delays that impact their fitness. Here, we consider whether this proposed action will affect the CA DPS 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 CA DPS Atlantic sturgeon to carry out any necessary behaviors or functions including spawning, foraging, resting and migrating. Any impacts to available forage will also be insignificant. The proposed actions will result in an extremely small amount of mortality (1 individual over the life of the project) 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 endangered. 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 actions. We have considered the effects of the proposed actions in light of cumulative effects explained above, including climate change, and have concluded that even in light of the ongoing impacts of these activities and conditions; the conclusions reached above do not change. Based on the analysis presented herein, the proposed action, resulting in the mortality of 1 subadult CA DPS Atlantic sturgeon over the life of the project, is not likely to appreciably reduce the survival and recovery of this species.

8.1.6 South Atlantic DPS

Individuals originating from the SA DPS are likely to occur in the action area. The SA DPS is listed as endangered. We expect that 2% of the subadult and adult Atlantic sturgeon in the action area will originate from the SA DPS. Most of these fish are expected to be subadults, with few adults from the SA DPS expected to be present. SA DPS origin Atlantic sturgeon are affected by numerous sources of human induced mortality and habitat disturbance (e.g., impingement at water intakes, dredging, bycatch in commercial and recreational fisheries, in-water construction activities, vessel traffic) throughout the riverine and marine portions of their range.

Over the life span of the project, we anticipate the mortality of up to 1 subadult SA DPS Atlantic sturgeon. These sturgeon could be killed due to entrainment in cutterhead dredges. While it is possible that entrained/entrapped fish could survive, we assume here that these fish will be killed. The number of SA DPS Atlantic sturgeon we expect to be killed (1 subadult) due to maintenance of the navigation channel represents an extremely small percentage of the SA DPS. Here, we consider the effect of the loss of a total of this subadults on the reproduction, numbers and distribution of the SA DPS.

While the death of 1 SA DPS Atlantic sturgeon over the life of the project 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 SA DPS population of subadults and an even smaller percentage of the DPS as a whole.

The reproductive potential of the SA DPS will not be affected in any way other than through a reduction in numbers of this individual. The loss of a total of 1 subadult, with no more than one per year, would have the effect of reducing the amount of potential reproduction as any dead SA DPS Atlantic sturgeon would have no potential for future reproduction. However, this small reduction in potential future spawners is expected to result in an extremely small reduction in the number of eggs laid or larvae produced in future years and similarly, an extremely small effect on the strength of subsequent year classes. Even considering the potential future spawners that would be produced by the individual that would be killed as a result of the proposed 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 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 while sturgeon may temporarily avoid areas where dredging or disposal activities are underway, all of these changes in distribution will be temporary and limited to movements to relatively nearby areas. We do not anticipate that any impacts to habitat will permanently impact how sturgeon use the action area. Further, the action is not expected to reduce the river by river distribution of SA DPS Atlantic sturgeon. Additionally, given the small percentage of the species that will be killed as a result of the proposed action, there is not likely to be any loss of unique genetic haplotypes and no loss of genetic diversity

Based on the information provided above, the death of up to 1 SA DPS Atlantic sturgeon over the life of the project, 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 1 subadult SA DPS of Atlantic sturgeon represents and extremely small percentage of the species; (2) the death of one subadult SA DPS Atlantic sturgeon over the life of the project is likely to have a small effect on reproductive output and will not change the status or trends of the species as a whole; (3) the loss of 1 subadult SA DPS Atlantic sturgeon will not have an effect on the levels of genetic heterogeneity in the population; (4) 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, (5) 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. As explained above, we have determined that the proposed action will not appreciably reduce the likelihood that the SA DPS of Atlantic sturgeon will survive in the wild. Here, we consider whether the action will appreciably reduce the likelihood of recovery from the perspective of ESA Section 4. As noted above, recovery is defined as the improvement in status such that listing under Section 4(a) as "in danger of extinction throughout all or a significant portion of its range" (endangered) or "likely to become an endangered species within the foreseeable future throughout all or a significant portion of its range…" (threatened) is no longer appropriate. Thus, we have considered whether the proposed action will appreciably reduce the likelihood that SA DPS of Atlantic sturgeon can rebuild to a point where it is no longer in danger of extinction through all or a significant part of its range.

A Recovery Plan for the SA DPS has not yet been developed. 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 listed species must have a sustained positive trend of increasing population over time. To allow that to happen for sturgeon, individuals must have access to enough habitat in suitable condition for foraging, resting and spawning. Conditions must be suitable for the successful development of early life stages. Mortality rates must be low enough to allow for recruitment to all age classes so that successful spawning can continue over time and over generations. There must be enough suitable habitat for spawning, foraging, resting and migrations of all individuals. For Atlantic sturgeon, habitat conditions must be suitable both in the natal river and in other rivers and estuaries where foraging by subadults and adults will occur and in the ocean where subadults and adults migrate, overwinter and forage. Habitat connectivity must also be maintained so that individuals can migrate between important habitats without delays that impact their fitness. Here, we consider whether this proposed action will affect the SA DPS 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 SA DPS Atlantic sturgeon to carry out any necessary behaviors or functions including spawning, foraging, resting and migrating. Any impacts to available forage will also be insignificant. The proposed action will result in an extremely small amount of mortality (one mortality over the life of the project) 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 endangered. 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 1 subadult SA DPS Atlantic sturgeon over the life of the project, is not likely to appreciably reduce the survival and recovery of this species.

10.0 CONCLUSION

After reviewing the best available information on the status of endangered and threatened species under our jurisdiction, the environmental baseline for the action area, the effects of the action, and the cumulative effects, it is our biological opinion that the proposed action may adversely affect, but is not likely to jeopardize the continued existence of the GOM, NYB, CB, CA, and SA DPSs of Atlantic sturgeon, and is not likely to adversely affect shortnose sturgeon, Kemp's ridley, loggerhead, green, hawksbills, or leatherback sea turtles. The proposed action is not likely to adversely affect critical habitat designated for the CB DPS of Atlantic sturgeon.

11.0 INCIDENTAL TAKE STATEMENT

Section 9 of the ESA prohibits the take of endangered species of fish and wildlife. "Fish and wildlife" is defined in the ESA "as any member of the animal kingdom, including without limitation any mammal, fish, bird (including any migratory, non-migratory, or endangered bird for which protection is also afforded by treaty or other international agreement), amphibian, reptile, mollusk, crustacean, arthropod or other invertebrate, and includes any part, product, egg, or offspring thereof, or the dead body or parts thereof." 16 U.S.C. §1532(8). "Take" is defined as to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture or collect, or to attempt to engage in any such conduct. "Harm" is further defined by NMFS to include any act which actually kills or injures fish or wildlife. Such an act may include significant habitat modification or degradation that actually kills or injures fish or wildlife by significantly impairing essential behavioral patterns including breeding, spawning, rearing, migrating, feeding, or sheltering. On December 21, 2016, we issued *Interim Guidance on the Endangered Species Term "Harass"*[8]. For use on an interim basis, we interpret "harass" to mean to "…create the likelihood of injury to wildlife by annoying it to such an extent as to significantly disrupt normal behavioral patterns which include, but are not limited to, breeding, feeding, or sheltering." Incidental take is defined as take that is incidental to, and not the purpose of, the carrying out of an otherwise lawful activity. "Otherwise lawful activities" are those actions that meet all State and Federal legal requirements except for the prohibition against taking in ESA Section 9 (51 FR 19936, June 3, 1986), which would include any state endangered species laws or regulations. Section 9(g) makes it unlawful for any person "to attempt to commit, solicit another to commit, or cause to be committed, any offense defined [in the ESA.]" 16 U.S.C. § 1538(g). See also 16 U.S.C. § 1532(13)(definition of "person"). Under the terms of section 7(b)(4) and section 7(o)(2), taking that is incidental to, and not the purpose of the agency action is not considered to be prohibited under the ESA provided that such taking is in compliance with the terms and conditions of this Incidental Take Statement.

The measures described below are non-discretionary, and must be undertaken by you so that they become binding conditions for the exemption in section 7(o)(2) to apply. You have a continuing duty to regulate the activity covered by this Incidental Take Statement. If you (1) fail to assume and implement the terms and conditions or (2) fail to require any contractors to adhere to the terms and conditions of the Incidental Take Statement through enforceable terms that are added to contracts or other documents as appropriate, the protective coverage of section 7(o)(2) may lapse. In order to monitor the impact of incidental take, you must report the progress of the action and its impact on the species to us as specified in the Incidental Take Statement [50 CFR §402.14(i)(3)] (See U.S. Fish and Wildlife Service and National Marine Fisheries Service's Joint Endangered Species Act Section 7 Consultation Handbook (1998) at 4-49). This ITS exempts take for activities that have not yet occurred as of the date of the Biological Opinion.

11.1 Amount or Extent of Incidental Take

The proposed action has the potential to result in the mortality of individuals from the GOM, NYB CB, CA, and SA DPSs of Atlantic sturgeon due to entrainment in cutterhead dredges. In this Opinion, we determined that the following levels of take are not likely to jeopardize the continued existence of listed species.

This ITS exempts the following lethal take from dredging entrainment through 2062:

- GOM DPS Atlantic sturgeon:
    - **1** subadult
- NYB DPS Atlantic sturgeon:
    - **1** subadult
- CB DPS Atlantic sturgeon;

[8] http://www.nmfs.noaa.gov/op/pds/documents/02/110/02-110-19.pdf

- **43** subadults, and juveniles
- **Post yolk-sac larvae (PYSL)**
  Dredge entrainment will result in the loss of 2.2% of the annual Atlantic sturgeon PYSL year class through 2062.

- CA DPS Atlantic sturgeon:
  - **1** subadult
- SA DPS Atlantic sturgeon:
  - **1** subadult

All sub-adult and juvenile (CB DPS only) take is at the rate of approximately one individual per 1.5 million cy (no more than one per year) for a total of 47 fish over the remaining 44 years of the action. Based on the best available information discussed in this Opinion, re-initiation of this Opinion assumes the take of 3 fish from 2012-2018 from the exempted 50 fish (2012) based on USACE dredging volumes.

11.1.1 Lethal Take of Sturgeon Post Yolk-Sac Larvae

We considered several methods to monitor the validity of our estimates that dredging activities (summarized above) will result in the lethal take of 2.2% of the Atlantic sturgeon post yolk-sac larvae (PYSL) of each year class from 2018 to 2062.

Monitoring on cutterhead dredges is not possible at overboard placement sites, and because of the size of sturgeon at these life stages (~30-57mm, depending on the stage), the sturgeon would be too small to reliably observe and quantify at upland disposal areas. We also considered requiring pre- and post-dredging surveys of areas to be dredged during the times of year when we would expect early life stages to be present. However, again, the sturgeon larvae are extremely small and hard to reliably find and quantify. Also, just because the sturgeon are not in the dredge area during the survey, that does not mean they will not enter the dredge area (e.g., foraging PYSL) during dredging activities.

For either of these methods we considered, even if we were able to reliably quantify the take of sturgeon early life stages from dredging, we would need an estimate of the total number of sturgeon in that year class in the James River to validate our estimates of the percentage of each year class killed from dredging activities. These data are not available at this time, and we are not aware of any feasible methodology that could be carried out to collect such data.

Because the monitoring methods considered above are neither reasonable and prudent nor necessary or appropriate, we will use a means other than counting individuals to monitor the estimated numerical level of take and provide a means for reinitiating consultation once that level has been exceeded.

For this action, the areas you have proposed to maintenance dredge in the freshwater tidal portion of the action area (waters of 0-0.5 ppt salinity above approximately RM 47) July through February of any given year provide a proxy for monitoring the actual amount of incidental take of PYSL that we anticipate. We understand that shoals change and shift, so we have used approximate areal extents of each shoal in this portion of the river, since PYSL are capable of drifting and free-swimming.

We will consider incidental take exceeded for PYSL if the following condition is exceeded:

- Dredging in the following shoals where PYSL may be present, exceeds a total of **1.8** square miles per year (combined approximate area of shoals):
  - Jordan Point – Harrison Bar – Windmill Point Shoal Channel;
  - City Point Shoal Channel;
  - Richmond Deepwater Terminal to Hopewell Channel;
  - Richmond Deepwater Terminal Turning Basin;
  - Richmond Harbor – Richmond Deepwater Terminal;
  - Richmond Harbor.

If maintenance dredging occurs in tidal freshwater portions of the James River (above the approximate location of salt front at RM 47 in waters of 0-0.5 ppt salinity) outside of July 1 through February 14 of any given year, please contact us to determine if re-initiation of consultation is necessary.

11.1.2 Lethal Take of Sturgeon Non-larval Sturgeon

The volume of material removed from the action area serves as a proxy for monitoring actual take. As explained in the *Effects of the Action*, we expect one subadult (from any DPS) or juvenile (from CB DPS only) Atlantic sturgeon will be entrained for every 1.5 million cy of material. No more than one juvenile or subadult fish is expected to be taken per year. This dredge volume represents the high end of expected sediment removal per year, as estimated by the USACE. Because direct take cannot be observed in areas with overboard placement (middle and lower segments of the action area), this proxy is used to monitor the amount of incidental take during cutterhead dredging operations. Proxy take will be used as the primary method of determining whether incidental take has occurred; that is, we will consider that one subadult Atlantic sturgeon of any DPS, or juvenile from CB DPS has been taken for every 1.5 million cy of material removed during cutterhead dredging. Actual take will also be monitored at upland disposal sites in the upper segment of the action area by an observer with the ability to identify Atlantic sturgeon.

Once the authorized number of Atlantic sturgeon takes provided in this Incidental Take Statement (either through observed takes or by proxy, or a combination of the two) is reached, any additional entrainment of Atlantic sturgeon, or any additional sediment volumes dredged beyond the 1.5 mcy per year, will exceed the exempted level of take and reinitiation is required.

11.2 Reasonable and Prudent Measures, Terms and Conditions, and Justifications

We believe the following reasonable and prudent measures (RPMs) are necessary and appropriate to minimize and monitor impacts of incidental take resulting from the proposed action. In order to be exempt from prohibitions of section 9 of the ESA, you must comply with the following terms and conditions, which implement the reasonable and prudent measures described above and outline required reporting/monitoring requirements. These terms and conditions are non-discretionary.

The reasonable and prudent measures, with their implementing terms and conditions, are designed to minimize and monitor the impact of incidental take that might otherwise result from the proposed action. Specifically, these RPMs and Terms and Conditions will keep us informed of when and where dredging and disposal activities are taking place and will require you to report any take in a reasonable amount of time, as well as implement measures to monitor for entrainment during dredging. The third column below explains why each of these RPMs and Terms and Conditions are necessary and appropriate to minimize or monitor the level of incidental take associated with the proposed action and how they represent only a minor change to the action as proposed by you.

Table 13: RPMs, TCs, and Justifications Applicable to the Action

Reasonable and Prudent Measures (RPMs)	Terms and Conditions (TCs)	Justifications for RPMs & TCs
RPMs Applicable for All Dredge Activities		
1. We must be contacted prior to the commencement of dredging and again upon completion of the dredging and disposal activity.	1. You must contact us at incidental.take@noaa.gov 3 days before the commencement of each dredging activity and again within 3 days of the completion of the activity. This correspondence will serve both to alert us of the commencement and cessation of dredging activities and to give us an opportunity to provide you with any updated contact information or reporting forms. At the start of dredging activities, you must include the total volume and area you anticipate removing and the Reach where dredging will occur (with RMs/RKMs) At the end of the dredging event, you must report to us the actual volume and area removed and location where dredging occurred (with RMs/RKMs),	These RPMs and TCs are necessary and appropriate because they serve to ensure that we are aware of the dates and locations of all dredging that may result in take. This will allow us to monitor the duration and seasonality of dredging activities as well as give us an opportunity to provide you with any updated species information or contact information for our staff. This is only a minor change because it is not expected to result in any delay to the project and will merely involve occasional e-mails between you and our staff.
2. For cutterhead dredging with upland disposal, an inspector, with sufficient training to	2. The inspector must conduct daily inspections for biological materials, including Atlantic sturgeon or sturgeon	These RPMs and TCs are necessary and appropriate to ensure that any direct take is accounted for during

Reasonable and Prudent Measures (RPMs)	Terms and Conditions (TCs)	Justifications for RPMs & TCs
identify sturgeon, must be present at the upland disposal site.	parts and must be able to identify parts and the difference between species. 100% inspection coverage (with all appropriate schedules and procedures sufficient enough to ensure a high likelihood of documenting entrained sturgeon) must occur. Additionally, inspector must inspect ponded areas and the area where water is discharged from the upland disposal site.	maintenance dredging operations. All other take will be monitored via area and volume proxies. These RPMs and TCs represent only a minor change as compliance will not delay the project or cause a decrease in the efficiency of the dredging operations
3. All sturgeon captures, injuries, mortalities in the immediate dredging area must be reported to us within 24 hours. All take proxies (dredge volumes and areal extent measurements for PYSL) must be reported to us when the take level (from section 11) is reached.	3. In the event of any observed captures or entrainment of Atlantic sturgeon (lethal or non-lethal), you must follow the Sturgeon Take Standard Operating Procedures (SOPs) found at: www.greateratlanticfisheries.noaa.gov/protected/section7/reporting.html) We shall have the final say in determining if the take should count towards the Incidental Take Statement. If the cause of death is unknown NMFS will have the mortality assigned to the incidental take statement if a necropsy determines that the death was due to injuries sustained from an interaction with dredge gear.	These RPMs and TCs are necessary and appropriate to ensure the documentation of any interactions with listed species as well as requiring that these interactions are reported to us in a timely manner with all of the necessary information. In some cases, when the cause of death is uncertain, a necropsy may be necessary to aid in the determination of whether or not a mortality should count toward the ITS. This is essential for monitoring the level of incidental take associated with the proposed action. These RPMs and TCs represent only a minor change as compliance

Reasonable and Prudent Measures (RPMs)	Terms and Conditions (TCs)	Justifications for RPMs & TCs
	Dredge proxies and areal extents (for PYSL) from the ITS must be tracked. When take is exceeded via proxy, you must report this to us within 24 hours. Take reporting forms and sturgeon salvage forms are available at www.greateratlanticfisheries.noaa.gov/protected/section7/reporting.html These forms must be used. All take should be reported to incidental.take@noaa.gov.	will not result in delay of the project or decrease in the efficiency of the dredging operations.
4. Any and all Atlantic sturgeon captured must have a fin clip taken for genetic analysis. This sample must be transferred to a NMFS-approved laboratory capable of performing the genetic analysis. Because all sturgeon are presumed dead in cutterhead dredges used on this project, samples will be taken from dead sturgeon.	4. You must ensure that fin clips are taken (according to the procedure outlined in Appendix A) of any Atlantic sturgeon captured during the project and that the fin clips are sent to a NMFS approved laboratory capable of performing genetic analysis. Fin clips must be taken prior to preservation of other fish parts or whole bodies. To the extent authorized by law, you are responsible for the cost of the genetic analysis.	These RPMs and TCs are necessary and appropriate to ensure the proper handling and documentation of any interactions with listed species as well as requiring that these interactions are reported to us in a timely manner with all of the necessary information. This is essential for monitoring the level of incidental take associated with the proposed action. Genetic analysis must be conducted on Atlantic sturgeon samples to determine the appropriate DPS of origin and accurately record take of this

Reasonable and Prudent Measures (RPMs)	Terms and Conditions (TCs)	Justifications for RPMs & TCs
		species. These RPMs and TCs represent only a minor change as compliance will not result in delay of the project or decrease in the efficiency of the dredging operations.
5. Any dead sturgeon must be transferred to us or to an appropriately permitted research facility identified by us so that a necropsy can be undertaken to attempt to determine the cause of death. Sturgeon should be held in cold storage.	5. In the event of any lethal takes of Atlantic sturgeon, any dead specimens or body parts must be photographed, measured, and preserved (refrigerate or freeze) until disposal procedures are discussed with us. The form is available at www.greateratlanticfisheries.noaa.gov/protected/section7/reporting.html and must be completed and submitted to us.	These RPMs and TCs are necessary and appropriate to ensure the proper handling and documentation of any interactions with listed species as well as requiring that these interactions are reported to us in a timely manner with all of the necessary information. This is essential for monitoring the level of incidental take associated with the proposed action. These RPMs and TCs represent only a minor change as compliance will not result in any increased cost, delay of the project or decrease in the efficiency of the dredging operations.
6. For all cutterhead dredge operations you shall provide annual monitoring reports to us regarding the status of dredging (i.e., volumes and	6. You will provide us with monitoring reports annually, via email (christine.vaccaro@noaa.gov and incidental.take@noaa.gov) recording the days that dredging occurred, where	These RPMs and TCs are necessary and appropriate to ensure the documentation of any interactions with listed species as well as requiring that these interactions are

Reasonable and Prudent Measures (RPMs)	Terms and Conditions (TCs)	Justifications for RPMs & TCs
areal extents), and interactions or observations of listed species.	dredging occurred (which shoals with RMs/RKMs), summaries of the observer reports from upland disposal sites, the volume of material removed during the previous year, the areal extent of dredging in freshwater reaches (serving as a proxy for PYSL take), and any observations of listed species.	reported to us in a timely manner with all of the necessary information. This is essential for monitoring the level of incidental take associated with the proposed action. These RPMs and TCs represent only a minor change as compliance will not result in any increased cost, delay of the project or decrease in the efficiency of the dredging operations.

12.0 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, we recommend that USACE consider the following Conservation Recommendations:

(1) To the extent practicable, you should avoid dredging in locations and during times of year when Atlantic sturgeon sensitive life stages (eggs, larvae, PYSL) are likely to be present (tidal freshwater (0-0.5 ppt salinity) above the approximate salt front at RM 47 from March to July and September to December).

(2) Ecological information for sturgeon is still sparse for this river system. You 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 (usage by pre-spawning adults, juveniles, as well as location of spawning areas). Population estimates are also lacking for Atlantic sturgeon. You should continue to support studies to assist in gathering the necessary information to develop a population estimate for the CB DPS (as well as other Atlantic sturgeon DPSs).

(3) You should conduct 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.

(4) You should conduct studies using a VEMCO Positioning System (VPS) to determine what life stages of sturgeon occur in the navigation channels and the extent to which sturgeon use the navigation channels throughout the year.

13.0 REINITIATION OF CONSULTATION

This concludes formal consultation on your proposal for the 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 taking specified in the incidental take statement is exceeded; (2) new information reveals effects of the action that may not have been previously considered; (3) the identified action is subsequently modified in a manner that causes an effect to listed species; or (4) a new species is listed or critical habitat designated that may be affected by the identified action. In instances where the amount or extent of incidental take is exceeded, Section 7 consultation must be reinitiated immediately.

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APPENDIX A

Procedure for obtaining fin clips from sturgeon for genetic analysis

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. Place fin clips in small screw top vials (2 ml screw top plastic vials are preferred) with preservative. Avoid using glass vials.
4. Label each vial with fish's unique ID number that matches the ID number you record on the metadata sheet. This is critical for accurate tracking and record keeping .
5. RNAlater™ is the preferred preservative and is not hazardous. Ninety-five percent absolute ETOH (un-denatured) is an accepted alternative. Note that ETOH is a Class 3 Hazardous Material due to its flammable nature.
6. If non-screw top vials are used, seal individual vials with leak proof positive measure (e.g., tape).
7. Package vials together (e.g., in one box) with an absorbent material within a double-sealed container (e.g., zip lock baggie).
8. If using excepted quantities of ETOH, follow DOT and IATA packaging regulations, including affixing ETOH warning label to air package. Accepted quantities of ETOH is 30 mL per inner package and 1 L for the total package.
9. A sub-sample of the fin clip must be sent to the sturgeon genetics archive at the USGS facility in Leetown, WV.
   a. Submit sample metadata to rjohnson1@usgs.gov with a cc to incidental.take@noaa.gov. Electronic metadata must be provided in order to properly identify and archive samples. A copy of the electronic metadata was emailed to the Federal agency point of contact for this Opinion and a list of the metadata fields is included below. Retain a copy of metadata sheets for your records.
   b. Mail samples to:

Robin Johnson
U.S. Geological Survey
Leetown Science Center
Aquatic Ecology Branch
11649 Leetown Road
Kearneysville, WV 25430

10. Send a subsample and associated metadata to the NMFS-approved lab for processing to determine DPS or river of origin per the agreement you have with that facility.

Metadata to be recorded for each genetic sample submitted to USGS and other NMFS-approved lab:

- Collection Date
- Species (ATS/SNS)
- Collector
- Collector Email
- Collector Phone Number
- Permit/Biological Opinion Number
- Permit Holder, Responsible Party (RP), or Principal Investigator (PI)
- Holder, RP, or PI Email
- Holder, RP, or PI Phone Number
- Unique Fish ID
- PIT Tag Number
- Location Collected
- Latitude
- Longitude
- Fork Length (mm)
- Total Length (mm)
- Weight (g)
- Sex
- Preservative
- Tag Info Available (Y/N)
- Tag Info
- Mortality (Y/N)
- Mortality Type
- Release of Information to Interested Party
- Recapture (Y/N)
- Comments