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

Agency: Federal Highway Administration (FHWA)

Activity: Governor Harry W. Nice/Senator Thomas "Mac" Middleton Bridge (Nice-Middleton Bridge) Replacement Project

GARFO-2023-01066

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Greater Atlantic Regional Fisheries Office

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TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

1.0 INTRODUCTION

This constitutes the biological opinion (Opinion) of NOAA's National Marine Fisheries Service (NMFS) issued pursuant to Section 7 of the Endangered Species Act (ESA) of 1973, as amended, on the consequences of the Federal Highway Administration (FHWA), in coordination with the Maryland Transportation Authority (MDTA), proposed subaqueous blasting as part of the Governor Harry W. Nice/Senator Thomas "Mac" Middleton Bridge (Nice-Middleton Bridge) replacement project. This Opinion is based on the information provided in the Biological Assessment (BA) received on June 16, 2023 to initiate formal consultation, the Biological Assessment (BA) received on December 21, 2018 to initiate informal consultation, past consultations with the FHWA, and scientific papers and other sources of information as cited in this Opinion. We will keep a complete administrative record of this consultation at our NMFS Greater Atlantic Regional Fisheries Office (GARFO). Formal consultation was initiated on June 16, 2023.

1.1 Application of ESA Section 7(a)(2) Standards – Analytical Approach

This section reviews the approach used in this Opinion in order to apply the standards for determining jeopardy and destruction or adverse modification of critical habitat as set forth in section 7(a)(2) of the ESA and as defined by 50 CFR §402.02 and 50 CFR §402.14 (the consultation regulations). Additional guidance for this analysis is provided by the Endangered Species Consultation Handbook, March 1998, issued jointly by NMFS and the USFWS and the section 7 regulations as revised in 2019 (84 FR 44976; August 27, 2019). In conducting analyses of actions under section 7 of the ESA, we take the following steps, as directed by the consultation regulations:

- Describes the proposed action and identifies the action area (Section 2);
- Evaluates the current rangewide status of the species with respect to biological requirements indicative of survival and recovery and the essential features of designated critical habitat (Section 4);
- Evaluates the relevance of the environmental baseline in the action area to biological requirements and the species' current status, as well as the status of designated critical habitat (Section 5);
- Evaluates the relevance of climate change on environmental baseline and status of the species (Section 6);
- Determines whether the proposed action affects the abundance, reproduction, or distribution of the species, or alters any physical or biological features of designated critical habitat (Section 7);
- Determines and evaluates any cumulative effects within the action area (Section 8); and,
- Evaluates whether the effects of the proposed action, taken together with any cumulative effects and the environmental baseline, can be expected, directly or indirectly, to reduce appreciably the likelihood of both the survival and recovery

of the affected species, or is likely to destroy or adversely modify their designated critical habitat (Section 9).

In completing the last step, we determine whether the action under consultation is likely to jeopardize the ESA-listed species or result in the destruction or adverse modification of designated critical habitat. If so, we must identify a reasonable and prudent alternative(s) (RPA) to the action as proposed that avoids jeopardy or adverse modification of critical habitat and meets the other regulatory requirements for an RPA (see 50 CFR §402.02). In making these determinations, we must rely on the best available scientific and commercial data.

On July 5, 2022, the U.S. District Court for the Northern District of California issued an order vacating the 2019 regulations that were revised or added to 50 CFR part 402 in 2019 ("2019 Regulations," see 84 FR 44976, August 27, 2019) without making a finding on the merits. On September 21, 2022, the U.S. Court of Appeals for the Ninth Circuit granted a temporary stay of the district court's July 5 order. On November 14, 2022, the Northern District of California issued an order granting the government's request for voluntary remand without vacating the 2019 regulations. The District Court issued a slightly amended order two days later on November 16, 2022. As a result, the 2019 regulations remain in effect, and we are applying the 2019 regulations here. For purposes of this consultation and in an abundance of caution, we considered whether the substantive analysis and conclusions articulated in the biological opinion and incidental take statement would be any different under the pre-2019 regulations. We have determined that our analysis and conclusions would not be any different

2.0 PROJECT HISTORY

Coordination between NMFS and the FHWA on the proposed Nice-Middleton Bridge project has been ongoing since 2008. On May 7, 2012, you (FHWA) and MDTA held a conference call with the NMFS GARFO section 7 team to discuss the project. On August 15, 2012, you sent a letter about the Nice-Middleton Bridge project updates. On September 24, 2012, we (NMFS GARFO) responded with a technical assistance letter and recommended that you request section 7 consultation and prepare a Biological Assessment (BA) when the final design for the bridge was selected. On April 20, 2015, NMFS and FHWA met to discuss project updates and ESA section 7 consultation requirements.

On May 23 and June 7, 2017, FHWA and NMFS GARFO met again to discuss project updates and the ESA section 7 consultation process. You submitted a final BA for construction of the new Nice-Middleton Bridge and demolition of existing substructures. The proposed action in the 2019 consultation included pile driving, dredging, jetting, construction of temporary structures, mechanical demolition, vessel traffic, and restoration of shallow water habitat to assess effects from these actions on ESA-listed species and critical habitat. Specifically, you considered effects on ESA-listed species from the following activities:

- Installation of 168 54-inch diameter concrete cylinder piles, with the main span and mid-level approaches using approximately 40 120-inch and 66 96-inch diameter drilled shafts;

- Dredging of 12.2 acres using a clamshell bucket for bridge construction, with an estimated volume of material to be removed of approximately 92,000 cubic yards. In addition, you proposed maintenance dredging of 28,000 cubic yards of sediment. The total proposed dredging to include dredging prior to construction and any maintenance dredging was 120,000 cubic yards of sediment. Jetting was proposed for sediment removal. All dredged material associated with the project was to be loaded into barges for transport to the Weanack Land/Shirley Plantation upland disposal site outside of Richmond, Virginia on the James River;
- Creation of a temporary causeway constructed of rock fill (>500 lb.) and shot rock graded to approximately five feet above normal high water, benthic impacts of 7.1 acres to accommodate the causeway. Installation of 70 piles to construct the temporary trestle/pier, with each pier impacting approximately 140 square feet of river bottom. The overall footprint of the temporary trestle/pier was estimated to total 4.6 acres;
- Mechanical demolition, above-water explosive demolition, and removal of the demolition debris from the river via a mechanical dredge to facilitate removal of the existing steel superstructure (including portions of the truss) by cranes operating on the deck and removal of larger steel members by flame cutting of bolted connections and use of large cranes to lift the members to a barge;
- Increase in vessel traffic in the Potomac River due to the use of up to 12 barges and up to four support vessels (two tugs and two crew boats) for construction and demolition activities;
- Restoration of shallow water habitat to preconstruction bathymetric contours in waters less than three feet in depth, to include artificial fishing reef enhancement at up to a 2:1 ratio for any shallow water habitat impacts and dispersal of oyster spat at established oyster reefs at a 1:1 ratio for the remaining deep-water habitat impacts.

Informal section 7 consultation for the project was initiated on December 21, 2018. On February 1, 2019, NMFS issued a letter of concurrence with FHWA's determination that the activities described above may affect but are not likely to adversely affect the federally endangered shortnose sturgeon (*Acipenser brevirostrum*), five endangered/threatened Distinct Population Segments (DPSs) of Atlantic sturgeon (*Acipenser oxyrinchus oxyrinchus*), and Atlantic sturgeon designated critical habitat. Mechanical demolition to dismantle the existing bridge started in October 2022 and is expected to be completed in 2024. The new Nice-Middleton Bridge was opened to traffic on October 12, 2022. Therefore, except for demolition and dismantling of the old bridge structure, all of the activities that were analyzed in the previous 2019 consultation have been completed.

You, in coordination with the MDTA, first submitted a draft supplemental BA to the original 2019 consultation, along with a request to reinitiate consultation for project modifications that will include subaqueous blasting and habitat modification for the proposed Nice-Middleton Bridge project on March 27, 2023. On April 19, 2023, we requested additional information that was necessary prior to initiation of formal consultation. You provided us with a final revised BA dated June 15, 2023, which we received on June 16, 2023. On July 13, 2023, we sent you a letter stating that all information required to initiate formal section 7 consultation was included in your letter and BA, or is otherwise accessible for our consideration and reference; therefore, June 16, 2023 will serve as the commencement date of the formal consultation process. The ESA and the section 7 regulations (50 CFR§402.14) require that formal consultation be concluded within 90 calendar days of initiation (*i.e.*, September 14, 2023), and that a biological opinion be completed within 45 days after the conclusion of formal consultation (*i.e.*, October 29, 2023), unless we mutually agree on an extension.

You submitted the supplemental BA on June 16, 2023 to request reinitiation of consultation to consider effects to ESA-listed species and designated Atlantic sturgeon critical habitat from the proposed project modifications. Reinitiation of consultation is required where discretionary federal involvement or control over the action has been retained or is authorized by law and: (a) the amount or extent of taking specified in the incidental take statement is exceeded; (b) new information reveals effects of the action that may not have been previously considered; (c) the identified action is subsequently modified in a manner that causes an effect to listed species; or (d) a new species is listed or critical habitat designated that may be affected by the identified action. We agree that reinitiation of consultation is required at this time based on the project modification of blasting, which constitutes a modification to the action that was not considered in the previous consultation. Upon review of the previous 2019 consultation, we have determined that all other potential effects have been previously considered and any new available information would not change the outcome of our concurrence, thus, the 2019 consultation remains valid for the original (*i.e.*, bridge construction that includes mechanical demolition) action and is incorporated herein by reference.

All of the activities considered in the 2019 consultation were completed as of October 2022, expect for mechanical demolition of the old bridge structure (discussed below). The following activities have been completed to date:

- Clamshell bucket dredging of 174,336 square feet (approximately 24,000 cubic yards) has been completed for crane barge access near the Virginia shoreline as well as pile muck-outs of large piles driven near the Federal Navigation Channel. No maintenance dredging was required and no jetting has occurred to date.
- A total of 845 permanent piles were driven for the construction of the new bridge. This included:
    - 80 66-inch diameter hollow pre-cast concrete cylinder piles in the river,
    - 24 48-inch diameter steel fender piles for the ship collision protection system in the river,
    - 741 36-inch square pre-cast concrete piles (of which, 655 were driven in the river and 86 were driven on land).
- No temporary causeway was constructed. The project did construct two temporary trestles, one extending off of the Maryland shoreline and one extending off of the Virginia shoreline, as well as a temporary pile-supported concrete conveyor system. In

addition, there were temporary piles driven and temporary mooring anchors were utilized for construction support. Details include:

  - Maryland trestle: 18 trestle piles, 127 square feet of benthic impact.
  - Virginia trestle: 32 trestle piles for the F trestle, 226 square feet of benthic impact.
  - Concrete batch plant conveyor system: 15 36-inch piles, 106 square feet of benthic impact.
  - Temporary support piles: 189 temporary support piles to date totaling 1,334 square feet of benthic impact.
  - Temporary mooring anchors: 9 mooring anchors, approximately 200 square feet each, totaling 1,800 square feet of benthic impact.
  - In summary, 254 temporary piles and 9 temporary mooring anchors totaling 3,593 square feet.

- The vast majority of demolition to date has been mechanical. This included saw-cutting of the barrier wall and roadway decks, cutting and lifting of steel girders, and mechanical hammering of pier elements.
  - Shape charges were used to instantaneously cut the steel truss sections (above the waterline) in strategic locations and drop the truss sections into the river for safe retrieval. There were five of these events to cut and drop the truss sections from March through June of 2023 from mid-river to the Maryland shoreline area.

Mechanical demolition was included as part of the proposed action in the 2019 Nice-Middleton Bridge consultation. Mechanical demolition to dismantle Piers 10, 11, 12, 13, and 19 includes the use of above-water explosives and removal of the demolition debris from the river via a mechanical dredge. These activities for demolition of the existing bridge started in October 2022 and are expected to be completed in 2024. Although these aspects of the 2019 consultation have not yet been completed, the majority of the bridge will be demolished as originally permitted. Therefore, FHWA and MDTA do not expect any changes to these uncompleted aspects of the proposed action as described in the 2019 consultation.

3.0 DESCRIPTION OF THE PROPOSED ACTION

This Opinion considers the consequences of the FHWA's proposed project to perform underwater blasting of five piers on the old Nice-Middleton Bridge (Piers 14, 15, 16, 17, and 18) in the Potomac River, Maryland and Virginia. Blasting is also proposed to remove the submerged fender ring of Pier 15 if mechanical methods of demolition that were considered in the 2019 consultation are not successful. The proposed project will also include use of clean concrete rubble from the demolition and blasting activities to fill in the pier scour holes (Piers 3 through 10 and Piers 14 through 16).

3.1 Blasting

The removal of the old Harry Nice Bridge over the Potomac River will require explosive demolition to sever the steel superstructure and to fragment in-water concrete pier foundations to facilitate removal. Subaqueous blasting of piers 14, 15, 16, 17, and 18 of the old Nice-Middleton Bridge will occur as part of the proposed action. The concrete fender ring nose (large 227-metric ton (250-ton) block of concrete) of Pier 15 of the old Nice-Middleton Bridge is collapsed and is resting against the base of Pier 15. Therefore, it must be removed before Pier 15 can be blasted. Mechanical demolition will be attempted, and if it is possible, the concrete block will be lifted from the water to the land for mechanical demolition. The depth of the Potomac River at this location is 21 meters (70 feet) and the location of the fender ring nose between the old and new bridge, creates challenges to accessibility. If mechanical demolition via the activities described in the 2019 consultation is not possible, the concrete fender ring nose will be blasted before Pier 15 is blasted. The blaster will attempt to blast the concrete fender ring nose at the same time as the blasting for Pier 14 or the fender ring nose blast may have to be a separate blast. Therefore, the proposed blasting events will occur as follows:

- one blast event for Pier 14 and the collapsed concrete fender ring nose of Pier 15;
- one blast event for Pier 15;
- one blast event involving three separate blasts for Piers 16, 17, and 18.

Three blast events in addition to the three described above may occur in the event that any of the planned blast events are ineffective, or if the collapsed fender ring nose of Pier 15 must be blasted separately. Therefore, FHWA has estimated that up to six blast events will occur. Blasting will occur at the rate of one blast event per week from October 15, 2023 to February 14, 2024, based on the findings of Balazik (2023) fish survey results and input from NOAA Fisheries, state agencies, Virginia Commonwealth University (VCU), and Potomac River Fisheries Commission (PRFC). In the proposed timeframe, the duration of blasting activities will occur within a four to six week timeframe. The timeframe for blasting accounts for technical challenges and also potential weather delays.

A certified master blaster developed a detailed blast plan to remove the five piers and fender ring nose to the mudline (see Attachment 4 of the BA for the blast plan). Drill rigs positioned on the piers will vertically drill holes 7 centimeters (2.75 inches) in diameter into the piers and place charges into the holes. The blaster proposes a total of three decks of charges with 13.6 kilograms (30 pounds) maximum explosive each. Each blast event will last 1 second and there will be a 9-millisecond delay between charges to more evenly disperse the blast. Piers 14 and 15 are the largest piers, but Pier 15 requires the most explosives to be blasted because of the depth at that point in the river. Detailed information on the size of the blasts is described in Table 1. FHWA anticipates that all six blasts could be equal in magnitude to the largest blast (Pier 15).

Table 1. Proposed Amount of Explosives by Pier

Pier	Maximum Explosive Weight/Delay	Total Weight of Explosives*	Average Powder Factor
14	13.6 kg (30 lb)	2,454 kg (5,412 lb)	0.89 kg/m^3 (1.5 lb/cy)
15	13.6 kg (30 lb)	2,989 kg (6,590 lb)	0.89 kg/m^3 (1.5 lb/cy)
16	9 kg (20 lb)	1,018 kg (2,245 lb)	0.78 kg/m^3 (1.3 lb/cy)
17	9 kg (20 lb)	580 kg (1,280 lb)	0.71 kg/m^3 (1.2 lb/cy)
18	8-9 kg (18-20 lb)	537 kg (1,185 lb)	0.78 kg/m^3 (1.3 lb/cy)

* May change due to actual pier conditions
kg = kilograms, lb = pounds, m^3 = cubic meters, cy = cubic yards

Before blasting activities begin, sonar fish deterrents and fish scare charges will be used in the river to encourage fish to leave the blast area. A drag-behind sonic deterrent will be used to move fish out of the Danger Zone (640 meters (2,100 feet) from each pier). VCU will also patrol the immediate blast area with telemetry to confirm that no tagged sturgeon are present in the blast Danger Zone prior to each blast event. Thirty minutes before the scheduled blast time a sonar fish deterrent system will be deployed and swept through the water in the vicinity of the pier by boat. At the sounding of the five-minute warning, the boat will exit the marine safety zone to a distance of 2,100 feet. If a tagged fish is detected in the Danger Zone, the blast would be delayed until the fish swims out of the Danger Zone. A sturgeon monitoring program will be in use prior to the intended blast time and the blast will not be detonated until the observer confirms that no sturgeon are detected within the Danger Zone. During all of the blasting events, steel cable-woven blasting mats or other protective measures placed over exposed portions of the concrete piers that are above the waterline will contain debris and projectiles. Therefore, no flying debris is expected to enter the water at any time as a result of the blasting.

3.2 Habitat Modification

As discussed above, mechanical demolition to dismantle Piers 10, 11, 12, 13, and 19 includes the use of above-water explosives and removal of the demolition debris from the river via a mechanical dredge (included as part of the proposed action in the 2019 Nice-Middleton Bridge consultation). The proposed habitat modification activities considered in this Opinion will include the use of concrete rubble from the pier demolition to partially fill the existing scour holes at the base of Piers 3 through 10 and Piers 14 through 16. No placement is proposed for Piers 17, 18, or 19 because there are no scour holes present at the bases of those piers. The 11 scour holes are lacking 32,737 cubic yards of material in total and a total of 12,922 cubic yards of concrete rubble material will be placed to fill the holes. The amount of concrete rubble that will be used per scour hole will vary based on the size and depth of the hole (Table 2). The clean concrete rubble from each pier after demolition will be pushed into the pier's scour holes with large excavators attached with buckets, grapple, and clamshells operating from barges. Space at the top of the scour holes will allow the river to naturalize and encourage soft sediment deposition on top of the rubble. The total area of soft bottom substrate below the old bridge that will be disturbed by the placement of proposed rubble in the scour holes is 0.5 hectares (1.2 acres). The demolition material associated with the other 69 pier locations will be removed from the river bottom per the previous consultation. The habitat modification portion of the project will occur from the fall of 2023 through mid-2024, which accounts for material placement after the end of the blasting window on February 14, 2024.

FHWA coordinated with Maryland Department of the Environment (MDE) and the Maryland Department of Natural Resources while in the planning stages for the habitat modification portion of this project. State regulatory agencies were not in favor of moving concrete demolition material from one pier location to another pier location to fill all of the existing scour holes. The Tidal License Modification requesting authorization for this portion of the project was vetted by MDE and has completed a Public Notice period. Therefore, it was decided to allow the demolition material from each pier to fall or be pushed into the associated pier's scour hole and to leave 0.6 meters (2 feet) of capacity at the top of the scour hole to encourage river bottom restoration.

Table 2. Scour Hole Dimensions and Proposed Amount of Concrete Fill by Pier

Pier	Scour Hole Dimensions				Concrete Fill	
	Square Feet	Average Depth	Cubic Feet	Cubic Yards	Cubic Yards	% Volume
3	18,393	2.30	42,304	1,567	488	31%
4	12,877	1.13	14,551	539	218	40%
5	20,190	2.02	40,784	1,511	227	15%
6	14,429	1.62	23,375	866	238	27%
7	13,226	1.41	18,649	691	263	38%
8	14,851	1.66	24,653	913	255	28%
9	13,238	2.17	28,726	1,064	286	27%
10	52,702	3.42	180,241	6,676	1,390	21%
14	46,810	3.04	142,302	5,270	3,608	68%
15	64,441	4.76	306,739	11,361	4,241	37%
16	20,949	2.94	61,590	2,281	1,708	75%

3.3 Project Vessels

A maximum of 17 project vessels will be used to complete the blasting and will be associated with the habitat modification portions of the project. Five to seven shallow draft barges, two to three shallow draft tugboats, and five to six small work skiffs and/or one small crew vessel will be used during subaqueous blasting activities to set up for blasting and to clean up the debris. The 17 project vessels will range in size and may be up to 15-92 meters (50-300 feet) long, with a maximum draft of 4 meters (12 feet) and maximum width of approximately 30 meters (100 feet). The vessels are expected to travel at a maximum of 6 knots (approximately 7 miles per hour) in the blasting and habitat modification component of the action area. In the action area downstream of the Nice-Middleton Bridge, the vessels travelling within the Federal Navigation Channel are expected to travel at a maximum of 8 knots (approximately 9 miles per hour).

Before blasting begins, vessels will move outside of the Danger Zone. The project vessels to support the habitat modification operation will include tug boats, support vessels, and barges with large excavators. Homeports and specific project vessel routes are unknown at this time. However, we assume that barges and support vessels will transit from the mouth of the Chesapeake Bay or from the mouth of the James River (*e.g.*, Port of Norfolk), up the Chesapeake Bay federal navigation channel, and up the Potomac River federal navigation channel to the Nice-Middleton Bridge and then back to the homeport once complete. Project vessels are reasonably certain to pass through these areas because large ports that may supply the type of vessels needed for this project are located within this geographic area. However, beyond the mouth of the Chesapeake Bay, we cannot predict with any reasonable certainty what project vessel routes will be used.

3.4 Fish Deterrents

Within the proposed window for subaqueous blasting (October 15, 2023 to February 14, 2024), FHWA proposes to employ fish deterrent activities before each blast to ensure that sturgeon leave the project area. FHWA proposes to use fish scare charges with blast cap detonations and acoustic deterrents via a sonar unit pulled behind a light vessel prior to blasting. The fish scare charges will be set off 30 seconds prior to the main detonation, then a 10-second count down will be given, and the blast will detonated. These fish scares will consist of a series of blasting caps, each containing 0.75 grams of explosives, suspended in the water column surrounding the structure to be blasted. The location of the scare charges is based on past experience and the intent to drive fish away from the structure being blasted. FHWA believes that placing the charges at far distances from the bridge may potentially drive fish back towards the structure. Therefore, the scare charges will likely be placed in very close proximity to the bridge and likely within the 640-meter Danger Zone described below and depicted in Figure 1.

3.5 Best Management Practices

FHWA will employ the measures listed below to avoid, minimize, and monitor potential effects of the proposed work on shortnose sturgeon and Atlantic sturgeon, as well as to designated critical habitat for Atlantic sturgeon:

- Acoustic telemetry monitoring of shortnose and Atlantic sturgeon in the action area from March 2022 through December 2023 to continue data collection on the presence of sturgeon;
- Proposed window for subaqueous blasting is October 15, 2023 to February 14, 2024 to avoid sturgeon and anadromous fish spawning run;
- Use of fish deterrent noises (via sonar unit pulled behind a light vessel) prior to blasting;
- Use of fisheries and telemetry observers prior to blasting;
- Use of fish scare charges with blast cap detonations prior to blasting;
- Maintainance of a zone of fish passage in the river during blasting (*i.e.*, the area outside of the Danger Zone);
- Use of fish kill observers post-blast to collect, identify, count, and document any dead fish; and

- Blast parameters designed to minimize underwater disturbance including:
  - minimization of maximum charge weights (*i.e.*, a blasting sequence from interior to exterior with lighter charges on the exterior),
  - a minimum of 9-millisecond charge delays,
  - stemming of drill holes,
  - utilization of blast mats placed over the exposed piers to be blasted to minimize projectiles.

3.6 Action Area

The action area is defined as "all areas to be affected directly or indirectly by the Federal action and not merely the immediate area involved in the action" (50 CFR 402.02). The action area includes the Potomac River surrounding the Nice-Middleton Bridge (38.361656 latitude, -76.997544 longitude) in Maryland and Virginia where blasting and habitat modification will occur as described above. The action area includes the 5.26 square kilometers of underwater area (526 hectares /1,300 acres) where blasting and habitat modification will occur, where project vessels will operate or be sited at in the Potomac River at the Nice-Middleton Bridge, and where any consequences of the action could be experienced (*i.e.*, increases in suspended sediment, noise, etc.) (Figure 1). This area also encompasses the 640-meter (2,100 foot) area around the blast site (*i.e.*, Danger Zone) where effects of blasting may be experienced.

The action area also includes the Federal Navigation Channel within the Chesapeake Bay and the lower James River to the Nice-Middleton Bridge where project vessels will likely operate or transit through (Figure 2). This includes the 333.23 square kilometer area (33,323 hectares / 82,343 acres) within the Federal Navigation Channel[1] from the mouth of the Chesapeake Bay and mouth of the James River up the Potomac River to the Nice-Middleton Bridge.

Therefore, for the purpose of this consultation, the action area is defined as the approximately 338.39 square kilometer area (33,849 hectares / 83,643 acres) within the Potomac River, the Chesapeake Bay, and the James River where blasting and habitat modification will occur and project vessels are likely to transit or operate. We anticipate that the consequences on ESA-listed species and designated critical habitat as a result of the proposed action include: (1) the consequences of blasting on ESA-listed species and critical habitat, (2) the consequences of habitat modification (*i.e.*, concrete rubble placement) on ESA-listed species and critical habitat, (3) the consequences from the operation of vessels on ESA-listed species, and (4) the consequences on other marine organisms (*i.e.*, prey) on the river substrate that may result from blasting and habitat modification.

[1] The width of any project vessel is expected to be less than 30 meters (100 feet) and no project vessel will occupy the entire width of the Federal Navigation Channel. Given that exact vessel route are unknown, the action area includes the entire width of the Federal Navigation Channel.

Figure 1. Blasting and Habitat Modification Component of Action Area

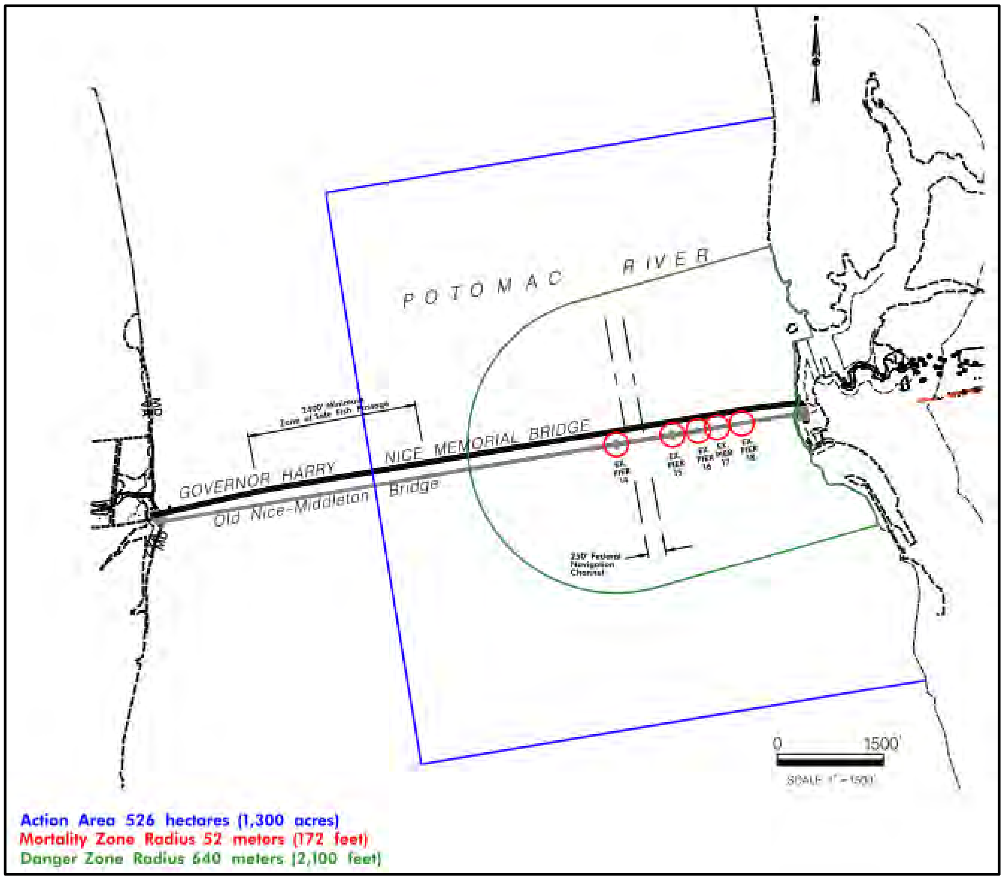

Figure 2. Vessel Operation Component of Action Area

3.6.1 Habitat in the Action Area

Potomac River

The substrate in the action area consists of soft and coarse-grained sand sediments (ERMA 2015). No hard bottom has been identified within the action area. Shallow water environments composed of sands are present near the shorelines and along the western and eastern side of the river. Soft substrate is present in deep-water habitat that occurs within and near the Federal Navigation Channel. The habitat of the action area is dominated by a large shallow western shoal consisting of soft sediments, a deep eastern section of the river with fine sands, and a narrower shallow shoal on the east side of the river dominated by soft sediments. The action area encompasses intertidal and subtidal habitats of varying depths, ranging from shallow intertidal shorelines to shallow subtidal shoals and deeper channel habitats.

The blasting and habitat modification component of the action area, which comprises the area around the Nice-Middleton Bridge, is located within the Lower Potomac River Watershed, and includes the tidal reach of the Potomac River Basin, extending from Little Falls near Chain

Bridge in Washington, DC, to the Potomac River's mouth at the Chesapeake Bay. Maryland's Nanjemoy Creek subwatershed and Virginia's Gambo Creek subwatershed are in the immediate vicinity of this component of the action area. The blasting and habitat modification component of the action area in the Potomac River has a salinity regime of low-mesohaline (*i.e.*, 5-18 parts per thousand). The saltwedge is located just upstream of the Nice-Middleton Bridge. The salinity at the bridge is typically 6-8 parts per thousand from September to January, but has varied from 1-13 parts per thousand since 1986 (MDNR 2023))[2]. Both Maryland and Virginia have placed portions of the tidal Potomac River on their 303(d) Impaired Waters Lists, in compliance with the US Environmental Protection Agency (US EPA) Clean Water Act (CWA), for polychlorinated biphenyl (PCB) contamination. In some cases, PCB concentrations in the Potomac River and its tributaries exceeded state standards.

The Potomac River at the Nice-Middleton Bridge is approximately 2.7 kilometers (1.7 miles) wide and varies in depth from the Maryland to the Virginia side of the river. Depth is roughly 2.1 meters (7 feet) on the western (Virginia) side, 2.1 to 16.8 meters (7 to 55 feet) deep in the middle, and 24 meters (80 feet) deep on the eastern (Maryland) side (including the Federal Navigation Channel). There is a steep deep-water ravine that climbs from 24 meters (80 feet) to the shoreline in roughly 100 meters (approximately 328 feet) relatively close to the Maryland bank. Approximately 55 percent of the river is greater than 3 meters (10 feet) deep. The tidal action of the river, currents, and the seasonal variation in the amount of freshwater contributed to it by precipitation and runoff make it a highly dynamic system. The flow is generally swift in this portion of the Potomac River, flowing at 0.6 to 1.2 meters (2 to 4 feet) per second on an ebbing tide. Tides are semidiurnal, having two high waters and two low waters each day with an average range of 0.6 meters (2.0 feet) (NOAA 2017). The river is classified by MDE as Use II (supports estuarine and marine aquatic life and shellfish harvesting).

Vessel Operation Component of Action Area - Potomac River, Chesapeake Bay, and James River
Potomac River

The upper reach of the Potomac River extends from Chain Bridge to Quantico, Virginia and contain freshwater habitat ideal for spawning and nursery areas for anadromous fish. The Nice-Middleton Bridge is located near a zone of mixing (*i.e.*, transition zone) between freshwater of the Potomac River and saltwater of the Chesapeake Bay. The average depth for this reach is 4 meters (13 feet). The bottom topography is characterized by a deep channel with an adjacent marginal slope that is bordered by a wide, shallow shelf. The channel ranges in depth from 6 to 33 meters (20 to 107 feet). The remainder of the Potomac River portion of the action area, extending from below the Nice-Middleton Bridge to the Chesapeake Bay, is saltwater. The average depth for this reach is 7 meters (22 feet). The bottom topography is dominated by a wide channel (1 to 3 miles) with gradually sloping, shallow flats nearshore. The channel ranges in depth from 6 to 24 meters (21 to 80 feet) (USGS 1984).

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[2] MDNR. 2023. Eyes on the Bay- Fixed Station Monthly Monitoring. https://eyesonthebay.dnr.maryland.gov/bay_cond/bay_cond.cfm?param=sal&station=RET24

The Potomac River Federal Navigation Channel within the action area encompasses subtidal habitats of varying depths. The channel depth allows the vessels to avoid the Kettle Shoals and other river hazards. The channel does not include shallow shorelines. The Potomac River federal navigation channel south to the Chesapeake Bay Federal Navigation Channel averages 12 meters (40 feet) to 30 meters (100 feet) and generally contain deeper channel habitats. Due to these water depths, there are no submerged aquatic vegetation (SAV) beds present in the Federal Navigation Channel.

Chesapeake Bay
The Chesapeake Bay is approximately 320 kilometers (approximately 200 miles) long and extends from Cape Henry and Cape Charles to Havre de Grace, Maryland. It is 4.5 kilometers (2.8 miles) wide at its narrowest (between Kent County's Plum Point near Newtown and the Harford County shore near Romney Creek) and 48 kilometers (30 miles) at its widest (just south of the mouth of the Potomac River). Water depth in the bay averages 6.4 meters (21 feet), reaching a maximum depth of 53 meters (174 feet). The lower Chesapeake Bay attained its current configuration after the end of the last Ice Age and it has been relatively stable for the last several thousand years (Bratton *et al.* 2002), although waters have continued to slowly rise over this time, due to glacial rebound and now the addition of human-induced climate change (Schulte *et al.* 2015).

The typical tidal range in the Chesapeake Bay is approximately 0.87 meters (2.85 feet), though this varies significantly with time of the month (spring and neap tides), storm activity, and specific location within the Bay. Tides are diurnal in the Chesapeake Bay, with two high and low tides per day. The mean discharge rate of Chesapeake Bay is approximately 2,500 cubic meters per second, over 80 percent of which is supplied by three rivers (the Susquehanna, Potomac, and James Rivers) (Goodrich 1988). Salinity typically ranges from 20-30 parts per thousand within the Chesapeake Bay and into the lower James River, while salinity decreases further upstream in the Potomac River. These areas are sufficiently mixed so that anoxic waters are not typical within the action area. Such deep channels can go anoxic in the summer, particularly in the mid to upper Chesapeake Bay, causing a significant “dead zone” of hypoxic waters. The bathymetry of the Chesapeake Bay ranges from intertidal shallows to the deep channels, which generally lie within the immediate action area where dredging is proposed and typically range in depth from approximately -20 feet in side and/or natural and unmaintained channels to -50 feet within the channel itself. Bottom sediment types primarily include fine sands, silts, with small amounts of small gravel (College of William and Mary 2006).

Project vessels may be traveling through the Federal Navigation Channel in the Chesapeake Bay, which comprises part of the action area. Depths in the Chesapeake Bay Federal Navigation Channel range between 6 meters (20 feet) and 30 meters (100 feet), with the mouth of the Chesapeake Bay at a depth of 30 meters. The current authorized depth is 16.8 meters (55 feet), though most of the channel is at approximately 15 meters (50 feet) deep. The channel follows the natural bathymetry of lower the Chesapeake Bay. This natural channel, however, has been deepened, where needed, to accommodate larger vessels. More information on deepening that has occurred within the Federal Navigation Channel is included in the *Environmental Baseline* section.

James River
The James River is a relatively shallow river with an average depth of 3.7 meters (12 feet) at mean low water, but depths may vary due to shallow flats and deep holes (-100 feet mean lower low water). Salinity is an average range of 18 – 21 parts per thousand at the mouth in the summer. The daily flushing rate of the river averages nearly 6,000 million gallons per day (http://www.virginiaplaces.org/watersheds/waterstats.html). 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. Sediments near the mouth of the river are primarily silt and clay.

Project vessels may be traveling through the Federal Navigation Channel in the James River, which comprises part of the action area. Within the James River Federal Navigation Channel, the channel is currently maintained to 7.62 meters (25 feet) deep and 91 meters (300 feet) wide from the mouth to Hopewell. Only soft sediments consisting of sand and silts/clay are found within the shoaling areas of the James River Federal Navigation Channel. Benthic studies in the James River have demonstrated a strong correlation between salinity and benthic community diversity (as reviewed in Diaz and Schaffner 1990), with low diversity in saline waters (Attrill 2002), similar to that which make up part of the action area within the James River Federal Navigation Channel.

4.0 STATUS OF LISTED SPECIES

We have determined that the action considered in this biological opinion may affect the following endangered or threatened species under our jurisdiction (Table 3):

Table 3**.** ESA-Listed Species in the Action Area

ESA-Listed Species - Common Name	**Latin Name**	**Distinct Population Segment (DPS)**	**Federal Register (FR) Citation**	**Recovery Plan**
Atlantic sturgeon	*Acipenser oxyrinchus oxyrinchus*	Gulf of Maine; New York Bight; Chesapeake Bay; Carolina; South Atlantic	77 FR 5880 and 77 FR 5914	N/A
Shortnose sturgeon	*Acipenser brevirostrum*	Range-wide	32 FR 4001	NMFS 1998a
Green sea turtle	*Chelonia mydas*	North Atlantic DPS	81 FR 20057	NMFS & USFWS 1991

Loggerhead sea turtle	*Caretta caretta*	Northwest Atlantic DPS	76 FR 58868	NMFS & USFWS 2008
Kemp's ridley sea turtle	*Lepidochelys kempii*	Range-wide	35 FR 18319	NMFS *et al.* 2011
Leatherback sea turtle	*Dermochelys coriacea*	Range-wide	35 FR 849	NMFS & USFWS 1992
North Atlantic right whale	*Eubalaena glacialis*	Range-wide	73 FR 12024	NMFS 2005
Fin whale	*Balaenoptera physalus*	Range-wide	35 FR 18319	NMFS 2010

4.1 Listed Species Not Likely to be Adversely Affected by the Proposed Action

The proposed project being considered in this Opinion is not likely to adversely affect the following ESA-listed species: leatherback, Kemp's ridley, the North Atlantic DPS of green sea turtles, the Northwest Atlantic DPS of loggerhead sea turtle, North Atlantic right whales, and fin whales (Table 3). The rationale for this "not likely to adversely affect" determination is presented below.

4.1.1 Sea Turtles

Sea turtles commonly occur in U.S. Atlantic waters throughout the inner continental shelf from Florida to Cape Cod, MA. Along the Atlantic coast of the United States, leatherback, green and loggerhead sea turtle nesting beaches occur from North Carolina south through Florida. Beaches in the two states do not support regular nesting of either species. In the United States, some Kemp's ridley turtle nesting has occurred along the coast of Texas, but most Kemp's ridley turtles nest in mass in Tamaulipas, Mexico, where nearly 95 percent of worldwide Kemp's ridley nesting occurs. Sea turtle nesting is rare north of North Carolina, although there is occasional loggerhead sea turtle nesting in Virginia. Since 1970, 166 loggerhead nests have been documented on Virginia's ocean-facing beaches (Virginia Department of Wildlife Resources 2016). The most abundant species in the Chesapeake Bay is loggerhead sea turtle followed closely by the Kemp's ridley sea turtles. Distribution and abundance models by Duke University suggests that Kemp's ridley are abundant near the mouth of the Chesapeake Bay (DiMatteo & Sparks 2023). Green sea turtles are also present and leatherback sea turtles also occur less frequently, in the Chesapeake Bay during the same timeframe.

Northward and inshore movement into waters of the Greater Atlantic Region from southern nesting beaches begins in the springtime. Sea turtles arrive into mid-Atlantic waters including Chesapeake Bay and lower Potomac River in May. The sea turtles in the Chesapeake Bay are typically small juveniles. Juvenile and occasionally adult sea turtles are expected to opportunistically forage in the Chesapeake Bay and the lower Potomac River and James River from May through the end of November, with the highest concentrations of sea turtles present from June to October. In the fall, as water temperatures cool, most sea turtles leave the region's waters by the end of November. Sea turtle presence in mid-Atlantic waters after this time is considered unlikely aside from cold-stunned individuals that fail to migrate south. With water temperatures changing due to climate change, the number of cold-stunned sea turtles is increasing. The annual average number of cold-stunned turtles in Massachusetts is now over 750.

The functional ecology of these four sea turtle species is varied. Loggerhead sea turtles are primarily carnivorous feeding mainly on mollusks and crustaceans. Kemp's ridley sea turtles are omnivorous feeding primarily on crabs and crustaceans. Green sea turtles are herbivores feeding mainly on algae and seagrasses, though they may also forage on sponges and invertebrates. Leatherback sea turtles are specialized feeders and prey primarily upon jellyfish.

Additional background on life history and population status can be found in the recovery plans: loggerhead (NMFS (National Marine Fisheries Service) and U.S. FWS (U.S. Fish and Wildlife Service) 2008), Kemp's ridley (NMFS (National Marine Fisheries Service) *et al.* 2011), green (NMFS (National Marine Fisheries Service) and U.S. FWS (U. S. Fish Wildlife Service) 1991), and leatherback (NMFS (National Marine Fisheries Service) and U.S. FWS (U.S. Fish and Wildlife Service) 1992).

4.1.1.1 Sea Turtle Presence in the Action Area

Adult and juvenile sea turtles are expected to be present migrating and foraging within the action area where project vessels will operate in the Chesapeake Bay and the lower Potomac River below the Wicomico River from the beginning of May through the end of November (Ecosystem Assessment Program 2012). Distribution and abundance models by Duke University suggests that sea turtles are abundant near the mouth of the Chesapeake Bay (DiMatteo and Sparks 2023). Sea turtles are not expected to occur in the vicinity of the Nice-Middleton Bridge.

Limited nesting of sea turtles occurs on Virginia ocean-facing beaches, primarily in the southernmost part of the state. Virginia represents the northernmost extreme of loggerhead sea turtle nesting along the U.S. Atlantic coast. From 1970-2015, 166 loggerhead nests have been documented on Virginia's ocean-facing beaches. The state's first and only green sea turtle nest was reported in 2005 and its first and second Kemp's ridley nests were documented in 2012 and 2014, respectively (Virginia DGIF 2016). Sea turtle nesting may occur on ocean-facing beaches and is unlikely to occur within the action area, therefore, no sea turtle hatchlings are expected to be present.

The Potomac River at the Nice-Middleton Bridge is mesohaline, which is characterized by brackish waters with a salinity of 5 to 18 parts per thousand. The primary forage base for sea turtles are in predominantly present in marine habitats. Sea turtle prey, including whelks, crabs, and other shellfish and benthic invertebrates for loggerheads and Kemp's ridley sea turtles; sea grasses and marine algae for green sea turtles, and cnidarians, salps, jellyfish and tunicates for leatherback sea turtles, becomes less abundant as salinity decreases. Therefore, we assume sea turtles are not present in the blasting and habitat modification component of the action area at the Nice-Middleton Bridge. Sea turtles are expected to be transient, opportunistically foraging and resting where appropriate forage and habitat exist, in the action area of the lower Potomac River, Chesapeake Bay, and lower James River where project vessel are expected to operate.

4.1.1.2 Consequences of the Proposed Action on Sea Turtles

Leatherback, green, Kemp's ridley, and loggerhead sea turtles are not expected to occur in the Potomac River at the Nice-Middleton Bridge where blasting and habitat modification will occur. They are also not expected to be present in mid-Atlantic waters during the timeframe when the proposed blasting will occur (October to mid-February). Therefore, sea turtles will not be exposed to any effects associated with blasting activities. However, the habitat modification portion of the project will occur from the fall of 2023 through mid-2024. Sea turtles may occur in the Chesapeake Bay and the lower Potomac River below the Wicomico River. Therefore, adult and juvenile sea turtles may be exposed to the increased vessel traffic associated with the project that occurs in October and November 2023 (when staging for the project will occur) and May 2024 (when the project ends). This section will address the effects of vessel traffic to sea turtles within the lower Potomac River and the Chesapeake Bay.

Vessel Traffic

Vessel strikes remain a relatively rare cause of mortality to sea turtles and an increase in vessel traffic in the action area would not necessarily translate into an increase in vessel strike events. However, although rare, interactions with project vessels related to the proposed project could potentially injure or kill sea turtles. Interactions between vessels and sea turtles are not well understood; however, collisions appear to be correlated with recreational boat traffic (NRC (National Research Council) 1990) and the speed of the vessel (Hazel *et al.* 2007, Sapp 2010). Sea turtles are thought to be able to avoid injury from slower moving vessels because they may be able to maneuver and avoid the vessel (Sapp 2010).

According to 2001 STSSN stranding data, at least 33 sea turtles (loggerhead, green, Kemp's ridley and leatherbacks) that stranded on beaches within the northeast (Maine through North Carolina) were struck by a boat. This number underestimates the actual number of boat strikes that occur since not every boat struck turtle will strand, every stranded turtle will not be found, and many stranded turtles are too decomposed to determine whether the turtle was struck by a boat. It should be noted, however, that it is not known whether all boat strikes were the cause of death or whether they occurred post-mortem (NMFS SEFSC (National Marine Fisheries Service Southeast Fisheries Science Center) 2001). More recently, boat strike wounds were confirmed to be ante-mortem (*i.e.*, occur prior to death) in over 75 percent of sea turtles that were found dead or stranded along the U.S. Atlantic coast (B. Stacy, NMFS, pers. comm., 2017) and a majority of sea turtles struck in Virginia waters were healthy prior to those collisions (Barco *et al.* 2017).

Sea turtles may interact with project vessels as they transition from the Nice-Middleton Bridge through the lower Potomac River, Chesapeake Bay, and James River. The addition of a minimal number of project vessels to the existing baseline increases vessel strike risk to sea turtles, but it is to such a small extent that the increase in risk of a potential strike cannot be meaningfully measured or detected. The addition of project vessels will be intermittent, temporary (a maximum of 17 over a nine month period), and restricted to a small portion of the overall size of the action area (vessels will only operate within the Federal Navigational Channel). In addition, vessels are expected to travel at slow speeds (maximum travel speed of approximately 8 knots (about 9 miles per hour)) within the action area. Sea turtles are expected to be present and may overlap with project vessel traffic for 3 months (October, November, and May) when sea turtle density is expected to be lower. Based on the factors considered above, the risk of vessel strike from project vessels is too small to be meaningfully measured or detected. As a result, the effect of the action on the risk of a vessel strike in the action area is insignificant.

4.1.2 Whales

North Atlantic right whales are large baleen whales. Their primary food sources are zooplankton, including copepods, euphausiids, and cyprids. Right whales commonly feed at or just below the water's surface and at depth. Right whales primarily occur in coastal or shelf waters, although movements over deep waters are known. Right whales migrate to higher latitudes during spring and summer (NMFS 2005). In the mid-Atlantic, adult and juvenile right whales occur throughout the continental shelf and slope waters, possibly off shore of New Jersey and Virginia. Whales begin moving north along the coast in the vicinity of Chesapeake Bay during November to April while on their way to northern foraging areas. Adult and juvenile right whales are commonly found foraging from January to October and overwintering from November to January in waters in and around Massachusetts Bay and north along the coast into Canadian waters.

Fin whales are found in deep, offshore waters of all major oceans, primarily in temperate to polar latitudes. During the summer, fin whales feed on krill, small schooling fish (*e.g.*, herring, capelin, and sand lance), and squid, but fast in the winter while they migrate south to warmer waters. They occur year-round in a wide range of latitudes and longitudes, but the density of individuals in any one area changes seasonally. In the mid-Atlantic, foraging occurs year round in the mid-shelf area off the east end of Long Island. Fin whales use the nearshore coastal waters of the Atlantic Ocean as they migrate to and from calving and foraging grounds. There is evidence of overwintering areas in mid-shelf areas east of New Jersey. Fin whale calving may take place offshore in mid-Atlantic waters from October to January. Fin whales may occupy both deep and shallow waters in and around Chesapeake Bay and are most abundant in spring, summer, and fall, but do have some presence during the winter months. Therefore, fin whales could be present year-round.

Additional background on life history and population status can be found in the recovery plans: North Atlantic right whales (NMFS 2005) and fin whales (NMFS 2010).

4.1.2.1 Whale Presence in the Action Area

Fin and right whales occur throughout the continental shelf and slopes of the mid-Atlantic (NMFS 2017a). Generally, sightings and satellite tracking data along the east coast indicate that endangered large whales such as right and fin whales rarely venture into bays, harbors, or inlets. However, right whale sightings have been documented near the Chesapeake Bay and in a few rare occasions within the Bay. For instance, since 2017 two right whale observations were reported at the mouth of the Chesapeake Bay during 2020 and 2023 (https://whalemap.org/WhaleMap/). Right whales are most likely to occur in waters off the

Virginia coast between November and April as they migrate between northern foraging and southern calving grounds, but could be present year round (NMFS 2017b). Fin whales could potentially be present year round within the action area in the Chesapeake Bay or at its mouth, but they have not been observed in these waters. Given the lower salinity and shallower depths than marine waters, right and fin whales are not present near the Nice-Middleton Bridge nor downstream in the lower Potomac River. Therefore, though unlikely, it is possible that adult and juvenile North Atlantic right whales and fin whales may be present year-round within the Chesapeake Bay.

4.1.2.2 Consequences of the Proposed Action on Whales

ESA listed species of whales will not occur in the mesohaline (salinity of 5 to 18 parts per thousand) waters of the Potomac River where blasting and habitat modification will occur and, thus, will not be exposed to any effects associated with these activities. Although rare and unlikely, fin and North Atlantic right whales may be present within the Chesapeake Bay where increased vessel traffic will occur. As such, this section will only address the effects of vessel traffic to whales within the Chesapeake Bay.

Vessel Traffic

Project vessels are expected to travel within the Chesapeake Bay to reach the Nice-Middleton Bridge in the Potomac River, therefore, whales may be exposed to these vessels. Collision with vessels remains a source of anthropogenic mortality for whales and project-related vessels would increase vessel traffic in the action area. Injuries and mortalities from vessel strikes are a threat to North Atlantic right and fin whales. Reports from 2009 to 2018 indicate that right whales experienced four vessel strike mortalities and five serious injuries, two of which were prorated serious injuries, in the U.S. or in an unknown country of origin. The annual average of vessel strikes between 2012 and 2016 in U.S. waters was 1.4 for fin whales (Hayes 2019). Large whales, particularly right whales, are vulnerable to injury and mortality from ship strikes. Ship strike injuries to whales occur in two ways: (1) propeller wounds characterized by external gashes or severed tail stocks; and (2) blunt trauma injuries indicated by fractured skulls, jaws, and vertebrae, as well as massive bruises that sometimes lack external expression (Laist *et al.* 2001). Collisions with smaller vessels may result in propeller wounds or no apparent injury, depending on the severity of the incident. Laist *et al.* (2001) reports that of 41 ship strike accounts that reported vessel speed, no lethal or severe injuries occurred at speeds below ten knots, and no collisions have been reported for vessels traveling less than six knots. An analysis by Vanderlaan and Taggart (2007) showed that at speeds greater than 15 knots, the probability of a ship strike resulting in death of a whale increases asymptotically to 100 percent. At speeds below 11.8 knots, the probability of a vessel decreases to less than 50 percent, and at 10 knots or less, the probability is further reduced to approximately 30 percent. Most ship strikes have occurred at vessel speeds of 13-15 knots or greater (Jensen and Silber 2003, Laist *et al.* 2001). Therefore, vessel strikes that injure or kill whales are most likely occur when vessels travel at speeds of 10 knots or more (Laist *et al.* 2001, Pace and Silber 2005, Vanderlaan and Taggart 2007). Despite being one of the primary known sources of direct anthropogenic mortality to whales, vessel strikes remain relatively rare, stochastic events, and an increase in vessel traffic in the action area would not necessarily translate into an increase in vessel strike events.

Seasonal Management Areas (SMA) were established in 2008 to reduce the likelihood of death and serious injuries to endangered right whales that result from collisions with ships (50 CFR 224.105). The areas are defined as the waters within a 20 nautical mile area with an epicenter located at the midpoint of the COLREG demarcation line crossing the entry into the designated ports or bays. A mid-Atlantic SMA is located at the mouth of the Chesapeake Bay and is active from November 1 through April 30 of any given year (Figure 2). Vessels 65 feet (19.8 meters) or longer are required to operate at speeds of 10 knots or less when traveling through the SMA. Project vessels may be up to 15-92 meters (50-300 feet) in length, therefore, any large project vessels (65 feet (19.8 meters) or longer) traveling to and from the Nice-Middleton Bridge through the mouth of the Chesapeake Bay must adhere to the speed requirements of 10 knots or less. Laist *et al.* (2014) demonstrates that the SMA has been effective at reducing vessel impacts to whales. Federal regulations, as specified in 50 CFR 222.32, require that a vessel steer a course away from a right whale and immediately leave the area at a slow safe speed if a whale is observed within 500 yards (458 meters) of the vessel. Requirements to steer a course away from a whale may further reduce the risk of vessel-whale collisions. Thus, measures to avoid vessel strike are already in place and will be applicable to project vessels associated with the proposed project if they exceed 65 feet (19.8 meters) in length. Therefore, the speed of any large project vessels will not exceed 10 knots while transiting to/from the Atlantic Ocean from November 1 through April 30 when whales are most likely to be present in the vicinity of the Chesapeake Bay, thereby reducing the likelihood of vessel collision impacts to whales. In addition, vessels are expected to travel at a maximum travel speed of approximately 8 knots (about 9 miles per hour) within the action area and will only travel within the Federal Navigation Channel within the Chesapeake Bay. Although there is no speed restriction during May 1 to October 31, the probability of a whale being present within the vicinity of the mouth of the Chesapeake Bay is extremely low. The risk of serious injury or death increases if the vessels travel at speeds above 10 knots, the speed of project vessels (up to 8 knots) during transit lessens the probability of a ship strike resulting in lethal or serious injuries. Requirements to steer a course away from a right whale may further reduce the risk of vessel-whale collisions. While there are no physical barriers preventing whales from entering the Chesapeake Bay, the probability of a whale being present within the Chesapeake Bay is extremely low. Based on the rarity of whales within the action area, that any large project vessels will be required to travel at a speed of 10 knots or lower between November 1 and April 30 in the SMA and all project vessels are expected to travel at speeds of approximately 8 knots (about 9 miles per hour) within the Federal Navigation Channel in the Chesapeake Bay, and that any project vessel is required to keep a 500-yard distance from an observed whale, we find it extremely unlikely that a whale will be exposed to a vessel strike. Therefore, effects from vessel traffic caused by the proposed action is discountable.

Figure 3. Seasonal Management Area in the Mid-Atlantic

4.2 Listed Species Likely to be Adversely Affected by the Proposed Action

4.2.1 Shortnose Sturgeon

Shortnose sturgeon are fish that occur in rivers and estuaries along the East Coast of the U.S. and Canada (SSSRT (Shortnose Sturgeon Status Review Team) 2010). They have a head covered in bony plates, as well as protective armor called scutes extending from the base of the skull to the caudal peduncle. Other distinctive features include a subterminal, protractile tube-like mouth, and chemosensory barbels for benthic foraging (SSSRT (Shortnose Sturgeon Status Review Team) 2010). Sturgeon have been present in North America since the Upper Cretaceous period, more than 66 million years ago. The information below is a summary of available information on the species. Detailed information on the populations that occur in the action area is provided below while details on activities that impact individual shortnose sturgeon in the action area can be found in *Environmental Baseline* and *Climate Change* sections.

4.2.1.1 Life History and General Habitat Use

There are differences in life history, behavior and habitat use across the range of the species. Current research indicates that these differences are adaptations to unique features of the rivers where these populations occur. For example, there are differences in larval dispersal patterns in the Connecticut River (MA) and Savannah River (GA) (Parker 2007). There are also morphological and behavioral differences. Growth and maturation occurs more quickly in southern rivers but fish in northern rivers grow larger and live longer. See Table 4 for shortnose sturgeon general life history attributes.

Table 4**.** Life History Summary for Shortnose Sturgeon (range-wide)

Stage	Size (mm)	Duration	Behaviors/Habitat Used
Egg	3-4	13 days post spawn	stationary on bottom; Cobble and rock, fresh, fast flowing water
Yolk Sac Larvae	7-15	8-12 days post hatch	Photonegative; swim up and drift behavior; form aggregations with other YSL; Cobble and rock, stay at bottom near spawning site
Post Yolk Sac Larvae	15 – 57	12-40 days post hatch	Free swimming; feeding; Silt bottom, deep channel; fresh water
Young of Year	57 – 140 (north); 57-300 (south)	From 40 days post-hatch to one year	Deep, muddy areas upstream of the saltwedge
Juvenile	140 to 450-550 (north); 300 to 450-550 (south)	1 year to maturation	Increasing salinity tolerance with age; same habitat patterns as adults
Adult	450-1100 average; (max recorded1400)	Post-maturation	Freshwater to estuary with some individuals making nearshore coastal migrations

Shortnose sturgeon live on average for 30 - 40 years (Kynard *et al.* 2016). Males mature at approximately 5-10 years and females mature between 7–13 years, with later maturation occurring in more northern populations (Kynard *et al.* 2016). Females typically spawn for the first time 5 years post-maturation (Dadswell 1979, Dadswell *et al.* 1984) and then spawn every 3-5 years (Kynard *et al.* 2016). Males spawn for the first time approximately 1-2 years after maturity with spawning typically occurring every 1-2 years (Kynard *et al.* 2016). Shortnose sturgeon are iteroparous (spawning more than once during their life) and females release eggs in multiple “batches” during a 24 to 36-hour period (total of 30,000-200,000 eggs). Multiple males are likely to fertilize the eggs of a single female.

Cues for spawning are thought to include water temperature, day length, and river flow (Brundage 2018, Kynard *et al.* 2016). Shortnose sturgeon spawn in freshwater reaches of their natal rivers when water temperatures reach 9–15°C (48.2–59°F) in the spring (Kynard *et al.* 2016). Spawning occurs over gravel, rubble, and/or cobble substrate (Kynard *et al.* 2016) in areas with average bottom velocities between 0.4 and 0.8 meters per second. Depths at spawning sites are highly variable, ranging from 1.2-27 meters (4-89 feet) (multiple references in (SSSRT 2010)). Eggs are small and demersal and stick to the rocky substrate where spawning occurs. Following spawning, adult shortnose sturgeon disperse quickly down river to summer foraging grounds areas and remain in areas downstream of their spawning grounds throughout the remainder of the year (Kynard *et al.* 2016).

Shortnose sturgeon occur in waters between 0 – 34°C (0 – 93.2°F) (Dadswell *et al.* 1984, Heidt and Gilbert 1978); with temperatures above 28°C (84.2°F) considered to be stressful. Depths used are highly variable, ranging from shallow mudflats while foraging to deep channels up to 30 meters (98.4 feet) (Dadswell *et al.* 1984, Kynard *et al.* 2016). Salinity tolerance increases with age. Young-of-the-year must remain in freshwater; however, adults have been documented in the ocean with salinities of up 30 parts per thousand (Kynard *et al.* 2016). Dissolved oxygen affects distribution, with preference for dissolved oxygen levels at or above 5 milligrams per liter and adverse effects anticipated for prolonged exposure to dissolved oxygen less than 3.2 milligrams per liter (Kynard *et al.* 2016).

Shortnose sturgeon feed on benthic insects, crustaceans, mollusks, and polychaetes (Kynard *et al.* 2016). Both juvenile and adult shortnose sturgeon primarily forage over sandy-mud bottoms, which support benthic invertebrates (Carlson and Simpson 1987, Kynard *et al.* 2016). Shortnose sturgeon have also been observed feeding off plant surfaces (Dadswell *et al.* 1984).

In northern rivers, shortnose sturgeon aggregate during the winter months in discrete, deep (3-10 meters (9.8-32.8 feet) freshwater areas with minimal movement and foraging (Brundage 2018, Buckley and Kynard 1985, Dadswell 1979, Dovel *et al.* 1992, Kynard *et al.* 2016). In the winter, adults in southern rivers spend much of their time in the slower moving waters downstream near the salt-wedge and forage widely throughout the estuary (Collins and Smith 1993, Weber *et al.* 1998). Pre-spawning sturgeon in some northern and southern systems migrate into an area in the upper tidal portion of the river in the fall and complete their migration in the spring (Kynard *et al.* 2016). Older juveniles typically occur in the same overwintering areas as adults while young of the year remain in freshwater (Jenkins *et al.* 1993).

4.2.1.2 Listing History

Shortnose sturgeon were listed as endangered in 1967 (32 FR 4001), and the species remained on the endangered species list with the enactment of the ESA in 1973. The species remains listed as endangered throughout their range. Shortnose sturgeon are thought to have been abundant in nearly every large East Coast river prior to the 1880s (Kynard *et al.* 2016). Pollution and overfishing, including bycatch in the shad fishery, were listed as principal reasons for the species' decline. While the 1998 Recovery Plan refers to Distinct Population Segments (DPS), the process to designate DPSs for this species has not been undertaken (NMFS). The SSSRT published a Biological Assessment for shortnose sturgeon in 2010. The report summarized the status of shortnose sturgeon within each river and identified stressors that continue to affect the abundance and stability of these populations.

4.2.1.3 Current Status

There is no current total population estimate for shortnose sturgeon range wide. Information on populations and metapopulations is presented below. In general, populations in the Northeast are larger and more stable than those in the Southeast (SSSRT 2010). Population size throughout the species' range is considered to be stable; however, most riverine populations are below the historic population sizes and most likely are below the carrying capacity of the river (Kynard 1997, Kynard *et al.* 2016).

4.2.1.4 Population Structure

There are 19 documented populations of shortnose sturgeon ranging from the St. Johns River, Florida (possibly extirpated from this system) to the Saint John River in New Brunswick, Canada. There is a large gap in the middle of the species range with individuals present in the Chesapeake Bay separated from populations in the Carolinas by a distance of more than 400 kilometers (248.5 miles). Currently, there are significantly more shortnose sturgeon in the northern portion of the range.

Recent developments in genetic research as well as differences in life history support the grouping of shortnose sturgeon into five genetically distinct groups, all of which have unique geographic adaptations (see (Grunwald *et al.* 2008, King *et al.* 2001, SSSRT 2010, Waldman *et al.* 2002, Wirgin *et al.* 2005). These groups are: 1) Gulf of Maine; 2) Connecticut and Housatonic Rivers; 3) Hudson River; 4) Delaware River and Chesapeake Bay; and 5) Southeast. The Gulf of Maine, Delaware/Chesapeake Bay and Southeast groups function as metapopulations[3]. The other two groups (Connecticut/Housatonic and the Hudson River) function as independent populations.

While there is migration within each metapopulation (*i.e.*, between rivers in the Gulf of Maine and between rivers in the Southeast) and occasional migration between populations (*e.g.*, Connecticut and Hudson), interbreeding between river populations is limited to very few individuals per generation; this results in morphological and genetic variation between most river populations (Grunwald *et al.* 2008, King *et al.* 2001, SSSRT 2010, Wirgin *et al.* 2005, Wirgin *et al.* 2002). Indirect gene flow estimates from mtDNA indicate an effective migration rate of less than two individuals per generation. This means that while individual shortnose sturgeon may move between rivers, very few sturgeon are spawning outside their natal river; it is important to remember that the result of physical movement of individuals is rarely genetic exchange.

4.2.1.5 Status in the Greater Atlantic Region

In NMFS's Greater Atlantic Region, shortnose sturgeon are known to spawn in the Kennebec, Androscoggin, Merrimack, Connecticut, Hudson and Delaware Rivers. Shortnose sturgeon also occur in the Penobscot and Potomac Rivers; although it is unclear if spawning is currently occurring in those systems.

Gulf of Maine Metapopulation

Tagging and telemetry studies indicate that shortnose sturgeon are present in the Penobscot, Kennebec, Androscoggin, Sheepscot, and Saco Rivers. Individuals have also been documented

[3] A metapopulation is a group of populations in which distinct populations occupy separate patches of habitat separated by unoccupied areas (Levins 1969). Low rates of connectivity through dispersal, with little to no effective movement, allow individual populations to remain distinct as the rate of migration between local populations is low enough not to have an impact on local dynamics or evolutionary lineages (Hastings and Harrison 1994). This interbreeding between populations, while limited, is consistent, and distinguishes metapopulations from other patchy populations.

in smaller coastal rivers; however, the duration of presence has been limited to hours or days and the smaller coastal rivers are thought to be only used occasionally (Zydlewski *et al.* 2011).

Since the removal of the Veazie and Great Works Dams (2013 and 2012, respectively), in the Penobscot River, shortnose sturgeon range from the Bay to the Milford Dam. Shortnose sturgeon now have access to their full historical range. Adult and large juvenile sturgeon have been documented to use the river. While potential spawning sites have been identified, no spawning has been documented. Foraging and overwintering are known to occur in the river. Nearly all pre-spawn females and males have been documented to return to the Kennebec or Androscoggin Rivers. Estimated seasonal adult abundance ranging from 636-1285 (weighted mean), with a low estimate of 602 (95 percent CI: 409.6-910.8) and a high of 1306 (95 percent CI: 795.6-2176.4) (Fernandes 2008; Fernandes *et al.* 2010; Dionne 2010 in Maine DMR 2010).

Kennebec/Androscoggin/Sheepscot

The estimated size of the adult population (>50 centimeters (>19.7 inches) tail length (TL)) in this system, based on a tagging and recapture study conducted between 1977-1981, was 7,200 (95 percent CI = 5,000 - 10,800; Squiers *et al.* 1982). A population study conducted 1998-2000 estimated population size at 9,488 (95 percent CI = 6,942 -13,358; Squiers 2003) (Squiers 2003) suggesting that the population exhibited significant growth between the late 1970s and late 1990s. Spawning is known to occur in the Androscoggin and Kennebec Rivers. In both rivers, there are hydroelectric facilities located at the base of natural falls thought to be the natural upstream limit of the species. The Sheepscot River is used for foraging during the summer months. Altenritter *et al.* (2017a) found that a large proportion of female shortnose sturgeon tagged in the Penobscot River migrated to the Kennebec River during probable spawning windows. They also found that shortnose sturgeon in the Penobscot River were larger and had a higher condition factor than shortnose sturgeon in the Kennebec River. Based on this, they speculated that, "increased abundance and resource limitation in the Kennebec River may be constraining growth and promoting migration to the Penobscot River by individuals with sufficient initial size and condition." These individuals then return to spawn in the Kennebec River at larger size that could potentially result in increased reproductive potential compared to non-migratory females. Thus, migrants could experience an adaptive reproductive advantage relative to non-migratory individuals. Furthermore, Altenritter *et al.* (2017b) noted that although migrants to the Penobscot River may be a small proportion of the Kennebec River population, they could disproportionately contribute to regional recruitment and facilitate population resilience to disturbance.

Merrimack River

The historic range in the Merrimack extended to Amoskeag Falls (Manchester, New Hampshire, river kilometer 116 (river mile 72); Piotrowski 2002); currently shortnose sturgeon cannot move past the Essex Dam in Lawrence, Massachusetts (river kilometer 46 (river mile 28.6)). Based on a study conducted 1987-1991, the adult population was estimated at 32 adults (20–79; 95 percent confidence interval; B. Kynard and M. Kieffer unpublished information). However, recent gill-net sampling efforts conducted by Kieffer indicate a dramatic increase in the number of adults in the Merrimack River. Sampling conducted in the winter of 2009 resulted in the capture of 170 adults. Preliminary estimates suggest that there may be approximately 2,000 adults using the Merrimack River annually. Spawning, foraging and overwintering all occur in the Merrimack River. Recent shortnose sturgeon surveys on the Merrimack River were conducted on behalf of the Massachusetts Department of Transportation in winter 2020-2021 and winter 2022-2023. Side Scan Sonar and acoustic monitoring was used for monitoring/counting of shortnose sturgeon for an updated population estimate across a long river reach in a one to two-day period. The results of the 2020-2021 survey estimated the population of overwintering shortnose sturgeon at 3,786 individuals, and the 2022-2023 overwintering shortnose sturgeon survey estimated the population to be 3,424 individuals (MADOT 2023). Both of the shortnose sturgeon population estimates from this 2023 study exceeded the previous population estimates of individuals in the Merrimack River.

Tagging and tracking studies demonstrate movement of shortnose sturgeon between rivers within the Gulf of Maine, with the longest distance traveled between the Penobscot and Merrimack Rivers. Genetic studies indicate that a small, but statistically insignificant amount of genetic exchange likely occurs between the Merrimack River and these rivers in Maine (King *et al.* 2013). The Merrimack River population is genetically distinct from the Kennebec-Androscoggin-Penobscot population (SSSRT 2010). In the fall of 2014, a shortnose sturgeon tagged in the Connecticut River in 2001 was captured in the Merrimack River.

Connecticut River Population

The Holyoke Dam divides the Connecticut River shortnose population; there is currently limited successful passage downstream of the Dam. No shortnose sturgeon have passed upstream of the dam since 1999 and passage between 1975-1999 was an average of four fish per year. The number of sturgeon passing downstream of the Dam is unknown. Despite this separation, the populations are not genetically distinct (Kynard 1997, Kynard *et al.* 2016, Wirgin *et al.* 2005). The most recent estimate of the number of shortnose sturgeon upstream of the dam, based on captures and tagging from 1990-2005 is approximately 328 adults (CI = 188–1,264 adults; B. Kynard, USGS, unpublished data in SSSRT 2010); this compares to a previous Peterson mark-recapture estimate of 370–714 adults (Taubert 1980). Using four mark-recapture methodologies, the long-term population estimate (1989-2002) for the lower Connecticut River ranges from 1,042-1,580 (Savoy 2004). Comparing 1989-1994 to 1996-2002, the population exhibits growth on the order of 65-138 percent. The population in the Connecticut River is thought to be stable, but small.

The Turners Falls Dam is thought to represent the natural upstream limit of the species, although in August of 2017 a shortnose sturgeon was caught by an angler above the Turner's Falls Dam near Vernon, Vermont (NOAA 2017e). Limited spawning is thought to occur below the Holyoke Dam, although in July 2021, young-of-year shortnose sturgeon were recently observed during a state mussel survey in the Connecticut River near Springfield, Massachusetts (K. Sprankle and M. Kieffer, pers. communication). They were present at a depth of approximately 10 feet in low flow conditions in an area mainly composed of sandy substrate. Successful spawning has been documented upstream of the Holyoke Dam. Abundance of pre-spawning adults was estimated each spring between 1994–2001 at a mean of 142.5 spawning adults (CI =14–360 spawning adults) (Kynard *et al.* 2012). Overwintering and foraging occur in both the upper and lower portions of the river. Occasionally, sturgeon have been captured in tributaries to the Connecticut River including the Deerfield River and Westfield River. Additionally, a sturgeon tagged in the Connecticut River was recaptured in the Housatonic River (T. Savoy, CT DEP, pers. comm.). Three individuals tagged in the Hudson River were captured in the Connecticut River, with one remaining in the River for at least one year (Savoy 2004).

Hudson River Population
The Hudson River population of shortnose sturgeon is the largest in the United States. Studies indicate an extensive increase in abundance from the late 1970s (13,844 adults (Dovel *et al.* 1992), to the late 1990s (56,708 adults (95 percent CI 50,862 to 64,072; Bain *et al.* 1997). This increase is thought to be the result of high recruitment (31,000 – 52,000 yearlings) from 1986-1992 (Woodland and Secor 2007). Woodland and Secor (2007) examined environmental conditions throughout this 20-year period and determined that years in which water temperatures drop quickly in the fall and flow increases rapidly in the fall (particularly October), are followed by high levels of recruitment in the spring. This suggests that these environmental factors may index a suite of environmental cues that initiate the final stages of gonadal development in spawning adults. The population in the Hudson River exhibits substantial recruitment and is considered to be stable at high levels.

Delaware River-Chesapeake Bay Metapopulation
Shortnose sturgeon range from Delaware Bay up to at least Scudders Falls (river kilometer 223); there are no dams within the species' range on this river. The population is considered stable (comparing 1981-1984 to 1999-2003) at around 12,000 adults (ERC 2006b, Hastings *et al.* 1987). Spawning occurs primarily between Scudders Falls and the Trenton rapids. Overwintering and foraging also occur in the river. Shortnose sturgeon have been documented to use the Chesapeake-Delaware Canal (C&D Canal) to move from the Chesapeake Bay to the Delaware River.

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 (Kynard *et al.* 2016, 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. Recent documented 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. 2018).

Spawning has not been documented in any tributary to the Bay although suitable spawning habitat and two pre-spawning females with late stage eggs have been documented in the Potomac River (Kynard et al 2009). Current information indicates that shortnose sturgeon are present year round in the Potomac River with foraging and overwintering taking place there (Kynard *et al.*

2009). Shortnose sturgeon captured in the Chesapeake Bay are not genetically distinct from the Delaware River population.

Southeast Metapopulation

There is no evidence of shortnose sturgeon between the mouth of Chesapeake Bay and the Carolinas. Shortnose sturgeon are only thought to occur in the Cape Fear River and Yadkin-Pee Dee River in North Carolina and are likely present in very small numbers.

The Altamaha River supports the largest known population in the Southeast with successful self-sustaining recruitment. The most recent population estimate for this river was 6,320 individuals (95 percent CI = 4,387-9,249; DeVries 2006). The population contains more juveniles than expected. Comparisons to previous population estimates suggest that the population is increasing; however, there is high mortality between the juvenile and adult stages in this river. This mortality likely results from incidental capture in the shad fishery, which occurs at the same time as the spawning period (DeVries 2006).

The only available estimate for the Cooper River is of 300 spawning adults at the Pinoplis Dam spawning site (based on 1996-1998 sampling; Cooke *et al.* 2004). This is likely an underestimate of the total number of adults as it would not include non-spawning adults. Estimates for the Ogeechee River were 266 (95 percent CI=236-300) in 1993 (Weber 1996, Weber *et al.* 1998); a more recent estimate (sampling from 1999-2004; (Fleming *et al.* 2003)) indicates a population size of 147 (95 percent CI = 104-249). While the more recent estimate is lower, it is not significantly different from the previous estimate. Available information indicates the Ogeechee River population may be experiencing juvenile mortality rates greater than other southeastern rivers.

Spawning is also occurring in the Savannah River, the Congaree River, and the Yadkin-Pee Dee River. There are no population estimates available for these rivers. Occurrence in other southern rivers is limited, with capture in most other rivers limited to fewer than five individuals. Shortnose sturgeon are extremely rare or possibly extirpated from the St. Johns River in Florida as only a single specimen was found by the Florida Fish and Wildlife Conservation Commission during extensive sampling of the river in 2002/2003. In these river systems, shortnose sturgeon occur in nearshore marine, estuarine, and riverine habitat.

4.2.1.6 Threats

Shortnose sturgeon are long-lived and slow growing, therefore, stock productivity is relatively low which makes the species vulnerable to rapid decline and slow recovery (Musick 1994). In well studied rivers (*e.g.*, Hudson, upper Connecticut), researchers have documented significant year to year recruitment variability (up to 10 fold over 20 years in the Hudson and years with no recruitment in the Connecticut). However, this pattern is not unexpected given the life history characteristics of the species and natural variability in hydrologic cues relied on for spawning.

The small amount of effective movement between populations means recolonization of currently extirpated river populations is expected to be very slow and any future recolonization of any rivers that experience significant losses of individuals would be expected to be very slow. Despite the significant decline in population sizes over the last century, gene diversity in shortnose sturgeon is moderately high in both mtDNA (Quattro *et al.* 2002, Wirgin *et al.* 2005) and nDNA (King *et al.* 2001) genomes.

A population of sturgeon can go extinct as a consequence of demographic stochasticity (fluctuations in population size due to random demographic events); the smaller the metapopulation (or population); the more prone it is to extinction. Anthropogenic impacts acting on top of demographic stochasticity further increase the risk of extinction.

All shortnose sturgeon populations are highly sensitive to increases in juvenile mortality that would result in chronic reductions in the number of sub-adults, and thereby, reductions in the number of spawning adults (Gross *et al.* 2002, Secor *et al.* 2002). Populations of shortnose sturgeon that do not have reliable natural recruitment are at increased risk of experiencing population decline leading to extinction (Secor *et al.* 2002). Elasticity analysis[4] of shortnose sturgeon indicate that the highest potential for increased population size and stability comes from young-of-the-year and juveniles as compared to adults (Gross *et al.* 2002). Therefore, increasing the number of young-of-the-year and juveniles has a more significant long term impact to the population than does increasing the number of adults or the fecundity of adults.

The Shortnose Sturgeon Recovery Plan (NMFS (National Marine Fisheries Service) 1998) and the Shortnose Sturgeon Status Review Team's Biological Assessment of shortnose sturgeon (2010) identify habitat degradation or loss and direct mortality as principal threats to the species' survival. Natural and anthropogenic factors continue to threaten the recovery of shortnose sturgeon and include: poaching, bycatch in riverine fisheries, habitat alteration resulting from the presence of dams, in-water and shoreline construction, including dredging; degraded water quality which can impact habitat suitability and result in physiological effects to individuals including impacts on reproductive success; direct mortality resulting from dredging as well as impingement and entrainment at water intakes; and, loss of historical range due to the presence of dams. Shortnose sturgeon are also occasionally killed as a result of research activities. The total number of sturgeon affected by these various threats is not known. Climate change, particularly shifts in seasonal temperature regimes and changes in the location of the salt wedge in rivers, may impact shortnose sturgeon in the future (more information on climate change is presented in the *Climate Change* section of this Opinion. More information on threats experienced in the action area is presented in the *Environmental Baseline* section of this Opinion.

4.2.1.7 Survival and Recovery

The 1998 Recovery Plan outlines the steps necessary for recovery and indicates that each population may be a candidate for downlisting (*i.e.*, to threatened) when it reaches a minimum population size that is large enough to prevent extinction and will make the loss of genetic

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[4] Elasticity analysis is used to understand a species' population growth rate relative to life history traits (fecundity, growth, and survival), which can be applied in the development of of management efforts.

diversity unlikely; the minimum population size for each population has not yet been determined. The Plan contains three major tasks: (1) establish delisting criteria; (2) protect shortnose sturgeon populations and habitats; and, (3) rehabilitate habitats and population segments. We know that, in order 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 conditions for foraging, resting, and spawning. In many rivers, particularly in the Southeast, habitat is compromised and continues to impact the ability of sturgeon populations to recover. Conditions must be suitable for the successful development of early life stages. Mortality rates must also 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. Habitat connectivity must also be maintained so that individuals can migrate between important habitats without delays that impact their fitness. The loss of any population or metapopulation would result in the loss of biodiversity and would create (or widen) a gap in the species' range.

4.2.1.8 Summary of Status

Shortnose sturgeon are listed as endangered throughout their range, with populations in the Northeast being larger and generally more stable than populations in the Southeast. All populations are affected by mortality incidental to other activities, including dredging, power plant intakes, and shad fisheries where those still occur, and impacts to habitat and water quality that affect the ability of sturgeon to use habitats and impacts to individuals that are present in those habitats. While the species is overall considered to be stable (*i.e.*, its trend has not changed recently, and we are not aware of any new or emerging threats that would change the trend in the future), we lack information on abundance and population dynamics in many rivers. We also do not fully understand the extent of coastal movements and the importance of habitat in non-natal rivers to migrant fish. While the species has high levels of genetic diversity, the lack of effective movement between populations increases the vulnerability of the species should there be a significant reduction in the number of individuals in any one population or metapopulation because recolonization is expected to be very slow. All populations, regardless of size, are faced with threats that result in the mortality of individuals and/or affect the suitability of habitat and may restrict the further growth of the population. Additionally, there are several life history traits and factors that combine to make the species particularly sensitive to existing and future threats; these factors include: the small size of many populations, gaps in the range, late maturation, long residence time in rivers from egg to adulthood, the sensitivity of adults to very specific spawning cues that can result in years with no recruitment if conditions are not met, and the impact of losses of young of the year and juvenile cohorts prior to reaching spawning age on population persistence and stability.

4.2.2 Atlantic Sturgeon

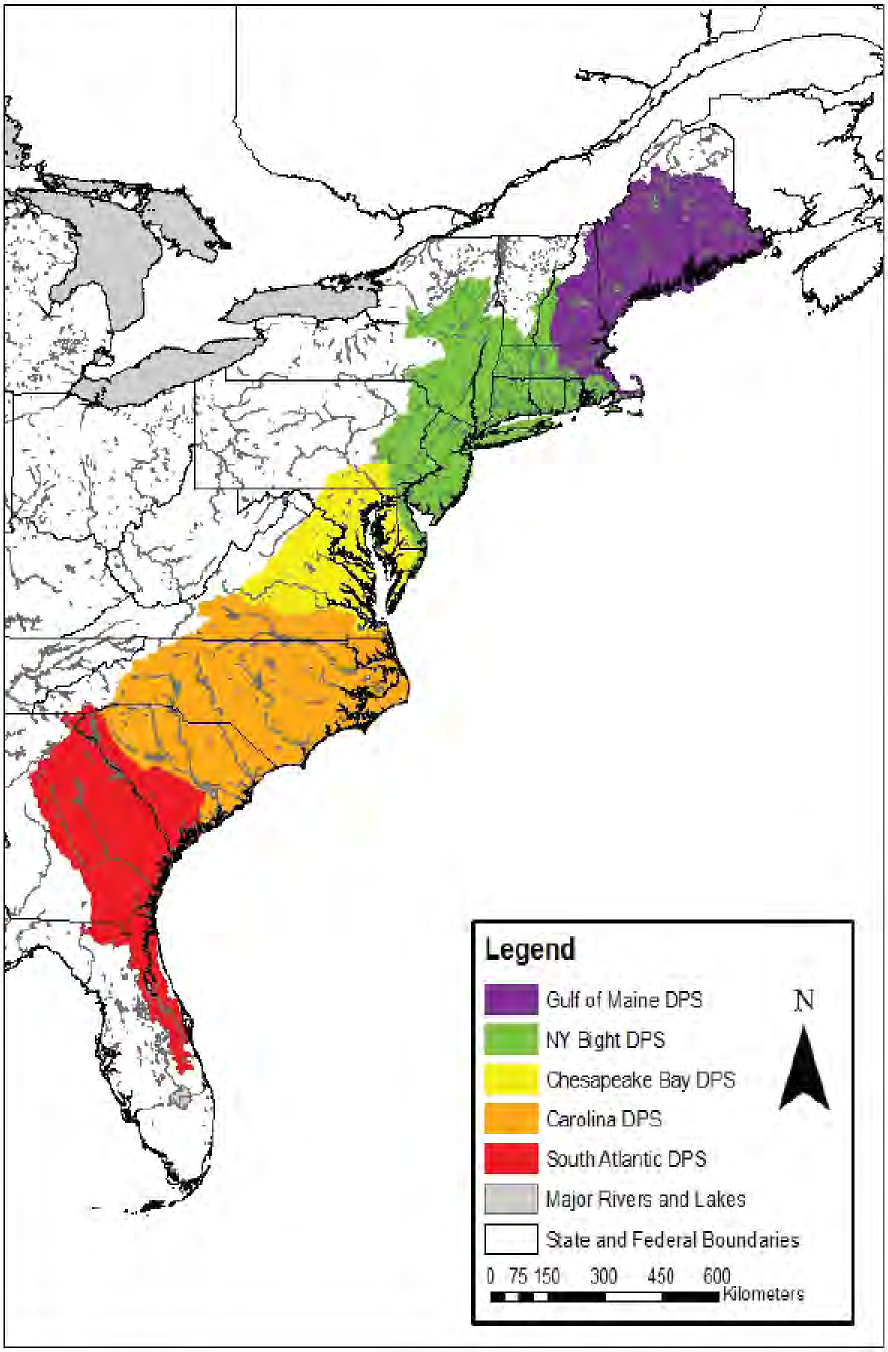
The section below describes the Atlantic sturgeon listing, provides life history information that is relevant to all DPSs of Atlantic sturgeon, and provides information specific to the status of each DPS of Atlantic sturgeon. Below, we also provide a description of which Atlantic sturgeon

DPSs are likely to occur in the action area and provide information on the use of the action area by Atlantic sturgeon.

The Atlantic sturgeon is one of two subspecies of *A. oxyrinchus*, the other being the Gulf sturgeon, *A. o. desotoi*. It is distributed along the eastern coast of North America from Hamilton Inlet, Labrador, Canada to Cape Canaveral, Florida, USA. We have delineated U.S. populations of Atlantic sturgeon into five DPSs. These are: the Gulf of Maine, New York Bight, Chesapeake Bay, Carolina, and South Atlantic DPSs (Figure 3). The results of genetic studies suggest that natal origin influences the distribution of Atlantic sturgeon in the marine environment. However, genetic data as well as tracking and tagging data demonstrate sturgeon from each DPS and Canada occur throughout the full range of the subspecies (Kazyak *et al.* 2021, Wirgin *et al.* 2015a). Therefore, sturgeon originating from any of the five DPSs can be affected by threats in the marine, estuarine, and riverine environment that occur far from natal spawning rivers.

The New York Bight, Chesapeake Bay, Carolina, and South Atlantic DPSs are listed as endangered, and the Gulf of Maine DPS is listed as threatened. The effective date of the listings was April 6, 2012. The DPSs do not include Atlantic sturgeon spawned in Canadian rivers. Therefore, Canadian spawned fish are not included in the listings. Individuals originating from any of the five listed DPSs are likely to occur in the action area.

Figure 4. Map depicting the general northern and southern boundaries to the coastline of each of the five Atlantic sturgeon DPSs. The extent to which each DPS is depicted inland is for general illustration purposes only, since the regulatory definitions of each DPS do not include a western boundary.



4.2.2.1 Life History and General Habitat Use

The Atlantic sturgeon is a long-lived (approximately 60 years), late maturing, and estuarine dependent, anadromous[5] fish (ASSRT 2007). They are a relatively large fish, even amongst sturgeon species (Pikitch *et al.* 2005). Once mature, they continue to grow, and the largest recorded Atlantic sturgeon was a female captured in 1924 that measured approximately 4.3 meters (14 feet) (Vladykov and Greeley 1963). Males weigh up to 41 kilograms (90 pounds) and females weigh up to 73 kilograms (160 pounds).

In appearance, they are bluish-black or olive brown dorsally (on their back) with paler sides and a white belly. They have no scales, but five rows of scutes (bony plates) cover their head and body: one along the back, one on either side and two along the belly. Its long, hard snout has an upturned tip, with four sensory barbels on the underside of its snout. Its mouth is located on the underside (ventrally-located) of the head, is protruding (can be withdrawn and extended like an accordion), soft and toothless. Atlantic sturgeons are bottom feeders that use the protruding mouth to pick up food (Bigelow and Schroeder 1953). The four chemosensory barbels in front of the mouth assist the sturgeon in locating prey.

The life stages of Atlantic sturgeon can be divided up into the general categories as described in the Table 5 below. Depending on life stage and time of year, sturgeon may be present in freshwater, marine and estuarine ecosystems.

[5] Anadromous refers to a fish that is born in freshwater, spends most of its life in the sea, and returns to freshwater to spawn.

Table 5. Atlantic sturgeon life stages and behaviors in NOAA Fisheries GARFO Section 7 Consultation Areas[6]

Stage	Size (mm)	Duration	Description
Eggs	~2mm – 3 mm diameter (Van Eenannnam et al. 1996, p. 773)	Hatching occurs ~3-6 days after egg deposition and fertilization (ASSRT 2007, p. 4)	Fertilized or unfertilized
Yolk-Sac Larvae (YSL)	~6mm – 14 mm (Bath et al. 1981, pp. 714-715)	8-12 days post hatch (ASSRT 2007, p.4)	Negative photo-taxis, nourished by yolk sac
Post Yolk-Sac Larvae (PYL)	~14mm – 37mm (Bath et al. 1981, pp. 714-715)	12-40 days post hatch	Free swimming; feeding; Silt/sand bottom, deep channel; fresh water
Young of Year (YOY)	0.3 grams <410 mm total length	From 40 days to 1 year	Fish that are >3 months and <1 year old; capable of capturing and consuming live food
Juveniles	>410 mm and <760 mm total length	1 year to time at which first coastal migration is made	Fish that are at least 1 year old, are not sexually mature, and do not make coastal migrations
Subadults	>760 mm and <1500 mm total length	From first coastal migration to sexual maturity	Fish that are not sexually mature, but make coastal migrations
Adults	>1500 mm total length	Post-maturation	Fish that are sexually mature

Spawning

Atlantic sturgeon spawn in freshwater habitats (NMFS 2017, ASSRT 2007) at sites with flowing water and hard bottom substrate (Bain *et al.* 2000, Balazik *et al.* 2012a, Gilbert 1989, Greene *et al.* 2009, Hatin *et al.* 2002, Mohler 2003, Smith and Clugston 1997, Vladykov and Greeley 1963). Water depths of spawning sites are highly variable, but may be up to 27 meters (88.6 feet) (Bain *et al.* 2000, Crance 1987, Leland 1968, Scott and Crossman 1973). This is also supported by tagging records, which show that Atlantic sturgeon return to their natal rivers to spawn (ASSRT 2007). Spawning intervals ranging from one to five years in males (Caron *et al.* 2002, Collins *et al.* 2000, Smith 1985) and two to five years for females (Stevenson 1997, Van Eenennaam *et al.* 1996, Vladykov and Greeley 1963). Males spawn more frequently than females, and females can spawn in consecutive years, but female spawning periodicity is more variable than males (Breece *et al.* 2021). Given spawning periodicity and a female's relatively late age to maturity, the age at which 50 percent of the maximum lifetime egg production is achieved is estimated to be 29 years (Boreman 1997). While long-lived, Atlantic sturgeon are exposed to a multitude of threats prior to achieving maturation and have a limited number of spawning opportunities once they are mature.

[6] The NOAA Fisheries GARFO Section 7 Consultation Areas are delineated here: https://noaa.maps.arcgis.com/apps/webappviewer/index.html?id=a85c0313b68b44e0927b51928271422a

The number of eggs produced by females range from 400,000 to approximately 4 million depending on body size (and age) (Hilton *et al.* 2016, Van Eenennaam *et al.* 1996). Therefore, observations of large-sized sturgeon are particularly important given that egg production correlates with age and body size (Smith *et al.*, 1982; Van Eenennaam *et al.*, 1996; Van Eenennaam and Doroshov, 1998; Dadswell, 2006).

Water temperature appears to play the primary role in triggering the timing of spawning migrations (Hilton *et al.* 2016). Spawning migrations generally occur during February-March in southern systems, April-May in Mid-Atlantic systems, and May-July in Canadian systems (Hilton *et al.* 2016). Male sturgeon begin upstream spawning migrations when waters reach approximately 6° C (43° F) (Hilton *et al.* 2016), and remain on the spawning grounds throughout the spawning season (Bain 1997). Females begin spawning migrations when temperatures are closer to 12° C to 13° C (54° to 55° F) (Dovel and Berggren 1983, Smith 1985), make rapid spawning migrations upstream, and quickly depart following spawning (Bain 1997). Females may leave the estuary and travel to other coastal estuaries until outmigration to marine waters in the fall (NMFS 2017b, Bain 1997, Bain *et al.* 2000, Balazik *et al.* 2012a, Breece *et al.* 2013, Dovel and Berggren 1983, Greene *et al.* 2009, Hatin *et al.* 2002, Smith 1985, Smith *et al.* 1982). Following spawning, males move downriver to the lower estuary and remain there until out migration in the fall (Bain 1997, Bain *et al.* 2000, Balazik *et al.* 2012c, Breece *et al.* 2013, Dovel and Berggren 1983, Greene *et al.* 2009, Hatin *et al.* 2002, Ingram *et al.* 2019, Smith 1985, Smith *et al.* 1982).

Eggs and Larvae

Sturgeon females deposit their eggs on the hard bottom substrate at the spawning site where they become adhesive shortly after fertilization (Hilton *et al.* 2016, Mohler 2003, Murawski and Pacheco 1977). Incubation time for the eggs increases as water temperature decreases (Mohler 2003). At temperatures of 20° and 18° C (68° and 64.4°F), hatching occurs approximately 94 and 140 hours, respectively, after egg deposition (ASSRT 2007).

Hatchlings (called free embryos) have a yolk sac that provides nourishment (endogenous feeding) during the first stage of larval development. Hatchlings are assumed to undertake a demersal existence, seek cover in the bottom substrate and yolk sac larvae (*i.e.*, free embryos less than 4 weeks old, with TL less than 30 millimeters (1.2 inches); Van Eenennaam *et al.* 1996) are assumed to inhabit the same riverine or estuarine areas where they were spawned (Bain *et al.* 2000, Kynard and Horgan 2002). The free embryo exhausts the yolk sac and becomes larvae (*i.e.*, post yolk-sac larvae) after about eight days (Kynard and Horgan 2002). Post yolk sac larvae drift downstream where they eventually settle, become demersal, and start foraging in freshwater reaches above the salt front (Kynard and Horgan 2002).

Juveniles

Studies suggest that age-0 (*i.e.*, young-of- year), age-1, and age-2 juvenile Atlantic sturgeon occur in low salinity waters of the natal estuary (Hilton *et al.* 2016) while older fish are more salt tolerant and occur in higher salinity waters as well as low salinity waters (Collins *et al.* 2000, Hilton *et al.* 2016). Atlantic sturgeon remain in the natal estuary for months to years before migrating to open ocean as subadults[7] (ASSRT 2007, Dadswell 2006, Dovel and Berggren 1983, Hilton *et al.* 2016). Juvenile Atlantic sturgeon feed on aquatic insects, insect larvae, and other benthic invertebrates (ASSRT 2007, Bigelow and Schroeder 1953, Guilbard *et al.* 2007).

Subadults and Adults

Upon reaching the subadult phase, individuals enter the marine environment, mixing with adults and subadults from other river systems (Bain 1997, Dovel and Berggren 1983, Hatin *et al.* 2007, McCord *et al.* 2007). Once subadult Atlantic sturgeon have reached maturity (*i.e.*, adult stage), they will remain in marine or estuarine waters that are typically less than 50 meters (164 feet.) deep, only returning far upstream to the spawning areas when they are ready to spawn (Bain 1997, Breece *et al.* 2016, Dunton *et al.* 2012, ASSRT 2007, Savoy and Pacileo 2003). Diets of adult and migrant subadult Atlantic sturgeon include gastropods, annelids (Polychaetes and Oligochaetes), crustaceans, and fish such as sand lance (ASSRT 2007, Bigelow and Schroeder 1953, Guilbard *et al.* 2007, Savoy 2007).

Overwintering

New information supports the understanding of the movements of Atlantic sturgeon into deeper waters in the fall compared to the depth where they occur in the spring. In general, there is a northerly coastal migration of subadult and adult Atlantic sturgeon to estuaries in the spring, and a southerly coastal migration from estuaries in the fall. Some marine aggregation areas were suspected of being overwintering areas, such as in waters off of the Virginia and North Carolina coast. However, the adult sturgeon tagged by Erickson *et al.* (2011) did not appear to move to a specific marine area where the fish reside throughout the winter. Instead, the sturgeon occurred within different areas of the Mid-Atlantic Bight and at different depths, occupying deeper and more southern waters in the winter months and more northern and shallow waters in the summer months with spring and fall being transition periods. The model constructed by Breece *et al.* (2017, 2018) similarly predicts an increase in probability of occurrence in shallow water during the spring, which shifts to an increase in probability of occurrence in deeper water in the fall.

Marine and Coastal Distribution

The marine range of U.S. Atlantic sturgeon extends from Labrador, Canada, to Cape Canaveral, Florida. As Atlantic sturgeon travel long distances in these waters, all five DPSs of Atlantic sturgeon have the potential to be anywhere in this marine range. Results from genetic studies show that, regardless of location, multiple DPSs can be found at any one location along the Northwest Atlantic coast. However, the New York Bight DPS was more prevalent relative to the other DPSs in Mid-Atlantic marine waters, bays, and sounds (Dunton *et al.* 2012; Waldman *et al.* 2013; Wirgin *et al.* 2015a; Wirgin *et al.* 2015b; Wirgin *et al.* 2018). A comprehensive analysis of Atlantic sturgeon stock composition coast wide provides further evidence that natal origin

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[7] Some of the published literature for Atlantic sturgeon uses the term juvenile to refer to all sexually immature Atlantic sturgeon, including sexually immature fish that have emigrated from the natal river estuary. We use "juvenile" in reference to immature fish that have not emigrated from the natal river estuary, and we use the term "subadult" for immature Atlantic sturgeon that have emigrated from the natal river estuary.

influences the distribution of Atlantic sturgeon in the marine environment. Atlantic sturgeon that originate from each of the five DPSs and from the Canadian rivers were represented in the 1,704 samples analyzed for the study. However, there were statistically significant differences in the spatial distribution of each DPS, and individuals were most likely to be assigned to a DPS in the same general region where they were collected (Kazyak *et al.* 2021). For the New York Bight DPS, the results support the findings of previous genetic analyses that Atlantic sturgeon belonging to the DPS occur in the Gulf of Maine and in the South Atlantic Bight, but that they are most prevalent in the Mid-Atlantic Bight. (ASMFC 2017b, 2019, ASSRT 2007, Chambers *et al.* 2012, Dadswell 2006, Dovel and Berggren 1983, Dunton *et al.* 2012, Dunton *et al.* 2015, Dunton *et al.* 2010, Erickson *et al.* 2011, Kynard *et al.* 2000, Laney *et al.* 2007, O'Leary *et al.* 2014, Stein *et al.* 2004b, Waldman *et al.* 2013, Wirgin *et al.* 2015a).

Based on fishery-independent, fishery dependent, tracking, and tagging data, Atlantic sturgeon appear to primarily occur inshore of the 50 meter (164 feet) depth contour (Dunton *et al.* 2015, Dunton *et al.* 2010, Erickson *et al.* 2011, Laney *et al.* 2007, O'Leary *et al.* 2014, Stein *et al.* 2004a, b, Waldman *et al.* 2013, Wirgin *et al.* 2015a). However, they are not restricted to these depths and excursions into deeper (*e.g.*, 75 meter (246 feet)) continental shelf waters have been documented (Colette and Klein-MacPhee 2002, Collins and Smith 1997, Dunton *et al.* 2010, Erickson *et al.* 2011, Stein *et al.* 2004a, Timoshkin 1968). Data from fishery-independent surveys and tagging and tracking studies also indicate that some Atlantic sturgeon may undertake seasonal movements along the coast (Dunton *et al.* 2010, Erickson *et al.* 2011, Hilton *et al.* 2016, Oliver *et al.* 2013, Post *et al.* 2014, Wippelhauser 2012b). For instance, studies found that satellite tagged adult sturgeon from the Hudson River concentrated in the southern part of the Mid-Atlantic Bight, at depths greater than 20 meters (66 feet), during winter and spring; while, in the summer and fall, Atlantic sturgeon concentrations shifted to the northern portion of the Mid-Atlantic Bight at depths less than 20 meters (66 feet) (Erickson *et al.* 2011).

In the marine range, several marine aggregation areas occur adjacent to estuaries and/or coastal features formed by bay mouths and inlets along the U.S. eastern seaboard (*i.e.*, waters off North Carolina, Chesapeake Bay; Delaware Bay; New York Bight; Massachusetts Bay; Long Island Sound; and Connecticut and Kennebec River Estuaries). Depths in these areas are generally no greater than 25 meters (82 feet) (Bain *et al.* 2000, Dunton *et al.* 2010, Erickson *et al.* 2011, Laney *et al.* 2007, O'Leary *et al.* 2014, Oliver *et al.* 2013, Savoy and Pacileo 2003, Stein *et al.* 2004a, Waldman *et al.* 2013, Wippelhauser 2012a, Wippelhauser and Squiers 2015). Although additional studies are still needed to clarify why Atlantic sturgeon aggregate at these sites, there is some indication that they may serve as thermal refuge, wintering sites, or marine foraging areas (Dunton *et al.* 2010, Erickson *et al.* 2011, Stein *et al.* 2004b).

4.2.2.2 Abundance

The information used for Atlantic sturgeon ocean abundance below is from Kocik *et al.* 2013. The NEFSC suggested that cumulative annual estimates of surviving fishery discards could provide a minimum estimate of abundance. The objectives of producing the Atlantic Sturgeon Production Index (ASPI) were to characterize uncertainty in abundance estimates arising from multiple sources of observation and process error and to complement future efforts to conduct a more comprehensive stock assessment (Table 6). The ASPI provides a general abundance metric to assess risk for actions that may affect Atlantic sturgeon in the ocean; however, it is not a comprehensive stock assessment. In general, the model uses empirical estimates of post-capture survivors and natural survival, as well as probability estimates of recapture using tagging data from the USFWS sturgeon tagging database, and federal fishery discard estimates from 2006 to 2010 to produce a virtual population. The USFWS sturgeon tagging database is a repository for sturgeon tagging information on the Atlantic coast. The database contains tag, release, and recapture information from state and federal researchers. The database records recaptures by the fishing fleet, researchers, and researchers on fishery vessels.

Table 6**.** Description of the ASPI Model and NEAMAP Survey-Based Area Estimate Method

Model Name	Model Description
A. ASPI	Uses tag-based estimates of recapture probabilities from 1999 to 2009. Natural mortality based on Kahnle *et al.* (2007) rather than estimates derived from tagging models. Tag recaptures from commercial fisheries are adjusted for non reporting based on recaptures from observers and researchers. Tag loss assumed to be zero.
B. NEAMAP Swept Area	Uses NEAMAP survey-based swept area estimates of abundance and assumed estimates of gear efficiency. Estimates based on an average of ten surveys from fall 2007 to spring 2012.

In addition to the ASPI, a population estimate was derived from the Northeast Area Monitoring and Assessment Program (NEAMAP) trawl surveys (Kocik *et al.* 2013).[8] NEAMAP trawl surveys are conducted from Cape Cod, Massachusetts to Cape Hatteras, North Carolina in nearshore waters at depths up to 18.3 meters (60 feet) during the fall since 2007 and spring since 2008. Each survey employs a spatially stratified random design with a total of 35 strata and 150 stations.

As illustrated by Table 7 below, the ASPI model projects a mean population size of 417,934 Atlantic sturgeon and the NEAMAP Survey projects mean population sizes ranging from 33,888 to 338,882 depending on the assumption made regarding efficiency of that survey. As noted above, the ASPI model uses empirical estimates of post-capture survivors and natural survival, as well as probability estimates of recapture using tagging data from the USFWS sturgeon tagging database, and federal fishery discard estimates from 2006 to 2010 to produce a virtual population. The NEAMAP estimate, in contrast, is more empirically derived and does not depend on as many assumptions. For the purposes of this Opinion, while the ASPI model is considered as part of the 2017 ASMFC stock assessment, we consider the NEAMAP estimate as the best available information on population size.

[8] Since fall 2007, NEAMAP trawl surveys (spring and fall) have been conducted from Cape Cod, Massachusetts to Cape Hatteras, North Carolina in nearshore waters at depths up to 18.3 meters (60 feet). Each survey employs a spatially stratified random design with a total of 35 strata and 150 stations.

Table 7. ASPI model results

Model Run	Model Years	95% low	Mean	95% high
A. ASPI	1999-2009	165,381	417,934	744,597
B.1 NEAMAP Survey, swept area assuming 100% efficiency	2007-2012	8,921	33,888	58,856
B.2 NEAMAP Survey, swept area assuming 50% efficiency	2007-2012	13,962	67,776	105,984
B.3 NEAMAP Survey, swept area assuming 10% efficiency	2007-2012	89,206	338,882	588,558

Available data do not support estimation of true catchability (*i.e.*, net efficiency X availability) of the NEAMAP trawl survey for Atlantic sturgeon. Thus, the NEAMAP swept area biomass estimates were produced and presented in Kocik *et al.* (2013) for catchabilities from five to 100 percent. In estimating the efficiency of the sampling net, we consider the likelihood that an Atlantic sturgeon in the survey area is likely to be captured by the trawl. Assuming the NEAMAP surveys have been 100 percent efficient would require the unlikely assumption that the survey gear captures all Atlantic sturgeon within the path of the trawl and all sturgeon are within the sampling area of the NEAMAP survey. Thus, we have in previous biological opinions (*e.g.*, NMFS 2014) and will, for this Opinion, rely on the population estimates derived from the NEAMAP swept area biomass assuming a 50 percent catchability (*i.e.*, net efficiency x availability) rate. We consider that the NEAMAP surveys sample an area utilized by Atlantic sturgeon, but do not sample all the locations and times where Atlantic sturgeon are present. We also consider that the trawl net captures some, but likely not all, of the Atlantic sturgeon present in the sampling area. Therefore, we assume that net efficiency and the fraction of the population exposed to the NEAMAP surveys in combination result in a 50 percent catchability (NMFS 2013). The 50 percent catchability assumption reasonably accounts for the robust, yet not complete, sampling of the Atlantic sturgeon oceanic temporal and spatial ranges and the documented high rates of encounter with NEAMAP survey gear. As these estimates are derived directly from empirical data with fewer assumptions than have been required to model Atlantic sturgeon populations to date, we believe these estimates continue to serve as the best available information. Based on the above approach, the overall abundance of Atlantic sturgeon in U.S. Atlantic waters are estimated to be 67,776 fish (see Kocik *et al.* 2013). Based on genetic frequencies of occurrence in the sampled area, this overall population estimate was subsequently partitioned by DPS (Table 8). Given the proportion of adults to subadults in the NMFS NEFSC observer data (approximate ratio of 1:3), we have also estimated the number of adults and subadults originating from each DPS. However, this cannot be considered an estimate of the total number of subadults, because it only considers those subadults that are of a size that are present and vulnerable to capture in commercial trawl and gillnet gear in the marine environment.

The NEAMAP-based estimates do not include young-of-the-year fish and juveniles in the rivers. The NEAMAP surveys are conducted in waters that include the preferred depth ranges of subadult and adult Atlantic sturgeon and take place during seasons that coincide with known Atlantic sturgeon coastal migration patterns in the ocean. However, the estimated number of subadults in marine waters is a minimum count because it only considers those subadults that are captured in the marine environment, which is only a fraction of the total number of subadults. In regards to adult Atlantic sturgeon, the estimated population in marine waters is also a minimum count as the NEAMAP surveys sample only a portion of the Atlantic sturgeon's range.

Table 8**.** Calculated population estimates based on the NEAMAP survey swept area model, assuming 50 percent efficiency

DPS	Estimated Ocean Population Abundance	Estimated Ocean Population of Adults	Estimated Ocean Population of Subadults (of size vulnerable to capture in fisheries)
GOM	7,455	1,864	5,591
NYB	34,567	8,642	25,925
CB	8,811	2,203	6,608
Carolina	1,356	339	1,017
SA	14,911	3,728	11,183
Canada	679	170	509

Precise estimates of population growth rate (intrinsic rates) are unknown for the five listed DPSs of Atlantic sturgeon due to a lack of long-term abundance data. The ASMFC (2017a) stock assessment referenced a population viability assessment (PVA) that was done to determine population growth rates for the five DPSs based on a few long-term survey programs, but most results were statistically insignificant or utilized a model that would not converge. In any event, the population growth rates reported from that PVA ranged from -1.8 to 4.9 percent (ASMFC 2017b).

The genetic diversity of Atlantic sturgeon throughout its range has been well-documented (Bowen and Avise 1990, ASSRT 2007, O'Leary *et al.* 2014, Ong *et al.* 1996, Waldman *et al.* 1996, Waldman and Wirgin 1998). Overall, these studies have consistently found populations to be genetically diverse, and the majority can be readily differentiated by using genetic data from individual fish. Relatively low rates of gene flow reported in population genetic studies (Fritts *et al.* 2016, Savoy *et al.* 2017, Wirgin *et al.* 2002) indicate that Atlantic sturgeon return to their natal river to spawn, despite extensive mixing in coastal waters.

The range of all five listed DPSs extends from Canada through Cape Canaveral, Florida. All five DPSs use the action area. We decided not to use the most recent published mixed stock analysis from Kazyak *et al.* 2021, because the percentages were based on genetic sampling of Atlantic sturgeon that were encountered across the U.S. Atlantic coast. Instead, we use the mixed stock analysis from Damon-Randall *et al.* 2013 for subadults and adults because their analysis is more consistent in habitat and geography to the action area defined in this biological opinion.

The proposed action takes place in the Potomac River, Chesapeake Bay, and James River. Spawning is known to occur in the James River. Spawning is assumed to occur in the Potomac River, but has not been confirmed (Balazik 2023). Given that early life stages (eggs, yolk-sac and post yolk-sac larvae, young-of-year) are not tolerant of saltwater, they are not expected to be present in the action area of the James or Potomac River. Any juvenile Atlantic sturgeon in the action area will likely belong to the Chesapeake Bay DPS and will have originated from their natal rivers, either the Potomac River or James River (Balazik 2023). However, we know that the Chesapeake Bay represents an area of extensive mixing, therefore, although unlikely, juvenile fish from any of the five DPSs may be found in the James River (Damon-Randall *et al.* 2013) and we assume the same for juvenile fish in the Potomac River. Therefore, juvenile fish from any of the five DPSs may be present in the action area. Subadult and adult Atlantic sturgeon can be found throughout the range of the species; therefore, subadult and adult Atlantic sturgeon in the action area would not be limited to just individuals originating from the Chesapeake DPS. Based on mixed-stock analysis, we have determined that subadult and adult Atlantic sturgeon in the action area likely originate from the five DPSs at the following frequencies: Gulf of Maine 2 percent; New York Bight 2 percent; Chesapeake Bay 92 percent; Carolina 2 percent; and South Atlantic 2 percent (Damon-Randall *et al.* 2013). As noted previously, because the James and the Potomac River share a common geographic area, the above percentages for the James River will be applied to the Potomac River. These percentages are based on genetic sampling of individuals (n=173) sampled during the Mixed Stock Analysis (MSA) Observer Program along the Greater Atlantic Region (Damon-Randall *et al.* 2013). This is the closest sampling effort (geographically) to the action area for which mixed stock analysis results are available. Because the genetic composition of the mixed stock changes with distance from the rivers of origin, it is appropriate to use mixed stock analysis results from the nearest sampling location. Therefore, this represents the best available information on the likely genetic makeup of individuals occurring in the action area.

A mixed stock analysis, performed from nDNA microsatellite markers, indicated that the Chesapeake Bay population was comprised of three main stocks: 1) Hudson River (23-30 percent), 2) Chesapeake Bay (0-35 percent), and 3) Delaware River (17-27 percent) (King *et al.* 2001, ASSRT 2007). The contribution of fish with Chesapeake Bay origin fish, which had not been identified in previous genetic studies, indicates the likely existence of a reproducing population within the Bay (ASSRT 2007).

Depending on life stage, sturgeon may be present in freshwater, marine and estuarine ecosystems. The action area for this biological opinion ranges from mesohaline (brackish water with a salinity range of 5 to 18 parts per thousand at the Nice-Middleton Bridge) to polyhaline (brackish water with a salinity of 18 to 30 parts per thousand) within the Chesapeake Bay; therefore, this section will focus only on the distribution of Atlantic sturgeon life stages (juvenile, subadult, and adult) tolerant of these conditions; it will not discuss the distribution of Atlantic sturgeon life stages (eggs, yolk-sac and post yolk-sac larvae, young-of-year) in exclusively freshwater ecosystems. For information on Atlantic sturgeon distribution in freshwater ecosystems, refer to: (ASSRT 2007); 77 FR 5880 (February 6, 2012); 77 FR 5914 (February 6, 2012); (NMFS 2017b); and (ASMFC 2017b).

The marine range of U.S. Atlantic sturgeon extends from Labrador, Canada, to Cape Canaveral, Florida. As Atlantic sturgeon travel long distances in these waters, all five DPSs of Atlantic sturgeon have the potential to be anywhere in this marine range. Results from genetic studies show that, regardless of location, multiple DPSs can be found at any one location along the Northwest Atlantic coast, although the Hudson River population from the New York Bight DPS dominates (ASMFC 2017b, 2019, Dadswell 2006, Dovel and Berggren 1983, Dunton *et al.* 2012, Dunton *et al.* 2015, Dunton *et al.* 2010, Erickson *et al.* 2011, Kynard *et al.* 2000, Laney *et al.* 2007, ASSRT 2007, O'Leary *et al.* 2014, Stein *et al.* 2004b, Waldman *et al.* 2013, Wirgin *et al.* 2015a, Wirgin *et al.* 2012).

Based on fishery-independent, fishery dependent, tracking, and tagging data, Atlantic sturgeon appear to primarily occur inshore of the 50 meter (164 feet) depth contour (Dunton *et al.* 2015, Dunton *et al.* 2010, Erickson *et al.* 2011, Laney *et al.* 2007, O'Leary *et al.* 2014, Stein *et al.* 2004a, b, Waldman *et al.* 2013, Wirgin *et al.* 2015a, 2015b). However, they are not restricted to these depths and excursions into deeper (*e.g.*, 75 meter (246 feet)) continental shelf waters have been documented (Colette and Klein-MacPhee 2002, Collins and Smith 1997, Dunton *et al.* 2010, Erickson *et al.* 2011, Stein *et al.* 2004a, Timoshkin 1968). Data from fishery-independent surveys and tagging and tracking studies also indicate that some Atlantic sturgeon may undertake seasonal movements along the coast (Dunton *et al.* 2010, Erickson *et al.* 2011, Hilton *et al.* 2016, Oliver *et al.* 2013, Post *et al.* 2014, Wippelhauser 2012a). For instance, studies found that satellite-tagged adult sturgeon from the Hudson River concentrated in the southern part of the Mid-Atlantic Bight, at depths greater than 20 meters (66 feet), during winter and spring; while, in the summer and fall, Atlantic sturgeon concentrations shifted to the northern portion of the Mid-Atlantic Bight at depths less than 20 meters (66 feet) (Erickson *et al.* 2011).

In the marine range, several marine aggregation areas occur adjacent to estuaries and/or coastal features formed by bay mouths and inlets along the U.S. eastern seaboard (*i.e.*, waters off North Carolina, Chesapeake Bay; Delaware Bay; New York Bight; Massachusetts Bay; Long Island Sound; and Connecticut and Kennebec River Estuaries). Depths in these areas are generally no greater than 25 meters (82 feet) (Bain *et al.* 2000, Dunton *et al.* 2010, Erickson *et al.* 2011, Laney *et al.* 2007, O'Leary *et al.* 2014, Oliver *et al.* 2013, Savoy and Pacileo 2003, Stein *et al.* 2004b, Waldman *et al.* 2013, Wippelhauser 2012a, Wippelhauser *et al.* 2015). Although additional studies are still needed to clarify why Atlantic sturgeon aggregate at these sites, there is some indication that they may serve as thermal refuge, wintering sites, or marine foraging areas (Dunton *et al.* 2010, Erickson *et al.* 2011, Stein *et al.* 2004a).

Water temperature plays a primary role in triggering the timing of spawning migrations (Hilton *et al.* 2016). Spawning migrations generally occur during February-March in southern systems, April-May in Mid-Atlantic systems, and May-July in Canadian systems (Hilton *et al.* 2016). Male sturgeon begin upstream spawning migrations when waters reach approximately 6° C (43°

F) (Hilton *et al.* 2016), and remain on the spawning grounds throughout the spawning season (Bain 1997). Females begin spawning migrations when temperatures are closer to 12° C to 13° C (54° to 55° F) (Dovel and Berggren 1983, Smith 1985), make rapid spawning migrations upstream, and quickly depart following spawning (Bain 1997). Females may leave the estuary and travel to other coastal estuaries until outmigration to marine waters in the fall (Bain 1997, Bain *et al.* 2000, Balazik *et al.* 2012a, Breece *et al.* 2013, Dovel and Berggren 1983, Greene *et al.* 2009, Hatin *et al.* 2002, NMFS 2017b, Smith 1985, Smith *et al.* 1982). Following spawning, males move downriver to the lower estuary and remain there until outmigration in the fall (Bain 1997, Bain *et al.* 2000, Balazik *et al.* 2012a, Breece *et al.* 2013, Dovel and Berggren 1983, Greene *et al.* 2009, Hatin *et al.* 2002, Ingram *et al.* 2019, Smith 1985, Smith *et al.* 1982).

4.2.2.3 Stock Assessments

Atlantic sturgeon were once present in 38 river systems and, of these, spawned in 35 (ASSRT 2007). There are currently 39 rivers and two creeks that are specifically occupied areas designated as critical habitat for Atlantic sturgeon (NMFS 2017d, NMFS (National Marine Fisheries Service) 2017). The decline in abundance of Atlantic sturgeon has been attributed primarily to the large U.S. commercial fishery, which existed for the Atlantic sturgeon through the mid-1990s in some states. Based on management recommendations in the interstate fishery management plan (ISFMP), adopted by the Atlantic States Marine Fisheries Commission (the Commission) in 1990, commercial harvest in Atlantic coastal states was severely restricted and ultimately eliminated from all states (ASMFC 1998). In 1998, the Commission called for a coastwide moratorium on fishing for Atlantic sturgeon in state waters to allow 20 consecutive cohorts of females to reach sexual maturity and spawn, which will facilitate restoration of the age structure. The moratorium was expected to be in place for 20-40 years because they considered the median maturity of female Atlantic sturgeon to be about age 18 and, therefore, it was expected that it could take up to 38 years before 20 subsequent year classes of adult females is established (ASMFC 1998). In 1999, NMFS closed the Exclusive Economic Zone to Atlantic sturgeon retention, pursuant to the Atlantic Coastal Act (64 FR 9449; February 26, 1999). However, all state fisheries for sturgeon were closed prior to this.

The most significant threats to Atlantic sturgeon are vessel strikes, bycatch in commercial fisheries, habitat changes, impeded access to historical habitat by dams and reservoirs in the south, degraded water quality, and reduced water quantity. Mortalities for Atlantic sturgeon populations within the vicinity of the Chesapeake Bay (*i.e.*, the York River) typically occur during migrations into (May and June) or out of (November and December) the Chesapeake Bay. Four of the suspected 5 mortalities were last detected near the mouth of the Chesapeake Bay where in an area of heavy vessel traffic and seasonal fishing effort, which may indicate an area of increased risk (Kahn *et al.* 2023). A first-of-its-kind climate vulnerability assessment, conducted on 82 fish and invertebrate species in the Northeast U.S. Shelf, concluded that Atlantic sturgeon from all five DPSs were among the most vulnerable species to global climate change (Hare *et al.* 2016b).

The Commission completed an Atlantic sturgeon benchmark stock assessment in 2017 that considered the status of each DPS individually, as well as all five DPSs collectively as a single unit (ASMFC 2017b). The assessment concluded all five DPSs of Atlantic sturgeon, as well as each individual DPS remain depleted relative to historic abundance. The assessment also concluded that the population of all five DPSs together appears to be recovering slowly since implementation of a complete moratorium on directed fishing and retention in 1998. However, there were only two individual DPSs, the New York Bight DPS and Carolina DPS, for which there was a relatively high probability that abundance of the DPS has increased since the implementation of the 1998 fishing moratorium. There was considerable uncertainty expressed in the stock assessment and in its peer review report. For example, new information suggests that these conclusions about the New York Bight DPS primarily reflect the status and trend of only the DPS's Hudson River spawning population. In addition, there was a relatively high probability that mortality for animals of the Gulf of Maine DPS and the Carolina DPS exceeded the mortality threshold used for the assessment. Yet, the stock assessment notes that it was not clear if: (1) the percent probability for the trend in abundance for the Gulf of Maine DPS is a reflection of the actual trend in abundance or of the underlying data quality for the DPS; and, (2) the percent probability that the Gulf of Maine DPS exceeds the mortality threshold actually reflects lower survival or was due to increased tagging model uncertainty owing to low sample sizes and potential emigration. Therefore, while Atlantic sturgeon populations may be showing signs of slow recovery since the 1998 and 1999 moratoriums when all five DPSs are considered collectively, these trends are not necessarily reflected with individual DPSs and there is considerable uncertainty related to population trends (ASMFC 2017b). In summary, across all five DPSs, several life history traits and factors contribute to making Atlantic sturgeon particularly sensitive to existing and future threats. These factors include the small size of many river-specific populations, existing gaps in the range, late maturation, long residence time in rivers from egg to juvenile, the sensitivity of adults to very specific temperature spawning cues which can result in years with no recruitment if conditions are not met, and the impact of losses of young of the year and juvenile cohorts prior to reaching spawning age on population persistence and stability.

In 2022, pursuant to Section 4(c)(2)(A) of the ESA, we published the 5-year reviews for the New York Bight DPS, Chesapeake Bay DPS, and Gulf of Maine DPS of Atlantic sturgeon. As part of the 5-year reviews, we are required to consider new information that has become available since the New York Bight DPS of Atlantic sturgeon was listed as endangered in February 2012. In addition to previously available information, this Opinion includes new information that has become available since the ESA-listing and critical habitat designation for the New York Bight DPS, and is considered the best available scientific information. The findings of the 5-year reviews are included in our discussion below for each DPS. The complete 5-year reviews for the three DPSs, are available on our website at: https://www.fisheries.noaa.gov/action/5-yearreview-new-york-bight-chesapeake-bay-and-gulf-maine-distinct-population-segments.

4.2.2.4 Critical Habitat

Critical habitat has been designated for the five DPSs of Atlantic sturgeon (82 FR 39160; August

17, 2017) in rivers of the eastern United States.

4.2.2.5 Recovery Goals

Recovery Plans for the Gulf of Maine, New York Bight, and Chesapeake Bay DPSs are currently at the draft stage, but have not been prepared for the South Atlantic and Carolina DPSs. A recovery outline (see https://www.fisheries.noaa.gov/resource/document/recovery-outlineatlantic- sturgeon-distinct-population-segments) has been developed as interim guidance to direct recovery efforts, including recovery planning, until a full recovery plan is approved.

4.2.2.6 Gulf of Maine DPS of Atlantic sturgeon

The Gulf of Maine DPS of Atlantic sturgeon includes Atlantic sturgeons spawned in the watersheds that drain into the Gulf of Maine from the Maine/Canadian border and extending southward to Chatham, Massachusetts. Within this range, Atlantic sturgeon historically spawned in the Penobscot, Kennebec, Androscoggin, Sheepscot, and Merrimack Rivers (ASSRT 2007). Spawning habitat is available and accessible in the Penobscot, Androscoggin, Kennebec, Merrimack, and Piscataqua (inclusive of Cocheco and Salmon Falls) Rivers. Spawning has been documented in the Kennebec River, and recent information from (Wippelhauser *et al.* 2017) confirms the location of occurrence (between river kilometer 70 and 75 (river mile 43.5 and 46.6)). During this study, between 2009-2011, eight sturgeon, including one male in spawning condition, were also captured in the Androscoggin River estuary, which suggests that spawning may be occurring in the Androscoggin River as well (Wippelhauser *et al.* 2017). However, additional evidence, such as capture of a spawning female, sturgeon eggs or larvae, is not yet available to confirm that spawning for the Gulf of Maine DPS is occurring in that river (NMFS 2018). Studies are on-going to determine whether Atlantic sturgeon are spawning in the other rivers within the DPS, but as of now, nothing is confirmed.

Bigelow and Schroeder (2002 (revised)) 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 (ASMFC (Atlantic States Marine Fisheries Commission) 1998, NMFS (National Marine Fisheries Service) and U.S. FWS (U.S. Fish and Wildlife Service) 1998, Wippelhauser *et al.* 2017). 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 four ripe males and one ripe female captured on July 26, 1980; (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, Maine (ASMFC 2007, NMFS (National Marine Fisheries Service) and U.S. FWS (U.S. Fish and Wildlife Service) 1998); and (4) as mentioned above, the capture of three Atlantic sturgeon larvae between river kilometer 72 and 75 (river mile 44.7 and 46.6) in July 2011 (Wippelhauser *et al.* 2017). The low salinity values for waters above Merrymeeting Bay are consistent with values found in rivers where successful

Atlantic sturgeon spawning is known to occur. Additionally, limited new information regarding spawning periodicity indicates that over a four-year period from 2010-2014, one fish was detected in three consecutive years on the Kennebec River spawning grounds. The majority of fish (12 out of 21) were only detected during one season (Wippelhauser *et al.* 2017). The data confirms variability in spawning periodicity.

Atlantic sturgeons that spawn elsewhere continue to use habitats within all of these rivers as part of their overall marine range (ASSRT 2007). Additionally, Atlantic sturgeon that spawn in the Gulf of Maine DPS have been detected off of Delaware (Wirgin *et al.* 2015a; Kazyak *et al.* 2021) and as far south as Cape Hatteras. 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). The Saco River supports a large aggregation of Atlantic sturgeon that forage on sand lance in Saco Bay and within the first few kilometers of the Saco River, primarily from May through October. Some sturgeon also overwinter in Saco Bay (Hylton *et al.* 2018, Little 2013) which suggests that the river provides important wintering habitat as well, particularly for subadults. However, none of the new information indicates recolonization of the Saco River for spawning. It remains questionable whether sturgeon larvae could survive in the Saco River even if spawning were to occur because of the presence of the Cataract Dam at river kilometer 10 (river mile 6.2) of the river (Little 2013), which limits access to the freshwater reach. Some sturgeon that spawn in the Kennebec have subsequently been detected foraging in the Saco River and Bay (Novak *et al.* 2017, Wippelhauser *et al.* 2017).

Data collected from 11 dead adult Atlantic sturgeon in the Bay of Fundy (seven individuals with age ranges from 17 to 28 years) further informs the DPS mixing that occurs throughout the marine range and in Canadian waters (Stewart *et al.* 2017). Dadswell *et al.* (2016) describes seasonal aggregations and movement (generally May through September) of Gulf of Maine DPS sturgeon in the Bay of Fundy. This information supports the 2012 listing rule's finding that 35 percent of Atlantic sturgeon captured in Canadian fisheries are of Gulf of Maine DPS origin (Wirgin *et al.* 2012).

Multiple 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 bycatch has been prohibited since 1998.

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 (ASMFC 2007, Stein *et al.* 2004a). Incidentally caught Atlantic sturgeon in state-managed fisheries are reported to the ASMFC through voluntary reporting (ASMFC 2019), and in federally managed fisheries through the Northeast Fishery Management plans. 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 Gulf of Maine DPS are not commonly taken as bycatch in areas south of Chatham, Massachusetts, with only 8 percent (*e.g.*, 7 of 84 fish) of interactions observed in the New York 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.* 2012), as stated above. Thus, a significant number of the Gulf of Maine DPS fish appear to migrate north into Canadian waters where they may be subjected to a variety of threats including bycatch. Dadswell *et al.* (2016) describes characteristics of the seasonal aggregation of sturgeon in the Bay of Fundy. Dadswell *et al.* does not identify the natal origin of each of the 1,453 Atlantic sturgeon captured and sampled for their study. However, based on Wirgin *et al.* (2012) and Stewart *et al.* (2017), NMFS considers the results of Dadswell *et al.* as representative of the movement of the Gulf of Maine DPS of Atlantic sturgeon. Dadswell *et al.* determined subadult and adult Atlantic sturgeon occur seasonally (approximately May to September) in the Bay of Fundy for foraging, and many return in consecutive years. Fork length (FL) of the 1,453 sampled sturgeon ranged from 45.8 to 267 centimeters (18 to 105 inches), but the majority (72.5 percent) were less than 150 centimeters (59 inches) FL. The age of the sturgeon (*i.e.*, 4 to 54 years old) is also indicative of the two different life stages. Detailed seasonal movements of sturgeon to and from the Bay of Fundy are described in Beardsall *et al.* (2016).

Habitat disturbance and direct mortality from anthropogenic sources are significant concerns to Atlantic sturgeon. 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 consequences to habitat. However, studies by Reine *et al.* (2014) and Balazik *et al.* (2020) indicate that sturgeon are not attracted to dredge activity and that dredging (*i.e.*, associated noise and turbidity) was not a barrier to passage, even though fish can become impinged or entrained in the dredging gear, itself.

Connectivity is disrupted by the presence of dams on some rivers in the Gulf of Maine region, including the Merrimack River. While there are also dams on the Kennebec and Androscoggin 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 the 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. Atlantic sturgeon primarily occur within the mesohaline reach of the river, particularly in areas with high densities of sturgeon prey which means that the Penobscot River is likely an important foraging area for Atlantic sturgeon belonging to the Gulf of Maine DPS (Altenritter *et al.* 2017a). There is no current evidence that spawning is occurring in the Penobscot River. Acoustic tag detections suggest that the adults that forage in the Penobscot River travel to the Kennebec River to spawn (Altenritter *et al.* 2017a). The Essex Dam on the Merrimack River blocks access to approximately 58 percent 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 (EPA 2008, Lichter *et al.* 2006). 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.

The threat of vessel strike appears to be less for Atlantic sturgeon belonging to the Gulf of Maine DPS compared to the New York Bight or Chesapeake Bay DPSs based on the number of Atlantic sturgeon vessel struck carcasses that are found in Gulf of Maine rivers, and given the differences in vessel activity in the respective natal rivers. Nevertheless, some strikes do occur within the Gulf of Maine and sturgeon belonging to the Gulf of Maine can also be struck in other areas of their range including higher salinity waters of the Hudson River Estuary, Delaware River Estuary, and Chesapeake Bay.

We described in the listing rule that potential changes in water quality as a result of global climate change (temperature, salinity, dissolved oxygen, contaminants, etc.) in rivers and coastal waters inhabited by Atlantic sturgeon will likely affect riverine populations, and we expected these effects to be more severe for southern portions of the U.S. range. However, new information shows that the Gulf of Maine is one of the fastest warming areas of the world as a result of global climate change (Brickman *et al.* 2021, Pershing *et al.* 2015). Markin and Secor (2020) further demonstrate the consequences of temperature on the growth rate of juvenile Atlantic sturgeon, and informs how global climate change may impact growth and survival of Atlantic sturgeon across their range. Their study showed that all juvenile Atlantic sturgeon had increased growth rate with increased water temperature regardless of their genetic origins. However, based on modeling and water temperature data from 2008 to 2013, they also determined that there is an optimal water temperature range, above and below which juveniles experience a slower growth rate, and they further considered how changes in growth rate related to warming water temperatures associated with global climate change might affect juvenile survival given the season (*e.g.*, spring or fall) in which spawning currently occurs.

There are no abundance estimates for the Gulf of Maine DPS or for the Kennebec River spawning population. Wippelhauser and Squiers (2015) reviewed the results of studies conducted in the Kennebec River System from 1977-2001. In total, 371 Atlantic sturgeon were captured, but the abundance of adult Atlantic sturgeon in the Kennebec spawning population could not be estimated because too few tagged fish were recaptured (*i.e.*, 9 of 249 sturgeon). Another method for assessing the number of spawning adults is through determinations of effective population size[9], which measures how many adults contributed to producing the next generation based on genetic determinations of parentage from the offspring. Effective population size is always less than the total abundance of a population because it is only a measure of parentage, and it is expected to be less than the total number of adults in a population because not all adults successfully reproduce. Measures of effective population size are also used to inform whether a population is at risk for loss of genetic diversity and inbreeding. The effective population size of the Gulf of Maine DPS was assessed in two studies based on sampling of adult Atlantic sturgeon captured in the Kennebec River in multiple years. The studies yielded very similar results which were an effective population size of: 63.4 (95 percent CI=47.3-91.1) (ASMFC 2017b) and 67 (95 percent CI=52.0–89.1) (Waldman *et al.* 2019).

Summary of the Gulf of Maine DPS

Spawning for the Gulf of Maine DPS occurs in Kennebec and may occur Androscoggin and in other rivers, such as the Penobscot, but has not been confirmed. In the Stock Assessment, the Commission concluded that the abundance of the Gulf of Maine DPS is "depleted" relative to historical levels and there is a 51 percent probability that abundance of the Gulf of Maine DPS has increased since implementation of the 1998 fishing moratorium (ASMFC 2017b). The Commission also noted that the Gulf of Maine is particularly data poor among all five DPSs.

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[9] Effective Population Size is the number of individuals that effectively participates in producing the next generation. https://www.sciencedirect.com/topics/earth-and-planetary-sciences/effective-population-size. It is less than the total number of individuals in the population.

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). The Saco River supports a large aggregation of Atlantic sturgeon that forage on sand lance in Saco Bay and within the first few kilometers of the Saco River, primarily from May through October with some overwintering as well (Hylton *et al.* 2018, Little 2013). However, none of the new information indicates recolonization of the Saco River for spawning.

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 because 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 Gulf of Maine DPS are not commonly taken as bycatch in areas south of Chatham, Massachusetts, and tagging results 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.* 2012). Dadswell *et al.* (2016) describes characteristics of the seasonal aggregation of sturgeon in the Bay of Fundy and NMFS considers the results of Dadswell *et al.* as representative of the movement of the Gulf of Maine DPS of Atlantic sturgeon. Dadswell *et al.* determined subadult and adult Atlantic sturgeon occur seasonally (approximately May to September) in the Bay of Fundy for foraging, and many return in consecutive years.

As noted previously, studies have shown that in order to rebuild, Atlantic sturgeon can only sustain low levels of bycatch and other anthropogenic mortality (ASMFC 2007, Boreman 1997, Brown and Murphy 2010, Kahnle *et al.* 2007). 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.

4.2.2.7 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 (including bays and sounds) from Chatham, Massachusetts to the Delaware-Maryland border on Fenwick Island. Within this range, Atlantic sturgeon historically spawned in the Connecticut, Delaware, Hudson, and Taunton Rivers

(ASSRT 2007, Murawski and Pacheco 1977, Secor *et al.* 2002). 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, in 2014 new inconclusive information regarding potential Connecticut River spawning was received. Additionally, 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).

There is uncertainty related to trends in abundance for the New York Bight DPS (ASMFC 2017b). The Commission concluded for their 2017 Atlantic Sturgeon Stock Assessment that abundance of the New York Bight DPS is "depleted" relative to historical levels but, there is a relatively high probability (75 percent) that the New York Bight DPS abundance has increased since the implementation of the 1998 fishing moratorium, and a 31 percent probability that mortality for the New York Bight DPS exceeds the mortality threshold used for the assessment (ASMFC 2017b). Moreover, new information suggests that the Commission's conclusions primarily reflect the status and trend of only the DPS's Hudson River spawning population. The ASMFC did not estimate the abundance of the New York Bight DPS or otherwise quantify the trend in abundance because of the limited available information.

At this time, there are no overall abundance estimates for the entire New York Bight DPS. There are, however, some abundance estimates for specific life stages (*e.g.*, natal juvenile abundance, spawning run abundance, and effective population size). In 1995, sampling crews on the Hudson River estimated that there were 9,500 juvenile Atlantic sturgeon in the estuary. Because 4,900 of these were stocked hatchery-raised fish, about 4,600 fish were of wild origin. Based on the juvenile assessments from Bain *et al.* (2000), the Hudson River suffered a series of recruitment failures, which triggered the ASMFC fishing moratorium in 1998 to allow the populations to recover. 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). Using side scan sonar technology in conjunction with detections of previously tagged Atlantic sturgeon, Kazyak *et al.* (2021) estimated the 2014 Hudson River spawning run size to be 466 sturgeon (95 percent CI = 310-745). While the spawning run estimate by Kazyak *et al.* (2021) cannot be directly compared with the estimated total abundance of adults in the early 1990s to determine if adult abundance has changed since the fishery was closed, it is clear that adult abundance is still several magnitudes lower than historical abundances. There is evidence to support the notion that the Hudson River spawning population is more robust than the Delaware River spawning population. This is further supported by the fact that Atlantic sturgeon originating from the Hudson River spawning population are more prevalent in mixed aggregations than sturgeon originating from the Delaware River spawning population.

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 (ASMFC 2010, Sweka *et al.* 2007). 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. However, the New York State Department of Environmental Conservation (DEC) has conducted annual surveys for Atlantic sturgeon juveniles in the Hudson River since 2004. Recent analyses suggest that the catch rate of juvenile Atlantic sturgeon belonging to the Hudson River spawning population has increased, with double the average catch rate for the period from 2012-2019 compared to the previous eight years, from 2004-2011 (Pendleton and Adams 2021). Thus, the fishing moratorium may have resulted in an increase in recruitment of spawning females (and consequently number of juveniles produced) or the increase may have been because survival of early life stages and/or juveniles has increased for unknown reasons in the Hudson River since 2004.

White *et al.* (2022a, b) recently estimated the number of adults (Ns) in the Delaware River that successfully reproduced in order to create a cohort of offspring by using genetic pedigrees constructed from progeny genotypes. Ns estimates the number of successful breeders and is not synonymous with effective population size (Ne) or effective number of breeders (Nb) as these metrics describe genetic processes (*e.g.*, inbreeding and genetic drift; Jamieson and Allendorf 2012, Waldman *et al.* 2019, Wang *et al.* 2016). (White *et al.* 2022a, White *et al.* 2022b) estimated that Ns ranged from 42 (95 percent CI: 36-64) spawners in 2014 to 130 (95 percent CI: 116-138) spawners in 2017 during the years from 2013 to 2019. Because Ns only includes adults that generate at least one offspring during a single breeding season, it sets a lower bound on the size of the spawning run. Nevertheless, the genetics information indicates that at least 42 to 130 adults successfully contributed to the 2014- and 2017-year classes. White *et al.* (2022a, b) concluded that bias in the data when sample size of offspring is small may result in the Ns being underestimated, as such, the Ns for Delaware River Atlantic sturgeon is likely between 125 and 250. Hale *et al.* (2016) estimated that 3,656 (95 percent CI = 1,935-33,041) early juveniles (age zero to one) utilized the Delaware River estuary as a nursery in 2014.

The effective population size (Ne) measures the genetic behavior (inbreeding and genetic drift) of a stable population with a 50/50 sex ratio, random mating, and equal reproductive success among individuals (*i.e.*, an idealized population). Thus, the Ne is not a population estimate but is used in conservation biology as a measure of the population's short- or long-term viability. Since the Ne is based on an 'idealized' population, the actual population of reproductive individuals needed for a particular Ne will usually, but not always, be larger than Ne. However, there is a general relationship between the size of the census population and the size of Ne. (White *et al.* 2021) found that the differences in estimated Ne between Atlantic sturgeon populations roughly corresponded to the differences in total population size. As such, the Hudson River has one of the largest estimates of Ne while the Delaware River has one of the smallest estimates. Based on genetic analyses of two different life stages, subadults and natal juveniles, Ne for the Hudson River population has been estimated to be 198 (95 percent CI=171.7-230.7; (O'Leary *et al.* 2014)) and 156 (95 percent CI=138.3-176.1), respectively, (Waldman *et al.* 2019), while estimates for the Delaware River spawning population from the same studies are 108.7 (95 percent CI=74.7-186.1) (O'Leary *et al.* 2014) and 40 (95 percent

CI=34.7-46.2) (Waldman *et al.* 2019), respectively. Genetic testing can differentiate between individuals originating from the Hudson or Delaware River and available information suggests that the straying rate is moderate between these rivers (Grunwald *et al.* 2008). However, the small sample size and the potential inclusion of non-natal fish in the samples may bias the calculations for the Delaware and Hudson Rivers (L. Lankshear, personal communication, April 2023).

The differences in estimated population size for the Hudson and Delaware River spawning populations and in Ne support the notion that the Hudson River spawning population is the more robust of the two spawning groups, although the White *et al.* (2021) study did not address the status of short and long term viability of either population. This trend is further supported by genetic analyses that demonstrates Atlantic sturgeon originating from the Hudson River spawning population were more prevalent in mixed aggregations than sturgeon originating from the Delaware River spawning population, even when sampling occurred in areas and at times that targeted adults belonging to the Delaware River spawning population (Wirgin *et al.* 2018, Wirgin *et al.* 2015b). The Waldman *et al.* (2019) calculations of maximum effective population size, and comparison of these to four other spawning populations outside of the New York Bight DPS further supports our previous conclusion that the Delaware River spawning population is less robust than the Hudson River, which is likely the most robust of all of the U.S. Atlantic sturgeon spawning populations.

New information from Breece *et al.* (2021) supports evidence of males having shorter spawning periodicity than females, but that females have more variability in the timing and number of spawning runs they make in the Hudson River. Salvage data from 2016 of a female Atlantic sturgeon in the Delaware River provided further support for the timing of spring spawning. Although the most recent Stock Assessment noted that movement of tagged fish and anecdotal reports suggest a fall spawning in the Delaware River; no further information is available to confirm whether it is occurring at this time.

In 2014, the Connecticut Department of Energy and Environmental Protection (CT DEEP) captured Atlantic sturgeon in the river that, based on their size, had to be less than one year old. Therefore, given the established life history patterns for Atlantic sturgeon which include remaining in lower salinity water of their natal river estuary for more than one year, the sturgeon were likely spawned in the Connecticut River. However, genetic analysis for 45 of the smallest fish (ranging from 22.5 to 64.0 centimeters (9 to 25 inches) TL) indicated that the sturgeon were most closely related to Atlantic sturgeon belonging to the South Atlantic DPS (Savoy *et al.* 2017). The conventional thinking is that the Connecticut River was most likely to be recolonized by Atlantic sturgeon from the Hudson River spawning population because: (1) it is the closest of the known spawning rivers to the Connecticut; the most robust of all of the spawning populations; and, (2) it occurs within the same, unique, ecological setting. Furthermore, the majority of the Atlantic sturgeon that aggregate in the Lower Connecticut River and Long Island Sound originate from the New York Bight DPS (primarily the Hudson River spawning population) whereas less than 10 percent originate from the South Atlantic DPS (Waldman *et al.*

2013). The genetic results for the juvenile sturgeon are, therefore, counter to prevailing information regarding straying and the affinity of Atlantic sturgeon for natal homing. The genetic analyses of the juvenile sturgeon also showed that many (*i.e.*, 82 percent) were full siblings which means that relatively few adults contributed to this cohort. Based on the genetic analysis of the captured juveniles using the calculations utilized for the Hudson and Delaware Rivers, the effective population (Ne) size for the Connecticut River was estimated to be 2.4 sturgeon (Savoy *et al.* 2017). The CT DEEP is conducting a multiyear investigation to further inform the status and origin of Atlantic sturgeon spawning in the river. At this time, we are not able to conclude whether the juvenile sturgeon detected are indicative of sustained spawning in the river or whether they were the result of a single spawning event due to unique straying of the adults from the South Atlantic DPS's spawning rivers.

As previously mentioned, there is no abundance estimate for the New York Bight DPS. As such, for the purposes of ESA Section 7 consultations, we estimated adult and subadult abundance of the New York Bight DPS based on available information for the genetic composition and the estimated abundance of Atlantic sturgeon in marine waters (Damon-Randall *et al.* 2013, Kocik *et al.* 2013). We use the mixed stock marine analysis as a proxy for in river composition because we do not have a subadult and adult mixed stock analysis for in-river usage. Therefore, we define the subadult and adult abundance of the New York Bight DPS as 34,567 sturgeon (NMFS 2014). This number encompasses many age classes since subadults can be as young as one year old when they first enter the marine environment, and adults can live as long as 64 years (Balazik *et al.* 2012c, Hilton *et al.* 2016). For example, in their study of Atlantic sturgeon captured in the geographic New York Bight, Dunton *et al.* (2016) determined that 742 of the Atlantic sturgeon captured represented 21 estimated age classes and that, individually, the sturgeon ranged in age from 2 to 35 years old.

A number of threats to Atlantic sturgeon exist in marine waters including bycatch in fishing gear. Atlantic sturgeon bycatch in fisheries authorized under Northeast FMPs is estimated to be four percent of adults. As presented in the mixed stock analysis results 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. 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. Commercial shad fishery continues in the Delaware Bay but is closed in the Delaware River. In the Hudson River, sources of potential mortality include vessel strikes and entrainment in dredges. Impingement at water intakes, including the Danskammer, Roseton, Indian Point, Salem, and Hope Creek (on the Delaware river) power plants also occurs. Recent information from surveys of juveniles 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.

Several additional 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, and climate change (EPA 2008, Lichter *et al.* 2006). 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 contaminant exposure. Annual differences in the capture rates of age 0-1 Atlantic sturgeon in the fall and comparisons to annual dissolved oxygen levels during the preceding summer months provide additional evidence that low dissolved oxygen levels are causing or contributing to the death of the young sturgeon in the Delaware River in some years (Moberg and DeLucia 2016; Stetzar *et al.* 2015; Park 2017). On December 1, 2022, the EPA issued a determination that revised Water Quality Standards are necessary for the Delaware River Estuary to meet the requirements of the Clean Water Act. Specifically, the EPA determined that the aquatic life designated uses and corresponding dissolved oxygen criterion in Zones 3, 4, and river kilometer 126.8 to 112.7 (river mile 78.8 to 70.0) of zone five of the Delaware River Estuary must be revised to protect the propagation of resident and migratory fish species, including Atlantic and shortnose sturgeon, which are likely experiencing adverse effects under the currently applicable Water Quality Standards that were established in 1967.

On the Delaware River, a dredged navigation channel extends from Trenton seaward through the tidal river (Brundage and O'Herron 2009), and the river receives significant shipping traffic. A dredged navigation channel is present in the Hudson River as well. Although dredging occurs regularly, some projects have observers and some do not. At this time, 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. Modeling by Breece *et al.* (2013) demonstrates that the Delaware River salt front is likely to advance even further upriver with climate change, which would reduce the amount of transitional salinity habitat available to natal juveniles, and individuals using the aforementioned habitat for specific behaviors. Coupled with other climate and anthropogenic changes, such as drought and channel deepening, the already limited amount of tidal freshwater habitat available for spawning could be reduced and the occurrence of low dissolved oxygen within early juvenile rearing habitat could increase.

Vessel strikes have been identified as a major threat in the Hudson and Delaware Rivers for migrating sturgeon and individuals aggregating on limited spawning or overwintering grounds. Vessel strikes occur in the Delaware River and Bay. One-hundred and three (103) Atlantic sturgeon mortalities believed to be the result of vessel strikes were documented in the Delaware River from 2005 to 2019, and at least 65 of these fish were large adults and subadults (data provided by DNREC, 2020). Based on evidence of Atlantic sturgeon vessel strikes since the listing, it is now apparent that vessel strikes are also occurring in the Hudson River. For example, the New York DEC reported that at least 17 dead Atlantic sturgeon with vessel strike injuries were found in the river in 2019 of which at least 10 were adults. Additionally, 108

Atlantic sturgeon carcasses were observed on the Hudson River and reported to the NYSDEC between 2013 and 2017. Of these, 71 were suspected of having been killed by vessel strike (NMFS 2017b). 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.

Based on genetic analyses, Atlantic sturgeon belonging to the New York Bight DPS have been identified among those captured in the Bay of Fundy, Canada as well as in U.S. waters that include Long Island Sound, the lower Connecticut River, and in marine waters off of western Long Island, New Jersey, Delaware, Virginia, and North Carolina. However, the New York Bight DPS was more prevalent relative to the other DPSs in Mid-Atlantic marine waters, bays, and sounds (Dunton *et al.* 2012, Waldman *et al.* 2013, Wirgin *et al.* 2015b, 2018). These findings support the conclusion of Wirgin *et al.* (2015a) that natal origin influences the distribution of Atlantic sturgeon in the marine environment, and suggest that some parts of its marine range are more useful to and perhaps essential to the New York Bight DPS.
Further evidence was presented by Erickson *et al.* (2011). Thirteen of the fifteen adult Atlantic sturgeon, that they captured and tagged in the tidal freshwater reach of the Hudson River (*i.e.*, belonging to the Hudson River spawning population), remained in the Mid-Atlantic Bight during the six months to one year time period of data collection. Of the remaining two fish, one traveled as far north as Canadian waters where its tag popped up in June, nearly one year after being tagged. The second fish traveled south beyond Cape Hatteras[10] before its tag popped up, about seven months after being tagged. Collectively, all of the tagged sturgeon occurred in marine and estuarine Mid-Atlantic Bight aggregation areas that have been the subject of sampling used for the genetic analyses, including in waters off Long Island, the coasts of New Jersey and Delaware, the Delaware Bay and the Chesapeake Bay.

Breece *et al.* (2016) further investigated the distribution and occurrence of Atlantic sturgeon in the Mid-Atlantic Bight based on associated habitat features, as well as the habitat features associated with presence of adults in the Delaware River, and their distribution and movements within Delaware Bay. The research provides evidence of specific, dynamic habitat features that Atlantic sturgeon are sensitive to in their aquatic environments such as substrate composition and distance from the salt front in the river estuary, water depth and water temperature in Delaware Bay, and depth, day-of-year, sea surface temperature, and light absorption by seawater in marine waters (2017, 2018, Breece *et al.* 2013). Their model, based on the features identified for the marine environment, was highly predictive of Atlantic sturgeon distribution in the Mid-Atlantic Bight from mid-April through October. Since the majority of Atlantic sturgeon occurring in the Mid-Atlantic Bight belong to the New York Bight DPS, these studies provide: (1) new information describing the environmental factors that influence the presence and movements of

[10] As explained in Erickson *et al.* (2011), relocation data for both of these fish were more limited for different reasons. Therefore, more exact locations could not be determined.

New York Bight DPS Atlantic sturgeon in the Mid-Atlantic Bight, the Delaware Bay and the Delaware River; (2) a modeling approach for predicting occurrence and distribution of New York Bight DPS Atlantic sturgeon, particularly in the spring through early fall; and, (3) information to better assess consequences to the New York Bight DPS given known, expected, or predicted changes to their habitat.

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, White *et al.* (2021) found that their genetic analysis could not distinguish Delaware River Atlantic sturgeon from Hudson River Atlantic sturgeon as clearly as they could distinguish Atlantic sturgeon from other rivers included in the study. This more recent study reinforces the findings of Grunwald (2008) that there is moderate straying between river systems, which further supports the single DPS represented in the New York Bight.

There is uncertainty related to trends in abundance for the New York Bight DPS (ASMFC 2017b). The 2017 ASMFC Atlantic Sturgeon Stock Assessment states that the abundance of the New York Bight DPS is "depleted" relative to historical levels, but there is a relatively high probability (75 percent) that the New York Bight DPS abundance has increased since the implementation of the 1998 fishing moratorium. However, new information suggests that these conclusions primarily reflect the status and trend of only the Hudson River spawning population (NMFS 2022). Some of the impacts 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 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, global climate change, continued bycatch in state and federally managed fisheries, and vessel strikes remain significant threats to the New York Bight DPS.

Additional information is available that informs the consequences of climate change on the New York Bight DPS. There is already evidence of habitat changes in the Delaware River from other anthropogenic activities. Modeling by Breece *et al.* (2013) demonstrates that the Delaware River salt front is likely to advance even further upriver with climate change, which would reduce the amount of transitional salinity habitat available to natal juveniles and would potentially restrict habitat for other necessary behaviors. With already limited tidal freshwater habitat available for spawning, habitat could be further reduced and the occurrence of low dissolved oxygen within early juvenile rearing habitat could increase. As evidenced by the studies of Hare *et al.* (2016b) and Balazik *et al.* (2010), the Delaware spawning population is unlikely to redistribute to another river even if their habitat in the Delaware River is increasingly insufficient to support successful spawning and rearing for the New York Bight DPS due to climate change.

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

(ASMFC 2007, Stein *et al.* 2004b). For Atlantic sturgeon, the model-based estimates of annual bycatch in gillnet and bottom trawl gear published in ASMFC (2017) represent the best available information for and analysis of bycatch. From 2011-2015, the average annual bycatch of Atlantic sturgeon in bottom otter trawl gear was 777.4 sturgeon under the best fit model. From 2011-2015, the average annual bycatch of Atlantic sturgeon in gillnet gear was 627.6 sturgeon under best fit model (ASMFC 2017b).

The best performing model for each gear type was applied to Vessel Trip Reports (VTRs) to predict Atlantic sturgeon bycatch across all trips. The total bycatch of Atlantic sturgeon from bottom otter trawls ranged between 624-1,518 fish over the 2000-2015 time series. The proportion of the encountered Atlantic sturgeon recorded as dead ranged from 0-18 percent (average 4 percent). This resulted in annual dead discards ranging from 0-209 fish. The total bycatch of Atlantic sturgeon from gillnets ranged from 253-2,715 fish. The proportion of Atlantic sturgeon recorded as dead ranged from 12-51 percent (average 30 percent), resulting in annual dead discards ranging from 110-690 fish. Otter trawls and gillnets caught similar sizes of Atlantic sturgeon, with most fish in the 3.3-6.6 feet (100-200 centimeter) total length range, although both larger and smaller individuals were captured. Wirgin and King (2011), indicates that 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 percent were from the New York Bight DPS (Wirgin *et al.* 2012). 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 consequences 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 (EPA 2008, Lichter *et al.* 2006). With improved water quality and toxic discharges limited through regulations, reduced in-water pollutants may be less of a concern, but legacy pollutants may exist long term in the benthic environment. When pollutants are present on spawning and nursery grounds, where sensitive life stages occur, there is potential for long-term impacts to developing individuals.

Vessel strikes occur in the Delaware River and Bay, and many mortalities have been identified as large adults and subadults. The New York DEC has also reported that dead Atlantic sturgeon with vessel strike injuries in the river in 2019, confirming that vessel strikes are also an issue on the Hudson River. 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, and are assumed to be of New York Bight DPS origin.

Studies have shown that to rebuild, Atlantic sturgeon can only sustain low levels of anthropogenic mortality (ASMFC 2007, Boreman 1997, Brown *et al.* 2012, Kahnle *et al.* 2007). There are no empirical abundance estimates of the number of Atlantic sturgeon in the New York Bight DPS. For the listing of the New York Bight DPS, we determined that the 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 (77 FR 5880, February 6, 2012). We reviewed new information for the 5-Year Review that became available since the listing and we concluded that the status of the DPS has likely neither improved nor declined from what it was when the DPS was listed in 2012. We, therefore, continued to recommend classification for the New York Bight DPS of Atlantic sturgeon as “endangered.” (NMFS 2022).

4.2.2.8 Chesapeake Bay DPS of Atlantic sturgeon

The Chesapeake Bay DPS of Atlantic sturgeon includes Atlantic sturgeon spawned in the watersheds that drain into the Chesapeake Bay and into coastal waters (including bays and sounds) from the Delaware-Maryland border at Fenwick Island to Cape Henry, Virginia. The marine range of Atlantic sturgeon from the Chesapeake Bay DPS extends from Hamilton Inlet, Labrador, Canada, to Cape Canaveral, Florida. Recent data confirms that Chesapeake Bay Atlantic sturgeon are most prevalent in the marine environment throughout the Mid-Atlantic Bight from Delaware to Cape Hatteras (Kazyak *et al.* 2021). The riverine range of the Chesapeake Bay DPS and the adjacent portion of the marine range are shown in Figure 3. Within this range, Atlantic sturgeon historically spawned in the Susquehanna, Potomac, James, York, Rappahannock, and Nottoway Rivers (ASSRT 2007). Based on the review by Oakley (2003), 100 percent of Atlantic sturgeon habitat is currently accessible in these rivers since most of the barriers to passage (*i.e.*, dams) are located upriver of where spawning is expected to have historically occurred (ASSRT 2007). Spawning still occurs in the James River, amongst the additional spawning populations for the Chesapeake Bay DPS, and there is evidence that most of the Chesapeake Bay DPS spawning populations spawn in the late summer to fall (hereafter referred to as "fall spawning") rather than in the spring. Fall spawning activity has been documented in the newly discovered spawning populations in the Pamunkey River, a tributary of the York River, and in Marshyhope Creek, a tributary of the Nanticoke River (Hager *et al.* 2014, Richardson and Secor 2016, Secor *et al.* 2021). The James River is currently the only river of the Chesapeake Bay DPS where evidence suggests there is both spring and fall spawning with separate spawning populations. The results of genetic analyses show that there is some limited gene flow between the populations but, overall, the spawning populations are genetically distinct (Balazik *et al.* 2017, Balazik *et al.* 2012a, Balazik and Musick 2015). Detections of acoustically-tagged adult Atlantic sturgeon along with historical evidence suggests that Atlantic sturgeon belonging to the Chesapeake Bay DPS may be spawning in the Mattaponi and Rappahannock Rivers, as well (ASMFC 2017b, Hilton *et al.* 2016, Kahn 2019). However, information for these populations is limited and the research is ongoing. In addition, research by Balazik (2023) in the Potomac River from November 2020 to November 2022 documented 24 tagged subadult and adult Atlantic sturgeon moving upstream to potential spawning grounds (Balazik 2023). However, it is important to note that some of the data collected are from fish that had internal surgeries, which may have modified natural behavior.

Age to maturity for Chesapeake Bay DPS Atlantic sturgeon is unknown. However, Atlantic sturgeon riverine populations exhibit clinal variation with faster growth and earlier age to maturity for those that originate from southern waters, and slower growth and later age to maturity for those that originate from northern waters (75 FR 61872; October 6, 2010). Age at maturity is 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.* 1988). Recent data indicates that Chesapeake Bay DPS juvenile Atlantic sturgeon remain in the natal estuary between one and four years before emigrating to the marine environment (Balazik *et al.* 2012b), and that males mature at about age 10 and females at age 15 (Balazik *et al.* 2012b; Hilton *et al.* 2016). New information regarding spawning periodicity is supported by the fact that acoustically-tagged males have made annual returns to spawning locations. Tagged females have returned approximately every two to three years, with some returning annually (Balazik *et al.* 2017a; Kahn *et al.* 2019; Kahn *et al.* 2021; Secor *et al.* 2021). Additionally, Kahn *et al.* (2021) used detections of tagged male and female sturgeon to inform the sex ratio in the Pamunkey River spawning population (males make up approximately 51 percent (95 percent CI=0.43-0.58 of the adult population).

There is currently no total abundance estimate for the Chesapeake Bay DPS; however, we estimated subadult and adult abundance in marine waters and concluded that approximately 8,811 sturgeon comprise the DPS (NMFS 2013). There are also several estimates of effective population size for Atlantic sturgeon that are spawned in the James River although only one study examined the effective population size of both the spring and fall spawning populations. Nevertheless, the estimates of effective population size from separate studies and based on different age classes are similar. These are: 62.1 (95 percent CI=44.3-97.2) based on sampling of subadults captured off of Long Island across multiple years; 32 (95 percent CI=28.8-35.5) based on sampling of natal juveniles and adults in multiple years (Waldman *et al.* 2019); 40.9 (95 percent CI = 35.6 – 46.9) based on samples from a combination of juveniles and adults, (ASMFC 2019); and, 44 (95 percent CI=26–79) and 46 (95 percent CI=32–71) for the spring and fall spawning populations, respectively, based on sampling of adults (Balazik *et al.* 2017). There is a single estimate of 12.2 (95 percent CI = 6.7– 21.9) for the Nanticoke River system (Secor *et al.* 2021), and also a single estimate of 7.8 (95 percent CI = 5.3 – 10.2) for the York River system based on samples from adults captured in the Pamunkey River (ASMFC 2017b).

Based on research captures of tagged adults, an estimated 75 Chesapeake Bay DPS Atlantic sturgeon spawned in the Pamunkey River in 2013 (Kahn *et al.* 2014). More recent information provided annual run estimates for the Pamunkey River from 2013 to 2018. The results suggest a spawning run of up to 222 adults but with yearly variability, likely due to spawning periodicity (Kahn 2019).

Research in the Nanticoke River system suggests a small adult population based on a small total number of captures (*i.e.*, 26 sturgeon) and the high rate of recapture across several years of study (Secor *et al.* 2021). By comparison, 373 different adult-sized Atlantic sturgeon (*i.e.*, total count does not include recaptures of the same fish) were captured in the James River from 2009 through spring 2014 (Balazik and Musick 2015). This is a minimum count of the number of adult Atlantic sturgeon in the James River during the time period because capture efforts did not occur in all areas and at all times when Atlantic sturgeon were present in the river.

New information regarding the importance of temperature on spawning and movement of sturgeon indicates that a relatively narrow temperature range (20°C to 25°C (68°F to 77°F)) triggers spawning, (Balazik *et al.* 2012a; Balazik *et al.* 2020; Hager *et al.* 2020; Secor *et al.* 2021), and new research has also demonstrated that limited hard-bottom habitat for Atlantic sturgeon spawning activities exist in Chesapeake Bay tributaries (Austin 2012; Bruce *et al.* 2016; Secor *et al.* 2021). Further informing potential spawning locations is research regarding the upriver range of the species based on detections of tagged adult Atlantic sturgeon (Balazik *et al.* 2021a; Hager *et al.* 2014; NMFS 2017; Secor *et al.* 2021), which supports the notion that available, suitable spawning habitat is sparse.

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

Decreased water quality also threatens Atlantic sturgeon of the Chesapeake Bay DPS, especially since the Chesapeake Bay system is vulnerable to the consequences 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 (ASMFC 1998, EPA 2008, ASSRT 2007, Pyzik *et al.* 2004). 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 some areas of the Bay's health, the ecosystem remains in poor condition. In 2022, the Chesapeake Bay Foundation gave the overall health index of the Bay a grade of 32 percent (D+) based on the best available information about the Chesapeake Bay for indicators representing three major categories: pollution, habitat, and fisheries (Chesapeake Bay Foundation 2020). The score remained unchanged from 2020; however, of the 13 indicators assessed, three improved, three declined, and seven stayed the same. While 32 percent is one percent lower than the state of the Bay score in 2018, this was an 18.5 percent increase from the first State of the Bay report in 1998, which gave the Bay a score of 27 percent (D). According to the Chesapeake Bay Foundation, the unchanged score is largely a result of failures to make needed changes on farmland to reduce pollution, but noted improvements due to the promising results from oyster reef restoration, regulations allowing the striped bass population to rebuild by 2029, less phosphorous in the water and a smaller dead zone. Highlights from the 2022 report are summarized below:

- Monitoring data indicated that the 2022 dead zone was the tenth smallest in the past 38 years;
- Water clarity dropped one point in the report due to average water clarity in the Bay decreasing slightly in 2022 compared to 2020;
- In the pollution category nitrogen, toxics, and dissolved oxygen indicators were unchanged, the phosphorus indicator improved, and overall water clarity declined. Recent farm conservation funding at the federal and state levels should help reduce nitrogen and phosphorus pollution, which fuels harmful algal blooms that remove dissolved oxygen from the water;
- In the fisheries category, the rockfish (striped bass) and oyster indicators rose, while the blue crab indicator declined(Chesapeake Bay Foundation 2020); and
- In the habitat category, scores for underwater grasses, forest buffers, and wetlands remained unchanged, but resource lands fell slightly by a point. Resource lands refer to forests, natural open areas, and well-managed farmland. The drop in score was largely due to approximately 95,000 acres of farms and forests transitioning to development across the Bay watershed during the most recent reporting period, from 2013/2014 to 2017/2018.

At this time, we do not have sufficient information to quantify the extent that degraded water quality affects 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. More than 100 Atlantic sturgeon carcasses have been salvaged in the James River since 2007 and additional carcasses were reported but could not be salvaged (Greenlee *et al.* 2019). Many of the salvaged carcasses had evidence of a fatal vessel strike. In addition, vessel struck Atlantic sturgeon have been found in other parts of the Chesapeake Bay DPS's range including in the York and Nanticoke river estuaries, within Chesapeake Bay, and in marine waters near the mouth of the Bay since the DPS was listed as endangered (NMFS Sturgeon Salvage Permit Reporting; Secor *et al.* 2021). The best available information supports the conclusion that sturgeon are struck by small (*e.g.*, recreational) as well as large vessels. NMFS has only minimum counts of the number of Atlantic sturgeon that are struck and killed by vessels because only the sturgeon that are found dead with evidence of a vessel strike are counted. New research, including a study conducted along the Delaware River that intentionally placed Atlantic sturgeon carcasses in areas used by the public, suggests that most Atlantic sturgeon carcasses are not found and, when found, many are not reported to NMFS or to our sturgeon salvage co-investigators (Balazik, pers. comm. in ASMFC 2017b, Balazik *et al.* 2012c, Fox *et al.* 2020). There has been an increased number of vessel struck sturgeon reported in the James River in recent years (ASMFC 2017b). However, it is unknown to what extent the numbers reflect increased carcass reporting.

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

Summary of the Chesapeake Bay DPS

There are no overall abundance estimates for the entire Chesapeake Bay DPS or for the spawning populations in the James River or the Nanticoke River system; however, estimates from the marine environment and effective population size are available. A study on effective population size for Atlantic sturgeon that are spawned in the James River examined the effective population size of both the spring and fall spawning populations, whereas in other rivers, only the fall pawning run was considered.

At this time, spawning for the Chesapeake Bay DPS is known to occur in only the James and Pamunkey Rivers and in the Nanticoke River system. Spawning may be occurring in other rivers, such as the Mattaponi, Rappahannock, and Potomac, 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.

Based on research captures of tagged adults, an estimated 75 Chesapeake Bay DPS Atlantic sturgeon spawned in the Pamunkey River in 2013 (Kahn *et al.* 2014). The results suggest a spawning run of up to 222 adults but with yearly variability, likely due to spawning periodicity (Kahn 2019). Research in the Nanticoke River system suggests a small adult population based on a small total number of captures (*i.e.*, 26 sturgeon) and the high rate of recapture across several years of study (Secor *et al.* 2021). By comparison, 373 different adult-sized Atlantic sturgeon (*i.e.*, total count does not include recaptures of the same fish) were captured in the James River from 2009 through spring 2014 (Balazik and Musick 2015). In addition, 24 Atlantic sturgeon were detected by acoustic monitoring in the Potomac River (data should be used with caution, as discussed above). Eleven of the sturgeon were tagged upstream of the Nice-Middleton Bridge, while the remaining were tagged in other water bodies (Balazik 2023).

Some of the impacts from the threats that facilitated the decline of the Chesapeake Bay DPS have been removed (*e.g.*, directed fishing) or reduced because of improvements in water quality since passage of the CWA. Areas with persistent, degraded water quality, habitat impacts from dredging, continued bycatch in U.S. state and federally-managed fisheries, Canadian fisheries, and vessel strikes remain significant threats to the Chesapeake Bay DPS of Atlantic sturgeon. Of the 35 percent of Atlantic sturgeon incidentally caught in the Bay of Fundy, about one percent were Chesapeake Bay DPS fish (Wirgin *et al.* 2012). Studies have shown that Atlantic sturgeon can only sustain low levels of bycatch mortality (ASMFC 2007, Boreman 1997, Kahnle *et al.* 2007). The Chesapeake Bay DPS is currently at risk of extinction given (1) precipitous declines in population sizes and the protracted period in which sturgeon populations have been depressed; (2) the limited amount of current spawning; and, (3) the impacts and threats that have and will continue to affect the potential for population recovery.

4.2.2.9 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 3. Sturgeon are commonly captured 64.4 kilometers (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 (164 feet) deep (ASMFC 2007, Stein *et al.* 2004a), but Atlantic sturgeon are recorded as bycatch out to 500 fathoms.

Rivers known to have current spawning populations within the range of the Carolina DPS include the Roanoke, Tar-Pamlico, Cape Fear, Waccamaw, and Pee Dee Rivers. We determined spawning was occurring if young-of-the-year were observed or mature adults were present in freshwater portions of a system (Table 9). 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 9. Major rivers, tributaries, and sounds within the ranges of the Carolina DPS and currently available data on the presence of 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; Winyah Bay	Yes	age-1, potentially YOY (1980s)
Pee Dee River, SC; Winyah Bay	Yes	running ripe male in Great Pee Dee River (2003)
Sampit, SC; Winyah Bay	Extirpated	
Santee River, SC	Unknown	
Cooper River, SC	Unknown	
Ashley River, SC	Unknown	

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 *et al.* 2002). Secor *et al.* (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 percent 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.

Although there are statutory and regulatory provisions 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 percent of the historical sturgeon habitat on the Cape Fear River and in the Santee-Cooper system. Dams are contributing to the status of the Carolina DPS by curtailing the extent of available spawning habitat and further modifying the remaining habitat downstream by affecting water quality parameters (such as depth, temperature, velocity, and 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.

4.2.2.10 South Atlantic DPS of Atlantic sturgeon

The South Atlantic DPS includes all Atlantic sturgeon that spawn or are spawned in the watersheds (including all rivers and tributaries) of the Ashepoo, Combahee, and Edisto Rivers (ACE) Basin southward along the South Carolina, Georgia, and Florida coastal areas to the St. Johns River, Florida. The marine range of Atlantic sturgeon from the South Atlantic DPS extends from the Hamilton Inlet, Labrador, Canada, to Cape Canaveral, Florida. The riverine range of the South Atlantic DPS and the adjacent portion of the marine range are shown in Figure 2.

Rivers known to have current spawning populations within the range of the South Atlantic DPS include the Combahee, Edisto, Savannah, Ogeechee, Altamaha, and Satilla Rivers. We determined spawning was occurring if young-of-the-year were observed, or mature adults were present, in freshwater portions of a system (Table 10). 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. Mary's 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. Mary's 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 South Atlantic DPS likely use other river systems than those listed here for their specific life functions.

Table 10. Major rivers, tributaries, and sounds within the range of the South Atlantic DPS and currently available data on the presence of an Atlantic sturgeon spawning population in each system.

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	Unknown	
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 South Atlantic DPSs, it is likely that some of the historical 8,000 fish would be attributed to both the Carolina DPS and South Atlantic 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 South Atlantic 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 South Atlantic 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 South Atlantic 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 gallons per day 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 lifespan also allows multiple opportunities to contribute to future generations, this is hampered within the South Atlantic DPS by habitat alteration, bycatch, and from the inadequacy of existing regulatory mechanisms to address and reduce habitat alterations and bycatch.

Dredging is contributing to the status of the South Atlantic DPS by modifying spawning, nursery, and foraging habitat. Habitat modifications through reductions in water quality and dissolved oxygen are also contributing to the status of the South Atlantic DPS, particularly during times of high water temperatures, which increase the detrimental consequences on Atlantic sturgeon habitat. Interbasin water transfers and climate change threaten to exacerbate existing water quality issues. Bycatch also contributes to the South Atlantic 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 South Atlantic DPS have been ameliorated or reduced due to the existing regulatory mechanisms, such as the moratorium on directed fisheries for Atlantic sturgeon, bycatch 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 South Atlantic DPS.

4.3 Critical Habitat Designated for the Chesapeake Bay DPS of Atlantic Sturgeon

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 was effective on September 18, 2017. The action area overlaps with the Potomac River critical habitat unit designated for the Chesapeake Bay DPS.

The conservation objective identified in the final rule 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 of Atlantic sturgeon, which encompass approximately 773 kilometers (480 miles) of aquatic habitat in the rivers of Maryland, Virginia, and the District of Columbia:

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 the 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 the 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 Bridge 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 the 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 the 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 in the rivers of Maryland, Virginia, and the District of Columbia.

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 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 parts per thousand 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 meters) 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 dissolved oxygen or greater for juvenile rearing habitat).

Each critical habitat unit, including the Potomac River, contains all four of the PBFs listed above. Information on the presence of PBFs within the action area is contained below in the *Environmental Baseline* section.

The paragraphs that follow are excerpted from the ESA Section 4(b)(2) Report for Atlantic sturgeon critical habitat (NMFS 2017). That document provides background information on the current status and function of the five critical habitat units designated for the Chesapeake Bay DPS, and summarizes their ability to support reproduction, survival, and juvenile development, and recruitment. Additional information on the status of the Chesapeake Bay DPS relevant to the current status and function of critical habitat can be found in the *Environmental Baseline* section.

> At the time of listing, the James River was the only known spawning river for the Chesapeake Bay DPS (ASSRT, 2007; Hager, 2011; Balazik *et al.*, 2012). Since the listing, evidence has been provided of both spring and fall spawning populations for the James River, as well as fall spawning in the Pamunkey River, a tributary of the York River, and fall spawning in Marshyhope Creek, a tributary of the Nanticoke River (Hager *et al.*, 2014; Kahn *et al.*, 2014; Balazik and Musick, 2015; Richardson and Secor, 2016). In addition, detections of acoustically tagged adult Atlantic sturgeon in the Mattaponi and Rappahannock Rivers at the time when spawning occurs in others rivers, and historical evidence for these as well as the Potomac River supports the likelihood of Atlantic sturgeon spawning populations in the Mattaponi, Rappahannock, and Potomac rivers.
>
> Adult Atlantic sturgeon enter the James River in the spring, with at least some eventually moving as far upstream as Richmond (river kilometer 155), which is also the head of tide and close to the upstream extent of Atlantic sturgeon in the river given the presence of Boshers Dam at the fall line (approximately river kilometer 160) (Bushnoe *et al.*, 2005; Hager, 2011; Balazik *et al.*, 2012). Adults disperse through downriver sites and begin to move out of the river in late September to early October, occupy only lower river sites by November, and are undetected on tracking arrays in the lower river by December suggesting that adult sturgeon leave the river for the winter (Hager, 2011; Balazik *et al.*, 2012).
>
> The availability of hard-bottom habitat is relatively limited in the James River and appears to be significantly reduced compared to the amount of available hard-bottom habitat described in historical records (Bushnoe *et al.*, 2005; Austin, 2012). In general, tracked adults occurred further upstream during the late summer and early fall residency (*e.g.*, river kilometer 108 to 132; Balazik *et al.*, 2012) than during the spring and early

summer residency (*e.g.,* river kilometer 29 to 108; Hager, 2011) suggesting two different spawning areas, depending on season, for the two James River spawning populations (Balazik and Musick, 2015).

The York River is 55 river kilometers from its mouth, tidally-influenced throughout its length, and with clay/silt and sand substrate. Habitat conditions suitable for Atlantic sturgeon spawning (*e.g.*, freshwater and hard substrate) occur within its tributaries, the Mattaponi and Pamunkey Rivers (Bushnoe *et al.*, 2005; Friedrichs, 2009; Reay, 2009).

The Pamunkey River is tidal for 73 river kilometers upriver of its confluence with the York River. Substrate includes patches of gravel, and monthly averages of dissolved oxygen in the late spring-summer months range from 5 to 8 milligrams per liter (Bushnoe *et al.*, 2005). Recent evidence of a spawning population includes capture of adult Atlantic sturgeon in spawning condition within tidal freshwater, at depths of 0.5 to 6.7 meters, 27 to 67 river kilometers upriver of the confluence with the York River (Hager *et al.*, 2014), and passive acoustic tracking of adult Atlantic sturgeon to the uppermost receiver in freshwater of the Pamunkey River during the spawning season (VIMS, 2016). Genetic analyses demonstrate these adults are part of a genetically unique spawning population, genetically dissimilar, for example, to spawning adults in the James River (Hager *et al.*, 2014; Kahn *et al.*, 2014).

The Mattaponi River, likewise, has patches of gravel, and late spring through summer dissolved oxygen levels of approximately 5 to 8 milligrams per liter (Bushnoe *et al.*, 2005). Atlantic sturgeon occur in the Mattaponi River although the data is currently more limited than for the Pamunkey River. In September 2015, an acoustically-tagged, adult, female Atlantic sturgeon was detected on multiple days in the Mattaponi River at the uppermost receiver located near the Route 360 Bridge crossing on the river. The detections were not on consecutive days but had lapses of one to five days. Based on examination of the time series of detections, Virginia Institute of Marine Science (VIMS) believes the fish moved past the receiver upstream, then back down again. VIMS recommended that we designate critical habitat for Atlantic sturgeon in the Mattaponi River, and extend the upriver boundary by 10 river kilometers. We considered the information provided by VIMS. Based on the information provided, we could not conclude that waters of the Mattaponi River upriver of the Route 360 Bridge crossing are part of the geographical area occupied by Atlantic sturgeon. While the tracking data suggests to VIMS that the single fish moved further upriver, we cannot determine whether the movements of this fish are representative of all Atlantic sturgeon that occur in the Mattaponi or are movements of a vagrant fish. Therefore, we are not changing the upriver boundary for the York River critical habitat unit in the Mattaponi River.

The Rappahannock River flows approximately 170 river kilometers from the fall line at Fredericksburg, Maryland, the site of the former Embrey Dam that was removed in 2005. The river is tidal throughout its length from the fall line to the river mouth. Mud substrate is abundant in the channel of the lower estuary, sand/silt/clay are present upriver of Wilmot, and sand and gravel substrate in the freshwater tidal region downriver of Fredericksburg. Monthly dissolved oxygen averages for May and June range from 6.6 to 10.5 milligrams per liter (Bushnoe *et al.*, 2005). The 1998 and 2007 status reviews for Atlantic sturgeon described information for presence of Atlantic sturgeon in the Rappahannock River, including commercial landings data from the 1880s and incidental captures reported to the U.S. Fish and Wildlife Service Reward Program in the 1990s (NMFS and USFWS 1998; ASSRT, 2007). VIMS provided additional information during the public comment period including information on the detection of two acoustically-tagged, adult Atlantic sturgeon in the Rappahannock River in the fall (VIMS, unpublished data). VIMS could not confirm if the adults were making spawning runs since there were no receivers to detect the sturgeon in the freshwater habitat near Fredericksburg. However, the presence of the adults as far upriver as river kilometer 129, and their presence at the time of year when other Chesapeake DPS Atlantic sturgeon spawn supports the likelihood of an Atlantic sturgeon spawning population in the Rappahannock River.

The Potomac River estuary extends approximately 187 river kilometers from Chain Bridge to the mouth of the river. The river is tidal freshwater from Chain Bridge to Quantico, Virginia with bottom topography characterized by a narrow channel, 6 to 21 meters deep, and a shallow shelf on either side of the channel. The mixing zone of transitional salinity occurs from Quantico, Virginia, to the crossing of the U.S. Highway 301 Bridge, Maryland. The remainder of the river estuary, from the U.S. Highway 301 Bridge crossing to the Chesapeake Bay, has a wide channel with gradually sloping, shallow flats near shore (USGS 1984). Sand and clay substrates are dominant in many areas, with patches of gravel. A suspected sturgeon spawning site occurs approximately 2 river kilometers downriver of the Chain Bridge, in freshwater and hard substrate (*e.g.*, large and small boulders, gravel-pebble, and cobble-rubble) (USGS, 1984; PCC, 2000; SSSRT, 2010). There are no studies currently directed at Atlantic sturgeon in the Potomac River. However, evidence of a historical sturgeon fishery in the Potomac, observations of a large mature female Atlantic sturgeon in the Potomac River in 1970, and the presence of hard substrate in freshwater suggest the likelihood of Atlantic sturgeon spawning in the Potomac River.

The Nanticoke River begins in Delaware and flows approximately 103 river kilometers across the Delmarva Peninsula, draining at its mouth into Chesapeake Bay. Salinity ranges from 0.1 parts per thousand near Sharptown, Maryland and 7 to 15 parts per thousand at the mouth near Roaring Point. The entire Maryland portion of the Nanticoke River is tidal (Maryland DNR, 2016). The Atlantic Sturgeon Status Review Team provided a brief summary of available information for Atlantic sturgeon presence in the Nanticoke River, but did not include the river in its list of historic or current spawning rivers for Atlantic sturgeon (ASSRT, 2007). Subsequently, after receiving fishermen reports of Atlantic sturgeon in the Nanticoke River and Marshyhope Creek, Maryland

DNR initiated a study to determine if there was a population of Atlantic sturgeon in these waterways, if the sturgeon simply moving through the system or if the fish were spawning. In 2014 and 2015, Maryland DNR captured a total of 15 Atlantic sturgeon in Marshyhope Creek, including ten males expressing milt and two females with ripe eggs. One of the capture events included a male and female in the same net, both in spawning condition, and the male with abrasions on the ventral scutes and caudal fin that are characteristic of spawning, male Atlantic sturgeon (Richardson and Secor, 2016). Benthic mapping was also conducted and provided evidence of spawning substrate in freshwater of Marshyhope Creek (Bruce *et al.*, 2016). Based on these lines of evidence, we agree with Maryland DNR's conclusion that the Nanticoke River estuary, including Marshyhope Creek, supports an Atlantic sturgeon spawning population.

Genetic assignment of Atlantic sturgeon captured within their marine range revealed that Chesapeake Bay DPS subadults and adults comprised approximately 5 percent to 21 percent of the Atlantic sturgeon sampled in the Connecticut River, Long Island Sound, the Atlantic Ocean off of Rockaway, New York, and the Atlantic Ocean off of Delaware Bay (Waldman *et al.*, 2013; O'Leary *et al.*, 2014; Wirgin *et al.*, 2015a). The DPS was not detected in the relatively small number of samples collected from Atlantic sturgeon captured off of North Carolina in the winter (Laney *et al.*, 2007), and comprised no more that 1 percent of Atlantic sturgeon sampled in the Bay of Fundy in the summer (Wirgin *et al.*, 2012). The greater concentration of Chesapeake Bay DPS Atlantic sturgeon in some parts of its marine range suggests certain marine habitats are more useful to and perhaps also essential to the New York Bight DPS.

The action area for the proposed work considered in this biological opinion comprises a 5.260913 square kilometer (1,300 acres) area within the Potomac River critical habitat segment (Unit 2). This area will include direct effects of habitat modification and blasting and also encompass indirect effects from turbidity. The critical habitat designation is bank-to-bank within the Potomac River. The river is 2.7 kilometers (1.7 miles) wide within the action area. Information about which PBFs are present within the action area for the proposed work can be found in *Environmental Baseline* section.

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 and critical habitat in the action area. The activities that shape the environmental baseline in the action area of this consultation generally include dredging operations, water quality, fisheries, scientific research, shipping and other vessel traffic, and recovery activities associated with reducing those impacts.

5.1 Federal Actions that have Undergone Section 7 Consultation

We have undertaken a number of formal and informal section 7 consultations to address the effects of federal actions on threatened and endangered species in the action area, specifically within the Chesapeake Bay. Each of those consultations sought to develop ways to reduce the probability of adverse impacts of the action on listed species. A description of each is provided below.

5.1.1 Nice-Middleton Bridge Project (NER-2018-15084)

As discussed in the *Project History* section, you submitted a final BA for informal consultation for the construction of the new Nice-Middleton Bridge and demolition of existing substructures. Activities considered in the BA are described in the *Project History* section. On February 1, 2019, NMFS issued a letter of concurrence with FHWA's determination that demolition and construction activities may affect but are not likely to adversely affect the federally endangered shortnose sturgeon (*Acipenser brevirostrum*), five endangered/threatened DPSs of Atlantic sturgeon (*Acipenser oxyrinchus oxyrinchus*), and Atlantic sturgeon designated critical habitat. As described in the *Project History* section, the activities considered in the 2019 consultation were completed as of October 2022, except for demolition of the old bridge structure. Mechanical demolition to dismantle the existing bridge started in October 2022 and is expected to be completed in 2024. According to FHWA and MDTA, the following activities have been completed:

- Clamshell bucket dredging of 174,336 square feet (approximately 24,000 cubic yards) has been completed for crane barge access near the Virginia shoreline as well as pile muck-outs of large piles driven near the Federal Navigation Channel. No maintenance dredging was required and no jetting has occurred to date.
- A total of 845 permanent piles were driven for the construction of the new bridge. This included:
    - 80 66-inch diameter hollow pre-cast concrete cylinder piles in the river,
    - 24 48-inch diameter steel fender piles for the ship collision protection system in the river,
    - 741 36-inch square pre-cast concrete piles (of which, 655 were driven in the river and 86 were driven on land).
- No temporary causeway was constructed. The project did construct two temporary trestles, one extending off of the Maryland shoreline and one extending off of the Virginia shoreline, as well as a temporary pile-supported concrete conveyor system. In addition, there were temporary piles driven and temporary mooring anchors utilized for construction support. Details include:
    - Maryland trestle: 18 trestle piles, 127 square feet of benthic impact.
    - Virginia trestle: 32 trestle piles for the F trestle, 226 square feet of benthic impact.
    - Concrete batch plant conveyor system: 15 36-inch piles, 106 square feet of benthic impact.
    - Temporary support piles: 189 temporary support piles to date totaling 1,334 square feet of benthic impact.

    - Temporary mooring anchors: 9 mooring anchors, approximately 200 square feet each, totaling 1,800 square feet of benthic impact.
    - In summary, 254 temporary piles and 9 temporary mooring anchors totaling 3,593 square feet.
- The vast majority of demolition to date has been mechanical. This included saw-cutting of the barrier wall and roadway decks, cutting and lifting of steel girders, and mechanical hammering of pier elements.
    - Shape charges were used to instantaneously cut the steel truss sections (above the waterline) in strategic locations and drop the truss sections into the river for safe retrieval. There were five of these events to cut and drop the truss sections from March through June of 2023 from mid-river to the Maryland shoreline area.

5.1.2 Maintenance Dredging of Chesapeake Bay Entrance Channels (F/NER/2018/14816)

USACE dredging in the Chesapeake Bay navigation channels and borrow areas has been ongoing since the 1980s. We have completed numerous consultations, culminating in four separate biological opinions, most of which have been reinitiated multiple times. We concluded in all of the Biological Opinions that the proposed dredging was likely to adversely affect, but not likely to jeopardize any species of listed sea turtle and was not likely to adversely affect any species of listed whales.

In the 2018 Biological Opinion, we consider the effects of proposed new dredging, continued maintenance dredging, and sand borrow operations in several Federal navigation channels located in the Chesapeake Bay and Atlantic Ocean (Table 11). In Table 11, the dredging activities occurring in the following channels overlap with the action area: Cape Henry Channel, York Spit Channel, Rappahannock Shoals Channel, Anchorage F, Newport News, Sewell's Point to Lamberts Bend, and Thimble Shoals locations. The Opinion considers that dredged material could be potentially placed at beneficial use sites or upland disposal sites, in addition to a number of off shore disposal sites that are not part of the action area. The proposed construction to deepen and widen the existing channels was scheduled to commence in 2023 and take approximately 3.5 to 4 years to complete. Following construction, maintenance dredging will continue for approximately the next 50 years. In the remaining channels, maintenance dredging has been ongoing since 2012 and has a 50-year project life.

Table 11. Summary of the Anticipated Dredging Locations and Quantities considered in the 2018 Biological Opinion

Channel	Type of Dredge	Typical Volume Removed	Frequency of Dredge Events	Number of events over the project life	Volume Removed over the project life
Baltimore Harbor Entrance Channels					
Cape Henry	*H*	*1.1 mcy*	*1-2 years*	*25-50*	*Up to 50 mcy*
York Spit Channel	*H*	*0.5 mcy*	*2 years*	*25*	*12.5 mcy*
Rappahannock Shoals Channel	*H*	*no maintenance dredging to date*	*Every 20 years*	*2*	*Up to 2 mcy*
Total: 64.5 MCY					
VA Beach Hurricane Protection	**H**	**0.27 mcy**	**Every 3 years**	**16**	**4.4 mcy**
Sandbridge	**H or C**	**0.5 mcy**	**Every 2 years**	**25**	**12.5 mcy**
Craney Island Eastward Expansion					
CIEE – Main Dike dredging (8,500 linear feet)	*C or M*	*Subject to Federal Funding*	*Subject to Federal Funding*	*Subject to Federal Funding*	22,400,000
CIEE – Access Channel dredging	*C or M*	*Subject to Federal Funding*	*Subject to Federal Funding*	*Subject to Federal Funding*	1,600,000
CIEE – Wharf Access dredging	*C or M*	*Subject to Federal Funding*	*Subject to Federal Funding*	*Subject to Federal Funding*	7,300,000
Total: 31.3 mcy (6.8 mcy cutterhead; 24.5 mcy mechanical)					

		Construction				**Maintenance over the life of the project**		**Construction + Maintenance**	
Channel	**Required Depth (ft)**	**Est. Max Depth (ft)**	**Est. Max Volume (cy)**	**Est. Max Duration (months)**	**Est. Max Bottom Disturbance (sq ft)**	**Est. Total Volume (cy)**	**Est. Total Duration (months)**	**Est. Max Volume (cy)**	**Est. Max Duration (months)**
Atlantic Ocean	59	64	16,074,736	42	78,738,613	15,191,112	62	31,265,848	104
Thimble Shoals	56	61	18,069,823	57	119,644,916	24,331,540	210	42,401,363	276
Thimble Shoals Meeting Areas #1 & #2	56	61	7,191,000	23	13,388,000	3,640,924	31	10,831,924	54
Sewell's Point to Lamberts Bend	55	60	12,147,318	11	57,012,805	42,346,689	78	54,494,008	89
Anchorage F	55	60	1,914,788	14	25,222,454	7,590,328	15	9,505,116	30
Newport News	55	60	4,906,284	4	29,272,754	6,676,305	16	11,582,589	19
Total			**60,303,949**	**151**	**323,279,542**	**99,776,899**	**412**	**160,080,647**	**564**

We determined that the dredging project has the potential to directly affect green, loggerhead and Kemp's ridley sea turtles, and individuals from the New York Bight, Gulf of Maine, Chesapeake Bay, South Atlantic and Carolina DPSs of Atlantic sturgeon which may become entrained in or interact with the dredge. Below is a summary of take information for Atlantic sturgeon. We also concluded that the level of take is not likely to jeopardize the continued existence of listed species. The Opinion exempts take incidental to the proposed project as detailed in Table 12. In 2020, relocation trawling captured and relocated three Atlantic sturgeon, but to date, no lethal takes have been reported.

Table 12. Incidental take exempt for Dredging of Chesapeake Bay Entrance Channels Opinion

Species	Non-lethal Capture	Mortality
NWA DPS of Loggerhead sea turtle	937	748
Kemp's ridley sea turtle	275	66
North Atlantic DPS of Green sea turtle	38	18
NYB DPS of Atlantic sturgeon	350	68
SA DPS of Atlantic sturgeon	150	29
CB DPS of Atlantic sturgeon	100	23
GOM DPS of Atlantic sturgeon	100	18
Carolina DPS of Atlantic sturgeon	50	10

5.1.3 EPA's Water Quality Criteria for the Chesapeake Bay and Tidal Tributaries (F/NER/2010/05732)

In the 2012 Biological Opinion, we consider the effects of EPA's approval of nutrient and sediment enrichment criteria (total maximum daily loads or TMDLs) for Maryland, Virginia, and the District of Columbia expressed as dissolved oxygen, water clarity and chlorophyll a criteria for the Chesapeake Bay and its tidal tributaries. We determined that the proposed action was reasonably certain to result in incidental take of shortnose sturgeon in the form of harassment (*i.e.*, avoidance or displacement) where habitat conditions will temporarily impair normal behavior patterns, particularly when dissolved oxygen levels fall below those protective of shortnose sturgeon.

Take is exceeded when annual monitoring data for the preceding summer indicates that the dissolved oxygen for any 30 days during the June 1 – September 30 for any of the designated use area failed to meet the attainment goals as detailed in Table 13.

Table 13. Designated use attainment goals for calculating shortnose sturgeon take in the 2012 EPA Opinion

Designated Use	% of area failing to meet 5mg/L monthly average upon attainment of Chesapeake Bay TMDL nutrient and sediment goals (see US EPA 2003c and US EPA 2011)
Open Water	2
Deep Water	29.8
Deep Channel	69.1

We concluded that the level of anticipated take was not likely to result in jeopardy to shortnose sturgeon and no lethal takes of any life stage of shortnose sturgeon are anticipated to occur as a result of the action.

The Chesapeake Bay Program Office has quantified the dissolved oxygen criterion attainment condition for open water (OW), deep water (DW), and deep channel (DC) for moving three-year periods from 1985-1987 to 2019-2021. As a result, EPA's analysis shows that water quality conditions in the Bay are not improving as readily as expected due to impacts from climate change. EPA also concluded that the attainment measures for take detailed above and outlined in detail in the 2012 Opinion have not been exceeded.

5.1.4 Authorization of Fisheries through Fishery Management Plans

Formal ESA section 7 consultations have been conducted on the American lobster, Northeast multispecies, monkfish, spiny dogfish, Atlantic bluefish, Northeast skate complex, Atlantic mackerel/squid/butterfish, summer flounder/scup/black sea bass, Atlantic deep-sea red crab, and Jonah crab fisheries (inclusive of the NEFMC Omnibus EFH Amendment 2) (GARFO batched fisheries; NMFS 2021a); Atlantic sea scallop fishery (NMFS 2021b); Atlantic highly migratory species, excluding pelagic longline (NMFS 2020a); and pelagic longline Atlantic highly migratory species (NMFS 2020b). The Atlantic bluefish, spiny dogfish, Atlantic mackerel/squid/butterfish, and summer flounder/scup/black sea bass fisheries may overlap in part with the action area for the proposed action, specifically in the Chesapeake Bay.

In these past Opinions, the GARFO batched fisheries, Atlantic sea scallop fishery, and Atlantic highly migratory species (excluding pelagic longline) concluded that there was a potential for collisions between fishing vessels and an ESA-listed species (specifically, sea turtles) (NMFS 2020a, 2021a, 2021b). Any effects to their prey and/or habitat were found to be insignificant and extremely unlikely. We have also determined that the GARFO Atlantic herring, Atlantic surfclam and ocean quahog, and golden and blueline tilefish fisheries are not likely to adversely affect any ESA-listed species or designated critical habitats.

The Opinons exempt a certain amount of lethal or non-lethal take of large whales, sea turtles, Atlantic sturgeon, Atlantic salmon, and giant manta rays. There are documented incidental takes of Atlantic sturgeon in the Federal fisheries listed above, however, the action area for them includes the entire EEZ along the U.S. Atlantic coast from Maine through Florida. The waters inside Chesapeake Bay represent a tiny fraction of the action area assessed and for which interactions of sturgeon are anticipated in the Opinons. Thus, the amount of incidental take of sturgeon that occurs in Chesapeake Bay as a result of Federal fisheries is also a tiny fraction of the amount exempted in those Opinions. Very little commercial and recreational fishing effort occur within Chesapeake Bay. Scup and summer flounder have a larger state waters recreational component, but that effort is often prosecuted offshore and outside of the Bay. The take of Atlantic sturgeon exempt is summarized in Table 14.

Table 14. Most recent Opinions prepared by NMFS GARFO and SERO for federally managed fisheries that result in takes of the five DPSs of Atlantic sturgeon and their respective ITSs.

	Date	Gulf of Maine DPS	New York Bight DPS	Chesapeake Bay DPS	Carolina DPS	South Atlantic DPS
GARFO FMPs						
American Lobster, Atlantic Bluefish, Atlantic Deep-Sea Red Crab, Mackerel/Squid/ Butterfish, Monkfish, Northeast Multispecies, Northeast Skate Complex, Spiny Dogfish, Summer Flounder/Scup/Black Sea Bass, and Jonah Crab Fisheries and Omnibus EFH Amendment 2 (Batched Fisheries)	May 27, 2021	615 (75 lethal) over a 5 year period in trawl and gillnet gear	5,020 (590 lethal) over a 5 year period in trawl and gillnet gear	755 (85 lethal) over a 5 year period in trawl and gillnet gear	180 (20 lethal) over a 5 year period in trawl and gillnet gear	395 (45 lethal) over a 5 year period in trawl and gillnet gear
Atlantic sea scallop	June 17, 2021	5 takes over a 5-year period in scallop dredge or trawl gear from any of the five DPSs (one lethal take every 20 years from any of the five DPSs)				
SERO FMPs						
HMS fisheries, excluding pelagic longline	January 10, 2020	34 (8 lethal) every 3 years	170 (36 lethal) every 3 years	40 (9 lethal) every 3 years	10 (5 lethal) every 3 years	75 (19 lethal) every 3 years

In a review of bycatch rates on fishing trips from 1989 to 2000, Atlantic sturgeon were recorded in both gillnet and trawl gears, and bycatch rates varied by gear type and target species. Bycatch was highest for sink gillnets in specific areas of the coast. Mortality was higher in sink gillnets than trawls (Stein *et al.* 2004b). More recent analyses were completed in 2011, 2016, and 2023. In 2011, the NEFSC prepared a bycatch estimate for Atlantic sturgeon captured in federally managed commercial sink gillnet and otter trawl fisheries from Maine through Virginia. This estimate indicated that from 2006-2010, an annual average of 3,118 Atlantic sturgeon were captured in these fisheries with 1,569 in sink gillnet and 1,548 in otter trawls. The mortality rate in sink gillnets was estimated at approximately 20 percent and the mortality rate in otter trawls was estimated at 5 percent. Based on this estimate, 391 Atlantic sturgeon were estimated to be killed annually in federal fisheries in the Greater Atlantic Region (Miller and Shepherd 2011).

An updated, although unpublished, Atlantic sturgeon bycatch estimate in Northeast sink gillnet and otter trawl fisheries for 2011-2015 was prepared by the NEFSC in 2016. Using this information, the authors of the recent Atlantic Sturgeon Benchmark Stock Assessment (ASMFC 2017) estimated that 1,139 fish (295 lethal; 25 percent) were caught in gillnet fisheries and 1,062 fish (41 lethal; 4 percent) were caught in otter trawl fisheries each year from 2000-2015. Atlantic sturgeon bycatch estimates for Northeast gillnet and trawl gear from 2011-2015 (approximately 761 fish per year for gillnets, 777 for trawls) were substantially lower than those from 2006-2010 (approximately 1,074 fish per year for gillnets, 1,016 for trawls) (ASMFC 2017). It should be noted that the models used in 2011 and 2016 differed. The 2011 analysis used a generalized linear model. In this model, the species mix considered comprises those species currently managed under a federal FMP. In the model used in the 2017 ASMFC stock assessment, the species considered as covariates were those species caught most on observed hauls encountering Atlantic sturgeon (ASMFC 2017).

In May 2023, the NEFSC released an updated set of Atlantic sturgeon bycatch estimates for the time period of 2000-2021. Atlantic sturgeon bycatch estimates for Northeast gillnet and trawl gear from the most recent five-year period of 2016-2021, excluding 2020 due to COVID-19 impacts to data collection, were approximately 1,126 fish per year for gillnets (327 mortalities) and 719 for trawls (19 mortalities). This estimate was produced using the same methods as previous NEFSC analyses (Miller and Shepherd 2011; ASMFC 2017). The bycatch estimates for gillnet gear are significantly higher than those for the previous five-year period of 2011-2015 and, therefore, consultation on the 2021 Batched Fisheries Opinion is being reinitiated.

In their 2020 Opinion on the Atlantic HMS fisheries (excluding pelagic longline), NMFS SERO estimated a total of 329 interactions, 77 of which are expected to be lethal, are likely to occur every three years in these fisheries. The level of interactions and mortalities were expected to be greatest within the NYB DPS, followed by the SA, CB, GOM, and Carolina DPSs.

5.1.5 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 dredging, sand mining, and nourishment projects on Atlantic sturgeon that may use the action area for the James River Federal Navigation Project (NER-2018-15090). In our 2018 Opinion, over the 44-year period of maintenance dredging of the James River federal navigation channel (2018-2062), we expected up to 47 total lethal dredge interactions of subadults/juveniles Atlantic sturgeon. Total amount dredged is used as a proxy for take calculation. 1.8 acres dredged equates to 2.2 percent of PYSL year class allowed per year. Therefore, dredging proxy calculations for take indicate that a total of one sturgeon per year were taken in 2017 and 2018 (total of two since 2012). No direct takes of Atlantic sturgeon have been reported since 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.

Maintenance dredging for access to the Dahlgren Marina, Aqualand Marina, and Morgantown Power Generating Plant is also periodically performed within the Potomac River action area.

5.1.6 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.

5.1.7 Wastewater Permits

The state of Virginia has been delegated authority to issue pollutant discharge permits by the U.S. Environmental Protection Agency (VDEQ 2017). The state of Virginia and the state of Maryland will continue to authorize the discharge of pollutants through the VPDES and NPDES permits, respectively. In addition, the state of Maryland has been delegated authority by the EPA to issue NPDES permits to the Maryland Dept. of the Environment. These permits authorize the discharge of pollutants in the action area. Some of the facilities that operate pursuant to these permits include municipalities for sewage treatment plants and other industrial users. More information can be found at https://www.deq.virginia.gov/permits/public-notices/water/surface-waters-vpdes and https://mde.maryland.gov/programs/water/wwp/Pages/index.aspx.

5.1.8 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 (GARFO-2023-00492)

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 are anticipated to carry out a total of 116 studies under these grant programs, mostly on an annual basis. There are several broad categories of fisheries surveys including: hook and line; beach seine; bottom and surface trawl; fishway trap; fish lift; boat and backpack electrofishing; long line; fyke net; dip net; eel pot; fish pot; staked and drifted gill net; haul seine; hoop net; trap net; cast net; plankton net; push net; pound net; jugging; Virginia Crab dredge; and, trotline. These surveys occur in state waters (rivers, bays, estuaries, and in nearshore ocean waters), generally from Maine through Virginia. Several of the studies occur in the action area, specifically the Chesapeake Bay and middle to lower portions of the rivers that empty into the Bay in Maryland and Virginia waters, including the Potomac River and the James River. The studies presented in Table 15 may overlap with the action area.

Table 15. USFWS Fish Surveys within the Action Area

State	Grant	Survey	Location	Gear
MD	F-48-R	Invasive Species Studies	Potomac River (tidal and nontidal sections)	Boat electrofishing, fyke netting, seine netting, hoop netting, hook and lining, and jugging
MD	F-48-R	Tidal Largemouth Bass Survey	Maryland's Chesapeake Bay and tidal rivers, including Potomac River and Upper Chesapeake Bay	Boat electrofishing
MD	F-61-R	Upper Chesapeake Bay Winter Trawl Survey	Upper Chesapeake Bay	Bottom trawl (7.6 m)
MD	F-61-R	Spring Striped Bass Experimental Drift Gillnet Survey	Potomac River and Upper Chesapeake Bay	Gillnet
MD	F-61-R	Juvenile Striped Bass Seine Survey	Chesapeake Bay	Beach seine (30.5 m)
MD	F-61-R	Assorted Pound and Fyke Net Surveys	Chesapeake Bay and Potomac River	Pound net; Fyke net
MD	F-63-R	Marine and Estuarine Finfish Ecological and Habitat Investigations	Chesapeake Bay	Bottom trawl (4.9 m); Beach seine (30.5 m)
MD	F-63-R	Ichthyoplankton Surveys	Chesapeake Bay subestuaries	Towed plankton net (0.5 m)
MD	F-110-R	Mycobacteriosis in Striped Bass Resident to Chesapeake Bay	Chesapeake Bay	Hook and line; Pound net; Beach seine

State	Grant	Survey	Location	Gear
VA	F-111-R	Tidal River Fish Community Monitoring	James River	Boat electrofishing
VA	F-111-R	Tidal River Fish Catfish Surveys	James River	Boat electrofishing
VA	F-111-R	American Shad Restoration - Gillnetting	James River	Gillnet
VA	F-111-R	American Shad Restoration - Electrofishing	James and Potomac Rivers	Boat electrofishing
VA	F-111-R	Northern Snakehead Monitoring in Virginia	Potomac River	Boat electrofishing
VA	F-116-R	American Shad Monitoring Program – Gillnetting	James River	Staked gillnet
VA	F-116-R	Striped Bass Spawning Stock Assessment - Fyke Netting	James River	Fyke net
VA	F-104-R	Juvenile Fish Trawl Survey	Chesapeake Bay	Bottom trawl (9.1 m)
VA	F-87-R	Juvenile Striped Bass Beach Seine Survey	Chesapeake Bay	Beach seine (30.5 m)
VA	F-130-R	Chesapeake Bay Multispecies Monitoring and Assessment Program	Chesapeake Bay	Bottom trawl
VA	F-77-R	Striped Bass Spawning Stock Assessment - Gillnetting	James River	Gillnet
VA	F-77-R	Striped Bass Spawning Stock Assessment - Electrofishing	James River	Electrofishing

We reinitiated the biological opinion in 2023 which bundled the eleven 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. Of the 116 surveys proposed for funding in the 2023 Opinion, ESA-listed species (including shortnose sturgeon and Atlantic sturgeon) have been incidentally captured in 27 of them. Thirteen of the 27 surveys have resulted in captures of ESA-listed species over the past ten years. Overall, we anticipate that the surveys to be funded by USFWS and carried out in Virginia and Maryland over a five-year period (2023-2027) will result in the capture of up to four shortnose sturgeon (up to two may be lethal) and 183 Atlantic sturgeon (up to 11 may be lethal) (Table 16). There are five projects in Maryland and Virginia waters with reported takes from 2013-2023 (Maryland Pound Net Surveys, Maryland Striped Bass Gillnet Surveys, Virginia Juvenile Fish Trawl Surveys, Virginia ChesMMAP Trawl Surveys, and Virginia American Shad Gillnet Surveys) with one additional project that has resulted in takes dating back to the 2000s (Virginia Striped Bass Gillnet Surveys). This includes 98 reported takes of Atlantic sturgeon (two from Maryland Pound Net Surveys (both takes occurred in the Potomac River), eight from the Maryland Striped Bass Gillnet Surveys (one of the takes occurred in the Potomac River), one from the Virginia ChesMMAP Trawl Surveys, 62 from the Virginia Juvenile Fish Trawl Surveys, and 25 from the Virginia American Shad Gillnet Surveys). No takes of shortnose sturgeon have been reported.

Table 16. Take exempt for USFWS surveys carried out by Maryland and Virginia over a five-year period from 2023-2027.

Study	shortnose sturgeon	Total Atlantic sturgeon	GOM DPS Atlantic sturgeon	NYB DPS Atlantic sturgeon	CB DPS Atlantic sturgeon	Carolina DPS Atlantic sturgeon	SA DPS Atlantic sturgeon
MD Coastal Bays	0	1	0	1	0	0	0
MD striped bass drift gillnet	0	5 (1 lethal)	1	2 (1 lethal)	1	0	1
MD pound nets	0	5	1	2	1	0	1
MD TOTAL	**0**	**11 (1 lethal)**	**2**	**5 (1 lethal)**	**2**	**0**	**2**
VA juvenile fish	1	55	6	27	8	3	11
VA ChesMMAP	1	2	1 GOM, CB, or SA	1	1 GOM, CB, or SA	0	1 GOM, CB, or SA
VA striped bass gillnet	1 (1 lethal)	2 (1 lethal)	0	0	2 (1 lethal)	0	0
VA shad gillnet	1 (1 lethal)	113 (9 lethal)	2	2	105 (9 lethal(	2	2
VA TOTAL	**4 (2 lethal)**	**172 (10 lethal)**	**9**	**30**	**116 (10 lethal)**	**5**	**14**

Section 10 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 five section 10(a)(1)(A) permits are currently in effect (four active until 2027 and one until 2031) for Atlantic sturgeon and shortnose sturgeon within the action area for this consultation. 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 is currently one active Section 10(a)(1)(B) permit in the action area for this consultation, Dominion Virginia Power. Dominion Chesterfield Power Station in Chester, Virginia is a coalfueled power generating facility. Virginia Electric and Power Company, D.B.A. Dominion Virginia Power has been issued a permit for the incidental take of ESA-listed Atlantic sturgeon (*Acipenser oxyrinchus oxyrinchus*) from the Chesapeake Bay Distinct Population Segment. The takes would be attributed to otherwise lawful activities associated with the continued operation and maintenance of the facility including entrainment and impingement sampling required by the Clean Water Act. The permit was issued on December 19, 2020 for a duration of five years.

In addition, most coastal Atlantic states are either in the process of applying for permits or considering applications for state fisheries. Active permits and permit applications for all ESA-listed species are posted online at https://apps.nmfs.noaa.gov/index.cfm and https://www.fisheries.noaa.gov/national/endangered-species-conservation/incidental-take-permits#issued-permit-applications.

5.2 Non-Federally Regulated Fisheries

Atlantic sturgeon and shortnose sturgeon may be vulnerable to capture, injury, and mortality in fisheries occurring in Maryland and Virginia state waters. Information on the number of sea turtles and Atlantic sturgeon captured or killed in Maryland and 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. Below, we discuss the different fisheries authorized by the state of Maryland and Virginia and any available information on interactions between these fisheries and Atlantic sturgeon or shortnose 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 may also occur within the action area, specifically within the Chesapeake Bay. In 2018, 53 percent of commercial landings (in pounds) came from Virginia (53 percent) and also the majority of recreational landings (in number of fish) were from Virginia (68 percent) (Atlantic Croaker Plan Review Team 2019). Atlantic sturgeon interactions have also 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 percent. An earlier review of bycatch rates and landings for the weakfish fishery reported that the weakfish-Atlantic croaker fishery had an Atlantic sturgeon bycatch rate of 0.02 percent from 1989-2000. Bycatch rates were the ratio of sturgeon catch weight to the catch weight of all species landed

(Stein *et al.* 2004b; ASSRT 2007). The ASSRT notes that the estimates can be heavily biased and the error rate large as observer coverage was not equal between fisheries or months of sampling and error (ASSRT 2007). In addition, fisheries have changed significantly since these estimates and, therefore, they are likely not applicable to contemporary fisheries.

Weakfish Fishery
Weakfish are found Nova Scotia to southeastern Florida, but are more common from New York to North Carolina. The weakfish fishery occurs in both state and federal waters, but the recreational fishery primarily occurs in state waters between New York and North Carolina (Weakfish Plan Review Team 2019). Most commercial landings occur in the fall and winter months (Weakfish Plan Review Team 2019). The dominant commercial gear is gillnets with about 55 percent of commercial landings. There has been a shift in the dominant source of landings from trawls in the 1950s to 1980s to gillnets from the 1990s to present (Weakfish Plan Review Team 2019). Other gears include pound nets, haul seines, and beach seines (ASMFC 2016). Virginia had 22 percent of the harvest in 2018 (Weakfish Plan Review Team 2019). North Carolina dominates commercial harvest, followed by Virginia and New Jersey. Together, these states have consistently accounted for 70-90 percent of the coast-wide commercial harvest since 1950 (ASMFC 2016; Weakfish Plan Review Team 2019). The recreational fishery catches weakfish using live or cut bait, jigging, trolling, and chumming, and the majority of fish are caught in state waters.

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 percent. Weakfish has also been identified as the top landed species on observed trips where sturgeon were incidentally captured (NEFSC observer/sea sampling database, unpublished data). In addition, as described above, the weakfish-striped bass fishery was identified as having higher bycatch rates using data from 1989-2000 (ASSRT 2007); however, there are a number of caveats associated with this data. 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 percent from 1989-2000; the weakfish-Atlantic croaker fishery had an Atlantic sturgeon bycatch rate of 0.02 percent, and the weakfish fishery had an Atlantic sturgeon bycatch rate of 1.0 percent (ASSRT 2007).

Whelk Fishery
A whelk fishery using pot/trap gear is known to occur in Virginia waters of Chesapeake Bay. Whelk pots, which unlike lobster traps are not fully enclosed, have been suggested as a potential source of entrapment for other ESA-listed species (*i.e.*, sea turtles). However, Atlantic sturgeon interactions with trap/pot gear have never been observed or documented and; therefore, this gear type is not expected to be a source of injury or mortality to these species.

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, bottom trawl, and dredge fisheries account for the majority (86 percent in the 2017 fishery) of commercial horseshoe crab landings in the bait fishery. Other methods used to land horseshoe crab are gillnets, fixed nets, rakes, hoes, and tongs (ASMFC 2019a; Horseshoe Crab Plan Review Team 2019). For most states, the bait fishery is open year round. However, the fishery operates at different times due to movement of the horseshoe crab. 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 from the bait fishery from 2014-2018 came from Maryland, Delaware, New York, Virginia, and Massachusetts (Horseshoe Crab Plan Review Team 2019). There is also a smaller fishery for biomedical uses.

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 percent. 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). However, the program was terminated in February 2012, with the listing of Atlantic sturgeon under the ESA. 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 the mesh size, the potential exists for Atlantic sturgeon to be entangled or captured in this gear.

American Lobster Fishery
An American lobster trap fishery occurs in state waters of New England and the Mid-Atlantic and is managed under the Commission's ISFMP. Like the federal waters component of the fishery, the state waters fishery uses trap/pot gear to land lobster. Atlantic sturgeon interactions with trap/pot gear have never been observed (NEFSC observer/sea sampling database, unpublished data) or documented; therefore, this gear type is not expected to be a source of injury or mortality to this species.

American shad fishery
An American shad fishery occurs in state waters of New England and the Mid-Atlantic and is managed under the Commission's ISFMP. Amendment 3 to the ISFMP requires states and jurisdictions to develop sustainable FMPs, which are reviewed and approved by the Commission's Technical Committee, in order to maintain recreational and commercial shad fisheries (ASMFC 2010). The fishery occurs in rivers and coastal ocean waters.

In the past, approximately 40-500 Atlantic sturgeon were reportedly captured in the spring shad fishery in Delaware. In recent years, this fishery has turned more to striped bass. Most of the Atlantic sturgeon were captured in the Delaware Bay, with only 2 percent caught in the Delaware River. The fishery uses five-inch mesh gillnets that are left to soak overnight; based on the available information, there is little bycatch mortality (NMFS 2011). Recreational hook and line shad fisheries are known to capture Atlantic sturgeon, particularly in southern Maine, and therefore, could represent a potential source of injury or mortality to Atlantic and shortnose sturgeon within the action area in the Potomac River and Chesapeake Bay.

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 open in Maryland and Virginia.

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 percent 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
Large and small mesh gillnet fisheries occur in state waters. Based on the gear type, 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.

The 2017 Benchmark Assessment (ASMFC 2017) used data from North Carolina Division of Marine Fisheries, the North Carolina gillnet fisheries, and the South Carolina American shad gillnet fishery to assess Atlantic sturgeon bycatch. For the North Carolina gillnet fisheries predicted bycatch for 2004-2005 ranged from 1,286 Atlantic sturgeon in 2011 to 13,668 in 2008. The Atlantic sturgeon caught in this fishery were primarily juveniles. The percent observed sturgeon that died ranged from 0-20 percent with an overall mean of 6 percent. Estimates of dead discards ranged from 0-424 fish (ASMFC 2017). In 2017, 167 Atlantic sturgeon were reported as bycatch from state water fisheries (0-3 miles offshore, including rivers and estuaries). This included 51 fish in the North Carolina gillnet fishery. Connecticut (15), Maryland (1), and Virginia (11) also reported bycatch in 2017 (ASMFC 2019).

Poundnet Fishery
This fishery is managed by the states, except for regulations NMFS issued under the authority of the ESA to protect sea turtles. Pound nets with large mesh and stringer leaders are set in the Chesapeake Bay as part of this fishery, therefore entanglement can be a cause of injury or mortality to sturgeon.

On February 9, 2015, we published a final rule amending the Bottlenose Dolphin Take Reduction Plan (BDTRP) and its implementing regulations under the Marine Mammal Protection Act (MMPA) to require year-round use of modified leaders for offshore Virginia pound nets in specified waters of the lower mainstem Chesapeake Bay and coastal state waters (80 FR 6925). Seasonality of modified leader use as previously required under the ESA regulations remains in place. Under both the MMPA and ESA, the final rule also included a one-time compliance training for fishermen using modified leaders, new and revised Virginia pound net-related definitions, and requirements to fish all sections of the gear at the same time. 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 (*NER-2003-1596*) on the gear regulations implemented by NMFS for the pound net fishery operating in nearshore coastal and estuarine waters of Virginia, including waters in the action area within the 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 (up to one lethal).

State Recreational Fisheries
Shortnose and Atlantic sturgeon have been observed captured in state recreational fisheries, yet the total number of interactions that occur annually is unknown. Recreational anglers have captured several shortnose sturgeon adults in the Potomac River in both the saltwater and freshwater reaches of the river (Welsh *et al.* 2002, M. Mangold unpublished data cited in Kynard *et al.* 2009). There have been no post-release survival studies for these species. However, we anticipate that sturgeon will likely be released alive, due to the overall hardiness of the species. NMFS also engages in educational outreach efforts on disentanglement, release, and handling and resuscitation of sturgeon.

5.3 Other Activities

5.3.1 Maritime Industry

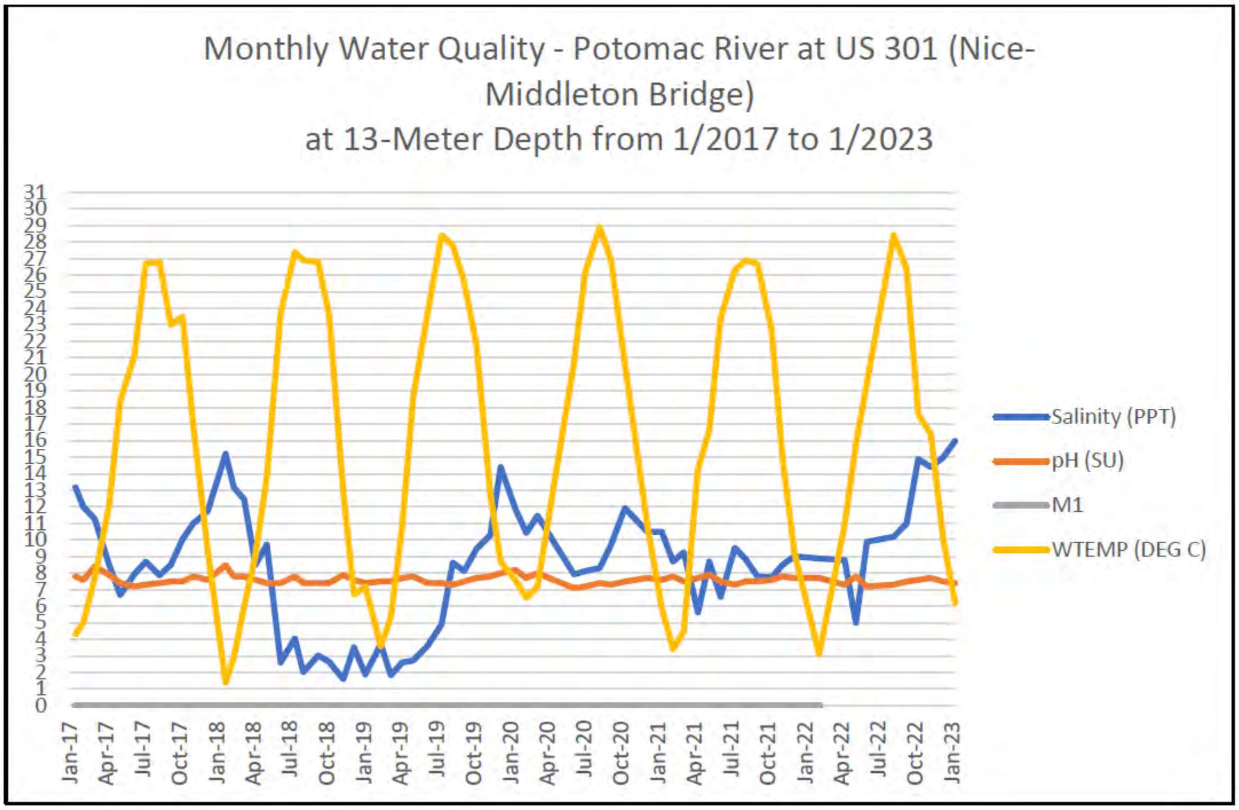
Private and commercial vessels, including fishing vessels, operating in the action area of this consultation also have the potential to interact with Atlantic sturgeon. The effects of fishing vessels, recreational vessels, or other types of commercial vessels on ESA-listed species may involve disturbance 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 percent) 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 Atlantic sturgeon resulting from fishing vessel fuel spills have been documented.

5.3.2 Water Quality

Maryland DNR has a fixed monthly monitoring station (RET2.4) on the Potomac River at the existing Nice-Middleton Bridge. This monitoring station is located in a mesohaline site (brackish water with a salinity of 5 to 18 parts per thousand), and data from this station vary depending on river flow. Salinity is low during high flows and higher during droughts. Generally, salinity in winter months peaks between 12 and 16 parts per thousand. The Potomac mesohaline segment (5 to 18 parts per thousand) extends from approximately 4 kilometers (2.5 miles) upstream of the Nice-Middleton Bridge and waters increase in salinity closer to the Chesapeake Bay.

Salinity, dissolved oxygen, and pH fluctuate seasonally in the Potomac River as shown in Figure 4. Within the Potomac River, dissolved oxygen is low, averaging 3.2 milligrams per liter, in the summer months and pH remains fairly constant throughout the year. Low dissolved oxygen concentrations below 5 milligrams per liter during the summer months could limit the occurrence of the shortnose and Atlantic sturgeon within the action area. Dissolved oxygen can also limit the distribution and survival of benthic organisms. Impacts of climate change, including increased temperatures increased runoff due to increased precipitation, are pathways for excess nutrients in the water which may also negatively affect dissolved oxygen.

Figure 5. Monthly salinity, pH, and water temperature data at the Nice-Middleton Bridge (January 2017 to January 2023)



Maryland DNR also has a fixed monthly monitoring station (CB5.3; Smith Point; 37.9117, -76.1679) at the Maryland/Virginia State line in the Chesapeake Bay near the mouth of the Potomac River. Over the past four years, salinity has averaged approximately 19 parts per thousand in the winter and 21 parts per thousand in the summer, leaning more towards polyhaline conditions. Dissolved oxygen levels near the mouth of the Potomac River in the Chesapeake Bay range from 3 milligrams per liter to over 12 milligrams per liter, averaging 6.7 milligrams per liter in the summer months and 10.4 milligrams per liter in winter. Throughout the year, pH remains fairly constant, ranging between 8.05 and 8.1. Water temperature ranges from an average of 10^{o}C (50^{o}F) in the winter to 21^{o}C (70^{o}F) in the summer (DataHub).

Farther downstream, data from a fixed monthly monitoring station near the mouth of the York River (CB6.4; Central Chesapeake Bay, Offshore from York River; 37.23658, -76.20441). This monitoring station is located in a polyhaline site (brackish water with a salinity of 18 to 30 parts per thousand). Over the past three years, salinity has averaged 20-22 parts per thousand in the winter and 23-25 parts per thousand in the summer (CBNERR-VA VIMS, 2023). Within this representative southern data point of the Extended Action Area, dissolved oxygen is also moderate. Dissolved oxygen levels range from 3 to 11 milligrams per liter, averaging 5.9 milligrams per liter in the summer months and 9.8 milligrams per liter in the winter. PH fluctuates slightly more than the northern monitoring station throughout the year, between 7.5

and 8.5. Water temperature ranges from 48°F (9°C) in the winter to 73°F (23°C) in the summer (DataHub).

5.3.2.1 Pollution

Anthropogenic sources of marine pollution, while difficult to attribute to a specific Federal, state, local, or private action, may affect Atlantic sturgeon and shortnose sturgeon in the action area. Sources of pollutants in the action area include point and nonpoint sources. Point sources include wasterwater treatment facility outfalls and combined sewer overflow (CSO) outfalls. Nonpoint sources of pollutants include PCBs; pesticides; stormwater runoff; groundwater discharges; and oil spills. In 2017, NMFS completed an Opinion on the EPA's registration of certain pesticides (NMFS 2017d). Effects ranged from killing species directly to reductions in prey, and impaired growth. Species likely to be affected include Atlantic sturgeon (all five DPSs). In specifying the ITS, NMFS identified surrogates for anadromous fish and sea turtles (NMFS 2017d).

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. Nutrients, specifically nitrogen and phosphorus, are essential nutrients for plant growth, but elevated concentrations can result in degradation of the waterbody. Eutrophication is one process that can occur when an overabundance of nutrients are present. This process starts when algae feed on the excess nutrients that grow and spread, which can, block sunlight, and even potentially release toxins. Many studies have demonstrated the link between phytoplankton toxin production and nutrient availability (Brandenburg *et al.* 2020, Van de Waal *et al.* 2013). Harmful algal blooms have been reported to affect zooplankton, macroinvertebrates, vertebrates (Landsberg 2002, Shumway *et al.* 2003). Algal blooms can occur naturally when elevated rainfall can increase nutrient loads, suggesting a link between eutrophication and the intensity and frequency of blooms (Phlips *et al.* 2010). However, they are frequently associated with elevated nutrient concentrations due to anthropogenic factors. Untreated wastewater effluent during operation of CSOs and untreated stormwater runoff can contain significant amounts of nitrogen and phosphorus from domestic and industrial sources (EPA 2004). Algal blooms often occur during the summer months in slow-moving water and with warm water temperatures and also can occur in coastal environments, similar to the bloom discussed in Fire *et al.* (2012). In coastal waters of New England, blooms of Alexandrium can produce toxins and have occurred most often during summer months. Freshwater cyanobacteria or blue-green algae blooms occur in rivers and have the potential to produce toxins that can harm wildlife and aquatic life. Effects to sturgeon may occur if increased nutrients produce toxic algal blooms that might be ingested by sturgeon through prey items and through their gills also when toxins are present in the water column. Severe algal blooms have been linked to die-offs of sturgeon prey items, including polychaetes, amphipods, and gastropods (Simon and Dauer 1972, Roberts 1979, Landsberg *et al.* 2009) and other filter feeding organisms (Flewelling *et al.* 2004). When filter-feeding shellfish consume toxic microalgae and accumulate the toxins, this transfers toxins up to higher trophic levels, which can negatively impact sturgeon (Landsberg 2002). Fire *et al.* (2012) studied algal bloom impacts on adult shortnose sturgeon in New England waters and results suggested that sturgeon mortality occurred due to saxitoxin exposure through trophic transfer.

Fire (2012) concluded that the level of toxins that the sturgeon were exposed to were three times higher than the federal regulatory limit for seafood and may have led to the shortnose sturgeons death. However, algal blooms of this magnitude are extremely rare in New England waters. Concentrations of Alexandrium observed during the event described by Fire *et al.* (2012) exceeded the highest density of a bloom ever reported for the Gulf of Maine (D. Couture unpublished data, as cited in Fire *et al.* 2012). Uptake of toxins through fish gills is also a potential pathway for effects from algal blooms to sturgeon (Pierce *et al.* 2008, Fire *et al.* 2008). Fire *et al.* examined toxins present in fish collected from Florida waters during a toxic algal bloom (2008). Toxins were found in 91 percent of gill samples (n = 35) (Fire *et al.* 2008). However, Pierce *et al.* notes that fish have the ability to detoxify toxins and may recover if removed from contaminated waters (2008). Therefore, if sturgeon do come in contact with toxins in the water column, exposure would be limited and short in duration due to the transient nature and high mobility of sturgeon. Therefore, contaminants could degrade habitat if pollution and other factors reduce the food available to sturgeon. The effects from pollution are long term and ongoing and may be worsened due to the impacts from climate change. More information about climate change and impacts to species is provided in the *Climate Change* section of this Opinion.

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. Coastal development may impact sturgeon if it disturbs or degrades foraging habitats or otherwise affects the ability of these species to use coastal habitats.

5.3.4 Vessel Traffic in the Action Area

Commercial, fishing, and recreational vessels use the channels of the Potomac River, James River, and Chesapeake Bay Federal Navigation Channels regularly. Atlantic and shortnose sturgeon may interact with vessels in the shipping lanes of these waterways if the vessels and individuals overlap in time and space.

5.3.4.1 Potomac River

Data from Waterborne Commerce Statistics Center for the Potomac River below Washington, DC demonstrates that there were a total of 1,957 vessel trips in 2021, with the majority of those vessels containing a 12 foot draft (n = 1,382). In 2020, there were a total of 1,773 vessel trips, with the majority of those vessels containing a 24 foot draft (n = 1,031) (data gathered from Waterborne Commerce Statistics Center, https://ndc.ops.usace.army.mil/wcsc/webpub/#/report-landing/year/2021/region/1/location/452). Therefore, the size of vessels varies greatly year to year, but the total number of vessel trips in the Potomac River is 1,950 trips annually on average, based on data from 2017 to 2021 (data from the Waterborne Commerce Statistics Center).

5.3.4.2 James River

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 (data gathered from Waterborne Commerce Statistics Center and AIS).

Deep draft tanker and cargo vessels with 40 foot drafts or greater 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.

5.3.4.3 Chesapeake Bay

There is a constant heavy flow of vessel traffic through the mouth of the Chesapeake Bay including military, commercial, recreational, and fishing vessels. The Naval Station Norfolk, which is the world's largest naval military installation, and the Port of Virginia, the sixth busiest container port in the United States, are both located within the Chesapeake Bay. From 2017 to 2021, there were an average of 13,728 vessel trips to the Port of Virginia. Vessels drafts varied greatly from one to 54 feet, with a majority of vessels containing a draft of 15 feet or less (data gathered from Waterborne Commerce Statistics Center).

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

5.4.3.1 Sturgeon Recovery Planning

Several conservation actions aimed at reducing threats to Atlantic and shortnose sturgeon are currently ongoing. NMFS produced a recovery plan outline for Atlantic sturgeon in 2018, which outlines recovery goals and criteria to recover all Atlantic sturgeon DPSs. More information can be found here: https://www.fisheries.noaa.gov/resource/document/recovery-outline-atlantic-sturgeon-distinct-population-segments.

A recovery plan for shortnose sturgeon was produced in 1998 and serves as an outline for how to recover populations of the shortnose sturgeon to levels of abundance at which they no longer require protection under the ESA (SSSRT 1998). More information can be found here: https://repository.library.noaa.gov/view/noaa/15971.

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 sturgeon.

5.4.3.2 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.

5.4.3.3 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 Status of Listed Species and Critical Habitat in the Action Area

There is limited information available on shortnose and Atlantic sturgeon presence in the action area. Therefore, the background information on the current status of the shortnose sturgeon and their reproduction, survival, juvenile development, and recruitment by river is mainly excerpted from *A Biological Assessment of Shortnose Sturgeon (Acipenser brevirostrum)* (SSSRT 2010), but other reports and studies were also used and are referenced herein. The information in the Atlantic sturgeon section is mainly excerpted from Balazik's (2023) report, but other reports and studies were also used and are referenced herein.

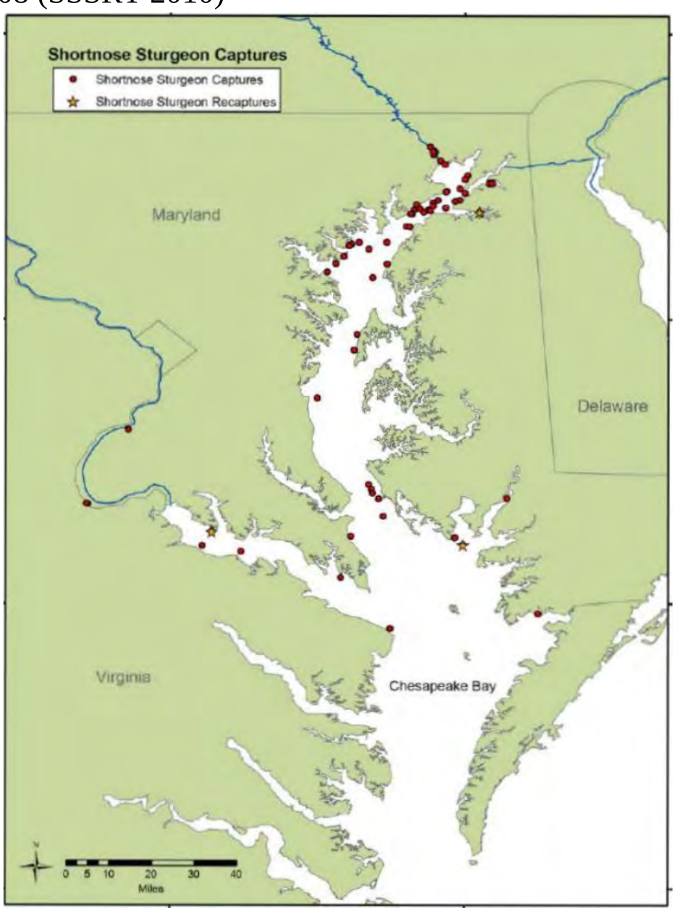
5.5.1 Shortnose Sturgeon

Fourteen shortnose sturgeon have been documented in the Potomac River since 1996 (Kynard *et al.* 2007 and 2009). Eleven shortnose sturgeon were documented in the Potomac River via an ongoing reward program sponsored by the USFWS to compensate commercial fishermen who report captures of Atlantic sturgeon in the Chesapeake Bay system. All shortnose sturgeon captured in the Potomac River were collected between the river mouth and Indian Head (river kilometer 103). The eleven incidental captures reported via the USFWS reward program were documented in the following locations: six at the mouth of the river (May 3, 2000, March 26, 2001, two on March 8, 2002, December 10, 2004, May 22, 2005); one at the mouth of the Saint Mary's River (river kilometer 14) (April 21, 1998); one at the mouth of Potomac Creek (river kilometer 101) (May 17, 1996); one at river kilometer 63 (March 22, 2006); one at river kilometer 57 (Cobb Bar; December 23, 2007); and, one at river kilometer 48 (March 14, 2008). The USFWS conducted two additional sampling studies between 1998 and 2000 in the Maryland waters of the Potomac River to determine occurrence and distribution of sturgeon within proposed dredge material placement sites in the Potomac River (Eyler *et al.* 2000). A two-year bottom gillnetting study was conducted at five sites located in the middle Potomac River. Although the sites were sampled for a total of 4,590 hours, no shortnose sturgeon were captured (Eyler *et al.* 2000). Additionally, the USGS and NPS conducted a telemetry study of shortnose sturgeon in the Potomac River from 2004–2007. Only one adult female was captured within the Potomac River (at river kilometer 103) in September 2005 (Kynard *et al.* 2007 and 2009). Kynard (2009) noted that annual movements of shortnose sturgeon in the Potomac River seem typical for adults. Both of the tracked female shortnose sturgeon in the study remained in freshwater for at least one year (Kynard 2009). Pre-spawning migration likely occurs in spring during mid-April, and is a one-step spawning migration as described by Kynard (1997).

There is very little information about shortnose sturgeon in the Chesapeake Bay. Dadswell *et al.* 1984, reports 13 records of shortnose sturgeon in the upper Chesapeake Bay during the 1970s and 1980s. The ongoing reward program sponsored by the USFWS to compensate commercial fishermen who report captures of Atlantic sturgeon in the Chesapeake Bay system reported a total of 82 shortnose sturgeon captures (82 overall, including three recaptures) in the Chesapeake Bay and its tributaries from 1996 to 2008 (M.Mangold, USFWS, pers. comm. 2008, SSSRT 2010). Most were caught in the upper (*i.e.*, Kent Island to the mouth of the Susquehanna River and the C&D Canal) and middle (*i.e.*, Fishing Bay and around Hoopers Island) portions of the Bay (SSSRT 2010) (Figure 6). The majority of captures of shortnose sturgeon from this study were outside of the Vessel Transit Component of the action area within the Chesapeake Bay. A USFWS sampling study with bottom-gillnetting at 19 sites was conducted in the upper Chesapeake Bay in during 1998 and 2000 and no shortnose sturgeon were captured (Skjeveland *et al.* 2000, SSSRT 2010).

Kynard (2009) reported long residence time in freshwater by two adult females, which suggests that females may not migrate along coastal areas to other river systems frequently. He also concluded that the two adult females were natal remnants or from a north-central population, likely the Delaware River. Genetics samples taken from the two females supports the idea that they may be from another river system because results showed similarities to Delaware River shortnose sturgeon (T. King, unpubl. data cited in Kynard 2009). Therefore, shortnose sturgeon found in Chesapeake Bay may be migrants from the Delaware River. A movement study of 13 shortnose sturgeon radio-tagged in the upper Chesapeake Bay and 26 tagged in the Delaware River (near Scudders Falls) showed movement through the C&D Canal (Skjeveland *et al.* 2000, Welsh *et al.* 2002). Distances traveled by shortnose sturgeon (0 to 5.7 kilometers per day) in the upper Chesapeake Bay were similar to those reported by Dadswell *et al.* (1984), but did not appear to follow a specific pattern, such as migrations to spawning grounds (Litwiler 2001).

Figure 6. Shortnose sturgeon captures in the sturgeon reward program from January 1996 through November 2008 (SSSRT 2010)



One shortnose sturgeon, that was suspected to be from the Potomac or the Delaware River, was captured in the James River on March 13, 2016 (Balazik 2017). Kynard (2017) suggests that because spawning adult and juvenile Atlantic sturgeon are present in the James River, as well as the Rappahanock and York Rivers, shortnose sturgeon may also be present in these rivers. However, no shortnose sturgeon have been captured in Rappahanock and York Rivers to date, despite ongoing research efforts.

Spawning

Shortnose sturgeon spawning has historically occurred in the Potomac River. Current spawning upstream of the action area in the Potomac River and the James River is assumed based on the presence of pre-spawning females and suitable habitat (Kynard *et al.* 2009). In the Potomac River, two late-stage females were captured and tracked, however, only one was observed to make an apparent spawning migration in the spring. Remote and manual tracking showed one female arrived at the Fletchers Marina (river kilometer 184.5) on April 9 and remained within a 2-kilometer reach (river kilometer 187–185) for six days. During this time, mean daily river temperatures were 12.0–16.0 °C and mean daily river discharge was 157–178 cubic meters per second. Video camera monitoring along three sampling transects within the reach used by this migrant showed the substrate was predominantly large and small boulders (70–80 percent), along with the suitable spawning substrate of gravel-pebble and cobble-rubble (15.5–24.0 percent).

During spring 2007, researchers determined mean bottom velocity along the channel shoulder in the Fletcher's Marina-Chain Bridge reach in the Potomac River, (river kilometer 184.5–187.0) upstream of the action area, was 1.05 meters per second and mean depth was 6.3 meters. The Potomac River is considered to be tidally influenced up to the Chain Bridge (river kilometer 187) which lies just two kilometers upstream of the suspected spawning area at Fletcher's Marina (Kynard *et al.* 2007 and 2009). Although researchers filtered 100,000 cubic meters of water at the Fletcher's site through 2-millimeter mesh anchored D-nets, no sturgeon early life stages (ELS) were captured (Kynard *et al.* 2007 and 2009).

The Bosher Dam on the James River has a vertical slot fish passage way to allow for upstream migration, however, no shortnose sturgeon have been observed to pass through this fishway (SSSRT 2010). Anecdotal reports from watermen indicate shortnose sturgeon presence in Gunpowder Falls, which enters the Gunpowder River in Baltimore County, although there has not been any documentation of spawning activity (J. Nichols, NOAA, pers. comm. as referenced in NMFS 2002). Incidental capture of shortnose sturgeon has been reported to the USFWS Reward Program in the Susquehanna River (April 4, 1996; April 24, 1997; April 28, 1998; February 19, 1999; February 6 and 17, 2001; June 2, 2002) and near the mouth of the Rappahannock River (May 1998) (Spells 1998, unpubl. report). If shortnose sturgeon spawning is occurring in tributaries to the Chesapeake Bay, migration to upriver spawning grounds would likely begin when water temperatures in the Bay reach between 8 and 15°C, approximately mid-March to the beginning of May (SSSRT 2010). Therefore, shortnose sturgeon may migrate through the action area within the James River to reach upstream spawning habitat. However, shortnose sturgeon spawning is not expected to occur within the action area in the James River due to the relatively high salinity levels present (18 to 21 parts per thousand).

Foraging
The Potomac River most likely has an acceptable environment for foraging activities (Kynard *et al.* 2007), but warming waters due to climate change may further degrade foraging habitat (Kynard *et al.* 2009). In 2005–2007, two female shortnose sturgeon were tracked in the Potomac River and spent the summer-fall in a 78-kilometer reach (river kilometer 141–63) (Kynard *et al.* 2009). Most of this area was in tidal freshwater, however, the downstream section of the range experiences tidal salinity. The two individuals shared the same 10-20 kilometer reach in June–July of 2006 (they were never tracked in the same specific location); however, winter sites used by each individual were about 35 kilometers apart or greater. The two female shortnose sturgeon used depths between 4.1–21.3 meters, but most locations (89.2 percent) were recorded in the channel. Throughout the summer and winter, they were observed in a wide range of water temperature (1.8–32.0°C), dissolved oxygen (4.8–14.6 milligrams per liter), and salinity (0.1–5.6 parts per thousand) (Kynard *et al.* 2007 and 2009). Substrate types recorded at locations where these females were present were mud (80.7 percent), sand/mud (15.8 percent), and gravel-mud (3.5 percent). The foraging area was also characterized by prolific tracts of submerged aquatic vegetation and algal blooms. In addition, tidal cycles caused currents to reverse throughout the entire summer-winter range.

A study by Kynard (2009) suggests that habitat is present in the Chesapeake Bay to support all activities of adults. There is no information available on habitat use for younger life stages in the Chesapeake Bay. Warming waters due to climate change may further degrade foraging habitat within the Chesapeake Bay (Kynard *et al.*, 2009). Niklitschek (2001) indicated via modeling that suitable habitats were very restricted during summer months with favorable foraging habitat limited to the upper tidal portions of the upper Bay (work referenced in Secor and Niklitschek 2002). During the summer (May – September) foraging period, 17 shortnose sturgeon have been caught (of 82 overall, including three recaptures) in the Chesapeake Bay by the sturgeon reward program (M.Mangold, USFWS, pers. comm. 2008, SSSRT 2010). Niklitschek (2001) indicated via modeling that suitable habitats was present, but very restricted during summer months with favorable foraging habitat possibly being present in the James River (work referenced in Secor and Niklitschek 2002). Although rare, adult shortnose sturgeon could be within the action area in the James River migrating and foraging year-round (Balazik 2017).

Overwintering
Shortnose sturgeon in the southern portion of their range (*i.e.*, within the action area) are moderately more active than northern populations and may move throughout the Potomac River during the overwintering period (Kynard *et al.* 2009, SSSRT 2010). In the Hudson River, shortnose sturgeon remain moderately active and vigorous at temperatures less than 5°C (Woodland and Secor 2007), therefore, we assume the same is true of shortnose sturgeon in the Potomac River. Results of models indicates juvenile shortnose sturgeon probably do not

encounter sub-lethal low temperatures during winter months (Niklitschek 2001). Two tracked females used 124 kilometer (river kilometer 63– 187) of the Potomac River during the overwintering period that encompasses the freshwater - saltwater interface (Kynard *et al.* 2009), which is similar to the lower river concentration areas of north-central populations (Delaware to Merrimack Rivers). Kynard (2009) tracked one female throughout an entire winter season (2005–2006). All winter sites selected by this female occurred within the 78-kilometer summer-fall reach. This female returned to the same reach for wintering three consecutive years (2005-2007) and occupied < 2 kilometers during winter. The other female that was tagged in spring 2006, was tracked only until February 2007, after which, it was not found again; it was noted at a site at river kilometer 85, which is the farthest downstream location tracked during the study. Therefore, given that in the southern portion of their range (*i.e.*, within the action area), shortnose sturgeon may be transient, occasionally migrating through the Potomac River and James River during the overwintering period (Kynard *et al.* 2009, SSSRT 2010), we assume that adult and juvenile shortnose sturgeon may be present migrating through the action area during the overwintering period within the action area in the James and Potomac River.

A total of 28 out of the 82 total shortnose sturgeon captures within the Chesapeake Bay and its tributaries have been reported to the sturgeon reward program during winter months (M. Mangold, USFWS, pers. comm. 2008; SSSRT 2010). Therefore, adult shortnose sturgeon may be present overwintering in the Chesapeake Bay from the beginning of November to the end of February.

Summary of Shortnose Sturgeon Presence

After their first year, juveniles become increasingly tolerant to saline water and may use the entirety of the species' range in the Potomac River and James River to forage. Therefore, they are likely present in the river year-round, and may utilize the full extent of the Potomac River from the mouth of the river to the Little Falls Dam and the James River from the mouth to the Bosher Dam (Kynard *et al.* 2007, Kynard *et al.* 2009). Where suitable habitat is available, juveniles are expected to use the same habitats as adults (Kynard *et al.* 2009). Therefore, within the Potomac River from the Nice-Middleton Bridge to the mouth of the River and near the mouth of the James River, we expect juvenile and adult shortnose sturgeon to be present year-round migrating and foraging. Shortnose sturgeon are expected to remain moderately active during the overwintering period and may be transient within the Potomac River and James River during this time. We also expect adults to be present year-round throughout the action area.

Based on best available data, although rare, adult shortnose sturgeon may be present within the action area of the Chesapeake Bay year-round. Due to the documented use of the Chesapeake Bay by shortnose sturgeon in the winter (M. Mangold, USFWS, pers. comm. 2008, SSSRT 2010), we also assume that adults could be overwintering anywhere in the Bay from November 1 to February 28.

The salinity in the Chesapeake Bay ranges from 20-30 parts per thousand, from 18 to 21 parts per thousand near the mouth of the James River, and from 5 to 18 parts per thousand in the Potomac River near the Nice-Middleton Bridge, therefore, early life stages are not expected to be present. Similarly, based on the salinity throughout the action area, spawning is not expected to occur.

5.5.2 Atlantic Sturgeon

Maryland DNR personnel reported a large mature female Atlantic sturgeon in the Potomac in 1970 (H. Speir, Maryland DNR, Per Comm. 1998, ASSRT 1998). During August 15 to September 21, 2006, USGS field investigators reported the capture of three juvenile Atlantic sturgeon near Quantico, Virginia, and Maryland Point (Kynard *et al.* 2007, ASSRT 2007), but the exact spawning area is currently unknown.

Balazik (2023) recently conducted an Atlantic sturgeon telemetry study in the Potomac River from November 2020 through November 2022. Results demonstrated that sturgeon may stay in the river longer than previously expected. A total of 24 Atlantic sturgeon were detected in the Potomac River during the study, comprised of twenty-one (21) tagged subadult sturgeon and three adults. Sixteen (16) of the tagged subadult fish crossed the Nice-Middleton Bridge project area at some point and the remaining five subadults stayed near the mouth of the river (Balazik 2023). Although Balazik (2023) acknowledges that surgery and handling effects may have effected migratory behavior (Pickering *et al.* 1982, Sigismondi and Weber 1988, Adams *et al.* 2011), he concluded that Atlantic sturgeon do not inhabit the Nice-Middleton Bridge area for any extended period of time, but rather are transient in the area as they migrate through to preferred habitats upstream or downstream, most likely between March/April and October/November. We consider the Balazik (2023) study to be the best available science for the presence of Atlantic sturgeon in the Potomac River.

Two tagged adult males were detected in the Potomac River (Balazik 2023). Each fish moved past the Nice-Middleton Bridge twice. One fish (transmitter 6898) remained near the bridge for about an hour on April 10, 2022, on its way to upstream to suspected spawning habitat and again on June 5, 2022 on its way to the ocean. This is the only telemetered spring adult to be documented in the Potomac River. The other fish (transmitter 21908) was detected at the bridge for about an hour on September 6, 2021, also on its way upstream to suspected spawning habitat and again on October 24, 2021 on its way to the ocean. Based on this telemetry data from adult fish, sturgeon may attempt to spawn in the Potomac River above river kilometer 150 (river mile 93), which is 69 kilometers (43 miles) upstream of the Nice-Middleton Bridge. No juveniles were recorded in the Potomac River during the study. Information about the tagged fish in the study can be found in Table 17.

Balazik (2023) telemetry results demonstrate fish will likely not remain in the project area (Nice-Middleton Bridge) for any extended period, but rather, subadults and adults may be migrating through the area during October and November, when the action is proposed to occur. A total of eight fish (assumed by Balazik (2023) to be acting naturally) were within the action area near the blasting site between October 15 and February 14 (Figure 5). The fish were within the action area near the blasting site for one hour to a maximum of 10 days for several hours each day (Table 18). Except for one fish that moved through the area on December 6, all detections in the blasting and habitat modification component of the action area from December through February may have been affected by recent internal surgeries, which may have modified their behavior. By early December, fish are expected to be either upstream of the salt wedge (upstream of the Nice-Middleton Bridge) or downstream in the Chesapeake Bay. Therefore, the chances of a migratory fish being within the proposed blast impact area are low in October and November and extremely low in December through February (Balazik 2023), when fish would otherwise be in overwintering grounds. Therefore, Balazik concludes that fish present within the action area during December through February are not overwintering fish, but rather an artifact of the recent surgeries, and Atlantic sturgeon are not expected to overwinter in the blasting and habitat modification component of the action area, but are expected to be transient (2023).

The marine and estuarine range of all five Atlantic sturgeon DPSs overlaps and extends from Canada through Cape Canaveral, Florida, therefore, Atlantic sturgeon originating from any of five DPSs could occur in the Chesapeake Bay (Damon-Randall *et al.* 2013; Wirgin *et al.* 2015), typically from spring through late fall. Migratory behaviors occur from April to late November/early December for adults and subadults and year round for juveniles (Dovel and Berggren 1983, Secor *et al.* 2002, Welsh *et al.* 2002, Horne and Stence 2016, Balazik 2023). Each of these life stages are expected to migrate and opportunistically forage within the Bay. Foraging behaviors typically occur in areas where suitable forage and appropriate habitat conditions are present. These areas include tidally influenced flats and mud, sand, and mixed cobble substrates (Stein *et al.* 2004a).

A Virginia Institute of Marine Science (VIMS) trawl survey was initiated in 1955 to investigate finfish dynamics within the Chesapeake Bay. From 1955 to 2007, 40 Atlantic sturgeon have been captured, 16 of which were captured since 1990, and two of these collections may have been YOY based on size. No fish were captured between 1990 and 1996; however, seven were captured in 1998. In subsequent years, catch declined ranging between zero and three fish per year. Similarly, American shad monitoring programs (independent stake gill net survey) also recorded a spike in Atlantic sturgeon bycatch that peaked in 1998 (n = 34; 27 from James River) and declined dramatically in later years to only one to three sturgeon being captured in each year from 2002-2004 (ASSRT 2007). These observations could be biased by stocking 3,200 juveniles in the Nanticoke River in 1996; however, the capture of wild fish in the Maryland Reward Tagging program conducted from 1996 to 2007 shows identical rates of capture for wild fish (ASSRT 2007). In addition, a large mature female was captured in the Nanticoke River in 1972 (H. Speir, Maryland DNR, Per Comm. 1998, ASSRT 1998).

A Maryland reward tagging has resulted in the capture of 1,700 Atlantic sturgeon. Five hundred and sixty seven (567) of these fish were hatchery fish, of which 462 were first time captures (14 percent recapture rate), the remaining captures (1,133) were wild. However, none of these 1,700 Atlantic sturgeon were considered YOY based on length data (S. Minkkinen, USFWS, Pers. Comm. 2006, ASSRT 1998). Similarly, Virginia initiated a reward tagging program in 1996 that ran through 1998. The majority of their recaptures were wild Atlantic sturgeon taken from the lower James and York rivers in the 20 – 40 centimeter size range and are believed to be YOY (A. Spells, USFWS, Pers. Comm. 1998). Captures of YOY and age-1 sturgeon in the James River during 1996 and 1997 suggest spawning has occurred in that system. Since then, captures from the reward program have varied, declining from 1999 to 2002 and then increasing in 2005 to levels similar to that of 1998 and with record levels during 2006. Further evidence that spawning may have occurred is provided by three carcasses of large adults found in the James River in 2000-2003, the discovery of a 213 centimeter carcass of an adult found in the Appomattox River in 2005, as well as the release of a 2.4 meter Atlantic sturgeon near Hoopers Island (the Bay) in April, 1998 (S. Minkkinen, USFWS, Pers. Comm. 2006). Several subadults were captured in the Chesapeake Bay and were later detected in the Hudson River (Dovel and Berggren 1983), suggesting extensive coastal migration.

Adult Atlantic sturgeon enter the James River in the spring, with at least some eventually moving as far upstream as Richmond (river kilometer 155), which is also the head of tide and close to the upstream extent of Atlantic sturgeon in the river given the presence of Boshers Dam at the fall line (approximately river kilometer 160) (Bushnoe *et al.*, 2005; Hager, 2011; Balazik *et al.*, 2012). Adults disperse through downriver sites and begin to move out of the river in late September to early October, occupy only lower river sites by November, and are undetected on tracking arrays in the lower river by December suggesting that adult sturgeon leave the river for the winter (Hager, 2011; Balazik *et al.*, 2012).

The availability of hard-bottom habitat is relatively limited in the James River and appears to be significantly reduced compared to the amount of available hard-bottom habitat described in historical records (Bushnoe *et al.*, 2005; Austin, 2012). In general, tracked adults occurred further upstream during the late summer and early fall residency (Balazik *et al.*, 2012) than during the spring and early summer residency (Hager, 2011) suggesting two different spawning areas, depending on season, for the two James River spawning populations (Balazik and Musick, 2015). An adult male Atlantic sturgeon tagged in the James River, Virginia has been detected from Maine to Georgia (Balazik, M., VCU, Richmond, Virginia, unpubl. data, Hilton et al 2016). In general, adult Atlantic sturgeon migrate into rivers in the spring (some heading to freshwater spawning grounds) and return to coastal marine waters in the fall. In the James River, there is a distinct fall spawning run (approximately August - October).

Spawning

Historical research suggests that spawning once occurred in the Potomac River. Due to the presence of features necessary to support reproduction and recruitment, the Potomac River potentially supports both spawning and rearing (NMFS 2017, Niklitschek & Secor 2005, Balazik 2023). In the Potomac River, spawning may occur from the upstream limit at the Little Falls Dam to the downstream limit of the salt front near Aquia Creek (NMFS 2017, Chesapeake Bay Program 2008) from March 15 to May 15 and from August 1 to November 30. The time of year based on presence of spawning Atlantic sturgeon in other nearby rivers (Balazik & Musick 2015, Balazik *et al.* 2012).

A review of spawning habitat availability in the Chesapeake Bay and its tributaries indicated that spawning habitat is available in the James, York, and Appomattox Rivers (Bushnoe *et al.* 2005). There is evidence of both spring and fall spawning populations for the James River, as well as fall spawning in the Pamunkey River, a tributary of the York River, and fall spawning in Marshyhope Creek, a tributary of the Nanticoke River (Hager *et al.*, 2014; Kahn *et al.*, 2014; Balazik and Musick, 2015; Richardson and Secor, 2016). In addition, detections of acoustically tagged adult Atlantic sturgeon in the Mattaponi and Rappahannock Rivers at the time when spawning occurs in others rivers, as well as recent evidence in the Potomac River (Balazik 2023) supports the likelihood of Atlantic sturgeon spawning populations in the Mattaponi, Rappahannock, and Potomac Rivers.

Given that salinity levels in some areas may support juveniles, juvenile Atlantic sturgeon may occur year-round in the Chesapeake Bay (Secor *et al.* 2000, Horne and Stence 2016). Subadult and adult Atlantic sturgeon are likely to occur in the Chesapeake Bay in spring, summer, and fall. In June, adults migrate to spawning tributaries, where they may remain until late September, or may remain in spawning tributaries as late as early December based on recent research (Balazik 2023). Atlantic sturgeon are known to use the action area for spawning migrations, foraging, and as juvenile development habitat prior to entering marine waters as subadults and adults.

Spawning migrations start around April in the Chesapeake Bay, Delaware, and Hudson River region (Smith 1985, Hilton 2017). Adult Atlantic sturgeon that spawn in the fall likely stage in the James River in the summer and fall in brackish water between river mile 14 and 66 (Balazik and Musick 2015). Fall spawning likely occurs between river mile 65 and the fall line near Richmond (river mile 96) (Balazik *et al.* 2012), while spring spawning likely occurs around river mile 56 and 60 (Balazik and Musick 2015).

Summary of Atlantic Sturgeon Presence

As explained above, although conclusive evidence of spawning has not been found in the Potomac River and no Potomac River juveniles have been documented (Balazik 2023), we assume that spawning may occur given that the features needed to support spawning are present. Therefore, juveniles from the Chesapeake Bay DPS may be migrating and foraging year-round in the action area within the Potomac River. Research suggests that males may remain in the river until late November/early December, and females are expected to resume their coastal migration after spawning (Hager *et al.* 2014, Balazik 2023). Subadults and adults from any of the five DPSs are expected to enter the Potomac River in late March and depart the freshwater spawning grounds in the fall, although a recent study by Balazik (2023) demonstrates that some subadult and adult Atlantic sturgeon may remain in the Potomac River until as late as early December. Atlantic sturgeon are not expected to overwinter in the blasting and habitat modification component of the action area, and are expected to be transient (Balazik 2023).

Adult Atlantic sturgeon are expected to pass through the action area as they move to Chesapeake Bay tributaries to spawn in the spring and fall, then return to the ocean, therefore, may be present in the Chesapeake Bay from late March (Balazik & Musick 2015) through November, or even as late as early December (Balazik 2023). During this time, adults may utilize the full extent of the bay and may migrate into adjacent tributaries (Horne and Stence 2016). We expect subadult Atlantic sturgeon behavior in the Chesapeake Bay to be similar to the adults and they are expected to be present in the Bay from late March (Balazik & Musick 2015) through November, and possibly as late as early December (Balazik 2023), and may utilize the full extent of the Bay while also migrating and foraging the Chesapeake Bay's tributaries (Horne and Stence 2016). We expect juveniles Atlantic sturgeon from the Chesapeake Bay DPS to be present in the Chesapeake Bay year-round and, because they are tolerant to saline water, may utilize the entire Bay and all connecting rivers to migrate and opportunistically forage (Horne and Stence 2016).

Juveniles from the Chesapeake Bay DPS may be present year-round in the action area within the James River migrating and foraging. Research suggests that adult males may remain in the river until late November/early December and adult females are expected to resume their coastal migration after spawning (Hager *et al.* 2014, Balazik 2023). Atlantic sturgeon are not expected to overwinter in the action area within the James River, but are expected to be transient (Balazik 2023). Subadults and adults from any of the five DPSs are expected to enter the James River in late March and depart the freshwater spawning grounds in the late fall. The salinity in the Chesapeake Bay ranges from 20-30 parts per thousand, from 18 to 21 parts per thousand near the mouth of the James River, and from 5 to 18 parts per thousand in the Potomac River near the Nice-Middleton Bridge, therefore, early life stages are not expected to be present. Similarly, based on the salinity throughout the action area, spawning is not expected to occur.

Table 17. Atlantic sturgeon tagged on the Potomac River from Balazik (2023)

Transmitter	Tag Owner	Waterbody Tagged	State	Release Date	FL (cm)	Lifestage When Tagged	Lifestage Within Array
19552	Matt Balazik	James	VA	11/4/2019	40	Juvenile	Subadult
19554	Matt Balazik	James	VA	11/5/2019	42	Juvenile	Subadult
19555	Matt Balazik	James	VA	11/5/2019	40	Juvenile	Subadult
24620	Matt Balazik	James	VA	11/11/2019	41	Juvenile	Subadult
24621	Matt Balazik	James	VA	11/11/2019	42	Juvenile	Subadult
24622	Matt Balazik	James	VA	11/11/2019	44	Juvenile	Subadult
24623	Matt Balazik	James	VA	9/29/2020	62	Subadult	Subadult
51173	Matt Balazik	Albemarle	NC	12/21/2021	53	Juvenile	Subadult
53366	Matt Balazik	James	VA	10/17/2020	53	Subadult	Subadult
53370	Matt Balazik	James	VA	10/23/2020	57	Subadult	Subadult
16700	Matt Balazik	Rapp	VA	10/1/2016	145	Adult	Adult
21908	Matt Balazik	Rapp	VA	9/30/2016	150	Adult	Adult
64703	Matt Breece	Potomac	MD	9/17/2021	70	Subadult	Subadult
64708	Matt Breece	Potomac	MD	5/15/2021	75	Subadult	Subadult
64710	Matt Breece	Potomac	MD	5/15/2021	82	Subadult	Subadult
6898	Matt Balazik	Albemarle	NC	5/19/2021	181	Adult	Adult
6904	Matt Balazik	Potomac	MD	12/12/2020	66	Subadult	Subadult
6905	Matt Balazik	Potomac	MD	12/12/2020	67	Subadult	Subadult
6906	Matt Balazik	Potomac	MD	12/12/2020	71	Subadult	Subadult
6907	Matt Balazik	Potomac	MD	12/10/2020	60	Subadult	Subadult
6908	Matt Balazik	Potomac	MD	12/10/2020	64	Subadult	Subadult
6909	Matt Balazik	Potomac	MD	11/27/2020	68	Subadult	Subadult
9205	Matt Balazik	Potomac	MD	12/3/2020	61	Subadult	Subadult
11058	Matt Balazik	Potomac	MD	11/25/2020	71	Subadult	Subadult

Figure 7. Number of Atlantic sturgeon detected each day within a radius of at least 1,200 meters at the Nice-Middleton Bridge by Balazik (2023)

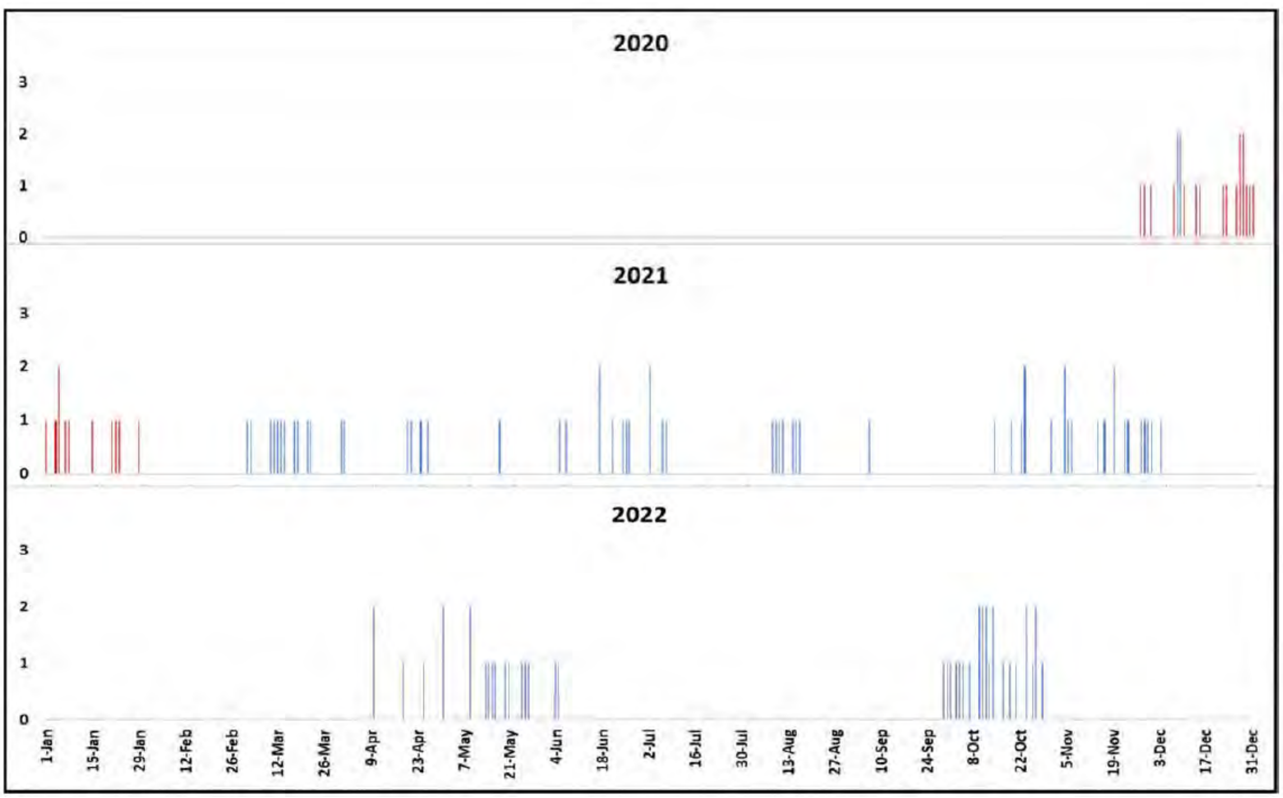


Table 18. Fish (n=8) detected within 1,200 meters (1.2 kilometers) of the Nice-Middleton Bridge from October 15 to February 14 (Balazik 2023).

Fish ID	Latest Date of Detection	Duration within radius of Nice-Middleton Bridge
21908	October 24	1 hour
9205	October 22	3 days for several hours each day
6906	November 4	2 hours
6905	November 30	4 days for several hours each day
64710	October 26	10 days for several hours each day
64708	October 27	7 hours
24922	November 4	3 hours
19555	December 6	6 hours

5.5.3 Atlantic Sturgeon Critical Habitat

As noted above, the action area considered in this biological opinion includes the Federal Navigation Channel from the mouth of the Chesapeake Bay (including the mouth and lower portion of the James River) to the Nice-Middleton Bridge in the Potomac River. The Potomac River critical habitat unit (Chesapeake Bay Unit 2: Potomac River) extends 187 river kilometers from Chain Bridge to the mouth of the river.

As discussed above, the river is tidal freshwater from Chain Bridge to Quantico, Virginia with bottom topography characterized by a narrow channel, 6 to 21 meters deep, and a shallow shelf on either side of the channel. A suspected sturgeon spawning site occurs approximately 2 river kilometers downriver of the Chain Bridge, in freshwater and hard substrate (*e.g.*, large and small boulders, gravel-pebble, and cobble-rubble) (USGS, 1984; PCC, 2000; SSSRT, 2010). The mixing zone of transitional salinity occurs from Quantico, Virginia, to the Nice-Middleton Bridge. The Nice-Middleton Bridge is considered to be within the mesohaline segment (5 to 18 parts per thousand) of the river (CBP 2005). The remainder of the river estuary, from the Nice-Middleton Bridge to the Chesapeake Bay, has a wide channel with gradually sloping, shallow flats near shore (USGS 1984). Sand and clay substrates are dominant in many areas, with patches of gravel. Therefore, the action area overlaps with critical habitat within the Potomac River contains PBFs 2, 3, and 4. Critical habitat is not present in the Chesapeake Bay or at the mouth of the James River.

5.5.3.1 Physical and Biological Feature 1

PBF 1 is defined as 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 range) for settlement of fertilized eggs, refuge, growth, and development of early life stages. PBF 1 not present within the action area because the salinity level present in the action area (5 to 18 parts per thousand at the Nice-Middleton Bridge, 20 to 30 parts per thousand in the Chesapeake Bay, and 18 to 21 parts per thousand near the mouth of the James River) exceed the salinity levels identified in PBF 1 (0 to 0.5 parts per thousand), as described above. Therefore, effects of the action on PBF 1 will not be considered further.

5.5.3.2 Physical and Biological Feature 2

PBF 2 is defined as aquatic habitat with a gradual downstream salinity gradient of 0.5 up to as high as 30 parts per thousand and soft substrate (*e.g.*, sand, mud) between the river mouth and spawning sites for juvenile foraging and physiological development. PBF 2 is present within the action area because the action area is comprised of mainly soft bottom substrate and salinities between 5 to 18 parts per thousand occur within the action area. The blasting event and the subsequent placement/removal of rubble on the river bottom at the footprints of the piers will impact approximately 2.5 hectares (6.2 acres) of soft bottom substrates and impact benthic communities within Potomac River.

Juvenile Atlantic sturgeon feed on aquatic insects, insect larvae, and other invertebrates (Bigelow and Schroeder 1953, ASSRT 2007, Guilbard *et al.* 2007). Suitable forage and appropriate habitat conditions are present within the Potomac River (ASSRT 2007), therefore juvenile foraging may be impacted by the action.

5.5.3.3 Physical and Biological Feature 3

PBF 3 is comprised of water of appropriate depth, with continuous flow, and absent physical barriers to passage between the river mouth and spawning sites necessary to support movement of adults to and from spawning sites, movement of juveniles, and resting, or holding of subadults or spawning condition adults. PBF 3 is present within the action area. Blasting activities (October 15, 2023 to February 14, 2024) will overlap with the latter portion of the migratory period for Atlantic sturgeon when adult fish are moving into spawning habitats (March 15 to May 15 and from August 1 to November 30) within the Potomac River and the James River. Recent research by Balazik (2023) also indicates sturgeon may be migrating past the Nice-Middleton Bridge as late as mid-December and an adult male sturgeon suspected of moving downstream after a potential spawning run was detected near the Nice-Middleton Bridge as late as October 24. Sturgeon could also migrate through the action area during the habitat modification portion of the action that will occur from fall of 2023 through mid-2024.

5.5.3.4 Physical and Biological Feature 4

PBF 4 is comprised of water, between the river mouth and spawning sites, with the temperature, salinity, and oxygen values that support spawning; survival; and growth, development, and recruitment of various sturgeon life stages (*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 dissolved oxygen or greater for juvenile rearing habitat). PBF 4 is present within the action area. The project may cause temporary impacts to PBF 4 because project activities may impact dissolved oxygen levels within the action area between the river mouth and potential spawning sites. Dissolved oxygen may be temporarily reduced in areas where an increase in TSS/turbidity occurs.

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). Suitable forage and appropriate habitat conditions are present within the Potomac River (ASSRT 2007). Because of the benthic nature of their prey, it is likely that foraging juveniles, sub-adult, adult Atlantic sturgeon could be impacted by blasting operations and habitat modification activities within the action area. Furthermore, direct removal and increased turbidity may affect the quality and quantity of prey resources in the action area.

6.0 CLIMATE CHANGE

The discussion below presents background information on global climate change, as well as information on past and predicted future effects of global climate change throughout the range of the listed species considered here. Additionally, we present the available information on predicted effects of climate change in the action area and how those predicted environmental changes may affect listed species. Climate change is relevant to the *Status of the Species*, *Environmental Baseline*, and *Cumulative Effects* sections of this Opinion. Therefore, rather than include partial discussions in several sections of this Opinion, we are synthesizing this information into one discussion. Consideration of the effects of the proposed action in light of predicted changes in environmental conditions due to anticipated climate change are included in the *Effects of the Action* below.

6.1 Background Information on Global Climate Change

In its Sixth Assessment Report (AR6) from 2021, the Intergovernmental Panel on Climate Change (IPCC) found that human activities are estimated to have caused approximately a 1.07°C (likely range 0.8°C to 1.3°C) global surface temperature increase over pre-industrial (1850-1900) levels. For the first time in an IPCC report, assessed future changes in global surface temperature, ocean warming, and sea level were constructed by combining multi-model projections with observational constraints based on past simulated warming, as well as the AR6 assessment of climate sensitivity. Even under a very low greenhouse gas (GHG) emissions scenario, the IPCC predicts that the 1.5°C global warming level is more likely than not going to be exceeded in the near term (2021-2040) (IPCC 2021). Since the 1860s, the Northeast U.S. shelf sea surface temperature (SST) has exhibited an overall warming trend, with the past decade measuring well above the long-term average (and the trend line). Changes in the Gulf Stream, increases in the number of warm core ring formations, and anomalous onshore intrusions of warm salty water are affecting the coastal ocean dynamics with important implications for commercial fisheries and protected species. Annual surface and bottom temperatures in the Gulf of Maine and Georges Bank have trended warmer since the early 1980s. The 2020 seasonal surface temperatures have trended warmer in summer and fall and just slightly warmer than average in the winter and spring throughout New England. The 2020 summer SST was the highest on record in Georges Bank with a heatwave of 4.3°C above the heatwave threshold. Annual surface and bottom temperatures in the Mid-Atlantic Bight have also trended warmer since the early 1980s, and seasonal temperatures have similarly trended warmer (NEFSC 2021a, 2021b).

Model projections of global mean sea level rise (relative to 1995-2014) suggest that the likely global mean sea level rise by 2100 is 0.28-0.55 meters (0.92-1.80 feet) under the very low GHG emissions scenario, 0.32-0.62 meters (1.05-2.03 feet) under the low GHG emissions scenario, 0.44-0.76 meters (1.4-2.5 feet) under the intermediate GHG emissions scenario, and 0.63-1.01

meters (2.07-3.3 feet) under the very high GHG emissions scenario (IPCC 2021). It is virtually certain that global mean sea level will continue to rise over the 21st century. The magnitude and rate of rise depends on future emission pathways (IPCC 2021). Temperature increases 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).

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 these waters suggest that this region will warm two to three times faster than the global average; given this, existing projections from the IPCC may be too conservative (Saba *et al.* 2015).

The past few decades have also 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 increased the export of freshwater to the North Atlantic. 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). Changes in salinity and temperature may be the result of changes in the Earth's atmosphere caused by anthropogenic forces (IPCC 2021). Specifically, recent research on the North Atlantic Oscillation (NAO), which impacts climate variability throughout the Northern Hemisphere, has found potential changes in NAO characteristics under future climate change until 2100 (Hanna and Cropper 2017).

Global warming of 1.5°C is projected to shift the ranges of many marine species to higher latitudes and drive the loss of coastal resources. The risk of irreversible loss of many marine and coastal ecosystems increases with global warming, especially at 2°C or higher (high confidence) (IPCC 2018). 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 changes in ice cover, salinity, oxygen levels, and circulation. Changes to the marine ecosystem due to climate change may result in changes in the distribution and abundance of the prey for protected species.

While predictions are available regarding potential effects of climate change globally, it is more difficult to assess the potential effects of climate change on smaller geographic scales, such as the action area. The effects of future change will vary greatly among coastal regions for the U.S. For example, sea level rise is projected to be worse in low-lying coastal areas where land is sinking (*e.g.*, the Gulf of Mexico) than in areas with higher, rising coastlines (*e.g.*, Alaska) (Jay *et al.* 2018). 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. As climate warms, water temperatures in streams and rivers are likely to increase; this will likely result wide-ranging effects to aquatic ecosystems. Changes in temperature will be most evident during low flow periods when the water column in waterways are more likely to warm beyond the physiological tolerance of resident species (NAST 2000). Low flow can impede fish entry into waterways and combined with high temperatures can reduce survival and recruitment in anadromous fish (Jonsson and Jonsson 2009).

Expected consequences of climate change for river systems are wide ranging. 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 (Hulme 2005). Rivers could experience 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). Increased water volume in 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. Within 50 years, river basins that are impacted by dams or by extensive development will experience greater changes in discharge and water stress than unimpacted, free-flowing rivers (Palmer *et al.* 2008). Given this, a global analysis of the potential effects of climate change on river basins indicates that large river basins impacted by dams will need a higher level of reactive or proactive management interventions in response to climate change than 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 respond and/or adapt to change. Given the above, under a continually changing environment, maintaining healthy riverine ecosystems will likely require adaptive management strategies (Hulme 2005).

Recent changes in climate conditions are well documented and are predicted to continue (IPCC 2021), increasing the likelihood for effects to marine and anadromous protected species and their habitats. In marine systems, climate change impacts extend beyond changes in temperature and precipitation to include changes in pH, ocean currents, loss of sea ice, and sea level rise. The increased frequency and intensity of floods, droughts, summer low-flows, and stressful water temperatures already occurring in freshwater rivers and streams used by anadromous species are expected to continue or worsen in many locations. Estuaries may experience changes in habitat quality/quantity and productivity because of changes in freshwater flows, nutrient cycling, sediment delivery, sea level rise, and storm surge.

6.2 Climate Change Impacts to Shortnose and Atlantic Sturgeon

Shortnose and 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. Shortnose and Atlantic sturgeon spawning occurs in freshwater reaches of rivers because early life stages have little to no tolerance for salinity. Similarly, juvenile sturgeon have limited tolerance to salinity and remain in waters with little to no salinity. If the salt wedge moves further upstream, sturgeon spawning and rearing habitat could be restricted. In river systems with dams or natural falls that are impassable by sturgeon, the extent that spawning or rearing may be shifted upstream to compensate for the shift in the movement of the salt wedge would be limited. While there is an indication that an increase in sea level rise would result in a shift in the location of the salt wedge, at this time there are no predictions on the timing or extent of any shifts that may occur; thus, it is not possible to predict any future loss in spawning or rearing habitat. However, in all river systems, spawning occurs miles upstream of the salt wedge. It is uncertain over the long term (which includes the foreseeable future) that shifts in the location of the salt wedge would reduce freshwater spawning or rearing habitat. Although if habitat was restricted or somehow eliminated, productivity or survivability would likely 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 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. Shortnose and 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 stranding 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. Shortnose and 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 range-wide. In the foreseeable future, gradual increases in sea surface temperature are expected, but it is unlikely that this expanded range will be observed in the near-term future. If any shift does occur, it is likely to be minimal and thus, it seems unlikely that any increases in temperature will cause a significant effect to shortnose and 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 actions. However, even a small increase in temperate can affect dissolved oxygen concentrations. A one degree change in temperature in Chesapeake Bay could make parts of Chesapeake Bay inaccessible to sturgeon due to decreased levels of dissolved oxygen (Batiuk *et al.* 2009).

Although the action area does not include spawning grounds for shortnose and Atlantic sturgeon, sturgeon are migrating through the action area to reach their natal rivers to spawn. 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 alone 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. Hare *et al.* (2016) assessed the vulnerability to climate change of a number of species that occur along the U.S. Atlantic coast. The authors define vulnerability as “the extent to which abundance or productivity of a species in the region could be impacted by climate change and decadal variability.” Atlantic sturgeon were given a vulnerability rank of very high (99 percent certainty from bootstrap analysis) and a climate exposure rank of very high. Three exposure factors contributed to this score: sea surface temperature, ocean acidification, and air temperature. The authors concluded that Atlantic sturgeon are relatively invulnerable to distribution shifts. Climate factors such as sea level rise, reduced dissolved oxygen, and increased temperatures have the potential to decrease productivity, but the magnitude and interaction of effects is difficult to assess (Hare *et al.* 2016). Increasing hypoxia, in combination with increasing temperature, affects juvenile Atlantic sturgeon metabolism and survival (Secor and Gunderson 1998). A multivariable bioenergetics and survival model predicted that within the Chesapeake Bay, a 1°C increase in Bay-wide temperature reduced suitable habitat for juvenile Atlantic sturgeon by 65 percent (Niklitschek and Secor 2005). These studies highlight the importance of the availability of water with suitable temperature, salinity and dissolved oxygen; climate conditions that reduce the amount of available habitat with these conditions would reduce the productivity of Atlantic sturgeon.

Changes in water availability may also affect the productivity of populations of Atlantic sturgeon. In rivers with dams or other barriers that limit access to upstream freshwater reaches, spawning and rearing habitat may be restricted by increased saltwater intrusion; however, no estimates of the impacts of such change are currently available.

7.0 CONSEQUENCES OF THE ACTION

7.1 Blasting

The project involves blasting to facilitate the demolition of the old Nice-Middleton bridge piers in the Potomac River (approximately river kilometer 81). You estimate the effects of blasting will occur within a 1,300-acre area surrounding the old bridge. Blasting and removal of bridge materials will occur between October 15, 2023 and February 14, 2024. During this time of year, the majority of adult and juvenile shortnose sturgeon are expected to be located at the overwintering areas outside of the action area. In the action area, shortnose sturgeon have been found overwintering predominantly near the fresh/saltwater interface (SSSRT 2010, Kynard *et al.* 2009). Juveniles become increasingly tolerant to saline water with age and may use the entirety of the species' range in the Potomac River to forage. Therefore, juveniles may be present in the river year-round and utilize the full extent of the Potomac River (Kynard *et al.* 2007, Kynard *et al.* 2009), including in the vicinity of the Nice-Middleton Bridge where blasting will occur. Where suitable habitat is available, juveniles are expected to use the same habitats as adults (Kynard *et al.* 2009). Two tagged adult shortnose sturgeon females were detected in the Potomac River between river kilometer 63 to 141, which suggests that this portion of the river may be used for transient foraging during overwintering (Kynard *et al.* 2009). During the time of year for blasting, adult shortnose sturgeon within the action area may be moderately active and move throughout the river during overwintering periods (Kynard *et al.* 2009, SSSRT 2010). Therefore, shortnose sturgeon adults and juveniles may be present within the action area when blasting will occur.

The majority of adult and subadult Atlantic sturgeon are expected to overwinter in estuaries (seaward of river mouth), bays, sounds, and marine environments. However, a Balazik (2023) telemetry study conducted on the Potomac River between November 2020 and November 2022 confirmed the presence of seven subadult and one adult Atlantic sturgeon in the Potomac River as late as mid-December (Table 18). By early December, fish are expected to be either upstream of the salt wedge (upstream of the Nice-Middleton Bridge) or downstream in the Chesapeake Bay. Therefore, migratory fish may be present within the proposed blast impact area in October and November and are less likely to be present in December through February (Balazik 2023), when fish would otherwise be in their overwintering grounds. According to Balazik (2023), adult and subadult Atlantic sturgeon may be present near the Nice-Middleton Bridge when blasting will occur, specifically between October and November. Salinity at the Nice-Middleton Bridge peaks in winter months peaks between 12 and 16 parts per thousand, which may limit, but not completely remove, the likelihood of juvenile Atlantic sturgeon presence in the action area because of the energetic cost of osmoregulation (Allen *et al.* 2014, Balazik 2023). However, given that juvenile Atlantic sturgeon are known to be tolerant of saline waters, they may use the entirety of the Potomac River year-round to forage and overwinter, particularly in areas with soft substrate (*e.g.*, sand, mud) and a salinity from 0.5 up to as high as 30 parts per thousand (Kynard *et al.* 2007, NMFS 2017). Therefore, we assume that juveniles may be present in the action area when blasting will occur.

Blasting operations will occur at the rate of one blast per week during the October 15, 2023 and February 14, 2024 blasting period. Each blast event will be one second long. The total duration of blasting activities will occur within a four to six week timeframe within the blasting period accounting for technical challenges and potential weather delays. FHWA estimates that up to six blast events may occur. Blasting could cause physical injury or mortality to individual sturgeon and displace the sturgeon from the area where blasting is occurring. The blasting may also affect sturgeon by modifying the habitat and benthic community within the reach as well as by reducing foraging opportunities.

You designed the blasting plan to minimize the potential for fish mortality. As noted above, all blasting will occur between October 15, 2023 and February 14, 2024, when fish density is expected to be lowest, and to avoid interacting with or disturbing sturgeon spawning migrations. You will take the following measures to monitor and reduce the potential for fish mortality:

- Perform acoustic telemetry monitoring of shortnose and Atlantic sturgeon in the action area from March 2022 through December 2023 to continue data collection on the presence of sturgeon and delay blasting until any detected sturgeon leaves the Danger Zone;
- Use of fish deterrent noises (via sonar unit pulled behind a light vessel) prior to blasting;
- Use of fisheries and telemetry observers to reduce the potential that sturgeon are within the project area during blasting;
- Use of fish scare charges[11] with blast cap detonations (each will contain 0.75 grams of explosives to be suspended in the water column surrounding the structure) will be set off 30 seconds prior to blasting to drive fish away from the Danger Zone;
- Maintain a zone of fish passage in the river during blasting (*i.e.*, the area outside of the Danger Zone);
- Post-blasting surface monitoring for injured or dead sturgeon that will occur following each detonation;

[11] A scare charge is a small charge of explosives detonated immediately prior to a blast for the purpose of scaring aquatic organisms away from the location of an impending blast without producing so much pressure or noise that they could be injured or killed.

- Blast parameters designed to minimize underwater disturbance including:
  - minimization of maximum charge weights (*i.e.*, a blasting sequence from interior to exterior with lighter charges on the exterior),
  - a minimum of 9-millisecond charge delays,
  - stemming of drill holes,
  - utilization of blast mats placed over the exposed piers to be blasted to minimize projectiles.

7.1.1 Acoustic Deterrence

You will use both (1) acoustic deterrents (via sonar unit pulled behind a light vessel) and (2) scare blasts prior to blasting. Because you do not have any additional information at this time about the acoustic deterrents that will be used, we will assume that it will be similar to the acoustic deterrent system that was used for the Delaware Deepening project (NMFS 2019). If the acoustic deterrent system that you employ is significantly different than this one and causes additional effects, reinitiation of consultation may be required. The purpose of an acoustic deterrent system is to behaviorally deter sturgeon from entering or remaining in the blasting area. In July 2015, ERC (2015) conducted a feasibility study to test an acoustic deterrent system for the Delaware Deepening project. Their analysis provided evidence that some sturgeon avoided the loudest portions of an experimental sound field and that sturgeon experienced no latent effects of the sound exposure. The study showed that sturgeon spent 4.55 hours less in the regions of interest when the sound was on than when the sound was off; however, the difference in time spent during test and control conditions was not statistically significant at the $\alpha = 5$ percent level. Regardless, there was some evidence of avoidance behavior, and the authors concluded that ensonifying the blast area would add a degree of protection for the sturgeon that cannot otherwise be accomplished.

The deterrent system for the Delaware Deepening project consisted of a sound source capable of producing impulsive sound of the appropriate amplitude and frequency range, and a generator to power the source, mounted on a self-propelled pontoon boat. The sound source was an Applied Acoustic Engineering Ltd. (AAE) “boomer” typically used for subsurface geophysical profiling (Moody and Van Reenan 1967). The boomer is an electromagnetically driven sound source consisting of a triggered capacitor bank that discharges through a flat coil. Eddy currents are induced in aluminum plates held against the coil by heavy springs or rubber bumpers. The plates are violently repelled when the capacitor fires, producing a cavitation volume in the water, which acts as a source of low-frequency sound (Edgerton and Hayward 1964).

The sound source was set to produce a sound level (as determined at 33 feet (10 meters) from the source) of ≤204 dB re 1 µPa peak at a repetition rate of 20 per minute; it was also mounted 162 horizontally such that the sound is projected downward and laterally into the water column below the pontoon boat.

The sound source was moored as closely to the blasting location as safety and operational considerations allow, and operated continuously for at least five hours prior to each detonation.

The sound source was operated as close in time to the blast as safety allowed before being moved away from the blasting site (approximately 30 minutes).

Within the proposed window for subaqueous blasting (October 15, 2023 to February 14, 2024), you will employ fish deterrent activities, specifically fish scare charges with blast cap detonations and acoustic deterrent via a sonar unit pulled behind a light vessel, prior to blasting. The fish scare will be set off 30 seconds prior to the main detonation, then a 10-second count down will be given, and the blast will detonated. These fish scares will consist of a series of blasting caps, each containing 0.75 grams of explosives, suspended in the water column surrounding the structure to be blasted. The scare charges will likely be placed in very close proximity to the bridge and likely within the 640-meter Danger Zone.

Research demonstrates that the use of scare charges with small blasting caps can be effective at deterring fish from the blast zone. They are most effective when deployed 30 to 60 seconds prior to the main blast detonation (FHWA 2019), similar to the deployment for this action, described above. However, it is important to note that the use of higher charge weight scare charges can be more harmful than effective (McAnuff *et al.* 1994, Keevin *et al.* 1997). The effectiveness of acoustic deterrents varies because different species may respond differently to various acoustic frequencies and amplitudes (FHWA 2019). For example, a 10 Hz tone successfully deterred migrating Atlantic salmon smolt in a small river (Knudsen *et al.* 1992). Therefore, based on the available literature, the deterrent methods you propose for this project are expected to effectively encourage sturgeon to leave the project area prior to blasting.

7.1.1.1 Consequences of Noise Produced by Acoustic Deterrents

As noted above, the sound source was set to produce a sound level of ≤204 dB re 1 µPa peak at a repetition rate of 20 per minute for at least five hours prior to each detonation. Based on the results of the pilot study trials where the system operated at maximum energy (350 J), we expected peak noise to be 193 dB 1 µPa peak-to-peak (146 dB re 1 µPa single-pulse SEL) at a distance of 5.3 meters from the sound source. The ensonified area was approximately 0.4 square kilometers, and all Atlantic sturgeon behavioral responses were anticipated to occur within the ensonified area.

We expect potential injury to Atlantic and shortnose sturgeon upon exposure to impulsive noises greater than 206 dB re 1µPa peak or 187 dB re 1uPa cSEL. Peak noise levels for the noise produced by acoustic deterrents in the Delaware Deepening project did not exceed 193 dB re 1uPa2·s peak and, therefore, we expect acoustic deterrents will not exceed the peak noise exposure threshold of 206 dB re 1µPa during the Nice-Middleton Bridge project.

In addition to the “peak” exposure criteria, which relates to the energy received from a single impulse, the potential for injury exists for multiple exposures to lesser noise. That is, even if an individual fish is far enough from the source to not be injured during a single impulse, the potential exists for the fish to be exposed to enough less intense noise impulses to result in physiological impacts. The cSEL criterion is used to measure such cumulative impacts. The cSEL is not an instantaneous maximum noise level, but is a measure of the accumulated energy over a specific period of time (*e.g.*, the period of time it takes to install a specific structure, such as a pile). For the Delaware Deepening project, the impulsive noise was generated for five hours prior to each detonation (max of two detonations per day). The cSEL is calculated by incorporating both the noise level associated with a single impulse as well as the total number of noise events. In this instance, this would mean accounting for every impulse over the entire day (*i.e.*, one impulse every two seconds for two five-hour periods, for a total of 18,000 impulses). We calculated that the distance to the 187 dB re 1uPa cSEL isopleth was less than five meters from the noise source[12]. That means that in order to accumulate enough energy to be injured, a sturgeon would need to stay within five meters of the noise source for the entire 10-hour period that the system is operational. We do not expect this to happen because sturgeon in the Potomac River are highly mobile. Shortnose sturgeon may be moderately active while overwintering in the river (Kynard 2009, SSSRT 2010), only opportunistically foraging and/or migrating through the project area and Atlantic sturgeon are not expected to overwinter in the action area, and are expected to be transient (Balazik 2023). While some of the sturgeon tracked during the noise deterrent study did not avoid the ensonified area during the deterrent study, none of them were stationary for hours at a time. Therefore, it is not reasonable to anticipate that any sturgeon would stay within five meters of the sound deterrent system for 10 hours.

Based on this information, we do not expect any injury or mortality to result from exposure to the noise produced by acoustic deterrents. This conclusion is supported by the findings of ERC (2015). All of the sturgeon that were exposed to sound during ERC’s 2015 tests were detected by multiple receivers in the weeks following testing. All of them showed normal patterns of movement, indicating that exposure to sound had not injured or impaired them. Based on the best available information (discussed above), it is extremely unlikely that any sturgeon will be exposed to injurious levels of underwater noise created by the deterrent device.

Behavioral effects, such as avoidance or disruption of foraging activities, may occur in sturgeon exposed to noise above 150 dB RMS. The width of the river is 1.7 miles (2,736 meters) and you calculate a 816-meter zone of passage where effects of the action will not be experienced, with effects encompassing a 1,920-meter area around the blasting site. It is reasonable to assume that a sturgeon, upon detecting underwater noise levels at or above these thresholds, would modify their behavior such that the fish redirects its course of movement away from the ensonified area surrounding the activity. If any movements away from the ensonified area do occur, it is extremely unlikely that these movements would affect essential sturgeon behaviors, as the Potomac River is sufficiently wide enough (approximately 1.7 miles wide) to allow individuals to avoid the ensonified area while continuing to forage and migrate within the 816-meter zone of passage. Therefore, the effects of underwater noise produced by acoustic deterrents on ESA species would be too small to be meaningfully measured or detected.

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[12] Using the NMFS pile driving calculator (available at: www.wsdot.wa.gov/) and using a peak noise level of 193 dB, SEL of 146, and RMS of 178 (calculated by subtracting 15 from the peak as recommended by the authors of the calculator), all measured at a distance of 5.3 m from the sound source as described in ERC (2015).

Here, we consider consequences to Atlantic and shortnose sturgeon that leave and/or are excluded from the ensonified area. Any sturgeon in the Potomac River project area during the time of year when acoustic deterrents are employed will be migrating and/or opportunistically foraging and their exposure times to potentially injurious noise levels will be short in duration, or will not occur because the fish are overwintering in nearby areas. Therefore, any consequences to Atlantic or shortnose sturgeon that are deterred from the action area in Potomac River are too small to be meaningfully measured or detected and are insignificant.

7.1.2 Available Information on Consequences of Sound Pressure on Fish

Sturgeon rely primarily on particle motion to detect sounds (Lovell *et al.* 2005). While there are no data either in terms of hearing sensitivity or structure of the auditory system for Atlantic and shortnose sturgeon, there are data for the closely related lake sturgeon (Lovell *et al.* 2005, Meyer *et al.* 2010), which serve as a good surrogate for Atlantic and shortnose sturgeon when considering acoustic impacts due to the biological similarities among the species. The available data suggest that lake sturgeon can hear sounds from below 100 Hz to 800 Hz (Lovell *et al.* 2005, Meyer *et al.* 2010). However, since these two studies examined responses of the ear and did not examine whether fish would behaviorally respond to sounds, it is hard to determine the level of noise that would trigger a behavioral response (that is, the lowest sound levels that an animal can hear at a particular frequency) using information from these studies. The best available information indicates that Atlantic and shortnose sturgeon are not capable of hearing noise in frequencies above 1,000 Hz (1 kHz) (Popper 2005). Sturgeon are categorized as hearing "generalists" or "non-specialists" (Popper 2005).

Sturgeon do not have any specializations, such as a coupling between the swim bladder and inner ear, to enhance their hearing capabilities, which makes these fish less sensitive to sound than hearing specialists. Low-frequency impulsive energies, including pile driving, cause swim bladders to vibrate, which can cause damage to tissues and organs as well as to the swim bladder (Halvorsen *et al.* 2012). Sturgeon have a physostomous (open) swim bladder, meaning there is a connection between the swim bladder and the gut (Halvorsen *et al.* 2012). Fish with physostomous swim bladders, including Atlantic and shortnose sturgeon, are able to expel air, which can diminish tension on the swim bladder and reduce damaging effects during exposure to impulsive sounds. Fish with physostomous swim bladders are expected to be less susceptible to injury from exposure to low-frequency impulsive sounds, such as pile driving, than fish with physoclistous (no connection to the gut) swim bladders (Halvorsen *et al.* 2012).

If a noise is within a fish's hearing range and is loud enough to be detected, effects can range from mortality to a minor change in behavior (*e.g.*, startle), with the severity of effects increasing with the loudness and duration of the exposure to the noise (Hastings and Popper 2005). The actual nature of effects and the distance from the source at which they could be experienced will vary and depend on a large number of factors. Factors include fish hearing sensitivity, source level, how the sounds propagate away from the source, and the resultant sound level at the fish, whether the fish stays near the source, the motivation level of the fish, etc.

7.1.2.1 Criteria for Assessing the Potential for Physiological Consequences to Sturgeon
The Fisheries Hydroacoustic Working Group (FHWG) was formed in 2004 and consists of biologists from NMFS, USFWS, FHWA, and the California, Washington, and Oregon DOTs, supported by national experts on sound propagation activities that affect fish and wildlife species of concern. In June 2008, the agencies signed a Memorandum of Agreement documenting criteria for assessing physiological effects of pile driving on fish. The criteria were developed for the acoustic levels at which physiological effects to fish could be expected. It should be noted that these are onset of physiological effects (Stadler and Woodbury 2009), and not levels at which fish are necessarily mortally damaged. These criteria were developed to apply to all species, including listed green sturgeon, which are biologically similar to Atlantic and shortnose sturgeon and, for these purposes, are considered a surrogate. The interim criteria are:

- Peak Sound Pressure Level (SPL): 206 decibels relative to 1 micro-Pascal (dB re 1 µPa) (206 dBPeak).
- Cumulative Sound Exposure Level (cSEL): 187 decibels relative to 1 micro-Pascal squared second (dB re 1µPa2 -s) for fishes above 2 grams (0.07 ounces) (187 dBcSEL).

At this time, these criteria represent the best available information on the thresholds at which physiological effects to sturgeon from exposure to impulsive noise, such as pile driving, are likely to occur. It is important to note that physiological effects may range from minor injuries from which individuals are anticipated to completely recover with no impact to fitness, to significant injuries that will lead to death. The severity of injury is related to the distance from the pile being installed and the duration of exposure. The closer the fish is to the source and the greater the duration of the exposure, the higher likelihood of significant injury.

Since the FHWG criteria were published, two papers relevant to assessing the effects of pile driving noise on fish have been published. Halvorsen *et al.* (2011) documented effects of pile driving sounds (recorded by actual pile driving operations) under simulated free-field acoustic conditions where fish could be exposed to signals that were precisely controlled in terms of number of strikes, strike intensity, and other parameters. The study used Chinook salmon and determined that onset of physiological effects that have the potential of reduced fitness, and thus a potential effect on survival, started at above 210 dB re 1µPa2-s cSEL. Smaller injuries, such as ruptured capillaries near the fins, which the authors noted were not expected to impact fitness, occurred at lower noise levels.

Halvorsen *et al.* (2012a) exposed lake sturgeon to pile driving noise in a laboratory setting. Lake sturgeon were exposed to a series of trials beginning with a cSEL of 216 dB re 1uPa2 -s (derived from 960 pile strikes and 186 dB re 1uPa2 -s sSEL). Following testing, fish were euthanized and examined for external and internal signs of barotrauma. None of the lake sturgeon died as a result of noise exposure. Lake sturgeon exhibited no external injuries in any of the treatments but internal examination revealed injuries consisting of hematomas on the swim bladder, kidney, and intestines (characterized by the authors as “moderate” injuries) and partially deflated swim bladders (characterized by the authors as “minor” injuries). The author concludes that an

appropriate cSEL criteria for injury is 207 dB re 1uPa2 -s. Chinook salmon are hearing generalists with physostomous swim bladders. Results from Halvorsen *et al.* (2012b) suggest that the overall response to noise between chinook salmon and lake sturgeon is similar.
It is important to note that both Halvorsen papers (2012a, 2012b) used a response weighted index (RWI) to categorize injuries as mild, moderate, or mortal. Mild injuries (RWI 1) were determined by the authors to be non-life threatening. The authors made their recommendations for noise exposure thresholds at the RWI 2 level and used the mean RWI level for different exposures. We consider even mild injuries to be physiological effects and we are concerned about the potential starting point for physiological effects and not the mean. Therefore, for the purposes of carrying out section 7 consultations, we will use the FHWG criteria to assess the potential physiological effects of noise on Atlantic and shortnose sturgeon and not the criteria recommended by Halvorson *et al.* (2012a, 2012b). Following the FHWG criteria, we will consider the potential for physiological effects upon exposure to impulsive noise of 206 dBPeak. Use of the 187 dBcSEL and 183 dBcSEL threshold (for sturgeon 2 grams or smaller) is a cumulative measure of cumulative impulsive sound (such as impact pile driving) and is not appropriate for blasting. As explained here, physiological effects from noise exposure can range from minor injuries that a fish is expected to completely recover from with no impairment to survival to major injuries that increase the potential for mortality or result in death.

7.1.3 Available Information on Consequences of Blasting on Fish

The formula in Hempen *et al.* (2007) was used to calculate the blasting Mortality Zone depicted in Figure 1. The equation below for open-water pressures was manipulated using the Hubbs and Rechnitzer (1952) lower bound of lethal pressure value of 280 kilopascal (40 pounds per square inch). This equation was previously used by Hempen *et al.* (2005). The mortality radius for single, open water shots (MROW) is calculated as:

MROW (feet) = 260 $wOW^{1/3}$

where wOW = the maximum charge weight (in pounds) per delay[13] of a single, open-water blast

This equation was developed as an estimate of pressure from the closest confined holes at Miami Harbor. The mortality radius for confined shots may be resolved from the confined pressure of the equation and using the low lethal pressure of 40 pounds per square inch. The mortality radius for single, confined shots, MRC, is:

MRC (feet) = 56 $wC^{1/3}$

where wC = the maximum charge weight (in pounds) per delay of a single, confined blast

Considering a maximum amount of explosive per delay of 13.6 kilograms (30 pounds), this yields a Mortality Zone of 52 meters (172 feet) around each of the five piers to be blasted for a combined area of 4.1 hectares (10.2 acres) (Figure 1). The maximum charge to be used is 13.6 kilograms (30 pounds) per delay, but these charges will be in the center of the pier. The charges

[13] A blast delay is a simple and intuitive delay within the blast sequencer. Delay patterns allow for more efficient use of the explosive energy in the blast.

closest to the exterior of the pier will be a minimum of 8.2 kilograms (18 pounds) per delay, 40 percent less than the maximum charge weight per delay.

The formula in Hempen *et al.* (2005) was utilized to calculate the Danger Zone around the blast area, which was calculated to encompass the underwater area where all the consequences of blasting may be experienced. The formula used to calculate the Danger Zone is:

$R = [520\ (W)^{1/3}]$

where R = the Danger Zone in feet

W = the maximum pounds of explosive per delay

The maximum pounds of explosive per delay for this project is 13.6 kilograms (30 pounds), which yields a Danger Zone of 640 meters (2,100 feet) around each pier (Figure 1). This formula has been used previously for bridge pier demolition via explosives under Section 7 consultation with us and is considered the best available information. Although this is the best available information, it may be considered conservative for the current project because the blast design requires that the 13.6-kilogram (30-pound) charges are located in the interior of the piers and the 8.2-kilogram (18-pound) charges are closest to the exterior of the piers (40 percent less charge weight than the maximum for the blast) and is expected to result in less energy release and resulting impact to the water column than predicted by the formula (Figure 1). The zones of influence described above are depicted in Figure 1 and are consistent with the available information described below on the consequences of blasting on fish.

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

Underwater explosions may affect marine life by causing death, injury, temporary threshold shifts (TTS or recoverable hearing loss), or behavioral reactions, depending on the distance an animal is located from a blast. An underwater explosion is composed of an initial shock wave, followed by a succession of oscillating bubble pulses. A shock wave is a compression wave that expands radially out from the detonation point of an explosion. At a distance from a detonation, the propagation of the shock wave may be affected by several components including the direct shock wave, the surface-reflected wave, the bottom-reflected wave, and the bottom-transmitted wave. The direct shock wave results in the peak shock pressure (compression) and the reflected wave at the air-water surface produces negative pressure (expansion). For an explosion with the same energy and at the same distance, an underwater blast is much more dangerous to animals than an air blast. The shock wave in air dissipates more rapidly and tends to be reflected at the body surface; in water, the blast wave travels through the body and may cause internal injury to gas-filled organs due to impedance differences at the gas-liquid interface. The soft sediments found in the action area may absorb shock waves and reduce the intensity of the bottom-reflected wave that may affect fish.

Fishes with swim bladders, including both species of sturgeon, are more likely to be killed or injured by blasting than fishes without swim bladders (Christian 1973). The primary cause of blast-related fish mortality is tissue damage to gas filled organs such as the intestinal tract and swim bladders. Internal injuries to other organ systems have resulted from the rapid expansion of the swim bladder because of exposure to negative pressures or "cavitation hat" from a shock wave. The magnitude of damage has been correlated with the mass of individuals, such that smaller size classes of fish would be expected to incur greater blast injury than larger size classes at the same exposure level (Yelverton *et al.* 1975, Goertner 1978, Wiley *et al.* 1981, O'Keefe 1984, Munday *et al.* 1986). This may be the reason some studies have reported that sturgeon exhibit less severe blast damage than other species tested (Moser, 1999a and 1999b). The larger size of sturgeon that may be present in the action area (juvenile through adult) may make sturgeon less susceptible to the adverse internal effects from blasting. However, sturgeon have been reported to be killed by underwater explosions, regardless of size, but other factors such as age, general health, water temperature, and reproductive condition may influence mortality (Keevin *et al.* 1997). External damage appears to be species specific and related to the magnitude of the pressure wave (*e.g.*, charge size and distance from explosion (Keevin *et al.* 2002).

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

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

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

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

Burton (1994) conducted experiments to estimate the effects of blasting to remove approximately 1,600 cubic yards of bedrock during construction of a natural gas pipeline in the Delaware River near Easton, Pennsylvania. American shad and smallmouth bass juveniles were exposed to charges of 112.5 and 957 kilograms of explosives in depths ranging between 0.5 and 2 meters. The fish were caged at a range of distances from the blasts. Tests with American shad were inconclusive due to an unavoidable delay between the time when the chambers were stocked and the detonation of the explosives; however, successful tests with smallmouth bass suggested that the explosives created a maximum kill radius of 12 meters (for both charge magnitudes). No fish were killed by the shock wave at the 24-meter position and beyond.

Hubbs and Rechnitzer (1952) looked at the consequences of blasting on the following caged fish: anchovies, jack mackerel, kingfish, sardine, queenfish, pompano, and grunion. The cages were placed anywhere from 10-92 feet from the charge. They determined that the lethal threshold peak pressure for a variety of marine fish species exposed to dynamite blasts varied from 40 pounds per square inch (280 kilopaschals, kPa) to 70 pounds per square inch (480 kPa) (Hubbs and Rechnitzer 1952).

Keevin (1995) compared the mortality of bluegill exposed to three high-explosive types (T-100 Two Component, Pellite, and Apex 260) spanning the range of detonation velocities within commercially available explosives. Using equivalent weights of explosives, there was no 167 significant difference in mortality curves based on distance from the explosive charge. An abrupt increase in internal damage (ruptured swim bladder, kidney, liver, and spleen damage) occurred at values above approximately 700 kPa peak pressure, and mortality abruptly increases at approximate values above 500 kPa peak pressure (Keevin 1995). According to the USACE (2004), Keevin (1995) found no mortality or internal organ damage to bluegill exposed to a high explosive at pressures at or below 400 kPa (60 pounds per square inch).

The preceding studies were not conducted on Atlantic or shortnose sturgeon, but the nature of the injuries and the optimal distance from the detonations could be applied to blasting activities and the two sturgeon species. The effects of blasting on shortnose sturgeon have been examined. Test blasting was conducted in the Wilmington Harbor, North Carolina, in December 1998 and

January 1999 in order to adequately assess the impacts of blasting on shortnose sturgeon, the size of the LD1 area (the lethal distance from the blast where 1 percent of the fish died), and the efficiency of an air curtain for mitigating blast effects.

As explained in Moser (1999a), the test blasting consisted of 32-33 blasts, about 24 to 28 kilograms of explosives per hole, and an approximate 25 meters per second delay after each blast. During test blasting, 50 hatchery reared juvenile striped bass and shortnose sturgeon were placed in 0.25 inch plastic mesh cylinder cages (two feet in diameter by three feet long) three feet from the bottom (worst case scenario for blast pressure as confirmed by test blast pressure results) at 35, 70, 140, 280, and 560 feet upstream and downstream of the blast location. For each test, 200 caged shortnose sturgeon were held at a control location 0.5 miles from the test blast area. The caged fish had a mean weight of 55 grams.

Several fish within 70 feet of the drill holes (most within 35 feet) were necropsied. These fish were in apparently normal condition when necropsied 24 hours after the blast. The fish were swimming normally in their cages and exhibited no outward signs of stress or physical discomfort (Moser 1999b). Of the 70 sturgeon necropsied, ten likely would not have survived the injuries sustained during blasting. While sturgeon had relatively little damage to their swim bladders, they more often had distended intestines with gas bubbles inside and hemorrhage to the body wall lining. In the fish caged 70 feet away, there was no sign of hemorrhage or swim bladder damage but two of the fish exhibited distended intestines, which may have been caused by the blast. Moser (1999) speculated that sturgeon fared better than striped bass because their air bladder has a free connection to the esophagus, allowing gas to be expelled rapidly without damage to the swim bladder.

The numbers of injured, dead, and mortally injured sturgeon varied greatly between tests. Of the 500 fish tested during each blast, mortalities (dead or mortally injured) ranged from one to 89 fish. Mortality rates for shortnose sturgeon as compared to the other species tested were low, with the author of the report concluding that this was likely due to the larger size of shortnose sturgeon tested (approximately 30 centimeter average) as compared to the size of the other species (3 – 20 centimeters). Therefore, mortality for sturgeon 30 centimeters or larger may occur less frequently due to their size. However, some fish caged as far as 560 feet away from the blast died or were injured/mortally injured within 24 hours of the blast. Given that some fish in the control study also died, and that none of the fish caged this far away were necropsied, it is impossible to know whether they died of causes unrelated to the blasting experiment.

The total number of blasts (n=33) used in the Moser (1999) study described above exceed the maximum number of blasts proposed for this study (n=6). In addition, the maximum amount of explosives used in the Moser (1999) study (24 to 28 kilograms of explosives) exceed the maximum amount of explosives for the Nice-Middleton Bridge project (13.6 kilograms per delay). Therefore, we can conclude that the consequences of blasting on fish may be less severe (less injury and mortality, particularly for fish that are 30 centimeters or larger) than described in the Moser (1999) study.

A monitoring program was implemented for the Kill Van Kull Deepening project in 2004 to examine the fish communities of the NY/NJ Harbor Complex, the potential consequences of blasting on the aquatic biota of the harbor, and recorded water-borne pressures from confined blasts. In-situ blast pressure monitoring was conducted to record water-borne blast pressures from confined blasts. Data was collected from actual blasts to compare with open water blasts, which are unconfined and produce high peak pressures in the water. Pressure data was collected from confined blasts of varying intensities to calculate theoretical mortality radii for aquatic organisms. The blast pressures recorded in the Kill Van Kull were noted to be quite low (3.4 to 20 pounds per square inch) compared to the theoretical value of an equivalent charge weight, open water shot (71-104 pounds per square inch) (USACE 2004). The St. Louis District has performed numerous studies on the waterborne energy from blasting, and stated that the blast pressures recorded during the Kill Van Kull study were among the lowest levels of maximum pressure recording that they have taken (USACE 2004). The data inferred that the confined charges used in the Kill Van Kull Blasting Program appear to have less of an impact on aquatic biota than would equivalent open water charges (USACE 2004). The fish kill that did occur was likely very close to the placed charges. The actual limits of the kill radii cannot be determined without caged fish. Stunned and killed fish were recovered by hand net from the surface. A theoretical estimate of the pressure and impact of the "average" blast event monitored during this study would result in a pressure of about 90 pounds per square inch with a kill radius of about 375 feet (USACE 2004). The data also implies that the confined charges used in the Kill Van Kull Blasting Program appear to have less of an impact on fish than would equivalent open water charges. However, without completion of a caged fish study, quantitative estimates and/or calculations of mortality radii may not be made.

The maximum pounds of explosive per delay for the Nice-Middleton Bridge project is 13.6 kilograms (30 pounds), which is less than the 90 pounds used in the USACE (2004) study. However, as described above, several variables impact the magnitude of the blasting consequences on fish (Teleki and Chamberlain 1978), including detonation velocity, density of material to be blasted, and charge weight of the blast and biological variables including fish shape, location of fish in the water column, size of the fish (Moser 1999), and swim bladder development. In addition, water depth and bottom composition also interact to determine the characteristics of the explosion pressure wave consequences on fish (Teleki and Chamberlain 1978, Moser 1999). Given all of the variables that may influence the consequences of blasting on fish, although the area is greater than the one calculated in the above USACE (2004) study, the Danger Zone of 640 meters (2,100 feet) around each pier calculated above represents the most accurate impact estimate based on the best available information. Therefore, compared to the studies discussed above, the zones of influence for blasting (*i.e.*, Mortality Zone and Danger Zone) are consistent with the available information on the consequences of blasting on fish and are expected to encompass all of the underwater areas that where the consequences of blasting may be experienced.

7.1.4 Consequences of Proposed Blasting on Shortnose and Atlantic Sturgeon

During the winter months, we expect some adult and juvenile shortnose sturgeon to be transient within the project area (river kilometer 81) within the Potomac River, specifically between river kilometer 63 to 141 (SSSRT 2010, Kynard *et al.* 2009), because of occasional movements between overwintering areas. Therefore, adult and juvenile shortnose sturgeon may be transient within the action area when blasting will occur.

Recent work by Balazik (2023) indicates that subadult and adult Atlantic sturgeon may migrate through the blasting and habitat modification component of the action area until early December. Juvenile Atlantic sturgeon may also be present in the action area in the winter months (Kynard *et al.* 2007, Kynard *et al.* 2009, SSSRT 2010). Therefore, adult, subadult, and juvenile Atlantic sturgeon may be transient within the action area when blasting will occur.

Sturgeon appear to be able to withstand some degree of exposure to blasting at a certain distance from the detonation, but it is apparent from the study results outlined above that if sturgeon are close enough to a detonation, the exposure to blasting may injure the species internally and/or externally. Given the discussion of past blasting studies, the impact zone calculations, and considering the multiple variables that may influence the consequences of blasting on fish described above, we conclude that the Danger Zone of 640 meters (2,100 feet) around each pier represents the most accurate impact estimate based on the best available information. Therefore, any sturgeon within 640 meters (2,100 feet) of the target pier during a given blasting event could experience injury or mortality.

The blast severity of the impact on fish is dependent on several biological and physical variables. Results from previous blasting studies conducted on thirteen species of fish other than shortnose and Atlantic sturgeon, revealed that swim bladder rupture and hemorrhaging in the pericardial and ceolomic cavities were common injuries that resulted from exposure to blasting. While studies on shortnose sturgeon revealed that they also suffer from swim bladder ruptures, more common blast induced injuries that resulted were distended intestines with gas bubbles inside and hemorrhage to the body wall lining (Moser 1999a, b). Overall, however, it is difficult to determine the extent of internal injury because many fish did not exhibit external stress or physical discomfort despite extensive internal damage. Approximately 10 percent of fish that appeared to have suffered no injury, actually sustained injuries from the blasting and it is speculated this would have led to their eventual death.

Based on the information presented above, shortnose and Atlantic sturgeon within 640 meters of a detonation would be exposed to noise and pressure levels that could result in behavioral avoidance, temporary stunning, external or internal injury with full recovery, injury with delayed mortality, or injury sufficient to cause immediate mortality. Based on the best available information, it is also likely that the smaller the fish is and the closer it is to the blast, the more significant the injuries would be (Moser 1999).

7.1.4.1 Estimating Sturgeon Exposure to Blasting Noise

Up to six blasting events may occur between October 15, 2023 and February 14, 2024 as part of the proposed project. You will utilize measures to minimize the potential for take of sturgeon resulting from blasting. You will use acoustic telemetry monitoring to determine if tagged sturgeon are within the Danger Zone of the blast site (total of 640 meters (2,100 feet) from each pier). If a sturgeon is detected or observed, you will delay the blast until the sturgeon has moved safely out of the Danger Zone. As explained above, we estimate that in order to be injured or killed, a sturgeon would need to be within 640 meters of the bridge (*i.e.*, Danger Zone) during the one-second duration of the detonation.

As noted above, as part of the Balazik (2023) Atlantic sturgeon telemetry study, a total of 24 adult and subadult (three adult, 21 subadult) Atlantic sturgeon were detected in the Potomac River during the two-year study (November 2020 to November 2022). Eleven of the sturgeon were tagged upstream of the Nice-Middleton Bridge in 2020 to 2021 while the remaining were tagged in other water bodies (Table 17). Balazik's (2023) report includes data from fish (n=5) that had internal surgeries within 3 months of the study, which may have affected their natural movements, but only data from fish that were characterized by the author to be "acting naturally" (*i.e.*, fish had not undergone surgery within 3 months of the study) were used to analyze effects in this Opinion. A total of eight fish that were expected to be acting naturally were detected within 1,200 meters (1.2 kilometers) of the action area near the blasting site between October 15 and February 14. The fish were within the vicinity of the Nice-Middleton Bridge from one hour to a maximum of ten days for several hours each day (Table 18). Except for one fish detected on December 6, all the detections from December through February were fish that were likely affected by recent internal surgeries, which likely modified their behavior. Therefore, by early December, most subadults and adults are likely outside of the action area, either upstream near the salt front or downstream in the Chesapeake Bay.

As noted above, two tagged adult shortnose sturgeon females used between river kilometer 63 to 141 during the overwintering period, which suggests that this portion of the river may be used for foraging as sturgeon migrate through the area during overwintering (Kynard *et al.* 2009). Shortnose sturgeon within the action area are also expected to be moderately active and may move throughout the river and pass through the action area during overwintering periods (SSSRT 2010), but are not expected to congregate or spend an extended period of time within the project area during this time.

Based on the information from Kynard *et al.* (2009) and Balazik (2023), we expect that some shortnose sturgeon and Atlantic sturgeon may be transient in the blasting area during the blasting period. At the blast site, active acoustic monitoring will provide notice of the presence of any tagged sturgeon in the area. In addition, the acoustic deterrent, described above, may act as a behavioral deterrent to at least some sturgeon and reduce the number of sturgeon passing within 640 meters (2,100 feet) of the bridge (Danger Zone) at the detonation site. We are unable to estimate the number of sturgeon that would be in the Danger Zone at the time of blasting because we do not have information regarding the number of shortnose or Atlantic sturgeon in the Potomac River. However, we expect the majority of sturgeon in the river will be well above or below the Danger Zone at the time of blasting. Based on information from Balazik (2023) and Kynard *et al.* (2009), we expect that a small proportion of sturgeon in the river could be moving through the action area in October and November. Due to the very short amount of time we expect sturgeon to linger in the area (a few hours to a few days), the relatively small number of blasts (up to six spaced at least a week apart), and the use of deterrents and observers (telemetry and visual), we expect that the majority of the already small proportion of sturgeon in the river will be effectively excluded from the Danger Zone. However, despite all of the minimization measures, there is still the potential for a very small number of sturgeon to be in the Danger Zone at the time of blasting. The ERC (2015) study described above concluded that, although some avoidance behavior was observed, the difference in time sturgeon spent in an area during acoustic deterrent tests when compared to control conditions was not statistically significant (α = 5 percent). Therefore, although there was some evidence of avoidance behavior, we cannot assume that sturgeon will completely avoid the area solely based on the fact that acoustic deterrents will be used. Based on the above information, it is reasonable to assume that up to one sturgeon could be killed during each blasting event (n=6). As such, we anticipate that up to six sturgeon total will be exposed to the effects of blasting and may be killed or injured during blasting events. Although the six sturgeon could be of either species, we anticipate that up to three of affected sturgeon will be Atlantic sturgeon and up to three will be shortnose sturgeon. Based on the life stages that occur in the action area and the research described above (Kynard *et al.* 2009, Balazik 2023), any shortnose sturgeon killed will likely be a juvenile or adult; and any Atlantic sturgeon will likely be juveniles, subadults, or adults from the Chesapeake Bay DPS.

Outside of the 640 meter (2,100 feet) Danger Zone, we do not expect any adverse effects to sturgeon from blasting. Levels of noise from the blast may exceed the behavioral threshold for sturgeon (150 dB RMS) beyond 640 meters (the maximum pounds of explosive per delay for this project is 13.6 kilograms (30 pounds), which yields a Danger Zone of 640 meters (2,100 feet) around each pier (Figure 1)) and increased turbidity and total suspended solids may also extend beyond this area, as discussed below. The width of the river is 1.7 miles (2,736 meters) and consequences of blasting are expected to encompass a 1,920-meter area around the blasting site, which accounts for the maximum of 3 blasts that may occur simultaneously for removal of Pier 16, 17 and 18, therefore, a minimum zone of passage of 816 meters where effects of blasting will not be experienced will be available for sturgeon foraging. Behavioral effects, such as avoidance or disruption of foraging activities due to noise, may also occur in sturgeon exposed to noise above 150 dBRMs. It is expected that underwater noise levels would be below 150 dB RMS at distances beyond approximately 640 meters from the blast site. If any movements away from the ensonified area do occur, it is extremely unlikely that these movements will affect essential sturgeon behaviors (*e.g.*, spawning, foraging, resting, and migration) as sturgeon will only be transient and opportunistically foraging in the action area. Given the small distance a sturgeon would need to move to avoid the disturbance levels of noise, any effects will be too small to be able to be meaningfully measured or detected. Therefore, any behavioral effects on sturgeon as they move away from the blasting noise will be insignificant.

Studies of the consequences of turbid water on fish suggest that concentrations of suspended sediment can reach thousands of milligrams per liter before an acute toxic reaction is expected (Burton 1993). Increased turbidity and total suspended solids is most likely to affect sturgeon if a plume causes a barrier to normal behaviors. Given that a zone of passage will be maintained, that sturgeon are tolerant of turbid waters, and that there are areas for forage in the action area outside of the affected area, any minor movements to avoid increased turbidity and total suspended solids on sturgeon's migrating and foraging behavior will be too small to be meaningfully measured or detected.

7.1.4.2 Consequences of blasting on sturgeon prey

You estimate that the total area of impact to bottom substrate from blasting will encompass a 1,300-acre area around the bridge location. Benthic organisms may be susceptible to effects from blasting operations within the action area, which may impact sturgeon foraging opportunity. Shortnose sturgeon generally feed when the water temperature exceeds 10°C and in general, foraging is heavy immediately after spawning in the spring and during the summer and fall, with lighter to no foraging during the winter (Kynard *et al.* 2016, NMFS 1996). However, shortnose and Atlantic sturgeon may be opportunistically foraging in the vicinity of the blasting operations.

Fry and Cox (1953) observed the effects of blasting using black powder on invertebrates off the coast of California. A 45-pound (20.4 kilogram) charge of E.P. 138 Seismograph Black Powder was detonated within 6 feet (1.8 meters) of the surface and divers made observations of the damage. The authors noted that "clams and tube worms were found, none of which had suffered ill effects from the blast. These animals all responded in the normal manner by quickly withdrawing siphons and tentacles when touched by the divers." After the second day of testing, the authors noted that "none of the invertebrates seemed to be affected; the sea anemones were extended, as were the tube worms; none of the corals had been broken; the sea urchins were still on the rocks and the sea cucumbers had not contracted."

Keevin and Hempen (1997) assembled a literature review on the effects of blasting to aquatic invertebrates that observed the impacts to benthic organisms over distance gradients using "shots" with similar or greater force as proposed to demolish the five piers and fender nose for this project. Mortality of oysters, blue crabs, various crabs, snails, shrimp, clams, and worms was observed. Mortality was low overall and benthic invertebrate organisms were not highly sensitive to underwater blasting. This could be attributable to the fact that all the invertebrate species tested lack gas-containing organs, which have been implicated in internal damage and mortality in vertebrates (Keevin and Hempen 1997). The impact on benthic species should not extend beyond the immediate blasting area as previous studies indicate that invertebrates are relatively insensitive to pressure related damage from underwater detonations (USACE 2000). As explained above, the width of the river is 1.7 miles (2,736 meters) and effects of blasting are expected to encompass up to a 1,920-meter area around the blasting site (accounts for the maximum of 3 blasts that may occur simultaneously for removal of Pier 16, 17 and 18), therefore, a 816-meter zone of passage where effects of blasting will not be experienced will be available for sturgeon foraging. Benthic communities impacted by blasting are expected to recolonize the area after the project is complete (Wilber and Clarke 2007). Therefore, any effects of the blasting operations on sturgeon prey items within the action area will be too small to be meaningfully measured or detected, and therefore, insignificant.

7.2 Habitat Modification

Mechanical demolition was included as part of the proposed action in the 2019 Nice-Middleton Bridge consultation and has not been completed to date, but will be carried out as originally consulted on. Mechanical demolition to dismantle Piers 10, 11, 12, 13, and 19 includes the use of above-water explosives and removal of the demolition debris from the river via a mechanical dredge. These activities for demolition of the existing bridge started in October 2022 and are expected to be completed in 2024.

The habitat modification part of the action considered herein involves the use of concrete rubble from the pier demolition to partially fill the existing scour holes that are up to 4.6 meters (15 feet) deep at the base of Piers 3 through 10 and Piers 14 through 16. No placement is proposed for Piers 17, 18, or 19 because there are no scour holes present at the bases of those piers. The 11 scour holes are lacking 32,737 cubic yards of material in total and a total of 12,922 cubic yards of concrete rubble material will be placed to fill the holes (Table 2). The clean concrete rubble from each pier after demolition will be pushed into the pier's scour holes with large excavators attached with buckets, grapple, and clamshells operating from barges. The concrete rubble from the demolition effort in these 11 locations will raise the elevation of the riverbed from the bottom of the deep scour holes to an elevation close to the river bottom. Space will be left on top of each filled scour hole to encourage soft sediment to fill in with depositional soft sediment over the concrete rubble.

You propose to use blast containment measures that will ensure that the rubble produced from the blasts is controlled, and does not land far away from the blasting site. Therefore, we expect that the rubble will be in close proximity to the location that it will subsequently be moved to, and placed within, the scour holes. The demolition material associated with the other 69 pier locations will be removed from the river bottom, as described in the 2019 consultation. The total area of soft bottom substrate below the old bridge that will be disturbed by the placement of the rubble is 0.5 hectare (1.2 acres). This portion of the project, in addition to the mechanical demolition considered in the 2019 consultation, will occur from the fall of 2023 through mid-2024, accounting for material placement after the end of the blasting window on February 14, 2024. You also expect that a 1,300-acre area around the old bridge of soft bottom substrate will be impacted from project activities (Figure 1). Activities that contribute to habitat modification, the resulting effects to bottom substrate from blasting, and mechanical demolition activities are all expected to occur within 1,300 acres of the old Nice-Middleton Bridge.

7.2.1 Effects of Habitat Modification on Sturgeon Foraging

The action has the potential to temporarily impact soft bottom substrates and benthic communities suitable for juvenile, subadult, and adult sturgeon foraging within the Potomac

River. However, these impacts are limited to an area within and immediately surrounding the footprint of each blasted pier within the action area. Habitat modification activities will occur in 0.5 hectare (1.2 acres) of the action area at the base of the old bridge, but effects of the action may extend up to 1,300 acres from the Nice-Middleton Bridge. Some of the area is part of the Federal Navigation Channel or directly adjacent to it. 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.

Shortnose and Atlantic sturgeon feed on a variety of benthic invertebrates. One of the major potential food sources for shortnose sturgeon is the Asiatic river clam (*Corbicula manilensis*) as this shellfish is very abundant (Brundage, pers. communication, 2014). While shortnose sturgeon feed on shellfish and other benthic invertebrates, shellfish typically make up a very small percentage of the prey base of Atlantic sturgeon; Atlantic sturgeon prey primarily on soft bodied invertebrates such as worms (Guilbard *et al.* 2007, Savoy 2007). However, habitat modification activities are 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). Habitat modification, that involves pushing concrete rubble into scour holes, and mechanical demolition activities are likely to kill at least some of these potential sturgeon forage items. The action area within the Potomac River is not known to support aggregating sturgeon for overwintering and sturgeon are likely to only migrate through and opportunistically forage during the overwintering period.

Both species of sturgeon may forage in the full extent of the action area, primarily over soft substrates. You estimate that the total area that is subject to impacts from habitat modification and blasting activities is approximately 1,300 acres (Figure 1). This area is approximately 1.6 percent of the total action area (82,343 acres). Therefore, impacts to benthic communities will occur in only a small portion of the action area and benthic communities are expected to recolonize the area after the project is complete (Wilber and Clarke 2007). Impacts from the habitat modification will be minor and temporary. Furthermore, the top of the scour holes will remain free of rubble and interstitial spaces in the rubble and areas downstream from the rubble will encourage soft sediment deposition on top of the rubble, which will likely restore bathymetry to a condition that is near to the surrounding elevation. As sedimentation occurs, soft sediment will reestablish and benthic communities are expected to recolonize the area within one to 11 months (Wilber and Clarke 2007). Rubble areas that remain exposed after sedimentation may also be able to be used as habitat for benthic communities. Given that the area around the Nice-Middleton Bridge represents an extremely small portion of the soft substrate that is available for foraging in the Potomac River, effects on sturgeon from reductions in benthic resources will be too small to be meaningfully measured or detected, and are therefore insignificant.

7.3 Water Quality

Resuspension of sediment may increase total suspended sediment (TSS) load and turbidity above ambient baseline levels within the water column. Turbidity relates to the optical quality of light transmission through a fluid containing sediment particles (most often measured as nephelometric turbidity units) and TSS concentration is the gravimetric measure of particles in suspension (generally measured as milligrams per liter). A USACE study on dredging states that the nature, degree, and extent of sediment suspension are controlled by many factors including: the particle size distribution, solids concentration, and composition of the material; 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).

High concentrations of suspended sediment or turbidity may affect fish through many pathways (Johnson 2018, Kjelland *et al.* 2015). Sediment and turbidity can affect fish directly by reducing the gill's ability to take up oxygen, causing acute toxic reactions, resulting in physiological stress, and reducing foraging efficiency and/or predator avoidance. Resuspension of fine sediment with high organic content can affect fish indirectly by reducing dissolved oxygen levels.

Impacts of increased TSS and turbidity varies greatly among species and research suggests that concentrations of suspended solids can reach thousands of milligrams per liter before an acute toxic reaction is expected to occur (Burton 1993, Kjelland *et al.* 2015, Wilber and Clarke 2001). Burton (1993) evaluated consequences of bucket dredging in the Delaware River and determined that lethal effects on fish due to turbid waters can occur at levels between 580 mg/L to 700,000 milligrams per liter, depending on the species. The studies reviewed by Kjelland *et al.* (2015) found that, depending on species, reported mortality ranged from 10 to 100 percent when exposed to TSS levels ranging from 300 to 300,000 milligrams per liter after exposure periods ranging from 24 to 48 hours. Wilber and Clarke (2001) found that for adult estuarine species, TSS consequences ranged from "no effect" when exposed to 14,000 milligrams per liter for a duration of three days for two species to the lowest observed concentration that caused mortality at 580 milligrams per liter after one day of exposure for Atlantic silverside. The concentration of suspended sediment is not the only factor determining consequences but also the duration at which a fish is exposed. Most studies report response after exposure ranging from 24 to 48 hours.

There have been no directed studies on the physiological consequences of TSS on shortnose or Atlantic sturgeon. However, Kjelland *et al.* (2015) noted that benthic species in general are more tolerant to suspended sediment than pelagic species. Shortnose and Atlantic sturgeon juveniles and adults are often documented in turbid water and Dadswell *et al.* (1984) reports that shortnose sturgeon are more active under lowered light conditions, such as those in turbid waters. As such, shortnose and Atlantic sturgeon are assumed to be at least as tolerant to suspended sediment as other estuarine fish. Therefore, we expect sublethal and lethal effects on juvenile, subadult, and adult Atlantic sturgeon and juvenile and adult shortnose sturgeon to occur when exposed to 24 hours of concentrations at or above 580 milligrams per liter.

High TSS levels can cause a reduction in dissolved oxygen levels. Both Atlantic and shortnose sturgeon may become stressed when dissolved oxygen falls below certain levels. Jenkins *et al.*

(1993) observed that younger shortnose sturgeon experienced high levels of mortality at low dissolved oxygen levels while older individuals tolerated those reduced levels for short periods of time. Tolerances may decline with chronic exposure to low levels. Johnson (2018) recommends that sturgeon should not be exposed to TSS levels of 1,000 milligrams per liter above ambient for longer than 14 days at a time to avoid behavioral and physiological consequences.

Behavioral responses to increased turbidity and turbidity plumes varies among species and depends on their specific biology such as sensory capabilities and adaptive strategies. Studies of how fish respond to suspended sediment have detected behavioral consequences of turbidity on feeding and vulnerability to predation (Kjelland *et al.* 2015, Wilber and Clarke 2001). High turbidity may affect feeding efficiency for species using visual detection during foraging, which again can result in reduced growth, fecundity or increase stress and susceptibility to disease and parasites. However, turbidity, at least at TSS levels below what would cause physiological consequences, is not likely to substantially impact Atlantic sturgeon or shortnose sturgeon foraging. Sturgeon typically occur in turbid waters and Atlantic sturgeon and shortnose sturgeon forage by rooting along the bottom with their snout in search for benthic prey that they grasp with their protuberant mouth (Kynard *et al.* 2016). During foraging, they use their barbels as sensory organs to detect prey (Hilton *et al.* 2016, Kynard *et al.* 2016). Both species also actively forage during the night (Dadswell *et al.* 1984). Based on foraging method, tolerance to high turbidity, and foraging during nighttime, it is unlikely that visual detection of prey is of major importance for Atlantic and shortnose sturgeon foraging success. Whereas, elevated TSS levels resulting in physiological consequences may elicit avoidance behavior and movement away from turbidity plumes; studies on another an anadromous species, striped bass, showed that pre-spawners did not avoid TSS concentrations of 954 milligrams per liter to 1,920 milligrams per liter to reach spawning sites (Summerfelt and Moiser 1976, Combs 1979 in Burton 1993).

You estimate that a 1,300 acre area around the bridge will be impacted by blasting activities and where increased TSS may occur. Effects will be caused by (1) blasting, and (2) habitat modification (including mechanical demolition) which are described in detail below.

7.3.1 Blasting

There is no available information on the TSS levels expected after a blast event. However, you estimate that the TSS levels following a blast event may be between 350 and 600 milligrams per liter, based on discussions with blast experts and water quality monitoring experts. You also estimate that the duration of levels above ambient TSS conditions is expected to be short (less than 30 minutes). Studies of the consequences of turbid water on fish suggest that concentrations of suspended sediment can reach thousands of milligrams per liter before an acute toxic reaction is expected (Burton 1993). Furthermore, the TSS levels expected are below those shown to have adverse effect on fish (typically up 1,000.0 mg/L; Wilber and Clarke 2001). Similarly, based on a comprehensive literature review, Johnson (2018) recommends that sturgeon should not be exposed to TSS levels of 1,000 mg/L above ambient for longer than 14 days at a time to avoid behavioral and physiological effects. While increased TSS may cause Atlantic and shortnose sturgeon to alter their normal movements, these minor movements will be too small to be meaningfully measured or detected. TSS is most likely to affect sturgeon if a plume causes a barrier to normal behaviors. However, we expect sturgeon to swim through the plume to avoid the area with no adverse effects. In addition, given the short duration of increased TSS expected, effects to sturgeon from increased TSS will be too small to be meaningfully measured or detected.

Increased TSS above 390 milligrams per liter may have adverse effects on benthic communities (EPA 1986), however, mobile prey items will likely be able to uncover themselves from any deposited sediment. A small percentage of non-mobile prey in the near field range of the blasting operations and habitat modification activities may be buried/suffocated, in addition to any non-mobile prey downstream of the action due to migration of sediments with the river flow. Therefore, effects to sturgeon foraging opportunities from TSS impacts to benthic communities will be temporary and limited to a small portion of the action area (*i.e.*, will encompass a 1,300-acre area around the bridge, with a 816-meter zone of passage where effects of blasting will not be experienced). Effects on sturgeon from increased TSS and turbidity are too small to be meaningfully measured or detected, and are insignificant.

7.3.2 Habitat Modification

You estimate that a total area of approximately 1,300 acres is subject to impacts, including plumes of increased turbidity and increased total suspended solids, from habitat modification within the blasting and habitat modification component of the action area in the Potomac River. In addition, mechanical demolition will also occur within the action area (included as part of the proposed action in the 2019 Nice-Middleton Bridge consultation) and has not been completed to date. Mechanical demolition includes the use of above-water explosives and removal of the demolition debris from the river via a mechanical dredge. There is no available information specific to the water quality impacts of habitat modification of this type (*i.e.*, moving/relocating concrete rubble). However, given the extremely localized nature of the activities, mechanical dredging activities using a clamshell bucket will be used as a proxy because it is similar to the equipment you propose to use for this activity. TSS concentrations associated with mechanical clamshell bucket dredging operations have been shown to range from 105 milligrams per liter in the middle of the water column to 445 milligrams per liter near the bottom (210 milligrams per liter, depth-averaged) (USACE 2001). Elevated TSS concentrations at several hundreds of milligrams per liter above background may be present in the immediate vicinity of the bucket, but would settle rapidly within a 2,400- foot (732 meter) radius of the dredge location.

You will use a clamshell to move concrete rubble along the bottom surface, which will allow sediment to move into the water column until gravitational forces cause it to settle. Given that the concrete rubble is expected to be in close proximity to the scour hole placement locations, this further reduces the turbidity and TSS that may result from the activities, and thereby, reduces effects on sturgeon and benthic communities. The small resulting sediment plume is expected to settle out of the water column within a few hours. Studies of the consequences of turbid water on fish suggest that concentrations of suspended sediment can reach thousands of milligrams per liter before an acute toxic reaction is expected (Burton 1993). The TSS levels expected for mechanical dredging (up to 445.0 milligrams per liter) are below those shown to have adverse effect on fish (typically up to 1,000.0 milligrams per liter; see summary of scientific literature in Burton 1993; Wilber and Clarke 2001). Given the temporary and minimal effects on sturgeon from changes in water quality and reductions in benthic resources in a limited area during limited periods, will be too small to be meaningfully measured or detected, and are therefore insignificant.

7.4 Vessel Traffic

A maximum of 17 project vessels will be used to complete the project. Five to seven shallow draft barges, two to three shallow draft tugboats, and five to six small work skiffs and/or one small crew vessel will be used during subaqueous blasting activities to set up for blasting and to clean up the debris. The 17 project vessels will range in size and may be up to 15-92 meters (50-300 feet) long, with a maximum draft of 4 meters (12 feet), and maximum width of approximately 30 meters (100 feet). The vessels are expected to travel at a maximum of 6 knots (approximately 7 miles per hour) in the vicinity of the Nice-Middleton Bridge. In the action area downstream of the Nice-Middleton Bridge, project vessels will travel within the Federal Navigation Channel in the lower James River and the Chesapeake Bay at a maximum of 8 knots (approximately 9 miles per hour). Homeports and specific project vessel routes are unknown at this time. However, we assume that barges and support vessels are anticipated to transit from the mouth of the Chesapeake Bay or from the mouth of the James River (*e.g.*, Port of Norfolk), up the Chesapeake Bay Federal Navigation Channel, and up the Potomac River Federal Navigation Channel to the Nice-Middleton Bridge and then back to the homeport once complete. Project vessels are reasonably certain to pass through these areas because large ports that may supply the type of vessels needed for this project are located within this geographic area. However, beyond the mouth of the Chesapeake Bay, we cannot predict with any reasonable certainty what project vessel routes will be used.

7.4.1 Background on Project Vessels Consequences on Sturgeon

Project vessels are anticipated to transit from the mouth of the Chesapeake Bay or from the mouth of the James River (*e.g.*, Port of Norfolk), up the Chesapeake Bay Federal Navigation Channel, and up the Potomac River Federal Navigation Channel to the Nice-Middleton Bridge. Project vessels are reasonably certain to pass through these areas, however, homeports and specific project vessel routes are unknown at this time. Therefore, the factors relevant to determining the risk to sturgeon from vessel strikes within the action area 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.

Sturgeon are known to breach the surface and are seen over foraging areas where sturgeon congregate. Atlantic sturgeon that ascend to the surface may be exposed to shallow draft vessels. One of the reasons for this behavior may be related to the fish needing to gulp air to fill their gas or swim bladder (Watanabe *et al.* 2008, Logan-Chesney *et al.* 2018). The need to inflate the swim bladder may be more pronounced and surfacing can occur more often at depths of ≤10 meters as the sharpest change in hydrostatic pressure with lateral movement occurs within this depth range. The number of surfacing events decreases substantially when at deeper depths, and the swim bladder may collapse at depths of 40 meters such that a sturgeon is negatively buoyant, remains near the bottom, and will have to swim actively to move off the bottom (Watanabe *et al.* 2008, Logan-Chesney *et al.* 2018). Since buoyancy is related to hydrostatic pressure, at depths of ≤10 meters, the need for regulating air in the swim bladder to control buoyancy may increase during flooding and ebbing tides when the hydrostatic pressure changes rapidly. Logan-Chesney *et al.* (2018) found in their study that about half of the recorded surfacing events occurred during flood tide, from mid- to high-tide, and the maximum number of breach events occurred between 23:00 and 03:00. Sturgeon actively swim when ascending and descending at swim speeds ranging from 0.17 to 3.17 meters per second. Thus, the ability to avoid approaching vessels may be limited when ascending.

An operating vessel can cause injury or death to a sturgeon when the hull or propeller strikes the sturgeon, or the sturgeon becomes entrained through the propeller. Examination of sturgeon carcasses in the Delaware River and the James River shows that the majority have injuries consistent with vessel strike (Balazik *et al.* 2012a, Brown and Murphy 2010). The Balazik *et al.* (2012a) 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 percent) from a narrow reach of the river near Turkey Island (river mile 75) that was modified to enhance shipping efficiency. The width of the waterway in that area ranges from 100 to 400 meters. Balazik *et al.* (2012a) 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 and comprises part of 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. Direct observations of vessel strikes killing sturgeon have also been reported (Park 2017, personal communication).

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 drafts are a source of vessel strike mortality on Atlantic sturgeon. A tugboat moving at about 11 knots was observed striking and killing an adult Atlantic sturgeon female in the Delaware Bay in 2016 (Ian Park, DENRC, personal communication, June 2017). 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, we conclude that interactions with vessels are not limited to large, deep draft vessels.

In addition to size, the timing and location of vessel traffic in the action area may influence the risk of a vessel striking a sturgeon. Sturgeon are migratory species that travel from marine waters to natal rivers to spawn. A significant increase in vessel traffic during the spawning period could potentially increase the risk of vessel strike for migrating adult sturgeon (Fisher 2011, Hondorp *et al.* 2017). Similarly, narrow channels or passageways with restricted clearance may increase the probability that sturgeon will be struck and killed by a vessel (Balazik *et al.* 2012b).

The use of 17 project vessels is expected to increase vessel traffic within the Federal Navigational Channel of the Potomac River, James River, and Chesapeake Bay. Increased vessel activities could result in vessels colliding with or the propellers striking listed species. Here, we review what we know about vessel-species interactions and the factors contributing to them, and analyze the consequences on ESA-listed sturgeon.

7.4.2 Factors Relevant to Vessel Strike

For sturgeon to interact with vessels and their propellers, they must overlap spatially and temporally. First, a vessel's activity has to occur in the same reach of the river where sturgeon are present. Second, a particular sturgeon life stage has to occupy the same portion (lateral location) of the river channel as the vessel (*e.g.*, the maintained navigation channel versus the non-navigational portion of the channel or waterway). Lastly, the hull, propeller, and the hydrological forces around the vessel have to be at the same depth in the water column as the sturgeon. Factors relevant to determining the risk of vessel strikes include, but may not be limited to, the 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 size and behavior of sturgeon in the area (*e.g.*, foraging, migrating, etc.). Physical characteristics of the river (*e.g.*, narrow channels, channel constrictions, etc.) may also be relevant risk factors.

For a vessel strike to occur, the sturgeon must either not respond to an approaching vessel (*i.e.*, not moving away or trying to avoid interaction) or be unable to avoid the vessel for any number of reasons. It is well documented that adult and juvenile sturgeon are killed by interactions with vessel propellers of large vessels (Balazik *et al.* 2012d, Brown and Murphy 2010, Demetras *et al.* 2020, Killgore *et al.* 2011). Therefore, it is clear that not all sturgeon respond to an approaching vessel by moving out of its way, and are not able to evade the propeller(s) even if they do attempt to move when approached by a vessel. A few studies have used VEMCO Positioning System (VPS) receiver arrays to study Atlantic sturgeon response to approaching vessels. Preliminary tracking studies in the James River indicate that Atlantic sturgeon seem to be oblivious to the threat of vessel propellers. In other words, they do not make any effort to leave the navigation channel or avoid approaching and passing deep draft vessels (Balazik 2018 personal communication, Balazik *et al.* 2017a), and, occasionally, the researchers observed sturgeon move into the path of an approaching vessel (Balazik *et al.* 2017a).

DiJohnson (2019) studied Atlantic sturgeon responses to approaching vessels in the Delaware River similarly using a VEMCO Positioning System to monitor fine-scale movements of telemetered adults and subadults as large vessels approached. The recently completed study found no evidence that Atlantic sturgeon altered their behavior in the presence of approaching commercial vessel traffic in the Delaware River (DiJohnson 2019). Both Balazik *et al.* (2017a) and DiJohnson (2019) concluded that their findings suggest that either Atlantic sturgeon do not consider vessels a threat or they cannot detect them until it is too late.

The hull itself may hit sturgeon that fail to avoid a vessel and cause injury or mortality. It seems likely that the chance of injury and death by impact increases with the vessel's speed and mass but we do not know at what speed mortality occurs for different types of vessels or for different sizes of sturgeon. Fast vessels have been implicated in shortnose sturgeon vessel strikes but there is no information available to suggest a minimum speed necessary for a sturgeon to avoid an approaching vessel nor has a threshold speed at which a sturgeon is injured or killed by a vessel hull been defined. More often observed is evidence that vessel strike mortalities occur when a propeller hits a sturgeon. The propeller may hit a sturgeon that is directly in the path of a vessel or when the water being sucked through a propeller entrains a sturgeon. Entrainment of an organism occurs when a water current (in this case the current created by the propeller) carries the organism along at or near the velocity of the current without the organism being able to overcome or escape the current. Propeller engines work by creating a low-pressure area immediately in front of the propeller and a high pressure behind. In the process, the propeller moves water at high velocities (can exceed 6 meters per second) through the propeller. Thus, as the boat propeller draws water through the propeller, it can also consequently entrain an organism in that water. Fish that cannot avoid a passing vessel, that are entrained by the propeller current, and who are unable to escape the low-pressure area in front of the propeller, will go through the propeller.

Killgore *et al.* (2011) found that the probability of propeller-induced injury (*i.e.*, propeller contact with entrained fish) depends on the propeller's revolutions per minute and the length of the fish. Simply put, the faster the propeller revolves around its axis, the less time a fish has to move through the propeller without being struck by a blade. Similarly, the longer the fish is, the longer time it needs to move through the propeller, thereby increasing the chance that a blade hits it. The injury probability model developed by Killgore *et al.* (2011) shows a sigmoid (or "S" shaped) relationship between fish length and injury rate at a given revolutions per minute. The model estimates probability of injury at about 150 revolutions per minute for the towboat in their study increased from 1 percent for a 12.5-centimeter (4.9 inch) fish to 5 percent for a 35-centimeter (13.8 inch) long fish, and from 50 percent for a 72-centimeter (28.3 inch) long fish to 80 percent for a 90-centimeter (35.4 inch) long fish. However, Killgore *et al.* (2011)

did not find that the number of fish entrained by the propeller was dependent on revolutions per minute even though the percentage of fish killed increased with increasing revolutions per minute.

Miranda and Killgore (2013) indicates that heavy large-towboat traffic on the Mississippi River (vessels with an average propeller diameter of 2.5 meters (8.2 feet), a draft of up to 2.7 meters (9 feet), and travel at approximately the same speed as tugboats (less than 10 knots)), kill a large number of fish by drawing them into the propellers. The study demonstrates that shovelnose sturgeon (*Scaphirhynchus platorynchus*), a small sturgeon (approximately 50-85 centimeters 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 geomorphology and depth of the Mississippi River – including its reaches and navigation channel where the study was conducted - differ substantially from the action area, and as shovelnose sturgeon is a common species in the Mississippi River with densities that are likely not comparable to Atlantic sturgeon and shortnose sturgeon populations in the Chesapeake Bay or the Potomac or James Rivers, this estimate cannot directly be used for this analysis. We also cannot modify the rate for this analysis because the type of vessels traveling on the two rivers differs and we do not know (a) the difference in density of shovelnose sturgeon and shortnose and/or Atlantic sturgeon and (b) if there are risk factors that increase or decrease the likelihood of strike in the action area. However, this information does suggest that high vessel traffic can be a major source of sturgeon mortality. A similarly sized tugboat moving about 11 knots was observed striking and killing an adult Atlantic sturgeon female in the Federal Navigation Channel of the Delaware River in 2016 (Ian Park, DENRC, personal communication, June 2017).

Other factors affect the probability of vessel interactions with sturgeon. For example, narrow channels can concentrate both sturgeon and vessels into smaller areas and thus increase the risk of vessel strike. Balazik *et al.* (2012b) notes that there is an inverse relationship between channel width and the number of observed vessel strike mortalities in the James River. Sturgeon are likely to use the navigation channels during spawning migrations as well as seasonal movements between summer and overwintering areas (Fisher 2011, Hondorp *et al.* 2017). Besides sturgeon being exposed to vessels during these months, it has also been suggested that sturgeon swimming higher in the water column during migration increases their exposure to vessels (Balazik *et al.* 2017a, Brown and Murphy 2010, Fisher 2011).

7.4.3 Consequences of Project Vessel Traffic on Sturgeon in the Action Area

There is the potential for sturgeon to be killed or injured by interacting with transiting project vessels associated with the action. We have considered the likelihood that an increase in vessel traffic associated with the project increases the risk of interactions between sturgeon and vessels in the action area, when added to the baseline conditions.

The proposed action will add as many as 17 project vessels to the action area. You estimated that project activities, the project vessels will make one round trip each from the homeport to the Nice-Middleton Bridge in the Potomac River. Once at the Nice-Middleton Bridge, project vessels will likely stay within the immediate vicinity of the bridge. We do not expect all of these vessels to be operating at once nor to come from the same homeports. The 17 project vessels will range in size and may be up to 15-92 meters (50-300 feet) long, with a maximum draft of 4 meters (12 feet) and maximum width of approximately 30 meters (100 feet). The vessels are expected to travel at a maximum of 6 knots (approximately 7 miles per hour) in the blasting and habitat modification component of the action area. In the action area downstream of the Nice-Middleton Bridge, the vessels travelling within the Federal Navigation Channel are expected to travel at a maximum of 8 knots (approximately 9 miles per hour).

As noted, project activities will add a maximum of 17 vessels to the action area. Smaller vessels have a much lower probability of striking sturgeon than larger vessels, however, strikes from these smaller vessels can still occur (Brown and Murphy 2010). Therefore, vessel strikes are not likely to occur as a result of the proposed action, due to shallow draft depth (12 feet maximum draft) and limits on travel speeds to 6 knots (about 7 miles per hour) for vessels entering the action area. Project vessels are expected to travel through the Chesapeake Bay or the mouth of the James River within the Federal Navigation Channel to the Nice-Middleton Bridge. These vessels would have a maximum travel speed of approximately 8 knots (approximately 9 miles per hour). The maximum vessel draft of 4 meters (12 feet) and relatively slow travel speed of vessels will reduce the risk for a potential strike to sturgeon. Therefore, while the proposed action will cause an increase in vessel traffic, the addition of this small number of project vessels will be intermittent, temporary, and restricted to a small portion of the overall action area on any given day (within the Federal Navigational Channel). Therefore, the increase in vessel traffic associated with the project vessels is extremely small. As such, any increased risk of a vessel strike to sturgeon caused by the project when added to the baseline will be too small to be meaningfully measured or detected, and is therefore insignificant.

7.5 Consequences on Critical Habitat Designated for the Chesapeake Bay DPS of Atlantic Sturgeon

We consider the direct and indirect effects of the action on each of the Atlantic sturgeon critical habitat PBFs present in the action area. For each feature that may be affected by the action, we then determine whether any negative effects to the feature may be insignificant, extremely unlikely, or entirely beneficial and if not, consider the consequences of those adverse effects. 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.

7.5.1 Physical and Biological Feature 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 areas of soft substrate within transitional salinity zones between the river mouth and spawning sites for juvenile foraging and physiological development; therefore, we consider effects of the action on soft substrate and salinity and any change in the value of this feature in the action area. We also consider whether the action will have effects on access to this feature, temporarily or permanently. We also consider the effect of the action on the action area's ability to develop the feature over time.

In order to successfully complete their physiological development, juvenile 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 increases with age. PBF 2 occurs from where the mouth of the river enters the Chesapeake Bay to Chain Bridge. The Potomac River is tidal freshwater from Chain Bridge (near the Little Falls Dam) to Quantico, Virginia. The mixing zone of transitional salinity occurs from Quantico, Virginia to the Nice-Middleton Bridge, Maryland (salinity of 5 to 18 parts per thousand at the Nice-Middleton Bridge). Salinity gradually increases within the remainder of the river estuary from the Bridge crossing to the Chesapeake Bay (salinity in the Chesapeake Bay range from 20-30 parts per thousand). Sand and clay substrates are dominant within the action area with few patches of gravel. Therefore, PBF 2 is present within this portion of the action area. Given that the Potomac River average channel width is between one and three miles and the Nice-Middleton Bridge is located at river kilometer 81 (approximately 50 miles upstream of the river mouth at the Chesapeake Bay), we estimate that there is at least 32,000 acres of soft substrates potentially meeting the criteria for PBF 2 within the action area, assuming that there are very few locations where soft bottom is not present. Blasting, rubble placement, and mechanical demolition (via above-water blasting and dredging) will overlap with PBF 2.

Blasting and rubble placement activities within PBF 2 will occur between October 15, 2023, and through mid-2024. Mechanical demolition that was considered in the 2019 consultation has already commenced and is also expected to occur through mid-2024. The total area of PBF 2 negatively affected will be 10.2 acres. Areas outside of this area may be impacted by sedimentation from the nearfield turbidity plume and may experience a loss of benthic life from burial/suffocation. You estimate that turbidity and increased TSS may extend beyond that to up to 1,300 acres from where blasting will occur at the Nice-Middleton Bridge. The 10.2 areas (of the 32,000 acres) where bottom substrate may be affected by the project activities represent a small (approximately 0.3 percent of the area potentially supporting PBF 2) and non-contiguous amount of the available soft bottom substrate within the action area. The impacts to these areas will not occur simultaneously. Considering the temporary nature of the project activities (less than one year) and that the effects of project activities will occur within a relatively small portion of PBF 2 habitat available in the action area, the effects on juvenile foraging or physiological development will be so small that they cannot be meaningfully measured, evaluated, or detected. Therefore, any effects to the value of PBF 2 to the conservation of the species are insignificant.

7.5.2 Physical and Biological Feature 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, as shallow water and inadequate flows can be barriers to sturgeon movements, particularly early life stages that are dependent on downstream drift. Therefore, we consider effects of the action on water depth and water flow and whether the action results in barriers to passage that impede the movements of Atlantic sturgeon. We also consider whether the action will have effects on access to this feature, temporarily or permanently and consider the effect of the action on the action area's ability to develop the feature over time.

The Little Falls Dam (near Chain Bridge) located just upstream from Washington DC represents the upper extent of the sturgeon range on the Potomac River. A suspected shortnose sturgeon spawning site occurs approximately two river kilometers downriver of the Chain Bridge, in freshwater and hard substrate (*e.g.*, large and small boulders, gravel-pebble, and cobble-rubble) (SSSRT 2010), which contains features that could also support Atlantic sturgeon spawning. Below this location, the river is not vulnerable to natural reductions in water flow or water depth that can result in barriers to sturgeon movements. We are not aware of any anthropogenic impacts or barriers at this time that reduce water depth or water flow in a way that impact sturgeon movements. There are areas in the Potomac 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 we expect there always to be a zone of passage through the affected areas. Activities that overlap with the portion of the Potomac River that contains PBF 3 include blasting operations, increased TSS and turbidity, and noise.

During the limited timeframe when project activities will occur October 15, 2023 to mid-2024, Atlantic sturgeon can still access and use the surrounding area. Areas subject to blasting and rubble placement will experience localized effects but Atlantic sturgeon will still have room to maneuver within the river while avoiding adverse effects from stressors related to project activities. Proposed activities will not prevent adults from migrating to and from potential spawning sites upstream, nor will they prevent juvenile sturgeon from reaching appropriate salinity zones necessary for foraging and development. Although a 816-meter wide zone of passage (where effects of the action will not be experienced) will be maintained, the project activities may temporarily disrupt juvenile movements within the river during usage of pre-blasting acoustic deterrents, mechanical demolition (dredging and land-based blasting), and rubble placement activities, and from noise and turbidity related to these activities. However, once completed, the action will not affect juvenile Atlantic sturgeon's unimpeded seasonal and physiologically dependent movement to appropriate salinity zones within the river estuary. The proposed project activities in the action area also will not affect water depth or impede movements of adults or subadults.

The proposed action may have temporary negative effects on PBF 3 by creating in water stressors from project activities; however, none of the proposed activities will be long-term barriers to the movements of adult, subadult, or juvenile Atlantic sturgeon. Given that a zone of passage of sufficient width (816-meters) will be maintained, it is extremely unlikely that the aforementioned stressors 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. Therefore, although impediments will occur, because of the width of the river, any impediments are so minor that they won't have a measurable effect on sturgeon migration. 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 and are discountable.

7.5.3 Physical and Biological Feature 4

Water with the temperature, salinity, and oxygen values that, combined, provide for dissolved oxygen 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, 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: spawning; annual and interannual adult, subadult, larval, and juvenile survival; and larval, juvenile, and subadult growth, development, and recruitment. Therefore, we consider effects of the action on temperature, salinity and dissolved oxygen needs for Atlantic sturgeon spawning and recruitment. Both temperature and salinity influence the dissolved oxygen saturation for a particular area. We also consider whether the action will have effects to the accessibility of this feature (either temporarily or permanently) or to the action area's ability to develop the feature over time.

Water quality factors of temperature, salinity and dissolved oxygen are interrelated environmental variables, and in a river system such as the Potomac, are constantly changing from influences of the tide, weather, season, etc. The area with PBF 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 spawning, survival, and juvenile and subadult development and recruitment), may be present throughout the extent of critical habitat designated in the Potomac River (depending on the life stage); therefore, PBF 4 overlaps with the entire action area.

Impacts to salinity and temperature are not expected as a result of the action. The project activities may impact DO through increased suspended sediments and turbidity. While project activities would result in impacts to water quality (increased dissolved oxygen as a result of increased TSS) in the action area, these increases would be temporary. Sediments suspended during blasting and habitat modification will be localized and we expect sediment to settle out of the water column within a few hours of the activities and, therefore, the changes would not affect the value of the feature for any life stage of Atlantic sturgeon. These minor changes in dissolved oxygen are not expected to alter how various life stages of Atlantic sturgeon use the river for spawning, rearing, and development.

To summarize, we expect the effects of blasting, rubble placement, and mechanical demolition activities on the value of PBF 4 to the conservation of the species (*i.e.*, the current and future development of this feature to provide the temperature, salinity, and oxygen values that, combined, support: spawning; annual and interannual adult, subadult, and juvenile survival; and juvenile and subadult growth, development, and recruitment) to be too small to be meaningfully measured or detected, and are therefore, insignificant.

8.0 CUMULATIVE EFFECTS

"Cumulative effects" are those consequences of future state or private activities, not involving federal activities, that are reasonably certain to occur within the action area of the federal action subject to consultation (50 CFR § 402.02). Future Federal actions that are unrelated to the proposed action are not considered in this section because they require separate consultation pursuant to section 7 of the ESA.

This section attempts to identify the likely future changes and their impact on ESA-listed species in the action area. This section is not meant to be a comprehensive socio-economic evaluation, but a brief outlook on future changes in the environment. Projections are based upon recognized organizations producing best available information and reasonable rough-trend estimates of change stemming from these data. However, all changes are based upon projections that are subject to error and alteration by complex economic and social interactions.

During this consultation, we searched for information on future state, tribal, local, or private (non-federal) actions reasonably certain to occur in the action area that would have consequences on species considered in this Opinion. We did not find any information about non-federal actions other than what has already been described in the *Environmental Baseline*. The primary non-federal activities that will continue to occur in the action area are recreational fisheries, fisheries authorized by the states, use of the action area by private vessels, discharge of wastewater and associated pollutants, and coastal development authorized by state and local governments. We do not have any information to indicate that consequences of these activities over the life of the proposed action will have different consequences than those considered in the *Status of the Species* and *Environmental Baseline* sections of this Opinion, inclusive of how those activities may contribute to climate change.

9.0 INTEGRATION AND SYNTHESIS OF CONSEQUENCES

In the *Consequences of the Action* section, we considered potential consequences from blasting, habitat modification, and mechanical demolition activities at the Nice-Middleton Bridge. We also considered the potential for interactions between ESA-listed species from project vessels, impacts to their habitats and prey, active acoustic sources used as deterrents, and changes in water quality on these species and designated critical habitat.

We have estimated that the Nice-Middleton Bridge project will result in injury and/or morality of up to three shortnose sturgeon and three Atlantic sturgeon over the life of the project that will occur from October 15, 2023 to mid-2024. These interactions are expected to result in serious injury or mortality. As explained in the *Consequences of the Action* section, the action will not result in adverse effects to Atlantic sturgeon critical habitat. In addition, as explained in the *Consequences of the Action* section, all other consequences to shortnose and Atlantic sturgeon from the project activities, including consequences to their prey and habitat, from project/commercial vessels, and from water quality will be insignificant and/or extremely unlikely to occur.

In the discussion below, we consider whether the consequences of the proposed action reasonably would be expected, directly or indirectly, to reduce appreciably the likelihood of both the survival and recovery of the listed species in the wild by reducing the reproduction, numbers, or distribution of the listed species that will be adversely affected by the action. The purpose of this analysis is to determine whether the proposed action, in the context established by the status of the species, environmental baseline, and cumulative effects, would jeopardize the continued existence of any listed species.

In the U.S. FWS/NMFS Section 7 Handbook (U.S. FWS and NMFS 1998), for the purposes of determining jeopardy, survival is defined as, "the species' persistence as listed or as a recovery unit, beyond the conditions leading to its endangerment, with sufficient resilience to allow for the potential recovery from endangerment. Said in another way, survival is the condition in which a species continues to exist into the future while retaining the potential for recovery. This condition is characterized by a species with a sufficient population, represented by all necessary age classes, genetic heterogeneity, and number of sexually mature individuals producing viable offspring, which exists in an environment providing all requirements for completion of the species' entire life cycle, including reproduction, sustenance, and shelter."

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

9.1 Atlantic sturgeon

As explained above, the proposed action is likely to result in the incidental take of up to three Atlantic sturgeon from the Chesapeake Bay DPSs during blasting activities associated with the Nice-Middleton Bridge project. We expect that the Atlantic sturgeon killed could be juvenile, subadults, or adults. No captures of eggs, larvae (yolk sac or post-yolk sac), or young-of-year Atlantic sturgeon are anticipated, because these life stages do not occur in the action area. All other consequences to Atlantic sturgeon, including consequences to habitat and prey due the deepening, impacts to water quality, and vessel traffic will be insignificant or extremely unlikely to occur.

9.1.1 Determination of DPS Composition

Using mixed stock analysis explained above, we have determined that juvenile, subadult, and adult Atlantic sturgeon in the action area likely originate from the five DPSs at the following frequencies: Gulf of Maine - 2 percent; New York Bight - 2 percent; Chesapeake Bay - 92 percent; Carolina - 2 percent; and South Atlantic - 2 percent (Damon-Randall *et al.* 2013). As a result of the proposed action and given these percentages, the three Atlantic sturgeon expected to be killed by blasting will most likely be of Chesapeake Bay DPS origin.

9.1.2 Chesapeake Bay DPS

The Chesapeake Bay DPS is listed as endangered, and Atlantic sturgeon occur and may potentially spawn in several rivers of the Chesapeake Bay. There is evidence of spawning in the James River; Pamunkey River, a tributary of the York River; and Marshyhope Creek, a tributary of the Nanticoke River (Hager *et al.* 2014, Kahn *et al.* 2014, Balazik and Musick 2015, Richardson and Secor 2016, NMFS 2017c, Richardson and Secor 2017, Secor *et al.* 2021). In addition, detections of acoustically-tagged adult Atlantic sturgeon in the Mattaponi and Rappahannock Rivers at the time when spawning occurs in others rivers, and historical evidence for these, as well as the Potomac River, supports the likelihood of Atlantic sturgeon spawning populations in the Mattaponi, Rappahannock, and Potomac Rivers (NMFS 2017c, Balazik 2023).

Chesapeake Bay 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 no census nor enough information to establish a trend for any life stage, for the James River spawning population, or for the DPS as a whole, although the NEAMAP data indicates that the estimated ocean population of Chesapeake Bay DPS Atlantic sturgeon is 8,811 subadult and adult individuals. The ASMFC (2017) stock assessment determined that abundance of the Chesapeake Bay DPS is “depleted” relative to historical levels. The assessment also determined there is a relatively low probability (36 percent) that abundance of the Chesapeake Bay DPS has increased since the implementation of the 1998 fishing moratorium, and a 30 percent probability that mortality for the Chesapeake Bay DPS exceeds the mortality threshold used for the assessment (ASMFC 2017).

We anticipate the mortality or injury of up to three juvenile, subadult, or adult CB DPS Atlantic sturgeon as a result of blasting. While it is possible that fish could survive the blast, we assume here that the three fish will be killed.

Here, we consider the consequences of the loss of up to three Atlantic sturgeon from the Chesapeake Bay DPS. The reproductive potential of the Chesapeake Bay DPS will not be affected in any way other than through a reduction in numbers of individuals. The loss of up to three female sturgeon over would have the consequences of reducing the amount of potential reproduction as any dead Chesapeake Bay DPS Atlantic sturgeon would have no potential for future reproduction. However, this small reduction in potential future female spawners is expected to result in an extremely small reduction in the number of eggs laid or larvae produced in future years and similarly, extremely small consequences 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 consequences 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 Chesapeake Bay 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 Chesapeake Bay DPS fish.

Because we do not have a population estimate for the Chesapeake Bay DPS, it is difficult to evaluate the consequences of the mortality caused by this action on the species. However, because the proposed action will result in the loss of no more than three individuals over the life of the project, it is unlikely that this death will have a detectable consequence on the numbers and population trend of the Chesapeake Bay DPS.

The proposed action is not likely to reduce distribution because the action will not impede Atlantic sturgeon from accessing any seasonal concentration areas, including foraging areas within the action area that may be used by Chesapeake Bay DPS juveniles, subadults, or adults. Further, the action is not expected to reduce the river by river distribution of Atlantic sturgeon. Any consequences to distribution will be minor and temporary and limited to the temporary avoidance of the area where the project activities and its impacts are occurring.

Based on the information provided above, the death of up to three Chesapeake Bay DPS Atlantic sturgeon, will not appreciably reduce the likelihood of survival of the Chesapeake Bay 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 Chesapeake Bay 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 consequences 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 up to three Chesapeake Bay DPS Atlantic sturgeon will not change the status or trends of the species as a whole; (2) the loss of up to three Chesapeake Bay DPS Atlantic sturgeon is not likely to have consequences on the levels of genetic heterogeneity in the population; (3) the action will have only a minor and temporary consequence on the distribution of Chesapeake Bay DPS Atlantic sturgeon in the action area and no consequence on the distribution of the species throughout its range; and, (4) the action will have no consequence on the ability of Chesapeake Bay DPS Atlantic sturgeon to shelter and only an insignificant consequence on any foraging Chesapeake Bay DPS Atlantic sturgeon.

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

We do not expect the proposed action to modify, curtail or destroy the range of the species since it will result in an extremely small reduction in the number of Chesapeake Bay DPS Atlantic sturgeon and since it will not affect the overall distribution of Chesapeake Bay DPS Atlantic sturgeon. Any consequences to habitat will be insignificant and will not affect the ability of Atlantic sturgeon to carry out any necessary behaviors or functions. Any impacts to available forage will also be insignificant. The proposed action will result in an extremely small amount of mortality and a subsequent small reduction in future reproductive output. For these reasons, we do not expect the actions to affect the persistence of the Chesapeake Bay DPS of Atlantic sturgeon. These actions will not change the status or trend of the Chesapeake Bay 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 Chesapeake Bay DPS of Atlantic sturgeon. The consequences of the proposed action will not delay the recovery timeline or otherwise decrease the likelihood of recovery. The consequences 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 Chesapeake Bay DPS of Atlantic sturgeon can be brought to the point at which they are no longer listed as endangered or threatened. Based on the analysis presented herein, the proposed action is not likely to appreciably reduce the survival and recovery of this species.

Despite the threats faced by individual Chesapeake Bay 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 consequences related to the proposed action. We have considered the consequences 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 up to three Chesapeake Bay DPS Atlantic sturgeon, is not likely to appreciably reduce the survival and recovery of this species.

9.2 Shortnose sturgeon

Historically, shortnose sturgeon are believed to have inhabited nearly all major rivers and estuaries along nearly the entire east coast of North America. Today, only 19 populations remain. The present range of shortnose sturgeon is disjunct, with northern populations separated from southern populations by a distance of about 400 kilometers. Population sizes range from under 100 adults in the Cape Fear and Merrimack Rivers to tens of thousands in the St. John and Hudson Rivers. As indicated in Kynard *et al.* (2016), adult abundance is less than the minimum estimated viable population abundance of 1,000 adults for five of 11 surveyed northern populations and all natural southern populations. The only river systems likely supporting populations close to expected abundance are the St John, Hudson and possibly the Delaware and the Kennebec (Kynard *et al.* 2016), making the continued success of shortnose sturgeon in these rivers critical to the species as a whole.

The Delaware River population of shortnose sturgeon is the second largest in the United States. Historical estimates of the size of the population are not available as historic records of sturgeon in the river did not discriminate between Atlantic and shortnose sturgeon. The most recent population estimate for the Delaware River is 12,047 (95 percent CI= 10,757-13,580) and is based on mark recapture data collected from January 1999 through March 2003 (ERC Inc. 2006). Comparisons between the population estimate by ERC Inc. and the earlier estimate by Hastings *et al.* (1987) of 12,796 (95 percent CI=10,228-16,367) suggests that the population is stable, but not increasing.

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 (Kynard *et al.* 2016, 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 use of Virginia waters within the 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. 2018).

Spawning has not been documented in any tributary to the Chesapeake Bay although suitable spawning habitat and two pre-spawning females with late stage eggs have been documented in the Potomac River (Kynard et al 2009). Current information indicates that shortnose sturgeon are present year round in the Potomac River with foraging and overwintering taking place there (Kynard *et al.* 2009). Shortnose sturgeon captured in the Chesapeake Bay are not genetically distinct from the Delaware River population.

Based on the number of adults in population for which estimates are available, there are at least 104,662 adult shortnose sturgeon, including 18,000 in the Saint John River in Canada. The lack of information on the status of some populations, such as that in the Chesapeake Bay, adds uncertainty to any determination on the status of this species as a whole. Based on the best available information (SSSRT 2010), trends in abundance for shortnose sturgeon in Northeast rivers demonstrate the majority of populations are stable (*i.e.*, Delaware, Hudson, Connecticut, Merrimack). The Kennebec River Complex is the only population in the Northeast that shows an increasing trend in abundance. In the Southeast abundance trends for many riverine populations are unknown due to lack of data (*i.e.*, Chowan, Tar Pamlico, Neuse, New, North, Santee, S-C Reservoir system, Satilla, St. Mary's, and St. John's). The Winyah Bay Complex, Cooper, Savannah, Ogeechee, and Altamaha Rivers show stable trends in abundance. The only riverine population in the Southeast demonstrating increasing trends in abundance is the Ashepoo-Combahee-Edisto (ACE) Basin. Based on the best available information, we consider the status of shortnose sturgeon throughout their range to be stable.

As described in the *Status of the Species*, *Environmental Baseline*, and *Cumulative Effects* sections above, the Shortnose Sturgeon Status Review Team's Biological Assessment of shortnose sturgeon (2010) identify habitat degradation or loss and direct mortality as principal threats to the species' survival. Shortnose sturgeon are also affected by impingement at water intakes, habitat alteration, dredging, bycatch in commercial and recreational fisheries, research activities, water quality, in-water construction activities, and vessel traffic. Climate change, particularly shifts in seasonal temperature regimes and changes in the location of the salt wedge in rivers, may impact shortnose sturgeon in the future. It is difficult to quantify the total number of shortnose sturgeon that may be killed in the Potomac River and within the Chesapeake Bay system each year due to anthropogenic sources.

As explained above, the proposed action is likely to result in the incidental take of up to three juvenile or adult shortnose sturgeon due to blasting. While it is possible that the fish could survive the blast, we assume here that this fish will be killed.

Here, we consider the consequences of the loss of up to three shortnose sturgeon over the life of the project. The reproductive potential of shortnose sturgeon will not be affected in any way other than through a reduction in numbers of individuals. The loss of up to three individuals would have the consequence of reducing the amount of potential reproduction as any dead shortnose 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 consequence 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 consequence 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 shortnose sturgeon fish spawn. The action will also not create any barrier to pre-spawning sturgeon accessing the overwintering sites or the spawning grounds.

Based on the information provided above, the death of no more than three shortnose sturgeon as a result of the proposed actions will not appreciably reduce the likelihood of survival (*i.e.*, it will not increase the risk of extinction faced by this species) for this species given that: (1) the death of three shortnose sturgeon represents a small percentage of the species as a whole; (2) the loss of three shortnose sturgeon will not change the status or trends of the species as a whole; (3) the loss of three shortnose sturgeon is likely to have an undetectable effect on reproductive output of the species as a whole; (4) and, the action will have no effect on the distribution of shortnose sturgeon in the action area or throughout its range.

The proposed action is not likely to reduce distribution because the actions will not impede shortnose sturgeon from accessing any seasonal concentration areas, including foraging areas within the action area that may be used by juveniles or adults. Further, the action is not expected to reduce the river by river distribution of shortnose sturgeon. Any consequences to distribution will be minor and temporary and limited to the temporary avoidance of the area where the project activities and its impacts are occurring.

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 shortnose sturgeon will survive in the wild. Here, we consider the potential for the action to reduce the likelihood of recovery. As noted above, recovery is defined as the improvement in status such that listing is no longer appropriate. Section 4(a)(l) of the ESA requires listing of a species if it is in danger of extinction throughout all or a significant portion of its range (*i.e.*, "endangered"), or likely to become in danger of extinction throughout all or a significant portion of its range in the foreseeable future (*i.e.*, "threatened") because of any of the following five ESA listing factors: (1) the present or threatened destruction, modification, or curtailment of its habitat or range, (2) overutilization for commercial, recreational, scientific, or educational purposes, (3) disease or predation, (4) the inadequacy of existing regulatory mechanisms, and (5) other natural or manmade factors affecting its continued existence.

The proposed actions are not expected to modify, curtail, or destroy the range of the species since it will result in only a slight reduction in the number of shortnose sturgeon and since it will not affect the overall distribution of shortnose sturgeon other than to cause minor temporary adjustments in movements within the action area. The proposed actions will not utilize shortnose sturgeon for recreational or commercial purposes or affect the adequacy of existing regulatory mechanisms to protect this species. The proposed actions are likely to result in up to three mortalities, a slight reduction in future reproductive output; therefore, the proposed actions are not expected to affect the persistence of shortnose sturgeon range-wide. There will be no change in the status or trend of shortnose sturgeon. As there will be only a slight reduction in numbers or future reproduction, the actions would not cause any reduction in the likelihood of improvement in the status of shortnose sturgeon. The effects of the proposed actions will not hasten the extinction timeline or otherwise increase the danger of extinction since the actions will not cause any significant reduction of overall reproductive fitness for the species. The effects of the proposed actions will also not reduce the likelihood that the status of the species can improve to the point where it is recovered and could be delisted. Therefore, the proposed actions will not appreciably reduce the likelihood that shortnose sturgeon can be brought to the point at which they are no longer listed as endangered. Based on the analysis presented herein, the proposed actions are not likely to appreciably reduce the survival and recovery of this species.

10.0 CONCLUSION

After reviewing the current status of the species, the environmental baseline and the cumulative effects in the action area, and the consequences of the Nice-Middleton Bridge project, it is our biological opinion that the proposed action may adversely affect, but is not likely to jeopardize the continued existence of the Chesapeake Bay DPS of Atlantic sturgeon or shortnose sturgeon. It is also our biological opinion that the proposed action is not likely to adversely affect leatherback, Kemp's ridley, the Northwest Atlantic DPS of loggerhead, and the North Atlantic DPS green sea turtles; and North Atlantic right or fin whales. The proposed action is not likely to adversely affect critical habitat designated for the Chesapeake Bay 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. 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)). A "person" is defined in part as any entity subject to the jurisdiction of the U.S., including an individual, corporation, officer, employee, department, or instrument of the Federal government (see 16 U.S.C. § 1532(13)). Under the terms of ESA section 7(b)(4) and section 7(o)(2), taking that is incidental to, and not the purpose of carrying out an otherwise lawful activity is not considered to be prohibited under the ESA provided that such taking is in compliance with the terms and conditions of this ITS. In issuing ITSs, NMFS takes no position on whether an action is an "otherwise lawful activity."

The measures described below are non-discretionary, and must be undertaken by the FHWA so that they become binding conditions for the exemption in section 7(o)(2) to apply. The FHWA has a continuing duty to regulate the activity covered by this ITS. If the FHWA (1) fails to assume and implement the terms and conditions or (2) fails to require any contractors and personnel to adhere to the terms and conditions of the ITS 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, the FHWA must report on the progress of the action and its impact on ESA-listed species to NMFS GARFO PRD as specified in the ITS [50 CFR §402.14(i)(3)] (See U.S. FWS and NMFS's Joint Endangered Species Act Section 7 Consultation Handbook (1998) at 4-49).

11.1 Anticipated Amount or Extent of Incidental Take

The proposed action has the potential to result in the mortality or injury of up to three shortnose sturgeon and three Atlantic sturgeon due to blasting. The three Atlantic sturgeon will most likely be of Chesapeake Bay DPS origin. This level of take is expected to occur over the entire period that comprises the life of the project (*e.g.*, from October 15, 2023 through mid-2024), and is not likely to jeopardize the continued existence of shortnose sturgeon or any DPS of Atlantic sturgeon.

This ITS exempts the following incidental take over the life span of the project:

Table 19. Exempted incidental take over the lifespan of the project.

Species	**Lethal Take**
Atlantic sturgeon	Up to 3 juveniles, subadults, or adults (blasting)
Atlantic Sturgeon Total	**3**
Shortnose sturgeon	Up to 3 juvenile or adults (blasting)
Shortnose Sturgeon Total	**3**

Once you reach the authorized number of shortnose sturgeon or Atlantic sturgeon takes provided in this Incidental Take Statement, any additional take of a shortnose sturgeon or an Atlantic sturgeon will exceed the exempted level of take and reinitiation is required.

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

NMFS has determined that the following Reasonable and Prudent Measures (RPMs) and associated Terms and Conditions (T&Cs) are necessary and appropriate to minimize and monitor impacts of the incidental take on shortnose sturgeon and the five DPSs of Atlantic sturgeon resulting from the proposed action. In order to be exempt from prohibitions of section 9 of the ESA and regulations issued pursuant to section 4(d), FHWA must comply with the following T&Cs, which implement the RPMs and outline required reporting/monitoring requirements. These T&Cs are non-discretionary. Any incidental take that is in compliance with the T&Cs specified in this ITS shall not be considered a prohibited take of the species concerned (ESA section 7(o)(2)). FHWA should ensure that all state organizations involved in the project (*i.e.*, MDTA) comply with these RPMs and T&Cs.

The RPMs, with their implementing TCs, are designed to minimize and monitor the impact of the incidental take resulting from the proposed actions. Specifically, these RPMs and T&Cs will keep us informed of when and where sturgeon interactions are taking place as well as how FHWA's project may affect the abundance, density, distribution, and interaction rate of those species. The third column below explains why each of these RPMs and T&Cs are necessary and appropriate to minimize or monitor the level of incidental take associated with the proposed actions and how they represent only a minor change to the proposed actions.

In order to effectively monitor the consequences of the proposed actions, it is necessary to monitor the impacts of the actions to document the amount of incidental take (*i.e.*, the number of shortnose sturgeon and Atlantic sturgeon captured, stunned, injured, or killed) and to assess any sturgeon that are captured during this monitoring. Monitoring provides information on the characteristics of sturgeon encountered and may provide data which will help develop more effective measures to avoid future interactions with ESA-listed species. We do not anticipate any additional injury or mortality to be caused by handling, assessing, and ultimately releasing sturgeon as required in the RPMs listed below.

Table 20. RPMs, T&Cs, and Justifications. Referenced forms and documents can be found on the NOAA GARFO website

Reasonable and Prudent Measures (RPMs)	**Terms and Conditions (T&Cs)**	**Justifications for RPMs & T&Cs**
RPMs Applicable for All Activities		
1. All sturgeon captures, injuries, or mortalities in the immediate activity area must be reported to us within 24 hours.	1. In the event of any injury of sturgeon (lethal or non-lethal), you must follow the Sturgeon Take Standard Operating Procedures (SOPs) **that can be downloaded from our website**. You must submit a completed Take Report Form for ESA-Listed Species within 24 hours of any take. **The form**	These RPMs and T&Cs are necessary and appropriate to ensure the documentation of any interactions with sturgeon, as well as requiring that these interactions are reported to us in a timely manner

Reasonable and Prudent Measures (RPMs)	Terms and Conditions (T&Cs)	Justifications for RPMs & T&Cs
	can be downloaded from our website. The completed Take Report Forms, together with any supporting photos or videos must be submitted to incidental.take@noaa.gov with "Take Report Form" in the subject line. 2. In the event of any lethal takes of sturgeon, any dead specimens or body parts must be photographed, measured, and preserved (refrigerate, not frozen) until disposal procedures are discussed with us.	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 T&Cs represent only a minor change as compliance will not delay the project or decrease the efficiency of blasting operations.
2. Any dead sturgeon must be held until proper disposal procedures can be discussed with us. The fish should be held in cold storage.	3. In the event you collect or capture a dead sturgeon (*e.g.*, dead sturgeon collected during blasting operations in the Potomac River) and you request concurrence that this take should not be attributed to the Incidental Take Statement, but we do not concur, or if it cannot be determined whether a proposed activity was the cause of death, then the dead sturgeon must be transferred to an appropriately permitted research facility identified by us so that a necropsy can be undertaken to attempt to determine the cause of death. 4. NMFS will have the mortality assigned to the Incidental Take Statement if the necropsy determines that the death was due to injuries sustained from exposure to blasting. We shall have the final say in determining if the take should count towards the Incidental Take Statement.	
3. All sturgeon over 75 cm total length that are captured must have a fin clip taken for genetic analysis. This sample must be transferred to a NMFS-approved	5. You must ensure that fin clips are taken according to the procedure outlined in the “Procedure for Obtaining Sturgeon Fin Clips” found on our website. The fin clips shall be sent to a NMFS approved laboratory capable of performing genetic analysis.	These RPMs and T&Cs are necessary and appropriate to ensure the proper handling and documentation of any interactions with sturgeon, as well as

Reasonable and Prudent Measures (RPMs)	Terms and Conditions (T&Cs)	Justifications for RPMs & T&Cs
laboratory capable of performing the 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.	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 sturgeon samples to determine the appropriate DPS of origin, when applicable, and accurately record take of sturgeon. These RPMs and T&Cs represent only a minor change as compliance will not result in delay of the project or decrease in the efficiency of the blasting operations.
RPMs Related to Blasting		
4. Acoustic measurement of the first three detonations must be conducted to confirm your estimated underwater pressure levels. If pressure levels exceed those estimates, you must contact us within 24 hours of the recorded measurement.	6. Acoustic measurement of the first three detonations must be conducted to confirm your estimated underwater pressure levels (*i.e.*, noise levels below 206dB (or the psi equivalent) beyond 640 meters from the bridge). Results of this monitoring must be reported to us prior to any subsequent blasting. This acoustic monitoring must be repeated for a representative sample of all blasts (occurring on at least one day per month during the blasting season). If you determine that 206dB are being exceeded outside of the 640-meter Danger Zone, blasting must stop and you must contact us to discuss whether sturgeon protection measures may be expanded to include a radius that encompasses all areas where	These RPMs and T&Cs are necessary and appropriate to minimize the potential for blasting activities to take place when sturgeon are within 640 meters of the detonation site. These conditions are also designed to verify that the sound and pressure levels presented by you, and that we rely on in estimating take, are valid and that a 640 meter exclusion zone is sufficient. This acoustic monitoring plan represents only a minor change, as the plan will be designed by you in

Reasonable and Prudent Measures (RPMs)	Terms and Conditions (T&Cs)	Justifications for RPMs & T&Cs
	noise/pressure levels are expected to exceed 206dB.	cooperation with us and is not anticipated to result in any delays of the project or decreased efficiency of blasting operations. Any increased cost will be very small in comparison to the total costs of the project. Further, the plan will not alter the time of year or location of detonation sites.
5. You must implement the mitigation measures identified in your incoming BA to minimize sturgeon exposure to blasting and ensure that any sturgeon killed during blasting are recorded.	7. Mitigation measures proposed by you to reduce adverse effects of blasting prior to blasting operations must remain in place. If lethal take for blasting exceeds the number (6) outlined in the ITS of this Opinion, new measures must be approved before blasting may continue.	These RPMs and T&Cs are necessary and appropriate as they serve to ensure that sturgeon have a minimized risk of injury or mortality from blasting activities. The implementation of the mitigation measures represent only a minor change as the measures were designed by you and previously approved by us. Implementation of the mitigation measures will not result in any significant delays to blasting and is not anticipated to result in any increased cost, delays of the project, or decreased efficiency of blasting operations.

12.0 CONSERVATION RECOMMENDATIONS

In addition to section 7(a)(2), which requires agencies to ensure that proposed 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 activities designed to minimize or avoid adverse consequences of a proposed action on listed species or critical habitat, to help implement recovery plans, or to develop information. The following additional measures are recommended regarding incidental take and conservation of Atlantic and shortnose sturgeon:

1. The FHWA should continue acoustic telemetry monitoring of shortnose and Atlantic sturgeon in the action area through February 2024 (through the proposed blasting window) to improve data collection on the presence of sturgeon in the Potomac River.

2. The FHWA should continue to support studies of potential Atlantic and shortnose sturgeon spawning and overwintering locations in the Potomac River.

3. The FHWA should support ongoing and/or future research to determine the abundance and distribution of Atlantic sturgeon and shortnose sturgeon in Maryland and Virginia waters.

4. The FHWA should support studies to assist in gathering the necessary information to develop a population estimate for the Atlantic sturgeon Chesapeake Bay DPS.

5. The FHWA should measure and report in-situ blasting noise measurements to NMFS.

13.0 REINITIATION OF CONSULTATION

This concludes formal consultation on the Nice-Middleton Bridge 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 consequences of the action that may affect listed species or critical habitat in a manner or to an extent not previously considered; (3) the agency action is subsequently modified in a manner that causes a consequence to listed species or critical habitat not considered in this Opinion; or (4) a new species is listed or critical habitat designated that may be affected by the action. In the event that the amount or extent of incidental take exempted in this Opinion is exceeded, the FHWA must immediately request reinitiation of formal consultation.

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