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

AGENCY:	Federal Highways Administration
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Table of Contents

1 INTRODUCTION 1

1.1 Application of ESA Section 7(a)(2) Standards – Analytical Approach 1

1.2 Analytical Approach to the Proposed Action 3

2 CONSULTATION HISTORY 4

3 DESCRIPTION OF THE PROPOSED ACTION 5

3.1 Dredging and Benthic Excavation 8

3.2 Structural Foundations and Pile Driving 9

3.3 Demolition of Existing Spans 12

3.4 Vessels to Support Project Activities 13

3.5 Fish Deterrents During Blasting 13

3.6 Best Management Practices 14

3.6.1 Underwater Noise/Hydroacoustic Energy 14

3.6.2 Turbidity and Sedimentation 15

3.6.3 Water Quality 16

3.6.4 Habitat Alteration 16

3.6.5 Fish Passage and Migration Habitat 17

3.6.6 Vessel Interaction 17

3.6.7 Impingement and Entrainment 18

3.7 Action Area 18

4 STATUS OF LISTED SPECIES 19

4.1 Species Not Likely to be Adversely Affected by the Proposed Action 20

4.1.1 Sea Turtles 20

4.2 Listed Species Likely to be Adversely Affected by the Proposed Action 36

4.2.1 Shortnose Sturgeon 36

4.2.1.1 Life History and General Habitat Use 37

4.2.1.2 Listing History 39

4.2.1.3 Current Status 39

4.2.1.4 Population Structure 40

4.2.1.5 Summary of Status of Metapopulations 40

4.2.1.6 Threats 46

4.2.1.7 Survival and Recovery 47
4.2.1.8 Summary of Status 48
4.2.2 Atlantic Sturgeon 48
4.2.2.1 Life History and General Habitat Use 51
4.2.2.2 Gulf of Maine DPS of Atlantic sturgeon 59
4.2.2.3 NY Bight DPS of Atlantic sturgeon 63
4.2.2.4 Chesapeake Bay DPS of Atlantic sturgeon 68
4.2.2.5 Carolina DPS of Atlantic sturgeon 72
4.2.2.6 South Atlantic DPS of Atlantic sturgeon 74
5 ENVIRONMENTAL BASELINE 78
5.1 Federal Actions that have Undergone Section 7 Consultation 79
5.1.1 EPA's Water Quality Criteria for the Chesapeake Bay and Tidal Tributaries (F/NER/2010/05732) 79
5.1.2 Vessel Activity and Military Operations 79
5.1.3 EPA’s Registration of Pesticides containing Chlorpyrifos, Diazinon, and Malathion (F/FPR/2017/9241) 80
5.1.4 Research and Other Permitted Activities 80
5.2 Non-Federally Regulated Fisheries 83
5.3 Other Activities 84
5.3.1 Maritime Industry 84
5.3.2 Water Quality 85
5.3.3 Pollution 86
5.3.4 Coastal Development 88
5.3.5 Vessel Traffic in the Action Area 88
5.4 Reducing Threats, Recovery Planning, and Research 89
5.4.1 Education and Outreach Activities 89
5.4.2 Salvage Program 89
5.4.3 Recovery Planning 89
5.4.4 Research Activity Guidelines 90
5.5 Habitat within the Action Area 90
5.5.1 Water Quality 91
5.5.2 Bathymetry 93

5.6 Status of Listed Species in the Action Area 97
5.6.1 Shortnose Sturgeon 97
5.6.2 Atlantic Sturgeon 101
6 EFECTS OF THE ACTION 103
6.1 Pile Driving 106
6.1.1 Basic Background on Acoustics and Fish Bioacoustics 107
6.1.2 Approach to Assessing the Potential for Physiological Effects 110
6.1.3 Approach to Assessing the Potential for Behavioral Effects 112
6.1.4 Exposure of Sturgeon to Increased Underwater Pile Driving Noise 113
6.1.5 Response of Sturgeon to Pile Driving Noise 116
6.1.6 Effects of Behavioral Response to Pile Driving Noise 117
6.1.7 Summary of Behavioral Effects 120
6.2 Dredging 120
6.2.1 Interactions between Dredge Equipment and sturgeon 121
6.3 Suspended Sediment/Turbidity 123
6.3.1 Thresholds for TSS and Turbidity Effects 123
6.3.2 Extent and Intensity of Water Quality Changes 125
6.3.2.1 Mechanical Dredging 125
6.3.2.2 Pile Driving 126
6.3.2.3 Vessel Operation 126
6.3.2.4 Blasting 128
6.3.3 Response of Sturgeon to Exposure 128
6.4 Benthic Habitat Modification 129
6.4.1 Intensity and Extent of Habitat Impacts 129
6.4.1.1 Dredging 130
6.4.1.2 Blasting 131
6.4.2 Effects to Habitat Modification and Loss of Forage 132
6.5 Vessel Strike 132
6.5.1 Increase in Vessel Traffic from the Proposed Action 133
6.5.2 Factors Relevant to Vessel Strike 134
6.5.3 Effects of Project Vessel Activity on Sturgeon 138
6.6 Blasting 141

6.6.1 Acoustic Deterrence 143
6.6.1.1 Effects of Noise Produced by Acoustic Deterrents 145
6.6.2 Available Information on Effects of Blasting on Fish 146
6.6.3 Effects of Proposed Blasting on Shortnose and Atlantic Sturgeon 156
6.6.3.1 Estimating Sturgeon Exposure to Blasting Noise 157
6.7 Non-Blasting Demolition Activities 160
6.8 Geotechincal Investigations 160
6.9 Temporary Moorings 161
6.10 Summary of Effect Determinations 162
7 CUMULATIVE EFFECTS 163
8 INTEGRATION AND SYNTHESIS OF EFFECTS 164
8.1 Atlantic sturgeon 165
8.1.1 Determination of DPS Composition 165
8.1.2 Jeopardy Determination by DPS 166
8.1.2.1 Chesapeake Bay DPS 166
8.1.2.2 Gulf of Maine DPS 170
8.1.2.3 New York Bight DPS 173
8.1.2.4 Carolina DPS 179
8.1.2.5 South Atlantic DPS 182
8.2 Shortnose sturgeon 186
9 CONCLUSION 189
10 INCIDENTAL TAKE STATEMENT 189
10.1 Anticipated Amount or Extent of Incidental Take 190
10.2 Reasonable and Prudent Measures, Terms and Conditions, and Justifications 190
11 CONSERVATION RECOMMENDATIONS 196
12 REINITIATION OF CONSULTATION 196
13 REFERENCES 197

1 INTRODUCTION

This is the biological opinion (Opinion) of NOAA's National Marine Fisheries Service (NMFS) issued pursuant to section 7 of the Endangered Species Act (ESA) of 1973, as amended, on the effects of the Federal Highway Administration's (FHWA) funding and authorization of the proposed Chesapeake Bay Crossing project, carried out in coordination with the Maryland Transportation Authority (MDTA). Other anticipated federal actions associated with the project include permit authorization under Section 10 of the Rivers and Harbors Act of 1899 and/or Section 404 of the Clean Water Act by the U.S. Army Corps of Engineers, Baltimore District, and issuance of a Bridge Permit by the U.S. Coast Guard.

This Opinion is based on the best scientific and commercial data available, including but not limited to information provided in the Biological Assessment (BA) received on March 18, 2026, past consultations with the FHWA, 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 March 18, 2026.

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

This section reviews the approach used in this Opinion to apply the standards for determining jeopardy 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). The Endangered Species Consultation Handbook, March 1998, issued jointly by NMFS and the United States Fish and Wildlife Service (USFWS) and the section 7 regulations provided additional guidance for this analysis. 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 3);
- Evaluates the current rangewide status of the species with respect to biological requirements indicative of survival and recovery (Section 4);
- Evaluates the relevance of the environmental baseline in the action area to biological requirements and the species' current status (Section 5);
- Evaluates the effects of the action and determines whether the proposed action affects the abundance, reproduction, or distribution of the species (Section 6);
- Determines and evaluates any cumulative effects within the action area (Section 7); 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 (Section 8).

In completing the last step, we determine whether the action under consultation is likely to jeopardize the ESA-listed species. If so, we must identify a reasonable and prudent alternative(s)

(RPA) to the proposed action that avoids jeopardy 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.

This Biological Opinion was prepared by NMFS pursuant to section 7(a)(2) of the ESA and implementing regulations at 50 CFR §402. On March 30, 2026, in Center for Biological Diversity v. Burgum, No. 24-cv-04651 (N.D. Cal.), the U.S. District Court for the Northern District of California vacated aspects of four provisions from the 50 CFR §402 regulations governing interagency consultation under section 7 of the Endangered Species Act and reinstated the provisions that were previously in effect. Consistent with the Court's ruling, these are the governing provisions for this consultation:

- "Effects of the action refers to the direct and indirect effects of an action on the species or critical habitat, together with the effects of other activities that are interrelated or interdependent with that action, that will be added to the environmental baseline. The environmental baseline includes the past and present impacts of all Federal, State, 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 which are contemporaneous with the consultation in process. Indirect effects are those that are caused by the proposed action and are later in time, but still are reasonably certain to occur. Interrelated actions are those that are part of a larger action and depend on the larger action for their justification. Interdependent actions are those that have no independent utility apart from the action under consideration."[1] 50 CFR §402.02 (2018).
- 50 CFR §402.16(a): "(a) Reinitiation of consultation is required and shall be requested by the Federal agency or by the Service, where discretionary Federal involvement or control over the action has been retained or is authorized by law and . . . ." (50 CFR §402.16(a) (2023)).

Some of the information and analyses considered in this consultation (i.e., the consultation request package submitted by FHWA and MDTA) were prepared under the version of the 50 CFR §402 regulations in effect prior to the Court's order. We have reviewed the information and analyses and confirm that the content of that information and those analyses, including the identification and analyses of effects, would be the same under either version of the applicable

1 This definition includes the second sentence of the definition of "effects of the action." That sentence provided the definition of "environmental baseline" in effect as of 2018. In the 2019 rule amending the 50 CFR part 402 regulations, the Services established "environmental baseline" as a stand alone definition. 84 Fed. Reg. 44976, 45016 (August 27, 2019). In the 2024 rule, the Services made minor revisions to the "environmental baseline" definition. 89 Fed. Reg. 24268, 24298 (April 5, 2024). The Court's ruling did not touch upon that definition of "environmental baseline," and it therefore remains valid. The definition is also fully consistent with the definition of "effects of the action" from 2018.

regulations. While revisions to the regulations were proposed in November 2025 (90 FR 52600), no final rule to revise the regulations has been issued.

1.2 Analytical Approach to the Proposed Action

The bridge replacement is currently in the preliminary engineering phase; as such, final construction means and methods have not been determined. Accordingly, this effects analysis is based on the description in the BA, which incorporates all construction activities that are currently anticipated. As described in the BA and DEIS, this is based on the design and engineering carried out to date, inclusive of consideration of the best available information from similar regional bridge construction and demolition projects, including the Francis Scott Key Bridge Rebuild, the Tappan Zee Bridge Replacement, and the Nice-Middleton Bridge Replacement. As the design progresses through final engineering and permitting, stressor characterizations and the associated effects determinations will be re-evaluated in coordination with us and consultation will be reinitiated if necessary.

Effects are assessed for each principal stressor category identified from the construction and demolition program: pile driving; dredging; turbidity; habitat modification; increased vessel traffic; and blasting associated with demolition of the existing eastbound and westbound bridge spans. For each stressor, the analysis characterizes: (1) the nature and magnitude of the stressor; (2) the spatial and temporal extent of exposure; (3) the life stages and behaviors of listed species most likely present during the relevant construction windows; and (4) the likely individual- and population-level consequences, including potential for injury, mortality, behavioral disruption, and habitat loss.

As described in the BA, FHWA and MDTA used the NMFS Multi-Species Pile Driving Calculator to predict distances to identified acoustic thresholds. The proxy sounds levels used, are consistent with the instructions provided with the calculator and when a proxy was not available for a specific pile type, the next nearest largest pile type was used. Calculations assumed 10 dB attenuation[2] for the use of bubble curtains, and considered the installation of up to 16 piles per day, 2,500 strikes per pile (impact), and 30 minutes of vibratory driving for piles installed with a vibratory hammer. Established formulas (Hempen *et al*. (2005, 2007)) were used to predict effects from blasting. The information incorporated into the BA and our resulting effects determinations reflect the full range of reasonably likely outcomes across all assumed construction scenarios.

[2] This value is grounded in monitored field verification from the Nice-Middleton Bridge Replacement, the primary analog project for this consultation. Per the Underwater Noise Monitoring Plan 2021 Annual Report (AECOM/SCM, January 2022), the contained air bubble curtain system was tested using an on/off protocol during individual pile drives (per NMFS guidance), documenting a 15–20 dB reduction in instantaneous maximum sound levels for 66-inch precast concrete cylinder piles and 48-inch steel fender piles. Fish kills observed during the first two 48-inch fender piles (driven before the curtain was operational) did not recur once the contained curtain was implemented. The 10 dB value applied here is conservative relative to this realized range and falls within the broader published range of 5–15 dB reported for bubble curtain systems (Molnar *et al.* 2020, WSDOT 2020), exceeding NMFS' generic default of 5 dB where site-specific analog data support a higher value. Attenuation performance will be confirmed via test pile prior to production driving (see Section 3.6.1).

The effects analysis is organized by stressor rather than by species, to enable a clear accounting of each construction activity's contribution to total exposure. A species-level synthesis and effects determination table are provided at the end of this section.

The effects analysis incorporates all avoidance and minimization measures that the FHWA and MDTA have committed to include and implement as part of the proposed action. As explained above, measures that are under consideration, but not yet committed to (as described in the BA), are not incorporated into the effects analysis.

2 CONSULTATION HISTORY

This section of the Opinion identifies the significant milestones in the consultation history; note that not all meetings and correspondence that occurred during the consultation period are noted here. The Chesapeake Bay Crossing Study (Bay Crossing Study) is a two-tiered engineering and environmental study being advanced by MDTA and FHWA. The Bay Crossing Study addresses existing and future transportation issues at the William Preston Lane, Jr. Memorial Bridge (Bay Bridge) and its approaches along U.S. 50/301. Each tier of the Bay Crossing Study involves development of an Environmental Impact Statement (EIS), in compliance with the National Environmental Policy Act (NEPA), to describe potential significant environmental effects and inform the evaluation of alternatives. Early coordination with us has been conducted throughout the Tier 1 and Tier 2 Studies. Tier 1 of the Bay Crossing Study (Tier 1 Study) was completed in April 2022. At that time, FHWA issued a Final Environmental Impact Statement /Record of Decision (FEIS/ROD) identifying Corridor 7, the corridor that includes the Bay Bridge and its approaches, as the Selected Corridor Alternative for further evaluation. Tier 2 of the Bay Crossing Study (Tier 2 Study) launched in June 2022 to focus on a project-level (site-specific) analysis within the Tier 1 Selected Corridor Alternative (Corridor 7). Additional Tier 2 Study coordination and regular interagency coordination meetings have been occurring with NMFS and other resource agencies before and during development of the DEIS, since July 2022. Coordination history for the Tier 2 Study is summarized below:

Table 1. Consultation Coordination History

Date	Coordination History
June 30, 2023	NMFS accepted FHWA and MDTA's invitation to be a Cooperating Agency on the Tier 2 Study.
December 5, 2023	A list of federally listed species under NMFS jurisdiction with the potential to occur in the vicinity of the Tier 2 Study area was obtained from the NMFS Greater Atlantic Region ESA Section 7 Mapper.
March 2024	NMFS reviewed the Notice of Intent (NOI) for FHWA and MDTA to prepare an EIS for the Tier 2 Study.
January 13, 2025	NMFS provided comments on the NOI.

February 5, 2025	The NMFS Greater Atlantic Region ESA Section 7 Mapper was reviewed again to confirm no changes occurred to the species list obtained on December 5, 2023.
April 30, 2025	A draft of the Natural Environment Technical Report (NETR) was provided to the Cooperating and Participating Agencies, including NMFS, for review. (NMFS provided comments on the NETR that were addressed in subsequent drafts of the NETR and DEIS.)
August 11, 2025	A draft of the DEIS was provided to the Cooperating and Participating Agencies, including NMFS, for review. (Comments were considered and incorporated in the DEIS, as well as the BA and the NETR.)
November 28, 2025	A draft of the BA was provided to NMFS for review.
January 15, 2026	NMFS provided comments to FHWA and MDTA on the draft BA. Comments were considered and incorporated in the subsequent draft BA.
February 23, 2026	A revised draft of the BA was provided to NMFS for review.
March 6, 2026	NFMS provided comments to FHWA and MDTA on the draft BA. Comments were considered and incorporated in the subsequent BA.
March 9, 2026	The NMFS Greater Atlantic Region ESA Section 7 Mapper was reviewed to confirm no changes to listed species or critical habitat in the Action Area.
March 18, 2026	FHWA requested initiation of formal consultation with NMFS for the proposed action. We deemed the information submitted by FHWA and MDTA sufficient to assess the effects of the proposed action on ESA-listed species and that the information constituted the best scientific and commercial data available (50 CFR §402.14(c)(-(d)); ESA formal section 7 consultation was initiated on this date.

3 DESCRIPTION OF THE PROPOSED ACTION

This Opinion considers the effects of the FHWA's proposed funding, authorization, and construction of a new crossing of the Chesapeake Bay along the existing U.S. Route 50/301 corridor. As noted above, authorizations or permits are also anticipated to be issued by the USACE and the USCG. However, as construction is not expected to begin until after 2031, there are not yet any draft permits available for review. As such, for the purposes of this consultation we expect that any permits/authorizations issued by these federal agencies will be consistent with

the scope of the proposed action as described here. In the event that either permit/authorization would result in effects not considered in this Opinion, consultation would need to be reinitiated.

The Draft Environmental Impact Statement (DEIS) identified Alternative C, consisting of two new four-lane bridges (eight lanes, total) located to the south of the existing bridge alignments with six-lane approaches in the study corridor on either shore (6-8-6 South), as the Preferred Alternative. The study corridor encompasses the existing Gov. William Preston Lane Jr. Memorial Bridge (Bay Bridge) spans connecting Sandy Point in Anne Arundel.

The proposed action consists of new eastbound (EB) and westbound (WB) bridge spans, located immediately adjacent to the existing spans, designed to provide additional traffic capacity. The project involves a multi-year, multi-phased in-water construction and subsequent demolition schedule estimated to span five to six years of active construction, with an additional one to two years for demolition of each existing bridge span. As described in the BA, FHWA and MDTA developed a preliminary construction duration with two general activities, construction of two new spans and demolition of the two existing spans, as follows:

- Construct first bridge span plus approach roads: years 1 to 5;
- Demolish first bridge span: years 6 to 7;
- Construct second bridge span plus approach roads: years 7 to 13; and
- Demolish second bridge span: years 14 to 15.

Work will not begin until after the completion date of environmental review and permitting, which is currently estimated to be completed on June 30, 2031[3].

The primary in-water construction and demolition elements are described in detail in the DEIS and BA and are summarized below.

Dredging and Benthic Excavation
Mechanical dredging will be conducted over approximately 50.2 acres of estuarine bottom to facilitate construction vessel access, accommodate temporary work barges, and prepare the substrate for bridge pier foundation installation.

Structural Foundation and Pile Driving
The new spans will be supported by a series of concrete piers anchored by 15,299 piles (7,513 eastbound and 7,786 westbound). Production pile driving will likely involve driving steel pipe piles up to 96 inches in diameter using both vibratory and impact hammers. The BA states that piles may be installed concurrently (i.e., multiple piles driven simultaneously).

[3] See permitting schedule available at: https://www.permits.performance.gov/permitting-project/dot-projects/chesapeake-bay-crossing-study-tier-2-eis

To construct the new bridge spans and demolish the existing bridges, temporary pile-supported trestles would be built for project-related vessels to use as a staging area. Additional staging areas may include mooring locations within the action area. Installation of temporary mooring may require pile driving or placement of mooring anchors.

Demolition of Existing Spans
Following the completion and opening of the first new span, the existing EB structure and its subaqueous piers will undergo a phased demolition process. The process repeats for the westbound bridge structures and their subaqueous piers. Pier demolition will involve a combination of mechanical dismantling and subaqueous explosive blasting. Demolition of the existing Bay Bridge's eastbound and westbound spans will require subaqueous explosive demolition of deep-water concrete piers located in water depths exceeding 12.2 meters (m) (40 feet (ft)), where mechanical means of removal are not feasible. There are 15 deep-water piers in the existing eastbound span and 15 deep-water piers in the existing westbound span that will require subaqueous blasting, for a total of 30 blast-subject structures across the two demolition phases. The total length of bridge supported by deep-water piers is approximately 6,132 linear m (20,117 linear ft), constituting approximately 48 percent of the total bridge length to be demolished.

Non-blasting demolition activities include:

- Mechanical demolition of pile bents (shallow water) — 67 EB + 89 WB bents, approximately 25 percent of total bridge length
- Mechanical demolition of moderate-depth piers (<12.2 m (40 ft) water) — 39 EB + 11 WB piers, approximately 27 percent of bridge length
- Above-water mechanical demolition of deep-water piers — the portion of every deep-water pier removed mechanically before blast-hole drilling can begin
- Superstructure/deck removal — saw-cutting and lifting of deck slabs, torch-cutting and lifting of girders

The BA states that rubble will be removed to the maximum extent practicable, and to the extent that removal would not result in greater impacts to benthic environments compared to leaving the rubble in place. In addition, the decision to remove, re-use, or leave rubble in place, or to use rubble to fill scour, will be determined in coordination with NMFS.

The BA describes commitments to employ a suite of Best Management Practices (BMPs), which were informed by our early coordination on this project along with the recommendations detailed in our Best Management Practices Manual (NOAA 2017). We consider these BMPs, referred to in the BA as BMP Commitments, to be part of the proposed action. In the BA, FHWA and MDTA also identified several avoidance and minimization measures, referred to as BMP Considerations, that would continue to be considered as project plans are finalized, but have not been adopted as part of the proposed action. Therefore, these BMP Considerations are not part of the proposed action and are not addressed in our effects analysis nor are they considered in

our jeopardy analysis. They are, however, incorporated by reference as Conservation Recommendations. The BMPs that are part of the proposed action are outlined below.

3.1 Dredging and Benthic Excavation

The proposed action includes dredging necessary to create access channels to support both demolition and construction activities. Mechanical dredging will be used to reach a target depth of nine feet below the mean low water (MLW) level and to a width necessary to facilitate equipment mobility, loading and unloading material barges, and erecting structures. The total dredge area at both shores of the Bay would be approximately 50.2 acres (2.2 million square feet), totaling 16.4 acres on the western shore and 33.8 acres on the eastern shore. These areas exclude the footprints of the proposed and existing bridge pier footings. The total dredged volume is approximately 236,095 cubic meters (308,800 cubic yards). Applying a bulking factor of 1:3 to the dredged volume, the volume of spoil to be hauled is approximately 311,556 cubic meters (401,500 cubic yards), which would be loaded to a barge for transfer to an existing disposal site (additional information below).

The dredging areas were established using the "Maryland bathymetry Chesapeake Bay contours" data at both shorelines of the Chesapeake Bay (Western and Eastern Shores). The northern limit of dredging is expected to occur approximately 15.2 m (50 ft) north of the existing westbound span piers (to be demolished) and the southern limit is expected to be approximately 18.3 m (60 ft) from the southern edge of a new eastbound span.

Dredging will occur through the duration of construction, although the exact timing of the dredging (i.e., which months) is unknown. An estimated two-thirds of the dredging will take place in the first year of construction to accommodate the eastbound bridge span. This initial dredged area will remain in place for up to 15 years. The remaining one-third of dredging will take place at the start of construction of the westbound bridge span. For the eastbound bridge, mechanical dredging is expected to take a total of about 14 days within construction years 1 and 2 and for the westbound bridge mechanical dredging is expected to take a total of about 7 days within construction years 7 and 8. To support vessel/equipment access in shallow areas, the dredged area would need to be wide enough to facilitate equipment mobility, loading and unloading material barges, and erecting structures. Based on the greater expanse of shallow water from the eastern shoreline, it is anticipated that more dredging would be required along the eastern shoreline than the western shoreline.

As described in the BA, FHWA and MDTA expect the dredge sediment to be clean (i.e., free from contaminants), based on sediment analysis from the USACE 50 Foot Project, which includes the main channel that runs through the project area. Sediment will be tested during geotechnical investigations and prior to disposal to determine the appropriate beneficial reuse or disposal site(s). Potential dredge disposal sites include Masonville Cove and Cox Creek dredged material containment facilities (DMCF). Both sites are owned and operated by the Maryland Port Administration (MPA), are adjacent to the Patapsco River, and are accessible by barge for placement operations; at both sites material would be placed in existing, contained facilities and in upland locations.

3.2 Structural Foundations and Pile Driving

Preliminary engineering assumptions incorporated into the proposed action include using a trestle for temporary construction access in waters less than 3 m (10 ft) deep below MLW. Based on the Francis Scott Key Bridge Rebuild Project design, FWHA and MDTA expect that the temporary trestle piers will be constructed every 11.6 m (38 ft) supported on 36-inch steel pipe piles. Preliminary engineering considers that bridge piers would be constructed with 36-inch square pre-stressed concrete piles as well as 36-inch, 48-inch, and 96-inch driven steel pipe piles. Pier protection fenders would be supported on 48-inch driven steel pipe piles. Pier protection dolphins are described to include 19.6-inch-wide sheet pile, backed by 14-inch steel H-piles. Pier protection would be built with the corresponding bridge span. The proposed action includes use of up to four pile driving rigs that may operate concurrently. Tables 2 and 3 provide the estimated number and type of proposed piles and piers for the eastbound and westbound bridges, respectively.

Table 2. Eastbound Bridge - Pile Summary

Pile Type and Size	Total Piles	Total Piers
Bridge Piers	**1,741**	**77**
36” Pre-stressed Square Piles	132	18
36” Steel Pipe Piles	240	10
48” Steel Pipe Piles	1,231	43
96” Steel Pipe Piles	138	6
Trestle Piers		
36” Steel Pipe Piles	**628**	**157***
Pier Protection	**5,144**	**24**
48” Steel Pipe Piles for fenders	40	2
19.6” Sheet Piles (For Dolphins)	2,552**	22
14” Steel H-Piles (For Dolphins)	2,552**	
Grand Total	**7,513**	**258**

**A trestle pier is anticipated every 38 feet, beginning on land and extending one bridge pier beyond the limits of dredging (extending to 10-feet below MLW). Four 36-inch steel pipe piles are assumed to be required for each trestle pier.*

*** Pier protection dolphins have a diameter of 60’ and a circumference of 188.5’. Sheet piles and Steel H-piles would be constructed around the circumference of each dolphin and therefore, 116 sheet piles and 116 Steel H-piles are required per dolphin.*

Table 3. Westbound Bridge - Pile Summary

Pile Type and Size	Total Piles	Total Piers
Bridge Piers	**2,014**	**60**
36” Pre-stressed Square Piles	203	22
36” Steel Pipe Piles	243	9
48” Steel Pipe Piles	1,412	43
96" Steel Pipe Piles	156	6
Trestle Piers		
36” Steel Pipe Piles	**628**	**157***
Pier Protection	**5,144**	**24**
48” Steel Pipe Piles for fenders	40	2
19.6” Sheet Piles (For Dolphins)	2,552**	22
14” Steel H-Piles (For Dolphins)	2,552**	
Grand Total	**7,786**	**261**

** A trestle pier is anticipated every 38 feet, beginning on land and extending one bridge pier beyond the limits of dredging (extending to 10-feet below MLW). Four 36-inch steel pipe piles are assumed to be required for each trestle pier.*
*** Pier protection dolphins have a diameter of 60’ and a circumference of 188.5’. Sheet piles and Steel H-piles would be constructed around the circumference of each dolphin and therefore 116 sheet piles and 116 Steel H-piles are required per dolphin.*

The proposed action incorporates the following construction assumptions based on preliminary engineering:

- Multiple foundation types could be used by the contractor; however, to ensure that the full extent of potential effects of underwater noise are considered, the proposed action considers the main span to be supported by multiple driven steel-pipe piles, which will require impact and vibratory hammering, and the approach span piles are expected to be pre-stressed square concrete piles installed by impact hammer.
    - Noise attenuation in the form of bubble curtains would be used for all pile driving.
- a cable-stayed or suspension bridge would be installed on the substructure.
- Piers would have some form of pier protection. Preliminary design includes 2 fenders and 22 dolphins installed on both the eastbound and westbound bridges, respectively, to provide collision protection.
- The proposed action includes trestles for construction access to facilitate pier placement for the new bridge within the dredged area. Trestles are included for both construction and demolition activities. The preliminary design includes a trestle pier every 11.6 m (38 ft), beginning on land and extending one bridge pier beyond the limits of dredging (extending to 3 m (10 ft) below MLW). Four 36-inch steel pipe piles are installed for each trestle pier. Trestles would remain in-place until construction is complete, approximately 15 years after which they will be removed. Removal is expected to be carried out with a vibratory hammer or cutting below the mudline.

- Other temporary construction methods including sheetpile cofferdams and other dewatering devices for pile driving may be used.
- Dredging in the shallows up to approximately 2.7 m (9 ft) depth is assumed necessary to access areas for pier construction.
- It is assumed, based on the Francis Scott Key Bridge Test Pile Exposure Analysis assumptions, that impact driving would take a maximum of 2 hours per pile.
    - up to 8 96-inch steel pipe piles may be driven in one day and up to 16 piles of other pile sizes could be driven in one day.
    - For the eastbound bridge, a total of 120 days of pile driving is anticipated across years 1-5 of construction.
    - For the westbound bridge, a total of 138 days of pile driving is anticipated across years 7-13 of construction.
- Throughout the construction duration an effective 12-hour quiet period of no pile driving will be implemented each day.
- For temporary staging areas, FHWA and MDTA anticipate using the existing MDTA piers that are currently used for bridge maintenance. Additional staging areas may be needed, which will be determined during final design. Any additional staging areas may include existing public or private industrial locations in the Baltimore Harbor area that would facilitate material transportation by barge. Staging areas may also include mooring locations within the Chesapeake Bay. Temporary mooring locations in the Chesapeake Bay may have additional bay bottom impacts, however FHWA and MDTA will avoid placing moorings in areas of oyster beds or submerged aquatic vegetation (SAV). The specific locations and number of moorings will be determined in final design and coordinated with NMFS.

Temporary lights may be used during construction, including in cases of extended construction day or overnight work.

Mitigation measures that will be employed during pile driving include the use of a bubble curtain system that achieves 10 dB or greater attenuation for bridge piles and 5 dB or greater attenuation for dolphin pier protection piles (effectiveness shall be demonstrated with a test pile and underwater noise program prior to initiating production pile driving activities); maintaining a Zone of Safe Fish Passage (ZSFP) from January 15 through May 15; using a "soft start[4]" or "ramping up" pile driving (e.g., driving does not begin at 100 percent energy) to allow sturgeon and sea turtles to move away from areas that may be ensonified to potentially injurious levels; restricting pile driving activity to no more than 12 consecutive hours per day, to allow for a 12-hour effective rest period; initially driving steel piles with a vibratory hammer through softer,

[4] For purposes of analysis, we applied the following NMFS recommended "soft start" for impact pile driving: (1) Initiate driving with an initial set of three single strikes by the hammer at 40% of its maximum energy; (2) Stop and wait for one full minute; (3) Deliver a second set of three strikes at 40% energy; (4) Stop and wait for another one full minute; (5) Deliver a final set of three strikes at 40% energy; (6) Stop and wait for a final one full minute; and (7) Begin continuous impact driving at the full operational rate and energy.

sandy soils prior to using an impact hammer through stiffer material, as practicable and appropriate; using cushion blocks to drive concrete piles with an impact hammer as practicable and appropriate; and developing an underwater noise monitoring plan to describe the underwater noise generated by project activities and adaptive management measures planned to address the underwater noise.

3.3 Demolition of Existing Spans

Demolition of the existing structures is expected to occur in two phases. It is anticipated that the first new bridge span will be built, then one existing bridge span will be demolished, and the new bridge span will be in use while the second new bridge span is built. Once both new bridge spans are complete, the second span of the existing bridge will be demolished.

Demolition of the existing structures may include both mechanical means and blasting. It is anticipated that blasting will not occur concurrently with pile driving, based on the expected project phasing. If construction of the second new span does begin while demolition of the first existing span is underway, blasting will still not occur concurrently with pile driving as construction would pause during blasting events.

The following are the demolition assumptions based on preliminary design:

- Mechanical removal would be employed wherever possible; however, blasting may be necessary when water depths or pier element size makes mechanical removal infeasible. As such, the proposed action considers both demolition techniques.
- Temporary trestles would be used where water depths are less than 10 feet to perform demolition activities, as needed.
- Marine cranes affixed to barges would be used where water depths are deeper than 10 feet below MLW to perform demolition activities, as needed.
- Steel bracing elements are anticipated to be torch cut and heavy lift marine cranes would be used to maneuver cut pieces.
- Shielding barges are anticipated for the removal and transportation of bridge elements from the water. These barges are positioned underneath the existing bridge decks to capture any debris that may be released during demolition.
- Terrestrial demolition of bridge decks, girders, substructures, and abutments is anticipated to use saw cutting, excavators, and slab grab buckets. All demolition debris would be disposed of in accordance with regulatory permits and applicable laws and regulations; disposal is expected to occur at existing locations.

Any blasting required during demolition would occur between October 1 and December 15. Blasting is anticipated to include 18 blast events during demolition of the first bridge span, to occur during years 6 to 7 of construction, and 16 blast events during demolition of the second bridge span, to occur during years 14 to 15 of construction. During explosive demolition, blast containment measures (e.g., confined blasting, bubble curtain, micro-second delay sequencing) will be implemented to ensure the rubble produced from the blast is controlled and therefore will

likely drop in the immediate vicinity of the piers. For demolition that does not involve blasting, FHWA and MDTA have committed to maintaining a minimum contiguous 2,134 m (7,000 ft) wide ZSFP from January 15 through May 15. Specific dates for blast events within the October 1 and December 15 window will be determined during the development of the Demolition Plan and will incorporate the best available data including any updated telemetry data that provides information on the presence of ESA listed species in the action area. Following each blasting event, a search for injured/killed fish will begin immediately upon receiving the "all clear" and extend for at least 30 minutes. The search area will include all surface waters within at least 150 m (450 ft) of the center of the blast area, with at least one vessel beginning at the centroid.

3.4 Vessels to Support Project Activities

Based on the construction phasing for the proposed action, construction-related vessel activity will be distributed across an approximately 15-year program. The project vessels will include tug boats, support vessels, and barges with large excavators. Construction vessels will primarily serve Bridge 1 (eastbound; years 1–5) and Bridge 2 (westbound; years 7–13), with demolition of the existing eastbound span occurring in years 6–7 and the existing westbound span in years 14–15. The anticipated home port for construction vessels is the Baltimore area, representing a one-way transit distance of approximately 30.6 kilometers (km) (19 miles (mi)) through the Federal navigation channel between the Port of Baltimore and the bridge site. Dredge material transport alone is estimated to require approximately 14 days of barge activity during years 1–2 and approximately 7 days during years 7–8, with a total dredge volume of approximately 236,095 cubic meters (308,800) cubic yards (approximately 306,969 cubic meters (401,500 cubic yards) bulked) proposed for disposal at Masonville Cove or Cox Creek DMCF via barge. Trained observers will be onboard all vessels along with operable and effective monitoring equipment.

3.5 Fish Deterrents During Blasting

FHWA and MDTA propose to employ fish deterrent activities before each blast to minimize the potential for exposure of sturgeon to blasting activities. Beginning approximately two hours prior to each scheduled detonation, a sonar fish deterrent system, consistent with the system used during the demolition of the Nice Bridge, will be deployed and continuously swept through the water column by vessel in the vicinity of the planned detonation. Sonar sweeping will continue until immediately before detonation; if a blast is delayed for any reason, the sonar fish clearance protocol will be restarted from the beginning of the two-hour window. In addition to the sonar deterrent system, fish scare charges will be detonated immediately prior to each main blast event. For planning purposes, the general parameters from the approved blast design from the Nice Bridge project are assumed for the proposed Bay Bridge demolition, including: 5 decks of explosives per hole; 13.6 kilograms (30 pounds) of explosives per delay; minimum of 9 milliseconds delay between explosives; and maximum of 17 milliseconds delay between decks in the same hole. Scare charges will consist of a series of blasting caps, each containing 0.75 grams (0.003 ounces) of explosives, suspended in the water column surrounding the structure to be blasted, and will be detonated 15 to 30 seconds before the main production blast. Consistent with guidance in FHWA (2019), scare charges will be placed in close proximity to the bridge

structure rather than at far distances, as placement at greater distances from the structure has the potential to drive fish back toward the blast zone rather than away from it. The acoustic deterrent program will be used in conjunction with a sturgeon monitoring program whereby receivers will be monitored for detections of tagged sturgeon. The blast will not be detonated until an observer confirms that no tagged sturgeon are detected within the Exclusion Zone[5]. If a tagged individual is detected within the Exclusion Zone, detonation will be delayed until the fish has moved beyond the zone boundary.

3.6 Best Management Practices

FHWA and MDTA will employ the measures listed below to avoid, minimize, and monitor potential effects of the proposed work on Atlantic and shortnose sturgeon and sea turtles. These measures are part of the proposed action under consultation:

3.6.1 Underwater Noise/Hydroacoustic Energy

- Use noise attenuation and minimization measures during pile driving, including:
    - A bubble curtain system that achieves 10 dB or greater attenuation for bridge piles and 5 dB or greater attenuation for dolphin pier protection piles. The effectiveness of the bubble curtain attenuation shall be demonstrated through underwater noise monitoring of each pile type prior to initiating production pile driving activities.
    - Using a "soft start" or "ramping up" pile driving (e.g., three 3-strike sequences at 40 percent of full power). Parameters of soft starts will be determined and coordinated with NMFS in design.
    - Where softer sandy soils are at the surface, use a vibratory hammer for initial pile driving through the softer soils prior to using an impact hammer through stiffer material as practicable and as appropriate.
    - Cushion blocks to drive concrete piles with an impact hammer as practicable and as appropriate.
- Develop and implement an underwater noise monitoring plan to monitor and minimize the underwater noise generated by pile driving and use adaptive management if underwater noise is above estimated levels. Adaptive management measures will be determined in consultation with NMFS during design.
- Include methods to document fish stuns/kills in the Underwater Noise Monitoring Plan and provide the Underwater Noise Monitoring Plan for review and approval by NMFS prior to the start of any noise generating activities.

[5] FHWA and MDTA calculated an Exclusion Zone radius of 640 m (2,100 ft) around each pier, for a total combined area of approximately 486 hectares (1,200 acres) for the entire Exclusion Zone.

- Implement an effective quiet time of no pile driving for 12 consecutive hours per 24-hour period.
- Employ scare charges and fish deterrent sonar from boats, and monitor for the presence of tagged sturgeon, ahead of blasting activities.
- Develop a detailed Demolition Plan in coordination with NMFS and submit to NMFS for review and approval in advance of any detonation activity. The Demolition Plan will address the following measures:
    - Detonation bore hole stemming, capping, or filling;
    - Firing all charges in a single firing circuit with a delayed detonation between each charge;
    - Focusing blast energy towards a solid substrate rather than towards the water column;
    - Evaluating the feasibility of noise attenuating devices;
    - Conducting the blasting during periods of low water or low tide;
    - Using rubber blasting mats to reduce debris and acoustic signature;
    - Employing scare charges;
    - Installing hydrophones to confirm the impact distance to adaptively manage the Demolition Plan;
    - Using explosive weights that result in injury/mortality thresholds that do not exceed 30.5 m (100 ft) of the blasting source; and
- Use adaptive management actions between blast events to minimize fish mortality.
- Continue to coordinate with NMFS throughout project design and construction to minimize the use of blasting.

3.6.2 Turbidity and Sedimentation

- Limit the amount and extent of turbidity and sedimentation by using appropriate sedimentation and turbidity controls such as silt curtains, settling basins, and cofferdams. FHWA and MDTA will specify the measures to be used in the construction plans:
- Install erosion control measures prior to ground disturbance;
- Inspect daily and maintain continuously in an effective operating condition all Erosion and Sediment Control (ESC) measures until such time as they are removed with prior permission from the Maryland Department of the Environment (MDE) inspector;
- Upon project completion, remove and stabilize all temporary construction materials with sediment and erosion control measures to prevent reentry into waterways.
- Use only mechanical dredging.
- Minimize the suspension of sediments and disturbance of the substrate when removing piles by implementing the applicable techniques:

    - Remove piles with a vibratory hammer, rather than by direct pull, jetting, or clamshell;
    - Remove piles slowly to reduce sediment sloughing off in the water column;
    - Strike or vibrate the pile to break the bond between the sediment and pile to minimize the pile breakage, and reduce the amount of sediment sloughing off the pile during removal;
- Place piles on a barge equipped with a basin to contain all attached sediment and runoff water after removal.
- Prevent sediment and debris from entering the water using geo-textile fabric, hay bales, or other methods. Use nets, tarps, and pans when demolishing bridge superstructures. Remove demolition debris that falls into the water to the maximum extent practicable, and to the extent that removal of rubble would not result in greater harm to benthic environments compared to leaving demolition rubble in place. The decision to remove, re-use, or leave rubble in place, or use rubble to fill scour, will be determined prior to the start of demolition, using the best available data at the time and in coordination with NMFS.

3.6.3 Water Quality

- Only use clean fill in the water.
- In the event that any timber piles are installed, avoid, to the greatest extent practicable, the use of creosote piles or other in-water structures, and coordinate with NMFS if the Contractor identifies a need to use creosote piles.
- Remove cofferdams or other diversion structures only after water quality is consistent with ambient levels outside the structure.
- Remove contaminants and sediments prior to discharging water into aquatic habitats from construction activities such as excavations, cofferdams, settling basins, and sediment ponds.
- Evaluate dredge material to determine the appropriate disposal method and location.
- Manage concrete wash water and cooling water effluent from concrete saw operations to ensure they do not enter the Bay untreated.

3.6.4 Habitat Alteration

- Employ an Independent Environmental Monitor (IEM) that would monitor compliance with environmental and conservation commitments and report to the regulatory agencies and MDTA concurrently.
- Remove temporary structures and fills in their entirety, including monitoring devices placed for underwater noise monitoring during pile driving and blasting. Return aquatic habitats impacted by temporary activities, fills, or

structures to pre-construction or better condition, including contours, elevations, substrate, and vegetation.

- Coordinate with NMFS on specific recommended time-of-year restriction (TOYR) dates for construction and demolition.
- Stage construction activities to reduce intensity of disturbance where appropriate and practicable. Staging of construction activities will be coordinated with the agencies during design.
- Avoid areas where protected species congregate for spawning/foraging or overwintering, if identified prior to or during construction. Currently, no specific spawning, foraging, or overwintering areas are known.
- Coordinate with NMFS and MDNR during Final Design to determine if SAV surveys would be informative of permit conditions. If so, conduct SAV surveys during the growing season, prior to construction, within nearshore areas of the action area to determine the presence and extent of SAV beds.

3.6.5 Fish Passage and Migration Habitat

- From January 15 through May 15 (the anadromous fish migratory period), a minimum contiguous ZSFP equivalent to approximately one-third the waterway width (approximately 2,134 linear m (7,000 linear ft) will be maintained. The ZSFP will allow federally-managed fish species, including migratory fish, to safely navigate around undesirable noise (i.e., above the 150 dB RMS behavioral threshold) and turbidity levels. The ZSFP will encompass the channel edges. To maintain the ZSFP, piles will not be driven from January 15 through May 15, unless underwater noise models or monitoring results demonstrate those piles can be driven while ensuring a minimum contiguous 2,134 m-wide (7,000 ft-wide) ZSFP. The contractor shall use pile driving underwater noise monitoring results to determine an acceptable pile driving sequence of construction that ensures the ZSFP is achieved from January 15 through May 15. The project team will work with NOAA Fisheries and MDNR to refine and approve ZSFP locations and the migratory focal period during Final Design and permitting.

3.6.6 Vessel Interaction

- Moor vessels outside of areas with SAV or in such a way that will not shade SAV.
- Operate construction vessel at reduced speeds (i.e., below 18.5 kilometers per hour (km/h) (10 knots(kts))) for all vessels and in all locations with safety exemptions, as needed.
- Employ species spotters to reduce species/vessel collisions; and keep appropriate distance from protected species if spotted.

3.6.7 Impingement and Entrainment

- Use construction equipment that reduces potential for impingement and entrainment such as environmental buckets on mechanical dredges.
- Employ a NMFS approved observer during mechanical dredging and removal of demolition debris in case of accidental capture.

3.7 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 (project area) involved in the action" (50 CFR §402.02). Effects of the action are defined in 50 CFR §402.02 (2018) as "the direct and indirect effects of an action on the species or critical habitat, together with the effects of other activities that are interrelated or interdependent with that action, that will be added to the environmental baseline…. Indirect effects are those that are caused by the proposed action and are later in time, but still are reasonably certain to occur. Interrelated actions are those that are part of a larger action and depend on the larger action for their justification. Interdependent actions are those that have no independent utility apart from the action under consideration." The action area is all areas where the proposed action, inclusive of interrelated and interdependent actions, may affect listed species and critical habitat.

The action area includes the Chesapeake Bay surrounding the William Preston Lane, Jr. Memorial Bridge (38.991596 latitude, -76.372357 longitude) in Maryland where construction, demolition, project-related vessel traffic, and habitat modification will occur as described above. The boundaries of the action area for the project have been determined by the anticipated extent of sedimentation, turbidity, noise, and vessel traffic, based on the description of the proposed action in the BA as informed by current high-level assumptions regarding design and construction/demolition activities.

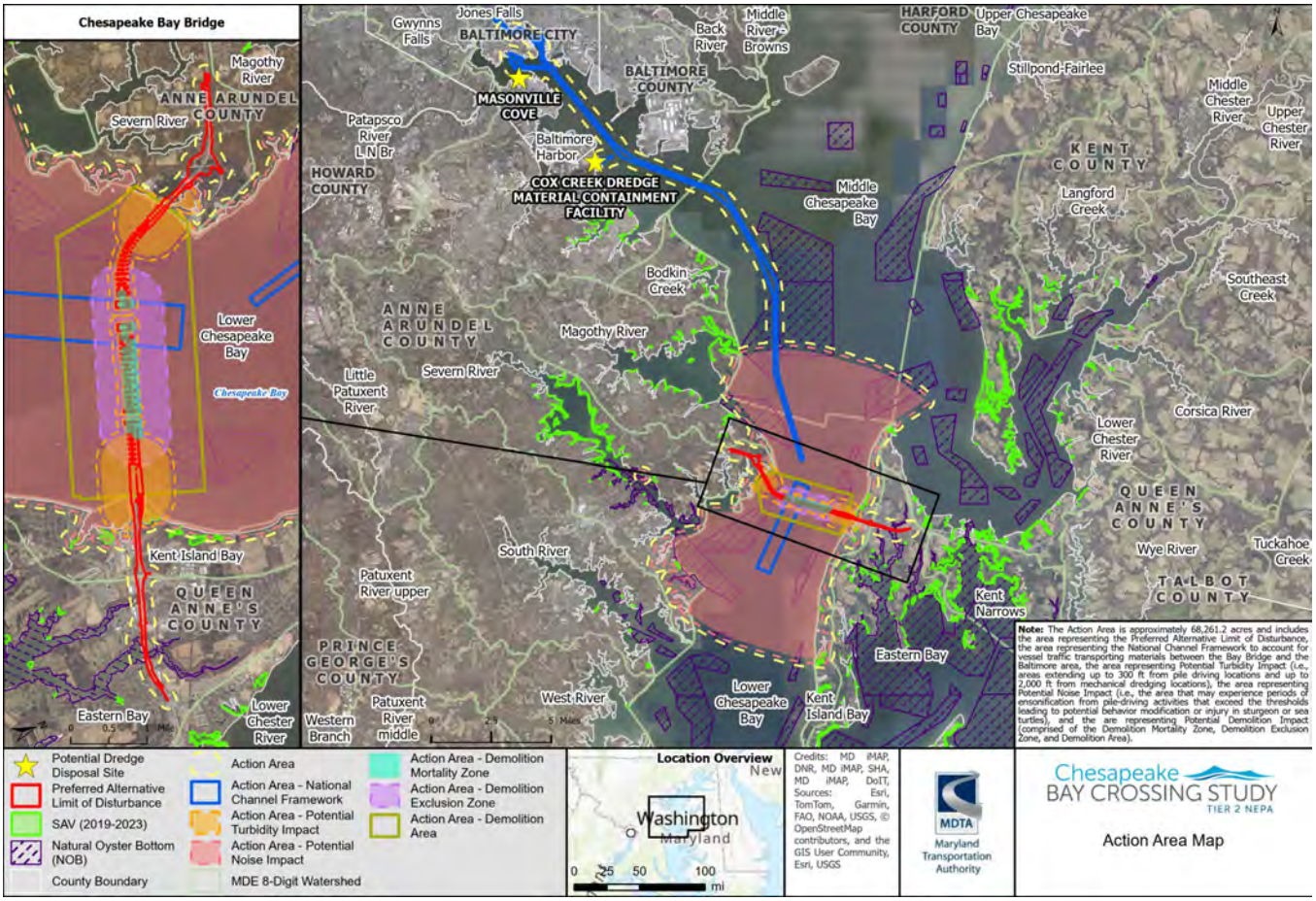
The action area includes areas within the waterway(s) that would experience temporary increases in sediment from dredging, pile driving, and demolition; temporary increases in noise from pile-driving activities and demolition of the existing bridge spans; and vessel routes traveled by project-related vessels between the project site and the Port of Baltimore. Noise generated by bridge demolition blasting is expected to be detectable within an approximately 1,200-acre area surrounding the bridge, representing the outer extent of potential underwater sound propagation from blasting rather than an area of physical habitat disturbance (see Benthic Habitat Modification – Blasting, below). The action area extends up to 10,000 m (32,808.4 ft) from the in-water portion of the proposed action Limit of Disturbance[6] (LOD) due to the anticipated noise generated by pile-driving. Sediment and turbidity impacts are expected to occur up to 91.4 m (300 ft) from the pile driving locations, and up to 731.5 m (2,400 ft) from the dredging locations (Burton 1993, FHWA 2012). It is anticipated that the vessel home port location would be in the Baltimore area, in which case construction-related vessel traffic would travel between the Bay

[6] The BA states that the limit of disturbance (LOD) is the boundary that would include all proposed construction, erosion and sediment control (ESC), stormwater management (SWM), and right-of-way offsets.

Bridge and the Baltimore area when involved in transport of material (a one-way distance of approximately 30.6 km (19 miles)). Any vessel traffic to/from home ports is anticipated to be limited to the Federal navigation channel extending from the Port of Baltimore to the project site.

Therefore, for the purpose of this consultation, the action area is defined as the approximately 338.39 square kilometer area (83,643 acres) within the Chesapeake Bay where in-water construction and demolition will occur and project vessels are likely to transit or operate (Figure 1).

Figure 1. Chesapeake Bay Crossing – Action Area



4 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 4):

Table 4. 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	In Development. Recovery Outline available online[7]
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

There is no designated critical habitat for species under our jurisdiction in the action area.

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

We have determined that the proposed action considered in this Opinion is not likely to adversely affect the following ESA-listed species: leatherback sea turtle, Kemp's ridley sea turtle, North Atlantic DPS of green sea turtles, and Northwest Atlantic DPS of loggerhead sea turtle. The rationale for this "not likely to adversely affect" (NLAA) determination is presented below.

4.1.1 Sea Turtles

The four species of sea turtles considered here are highly migratory. One of the main factors influencing sea turtle presence in the action area is seasonal temperature patterns (Ruben and Morreale 1999) as waters in this area are not warm enough to support sea turtle presence year-

[7] https://www.fisheries.noaa.gov/resource/document/recovery-outline-atlantic-sturgeon-distinct-population-segments; last accessed June 24, 2026

round. In general, sea turtles move up the U.S. Atlantic coast from southern wintering areas to foraging grounds as water temperatures warm in the spring. The trend reverses in the fall as water temperatures cool. By December, sea turtles have passed Cape Hatteras, returning to more southern waters for the winter (Braun-McNeill and Epperly 2002, Ceriani *et al*. 2012, Griffin *et al.* 2013, James *et al.* 2005b, Mansfield *et al.* 2009, Morreale and Standora 2005, Morreale and Standora 1998, NEFSC and SEFSC 2011, Shoop and Kenney 1992, TEWG 2009, Winton *et al*. 2018).

Juvenile and occasionally adult sea turtles opportunistically forage in the Chesapeake Bay 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.

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 suggest that Kemp's ridley are abundant near the mouth of the Chesapeake Bay (DiMatteo & Sparks 2023). Loggerhead turtle habitat was predicted to extend farther north than Kemp's ridley habitat and was generally found in deeper areas of the middle Bay (DiMatteo & Sparks 2023). Recent satellite-telemetry studies found that both species spend most of their time engaged in area-restricted search behavior, generally interpreted to be foraging (Barco *et al*. 2017, 2018b). Home range analyses (Barco *et al*. 2018b) identified presumed foraging habitat for Kemp's ridley turtles in the southwestern corner of the Bay, the James and York Rivers, and several other nearshore locations (approximately 193 km (120 mi) south of the Bridge), although there was extensive variation in home range size and location among individuals (DiMatteo *et al*. 2021). In contrast, presumed loggerhead turtle foraging habitat was found primarily in the center of the Bay (between Mobjack Bay and Tilghman Island – approximately 37 km (23 mi) south of the Bridge), into the waters of southern Maryland, with some additional habitat closer to shore (Barco *et al.* 2017). Green sea turtles are also present and leatherback sea turtles occur less frequently, in the Chesapeake Bay.

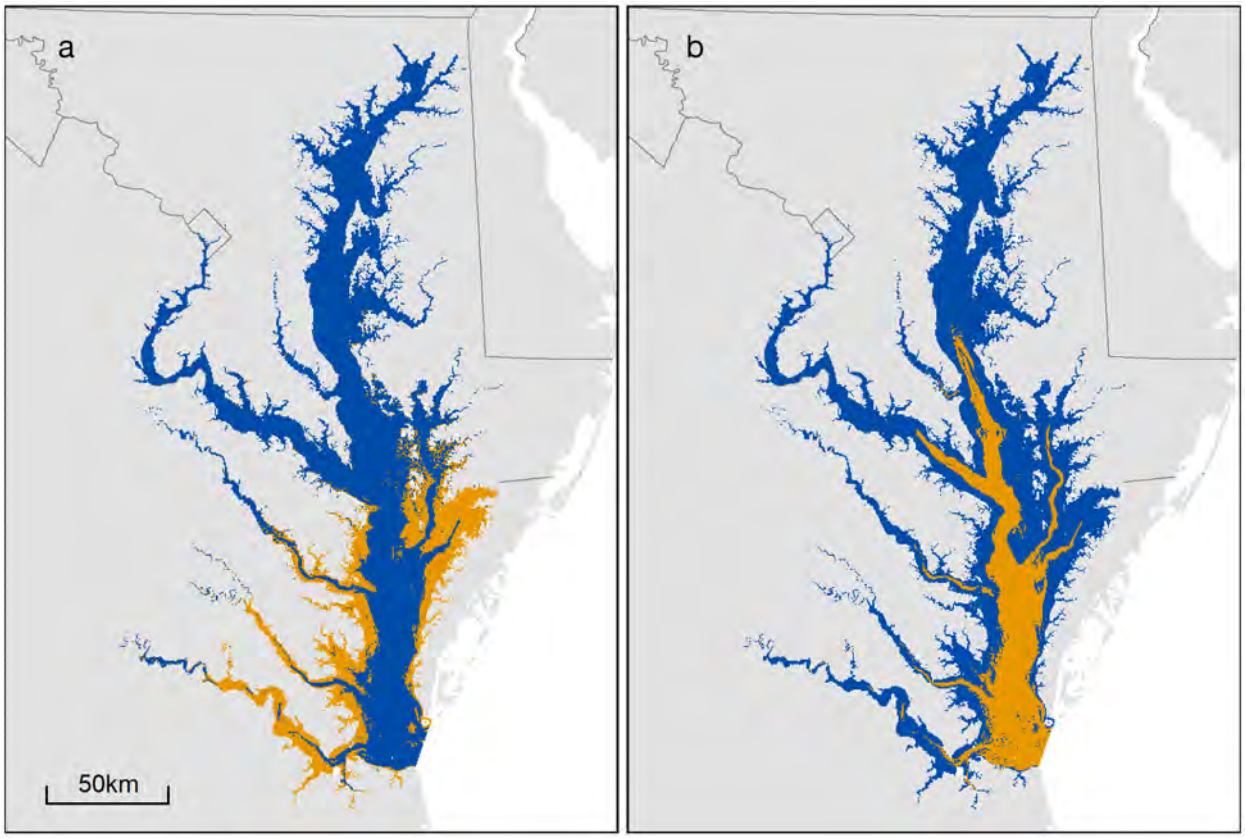
The functional ecology of these four sea turtle species is varied. Loggerhead sea turtles are primarily carnivorous feeding mainly on mollusks and crustaceans. Kemp's ridley sea turtles are omnivorous feeding primarily on crabs and crustaceans. Green sea turtles are herbivores feeding mainly on algae 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 most recent 5-year reviews (NMFS & U.S. FWS, 2023) and recovery plans: loggerhead (NMFS (National Marine Fisheries Service) & 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) & U.S. FWS (U. S. Fish Wildlife Service), 1991), and leatherback (NMFS (National Marine Fisheries Service) & U.S. FWS (U.S. Fish and Wildlife Service), 1992).

4.1.1.1 Sea Turtle Presence in the Action Area

Based on our professional judgment and experience with other section 7 consultations conducted in the Chesapeake Bay, we conclude that sea turtles are unlikely to be present in the action area on any given day, and that any presence, if it occurred, would be infrequent, transient, and of short duration. This conclusion is supported by the following factors, and by the absence of any documented sea turtle sightings, strandings, or telemetry detections in the immediate vicinity of the Bay Bridge - an absence that would be unexpected if turtles regularly used this specific location.

Figure 2. Important habitat (orange) for (a) the Kemp's ridley random pseudo-absence model and (b) the loggerhead target group absence model. Blue areas were modeled areas that were not classified as important (from DiMatteo *et al*. 2022)



The action area lies at or near the northernmost extent of regularly used and modelled sea turtle habitat within the Chesapeake Bay (Figure 2). Habitat suitability modeling using satellite telemetry (DiMatteo *et al*. 2022) predicts Kemp's ridley foraging habitat concentrated in the southwestern Bay, tidal rivers, and shallow coastal areas well south of the Bay Bridge, with "almost no important habitat" identified anywhere in Maryland waters of Chesapeake Bay. This pattern is corroborated by stranding records from 2008-2012: of 224 documented Kemp's ridley strandings in the Bay, none occurred north of latitude 38.8° N (DiMatteo *et al*. 2022,

citing Barco *et al*. 2015) - the action area, at approximately 38.99° N, lies north of this documented range entirely. Loggerhead foraging habitat, while extending somewhat farther north, remains concentrated in the deeper central and southern Bay (DiMatteo *et al*. 2022; Barco *et al*. 2018a). Aerial line-transect surveys similarly found consistently lower sea turtle density in the northern Bay stratum encompassing the action area than in the southern Bay, and fall (September–October) encounter rates in the Bay were too low to support density or abundance estimates at all, regardless of survey effort or availability corrections (Barco *et al.* 2018a).

The modelling results from DiMatteo *et al*. (2022) are further supported by the salinity of the action area. The Chesapeake Bay at the Bridge is mesohaline, with salinity of 5 to 18 parts per thousand. The marine prey base for all four species - mollusks, crustaceans, sea grasses, and gelatinous zooplankton - becomes less abundant as salinity decreases, making the action area comparatively poor foraging habitat relative to the higher-salinity waters to the south where turtles are known to concentrate.

Considered together, these factors support our determination that sea turtle occurrence in the action area, when it happens at all, is a rare, transient, opportunistic event rather than indication of sustained use. The stressor-specific analyses that follow are structured accordingly: each first notes that the probability of an individual turtle being present at a given place and time in the action area is low, and each then addresses, as a separate, secondary basis for the NLAA determination, what would be expected even in the unlikely event that a turtle was present.

4.1.1.2 Effects of the Proposed Action on Sea Turtles

As stated above, leatherback, green, Kemp's ridley, and loggerhead sea turtles are unlikely to be present in the action area on any given day, and any presence would be infrequent, transient, and of short duration. Although sea turtles are not expected to be present in the action area during in-water construction and demolition activities carried out from May through November, the implementation of BMPs (soft starts, bubble curtains, acoustic deterrents, observers) makes exposure to stressors unlikely. Nevertheless, to comprehensively assess potential impacts, the following sections evaluate pile driving, dredging, turbidity, vessel traffic, habitat modification, and blasting in the unlikely event that sea turtles are present in the action area while in-water activities are occurring.

Pile Driving and Removal

Noise created by pile driving and removal activities can physically injure animals or change animal behavior. NMFS has established thresholds, based on the best available scientific information, for when the onset of auditory injury from exposure to impulsive noise sources and for when behavioral responses to non-explosive noises are anticipated[8]. The onset of auditory injury thresholds considers peak noise (i.e., instantaneous exposure) and cumulative noise (i.e., cumulative sound exposure level (SELcum or cSEL), the accumulation of energy over time). For sea turtles, exposure to impulsive (e.g., impact pile driving) underwater noise levels of 230

[8] https://www.fisheries.noaa.gov/s3/2025-09/ESA-AllSpeciesThresholdSummary-2025-508-OPR1-9.16.25-.pdf

dB Peak, is expected to result in the onset of acoustic injury. The SELcum is not an instantaneous maximum noise level but represents a measure of the accumulated energy over a specific period of time (e.g., typically, a 12 or 24 hour period, within which multiple noise events may take place); for sea turtles, this threshold is 184 dB for impulsive noise sources (e.g., impact pile driving) and 198 dB for non-impulsive sources (e.g., vibratory pile driving). Noise can also interfere with an animal's behavior; behavioral effects, such as avoidance or disruption of foraging activities, may occur in sea turtles exposed to noise (non-explosives) around 175 dB RMS. Here, we consider the potential for sea turtles in the action area to be exposed to noise above these thresholds during pile driving.

Pile driving for construction of the first span and its pier protection is expected to occur for approximately 120 days during year 1 through year 3 of construction. Pile driving for construction of the second span and its pier protection is expected to occur for approximately 138 days during year 7 through year 12 of construction. In addition, piles will be driven to install mooring piles and construct a temporary trestle for project-related vessel access in waters less than 3 m (10 ft) deep below MLW. Based on the Francis Scott Key Bridge Rebuild Project design, the MDTA assumes trestle piers will be constructed every 11.6 m (38 ft) supported on 36-inch steel pipe piles. The mooring piles, trestle, and supporting piles will be removed after the project's completion. Pile driving will not happen on a daily basis and, when it occurs, FHWA and MDTA have committed to no more than 12 hours of pile driving per day.

Table 5. Estimated Distances to Sea Turtle Auditory Injury and Behavioral Disturbance Thresholds

Type of Pile	**Hammer Type**	**Distance (ft) to 230 dB_{Peak}**	**Distance (ft) to SEL_{cum} threshold (184 dB Impact / 198 dB Vibratory)**	**Distance (ft) to Behavioral Disturbance Threshold (175 dB_{RMS})**
36" Square Concrete	Impact	0.1	519.5	8.2
36" Steel Pipe	Impact	0.3	7,061.8	112.0
	Vibratory	N/A	193.7	7.1
48" Steel Pipe	Impact	0.5	3,821.6	96.1
	Vibratory	N/A	417.3**	15.2**
48" Steel Pipe (60" Steel Pipe Proxy)*	Impact	0.3	9,599.5	152.3
	Vibratory	N/A	417.3**	15.2**
96" Steel Pipe	Impact	1.5	28,069.2	706.8

Type of Pile	Hammer Type	Distance (ft) to 230 dB_{Peak}	Distance (ft) to SEL_{cum} threshold (184 dB Impact / 198 dB Vibratory)	Distance (ft) to Behavioral Disturbance Threshold (175 dB_{RMS})
	Vibratory	N/A	417.3**	15.2**
14" H-Pile	Impact	0.5	6,056.9	96.1
	Vibratory	N/A	9.0	0.3
AZ Sheet Pile	Impact	0.3	9,599.5	152.3
	Vibratory	N/A	89.9	3.3

The best available scientific information (Accomando *et al*. 2025) indicates that exposure to underwater noise levels at or above of 230 dB peak (for impulsive sounds), and at or above 184 dB SELcum (24 hours; impulsive sounds) and 198 dB SELcum (24 hours; non-impulsive sounds) can result in auditory injury to sea turtles. These noise levels refer to the maximum instantaneous sound pressure in water and the cumulative sound exposure level, respectively, expressed in decibels.

We note that the BA states it is possible that multiple pile sizes could be driven simultaneously, resulting in overlapping isopleths and a larger overall ensonified area than would result from a single pile being driven (BA at 5-6, 5-7). The BA does not commit to a specific concurrent pile-driving scenario, and the NMFS Multi-Species Pile Driving Calculator used in this analysis evaluates one pile at a time. Accordingly, our peak and RMS isopleth distances, which are governed by the loudest single source, remain a defensible outer bound even under concurrent driving. However, our SELcum calculations, which depend on total accumulated energy, do not account for the additive contribution of multiple simultaneously active piles and may underestimate the cumulative isopleth in any area where multiple pile-driving rigs are operating concurrently. The BMPs FWHA and MDTA committed to include the development of an underwater noise monitoring plan to describe the underwater noise generated by project activities and adaptive management measures to address the underwater noise. We will coordinate with FHWA and MDTA during the development of the plan, but also acknowledge that this consultation may need to be reinitiated if the final plan includes concurrent pile driving that appears to exceed our estimated effects.

For sea turtles, the distance to the 230 dB peak threshold is predicted to be 0.1 to 1.5 feet, depending on pile type (see Table 5); this means that to experience auditory injury a sea turtle would need to be within 0.46 m (0.1 to 1.5 feet) of a pile being installed with an impact hammer. Even considering a single pile strike, exposure to noise above 230 dB peak is extremely unlikely

to occur because pile driving will begin with a "soft start" where a reduced hammer energy is used. Underwater noise is not expected to exceed the 230 dB peak threshold during the soft-start period but is expected to be loud enough that sea turtles would begin swimming away from the noise source. By initiating impact pile driving with a localized, low-energy source (three 3-strike sequences at 40 percent of full power), the procedure provides a behavioral warning mechanism. This sub-lethal acoustic stimulus is expected to provoke an immediate avoidance response, allowing sea turtles to actively swim away from the sound source and avoid the immediate vicinity before sound pressure levels ramp up to full operational energy, which prevents exposure to acoustic thresholds that could result in injury. Presumably, the soft start is loud enough to be above the behavioral threshold, but below the threshold to cause injury and any sea turtles in the area would avoid the sound source before they are exposed to "full strength" pile driving. As such, sea turtles are extremely unlikely to be within 0.46 m (1.5 feet) of the pile when the soft start ends and full energy pile driving begins as any sea turtles that close to the pile would have already moved away.

Sea turtles are expected to avoid areas where noise is above 175 dB RMS behavioral threshold, which in all cases, is an area significantly larger than the area where noise would exceed the peak injury threshold (e.g., for the 96-inch steel pipe piles it extends over 213.4 m (700 ft) from the pile). As such, after impact driving begins, we expect sea turtles would be deterred from the area by the noise and would not approach to within a close enough distance to be exposed to noise above the peak threshold. Therefore, exposure to noise above the peak injury threshold is extremely unlikely to occur.

The calculations to establish the distance to the cumulative noise thresholds for impact and vibratory pile driving considered pile installation over a full day, with up to 12 hours of pile driving; thus, it considers the installation of multiple piles in a day. To be exposed to noise above the cumulative injury threshold, a sea turtle would need to remain within approximately 2.7 m to 8,534.4 m (9 to 28,000 ft) or approximately 8.5 km (5 mi) of all piles installed in a 24-hour period. As outlined in Table 6, for nearly all pile types, while the calculated SELcum isopleth exceeds the behavioral isopleth in all pile installation scenarios (Table 6), we still do not expect that a sea turtle would remain close enough to any piles being installed for the full duration of pile driving in a day. This is because sea turtles in the action area are transient and highly mobile; therefore, they are not expected to remain in any particular area for more than a few minutes to a few hours. Telemetry and distributional studies summarized elsewhere in this Opinion (DiMatteo *et al*. 2020; Barco *et al*. 2017) describe home ranges and movement patterns for sea turtles in the Bay that are outside of, and not concentrated within, the area ensonified above the cumulative threshold. Because turtles move through - rather than remain stationary - within a given area of the Bay, including the action area, the SELcum metric, which assumes continuous exposure at a fixed location for the full averaging period, overstates the exposure any single transiting individual would actually accumulate over 12 hours. Sea turtle swim speeds vary significantly depending on life stage, but average cruising speeds are estimated to hover around 0.5 m/s to 0.7 m/s (1.6 ft/s to 2.3 ft/s) (Kinoshita *et al*. 2021). With the implementation

of a soft start, it would take approximately 20 minutes for the hammer to reach full energy during the installation of the largest piles considered (96-inch piles). Therefore, once the soft start begins, a sea turtle would be expected to exit the area ensonified above the 175 dB RMS behavioral threshold (up to 215.4 m (706.8 ft) from the pile) during the first 20 minutes and before the hammer reaches full power. This swim-speed calculation demonstrates that an individual sea turtle would not remain within the behavioral disturbance isopleth for the full 12-hour working day; however, it does not by itself demonstrate that a turtle would exit the much larger area within which the cumulative (SELcum) injury threshold could be exceeded (up to approximately 8.5 km (5 mi) in diameter, discussed above). Our conclusion regarding the cumulative threshold rests on the unlikely presence of sea turtles near the Bridge. Furthermore, should a sea turtle enter the area, the implementation of BMPs—coupled with the species' transient, wide-ranging movements in the Bay—ensures that potential effects are extremely unlikely to occur. As a result, sea turtles are not likely to be adversely affected.

The avoidance response itself - increased swim speed and directional movement away from the noise source - imposes a minor, short-duration energetic cost that is well within the normal swim capacity of sea turtles. At the speeds used in the exit-time calculation above (0.5 to 0.7 m/s (1.6 ft/s to 2.3 ft/s)), this is not a forced or maximal-effort swim and considering the relatively small distance an individual would need to swim to avoid noise above the 175 dB threshold (no more than 215.4 m (706.8 ft)), this response would be limited to a very short period of time (less than 10 minutes). We also consider the temporary loss of access to foraging habitat within the ensonified area for the duration of active pile driving. Given the 12-hour daily working limit, any individual displaced during active driving is expected to regain access to the area during the intervening rest period, limiting the foraging loss associated with any single event to a period of hours.

Because pile driving for this project will recur intermittently over 258 days across a multi-year construction schedule, we also considered whether repeated, intermittent displacement could impose a cumulative energetic or nutritional cost distinct from any single avoidance event. Based on our best professional judgement, sea turtles seasonally occupying the Chesapeake Bay are unlikely to occur in the area ensonified by pile-driving. This conclusion is supported by our prior section 7 consultations in this part of the Bay, and by the absence of any documented sea turtle sightings, strandings, or telemetry detections in the immediate vicinity of the Bay Bridge — an absence that would be unexpected if turtles regularly used this specific location. In addition, according to studies by Barco *et al*. (2017, 2018b) and DiMatteo *et al*. (2022) the Bay supports a broad foraging range for the species present, and availability of alternative foraging habitat outside the ensonified area during active pile driving reduces the likelihood that repeated displacement, if it were to occur, would result in a measurable reduction in individual foraging success, growth, or reproductive fitness over the course of a season. While no population or individual-level data specific to Chesapeake Bay sea turtles are available to quantify this further, our conclusion is based on the temporal and spatial limits on exposure described elsewhere in this section, and consistent with the general finding that the magnitude of any energetic

consequence of displacement depends on its temporal and spatial scale which in this case is very small in space and time.

Based on this analysis, the implementation of BMPs and the unlikely occurrence of sea turtles in the action area make exposure to elevated pile driving noise extremely unlikely to occur. Therefore, potential behavioral effects resulting from increased underwater noise associated with pile installation are discountable. As such, effects of exposure to pile driving will not impact any individual sea turtle's ability to carry out any essential behaviors such as resting, foraging or migrating and/or affect the fitness of any individuals.

Dredging

Mechanical dredging entails lowering the open bucket or clamshell through the water column, closing the bucket after impact on the bottom, lifting the bucket up through the water column, and emptying the bucket into a barge. The bucket operates without suction or hydraulic intake, moves relatively slowly through the water column and affects only a small area of the aquatic bottom at any time. In order to be captured in a dredge bucket, an animal must be on the bottom directly below the dredge bucket as it contacts the substrate and remain stationary as the bucket closes. Species captured in dredge buckets can be injured or killed if entrapped in the bucket or buried in sediment during dredging and/or when sediment is deposited into the dredge scow. Species captured and emptied out of the bucket can suffer stress or injury, which can lead to mortality.

Sea turtles are not known to be vulnerable to entrapment in mechanical dredges (Dickerson *et al*. (1998, 2004, 2019)), presumably because they are able to avoid the dredge bucket. As described above, sea turtles are unlikely to occur in the action area. Furthermore, should a sea turtle be present at the dredge site, direct capture in the mechanical dredge bucket or injury/mortality resulting from dredging operations is extremely unlikely; therefore, potential effects are discountable. Based on this information, the likelihood of an interaction between a sea turtle and the mechanical dredge is extremely unlikely. Therefore, effects to sea turtles from mechanical dredging activities described as part of the proposed action are extremely unlikely to occur and are discountable.

Turbidity

In-water construction, demolition, dredging activities, geotechnical borings, and removal of temporary piles and cofferdams will generate localized, temporary increases in suspended sediment and turbidity in the action area. As described in Section 6.3.2, mechanical dredging is expected to produce TSS concentrations of up to approximately 445 mg/L near the bottom, with plumes dissipating to background levels within approximately 732 m (2,400 ft) of the dredge location. Pile driving and removal are expected to produce more localized and lower-magnitude increases, on the order of 5.0 to 10.0 mg/L above background within approximately 91 m (300 ft) of the pile being driven. Blasting is expected to generate short-duration TSS concentrations of approximately 350 to 600 mg/L, persisting for less than 30 minutes following each event. These are the same turbidity source terms and spatial extents used to assess effects to sturgeon

elsewhere in this Opinion (Section 6.3), and we rely on them here as the best available estimate of the turbidity conditions to which sea turtles could be exposed.

There are no directed studies quantifying the physiological effects of suspended sediment on sea turtles. However, unlike fish, sea turtles do not rely on gills for respiration, so the primary pathway by which elevated TSS causes physiological harm in fish - impaired oxygen uptake across the gill surface - is not applicable. Sea turtles are highly mobile, air-breathing, and capable of readily traversing zones of elevated turbidity without becoming trapped in the sediment plume itself, unlike more sedentary or substrate-associated organisms. Given this, the primary route by which turbidity could affect sea turtles is behavioral: a plume dense enough to obscure vision or create a perceived barrier could cause a sea turtle to alter its course, delaying or redirecting movement rather than causing direct injury.

Applying the TSS levels and spatial extents described above, we expect any turbidity-related avoidance behavior by sea turtles to be limited to the localized areas immediately surrounding active dredging (within approximately 732 m (2,400 ft)), pile installation and removal (within approximately 91 m (300 ft)), and individual blast events (for less than 30 minutes post-detonation). These areas represent a small fraction of the total action area and of the width of the Chesapeake Bay at the Bay Bridge crossing (approximately 7.2 km (4.5 mi)), leaving sea turtles ample unaffected water column through which to continue migrating or foraging while avoiding the immediate plume. Because sea turtles are transient in the action area and are not expected to hold station within these localized zones, we expect any behavioral modification to consist of, at most, a brief course adjustment around the plume rather than a sustained avoidance of the action area or a barrier to movement through it.

Based on this information, we expect the effects of re-suspended sediment on sea turtles resulting from in-water construction, demolition, dredging, and removal of temporary piles and cofferdams when added to baseline conditions, to be limited to brief, localized behavioral adjustments that do not rise to the level of a barrier to normal behavior. These effects are too small to be meaningfully measured, evaluated, or detected and are, therefore, insignificant.

Vessel Traffic

Vessel strikes are a known source of injury and mortality for sea turtles. Increased vessel activity in the action area associated with the construction and demolition activities of the proposed action would pose a theoretical risk of increased collision-related injury and mortality for sea turtles. In general, sea turtles are vulnerable to a range of vessel types and speeds depending on the environment. Sea turtle collision risk is thought to be at least in part commensurate with vessel speed (Hazel *et al*. 2007; Shimada *et al.* 2017). Hazel *et al*. (2007) found that green sea turtles were unlikely to actively avoid vessels traveling faster than 4 km/h (2.1 kts), indicating that 18.5 km/h (10 kts) speed restrictions may not be protective for this and potentially other sea turtle species.

Based on our best professional judgement, sea turtles seasonally occupying the Chesapeake Bay are not likely to occur in the navigation channel between the Bay Bridge and the Port of Baltimore or the immediate project area where vessels will operate. The Bay Bridge is located at the northern extent of their range and we consider the Port of Baltimore – approximately 30.6 km (19 m) north – to be outside of their range. This conclusion is supported by our prior section 7 consultations in this part of the Bay, and by the absence of any documented sea turtle sightings, strandings, or telemetry detections in the immediate vicinity of the Bay Bridge, the Federal Navigation Channel, and the Port of Baltimore - an absence that would be unexpected if turtles regularly used this specific location. As described above, sea turtles are unlikely to occur in the action area; however, as detailed below, if a sea turtle were to be present at the project site or the navigation channel, the risk of a vessel strike would be extremely unlikely.

According to the BA, the approximate size and type of vessel, travel routes, and number of trips is currently unknown. Therefore, to analyze the risk of vessel interactions, we found it necessary to develop a proxy involving similar deep-water foundation installation and demolition. We identified the following projects as potential proxies for project-related vessel traffic in the action area for the Bay Crossing Project:

- The Hampton Roads Bridge-Tunnel (HRBT) Expansion Project: A relevant, multi-year estuarine bridge project with dense vessel traffic in sea turtle foraging habitat.
- The Governor Harry W. Nice/Senator Thomas "Mac" Middleton Memorial Bridge Replacement: A localized Maryland project (Potomac River) involving large-diameter piles and extensive barge/tug traffic.

Our analytical framework draws from the construction and demolition parameters of the Governor Mario M. Cuomo Bridge and the Hampton Roads Bridge-Tunnel Expansion projects to classify potential traffic into the following three distinct operational tiers based on vessel displacement and transit velocity:

- Tier 1: Heavy-Displacement / Slow-Moving Construction Vessels
    - Proxy Specs: Crane/derrick barges, material transport barges (45.7-91.4 m (150–300 ft) in length), and attendant ocean-going or coastal tugboats (18.3-30.5 m (60–100 ft)).
    - Operational Character: Highly predictable, slow-moving (4–6 kts), deep drafts.

- Tier 2: Medium-Displacement Support & Service Craft
    - Proxy Specs: Anchor-handling boats, dive support vessels, and fuel/water barges (12.2-24.4 m (40–80 ft)).
    - Operational Character: Moderate speeds (8–12 kts), operating dynamically around the bridge structures.

- Tier 3: Light-Displacement / High-Speed Crew Transfer Vessels

- Proxy Specs: Rigid-hull inflatable boats (RHIBs), center-consoles, or small commercial vessels (6.1-12.2 m (20–40 feet)).

Operational Character: Highly mobile, frequent transits, traveling at planing speeds (>15–20 kts). Operation at planing speeds (>15–20 kts) is limited to documented safety exemptions (e.g., emergency response, adverse weather requiring expedited transit) and is not representative of routine daily operations.

For purposes of this analysis, spatial and temporal routing assumes low-displacement, high-speed crew transfer vessels will frequently traverse the shoals flanking the bridge spans during peak summer foraging months (June–September), as well as the following:

- The Channel-to-Shoal Transit: Assume that all larger vessels (Tiers 1 & 2) will originate from major industrial staging areas (e.g., the Port of Baltimore) and utilize the 50-foot Federal Navigation Channel to reach the bridge.
- The Shallow Zone Assumption: Assume that all vessels, particularly Tier 3 crew transfer vessels, will routinely transit outside the main navigation channel, crossing the shallow shoals and flats (< 9.1 m (30 ft)) flanking Sandy Point and Kent Island to access the shallow-water bridge bents.

Although, based on our best professional judgement, sea turtles are not expected to be present in the action area, this section will address the effects of vessel traffic in the unlikely event of sea turtles co-occurring with vessels in the action area. By analyzing the maximum anticipated daily transits, we ensure that the subsequent risk determination encompasses the highest potential exposure scenario in the unlikely event that sea turtles occur within the action area:

- Tier 1 (Barges/Tugs): Up to 4 round-trips per day (material deliveries or transport of dredge material).
- Tier 2 (Support Craft): Up to 10 round-trips per day (equipment and safety monitoring).
- Tier 3 (Crew Boats): Up to 30 round-trips per day (shift changes, inspector transits, and courier runs).
- Total Project Fleet Estimate: up to 44 round-trips (88 linear transits) per day within the action area.

In the unlikely event that a sea turtle is present within the action area, project-related vessels would pose a potential collision risk. In areas where high densities of sea turtles aggregate, including parts of Chesapeake Bay south of the action area, vessel-animal collisions are a measurable and increasing source of mortality and injury for sea turtles; the percentage of stranded loggerhead sea turtles with injuries that were apparently caused by vessel strikes increased from approximately 10 percent in the 1980s to over 20 percent in 2004, although some stranded turtles may have been struck post-mortem (NMFS and USFWS 2008). Sea turtles are expected to be most vulnerable to vessel strikes in coastal foraging areas and may not be able to

avoid collisions when vessel speeds exceed 1 m/s (2 kts) (Hazel *et al.* 2007). The recovery plan for loggerhead sea turtles (NMFS and USFWS 2008) notes that, from 1997 to 2005, 14.9 percent of all stranded loggerheads in the U.S. Atlantic and Gulf of Mexico were documented as having some type of propeller or collision injuries, although it is not known what proportion of these injuries occurred before or after the turtle died.

Vessels traveling at higher speeds pose a higher risk to sea turtles relative to other species, like marine mammals; sea turtles require more stringent speed reductions before lethal injury probabilities are reduced. To reduce the risk of lethal injury to loggerhead sea turtles from vessel strikes by 50 percent, Sapp (2010) found that small vessels (3 to 6 m (10 to 30 ft) in length) had to slow down to 3.9 m/s (7.5 kts); the probability of lethal injury decreased by 60 percent for vessels idling at 2.1 m/s (4 kts). Foley *et al*. (2008) further indicated that vessel speed greater than 2.1 m/s (4 kts) may cause serious injury or mortality to sea turtles. The most informative study of the relationship between ship speed and collision risk was conducted on green sea turtles (Hazel *et al.* 2007). Green sea turtles often failed to flee approaching vessels. Hazel *et al*. (2007) concluded that green sea turtles rarely fled when encountering fast vessels (greater than 5 m/s (10 kts)), infrequently fled when encountering vessels at moderate speeds of around 3.1 m/s (6 kts), and frequently fled when encountering vessels at slow speeds of approximately 1 m/s (2 kts). Based on the observed responses of green sea turtles to approaching boats, Hazel *et al*. (2007) further concluded that sea turtles rely primarily on vision rather than hearing to avoid vessels; although both may play a role in eliciting responses, sea turtles may habituate to vessel sound and be more likely to respond to the sight of a vessel rather than the sound of a vessel. The potential for collisions between vessels and sea turtles, thus, increases at night and during inclement weather. Based on these findings, vessel speed restrictions may be inconsequential to reducing strike risk at anything but the slowest speeds (less than 1 m/s (2 kts)) due to the relatively low rate of flee responses of sea turtles.

Compared to the baseline of approximately 34,302 annual vessel transits in the upper Chesapeake Bay and Federal Navigation Channel, project vessels represent a small fraction of overall vessel activity in the action area, distributed across an approximately 15-year construction and demolition program rather than concentrated in a single season. There are limited measures that prove to be effective at reducing collisions between sea turtles and vessels (Schoeman *et al.* 2020). The relatively small size of turtles and the significant time spent below the surface makes their observation by vessel operators extremely difficult, which reduces the effectiveness of trained observers to mitigate vessel strike risk on sea turtles. Nevertheless, the use of trained lookouts would serve to reduce potential collisions. In addition to the observers, strike avoidance measures that are specifically geared towards sea turtles include:

- Do not moor vessels in SAV or in such a way that could shade SAV.
- Enforcement of reduced construction vessel speeds (e.g., below 18.5 km/h (10 kts)).
- Keeping appropriate distance from protected species if spotted.

Although vessel strike risk to sea turtles is expected to be reduced with the application of monitoring and mitigation measures, some unavoidable effects on sea turtles may occur, primarily due to the difficulty in detecting sea turtles. Though vessel speed restrictions are designed primarily to reduce impact to marine mammals, they would also reduce potential impacts to sea turtles. However, sea turtle collisions may still occur at slow speeds, and individuals would still be vulnerable when vessels travel over 1 m/s (2 kts). Additionally, effective detection of sea turtles in low visibility conditions (nighttime, fog, inclement weather) is likely low, even with the application of alternative monitoring technologies, thereby increasing the vulnerability of sea turtles to vessel strike risk during these periods, even with all other mitigative measures implemented.

We recognize that project-related vessel activity, estimated at up to 44 round-trips (88 linear transits) per day on peak activity days and approximately 27,500 total transits over the ~15-year construction and demolition schedule, represents a measurable increase over the approximately 34,300 annual baseline transits in the upper Bay and Federal Navigation Channel - on the order of a 5 percent increase in some years, concentrated on active construction days rather than distributed evenly across the year. However, because the primary determinant of strike risk is the probability that a sea turtle and a vessel occupy the same location at the same time, and because we have concluded that sea turtles are unlikely to be present in the action area (Section 4.1.1.1), in addition to the mitigation measures described above, we conclude that the risk of a vessel strike associated with the project is extremely unlikely to occur, and discountable.

Habitat Modification

Sea turtle species could potentially be affected by geotechnical borings, in-water construction, demolition, and dredging activities in the unlikely event they occur in the action area (generally during the peak warmer months of June to October). Their presence in the Bay would most likely be where suitable forage (e.g., benthic invertebrates such as mollusks and crustaceans) and appropriate habitat conditions are present (e.g., depth, temperature, salinity). Preferred foraging habitat for Kemp's ridley turtles was identified in the southwestern corner of Chesapeake Bay, the James and York rivers, and several other nearshore locations, though there was extensive variation in home range size and location among individuals (DiMatteo *et al*. 2020). Loggerhead foraging habitat was found primarily in the center of the Bay, into the waters of southern Maryland, with some additional habitat closer to shore (Barco *et al.* 2017). Like Kemp's ridleys, there was extensive variation in the size and location of individual home ranges. Due to this variation, the mobility of sea turtles, the absence of physical barriers, and the presence suitable habitat features (temperature, salinity, and bathymetry), sea turtles may be opportunistically foraging within the action area. The physical disturbance of sediments and entrainment of associated benthic resources could reduce the availability of sea turtle prey, but the impacted benthic habitat represents a minimal amount of the available habitat in the region, and recolonization of the opportunistic benthic species would occur quickly (Blake *et al*. 1996, Van Dolah *et al*. 1992), making these localized impacts to sea turtle habitat and prey too small to be meaningfully measured, detected, or evaluated and, therefore, insignificant.

Blasting

As stated above, sea turtles are unlikely to be present in the action area on any given day, and any presence would be infrequent, transient, and of short duration. They are even less likely to occur as water temperatures cool in the fall. Although sea turtles are not expected to be present in the action area during blasting, the use of acoustic deterrents and protected species observers makes exposure to blasting extremely unlikely. Nevertheless, to comprehensively assess potential impacts, this section will address the effects of blasting in the unlikely event of sea turtles co-occurring with blasting operations in the action area. Limited data is available regarding impacts of blasting on sea turtles, though some studies have demonstrated that blasting can result in mortality to sea turtles. The likelihood of nonlethal damage or delayed mortality in sea turtles resulting from blasting is unknown (Keevin and Hempen 1997).

Any required blasting will occur between October 1 and December 15, a window selected to reduce, though not fully eliminate, overlap with the period of peak sea turtle abundance in the Chesapeake Bay (June through October). The blasting window necessarily begins during the tail end of that peak period; the rationale for why this overlap does not meaningfully increase risk is addressed in the discussion that follows.

First, sea turtle abundance in the Chesapeake Bay declines sharply after the summer peak. The BA documents that adult and juvenile sea turtles are present from May through the end of November; with highest concentrations from June through October. Sea turtles cannot survive in Chesapeake Bay when water temperatures fall below 18°C–20°C (64.4°F-68°F) (typically October to November). Because the Upper Bay cools rapidly in early autumn, any turtle lingering there is at extreme risk of becoming "cold-stunned" and stranded. Therefore, by October, animals are actively migrating south and out of the Bay in response to declining water temperatures. The absence of sea turtles in the action area is supported by aerial line-transect surveys in the region. Barco *et al*. (2018a) found consistently lower sea turtle density in the northern Bay stratum encompassing the action area than in the southern Bay, and fall (September–October) encounter rates in the Bay were too low to support density or abundance estimates at all, regardless of survey effort or availability corrections. While we do not assert that no turtles remain in the Bay in October, the best available survey data indicate that detectable presence drops sharply entering the blasting window, rather than opening during a period of peak abundance.

Second, even accounting for the low baseline probability of sea turtles occurring in the action area, exposure to injurious blast pressure requires an extraordinary degree of spatial and temporal overlap. To experience injurious overpressure, an individual would need to be positioned within the immediate vicinity of a specific pier - the Mortality Zone extends only 65.5–67 m (215–220 ft), and the Exclusion Zone extends 640 m (2,100 ft) - at the exact instant of detonation during one of only 34 total discrete blast events (distributed across two non-consecutive construction years). The probability of such exposure occurring depends on two compounding conditions: (1) the low likelihood of an individual being present in the action area on a given day; and (2) the further requirement that, if present, the turtle be positioned within this narrow footprint at the exact millisecond of a blast. Given the transient, wide-ranging movement patterns of sea turtles

and the brief, localized nature of each detonation, the chance of this precise spatial and temporal alignment is extremely remote.

Third, protected species observers will monitor the Exclusion Zone for sea turtles (and other listed species) prior to and during each blast event as part of the blast monitoring protocol described in the RPMs/Terms and Conditions, which provides an additional means of confirming the absence of turtles before detonation. In addition, the same avoidance and minimization measures described in Section 3 to reduce sturgeon exposure - pre-blast fish deterrent sonar sweeps and fish scare charges detonated 15 to 30 seconds ahead of the main blast - will be deployed in the water column immediately prior to each blast event. While these measures were designed and tested with fish species, sea turtles are known to be sensitive to underwater impulsive noise and are reasonably expected to respond similarly to pre-blast deterrent activity by moving away from the immediate blast area, providing an additional, though non-quantified, reduction in exposure risk.

Taken together, these factors—the unlikely baseline presence of sea turtles, a blasting schedule aligned with the declining edge of seasonal presence, the action area's position at the periphery of regularly used habitat, the localized spatial footprint of potential injury, the small number of discrete blast events, and the implementation of pre-blast deterrents—demonstrate that physical exposure resulting in injury or mortality is extremely unlikely to occur.

With respect to potential behavioral disruption, the pre-blast fish deterrent sonar sweeps and scare charges are brief and localized, operating for only 15 to 30 seconds immediately preceding each of the 34 discrete detonations rather than continuously over extended periods. Given that sea turtles are unlikely to occur in the action area initially, combined with the transient mobility of individuals and the brief, localized nature of both the deterrents and the detonations, the probability of a sea turtle encountering these stressors and experiencing a detectable behavioral response is extremely remote.

Because exposure leading to injury, mortality, or behavioral disruption is extremely unlikely to occur, we conclude that the effects of blasting on leatherback, Kemp's ridley, the Northwest Atlantic DPS of loggerhead, and the North Atlantic DPS of green sea turtles are discountable.

Non-blasting demolition

Physical strike and debris. Demolition rubble from mechanical removal of piers and pile bents will drop to the Bay bottom in the immediate vicinity of each structure. After reviewing the best available information, as discussed above, it is our professional opinion that the possibility of encountering a sea turtle during non-blasting demolition is extremely unlikely. Although sea turtles are not expected to be present in the action area, the use of protected species observers on project-related vessels makes exposure to falling debris extremely unlikely. Therefore, we anticipate the likelihood of a sea turtle being struck by falling demolition debris to be extremely unlikely, and discountable.

Turbidity. See turbidity analysis above; the conclusion reached there (insignificant, discountable effects) applies equally to turbidity generated by non-blasting demolition activities.

Vessel traffic. Vessel activity associated with mechanical demolition at each of the 206 mechanically demolished structures is encompassed within the project's overall vessel traffic analysis above including the density and duration-based rationale developed there, and does not represent an additional, separately quantified source of vessel-strike risk to sea turtles.

For the reasons discussed above, non-blasting demolition activities are not expected to cause effects on sea turtles that can be meaningfully measured, detected, or evaluated, and are, therefore, insignificant. The risk of direct physical strike is discountable.

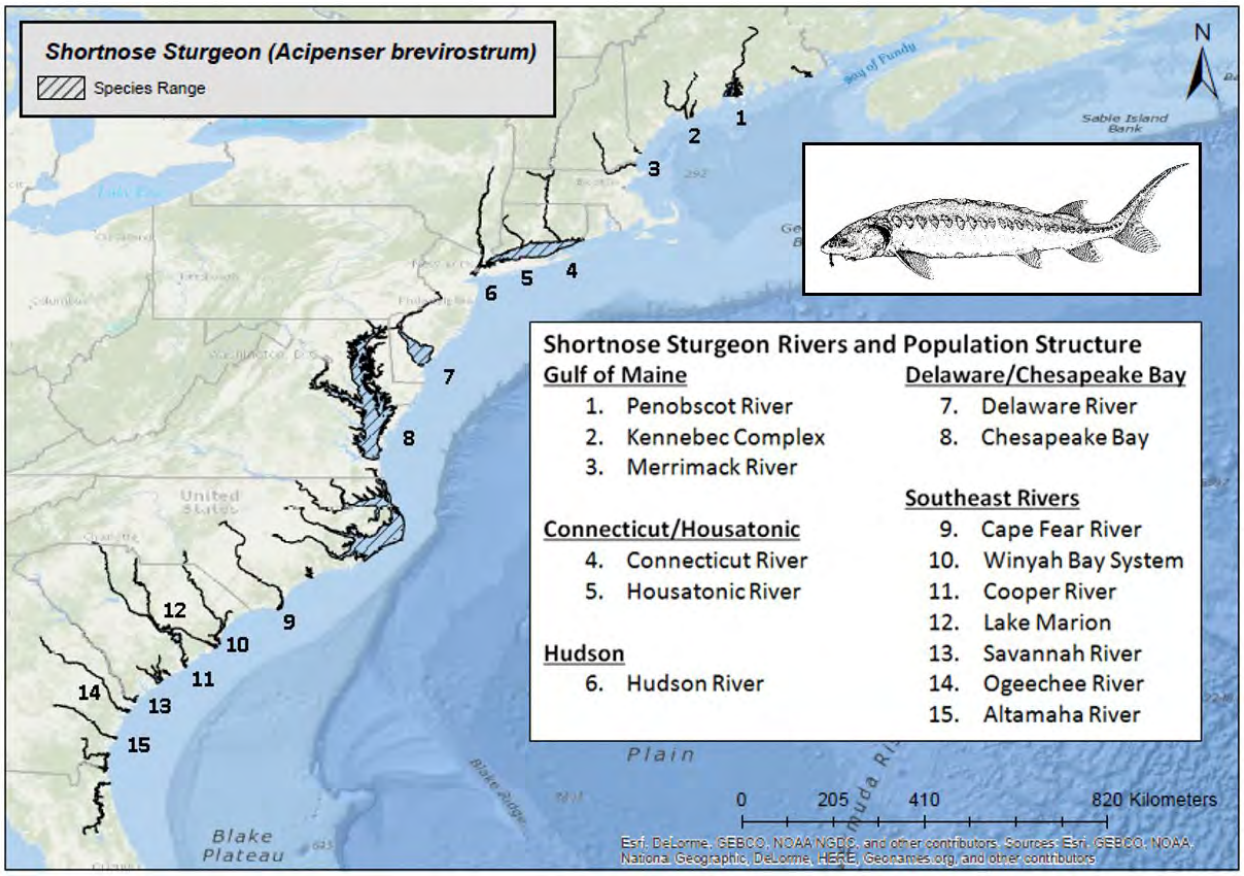
4.2 Listed Species Likely to be Adversely Affected by the Proposed Action

This section will focus on the status of the species of shortnose and Atlantic sturgeon (all 5 DPSs), summarizing information necessary to establish the environmental baseline and to assess the effects of 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. More thorough discussions can be found in the cited references as well as the SSSRT's Biological Assessment (2010). 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* section.

Figure 3. Geographic range of shortnose sturgeon



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 occur more quickly in southern rivers but fish in northern rivers grow larger and live longer. See Table 6 for shortnose sturgeon general life history attributes.

Table 6. General 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 (Dadswell *et al.* 1984). Males mature at approximately 5-10 years and females mature between age 7 and 13, with later maturation occurring in more northern populations (Dadswell *et al.* 1984). Females typically spawn for the first time 5 years post-maturation (age 12-18; Dadswell 1979; Dadswell *et al.* 1984) and then spawn every 3-5 years (Dadswell 1979; Dadswell *et al.* 1984;). Males spawn for the first time approximately 1-2 years after maturity with spawning typically occurring every 1-2 years (Kieffer and Kynard 1996; NMFS 1998; Dadswell *et al.* 1984). 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 m/s (1.3 and 2.6 ft/s). Depths at spawning sites are highly variable, ranging from 1.2-27 m (4-89 ft) (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 & 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 m (98.4 ft) (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 m (9.8-32.8 ft) 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 400, March 11, 1967), 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. The species remains listed as endangered throughout its range. While the 1998 Recovery Plan refers to Distinct Population Segments (DPS), the process to designate DPSs for this species has not been undertaken. 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 km (248.5 mi). 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 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[9]. 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 (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 Summary of Status of Metapopulations

In NMFS's Greater Atlantic Region, shortnose sturgeon are known to spawn in the Kennebec, Androscoggin, Merrimack, Connecticut, Hudson, and Delaware Rivers (SSSRT 2010). Shortnose sturgeon are also known to occur in the Penobscot, Sheepscot, Saco and Potomac Rivers; although it is unclear if spawning is currently occurring in those systems (SSSRT 2010, Wippelhauser *et al*. 2015 and Altenritter *et al*. 2017).

Gulf of Maine Metapopulation

Tagging and telemetry studies indicate that shortnose sturgeon are present in the Penobscot, Kennebec, Androscoggin, Sheepscot, and Saco Rivers (SSSRT 2010, Wippelhauser *et al*. 2015

[9] 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.

and Altenritter *et al*. 2017). Individuals have also been documented 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. Robust design analysis with closed periods in the summer and late fall 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). These studies predate the tagging and telemetry data discussed above (e.g., Zydlewski *et al*. 2011; Altenritter *et al.* 2017a, 2017b) documenting substantial movement of shortnose sturgeon among Gulf of Maine rivers, including to and from the Penobscot. Because the robust design closure assumption may not hold if individuals moved among rivers during the nominal "closed" summer and late-fall sampling windows, these seasonal abundance figures should be treated as dated and potentially imprecise, rather than as a current, defensible estimate of Penobscot River abundance.

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.

Merrimack River

The historic range in the Merrimack extended to Amoskeag Falls (Manchester, New Hampshire, River Kilometer (RKM) 116 (River Mile (RM) 72); Piotrowski 2002); currently shortnose sturgeon cannot move past the Essex Dam in Lawrence, Massachusetts (RKM 46 (RM 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). More 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.* 2014). 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; until major modifications were implemented at the project's fish passage facilities in 2016, there was limited successful passage upstream of the Dam. Fishways have been operational at the project since the 1950s, however we have no information on sturgeon passage until 1975. Upstream passage between 1975-1999 was an average of four fish per year. From 1999 through 2016, all shortnose sturgeon collected in the lifts were released back downstream given concerns about the risk of mortality from downstream passage. Following fishway upgrades and studies, upstream passage resumed in 2017. Since 2017, the number of shortnose sturgeon passed upstream has ranged between a low of 18 and a high of 91.

The number of sturgeon passing downstream of the Dam annually is largely unknown although some information is available from tagging and tracking studies. Despite this historical separation, fish collected upstream and downstream of the dam are not genetically distinct (Kynard 1997, Wirgin *et al.* 2005, Kynard *et al.*2012). 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, unpubl. Data in SSSRT 2010); this compares to a previous Peterson mark-recapture estimate of 370–714 adults (Taubert 1980a). 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 percentr. The population in the Connecticut River is thought to be stable, but at a small size.

As described in SSSRT (2010), the historic range of shortnose sturgeon in the Connecticut River is considered to be from the Turners Falls Dam (Turners Falls, MA; RKM 198 (RM 123)) to Long Island Sound. Construction of the Turners Falls Dam was completed in 1798; the dam was built on a natural falls-rapids that, based on available information, is expected to be impassable by sturgeon. As such, Turners Falls is considered to be the historic upstream boundary of shortnose sturgeon in the Connecticut River; however, there have been anecdotal sightings of sturgeon upstream of the dam in recent years. In the summer of 2017, an angler reported a catch of a shortnose sturgeon upstream of the Turners Falls Dam; the species identification was verified by review of a photograph but NMFS was not able to verify the location of the capture. Similarly, in 2024 video was shared with NMFS that appears to show one or two shortnose sturgeon; the reported location was upstream of the Turners Falls Dam in the Connecticut River but again NMFS was not able to verify the location of the video. Following the report in 2017, USGS biologists carried out a series of gillnet surveys in the upper Connecticut River targeting shortnose sturgeon. However, despite extensive sampling from 2020-2024, no shortnose sturgeon were collected. While not targeting shortnose sturgeon, no shortnose sturgeon were captured in electrofishing or gillnet surveys conducted between Vernon Dam and Turners Falls Dam from June - October 2015; these studies were carried out in support of project relicensing. There are also no records of shortnose sturgeon detected in boat electrofishing carried out by Vermont Yankee from 1968-2011. Standardized methodology was used from 1991 through 2014 to sample the reach from Vernon Dam to approximately five miles downstream. With some exceptions due to extreme flow conditions, sampling was conducted monthly from July through October at 4 to 5 sites for general species collections and twice monthly from July through October at six sites for targeted anadromous species collections. Despite decades of electrofishing surveys that documented at least 35 species, no shortnose sturgeon were ever collected in those studies (Aquatec 1993, 1995, Normandeau, 1997-2016).

Environmental DNA (eDNA) sampling has also been carried out in this reach of the Connecticut River. Environmental DNA is the genetic material shed by organisms in the water column. Water is collected and then the eDNA is separated out, amplified, and identified to species. This technique samples areas and identify species whose DNA is present in the water. Typically, this means that an individual from that species occurred in the area; however, “false positives” can be triggered by introduction of contaminated materials (e.g., fishing waders that haven’t been cleaned) or digestion of prey (excreting the prey DNA into the water column by the predator species). As described in a November 2018 report filed with Federal Energy Regulatory Commission (FERC), First Light collected a total of 170 water samples in July and August 2018 below Vernon Dam and in the Turners Falls Impoundment. No shortnose sturgeon DNA was detected.

As reported in a December 2024 filing with FERC, eDNA sampling of bottom water from the Turners Falls impoundment to Bellow Falls dam was carried out by the Connecticut River Conservancy (CRC) in summer 2024. CRC reports positive detections of shortnose sturgeon

upstream of the Turners Falls Dam. This includes reports of positive detections at sites between Turners and Vernon and one site between Vernon and Bellows Falls; of the eleven sites sampled, five were reported as having positive detections in at least one replicate. To date, these results have not been published and we are not aware of any peer review of the techniques or findings. However, together, the available information indicates that at least occasional individual shortnose sturgeon may be present upstream of the Turners Falls Dam. We do not know how these individuals came to be present in this area. At this time there is no evidence to support that there is a self-sustaining (i.e., reproductive) population of shortnose sturgeon in this reach of the river. We have no information on how shortnose sturgeon accessed this reach or how many sturgeon may be present in this area but based on the detections being limited to a small number of apparent positive detections of eDNA (Buckman and Garner 2024), anecdotal reports, and no captures of any individuals in any fisheries surveys carried out in this reach we consider the number to be likely very small.

Spawning in the Connecticut River primarily occurs in the reach upstream of the Holyoke Dam, just below the Turners Falls project (i.e., Rock Dam and Cabot Station). The 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). There is more recent evidence of at least limited spawning downstream of Holyoke Dam. During ichthyoplankton sampling in the Connecticut River during 2005 and 2006, three shortnose sturgeon larvae were captured downstream of Holyoke Dam (one in 2005 and two in 2006; Kleinschmidt, 2006, 2007; SSSRT, 2010), with a determination made that these larvae were too far downstream from the Rock Dam or Cabot Station spawning sites to have originated there. Additionally, shortnose sturgeon eggs (n=70) were captured on egg mats placed downstream of Holyoke Dam in 2021 by Connecticut Department of Energy and Environmental Protection (CT DEEP) (CRASC 2021; HG&E 2023). Eggs were also captured during similar surveys performed in 2022, with 36 eggs and two hatched larvae found on the mats (HG&E 2023). Divers have also observed juvenile sturgeon in 2021 and 2022 while searching for mussels in the Springfield, CT area (HG&E 2023). 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 CT river was recaptured in the Housatonic River (T. Savoy, CT DEEP, pers. comm.). Three individuals tagged in the Hudson were captured in the CT, 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% 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 (RKM 223 (RM 139)); 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% 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% 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% 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 1999). 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[10] 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); that is, increasing the number of young-of-the-year (YOY) and juveniles has a more significant long-term impact to the population because the more juveniles YOY fish that survive the more adult population/ spawners there will ultimately be.

The Shortnose Sturgeon Recovery Plan (NMFS 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. Changing environmental conditions, particularly shifts in seasonal temperature regimes and changes in the location of the salt wedge, may impact shortnose sturgeon in the future. 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 diversity unlikely; the minimum population size for each population has not yet been determined. The Recovery Outline 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 general, to recover, a listed species must have a sustained positive trend of increasing population over time. To allow that to happen for sturgeon, individuals must have access to enough habitat in suitable condition for foraging, resting and spawning. 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 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.

10 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 management efforts.

4.2.1.8 Summary of Status

Shortnose sturgeon remain 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 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 as 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 factors that combine to make the species particularly sensitive to existing and future threats; these factors include: the small size of many populations, existing gaps in the range, late maturation, the sensitivity of adults to very specific spawning cues which can result in years with no recruitment, and the impact of losses of young of the year and juveniles to 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.

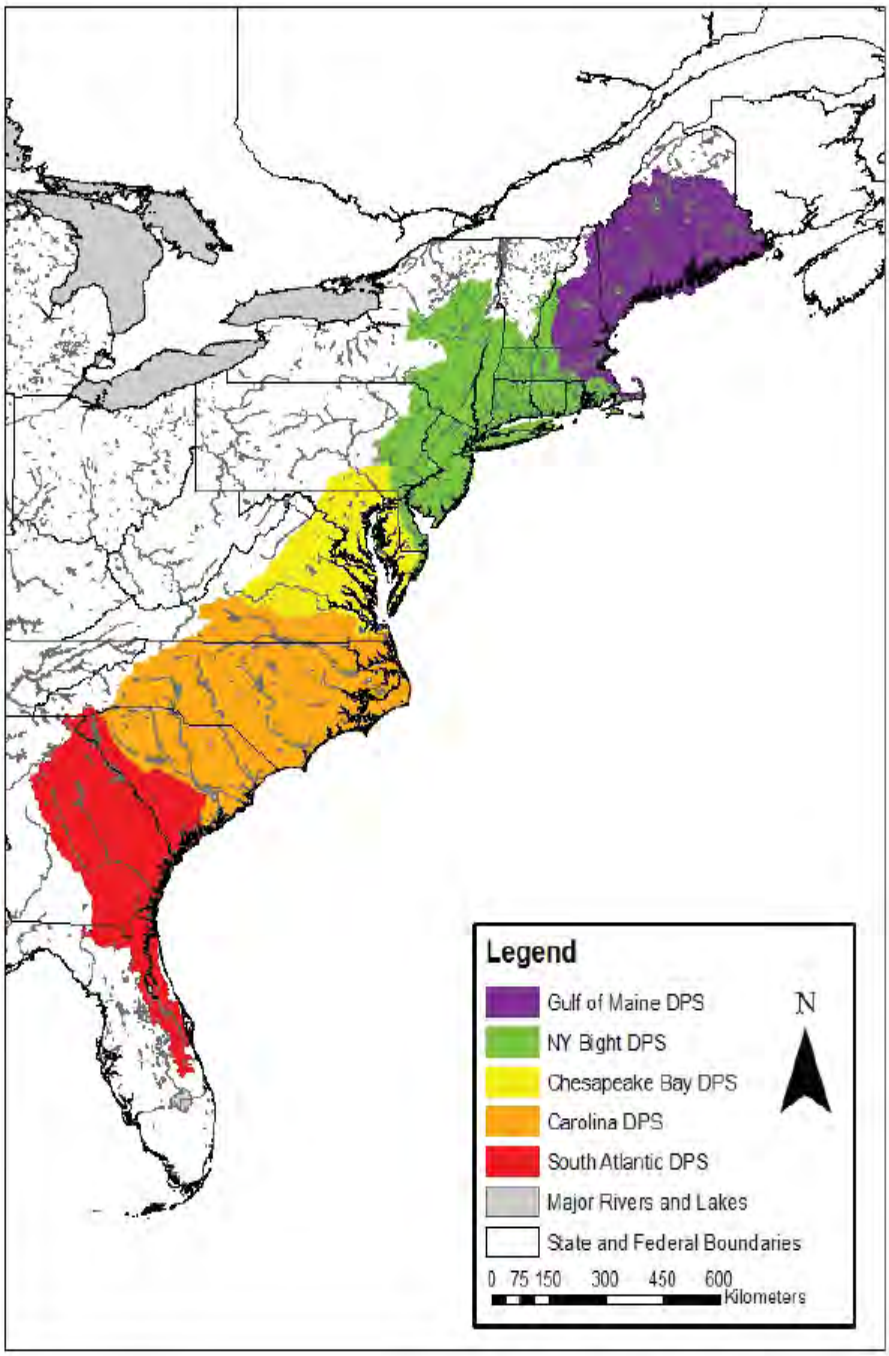
The Atlantic sturgeon (*Acipenser oxyrinchus oxyrinchus*) is one of two subspecies of *A. oxyrinchus*, the other being the Gulf sturgeon, *A. o. desotoi*. It is distributed along the eastern coast of North America from Hamilton Inlet, Labrador, Canada to Cape Canaveral, Florida, USA. On February 6, 2012, NMFS listed five DPSs of Atlantic sturgeon under the ESA: Gulf of Maine (GOM), New York Bight (NYB), Chesapeake Bay (CB), Carolina, and South Atlantic (77 FR 5880 and 77 FR 5914). The Gulf of Maine DPS is listed as threatened, and the New York Bight, Chesapeake Bay, Carolina, and South Atlantic DPSs are listed as endangered. 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. 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. The action area does not overlap with critical habitat designated for any DPS of Atlantic sturgeon.

Information available from the 2007 Atlantic sturgeon status review (ASSRT 2007), 2012 final listing rules (77 FR 5880 and 77 FR 5914, February 6, 2012), 2017 Atlantic States Marine Fisheries Commission (ASMFC) benchmark stock assessment and 2024 update (ASMFC 2017, 2024), 2017 critical habitat designations (NMFS 2017a; NMFS, (National Marine Fisheries Service),, 2017), and recent 5-year reviews for each of the five listed DPSs (NMFS, 2022a, 2022b, 2022c, 2023a, 2023b) were used to summarize the life history, population dynamics, and status of the species.

Table 7. Atlantic sturgeon resources incorporated by reference.

2007 Atlantic Sturgeon Status Review	Final Listing Rules	2017 ASMFC Benchmark Stock Assessment	Material Supporting the Designation of Atlantic Sturgeon Critical Habitat	Five-Year Reviews	Critical Habitat Listing
(ASSRT, 2007)	(77 FR 5880 and 77 FR 5914; February 6, 2012)	(ASMFC, 2017)	(NMFS, 2017a)	Gulf of Maine, New York Bight, and Chesapeake Bay DPSs (NMFS, 2022a, 2022b, 2022c) and Carolina and South Atlantic DPSs (NMFS, 2023a, 2023b)	82 FR 39160

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

Atlantic sturgeon are a long-lived (approximately 60 years), late maturing, estuarine dependent, anadromous[11] species (ASSRT 2007; Balazik *et al*., 2010; Hilton *et al*., 2016; Sulak & Randall, 2002). Adult sturgeon reach sexual maturity between the ages of 5 to 34 years. Sturgeon originating from rivers in lower latitudes (e.g., South Carolina rivers) mature faster than those originating from rivers located in higher latitudes (e.g., Saint Lawrence River) (NMFS 2017a; NMFS, (National Marine Fisheries Service), 2017).

Atlantic sturgeon spawn in freshwater (ASSRT 2007; NMFS 2017a; NMFS, (National Marine Fisheries Service), 2017) at sites with flowing water and hard bottom substrate (Bain *et al*., 2000; Balazik *et al*., 2012; Gilbert, 1989; Greene *et al*., 2009; Hatin *et al*., 2002; Mohler, 2003; Smith & Clugston, 1997; Vladykov & Greeley, 1963). Water depths of spawning sites are highly variable, but may be up to 27 m (88.6 ft) (Bain *et al*., 2000; Crance, 1987; Leland, 1968; Scott & Crossman, 1973). Based on tagging records, Atlantic sturgeon return to their natal rivers to spawn (ASSRT 2007). Spawning intervals range from one to five years in males (Caron et al., 2002; Collins, Smith, *et al*., 2000; Smith, 1985) and two to five years for females (Stevenson & Secor, 1999; Van Eenennaam *et al*., 1996; Vladykov & 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). The number of eggs produced by females ranges from 400,000 to approximately 4 million depending on body size and age (Hilton *et al*., 2016; Van Eenennaam & Doroshov, 1998; Van Eenennaam *et al*., 1996). Therefore, large-sized Atlantic sturgeon are particularly important given that egg production correlates with age and body size (Dadswell, 2006; Smith *et al*., 1982; Van Eenennaam & Doroshov, 1998; Van Eenennaam *et al*., 1996).

Some Atlantic sturgeon river populations may have up to two spawning seasons comprised of different spawning adults (Balazik, Farrae, *et al*., 2017; Balazik & Musick, 2015; Collins, Smith, *et al*., 2000; Denison *et al*., 2023), although the majority likely just have just one, either in the spring or fall.[12] There is evidence of spring and fall spawning for the Chesapeake, Carolina, and South Atlantic DPSs (77 FR 5914, February 6, 2012; ASSRT, 2007; Balazik, Farrae, *et al.*, 2017; Collins, Smith, *et al*., 2000; Denison *et al.*, 2023), and spring spawning for the Gulf of Maine and New York Bight DPSs (NMFS 2017a). In the Chesapeake Bay DPS, telemetry and empirical data suggest that there may be two potential spawning runs in the James River: a spring run from late March to early May and a fall run around September after an extended

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

[12] Although referred to as spring spawning and fall spawning, the actual time of Atlantic sturgeon spawning may not occur during the astronomical spring or fall season Balazik, M. T., & Musick, J. A. (2015). Dual annual spawning races in Atlantic sturgeon [Scientific Journal]. *PLoS ONE, 10*(5), e0128234. https://doi.org/10.1371/journal.pone.0128234 .

staging period in the lower river (Balazik *et al*. 2012a, Balazik and Musick 2015, Balazik *et al*. 2017a). 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, Farrae, *et al*., 2017; Balazik *et al*., 2012; Balazik & Musick, 2015). Fall spawning activity has also been documented 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 & Secor, 2016; Secor *et al*., 2022).

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 New England and 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° to 13°C (54° to 55°F) (Dovel & Berggren, 1983; Smith, 1985), make rapid spawning migrations upstream, and quickly depart following spawning (Bain, 1997).

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*., 2012; Breece *et al*., 2013; Dovel & Berggren, 1983; Greene *et al*., 2009; Hatin et al., 2002; Ingram *et al*., 2019; Smith, 1985; Smith *et al*., 1982). Females move downriver and 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*., 2012; Breece *et al*., 2013; Dovel & Berggren, 1983; Greene *et al*., 2009; Hatin *et al*., 2002; NMFS 2017a; NMFS, (National Marine Fisheries Service), 2017; Smith, 1985; Smith *et al*., 1982).

Atlantic sturgeon deposit eggs on hard bottom substrate. They hatch into the yolk sac larval stage approximately 94 to 140 hours after deposition (Mohler, 2003; Murawski & Pacheco, 1977; Smith *et al*., 1980; Van Den Avyle, 1984; Vladykov & Greeley, 1963). 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 total lengths (TL) less than 30 mm (1.2 in) (Van Eenennaam *et al*., 1996)) are assumed to inhabit the same riverine or estuarine areas where they were spawned (Bain *et al*., 2000; Kynard & Horgan, 2002).

After about eight days, the free embryo exhausts the yolk sac and becomes (post yolk sac) larvae (Kynard & 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 & Horgan, 2002). Shortly after, they become young of year and then juveniles.

The juvenile stage can last months to years in the brackish waters of the natal estuary (ASSRT 2007; Calvo *et al*., 2010; Collins, Rogers, et al., 2000; Dadswell, 2006; Dovel & Berggren, 1983; Greene *et al*., 2009; Hatin *et al*., 2007; Holland & Yelverton, 1973; Kynard & Horgan, 2002;

Mohler, 2003; Schueller & Peterson, 2010; Secor *et al*., 2000; Waldman *et al*., 1996). Upon reaching the subadult phase, individuals enter the marine environment, mixing with adults and subadults from other river systems (Bain, 1997; Dovel & Berggren, 1983; Hatin *et al*., 2007; McCord *et al.*, 2007; NMFS, 2017a; NMFS, (National Marine Fisheries Service), 2017). 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 m (164 ft) deep, only returning far upstream to the spawning areas when they are ready to spawn (ASSRT 2007; Bain, 1997; Breece *et al*., 2016; Dunton *et al*., 2012; 2015; Savoy & Pacileo, 2003).

Table 8. General descriptions of Atlantic sturgeon life history stages*

Age Class	Size	Duration	Description
Egg	~2 mm – 3 mm diameter (Van Eenennaam *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)	~6 mm – 14 mm (Bath *et al*., 1981, pp. 714-715)	8-12 days post hatch (ASSRT, 2007, p. 4)	Negative photo-taxic, nourished by yolk sac
Post yolk-sac larvae (PYSL)	~14 mm – 37 mm (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 TL	From 40 days to 1 year	Fish that are > 3 months and < 1 year; capable of capturing and consuming live food
Juveniles	>410 mm and <760 mm TL	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 TL	From first coastal migration to sexual maturity	Fish that are not sexually mature but make coastal migrations

Age Class	Size	Duration	Description
Adults	>1500 mm TL	Post-maturation	Fish that are sexually mature

* The size ranges are only guidelines for the life stages, which are more dependent on behavior (e.g., if a sturgeon is measured to be <760 mm total length, but is reported to have traveled in offshore marine waters, it is most likely a subadult and not a juvenile). See https://media.fisheries.noaa.gov/dam-migration/ans_life_stage_behavior_descriptions_20191029_508.pdf for more information.

Population Dynamics

The ASMFC evaluated the status of Atlantic sturgeon in 2017 using fisheries- dependent and -independent sources in order to inform a variety of population parameters. One index of population abundance used by the ASMFC for estimating Atlantic sturgeon abundance in Northeast U.S. waters is the Northeast Area Monitoring and Assessment Program (NEAMAP) trawl surveys. The Review Panel for the ASMFC (2017) stock assessment encouraged use of this index, in addition to others discussed in the stock assessment, to assess trends in Atlantic sturgeon abundance. It currently meets the recommended minimum standard of 15 years for use in a trend analysis. For our analyses, we are relying on the population estimates derived from the NEAMAP swept area biomass, which takes into account the catchability rate (i.e., net efficiency x availability). 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. Atlantic sturgeon that occur in estuaries or rivers, and also north of Cape Cod or south of Cape Hatteras, are not included in the population index. As the estimates from Boucher (2025) are derived directly from empirical data with fewer assumptions than have been required to model Atlantic sturgeon populations to date, we determined that they are the best available information. Based on the latest population estimates in Boucher (2025), the overall minimum abundance of Atlantic sturgeon in nearshore U.S. Atlantic waters from Cape Cod to Cape Hatteras is estimated to be 47,044 fish, using the average estimates from the spring and fall surveys across the years of 2010-2023, and assuming 100 percent catchability.

Although NEAMAP only covers the Mid-Atlantic region, we consider its resulting estimates to represent the best available index of abundance in the marine environment and to be reliable for use as a proxy for broader regional abundance estimates. Based on genetic frequencies of occurrence in the sampled area, this regional population estimate was subsequently partitioned by DPS using the 'Mid-Atlantic (MID) Offshore' percentage breakdowns in Kazyak *et al.* (2021a), as that study region most closely aligns with the NEAMAP survey area (Table 9). It is important to note that the NEAMAP-based estimates do not include young of year fish and juveniles in the rivers. The NEAMAP surveys are conducted in ocean waters that include the preferred depth ranges of sub-adult and adult Atlantic sturgeon and take place during seasons that coincide with known Atlantic sturgeon coastal migration patterns in the ocean.

Table 9. Summary of minimum swept area population estimates of Atlantic sturgeon based upon the NEAMAP survey swept area model.

DPS	Estimated Ocean Population Abundance
Gulf of Maine	184
NY Bight	31,797
Chesapeake Bay	5,951
Carolina	4,276
South Atlantic	4,836
Canada	0
Total	47,044

It is important to note, the NEAMAP-based estimates do not include YOY fish and juveniles in the rivers; however, those Atlantic sturgeon life stages are at minimal risk from the proposed actions since they are rare to absent within the action area. In addition, although these population estimates are current through 2023, there are other recent studies and indications that the abundance of specific DPSs and spawning river populations may be smaller at present than currently estimated (Kazyak *et al*. 2020a; NMFS 2022a, 2022b, 2022c; White *et al*. 2022).

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 (2017) 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. The population growth rates reported from that PVA ranged from -1.8 percent to 4.9 percent (ASMFC 2017). In the ASMFC (2024) stock assessment update, nine fishery-independent surveys were developed into indices of relative abundance for Atlantic sturgeon. Most indices either had no trend over the time series or were increasing. The individual indices were then combined to develop a coastwide index of relative Atlantic sturgeon abundance. The coastwide index was variable from 1990-2022 but had been steadily increasing since 2013 (ASMFC, 2024).

The genetic diversity of Atlantic sturgeon throughout its range has been well-documented (ASSRT 2007, Bowen and Avise 1990, O'Leary *et al.* 2014, Ong *et al.* 1996, Waldman *et al.* 1996, Waldman and Wirgin 1998, Kazyak *et al.* 2021, White *et al.* 2021). Overall, these studies

have consistently found populations to be genetically diverse, and the majority can be readily differentiated. 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 typically return to their natal river to spawn, despite extensive mixing in coastal waters.

Based on fishery-independent, fishery dependent, tracking, and tagging data, Atlantic sturgeon appear to primarily occur inshore of the 50 m (164 ft) depth contour (Dunton *et al.* 2012, 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, Wirgin *et al.* 2015b). However, they are not restricted to these depths and excursions into deeper (e.g., 75 m (250 ft)) continental shelf waters have been documented (Colette and Klein-MacPhee 2002, Collins and Smith 1997, Erickson *et al.* 2011, Stein *et al.* 2004b, 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; Wippelhauser 2012; Oliver *et al.* 2013; Post *et al.* 2014; Hilton *et al.* 2016; Altenritter *et al*. 2017; Breece *et al.* 2017; Wippelhauser *et al.* 2017; Rothermel *et al.* 2020; Kahn *et al.* 2023). 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 m (66 ft), 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 m (66 ft) (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 m (82 ft) (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 2012, 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 refugia, wintering sites, or marine foraging areas (Stein *et al.* 2004a; Dunton *et al.* 2010; Erickson *et al*. 2011; Breece *et al.* 2017; Rothermel *et al.* 2020).

Status

Atlantic sturgeon were once present in 38 river systems and, of these, spawned in 35 (ASSRT 2007). They are currently present in 36 rivers and are probably present in additional rivers that provide sufficient forage base, depth, and access (ASSRT 2007). The benchmark stock assessment evaluated evidence for spawning tributaries and sub-populations of U.S. Atlantic sturgeon in 39 rivers (ASSRT 2007). They confirmed (eggs, embryo, larvae, or young of year observed) spawning in ten rivers, considered spawning highly likely (adults expressing gametes, discrete genetic composition) in nine rivers, and suspected (adults observed in upper reaches of tributaries, historical accounts, presence of resident juveniles) spawning in six rivers (ASSRT

2007). Spawning in the remaining rivers was unknown (ten) or suspected historical (four) (ASMFC 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. Based on management recommendations in the Interstate Fisheries Management Program (ISFMP), adopted by the Commission in 1990, commercial harvest in Atlantic coastal states was severely restricted and ultimately eliminated from most coastal states (ASMFC 1998a). In 1998, the Commission placed a moratorium on all Atlantic sturgeon fisheries until the spawning stock could be restored to a level where 20 subsequent year classes of adult females were protected (ASMFC 1998a, b). In 1999, NMFS closed the U.S. EEZ to Atlantic sturgeon retention, pursuant to the Atlantic Coastal Fisheries Cooperative Management Act (ACFCMA) (64 FR 9449, February 26, 1999). However, all state fisheries for sturgeon were closed prior to this.

As described in the listing rules, and in the 2022 and 2023 5-year reviews, the most significant known threats to Atlantic sturgeon are incidental catch, dams that block access to spawning habitat in southern rivers, poor water quality, dredging of spawning areas, water withdrawals from rivers, vessel strikes, and climate instability (e.g., impacts water temperature, salinity, dissolved oxygen, contaminants).

ASMFC 2017 indicates that based on historic removals and estimated effective population size, all five Atlantic sturgeon DPSs are depleted relative to historical levels. However, the 2017 stock assessment does provide some evidence of population recovery at the coastwide scale, and mixed population recovery at the DPS scale (ASMFC 2017). The 2017 stock assessment also concluded that a variety of factors (i.e., bycatch, habitat loss, and ship strikes) continue to impede the recovery rate of Atlantic sturgeon (ASMFC 2017). Over the long term, changing environmental conditions may affect Atlantic sturgeon by affecting the location of spawning, distribution of prey, water temperature, and water quality (ASMFC 2017).

Elevated temperatures could modify range and migratory patterns (Hare *et al.* 2016, Kynard *et al.* 2016), cues for spawning migration that result in an earlier spawning season (Denison *et al*. 2023), and thus, alter 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, spawning may not be triggered solely by water temperature. Although the results lack consensus in the scientific community, some research suggests that day length (which would not be affected by changing conditions) and river flow (which could be affected) are contributing factors (Forsythe *et al.* 2012). Therefore, it is not possible to predict how any change in water temperature alone will affect the seasonal movements of sturgeon through the action area.

Changes in water temperature may also alter the forage base and thus, foraging behavior of sturgeon (Hare *et al*. 2016, Mayfield and Cech 2004). 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 (Hare *et al*. 2016; Jetter *et al*. 2023). However, because we do not know

the adaptive capacity of this 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 with prey distribution, it is likely that there would be minimal, if any, impact on the availability of food, and they would be able to continue to meet their foraging needs. Similarly, if sturgeon shifted to areas where different forage was available and were able to obtain sufficient nutrition from that new source of forage, any effects would also be minimal. The greatest potential for effects would be if sturgeon shifted spatially or temporally to areas where insufficient forage was available; however, the likelihood of this happening is unknown.

Increasing hypoxia, in combination with increasing temperature, affects juvenile sturgeon metabolism and survival (Secor and Gunderson 1998, Kieffer *et al.* 2011). 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 DO; climate conditions that reduce the amount of available habitat with these conditions could reduce the productivity of Atlantic sturgeon (McBryan *et al*. 2013). However, there is significant uncertainty, due to a lack of specific scientific data, on the degree to which these effects may be experienced and the degree to which Atlantic sturgeon will be able to successfully adapt to any such changes (Hare *et al.* 2016, Shackell *et al*. 2014). Any activities occurring within and outside the action area that contribute to changing environmental conditions are also expected to affect Atlantic sturgeon in the action area (Hare *et al*. 2016). While we can make some predictions on the likely effects of these changes on these species and critical habitat, without modeling and additional scientific data, these predictions remain speculative (Hare *et al*. 2016, Shackell *et al*. 2014). Additionally, these predictions do not take into account the adaptive capacity of this species, which uses varied habitat types and forage, and may allow them to deal with change better than predicted (Dunton *et al*. 2015; Hare *et al*. 2016; McLean *et al*. 2014).

Despite the depleted status, the ASMFC stock assessment update did include signs that the coastwide index is above the 1998 value (100 percent probability). The New York Bight and Carolina DPS indices also had a greater than 50 percent chance of being above their 1998 value; however, the indices from the Chesapeake Bay and South Atlantic DPSs only had a 27 percent and 31 percent chance, respectively, of being above the 1998 value. Total mortality from the tagging model was very low at the coastwide level. Small sample sizes made mortality estimates at the DPS levels more difficult. The New York Bight, Chesapeake Bay, Carolina, and South Atlantic DPSs all had a less than 50 percent chance of having a mortality rate higher than the threshold. The Gulf of Maine DPS had a 55.5 percent probability of being above the mortality threshold (ASMFC 2024). The 2017 stock assessment and 2024 update describe that the DPS-level estimates of mortality from the tagging model had wide credible intervals, so one cannot conclude with statistical certainty whether any of the DPS-level mortality estimates are above or below its respective thresholds. The Atlantic sturgeon is a data-limited species, and the ASMFC

acknowledged that there are several limitations and sources of uncertainty in the data used in the 2017 assessment and 2024 update. Those factors need to be taken into account when evaluating stock status by DPS (ASMFC 2024). For those reasons, we consulted the latest 5-year reviews for each DPS for additional status information. No changes to the classification for any DPS are recommended in the 5-year reviews (NMFS 2022 a, b, and c, NMFS 2023 a, b).

Recovery Goals for All DPSs

A Recovery Plan has not been completed for any DPS of Atlantic sturgeon. In 2018, NMFS published a Recovery Outline[13] to serve as an initial recovery-planning document. In this, the recovery vision is stated, "Subpopulations of all five Atlantic sturgeon DPSs must be present across the historical range. These subpopulations must be of sufficient size and genetic diversity to support successful reproduction and recovery from mortality events. The recruitment of juveniles to the sub-adult and adult life stages must also increase and that increased recruitment must be maintained over many years. Recovery of these DPSs will require conservation of the riverine and marine habitats used for spawning, development, foraging, and growth by abating threats to ensure a high probability of survival into the future." The Recovery Outline also includes steps that are expected to serve as an initial recovery action plan. These include protecting extant subpopulations and the species' habitat through reduction of threats; gathering information through research and monitoring on current distribution and abundance; and addressing vessel strikes in rivers, the effects of changing environmental conditions, and bycatch.

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.

4.2.2.2 Gulf of Maine DPS of Atlantic sturgeon

The Gulf of Maine DPS of Atlantic sturgeon includes Atlantic sturgeon that are spawned in the watersheds that drain into the Gulf of Maine from the Maine/Canada border and extending southward to Chatham, Massachusetts, as well as Atlantic sturgeon held in captivity that are progeny of such fish. The marine range of Atlantic sturgeon from the Gulf of Maine DPS extends from Hamilton Inlet, Labrador, Canada, to Cape Canaveral, Florida. The riverine range of the Gulf of Maine DPS and the adjacent portion of the marine range are shown in Figure 4. Genetic analyses indicate the presence of Atlantic sturgeon belonging to the Gulf of Maine DPS in many parts of the marine range including the Gulf of Maine, the Bay of Fundy, and the New York Bight. In their mixed-stock analysis of 1,704 Atlantic sturgeon encountered across the U.S. Atlantic coast, Kazyak *et al*. (2021) did not observe any Atlantic sturgeon from the Gulf of Maine DPS south of Cape Hatteras. Of the 41 individuals captured in the NORTH region of the study (north of Cape Cod), 36 (87.8 percent) were assigned to the Gulf of Maine DPS.

[13] https://media.fisheries.noaa.gov/dam-migration/ats_recovery_outline.pdf; last accessed July 26, 2024.

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 information from Wippelhauser *et al*. (2017) confirms the location of occurrence between RKM 70 and 75 (RM 43.5 and 46.6). During this study from 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 the 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.

Atlantic sturgeon 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). Acoustic tag detections suggest that the adults that forage in the Penobscot River travel to the Kennebec River to spawn (Altenritter *et al*. 2017, Wippelhauser *et al*. 2017). Data from the Altenritter *et al*. (2017) study indicate that, based on the temporal and spatial predictability of habitat use, the Penobscot River estuary is important for subadult Atlantic sturgeon of the Gulf of Maine DPS. The Saco River also 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 RKM 10 (RM 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).

Dadswell et al. (2016) describes characteristics of the seasonal aggregation of sturgeon in the Bay of Fundy, but 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*. (2016) as representative of the movement of the Gulf of Maine DPS of Atlantic sturgeon. Dadswell *et al*. (2016) 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 Atlantic sturgeon (i.e., 4 to 54 years old) is also indicative of the two different life stages. Detailed seasonal movements of Atlantic sturgeon, a number of which are likely Gulf of Maine DPS origin, to and from the Bay of Fundy are described in Beardsall et al. (2016).

There are no abundance estimates for the Gulf of Maine DPS or for the Kennebec River spawning population. However, we have estimated subadult and adult abundance in nearshore marine waters from Cape Cod to Cape Hatteras and concluded that, at a minimum, approximately 727 adult and subadult Atlantic sturgeon may comprise the DPS, based upon the NEAMAP survey swept area model (Boucher, 2025). We expect this estimate (727 adult and subadults) to represent a minimum abudance for the total population based on stock assessments and that the NEAMAP trawls are mid-Atlantic centered. The ASSRT (2007) status review estimated that the number of spawning adults in the Gulf of Maine DPS was less than 300 per year, but that estimate was based on a comparison to the larger Hudson and Altamaha River spawning populations and not an actual number. 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 population viability is through determinations of effective population size (N_e)[14], 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 a measure of parents in an idealized panmictic and stable population because it is only a measure of parentage, which is less than the total abundance of a population because not all adults successfully reproduce. Measure of effective population size is used to inform whether a population is at risk of inbreeding and loss of adaptive potential. Thus, the effective population size can be a key variable to evaluate population viability and extinction risk (Frankham *et al.*, 2014; Hoban *et al.*, 2020). As a general rule, a minimum N_e of 50 and a minimum of 500 have been widely used in conservation biology as thresholds to avoid inbreeding depression and maintain long-term evolutionary potential, respectively (Clarke *et al.*, 2024; Franklin, 1980; Jamieson & Allendorf, 2012). However, other authors have suggested that minimum N_e thresholds of 100 and 1,000 are needed to maintain a populations' fitness and evolutionary potential (Frankham *et al.*, 2014; Pérez-Pereira et al., 2022). The effective population size of the Gulf of Maine DPS has been

[14] Effective Population Size (N_e) is defined as the size of a hypothetical ideal population (or the number of ideal individuals) that would experience the same rate of genetic drift as the population under consideration Wang, J., Santiago, E., & Caballero, A. (2016). Prediction and estimation of effective population size. *Heredity*, *117*(4), 193-206. https://doi.org/10.1038/hdy.2016.43 , Wright, S. (1969). *Evolution and the genetics of populations. 2. The theory of gene frequencies*. University of Chicago Press. https://books.google.com/books?id=HemscDlWXCQC&printsec=copyright#v=onepage&q&f=false . Therefore, it is in most cases less than the total number of individuals in the population. See https://www.sciencedirect.com/topics/biochemistry-genetics-and-molecular-biology/effective-population-size.

assessed in three recent 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% CI=47.3-91.1)(ASMFC, 2017), 67 (95% CI=52.0–89.1) (Waldman et al., 2019), and 79.4 (95% CI=60.3-111.7)(White *et al*., 2021).

The current status of the Gulf of Maine DPS is affected by historical and modern fisheries dating as far back as the 1800s (Squiers *et al.*, 1979; Stein *et al*., 2004; ASMFC 2007). Incidental capture of Atlantic sturgeon in state and Federal fisheries continues today. As explained above, we have estimates of the number of subadults and adults killed as a result of bycatch in fisheries authorized under Northeast FMPs. At this time, we are not able to quantify the impacts from other threats or estimate the number of individuals killed as a result of other anthropogenic threats. Habitat disturbance and direct mortality from anthropogenic sources are the primary concerns.

Some of the impacts from the threats that contributed to the decline of the Gulf of Maine DPS have been removed (e.g., directed fishing), or reduced as a result of improvements in water quality and removal of dams (e.g., the Edwards Dam on the Kennebec River in 1999, the Veazie Dam on the Penobscot River). There are strict regulations on the use of fishing gear in Maine state waters that incidentally catch sturgeon. In addition, there have been reductions in fishing effort in state and federal waters, which most likely would result in a reduction in bycatch mortality of Atlantic sturgeon. A significant amount of fishing in the Gulf of Maine is conducted using trawl gear, which is known to have a much lower mortality rate for Atlantic sturgeon caught in the gear compared to sink gillnet gear (ASMFC 2007). Atlantic sturgeon from the GOM DPS are not commonly taken as bycatch in areas south of Chatham, MA, with only 8 percent (e.g., 7 of the 84 fish) of interactions observed in the Mid Atlantic/Carolina region being assigned to the Gulf of Maine DPS (Wirgin and King, 2011). Tagging results also indicate that Gulf of Maine DPS fish tend to remain within the waters of the Gulf of Maine and only occasionally venture to points south. However, data on Atlantic sturgeon incidentally caught in trawls and intertidal fish weirs fished in the Minas Basin area of the Bay of Fundy (Canada) indicate that approximately 35 percent originated from the Gulf of Maine DPS (Wirgin *et al.* 2012). This figure reflects only the three DPSs for which mixed-stock assignments were reported in that study and does not represent the full composition of the Minas Basin aggregation; the same dataset found that the majority of individuals sampled (approximately 60 percent) originated from Canadian populations, which are not part of any of the five U.S. DPSs addressed in this Opinion.

As noted previously, studies have shown that in order to rebuild, Atlantic sturgeon can only sustain low levels of bycatch and other anthropogenic mortality (Boreman, 1997; ASMFC, 2007; Kahnle *et al.*, 2007; Brown and Murphy, 2010). NMFS has determined that the Gulf of Maine DPS is at risk of becoming endangered in the foreseeable future throughout all of its range 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.

In 2018, we announced the initiation of a 5-year review for the Gulf of Maine DPS. We reviewed and considered new information for the Gulf of Maine DPS that has become available since this DPS was listed as threatened in February 2012. We completed the 5-year review for the Gulf of Maine DPS in February 2022 (NMFS 2022a); the review includes a summary of additional information available since the listing determination, including information on life history and threats. Based on the best scientific and commercial data available at the time of the review, we concluded that no change to the listing status is warranted.

4.2.2.3 NY Bight DPS of Atlantic sturgeon

The New York Bight DPS of Atlantic sturgeon includes Atlantic sturgeon that are spawned in the watersheds that drain into coastal waters (including bays and sounds) from Chatham, Massachusetts to the Delaware-Maryland border on Fenwick Island, as well as Atlantic sturgeon held in captivity that are progeny of such fish. Within this range, Atlantic sturgeon historically spawned in the Connecticut, Delaware, Hudson, and Taunton Rivers (Murawski and Pacheco 1977, Secor 2002, ASSRT 2007, ASMFC 2017b). Spawning still occurs in the Delaware and Hudson Rivers. There is no recent evidence (within the last 15 years) of spawning in the Taunton River (ASSRT 2007). Atlantic sturgeon that are spawned elsewhere continue to use habitats within the Connecticut and Taunton Rivers as part of their overall marine range (ASSRT 2007, Savoy 2007, Wirgin and King 2011).

In 2014, several presumed age-0 Atlantic sturgeon were captured in the Connecticut River; the available information indicates that successful spawning took place in 2013 by a small number of adults. Genetic analysis of the juveniles indicates that the adults were likely migrants from the South Atlantic DPS (Savoy *et al*. 2017). As noted by the authors, this conclusion is counter to prevailing information regarding straying of adult Atlantic sturgeon. As these captures represent the only contemporary records of possible natal Atlantic sturgeon in the Connecticut River and the genetic analysis is unexpected, more information is needed to establish the frequency of spawning in the Connecticut River and whether there is a unique Connecticut River population of Atlantic sturgeon. 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 (see additional explanation in NMFS 2022b).

There is uncertainty related to trends in abundance for the New York Bight DPS (ASMFC, 2017). There are no abundance estimates for the entire DPS or for the entirety (i.e., all age classes) of the Hudson River or Delaware River populations. We also have no estimate of any potential spawning population in the Connecticut River. Collecting this information has proven difficult and time consuming given the Atlantic sturgeon's life history, the environments in which they occur, and mixing of the DPSs in estuarine and marine waters (NMFS 2022b).

The ASMFC concluded for their 2024 stock assessment update that abundance of the New York Bight DPS is depleted relative to historical levels, that there is a 59 percent probability that the New York Bight DPS abundance has increased since the implementation of the 1998 fishing moratorium, and a 20.2 percent probability that mortality for the New York Bight DPS exceeds the mortality threshold used for the assessment (ASMFC 2017). Moreover, new information suggests that the ASMFC conclusions primarily reflect the status and trend of only the 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. In addition, as mentioned previously, the DPS-level estimates of mortality from the tagging model had wide credible intervals, so one cannot conclude with statistical certainty whether any of the DPS-level mortality estimates are above or below its respective thresholds.

Although there are no overall abundance estimates for the entire New York Bight DPS, there are some abundance estimates for specific life stages (e.g., natal juvenile abundance, spawning run abundance, and effective population size). Recent analyses suggest that the abundance 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). Standardizing juvenile catch data using zero-inflated modeling to account for environmental influences - such as water temperature and salt front positioning - has further clarified juvenile relative abundance trends and sampling catchability during periods of low density (DuFour and Qian, 2023). A study by Stich *et al*. (2025) found that relative abundance of juveniles increased from 2004 to 2015 prior to declining through 2022. Results also showed that detection-corrected indices for adult sturgeon indicated a consistent increase in relative abundance that was not readily apparent in raw catch indices (Stich *et al*. 2025). Furthermore, integrating genetic assignment and demographic data has helped refine adult abundance indices, demonstrate strong spawning reach fidelity, and characterize effective population size for the Hudson River spawning stock (White *et al*. 2024).

There is limited new information on the spawning population abundance in the Hudson River since the time of listing; Kazyak *et al.* (2020) used side scan sonar technology in conjunction with detections of previously tagged Atlantic sturgeon to estimate a Hudson River spawning run size of 466 sturgeon (95% CRI = 310-745) in 2014. Another method for assessing the number of spawning adults is through determinations of effective population size (the number of individuals that effectively participates in producing the next generation, as discussed above (See NMFS 2022b for more information). The estimates of effective population size for the Hudson River spawning population from separate studies and based on different age classes are relatively similar to each other: 198 (95% CI=171.7-230.7) based on sampling of subadults captured off of Long Island across multiple years, 156 (95% CI=138.3-176.1) based on sampling of natal juveniles in multiple years (O'Leary *et al*. 2014; Waldman *et al*. 2019), and 144.2 (95% CI=82.9-286.6) based on samples from a combination of juveniles and adults (ASMFC 2017).

As described in the Status Review and listing rule, in addition to capture in fisheries operating in Federal waters, bycatch and mortality also occur in state fisheries; however, the primary fishery (shad) that impacted juvenile sturgeon in the Hudson River, closed and there is no indication that it will reopen soon.

In the Hudson River, sources of mortality include vessel strikes and entrainment in dredges. Impingement at water intakes including the Danskammer, Roseton, Indian Point, and Salem and Hope Creek (on the Delaware River) power plants have also occurred, although a few of those plants are no longer active. 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. Kazyak *et al*. (2020) integrated side-scan sonar with acoustic telemetry to estimate size of the 2014 spawning run for the Hudson River (N=466, 95% CI = 310-745). Taking reported spawning intervals into account, the estimate appears similar to the historical total adult population estimate by Kahnle *et al*. (2007).

There is no total abundance estimate for the Delaware River population of Atlantic sturgeon. Harvest records from the 1800s indicate that this was historically a large population with an estimated 180,000 adult females prior to 1890 (Secor and Waldman 1999, Secor 2002). Sampling in 2009 to target young of year Atlantic sturgeon in the Delaware River (i.e., natal sturgeon) resulted in the capture of 34 young of year, ranging in size from 178 to 349 mm TL (Fisher 2009) and the collection of 32 young of year Atlantic sturgeon in a separate study (Brundage and O'Herron in Calvo *et al.* 2010). Genetics information collected from 33 of the 2009-year class young of year indicates that at least three females successfully contributed to the 2009-year class (Fisher 2011). Therefore, while the capture of young of year in 2009 provides evidence that successful spawning is still occurring in the Delaware River, the relatively low numbers suggest the existing riverine population is limited in size. The Delaware Division of Fish and Wildlife (DFW) has conducted juvenile abundance surveys in the Delaware River in most years since 2010. The estimated abundance in 2014 was 3,656 (95% CI = 1,935–33,041) age 0-1 juvenile Atlantic (Hale *et al*. 2016). Estimates for the Delaware River effective population size by the same authors and using the same methods as described above for the Hudson River were: 108.7 (95% CI=74.7-186.1) and 40 (95% CI=34.7-46.2) for samples from subadults and natal juveniles, respectively (O'Leary *et al*. 2014, Waldman *et al*. 2019), and 56.7 (95% CI=42.5-77.0) based on samples from a combination of juveniles and adults (ASMFC 2017).

White *et al*. (2022) estimated the number of adults (N_s) in the Delaware River that successfully reproduced in order to create a cohort of offspring by using genetic pedigrees constructed from progeny genotypes. N_s estimates the number of successful breeders and is not synonymous with effective population size (N_e) or effective number of breeders (N_b) as these metrics describe genetic processes (e.g., inbreeding and genetic drift; Jamieson & Allendorf, 2012; Waldman e*t*

al., 2019; Wang *et al*., 2016). White *et al*. (2022) estimated that N_s ranged from 42 (95 percent CI: 36-64) spawners in 2014 to 130 (95% CI: 116-138) spawners in 2017 during the years from 2013 to 2019. Because N_s 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*. (2022) concluded that bias in the data when sample size of offspring is small may result in the N_s being underestimated, as such, the N_s for Delaware River Atlantic sturgeon is likely between 125 and 250. Hale *et al.* (2016) estimated that 3,656 (95% CI = 1,935-33,041) early juveniles (young of year, age zero to one) utilized the Delaware River estuary as a nursery in 2014. Because White *et al*. (2021) found that the differences in estimated N_e between Atlantic sturgeon populations roughly corresponded to the differences in total population size, the Hudson River has one of the largest estimates of N_e while the Delaware River has one of the smallest estimates.

While the White *et al*. (2021) study did not address the status of short- and long-term viability of either population, the differences in estimated population size for the Hudson and Delaware River spawning populations and in N_e support the notion that the Hudson River spawning population is the more robust of the two spawning groups, as discussed in the 2022 Status Review and 2012 listing rule. 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 for adults belonging to the Delaware River spawning population (Wirgin *et al*., 2015; Wirgin *et al*., 2018).

As mentioned, there is no overall abundance estimate for the New York Bight DPS. Using Boucher (2025), we have estimated adult and subadult abundance of the New York Bight DPS, based on the estimated abundance of Atlantic sturgeon in nearshore marine waters from Cape Cod to Cape Hatteras (Boucher, 2025) and available information on the genetic composition of Atlantic sturgeon in those waters (Kazyak *et al*., 2021), to be at a minimum, approximately 24,963 Atlantic sturgeon, based upon the NEAMAP survey swept area model (Boucher, 2025). 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*., 2012; Hilton *et al*., 2016).

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 Clean Water Act (CWA). In addition, there have been reductions in fishing effort in state and federal waters, which may result in a reduction in bycatch mortality of Atlantic sturgeon. Nevertheless, areas with persistent, degraded water quality, habitat impacts from dredging, continued bycatch in state and federally managed fisheries, vessel strikes, and changing environmental conditions remain significant threats to the New York Bight DPS.

In the marine range, New York Bight DPS Atlantic sturgeon are incidentally captured in federal and state managed fisheries, reducing survivorship of subadult and adult Atlantic sturgeon (Stein *et al.* 2004, ASMFC 2007). Recent estimates of adults and subadults were based upon the NEAMAP ocean population estimates from Boucher (2025) and the latest bycatch assessment by Hocking (2025). Based on mixed stock analysis results presented by Wirgin and King (2011), over 40 percent of the Atlantic sturgeon bycatch interactions in the Mid Atlantic Bight region were sturgeon from the New York Bight DPS. Individual-based assignment and mixed stock analysis of samples collected from sturgeon captured in Canadian fisheries in the Bay of Fundy indicated that approximately 1-2 percent were from the New York Bight DPS. The mixed stock analysis in Kazyak *et al*. (2021) determined that 37.5 percent of the Atlantic sturgeon bycatch interactions in the Mid-Atlantic Bight region were fish from the New York Bight DPS, however, Kazyak *et al*. (2020) found that 71.4 percent of the captures in the larger GARFO region (Maine to Virginia) were from the New York Bight DPS.

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

New York Bight DPS Atlantic sturgeon may also be affected by degraded water quality. In general, water quality has improved in the Hudson and Delaware over the past decades (Lichter *et al.* 2006, EPA, 2008). Both the Hudson and Delaware rivers, as well as other rivers in the New York Bight region, were heavily polluted in the past from industrial and sanitary sewer discharges. While water quality has improved and most discharges are limited through regulations, many pollutants persist in the benthic environment. This can be particularly problematic if pollutants are present on spawning and nursery grounds as developing eggs and larvae are particularly susceptible to exposure to contaminants. 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 RKM 126.8 to 112.7 (RM 78.8 to 70.0) of Zone 5 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 (see EPA's proposed rule at 90 FR 46483, September 29, 2025).

Vessel strikes occur in the Delaware and Hudson rivers. A summary of recently available information is included in a recent assessment by NMFS (2022 b). NMFS has only minimum counts of the number of Atlantic sturgeon that are struck and killed by vessels because only

sturgeon that are found dead with evidence of a vessel strike are counted. Research, including a study that intentionally placed Atlantic sturgeon carcasses along the Delaware River 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 coinvestigators (Balazik *et al.* 2012b, Balazik, pers. comm. in ASMFC 2017, Fox *et al.* 2020). Based on the reporting rates in their study, Fox *et al*. (2020) estimated that a total of 199 and 213 carcasses were present along the Delaware Estuary shoreline in 2018 and 2019, respectively. Delaware State University (DSU) collaborated with the Delaware Division of Fish and Wildlife (DDFW) in an effort to document vessel strikes in 2005. Approximately 200 reported carcasses with over half attributed to vessel strikes based on a gross examination of wounds have been documented through 2019 (DiJohnson 2019). One hundred thirty-eight (138) sturgeon carcasses were observed on the Hudson River and reported to the NYSDEC between 2007 and 2015. Of these, 69 are suspected of having been killed by vessel strike. Genetic analysis has not been completed on any of these individuals to date, given that the majority of Atlantic sturgeon in the Hudson River belong to the New York Bight DPS; we assume that the majority of the dead sturgeon reported to NYSDEC belonged to the New York Bight DPS. Given the time of year in which the fish were observed (predominantly May through July), it is likely that many of the adults were migrating through the river to the spawning grounds.

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

In 2018, we announced the initiation of a 5-year review for the New York Bight DPS. We reviewed and considered new information for the New York Bight DPS that has become available since this DPS was listed as endangered in February 2012. We completed the 5-year review for the DPS in February 2022 (NMFS 2022b); the review includes a summary of additional information available since the listing determination, including information on life history and threats. Based on the best scientific and commercial data available at the time of the review, we concluded that no change to the listing status is warranted.

4.2.2.4 Chesapeake Bay DPS of Atlantic sturgeon

The Chesapeake Bay DPS includes the following: all anadromous Atlantic sturgeon that spawn or are spawned in the watersheds that drain into the Chesapeake Bay and into coastal waters from the Delaware-Maryland border on Fenwick Island to Cape Henry, Virginia. The marine range of Atlantic sturgeon from the Chesapeake Bay DPS extends from Hamilton Inlet, Labrador, Canada, to Cape Canaveral, Florida. 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). 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).

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, Secor *et al*. 2021). 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 (Hilton *et al*. 2016, ASMFC 2017a, Kahn *et al*. 2019). However, information for these populations is limited and the research is ongoing.

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). There is currently no total abundance estimate for the Chesapeake Bay DPS; however, we have estimated subadult and adult abundance in nearshore marine waters from Cape Cod to Cape Hatteras and concluded that, at a minimum, approximately 10,332 Atlantic sturgeon of those two age classes comprise the DPS, based upon the NEAMAP survey swept area model (Boucher, 2025). Tagging and research captures provided annual run estimates for the Pamunkey River from 2013 to 2018, and 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.*, 2022). By comparison, 373 different adult-sized Atlantic sturgeon (i.e., total count does not include recaptures of the same fish and this is likely a minimum count) were captured in the James River from 2009 through spring 2014 (Balazik & Musick, 2015). Most recently, Coleman *et al.* (2024) estimated that 32 (95% confidence interval [CRI] = 23-47) and 70 (95% CRI = 49-105) Atlantic sturgeon used the Marshyhope Creek-Nanticoke River system in 2020 and 2021, respectively. In both years, high spawning run connectivity between Marshyhope Creek and the upper Nanticoke River was observed. Overall, run estimates supported previous hypotheses that this river system supports a very small population and that both Marshyhope Creek and the upper Nanticoke River serve as important areas for spawning activity (Coleman *et al*., 2024).

There are also several estimates of effective population (N_e) size for Atlantic sturgeon 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. They are: 62.1 (95% CI=44.3-97.2) based on sampling of subadults captured off of Long Island across multiple years; 32 (95% CI=28.8-35.5) based on sampling of natal juveniles and adults in multiple years (Waldman *et al*., 2019); 40.9 (95% CI=35.6-46.9) based on samples from a combination of juveniles and adults (ASMFC 2019); and 44 (95% CI=26-79) and 46 (95% CI=32-71) for the spring and fall spawning populations, respectively, based on sampling of adults (Balazik, Farrae, *et al*., 2017). There is a single estimate of 12.2 (95% CI = 6.7-21.9) for the Nanticoke River system (Secor *et al*., 2022), and also a single estimate of 7.8 (95% CI=5.3-10.2) for the York River system based on samples from adults captured in the Pamunkey River (ASMFC 2017).

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 1998a; ASSRT 2007; Bushnoe *et al*., 2005; Hildebrand & Schroeder, 1928; Secor, 2002; Vladykov & Greeley, 1963) as well as subsistence fishing and attempts at commercial fisheries as early as the 17th century (ASSRT 2007; Balazik *et al*., 2010; Bushnoe *et al*., 2005; Secor, 2002). Habitat disturbance caused by in-river work, such as dredging for navigational purposes, reduced available spawning habitat in the James River (ASSRT 2007; Bushnoe *et al*., 2005; Holton & Walsh, 1995). 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 1998b; ASSRT 2007; EPA 2008; 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 & 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, 2022). 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. 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 of Atlantic sturgeon have been observed in the James River (ASSRT ASMFC, 2017; 2007; Balazik, Reine, *et al*., 2012; NMFS, 2022a). 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). 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 2017; Balazik, Reine, *et al*., 2012; Fox *et al*., 2020). There has been an increased number of vessel struck sturgeon reported in the James River in recent years (ASMFC 2017). 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; ASSRT 2007; Stein *et al*., 2004). Of the of Atlantic sturgeon incidentally caught in the Bay of Fundy, about 1 percent were Chesapeake Bay DPS fish (Wirgin *et al.* 2012). Studies have shown that Atlantic sturgeon can only sustain low levels of bycatch mortality (Boreman 1997, ASMFC 2007, Kahnle *et al.* 2007). The Chesapeake Bay DPS is currently at risk of extinction given: (1) precipitous declines in population sizes and the protracted period in which sturgeon populations have been depressed; (2) the limited amount of current spawning; and (3) the impacts and threats that have and will continue to affect the potential for population recovery.

In 2018, we announced the initiation of a 5-year review for the Chesapeake Bay DPS. We reviewed and considered new information for the Chesapeake Bay DPS that has become available since this DPS was listed as endangered in February 2012. We completed the 5-year review for the Chesapeake Bay DPS in February 2022 (NMFS 2022c); the review includes a summary of additional information available since the listing determination, including information on life history and threats. Based on the best scientific and commercial data available at the time of the review, we concluded that no change to the listing status is warranted.

4.2.2.5 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.

Rivers in the Carolina DPS considered to be spawning rivers include the Neuse, Roanoke, Tar-Pamlico, Cape Fear, and Northeast Cape Fear rivers, and the Santee-Cooper and Pee Dee river (Waccamaw and Pee Dee rivers) systems. Historically, both the Sampit and Ashley Rivers had 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. We have no information, current or historical, of Atlantic sturgeon using the Chowan and New Rivers in North Carolina. Recent telemetry work by Post *et al*. (2014) indicates that Atlantic sturgeon do not use the Sampit, Ashley, Ashepoo, and Broad-Coosawhatchie Rivers in South Carolina. These rivers are short, coastal plains rivers that most likely do not contain suitable habitat for Atlantic sturgeon. Fish from the Carolina DPS likely use other river systems than those listed here for their specific life functions.

Historical landings data indicate that between 7,000 and 10,500 adult female Atlantic sturgeon were present in North Carolina prior to 1890 (Armstrong and Hightower 2002, Secor 2002). Secor (2002) estimates that 8,000 adult females were present in South Carolina during that same period. Reductions from the commercial fishery and ongoing threats have drastically reduced the numbers of Atlantic sturgeon within the Carolina DPS. Currently, the Atlantic sturgeon spawning population in at least one river system within the Carolina DPS has been extirpated, with a potential extirpation in an additional system. The ASSRT estimated the remaining river populations within the DPS to have fewer than 300 spawning adults; this is thought to be a small fraction of historic population sizes (ASSRT 2007). There is currently no total abundance estimate for the Carolina DPS; however, we have estimated subadult and adult abundance in nearshore marine waters from Cape Cod to Cape Hatteras and concluded that, at a minimum, approximately 2,617 Atlantic sturgeon of those two age classes comprise the DPS, based upon the NEAMAP survey swept area model (Boucher, 2025).

There are also several estimates of effective population (N_e) size for Atlantic sturgeon spawned in Abermarle Sound and the Pee Dee River (spring and fall spawning runs). This information is tabulated in Table 10.

Table 10. Available Estimates of Effective Population Sizes (N_e) in the Carolina DPS.

River	Effective Population Size (N_e) (95% CI)	Sample Size	Collection Years	Reference
	14.2 (11.8-17.1)	37	1998-2008	ASMFC (2017)

River	Effective Population Size (N_e) (95% CI)	Sample Size	Collection Years	Reference
Albemarle Sound	19.0 (16.5–20.6)	88	1998, 2006-2011, 2013-2014	Waldman *et al.* (2019)
	29.5 (24.2-36.3)	71	1998, 2006-2009, 2012, 2015 2016	White *et al.* (2021)
Pee Dee	Fall Run – 82 (60.3-122.1)	50	2011, 2012, 2017-2019	White *et al.* (2021)
	Spring Run – 16.4 (12.8-20.6)	66	2012, 2017-2019	White *et al.* (2021)

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

The modification and curtailment of Atlantic sturgeon habitat resulting from dams, dredging, and degraded water quality is contributing to the status of the Carolina DPS. Dams have curtailed Carolina DPS Atlantic sturgeon spawning and juvenile developmental habitat by blocking over 60 percent of the historical sturgeon habitat upstream of the dams in the Cape Fear and Santee-Cooper River systems. Water quality (velocity, temperature, and dissolved oxygen) downstream of these dams, as well as on the Roanoke River, has reduced, which modifies and curtails the extent of spawning and nursery habitat for the Carolina DPS. Dredging in spawning and nursery grounds modifies the quality of the habitat and is further curtailing the extent of available habitat in the Cape Fear and Cooper Rivers, where Atlantic sturgeon habitat has already been modified and curtailed by the presence of dams. Reductions in water quality from terrestrial activities have modified habitat utilized by the Carolina DPS. In the Pamlico and Neuse systems, nutrient-loading and seasonal anoxia are occurring, associated in part with concentrated animal feeding operations (CAFOs). Heavy industrial development and CAFOs have degraded water quality in the Cape Fear River. Water quality in the Waccamaw and Pee Dee rivers is affected by industrialization and riverine sediment samples contain high levels of various toxins, including dioxins. Additional stressors arising from water allocation and climate change threaten to exacerbate water quality problems that are already present throughout the range of the Carolina DPS. The removal of large amounts of water from the system will alter flows, temperature, and DO. Existing water allocation issues will likely be compounded by population growth and potentially, by changing environmental conditions. Changing environmental conditions are also predicted to elevate water temperatures and exacerbate nutrient-loading, pollution inputs, and lower DO, all of which are current stressors to the Carolina DPS.

Overutilization of Atlantic sturgeon from directed fishing caused initial severe declines in Atlantic sturgeon populations in the Southeast, from which they have never rebounded. Further, continued overutilization of Atlantic sturgeon as bycatch in commercial fisheries is an ongoing

impact to the Carolina DPS. Little data exists on bycatch in the Southeast and high levels of bycatch underreporting are suspected. Stress or injury to Atlantic sturgeon taken as bycatch but released alive may result in increased susceptibility to other threats, such as poor water quality (e.g., exposure to toxins and low DO). This may result in reduced ability to perform major life functions, such as foraging and spawning, or even post-capture mortality.

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

In the 2023 5-year review for the Carolina DPS, NMFS Southeast Regional Office reviewed and considered new information for the DPS that has become available since listing this DPS as endangered in February 2012. In the review, NMFS concluded that the Carolina DPS's demographic risk is "High" because of its productivity (i.e., relatively few adults compared to historical levels and irregular spawning success), abundance (i.e., riverine populations vary significantly and abundance is generally low in the DPS, overall), and spatial distribution (i.e., riverine populations and connectivity vary, creating inconsistent population coverage across the DPS and potentially limited ability to repopulate extirpated river populations). However, NMFS also concluded that the Carolina DPS' potential to recover is also "High" because man-made threats that have a major impact on the species' ability to persist have been identified (e.g., bycatch in federally-managed fisheries, dams blocking access to spawning habitat, dredging, vessel strikes), the DPS' response to those threats are well understood, management or protective actions to address major threats are primarily under U.S. jurisdiction or authority, and management or protective actions are technically feasible even if they require further testing (e.g., gear modifications to minimize dredge or fishing gear interactions). The review includes a summary of additional information available since the listing determination, including information on life history and threats. Based on the best scientific and commercial data available at the time of the review, the review concluded that no change to the listing status is warranted (NMFS 2023a).

4.2.2.6 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.

Rivers known to have current spawning populations within the range of the South Atlantic DPS include the Combahee, Edisto, Savannah, Ogeechee, Altamaha, St. Marys, and Satilla Rivers. Recent telemetry work by Post *et al.* (2014) indicates that Atlantic sturgeon do not use the Sampit, Ashley, Ashepoo, and Broad-Coosawhatchie Rivers in South Carolina. These rivers are short, coastal plains rivers that most likely do not contain suitable habitat for Atlantic sturgeon. Post *et al*. (2014) also found Atlantic sturgeon only use the portion of the Waccamaw River downstream of Bull Creek. Due to manmade structures and alterations, spawning areas in the St. Johns River are not accessible and therefore do not support a reproducing population.

Secor (2002) estimates that 8,000 adult females were present in South Carolina prior to 1890. Prior to the collapse of the fishery in the late 1800s, the sturgeon fishery was the third largest fishery in Georgia. Secor (2002) estimated from U.S. Fish Commission landing reports that approximately 11,000 spawning females were likely present in the state prior to 1890. Reductions from the commercial fishery and ongoing threats have drastically reduced the numbers of Atlantic sturgeon within the South Atlantic DPS. Currently, the Atlantic sturgeon spawning population in at least one river system within the South Atlantic DPS has been extirpated. The Altamaha River population of Atlantic sturgeon, with an estimated 343 adults spawning annually, is believed to be the largest population in the Southeast, yet is estimated to be only 6 percent of its historical population size. The ASSRT estimated the abundances of the remaining river populations within the DPS, each estimated to have fewer than 300 spawning adults, to be less than one percent of what they were historically (ASSRT 2007). There is currently no total abundance estimate for the South Atlantic DPS; however, we have estimated subadult and adult abundance in nearshore marine waters from Cape Cod to Cape Hatteras and concluded that, at a minimum, approximately 6,154 Atlantic sturgeon of those two age classes comprise the DPS, based upon the NEAMAP survey swept area model (Boucher 2025).

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

The stock assessment also estimated effective population sizes (N_e) when possible. For the South Atlantic DPS, the assessment reported N_e for the Edisto, Savannah, Ogeechee, and Altamaha rivers (Table 11). Additional estimates of N_e have been conducted since the completion of the assessment, including for additional river systems; Table 11 reports those estimates. White *et al*. (2021) cautions that because the populations they considered were sampled at varying temporal scales and intensities and represented a mixture of single and mixed-cohort samples, the N_e estimates they report should be interpreted with reservation as they technically represent a value between true N_e and the effective number of breeders. They also

state that while their estimates are valuable for comparing the general magnitude of difference among populations, they should not be used to make inferences about long-term population viability (White *et al*., 2021).

Table 11. Available estimates of Effective Population Sizes (N_e) in the rivers of the South Atlantic DPS.

River	Effective Population Size (N_e) (95% CI)	Sample Size	Collection Years	Reference
Edisto	55.4 (36.8-90.6)	109	1996-2005	ASMFC (2017)
	Fall Run – 48.0 (44.7-51.5)	1,154	1996-2004	Farrae *et a*l. (2017)
	Fall Run (82 (60.3-122.1)	373	1996, 1998, 2001-2003, 2005	White *et al*. (2021)
	Spring Run – 13.3 (12.1-14.6)	198	1998, 2003	Farrae *et al*. (2017)
	Spring Run – 16.4 (12.8-20.6)	123	1998, 2003	White *et al*. (2021)
	60.0 (51.9-69.0)	145	1996, 1998, 2005	Waldman *et al*. (2018)
Savannah	126.5 (88.1-205)	98	2000-2013	ASMFC (2017)
	123 (103.1-149.4)	161	2013, 2014, 2017	Waldman *et al.* (2018)
	154.5 (99.6-287.7)	134	2000, 2007, 2208, 2013, 2017, 2018	White *et al.* (2021)
Ogeechee	32.2 (26.9-38.8)	115	2003-2015	ASMFC (2017)
	26 23.9–28.2	200	2007-2009, 2014-2017	Waldman *et al*. (2018)
	23.9 (22.2-25.7)	197	2007-2009, 2014-2017	Fox *et al.* (2019)
	Spring Run – 31.1 (24.3-40.2)	92	2003, 2007, 2009, 2014, 2015, 2016	White *et al*. (2021)
	Fall Run – 56.5 (36.3-103.6)	55	2003, 2004, 2008, 2009, 2015, 2016	White *et al.* (2021)
Altamaha	111.9 (67.5-216.3)	186	2005-2015	ASMFC (2017)
	149 (128.7–174.3)	245	2005, 2011, 2014, 2016-2017	Waldman *et al*. (2018)
	142.1 (124.2-164.0)	268	2005, 2011, 2014-2017	Fox *et al*. (2019)
	141.7 (73.4-399)	189	2005, 2010, 2011, 2018	White *et al*. (2021)
Satilla	21 (18.7–23.2)	68	2015-2016	Waldman *et al*. (2018)
	11.4 (9.1-13.9)	74	2010, 2014, 2016	White *et al*. (2021)

River	Effective Population Size (N_e) (95% CI)	Sample Size	Collection Years	Reference
St. Marys	1 (1.3–2.0)	14	2014-2015	Waldman *et al.* (2018)

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

Overutilization of Atlantic sturgeon from directed fishing caused initial severe declines in Atlantic sturgeon populations in the Southeast, from which they have never rebounded. Further, continued overutilization of Atlantic sturgeon as bycatch in commercial fisheries is an ongoing impact to the South Atlantic DPS. The loss of large, mature subadults and adults as a result of bycatch impacts Atlantic sturgeon populations because they are a long-lived species, have an older age at maturity, have lower maximum fecundity values, and a large percentage of egg production occurs later in life. Little data exist on bycatch in the Southeast and high levels of bycatch underreporting are suspected. However, fisheries are known to incidentally catch Atlantic sturgeon throughout the marine range of the species and in some riverine waters as well. Because Atlantic sturgeon mix extensively in marine waters and may access multiple river systems, they are subject to catch in multiple fisheries throughout their range. In addition, stress or injury to Atlantic sturgeon taken as bycatch but released alive may result in increased susceptibility to other threats, such as poor water quality (e.g., exposure to toxins and low DO).

This may result in reduced ability to perform major life functions, such as foraging and spawning, or even post-capture mortality.

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

In the 2023 5-year review for the South Atlantic DPS, NMFS Southeast Regional Office reviewed and considered new information for the DPS that has become available since this DPS was listed as endangered in February 2012. In the review, NMFS concluded that the South Atlantic DPS' demographic risk is "High" because of its productivity (i.e., relatively few adults compared to historical levels and irregular spawning success), abundance (i.e., riverine populations vary significantly and abundance is generally low in the DPS, overall), and spatial distribution (i.e., riverine populations and connectivity vary, creating inconsistent population coverage across the DPS and potentially limited ability to repopulate extirpated river populations). However, NMFS also concluded that the South Atlantic DPS' potential to recover is also "High" because man-made threats that have a major impact on the species' ability to persist have been identified (e.g., bycatch in federally-managed fisheries, dams blocking access to spawning habitat, dredging, vessel strikes), the DPS' response to those threats are well understood, management or protective actions to address major threats are primarily under U.S. jurisdiction or authority, and management or protective actions are technically feasible even if they require further testing (e.g., gear modifications to minimize dredge or fishing gear interactions). The review includes a summary of additional information available since the listing determination, including information on life history and threats. Based on the best scientific and commercial data available at the time of the review, the review concluded that no change to the listing status is warranted (NMFS 2023b).

5 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. 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 with a focus on effects to shortnose and Atlantic sturgeon as these are the species being evaluated in the remainder of this Opinion.

5.1.1 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 criterion for the Chesapeake Bay and its tidal tributaries. In the Opinion, we concluded that the proposed action was likely to adversely affect but not likely to jeopardize the continued existence of shortnose sturgeon. The Opinion includes an Incidental Take Statement exempting the non-lethal take of shortnose sturgeon (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).

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. EPA's analysis shows that water quality conditions in the Bay are not improving as readily as expected due to impacts from climate instability. EPA has concluded that the attainment measures for take detailed above and outlined in detail in the 2012 Opinion have not been exceeded.

5.1.2 Vessel Activity and Military Operations

Potential sources of adverse effects to Atlantic sturgeon from Federal vessel operations in or near the action area include operations of the U.S. Navy (USN) and the U.S. Coast Guard (USCG), which maintain the largest Federal fleets, as well as the Bureau of Ocean Energy Management (BOEM), Maritime Administration (MARAD), Environmental Protection Agency (EPA), NOAA, and ACOE. We have conducted formal consultations with the USN, USCG, EPA, and NOAA on their vessel-based operations. We have also conducted section 7 consultations with BOEM and MARAD on vessel traffic related to energy projects in the Greater Atlantic Region and implemented conservation measures. Through the section 7 process, where applicable, we

have and will continue to establish conservation measures for all these agency vessel operations to avoid or minimize adverse effects to listed species. To date, ocean-going vessels and military activities have not been identified as significant threats to sturgeon in the marine environment, but when vessels move into estuarine systems, such as the action area, the possibility exists for interactions between vessels and sturgeon.

In 2024, we completed formal consultation with BOEM regarding the Construction, Operation, Maintenance, and Decommissioning of the Maryland Wind Offshore Energy Project. The anticipated lethal take of Atlantic and shortnose sturgeon over the 35-year life of the project, inclusive of construction, operations, and decommissioning of Maryland Wind the Mar Win Construction Campaign, Momentum Wind Construction Campaign, and Future Development Construction Campaign from vessels operating in the Chesapeake Bay entrance area (to/from ports in MD and VA) is anticipated as follows:

Port	**Species/DPS**	**Vessel Strike Mortality**
MD and VA (transiting in Chesapeake Bay Entrance)	NYB DPS Atlantic Sturgeon	2
	Chesapeake Bay DPS Atlantic sturgeon	1

5.1.3 EPA's Registration of Pesticides containing Chlorpyrifos, Diazinon, and Malathion (F/FPR/2017/9241)

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 (NMFS 2017d).

5.1.4 Research and Other Permitted Activities

Research activities either conducted or funded by Federal agencies within the action area may adversely affect Alantic and shortnose sturgeon. 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. In Maryland, some of the survey activities covered in the consultation occur in the action area.

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 12). 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 12. Take exempt for USFWS surveys carried out by Maryland and Virginia from 2023-2026

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 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 can only be authorized when they are found to be not likely to jeopardize the continued existence of the listed species and are consistent with the purposes of the ESA, as outlined in section 2 of the Act.

Two section 10(a)(1)(A) permits are currently in effect for research activities on Atlantic sturgeon and shortnose sturgeon captured within the action area for this consultation. Permit 20134 is issued to the U.S. Fish and Wildlife Service and authorizes the collection, tagging, and sampling of live juvenile and adult Atlantic sturgeon and the mortality of up to 50 Atlantic sturgeon eggs and larvae; this permit expires in 2027. Permit 24016 is issued to Dr. Jason Kahn and authorizes the collection, tagging, and sampling of live juvenile and adult shortnose and Atlantic sturgeon, the mortality of a small number of shortnose Atlantic sturgeon eggs and larvae, and the unintentional mortality of a small number of shortnose and Atlantic sturgeon; this permit expires in 2031.

5.2 Non-Federally Regulated Fisheries

Atlantic sturgeon and shortnose sturgeon may be vulnerable to capture, injury, and mortality in fisheries occurring in Maryland state waters. Prior to listing, an Atlantic sturgeon "reward program" where fishermen received monetary rewards for reporting captures of Atlantic sturgeon, operated in Maryland. During its active run, commercial watermen voluntarily reported 1,710 live catches of Atlantic sturgeon. Additionally, the program recorded 32 shortnose sturgeon in the upper Chesapeake Bay between 1996 and 2000. Below, we discuss the different fisheries authorized by the state of Maryland and any available information on interactions between these fisheries and Atlantic sturgeon or shortnose sturgeon.

American shad fishery

Maryland authorizes only a catch-and-release recreational hook-and-line fishery for American shad; the commercial fishery has been closed since 1980. Recreational shad anglers are known to incidentally capture Atlantic sturgeon, representing a potential low-level source of injury or mortality within the action area.

Striped Bass Fishery

A commercial striped bass fishery is authorized in Maryland, including in the mainstem Chesapeake Bay, using pound net, gill net, and hook-and-line gear. Atlantic and shortnose sturgeon may be captured in any of these gear types operating in or near the action area; no estimates of sturgeon bycatch specific to the Maryland striped bass fishery are available. Coastwide, the striped bass fishery has historically accounted for a substantial share of reported Atlantic sturgeon recaptures, and gear soak time, season, and location are understood to be more important than gear type alone in determining bycatch mortality risk.

State Gillnet Fisheries

Large- and small-mesh gillnet fisheries occur in Maryland state waters, including portions of the upper Chesapeake Bay overlapping the action area. Atlantic sturgeon are known to be captured in gillnet gear; a historical reward program that operated in Virginia documented the majority of reported Atlantic sturgeon captures in drift gillnets and pound nets. State-reported gillnet bycatch of Atlantic sturgeon in Maryland waters has been low in recent years relative to other states in the region.

Poundnet Fishery

Pound nets with large mesh and stringer leaders are set in the Chesapeake Bay, including within or near the action area, and entanglement in this gear can be a source of injury or mortality to sturgeon. Atlantic sturgeon are known to become entrapped in pound nets and have been routinely documented in Maryland waters through historical reward-tagging programs. Modified leader requirements adopted under the Marine Mammal Protection Act's Bottlenose Dolphin Take Reduction Plan apply seasonally to some Virginia pound net gear but do not extend to the Maryland action area.

Horseshoe Crab
A horseshoe crab bait fishery occurs in Maryland waters, primarily using hand harvest, bottom trawl, and dredge methods, with a smaller biomedical-use fishery also authorized. Bycatch rates of Atlantic sturgeon in the horseshoe crab fishery have been documented as low (approximately 0.05 percent) in prior bycatch assessments, and a historical Maryland sturgeon reward program recorded only a single crab-pot capture of a wild Atlantic sturgeon over an 11-year period.

Other Fisheries
Blue crab, American eel, and Atlantic croaker fisheries also occur within or near the action area. Sturgeon are not known to interact meaningfully with the eel fishery. Atlantic sturgeon interactions with the Atlantic croaker fishery have been documented but not quantitatively assessed for Maryland waters specifically; a mortality rate of approximately 5 percent has been estimated for sturgeon captured in commercial trawls generally.

State Recreational Fisheries
Shortnose and Atlantic sturgeon have been documented in Maryland recreational fisheries; however, recreational bycatch risk in the open mainstem Bay - including the action area - is expected to be substantially lower than in tidal tributaries. The lower risk is due to the lack of ecological and operational overlap between sturgeon and local recreational fishing effort. Angling at the bridge is heavily concentrated around the physical pilings and focused on pelagic or structure-associated species, primarily striped bass (*Morone saxatilis*). The dominant fishing modalities—including trolling, mid-water chumming, and vertical jigging—do not deploy gear within the benthic zone occupied by sturgeon. Furthermore, the high-tackle, heavy-scent bottom-fishing practices targeting invasive ictalurids, which represent a primary source of sturgeon bycatch in tidal tributaries, are absent from this mesohaline portion of the mainstem. Consequently, while sturgeon physically pass through the action area, their exposure to recreational fishing stressors (e.g., hooking, trailing line, handling) is minimized by both their rapid, transient behavior and the mid-water nature of the localized fishery.

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 and shortnose 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. The Port of Baltimore typically has over 100 vessel arrivals and departures per day and had approximately 3,000 inbound and 3,000 outbound commerce-carrying vessel trips in 2021 (ACOE 2021). According to the Sturgeon Stranding Database, between 2021 and 2026, eleven reports originated from Maryland; however, all of these reports were outside of the action area and only one showed signs of a vessel interaction (a “clean cut" with the back third of the fish missing). That individual was salvaged in 2025 at Elk Neck State Park – approximately 63 km

(39 mi) northeast of the Bridge. 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 or shortnose sturgeon resulting from fishing vessel fuel spills have been documented.

5.3.2 Water Quality

Water quality data for the action area were obtained from multiple sources, including the Maryland Department of Natural Resources (MDNR) Eyes on the Bay Fixed Station Monthly Monitoring Program, MDNR's Chesapeake Bay Benthic Monitoring Program (CBBMP), the Chesapeake Bay Program (CBP) DataHub, the National Water Quality Monitoring Council (NWQMC) database, and near real-time data from the NOAA Chesapeake Bay Interpretive Buoy System (CBIBS) Annapolis buoy (Station AN), located approximately 5.6 km (3.5 mi) southwest of the Bay Bridge at the mouth of the Severn River. MDNR operates three dedicated long-term fixed monitoring stations in the immediate vicinity of the Bay Bridge: CB3.3C (Bay Bridge North), CB3.3E (Bay Bridge Northeast), and CB3.3W (Bay Bridge Northwest). These stations have been sampled monthly since 1985 and represent the most directly applicable long-term water quality record for the action area.

Water Temperature

Water temperature in the Chesapeake Bay at the Bay Bridge exhibits strong seasonal variation characteristic of the upper mesohaline mainstem. Surface temperatures at the Bay Bridge stations typically reach their annual minima during January and February, when values approach or occasionally fall near freezing, and their annual maxima during July and August. Long-term monthly mean surface water temperatures at stations CB3.3C, CB3.3W, and CB3.3E range from approximately 2–4°C (35.6-39.2°F) in winter to approximately 27–29°C (80.6-84.2°F) in midsummer, based on the MDNR fixed station monitoring record (MDNR, Eyes on the Bay, 2025). The CBIBS Annapolis buoy recorded a surface water temperature of 23.1°C (73.6°F) on June 10, 2026, consistent with expected early-summer conditions at this location. Annual mean surface water temperature across the monitoring record is approximately 17–18°C (62.6-64.4°F). These thermal conditions are ecologically significant because water temperatures above 28°C (82.4°F) have been demonstrated to have deleterious effects on Atlantic and shortnose sturgeon, and temperatures in this range occur with regularity at the Bay Bridge from approximately June through August.

Salinity

The Chesapeake Bay at the Bay Bridge is classified as a mesohaline system, with salinity typically ranging from 5 to 18 parts per thousand (ppt) depending on season, depth, and freshwater inflow from the Susquehanna River and other tributaries. The Bay Bridge is located within the CB3 segment of the Chesapeake Bay mainstem, characterized by moderate salinity generally ranging from 7 to 13 ppt, though values at the bridge location can exceed this range

during dry periods. The CBIBS Annapolis buoy recorded a surface salinity of 10.4 PSU on June 10, 2026. Long-term monthly mean surface salinities at the Bay Bridge stations generally reach their annual minima in spring (March through May), reflecting peak freshwater inflow from winter snowmelt and spring precipitation, and their annual maxima in late summer and fall (August through November) when tributary flows recede. Based on the MDNR fixed station monitoring record and CBP DataHub data for the action area, surface salinity at the Bay Bridge ranges from approximately 5–8 ppt at spring minima to approximately 13–16 ppt at late-season maxima. The BA documents surface salinity in the broader action area ranging from 0.50 to 22.32 ppt depending on sampling event, location, and depth, with bottom salinities consistently exceeding surface values due to the stratified, two-layer estuarine circulation characteristic of this segment of the Bay. Both Atlantic and shortnose sturgeon exhibit salinity-dependent habitat use across life stages, and the mesohaline conditions at the Bay Bridge represent suitable foraging and migratory habitat for subadult and adult individuals from spring through fall.

pH

Surface water pH in the action area is generally near neutral to slightly alkaline, consistent with the buffered mesohaline conditions of the mid-Bay. Based on CBP DataHub monitoring data for stations in the vicinity of the Bay Bridge, surface pH values typically range from approximately 7.1 to 9.1, with approximately 9–10 percent of surface records exceeding the upper COMAR criterion of 8.5, most commonly during periods of elevated phytoplankton productivity in summer. Bottom pH values show a narrower range and are less subject to photosynthesis-driven excursions. Long-term monthly mean pH at the Bay Bridge stations ranges from approximately 7.4–7.8 in winter to approximately 8.0–8.4 in summer, based on the MDNR fixed station monitoring record (MDNR, Eyes on the Bay, 2025).

Dissolved Oxygen

Bottom dissolved oxygen (DO) conditions at the Bay Bridge reflect the seasonal hypoxic dynamics characteristic of the stratified mesohaline mainstem. Surface DO values generally meet COMAR criteria throughout the year. Bottom DO readings, however, frequently fall below COMAR criteria during the summer stratification period, with 12 to 51 percent of bottom readings in the action area not meeting applicable COMAR criteria depending on season and designated habitat type, based on CBP DataHub monitoring data. Dissolved oxygen levels below 4.0 mg/L are known to have deleterious effects on Atlantic and shortnose sturgeon. The seasonal occurrence of bottom hypoxia at the Bay Bridge is therefore a relevant baseline condition for the effects analysis, as it constrains sturgeon depth distribution during summer and can influence their spatial overlap with construction activities.

5.3.3 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 wastewater treatment facility outfalls and combined sewer overflow (CSO) outfalls.

Nonpoint sources of pollutants include polychlorinated biphenyls (PCBs); pesticides; stormwater runoff; groundwater discharges; and oil spills.

Nutrient loading from land-based sources, such as coastal communities and agricultural operations, is known to stimulate plankton blooms in closed or semi-closed estuarine systems. 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 from an overabundance of nutrients. 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 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 (Philips *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 sturgeon ingest 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 *et al*. (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.* (2008) notes that fish have the ability to detoxify toxins and may recover

if removed from contaminated waters. 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. In addition, contaminants could degrade habitat if pollution and other factors reduce the food available to sturgeon.

5.3.4 Coastal Development

Coastal development within the action area is dominated by the permanent infrastructure of the William Preston Lane, Jr. Memorial Bridge and localized shoreline stabilization (e.g., riprap, bulkheads) along the shoreline. These activities have a negligible impact on sturgeon foraging and migration because both Atlantic and shortnose sturgeon predominantly utilize the deep-water, offshore benthic channels to transit through the action area, well away from shallow, hardened shorelines. Furthermore, while artificial lighting from the bridge deck, navigation markers, and waterfront properties is an ongoing feature within the action area, it does not present a barrier to sturgeon. As a benthic species, sturgeon adapt to low-light, highly turbid estuarine environments, surface-level artificial light does not penetrate to the depths where sturgeon transit, resulting in no discernable impact on their migratory behavior or habitat utilization.

5.3.5 Vessel Traffic in the Action Area

Commercial, fishing, and recreational vessels use the 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.

There is a constant heavy flow of vessel traffic through the Chesapeake Bay including military, commercial, recreational, and fishing vessels. The Port of Baltimore is one of the nation's major commercial ports, ranking ninth among major U.S. ports for total foreign cargo handled and first nationally for volume of automobiles and light trucks, roll-on/roll-off heavy farm and construction machinery, imported sugar, and imported gypsum (MPA, 2024). In 2023, the Port handled a record 52.3 million tons of foreign cargo valued at approximately $80 billion (MPA, 2024). The Port of Baltimore typically has over 100 vessel arrivals and departures per day and had approximately 3,000 inbound and 3,000 outbound commerce-carrying vessel trips in 2021 (ACOE 2021). Vessel drafts varied greatly, with the Port's 50-foot-deep main shipping channel capable of accommodating some of the largest oceangoing vessels in service, including Neo-Panamax container ships exceeding 165,000 gross tons. The majority of vessels calling at the port contain a draft of 4.6 m (15 feet) or less (data gathered from Waterborne Commerce Statistics Center). According to the Sturgeon Stranding Database, between 2021 and 2026, eleven reports originated from Maryland; however, all of these reports are outside of the action area and only one showed signs of a vessel interaction (a “clean cut" with the back third of the fish missing). That individual was salvaged in 2025 at Elk Neck State Park – approximately 63 km (39 mi) northeast of the Bridge (data gathered from Waterborne Commerce Statistics Center).

5.4 Reducing Threats, Recovery Planning, and Research

5.4.1 Education and Outreach Activities

Education and outreach activities are 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. These activities are authorized under an ESA section 10 permit held by NMFS GARFO PRD.

5.4.3 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.

5.4.4 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 researchers to minimizes the adverse impacts of their activities on individuals 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.

5.5 Habitat within the Action Area

Chesapeake Bay

The Chesapeake Bay is approximately 320 km (200 mi) long and extends from Cape Henry and Cape Charles, Virginia to Havre de Grace, Maryland. It is 4.5 km (2.8 mi) wide at its narrowest (between Kent County's Plum Point near Newtown and the Harford County shore near Romney Creek) and 48 km (30 mi) at its widest (just south of the mouth of the Potomac River). Water depth in the bay averages 6.4 m (21 ft), reaching a maximum depth of 53 m (174 ft).

The typical tidal range in the Chesapeake Bay is approximately 0.87 m (2.85 ft), 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. There is sufficient mixing so that anoxic waters are not typical within the action area; however, deep channels can become 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 -6.1 m (-20 ft) in side and/or natural and unmaintained channels to -15 m (-50 ft) 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 will travel through the Federal Navigation Channel from the Port of Baltimore to the project site. The current authorized depth of the channel is 16.8 m (55 ft), though most of the channel is approximately 15 m (50 ft) 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 in the *Environmental Baseline* section.

Cox Creek

Cox Creek is a tidal system both north and south of U.S. 50/301 that almost bisects Kent Island. This is a wide system that narrows where it is bridged by U.S. 50/301 and is approximately 175.3 m (575 ft) wide north of the roadway and 503 m (1,650 ft) wide south of the roadway. Although the FEMA 100-year floodplain is associated with this waterway both north and south of the road, there are no vegetated wetlands identified to the north. Large areas of estuarine common reed (*Phragmites australis*) wetland are located along the western bank, on the south side of the road.

5.5.1 Water Quality

Water quality data was gathered from MDE, Maryland Department of Natural Resources' (MDNR) Eyes on the Bay Program, and other monitoring programs accessed through the Chesapeake Bay Program (CBP) DataHub to assess water quality during the development of the Tier 2 Study NETR. In addition, water quality data from the National Water Quality Monitoring Council (NWQMC) database and in situ data were obtained from MDNR's Chesapeake Bay Benthic Monitoring Program (CBBMP). This section summarizes the water quality data for the watersheds within the action area.

Data available within the Chesapeake Bay closest to the western shore have sampling locations north of and beyond the action area, however, these locations are along the shoreline of the Chesapeake Bay and flow directly into the action area. Dissolved Oxygen (DO) data for this area reflects existing turbidity and shoreline erosion conditions, since DO and turbidity are inversely related, and provides baseline conditions for the area where the bridge would be constructed.

Recent chemical grab data from this part of the Chesapeake Bay is available for three monitoring locations from the NWQMC database, which indicated approximately 5 percent of pH records, 14 percent of all Enterococcus records, and 8 percent of fecal coliform records not meeting Code of Maryland Regulations (COMAR) criteria. Values for pH ranged from 6.1 to 9.0, which violated both the low and high COMAR criteria of 6.5 and 8.5, respectively. In general, DO values met COMAR criteria for the various designated habitats and seasons, with records infrequently falling below specific criteria. Salinity ranged from 1.9 to 16 ppt, depending on sampling event.

Sampling data is captured just north of the Bay Bridge landside connection with Anne Arundel County. In situ and grab sample water quality data for two locations in this area were gathered from the CBP DataHub, where approximately 10 percent of surface pH records exceeded the COMAR criterion of 8.5, with a maximum recorded value of 9.1. All surface DO readings met COMAR criteria for the various designated habitats and seasons, and between 7 percent and 29 percent of bottom DO readings fell below COMAR criteria, depending on the designated habitat and season. The full range of DO values observed across all seasons and habitat types is in Table 13. Chemical grab sample data was available for one monitoring location from the NWQMC database, indicating approximately 8 percent of all fecal coliform records exceeded the most stringent COMAR criterion for shellfish harvesting areas (i.e., ≤14 MPN/100 mL). Recent

in-situ water quality data for one location, available from CBBMP, revealed that there were no exceedances of water quality criteria, however, this location is well south of the action area and flowing away from the Bay Bridge. Salinity ranged from 0.61 to 18.48 ppt, depending on the sampling event, location, and depth.

Recent chemical grab sample data from one location in the Northern Eastern Bay MD 12-digit watershed, located downstream of the build alternatives, were available from the NWQMC database. Approximately 30 percent of all fecal coliform records exceed the most stringent COMAR criterion for shellfish harvesting areas (i.e., ≤14 MPN/100 mL).

Additional in situ and grab sample water quality data was retrieved from five sampling sites in the Kent Island True Bay MD 12-digit watershed, within the Chesapeake Bay, just north of the Bay Bridge. Data from two sites in the CBP DataHub and three sites in the NWQMC dataset indicated that approximately 9 percent of in situ surface records for pH and less than 1 percent of bottom records exceeded the upper COMAR criterion of 8.5. All surface DO readings met COMAR criteria for the various designated habitats and seasons (see Table 13). Bottom DO readings frequently fell below COMAR criteria, with 12 percent to 51 percent of readings not meeting COMAR criteria, depending on the designated habitat and season. Approximately one percent of all fecal coliform records exceeded the most stringent COMAR criterion for shellfish harvesting areas (i.e., ≤14 MPN/100 mL). Salinity ranged from 0.50 to 22.32 ppt, depending on the sampling event, location, and depth (Table 14).

Table 13. COMAR Water Quality Parameters

Watershed	Source	Number of Sites	Year	Depth (m)	Parameter				
					Temperature (°C)	pH	DO (mg/L)*	Enterococcus (MPN/100mL)	Fecal Coliform (MPN)
Annapolis Shore	CBBMP	1	2018	0.5 / 9	26.30 / 26.37	7.8 / 7.2	6.35 / **4.20** (ppm)	---	---
	CBP	2 / 1	2013 - 2023	0.5 / 4	3.7 - 30.9 / 1 - 28.3	7.1 - **9.1** / 7.1 - 8.4	**4.6** - 15.1 / **0.28** - 12.6	---	---
	NWQMC	1	2013 - 2019	---	---	---	---	---	1 - **23**
Northern Eastern Bay	NWQMC	1	2013 - 2019	---	---	---	---	10 - **2,010** (2013 - 2022)	1 - **1,100**
Kent Island True Bay	CBP	2	2013 - 2023	0.5 / 6	1.3 - 29.6 / 0 - 28	6.9 - **9.6** / 6.8 - **8.7**	5.1 - 17.8 / **0.09** - 12.7	---	---
	NWQMC	1 - 3	2013 - 2019	---	1.2 - 29	7.4 - **8.8**	**4.1** - 14.5	10 - **1,450** (2013 - 2022)	1 – **23**

*In dilute aqueous solutions, 1 mg/L is approximately equivalent to 1 ppm.

Notes:

1. Red values indicate that they exceed/are below COMAR criteria during the listed time period.

2. Data collected at two depths is shown in the same cell separated by a "/," corresponding to the two depths reported in the Depth column.

3. Not all parameters or sites were monitored in each year within the year range.

Watershed	Source	Number of Sites	Year	Depth (m)	Parameter				
					Temperature (°C)	pH	DO (mg/L)*	Enterococcus (MPN/100mL)	Fecal Coliform (MPN)

4. A range of number of sites is presented to note that not all parameters were assessed at all sites for certain watersheds and datasets.

Table 14. Salinity and Conductivity

Watershed	Source	Number of Sites	Year	Depth (m)	Parameter	
					Salinity (ppt)*	Conductivity (UMHO/cm)
Annapolis Shore	CBBMP	1	2018	0.5 / 9	3.26 / 5.83 (PSU)	5,972 / 10,340
	CBP	2 / 1	2013 - 2023	0.5 / 4	0.61 - 16.43 / 3.38 - 18.48	3,100 - 27,000 / 6,640 - 30,000
Kent Island True Bay	CBP	2	2013 - 2023	0.5 / 6	0.5 - 16.56 / 4.75 - 22.32	3,120 - 27,200 / 8,940 - 35,500
	NWQMC	1	2013 - 2019	---	2.8 - 15.2	---

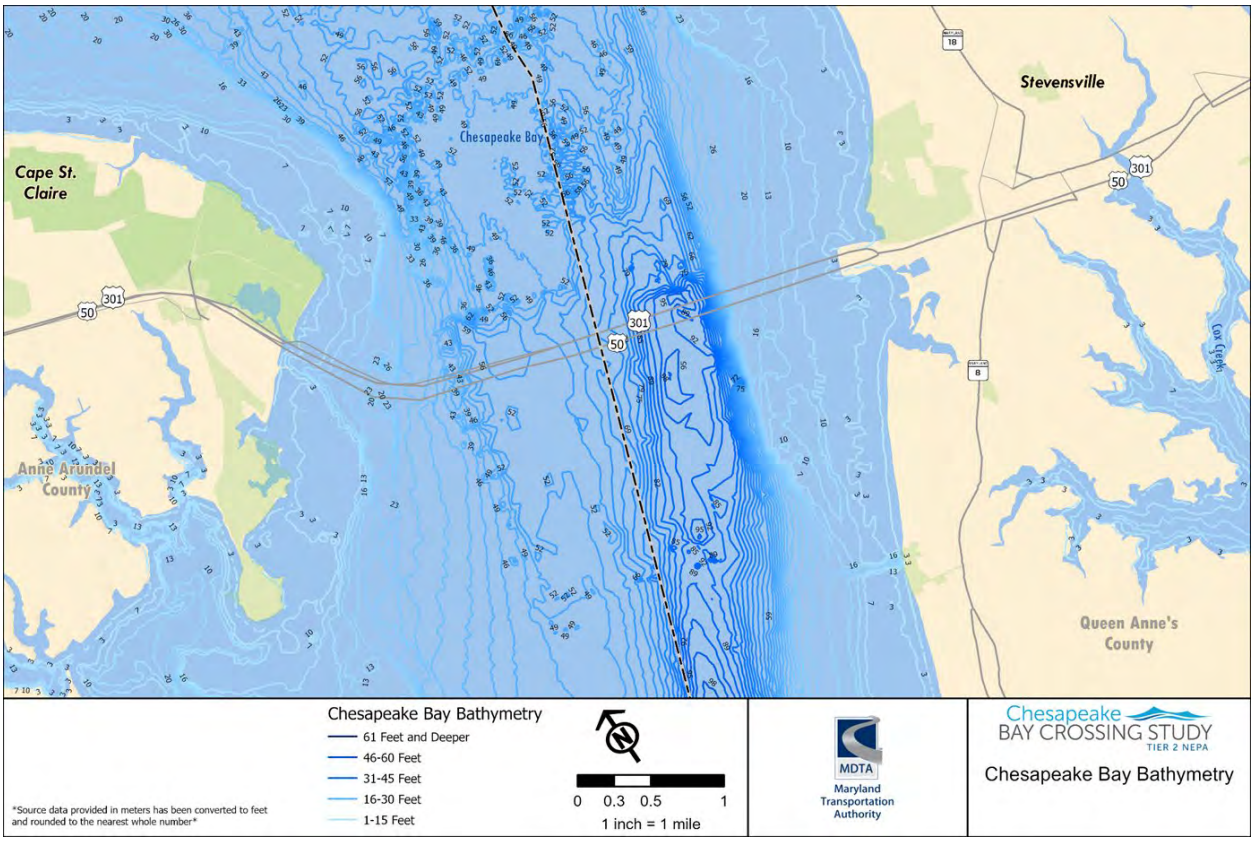
*1 PSU is approximately equivalent to 1 ppt.

5.5.2 Bathymetry

The Chesapeake Bay in the action area is deepest in the center and east of the county boundary, located within the Chesapeake Bay Bridge Auxiliary Federal navigation channel. The depth becomes increasingly shallower towards the shorelines. The Chesapeake Bay has an average depth of approximately 12.2 m (40 ft) within the action area, with the main channel depth approximately 17 m (56 ft), and the Chesapeake Bay Bridge Auxiliary channel depth approximately 28 m (92 ft). Figure 5 illustrates the bathymetry of the Chesapeake Bay, with the close contours indicative of varying steep slopes within the deeper areas.

The shallows of the Chesapeake Bay (0.3 to 0.9 m (1 to 3 ft)) extend channelward approximately 244 to 290 m (800 to 950 ft) from the western shoreline in Anne Arundel County, and approximately 366 to 396 m (1,200 to 1,300 ft) from the eastern shoreline in Queen Anne's County. Areas with depths from approximately 0.9 m to 3.7 m (3 ft to 12 ft) generally extend from about 640 to 671 m (2,100 to 2,200 ft) from the western shoreline and 1,189 to 1,433 m (3,900 to 4,700 ft) from the eastern shoreline.

Figure 5. Chesapeake Bay Bathymetry



Aquatic Substrate and Biota

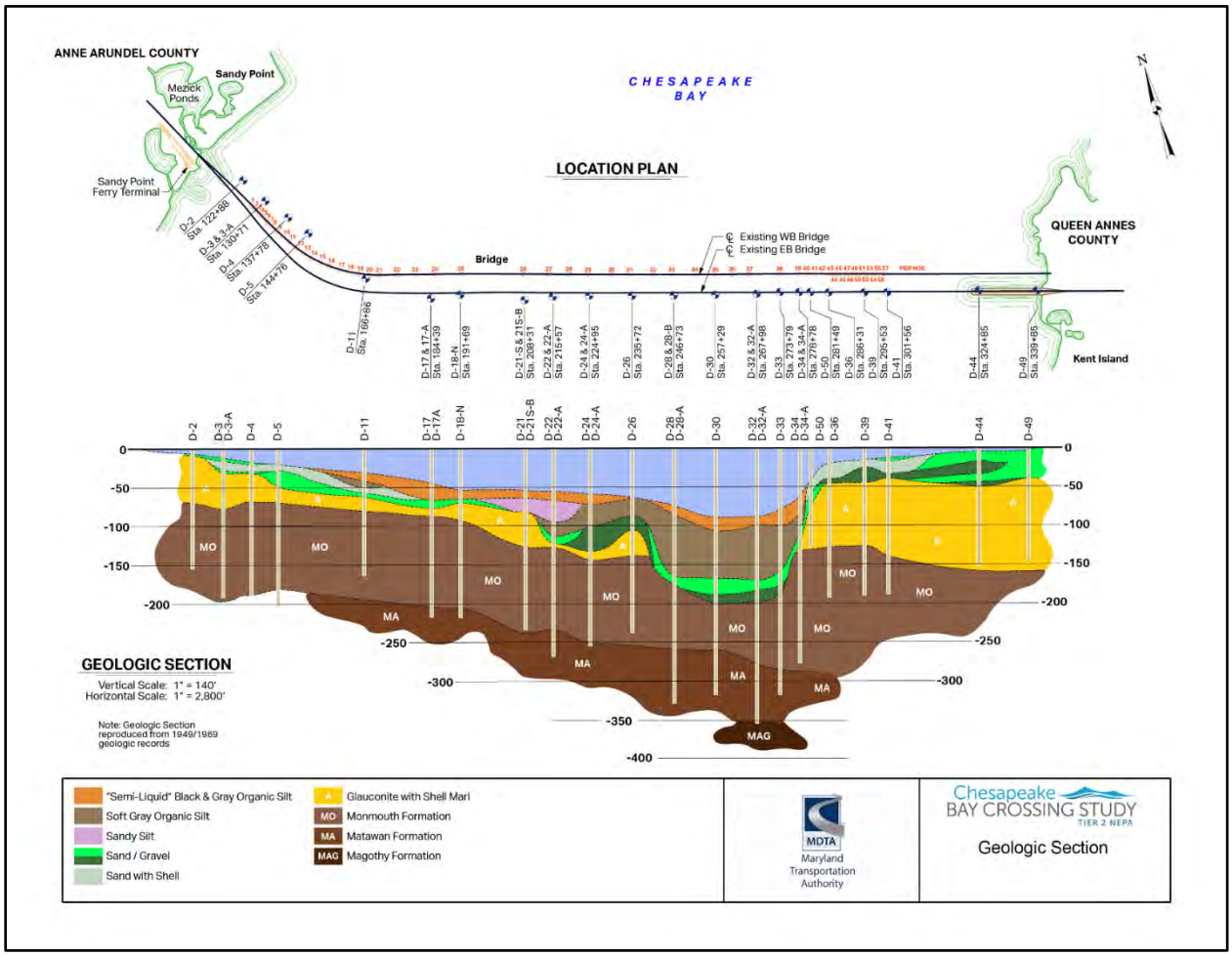
The Chesapeake Bay bottom consists of layers of from the Magothy, Matawan, and Monmouth formations, which is overlaid by sandy material in the shallow areas and loose silty clay material in the deeper channels. Surficial sand is in the areas that are most affected by wave action and tidal fluctuations. The waves and tide move fine silt, clay, and organic material out of the sand and deposit them in lower energy areas along the bottom (Figure 6). Currently there is no indication of contaminated material, as the USACE 50-foot Project has not found contaminated material in the Bay Bridge area (USACE 2017).

Sand: Surficial sand extends approximately 335 m (1,100 ft) channelward from the Anne Arundel County shore, which corresponds to an approximate 1.8 m (6-ft) water depth. Surficial sand extends approximately 1,280 m (4,200 ft) channelward from the Queen Anne's County shore which corresponds to an approximate 3.7 m (12-ft) water depth. Both shorelines correspond to bottom slopes that are flat (less than 0.5 percent) and near the surface. Geotechnical borings near the shorelines show the Chesapeake Bay bottom is underlain by sand to 15.2 m (50 ft) deep where it begins to increase in clay content.

Cultch: Material (such as oyster shells) placed on oyster grounds, furnishes points of attachment for oyster spat in shallower areas (less than 7.9 m (26 ft) deep). Cultch areas are generally inclusions in sandy bottom and may become incorporated into organic/silt mud areas.

Silty Clay: Surficial silty clay covers most of the Chesapeake Bay bottom along the action area. Silty clay is generally associated with relatively deep waters (deeper than 1.8 to 3.7 m (6 to 12 ft)). Geotechnical borings in the mid-bay show organic silt and silty clay layers from 3 to 15 m (10 to 50 ft) thick, before transitioning to clayey sand below.

Figure 6. Chesapeake Bay Geology



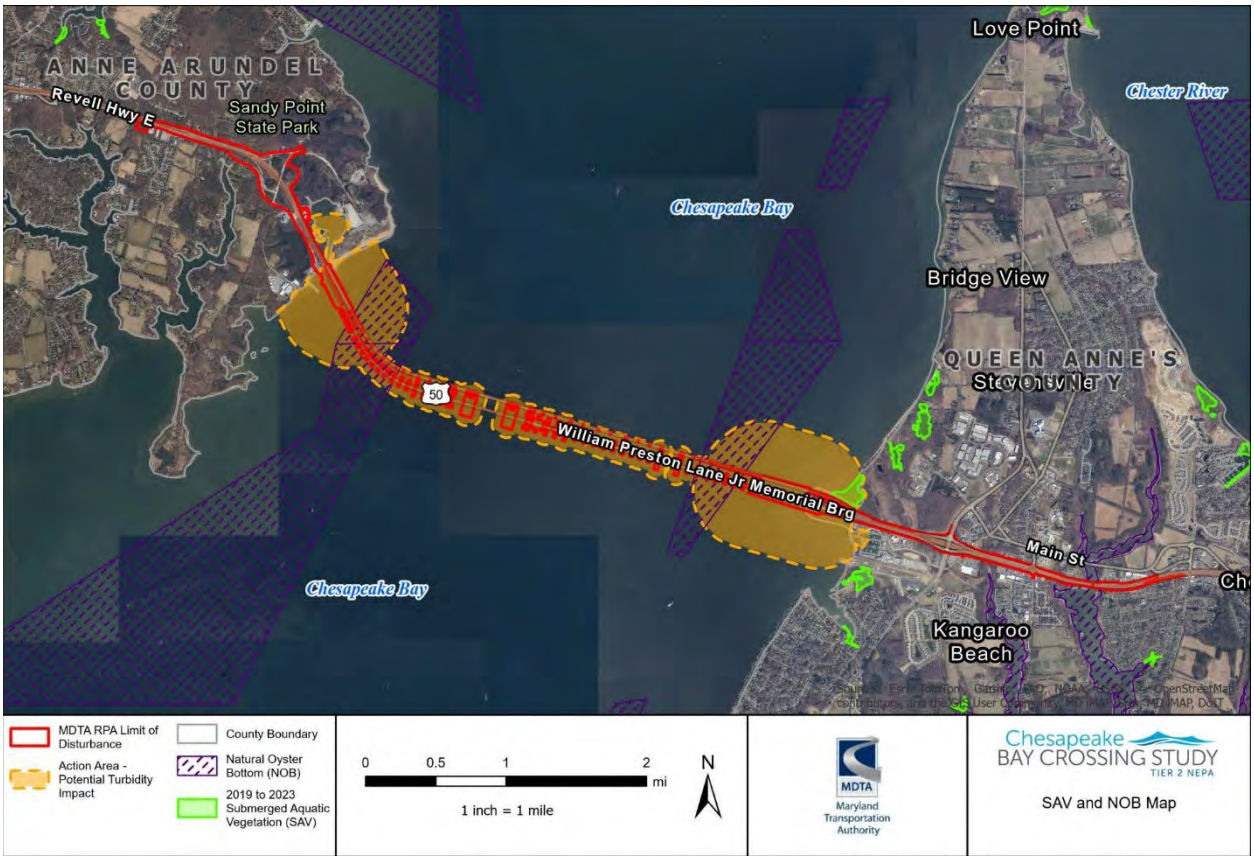
Within the vicinity of the action area, MDNR CBBMP tidal benthic macroinvertebrate data is available for the Chesapeake Bay. MDNR assessed benthic macroinvertebrate communities at two random sites and one fixed monitoring location, all located upriver of U.S. 50/301. Benthic macroinvertebrate community health varied from “severely degraded” to “meets restoration goals” for these sites, based on benthic index of biotic integrity (IBI) scores. Benthic macroinvertebrate data was not available for Cox Creek.

Submerged Aquatic Vegetation (SAV)
Information regarding SAV was obtained from the Virginia Institute of Marine Science (VIMS) SAV monitoring program (Figure 7), which uses multispectral aerial imagery to annually assess the distribution and abundance of SAV in areas including the Chesapeake Bay. Ground surveys provide supplementary information, including species data, though not all areas are ground surveyed. This data identifies trends, areas of decline and abundance, and informs implementation strategies for preservation.

SAV occurs in isolated areas near the action area but not within the footprint of the proposed action and will not be physically affected by construction; it is therefore not carried forward in the effects analysis for listed species.

Natural Oyster Bars (NOB)
Information on the locations of NOBs was obtained through coordination with MDNR (Figure 7). NOBs exist from approximately 457 m to 1,373 m (1,500 ft to 4,500 ft) off the Anne Arundel County shoreline towards the main channel, extending north and south of the Chesapeake Bay Bridge. NOBs exist from approximately 1,250 m to 1,890 m (4,100 ft to 6,200 ft) off the Queen Anne's County shoreline towards the main channel, extending north and south of the Chesapeake Bay Bridge. Of the total benthic habitat within the action area, approximately 124.8 acres consists of natural oyster bar, which may support benthic invertebrate prey utilized by sturgeon; this is accounted for within the *Effects on Listed Species* section.

Figure 7. Submerged Aquatic Vegetation and Natural Oyster Bars



5.6 Status of Listed Species in the Action Area

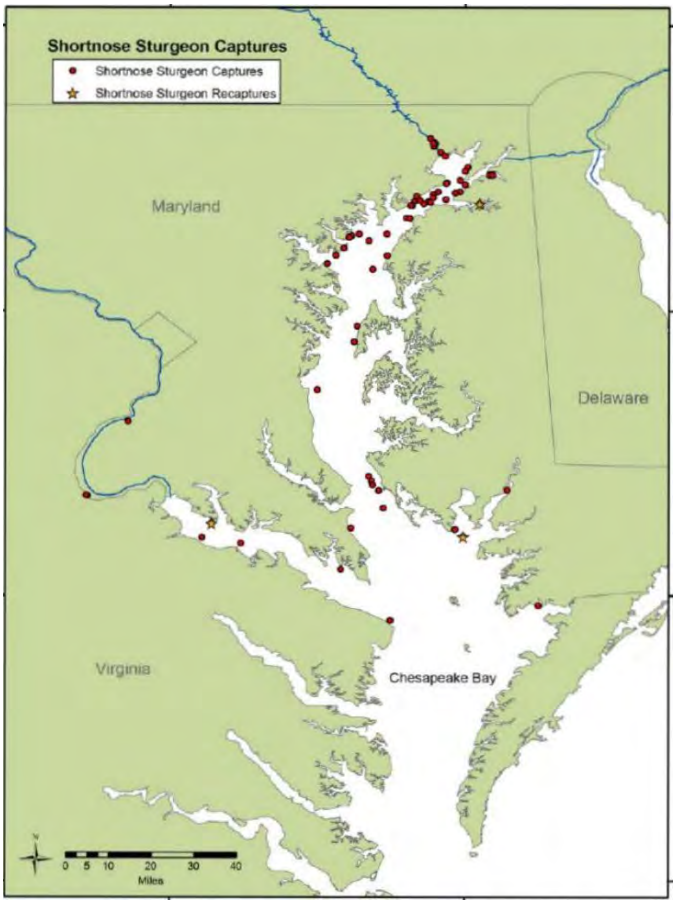
5.6.1 Shortnose Sturgeon

There is very little information about shortnose sturgeon in the mainstem of the Chesapeake Bay. Dadswell *et al.* 1984, reports 13 records of shortnose sturgeon captured in the upper Chesapeake Bay during the 1970s and 1980s. A reward program sponsored by the USFWS to compensate commercial fishermen who reported captures of Atlantic sturgeon in the Chesapeake Bay system (prior to the ESA listing of Atlantic sturgeon) reported a total of 82 shortnose sturgeon captures (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 8). The majority of captures of shortnose sturgeon were outside of the action area. USFWS conduced a sampling study with bottom-gillnetting at 19 sites in the upper Chesapeake Bay during 1998 and 2000 and no shortnose sturgeon were captured (Skjeveland *et al.* 2000, SSSRT 2010).

Kynard (2009) documented a study of shortnose sturgeon in the Potomac River. Targeted sampling for adults was carried out from 2004-2007 (2,932 net hours); one adult female was captured and tagged in 2005 and captured again in 2006 (twice) and 2007. A second adult female was captured by a commercial angler and tagged by the researchers. Despite both adults carrying eggs, successful spawning was not documented during the study. Kynard (2009) concludes that the females are either natal remnants or from a north-central population, likely the Delaware River. Genetic analysis indicates similarities to Delaware River shortnose sturgeon (T. King, unpubl. data cited in Kynard 2009). At this time, it remains unknown if the Potomac River supports a self-sustaining or spawning population of shortnose sturgeon; we also do not know if shortnose sturgeon from the Potomac River would be present in Chesapeake Bay, including within the action area.

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 km (0 to 3.5 mi) 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). Based on the currently available data, we expect that, shortnose sturgeon found in Chesapeake Bay are most likely migrants from the Delaware River. At this time, it is unknown if there are any tributaries to the Bay where successful spawning of shortnose sturgeon occurs and there are not any self-sustaining populations of shortnose sturgeon in the Bay watersheds.

Figure 8. Shortnose sturgeon captures in the sturgeon reward program from January 1996 through November 2008 (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). However, the amount of freshwater habitat below the Conowingo Dam in the Susquehanna River likely limits the potential for the river to support a spawning population of shortnose sturgeon. 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 (46.4 and 59°F), approximately mid-March to the beginning of May (SSSRT 2010); however, given that shortnose sturgeon typically remain within their natal river, it is unknown whether shortnose sturgeon would be

migrating from the mainstem Bay into any river for spawning. Regardless, shortnose sturgeon spawning does not occur within the action area due to the relatively high salinity levels present (5 to 18 parts per thousand).

Foraging

A study by Kynard (2009) suggests that habitat is present in the Chesapeake Bay to support all adult activities. There is no information available on habitat use for younger life stages in the Chesapeake Bay; salinity and DO are limiting factors for the presence of younger life stages and likely would limit distribution within the mainstem Bay, including the action area. Warming waters 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). Of these, there were two (2) shortnose sturgeon captures documented within or immediately adjacent to the action area for the Bay Crossing Project (SSSRT 2010). Niklitschek (2001) indicated via modeling that suitable habitat 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 migrating and foraging year-round (Balazik 2017).

Overwintering

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). Of the 28 shortnose sturgeon captures reported to the USFWS Sturgeon Reward Program during the winter months (typically defined as November through February), zero (0) occurred within the action area for the Chesapeake Bay Crossing Project (SSSRT 2010).

Based on a review of species-specific physiology, behavioral ecology, and regional telemetry data, we conclude that shortnose sturgeon are not overwintering within the action area. Shortnose sturgeon are physiological ectotherms that experience a severe reduction in osmoregulatory capacity at low water temperatures (<10°C (50°F)). To avoid lethal osmotic stress in mesohaline waters, the species exhibits strict winter fidelity to freshwater or oligohaline refugia. Furthermore, acoustic telemetry arrays operated within the mid-Chesapeake Bay consistently demonstrate that shortnose sturgeon completely vacate the mainstem corridor by late autumn to occupy sedentary overwintering aggregations in the upper Potomac River and the extreme upper reaches of the northern Bay. However, although the action area lacks the requisite freshwater chemistry and low-velocity benthic habitat features necessary to support

overwintering shortnose sturgeon, individual fish may occur within the action area between December and February.

Summary of Shortnose Sturgeon Presence
Based on best available data, although rare, adult shortnose sturgeon may be present within the action area year-round. While outside of the action area, 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 present anywhere in the Maryland portion of the Bay, including the action area year-round, including from November 1 to February 28.

The salinity in the Chesapeake Bay is highly variable, but within the mesohaline portion of the Bay ranges from 5-18 parts per thousand; therefore, early life stages are not present. Similarly, based on the salinity throughout the action area, spawning does not occur.

5.6.2 Atlantic Sturgeon

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 (Dunton *et al*. 2010, 2012, Erickson *et al*. 2011, Wirgin *et al*. 2015a, Kazyak *et al*. 2021a), typically from spring through late fall. Adults may enter the Bay in spring or late summer/early fall and depart after spawning; subadults are present year-round and juveniles may be present in areas with low salinity near their natal rivers (Dovel and Berggren 1983, Secor *et al.* 2002, Welsh *et al.* 2002, Horne and Stence 2016, Balazik 2023). Information on the use of the mainstem Chesapeake Bay is limited; however, based on information from other estuaries we expect sturgeon to be migrating and foraging 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).

Prior to the ESA listing in 2012, a Maryland reward tagging resulted in the reporting of 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). Since 2014, DNR and its research partners have tagged and released 41 mature adult Atlantic sturgeon in Marshyhope Creek, a major tributary of the Nanticoke River on Maryland's Eastern Shore. Based on repeated captures of ripe males and females with mature eggs, spawning in the Nanticoke watershed is considered highly likely. On November 21, 2025, during the MDNR's Atlantic sturgeon gillnetting survey, an adult female just under 7 feet 10 inches and weighing more than 200 pounds was caught and released - the largest female recorded in the survey's history.

Data collected from passive acoustic telemetry at the Chesapeake Bay Bridge North array (2021-2024) offers valuable insights into fish activity in the area that bridge construction and demolition activities may impact. The array data, compiled by NMFS from 12 collaborating

research institutions through the Atlantic Cooperative Telemetry Network (including the Smithsonian Environmental Research Center, Virginia Commonwealth University, USFWS, the University of Maryland Center for Environmental Science, the Virginia Institute of Marine Science, and state natural resource agencies in Maryland, Delaware, and Virginia, among others), recorded detections of 118 tagged individuals across 10 species, including striped bass, American eel, gizzard shad, cownose ray, and Atlantic sturgeon. Detections of tagged Atlantic sturgeon occurred mainly during the warmer months (May through July), with additional detections in October through December - a pattern consistent with the species' broader seasonal use of the Chesapeake Bay described above. On days when tagged Atlantic sturgeon were detected, individuals were within the vicinity of the bridge for approximately one to four hours, indicating that sturgeon move through the action area rather than remaining in the immediate vicinity of the bridge for extended periods. There were no detections of tagged shortnose by this array during the 2021–2024 period.

Spawning

Given salinities, spawning does not occur in the action area. A number of tributaries to the Chesapeake Bay support spawning populations of Atlantic sturgeon; however, all of them are located south of the action area. Historical research suggests that spawning once occurred in many of the Bay's rivers and tributaries. A review of current spawning habitat availability in the Chesapeake Bay and its tributaries indicates 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.

Although salinity levels in some areas of Chesapeake Bay may support juveniles, juvenile Atlantic sturgeon are more likely to adapt to higher salinity levels closer to their natal rivers, which are outside of the action area. Subadult and adult Atlantic sturgeon are more likely to occur in the action area 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 use the action area for migration and foraging as subadults and adults.

Summary of Atlantic Sturgeon Presence

Adult Atlantic sturgeon enter the Chesapeake Bay from the Atlantic Ocean in the spring and fall as they migrate to spawning grounds in their natal river; following spawning, they return to the ocean, therefore, they 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); as such, we expect transient adult Atlantic sturgeon could be present in the action area from late March through early December. 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 and 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 do not expect juvenile Atlantic sturgeon to be present in the action area because they become tolerant to saline water in their natal rivers, which are closer to the mouth of the Bay (Horne and Stence 2016). Early life stages are not present in the action area and, similarly, based on the salinity throughout the action area, spawning is not expected to occur.

6 EFECTS OF THE ACTION

This section of a Biological Opinion assesses the effects of the proposed action on threatened or endangered species or critical habitat. The "effects of the action" are defined at 50 CFR § 402.02 (2018) as “the direct and indirect effects of an action on the species or critical habitat, together with the effects of other activities that are interrelated or interdependent with that action, that will be added to the environmental baseline…. Indirect effects are those that are caused by the proposed action and are later in time, but still are reasonably certain to occur. Interrelated actions are those that are part of a larger action and depend on the larger action for their justification. Interdependent actions are those that have no independent utility apart from the action under consideration.” In this section of the Opinion, we address the effects of the proposed action on Atlantic and shortnose sturgeon. We consider these effects on the species within the context of the species status now and projected over the course of the action.

Approach to the Assessment

The bridge replacement is currently in the preliminary engineering phase; as such, final construction means and methods have not been determined. Accordingly, this effects analysis is based on the description in the BA, which incorporates all construction activities that are currently anticipated. As described in the BA and DEIS, these plans are based on the design and engineering carried out to date, inclusive of consideration of the best available information from similar regional bridge construction and demolition projects, including the Francis Scott Key Bridge Rebuild, the Tappan Zee Bridge Replacement, and the Nice-Middleton Bridge Replacement. As the design progresses through final engineering and permitting, stressor characterizations and the associated effects determinations will be re-evaluated in coordination with us and consultation will be reinitiated if necessary.

Effects are assessed for each principal stressor category identified from the construction and demolition program: pile driving; dredging; turbidity and habitat modification; increased vessel traffic; and blasting associated with demolition of the existing eastbound and westbound bridge spans. For each stressor, the analysis characterizes: (1) the nature and magnitude of the stressor; (2) the spatial and temporal extent of exposure; (3) the life stages and behaviors of listed species most likely present during the relevant construction windows; and (4) the likely individual- and

population-level consequences, including potential for injury, mortality, behavioral disruption, and habitat loss.

As described in the BA, the NMFS Multi-Species Pile Driving Calculator was used to predict distances to identified acoustic thresholds. Proxy sounds levels were used, consistent with the instructions provided with the calculator and when a proxy was not available for a specific pile type, the next nearest largest pile type was used. Calculations assumed 10 dB attenuation[15] for the use of bubble curtains, and considered the installation of up to 16 piles per day, 2,500 strikes per pile (impact), and 30 minutes of vibratory driving for piles installed with a vibratory hammer. Established formulas (Hempen *et al.* (2005, 2007)) were used to predict effects from blasting. The information incorporated into the BA and our resulting effects determinations reflect the full range of reasonably likely outcomes across all assumed construction scenarios.

The effects analysis is organized by stressor rather than by species, to enable a clear accounting of each construction activity's contribution to total exposure. A species-level synthesis and effects determination table are provided at the end of this section.

All avoidance and minimization measures that the MDTA has committed to implementing, and FHWA has incorporated into the proposed action, are considered in the effects analysis as part of the proposed action. As explained above, measures that are under consideration but not yet committed to (as described in the BA) are not incorporated into the action or the effects analysis.

Anticipated Stressors

Construction and demolition of the Bridge will introduce the following categories of stressors to the action area over an approximately 15-year construction period.

Underwater Noise from Pile Driving. Construction of two new bridge spans will require installation of a substantial number of driven piles, including 96-inch, 48-inch, and 36-inch steel pipe piles, 36-inch pre-stressed square concrete piles, 14-inch steel H-piles, and AZ sheet piles for pier protection dolphins. Pile driving generates impulsive underwater noise that propagates through the water column and substrate. Exposure at or above threshold levels can cause injury - including barotrauma and swim bladder rupture - and behavioral disturbance, including avoidance of the ensonified area and disruption of migration and foraging. Up to four pile driving rigs may operate concurrently, with production pile driving anticipated for approximately 120 days during construction years 1–5 (eastbound bridge) and 138 days during years 7–13 (westbound bridge). Tables 15 and 16 present estimated distances to sturgeon injury and behavioral thresholds under the full range of assumed pile types and hammer configurations.

Dredging. Both the western and eastern shorelines of the Chesapeake Bay require dredging to create access channels sufficient to support construction and demolition equipment and material

[15] Based on monitored attenuation of 15–20 dB for a contained bubble curtain system on comparable pile types at the Nice-Middleton Bridge Replacement, verified via on/off testing per NMFS guidance (AECOM/SCM 2022). The 10 dB value applied here is conservative relative to this result and consistent with the published range for bubble curtain performance (Molnar *et al*. 2020; WSDOT 2020). Attenuation will be confirmed via test pile prior to production driving.

barges. Mechanical (bucket) dredging is assumed, targeting a depth of 2.7 m (9 ft) below mean lower low water (MLLW) across a total footprint of approximately 50.2 acres (approximately 236,095 cubic meters (308,800 cubic yards)). Dredging activities introduce the potential for physical disturbance of the substrate, entrainment or impingement of benthic-associated species, and localized turbidity. The estimated dredging duration is 14 days for the eastbound bridge (construction years 1–2) and 7 days for the westbound bridge (construction years 7–8).

Turbidity and Habitat Modification. Pile driving, dredging, vessels, and demolition debris will generate suspended sediments in the water column and result in temporary and permanent alteration of substrate conditions across approximately 134.8 acres of tidal water bottom within the action area. Permanent fill associated with new pier footprints, pier protection systems, and approach roadway widening will eliminate a portion of existing soft-bottom benthic foraging habitat used by both sturgeon species. Sediment and turbidity impacts are expected within 91.4 m (300 ft) of pile driving locations and up to 609.6 m (2,000 ft) from dredging locations.

Increased Vessel Traffic. Construction and demolition operations will increase vessel traffic within the action area including transit routes between the project site and the Baltimore Harbor area, a one-way distance of approximately 30.6 km (19 mi). Project-related vessels - including heavy lift barges, material transport barges, trestle work vessels, and support craft.

Blasting. Demolition of the existing bridge spans will require subaqueous explosive demolition of deep-water piers located in water depths exceeding 12.2 m (40 ft). There are 15 deep-water piers in the existing eastbound span and 15 in the existing westbound span subject to this stressor. Blasting is anticipated during 18 events over construction years 6–7 (eastbound demolition) and 16 events over construction years 14–15 (westbound demolition). Explosive demolition generates intense instantaneous pressure waves with demonstrated potential to cause swim bladder rupture, hemorrhage, and mortality in fish at close range, and unknown but potentially lethal or injurious effects in sea turtles. Blast events will be subject to a time-of-year restriction (TOYR) limiting subaqueous blasting to October 1 through December 15. The Mortality Zone and Exclusion Zone for each span were calculated using the Hempen *et al*. (2007) confined-shot formula (MRC) and the Hempen *et al*. (2005) Exclusion Zone formula, respectively, using a maximum charge weight of 30 pounds per delay - consistent with the Nice Bridge precedent blast design. The resulting adjusted Mortality Zone radius is 65.5 m (215 ft) per eastbound pier and 67 m (220 ft) per westbound pier; the Exclusion Zone radius is 640 m (2,100 ft) around each pier.

Geotechnical Investigation. The BA identifies geotechnical investigations as one of several temporary activities contributing to the project's combined 134.8-acre estimate of tidal water bottom impact. The BA does not specify the number or location of borings, the sampling method (e.g., rotary wash boring, Standard Penetration Test sampling, or vibracore sampling), the vessel platform (e.g., jack-up barge or anchored barge), or the duration of the investigation program; these details are expected to be developed during final design. For purposes of this analysis, we assume geotechnical investigations will be conducted using methods standard for bridge foundation design in tidal waters - individual, discrete borings advanced from a barge or

jack-up platform, each requiring on the order of hours rather than days to complete, with any temporary casing removed and the borehole grouted or backfilled on completion.

Temporary Moorings. The BA indicates that staging areas may include temporary mooring locations within the action area, used to stabilize barges and support vessels, and that moorings would be installed as temporary mooring piles or mooring ball anchors. FHWA and MDTA have committed to avoiding placement of moorings in areas of oyster beds or submerged aquatic vegetation (SAV), and to avoid mooring vessels in SAV or in a manner that could shade SAV. The specific number and location of moorings will be determined during final design and coordinated with NMFS.

6.1 Pile Driving

In this section, we provide background information on underwater noise and how it affects listed sturgeon, establish the underwater noise that listed species are likely to be exposed to, and then establish the expected response of the individuals exposed to that noise. This section contains a brief technical background on sound, the characteristics of certain sound types, and metrics used in this consultation that are relevant to the specified activity and to consideration of the potential effects of the specified activity on listed species found later in this document.

The Bay Crossing Project includes the following number and types of piles to be installed using vibratory hammering to the maximum extent possible (i.e., if sediments are soft enough for vibratory hammering) and impact hammering with a soft start:

Table 15. Pile size and number for the Eastbound Bridge

Pile Type and Size (EB)	**Total Piles**
Bridge Piers	**1,741**
36” Pre-stressed Square Piles	132
36” Steel Pipe Piles	240
48” Steel Pipe Piles	1,231
96” Steel Pipe Piles	138
Trestle Piers	
36” Steel Pipe Piles	**628**
Pier Protection	**5,144**
48” Steel Pipe Piles for fenders	40
19.6” Sheet Piles (For Dolphins)	2,552**
14” Steel H-Piles (For Dolphins)	2,552**

Table 16. Pile size and number for the Westbound Bridge

Pile Type and Size (WB)	**Total Piles**
Bridge Piers	**2,014**
36” Pre-stressed Square Piles	203

Pile Type and Size (WB)	Total Piles
36” Steel Pipe Piles	243
48” Steel Pipe Piles	1,412
96" Steel Pipe Piles	156
Trestle Piers	
36” Steel Pipe Piles	**628**
Pier Protection	**5,144**
48” Steel Pipe Piles for fenders	40
19.6” Sheet Piles (For Dolphins)	2,552**
14” Steel H-Piles (For Dolphins)	2,552**

6.1.1 Basic Background on Acoustics and Fish Bioacoustics

This section contains technical background on sound, the characteristics of certain sound types, and metrics used in this consultation when the information is relevant to the specified activity and to consideration of the potential effects of the specified activity on listed species found later in this document.

Sound travels in waves, the basic components of which are frequency, wavelength, velocity, and amplitude. Frequency is the number of pressure waves that pass by a reference point per unit of time and is measured in hertz (Hz) or cycles per second. Wavelength is the distance between two peaks or corresponding points of a sound wave (length of one cycle). Higher frequency sounds have shorter wavelengths than lower frequency sounds, and typically attenuate (decrease) more rapidly, except in certain cases in shallower water. Amplitude is the height of the sound pressure wave or the “loudness” of a sound and is typically described using the relative unit of the decibel (dB). A sound pressure level (SPL) in dB is described as the ratio between a measured pressure and a reference pressure (for underwater sound, this is 1 microPascal (µPa)), and is a logarithmic unit that accounts for large variations in amplitude; therefore, a relatively small change in dB corresponds to large changes in sound pressure. The source level (SL) typically represents the SPL referenced at a distance of 1 m from the source, while the received level is the SPL at the listener’s position (referenced to 1 µPa).

Root mean square (rms) is the quadratic mean sound pressure over the duration of an impulse. Root mean square is calculated by squaring all of the sound amplitudes, averaging the squares, and then taking the square root of the average (Urick 1983). Root mean square accounts for both positive and negative values; squaring the pressures makes all values positive so that they may be accounted for in the summation of pressure levels (Hastings and Popper 2005). This measurement is often used in the context of discussing behavioral effects, in part because behavioral effects, which often result from auditory cues, may be better expressed through averaged units than by peak pressures.

Sound exposure level (SEL; represented as dB re 1 µPa2-s) represents the total energy in a stated frequency band over a stated time interval or event, and considers both intensity and duration of exposure. The per-pulse SEL is calculated over the time window containing the entire pulse (i.e., 100 percent of the acoustic energy). SEL is a cumulative metric; it accumulates

over a single pulse, or calculated over periods containing multiple pulses. Cumulative SEL represents the total energy accumulated by a receiver over a defined time window or during an event. Peak sound pressure (also referred to as zero-to-peak sound pressure or 0-pk) is the maximum instantaneous sound pressure measurable in the water at a specified distance from the source, and is represented in the same units as the rms sound pressure.

When underwater objects vibrate or activity occurs, sound-pressure waves are created. These waves alternately compress and decompress the water as the sound wave travels. Underwater sound waves radiate in a manner similar to ripples on the surface of a pond and may be either directed in a beam(s)or may radiate in all directions (omnidirectional sources), as is the case for sound produced by the pile driving activity considered here. The compressions and decompressions associated with sound waves are detected as changes in pressure by aquatic life and man-made sound receptors such as hydrophones.

Even in the absence of sound from the specified activity, the underwater environment is typically loud due to ambient sound, which is defined as environmental background sound levels lacking a single source or point (Richardson *et al*. 1995). The sound level of a region is defined by the total acoustical energy being generated by known and unknown sources. These sources may include physical (e.g., wind and waves, earthquakes, ice, atmospheric sound), biological (e.g., sounds produced by marine mammals, fish, and invertebrates), and anthropogenic (e.g., vessels, dredging, construction) sound. A number of sources contribute to ambient sound, including wind and waves, which are a main source of naturally occurring ambient sound for frequencies between 200 hertz (Hz) and 50 kilohertz (kHz) (Mitson 1995). In general, ambient sound levels tend to increase with increasing wind speed and wave height. Precipitation can become an important component of total sound at frequencies above 500 Hz, and possibly down to 100 Hz during quiet times. Marine mammals can contribute significantly to ambient sound levels, as can some fish and snapping shrimp. The frequency band for biological contributions is from approximately 12 Hz to over 100 kHz. Sources of ambient sound related to human activity include transportation (surface vessels), dredging and construction, oil and gas drilling and production, geophysical surveys, sonar, and explosions. Vessel noise typically dominates the total ambient sound for frequencies between 20 and 300 Hz. In general, the frequencies of anthropogenic sounds are below 1 kHz and, if higher frequency sound levels are created, they attenuate rapidly.

The sum of the various natural and anthropogenic sound sources that comprise ambient sound at any given location and time depends not only on the source levels (as determined by current weather conditions and levels of biological and human activity) but also on the ability of sound to propagate through the environment. In turn, sound propagation is dependent on the spatially and temporally varying properties of the water column and sea floor and is frequency-dependent. As a result of the dependence on varying factors, ambient sound levels can be expected to vary widely over both coarse and fine spatial and temporal scales. Sound levels at a given frequency and location can vary by 10-20 dB from day to day (Richardson *et al*. 1995). The result is that, depending on the source type and its intensity, sound from the specified activity may be a negligible addition to the local environment or could form a distinctive signal that may affect a

particular species. The Bay Crossing action area lies within a dynamic ambient noise environment, with natural background noise contributed by natural wind and wave action and a diverse community of vocalizing organisms. Anthropogenic noise sources, including commercial shipping traffic in high-use shipping lanes, also contribute to ambient sound.

In general, sounds fall into one of two types: pulsed and non-pulsed. The distinction between these two sound types is important because they have differing potential to cause physical effects, particularly regarding hearing (e.g., Ward 1997 in Southall *et al*. 2007). Non-impulsive sounds can be tonal, narrowband, or broadband, brief or prolonged, and may be either continuous or intermittent (ANSI 1995, NIOSH 1998).

Pulsed sound sources (e.g., impact pile driving) produce signals that are brief (typically considered to be less than one second), broadband, atonal transients (ANSI 1986, 2005, Harris 1998, NIOSH 1998, ISO 2003) and occur either as isolated events or repeated in some succession. Pulsed sounds are all characterized by a relatively rapid rise from ambient pressure to a maximal pressure value followed by a rapid decay period that may include a period of diminishing, oscillating maximal and minimal pressures, and generally have an increased capacity to induce physical injury as compared with sounds that lack these features.

Non-pulsed sounds can be tonal, narrowband, or broadband, brief or prolonged, and may be either continuous or intermittent (ANSI 1995, NIOSH 1998). Some of these non-pulsed sounds can be transient signals of short duration but without the essential properties of pulses (e.g., rapid rise time). Examples of non-pulsed sounds include those produced by vessels, aircraft, drilling or dredging, and vibratory pile driving.

Specific to pile driving, the impulsive sound generated by impact hammers is characterized by rapid rise times and high peak levels. Vibratory hammers produce non-impulsive, continuous noise at levels significantly lower than those produced by impact hammers. Rise time is slower, reducing the probability and severity of injury, and sound energy distributes over a greater amount of time (e.g., Nedwell and Edwards 2002, Carlson *et al*. 2005).

The hearing range for most fish ranges from a low of 20 Hz to 1,000 Hz. Most fish in the action area fit into this hearing range, although catfish may hear up to about 3,000 or 4,000 Hz and some of the herring-like fishes can hear sounds to about 4,000 Hz, while a few, and specifically the American shad, can hear to over 100,000 Hz (Bass and Ladich 2008, Popper *et al*. 2003, Popper and Schilt 2008).

An acoustic field from any source consists of a propagating pressure wave, generated from particle motions in the medium that causes compression and rarefaction. This sound wave consists of both pressure and particle motion components that propagate from the source. All fishes have sensory systems to detect the particle motion component of a sound field, while fishes with a swim bladder (a chamber of air in the abdominal cavity) may also be able to detect the pressure component. Pressure detection is primarily found in fishes where the swim bladder (or other air chamber) lies very close to the ear, whereas fishes in which there is no air chamber near the ear primarily detect particle motion (Popper *et al*., 2003). Sturgeon have swim bladders,

but they are not located very close to the ear; thus, sturgeon are assumed to detect primarily particle motion rather than pressure.

The level of a sound in water can be expressed in several different ways, but always in terms of dB relative to 1 micro-Pascal (μPa). Decibels are a logarithmic scale; each 10 dB increase is a tenfold increase in sound pressure. Accordingly, a 10 dB increase is a factor of 10 increase in sound pressure, and a 20 dB increase is a 100-fold increase in sound pressure.

The following are commonly used measures of sound:

- Peak sound pressure level (SPL): the maximum sound pressure level (highest level of sound) in a signal measured in dB re 1 μPa.
- Sound exposure level (SEL): the integral of the squared sound pressure over the duration of the pulse (e.g., a full pile driving strike.) SEL is the integration over time of the square of the acoustic pressure in the signal and is thus an indication of the total acoustic energy received by an organism from a particular source (such as pile strikes). Measured in dB re1μPa2-s.
- Single Strike SEL (ssSEL): the amount of energy in one strike of a pile.
- Cumulative SEL (cSEL): the energy accumulated over multiple strikes. cSEL indicates the full energy to which an animal is exposed during any kind of signal. The rapidity with which the cSEL accumulates depends on the level of the single strike SEL. The actual level of accumulated energy (cSEL) is the logarithmic sum of the total number of single strike SELs. Thus, cSEL (dB) = Single-strike SEL + 10log10(N); where N is the number of strikes.
- Root Mean Square (RMS): the average level of a sound signal over a specific period of time.

6.1.2 Approach to Assessing the Potential for Physiological Effects

There is limited data from other projects to demonstrate the circumstances under which immediate mortality of fish from exposure to pile driving is likely to occur: mortality appears to occur when fish are close (within 0.9 m to 9.1 m (3 ft to 30 ft)) to driving of relatively large diameter piles. Studies conducted by the California Department of Transportation (Caltrans) showed some mortality for several different species of wild fish exposed to the driving of steel pipe piles 2.4 m (8 ft) in diameter, whereas Ruggerone *et al*. (2008) found no mortality to caged yearling coho salmon (*Oncorhynchus kisutch*) placed as close as 0.6 m (2 ft) from a 0.5 m (1.5 ft) diameter pile and exposed to over 1,600 strikes. As noted above, the data indicates that species have different tolerances to noise and may exhibit different responses to the same noise source.

Potential physiological effects are highly diverse. Sound exposure that may result in mortality-inducing physiological effects could in one species result in physiological effects that would have no effect on fish survival in another. Potential effects range from very small ruptures of capillaries in fins (which are not likely to have any consequences on survival) to severe

hemorrhaging of major organ systems such as the liver, kidney, or brain (Stephenson *et al*., 2010). Other potential effects include rupture of the swim bladder (the bubble of air in the abdominal cavity of most fish species that is involved in maintenance of buoyancy). See (Halvorsen *et al*., 2011) for a review of potential injuries from pile driving.

Effects on body tissues may result from barotrauma or result from rapid oscillations of air bubbles. Barotrauma occurs when there is a rapid change in pressure that directly affects the body gasses. Gas in the swim bladder, blood, and tissue of fish can experience a change in state, expand and contract during rapid pressure changes, which can lead to tissue damage and organ failure (Stephenson *et al*., 2010).

Related to this are changes that result from very rapid and substantial excursions (oscillations) of the walls of air-filled chambers, such as the swim bladder, striking nearby structures. Under normal circumstances the walls of the swim bladder do not move very far during changes in depth or when exposed to normal sounds. However, very intense noise, and particularly those with very sharp onset (also called "rise time") will cause the swim bladder walls to move a much greater distance and thereby strike nearby tissues such as the kidney or liver. Rapid and frequent striking (as can occur during one or more sound exposures) may result in bruising, and ultimately in damage, to the nearby tissues.

The Fisheries Hydroacoustic Working Group (FHWG) was formed in 2004 and consists of biologists from NMFS, USFWS, FHWA California Department of Fish and Game, USACE, 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 NMFS, USFWS, FHWA, and the state agencies signed an MOA documenting criteria for assessing physiological effects of pile driving on fish (Molnar *et al*., 2020). The criteria were developed for the acoustic levels at which physiological effects to fish could be expected. It should be noted that these are the onset of physiological effects (Molnar *et al.*, 2020), and not levels at which fish are necessarily mortally damaged. These criteria were developed to apply to all fish species, including listed green sturgeon, which are biologically similar to Atlantic sturgeon and for these purposes can be considered a surrogate. The interim criteria are:

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

The FHWG developed the interim criteria because resource agencies needed immediate thresholds to guide the evaluation of the effects of pile driving in order to ensure protection of threatened and endangered fish. However, at the time when the FHWG developed the interim criteria, the FHWG recognized that more data and research was necessary to further consider and refine the thresholds. Studies of noise effects on fish do demonstrate that individual species possess different "tolerances" to varying noise sources and that for some species and in unique situations, fish can be exposed to noise levels greater than the FHWG criteria and exhibit little or no negative effects. For instance, recent research summarized in Popper *et al*. (2014) suggests that $SEL_{CUMULATIVE}$ thresholds for injury may be well above 200 dB. Molnar *et al*. (2020) noted

that "during the time that has passed since the interim injury thresholds were first established in 2008, there has not been a single documented (in the field or lab studies) instance of even minor injury to fish that have been exposed to sound pressure levels in excess of the $SEL_{CUMULATIVE}$ threshold." However, for different reasons, the FHWG discussions related to modifications of the interim thresholds, though warranted, have not proceeded and the 2008 criteria remain in place. Given this, we currently consider the FHWG criteria to represent the best available information on the thresholds at which physiological effects to sturgeon are likely to occur. Thus, for the purposes of this Opinion, we consider the potential for physiological effects upon exposure to 206dB re 1 µPa peak and 187 dB re 1 μPa^2-s cSEL. It is important to note that physiological effects may range from minor injuries that individuals are anticipated to completely recover from with no impact to overall 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 to the source and the greater the duration of the exposure, the higher likelihood of significant injury.

6.1.3 Approach to Assessing the Potential for Behavioral Effects

Empirical studies on the hearing of fishes, amphibians, birds, and mammals (including humans), in general, show that behavioral responses vary substantially. Even within a single species, depending on a wide range of factors (e.g., the motivation of an animal at a particular time, the nature of other activities that the animal is engaged in when it detects a new stimulus, the hearing capabilities of an animal or species) responses demonstrate variability (Brumm & Slabbekoorn, 2005). Thus, it may be difficult to assign a single criterion above which behavioral responses to noise would occur.

For purposes of assessing behavioral effects of pile driving on ESA listed fish, NMFS uses a 150dB re 1 µPa RMS SPL criterion[16]. Based on the best available information, for the purposes of this consultation, we will use 150 dB re 1 µPa RMS as an indicator of the noise level at which there is the potential for behavioral consequences. That is not to say that exposure to noise levels of 150 dB re 1 µPa RMS will always result in behavioral modifications or that any behavioral modifications will rise to the level of take (e.g., harassment) but that there is the potential, upon exposure to noise at this level, to experience some behavioral response. Behavioral responses could range from a temporary startle to avoidance of an ensonified area.

As hearing generalists, sturgeon rely primarily on particle motion to detect sounds (Lovell *et al.*, 2005), which does not propagate as far from the sound source as pressure. However, a clear threshold for particle motion was not provided in the Lovell study. In addition, flanking[17] of the sounds through the substrate may result in higher levels of particle motion at greater distances than would be expected from the non-flanking sounds. Unfortunately, data on particle motion from pile driving is not available at this time, and we must rely on sound pressure level criteria.

[16] https://www.fisheries.noaa.gov/s3/2025-09/ESA-AllSpeciesThresholdSummary-2025-508-OPR1-9.16.25-.pdf ; last accessed June 29, 2026

17 Flanking sound (or flanking noise) is sound that transmits between spaces indirectly, going over or around, rather than directly through the main separating element.

Although we agree that more research is needed, the studies noted above support the 150 dB re 1 μPa RMS criterion as an indication for when behavioral effects could be expected. With the exception of studies carried out during the Tappan Zee Pile Installation Demonstration Project in the Hudson River, NY, (Krebs *et al*., 2012, 2016), we are not aware of any studies that have considered the behavior of shortnose or Atlantic sturgeon in response to peak pile driving noise levels. Given this and the available information from studies on other fish species, we consider 150 dB re 1 μPa RMS to be a reasonable estimate of the noise level at which exposure may result in behavioral modifications.

6.1.4 Exposure of Sturgeon to Increased Underwater Pile Driving Noise

As described in the BA, FHWA and MDTA used the acoustic tool developed by our Office of Protected Resources (Multi-Species Pile Driving Calculator) that applies noise results from installation of proxy piles (i.e., piles that are most like the pile and conditions of the proposed action) to estimate the ensonified area for piles of different types and sizes, driven with different hammers, and with different attenuations[18]. This tool uses representative data from installation of similar pile types; many of the examples rely on data compiled for the California Department of Transportation from tests conducted by others under similar conditions (Molnar *et al.*, 2020).

The calculator incorporates a Practical Spreading Loss Model (PSLM) which requires an estimate of the number of strikes needed to install a pile (or the number of seconds with a vibratory hammer). For this Opinion, we use the Multi-Species Pile Driving Calculator and its use of the PSLM to estimate intensity and spatial extent of sound levels to analyze the effects of the proposed pile driving, in consideration of the thresholds identified above (summarized in the Tables below).

NMFS typically recommends using a default attenuation of 5 dB during impact pile driving with bubble curtains. However, in the BA FHWA indicates that for this project, calculations were completed with attenuation levels set at 10 dB for most pile types, based on the 15-20 dB of attenuation attained with pile driving associated with the Nice-Middleton Bridge Project. The calculations for the dolphin pier protection installation were completed with attenuation levels set at 5 dB based on the assumption that the bubble curtain would be less protective in this scenario. Studies indicate sound attenuation from unconfined bubble curtains can range from 5 to 10 dB in shallow waters (Molnar *et al*., 2020; WSDOT, 2020), and confined bubble curtains can reduce sound by 10 to 15 dB (Molnar *et al*., 2020). It is not uncommon to observe a 10 dB reduction in pile driving noise or more when bubble curtains are effectively deployed. Higher levels of sound attenuation can be achieved with confined air bubble curtains under low current situations. Based on our review of the available information, we agree that the approach to incorporating attenuation into the calculations presented in the BA is reasonable.

[18] The spreadsheet is available at https://www.fisheries.noaa.gov/national/marine-mammal-protection/marine-mammal-acoustic-technical-guidance

Table 17 and Table 18 provide the project's piling specifications and the estimated sound levels of those piles from proxy projects. Input data (source levels) for all pile types, sizes, and hammer types were not available in the pile driving calculator, and in these cases the next largest size pile was used as a proxy. For example, data were not available for 48-inch steel pipe piles for impact hammering so the next size steel pipe pile (60-inch) was used. Data for 48-inch steel pipe piles were also not available for vibratory hammering and proxy data for the next available size larger (72-inch) were used. No data were available for vibratory hammering of any size of concrete piles, and thus only impact hammering estimates are provided. In all of these cases we recognize that the estimated distances to the identified thresholds are likely larger than what will be experienced; however, they are the best, reasonable, estimates that are possible given the available information.

Table 17 provides metrics associated with the various pile types and installation methods and Table 18 provide estimated distances from the project piles to the identified injury and behavioral effect thresholds as determined from the Multi-Species Pile Driving Calculator.

Table 17. Proxy levels for underwater noise.

Type of Pile**	**Hammer Type**	**Proxy Type Used**	**Estimated Peak Noise Level (dB_{Peak})**	**Estimated Single Strike Sound Exposure Level (dB_{SELss})**	**Estimated Pressure Level (dB_{RMS})**
36" Square Concrete	Impact	30" Square (Type II)	200	166	176
36" Steel Pipe	Impact	36" Steel Pipe	210	183	193
	Vibratory	36" Steel Pipe	N/A	N/A	175
48" Steel Pipe	Impact	48" Steel Pipe	213	179	192
48" Steel Pipe (60" Steel Pipe Proxy)*	Impact	60" Steel Pipe	210	185	195
48" Steel Pipe (72" Steel Pipe Proxy)	Vibratory	72" Steel Pipe	N/A	N/A	180
	Impact	96" Steel Pipe	220	195	205

Type of Pile**	Hammer Type	Proxy Type Used	Estimated Peak Noise Level (dB_{Peak})	Estimated Single Strike Sound Exposure Level (dB_{SELss})	Estimated Pressure Level (dB_{RMS})
96” Steel Pipe	Vibratory	72” Steel Pipe	N/A	N/A	180
14” H-Pile	Impact	14” Steel H-Pile	208	177	187
	Vibratory	14” Steel H-Pile	N/A	N/A	150
AZ Sheet Pile	Impact	24” AZ Sheet Pile	205	180	190
	Vibratory	AZ Steel Sheet – Loudest	N/A	N/A	165

Table 18. Estimated distances to sturgeon injury and behavioral disturbance thresholds

Type of Pile	Hammer Type	Distance (ft) to 206 dB_{Peak}	Distance (ft) to Behavioral Disturbance Threshold (150 dB_{RMS})
36” Square Concrete	Impact	2.8	382.5
36” Steel Pipe	Impact	13.1	5,199.8
	Vibratory	N/A	328.1
48” Steel Pipe	Impact	20.7	4,459.8
	Vibratory	N/A	706.8**
48” Steel Pipe (60” Steel Pipe Proxy)*	Impact	13.1	7,068.4
	Vibratory	N/A	706.8**
96” Steel Pipe	Impact	60.6	32,808.4
	Vibratory	N/A	706.8**

Type of Pile	Hammer Type	Distance (ft) to 206 dB_{Peak}	Distance (ft) to Behavioral Disturbance Threshold (150 dB_{RMS})
14" H-Pile	Impact	20.7	4,459.8
	Vibratory	N/A	15.2
AZ Sheet Pile	Impact	13.1	7,068.4
	Vibratory	N/A	152.3

As outlined above, in order to be exposed to pile driving noise that could result in injury due to a single strike (i.e., the peak threshold), a sturgeon would need to be within 0.85 to 18.5 m (2.8 to 60.6 ft) of the pile being installed. The cSEL threshold accounts for multiple exposures. The cSEL is a measure of the accumulated energy over a specific period of time (e.g., the period of time it takes to install all piles in a given period, in this case 12 hours), rather than an instantaneous maximum noise threshold (Buehler *et al.* 2015). The greater the distance between the fish and the pile being driven, the greater the number of strikes it must be exposed to in order to be injurious. The threshold distance from the pile indicates that the fish is far enough away that, regardless of the number of strikes it is exposed to, the energy accumulated is not sufficient to cause injury. A fish located outside of this isopleth is considered to have no risk of auditory injury, regardless of the number of pile strikes. Considering the cumulative threshold, a sturgeon would need to remain within 82.4 to 7,068.4 m (270 to 23,190 ft) of the noise source for the duration of all pile driving during the 12-hour period that pile driving was conducted in a given day. Note that injury is not an expected outcome of exposure of sturgeon to vibratory pile driving noise, regardless of pile size.

6.1.5 Response of Sturgeon to Pile Driving Noise

Based on the best available information, as outlined herein, it is reasonable to assume that sturgeon, on hearing pile driving, will either not approach the source or will move to avoid it. Rare and transient sturgeon in the area are expected to leave the area when pile driving begins facilitated by the use of a "soft start" or system of "warning strikes" where the pile driving begins with an initial set of three single strikes by the hammer at 40 percent of its maximum energy. These "warning strikes" cause fish to leave the area before the pile driving begins at full energy.

Studies on sturgeon behavior towards noise from pile driving in relation to the construction of the Tappen Zee Bridge over Hudson River found that sturgeon avoid or move out of the ensonified area (NMFS, 2017b). Thus, we expect the sturgeon to avoid an ensonified area upon exposure to underwater noise levels of 150 dB RMS, if fish do not completely leave after the

warning strikes. Noise above the threshold where behavioral modification (avoidance) is expected at distances ranging from 4.6 to 10,000 m (15.2 to 32,808.4 ft) from the piles being driven, depending on pile type, size, and installation method.

Given the use of soft start, we do not expect any sturgeon to be exposed to noise above the peak injury threshold. Here, we explain why we also do not expect any sturgeon to be exposed to noise above the cumulative injury threshold.

As explained above, we expect that sturgeon will react to detection of noise above the 150 dB threshold by swimming away from the noise source. We expect that this response will result in sturgeon swimming away from the pile prior to accumulating enough energy to experience injury.

We have considered whether a sturgeon is likely to be able to swim far enough away from the pile being installed in time to avoid exposure to the full duration of pile installation. The furthest distances required for a sturgeon to swim are for the 96-inch steel pipe piles. A study by D. Deslauriers and James D. Kieffer (2012) measured sustained swimming speed (swimming against a current for 200 minutes) for young-of-the-year shortnose sturgeon at 18 cm/s (0.18 m/s). Further, shortnose sturgeon young-of-the-year could sustain swimming at velocities of 0.35 m/s for up to 30 to 50 minutes depending on water temperature (D. Deslauriers & J. D. Kieffer, 2012). We estimate that shortnose and Atlantic sturgeon have a prolonged swim speed of at least 35 cm/s (1.1 feet per second (fps)) and an escape or burst speed of at least 45 cm/s (1.4 fps). We also estimate that sturgeon could sustain their prolonged swim speed for up to 200 minutes without muscle fatigue (Webb 1986). Based on the estimated prolonged swim speed, a sturgeon could be expected to exit the maximum SEL_{cum} ensonified area (2,154 m (7,068.4 ft) from the pile driving location) within approximately 6,426 seconds, or 107 minutes, and would not reach or exceed the duration at which muscle fatigue would be expected. Based on this, we expect that any sturgeon in the action area would be able to move away from the sound source with sufficient time to avoid exposure to injurious levels of noise as the cumulative threshold calculations considered installation of multiple piles in a 12-hour period (720 minutes). We also note that the requirement to maintain a wide zone of passage at all times ensures that there is a path for sturgeon to use to avoid the noise and there is not a risk of sturgeon not being able to avoid the area with noise above the cumulative injury threshold. Therefore, we expect all sturgeon in the action area to be able to readily swim away from any ensonified area in time to avoid injury. As such, injury of any type due to exposure to pile driving noise is extremely unlikely to occur and effects are discountable. We consider the effects of avoidance below.

6.1.6 Effects of Behavioral Response to Pile Driving Noise

As noted above, available information suggests that behavioral responses (avoidance) may begin upon exposure to noise at levels of 150 dB re 1 μPa RMS. Depending on pile type and installation method, the 150 dB re 1 μPa RMS isopleth (radius) would extend from approximately 4.6 m (15.2 ft), during vibratory installation of 14-inch steel H-piles, to approximately 10,000 m (32,808 ft) during impact driving of 96-inch steel pipe piles. The isopleths associated with impact pile driving of the 96-inch steel pipe piles represent the project's

largest ensonified area and are used here to frame the analysis. Rather than relying exclusively on the spatial extent of the ensonified area that, at its maximum (10,000 m (32,808 ft, or 6.2 mi), in radius for impact driving of 96-inch steel pipe piles), exceeds the approximately 7.2 km (4.5 mi) width of the Bay at the Bay Bridge crossing - our conclusion that behavioral effects from pile driving are insignificant rests primarily on the limited duration and frequency of pile driving activity, combined with the mobile, non-aggregating use of the action area by Atlantic and shortnose sturgeon as described in the *Status of the Species* and *Environmental Baseline* sections of this Opinion. The action area is not known to support unique overwintering habitat, concentrated foraging areas, or other conditions that would cause sturgeon to remain in one location for an extended period; rather, sturgeon use the action area primarily while migrating through the Bay and opportunistically foraging. According to data received from the telemetry array, Atlantic sturgeon only spent one to four hours in the action area. Sturgeon that move away from the immediate vicinity of active pile driving are expected to continue these same behaviors (foraging, resting, or migrating) elsewhere within the tens of thousands of acres of comparable habitat available throughout the Chesapeake Bay, and no information indicates that temporary displacement to nearby habitat of similar quality would impose a measurable energetic or fitness cost on a transiting individual.

Most importantly, pile driving will not be a continuous, sustained operation across the full construction period. For the eastbound bridge, a total of approximately 120 days of pile driving is anticipated across construction years 1 through 5; for the westbound bridge, approximately 138 days across construction years 7 through 13. This means that for the eastbound construction period, pile driving is expected on approximately 6.5 percent of days (120/1825) and will occur for no more than 12-hours on each of those days; similarly, for the westbound construction, pile driving is expected on approximately 5.4 percent of days (138/2,555), also limited to 12 hours per day.

Sturgeon are likely to be foraging (where forage is present), resting, or migrating in the action area. Here, we consider two scenarios: (1) sturgeon near the pile being installed that must swim away from the pile to move out of the area where noise is greater than 150 dB re 1µPa RMS; and (2) sturgeon outside of the area where noise is greater than 150 dB re 1µPa RMS at the onset of pile driving that would need to avoid this area when pile driving is ongoing.

Sturgeon present within the 150 dB re 1 µPa RMS isopleth when pile driving commences are expected to move away from the sound source and exit the ensonified area. We estimate that Atlantic and shortnose sturgeon have a prolonged sustained swim speed of at least 35 cm/s (1.1 fps) and a burst or escape swim speed of at least 45 cm/s (1.4 fps), and that sturgeon can sustain their prolonged swim speed for up to 200 minutes without muscle fatigue (Castro-Santos *et al.* 2024, McLean *et al.* 2014). At the prolonged sustained swim speed of 35 cm/s (1.1 fps), a sturgeon located at the outermost boundary of the maximum 150 dB RMS behavioral isopleth (10,000 m (32,808 ft) from the pile during 96-inch pipe pile impact driving) would be expected to exit the ensonified area in approximately 107 minutes (approximately 6,426 seconds), well within the 200-minute fatigue threshold. At the more conservative minimum sustained swim speed of 0.18 m/s (0.6 fps), even a slow-moving individual at the outer boundary of this largest

isopleth would exit the ensonified area within two hours, which is the approximate time period needed to install a single 96-inch steel pipe pile.

In practice, sturgeon would not typically be located at the outermost boundary of the behavioral isopleth at the moment pile driving begins, nor would they need to complete the full swim-out distances calculated above, which, in order to avoid disruptive noise levels, assume a fish already at the isopleth's outer edge when the hammer reaches full power. Soft-start procedures, which commence pile driving at reduced energy before reaching full operational intensity, give animals time to detect increasing noise levels and move progressively away from the sound source before threshold levels are reached. The committed use of soft start as and avoidance and minimization measure, typically provides 20 minutes at reduced energy before reaching full power. Accordingly, the realistic duration of behavioral disruption in this scenario is on the order of 20 minutes - the length of the soft-start period - rather than the full swim-out times of up to 107 minutes (or, at the most conservative swim speed, approximately two hours) calculated above for a fish that begins at the outer edge of the isopleth once the hammer is already at full power, and considerably shorter than the approximately two-hour period needed to install a 96-inch steel pipe pile.

Sturgeon located outside the ensonified area at the onset of pile driving would need to avoid entering the 150 dB re 1 μPa RMS isopleth while pile driving is underway. This avoidance behavior would entail, at most, a temporary rerouting of migratory movement, a shift in foraging location, or a brief pause in movement until the end of the 12-hour pile driving period. Given the breadth of suitable habitat available throughout the Chesapeake Bay action area, sturgeon engaging in this avoidance behavior would have access to comparable foraging substrate elsewhere in the Bay outside of the daily ensonified area. No information is available to indicate that any particular portion of the Chesapeake Bay within the action area provides superior foraging, resting, or migratory conditions relative to any other, so this displacement is not expected to disadvantage an individual relative to the continued use of the location it otherwise would have occupied. We recognize, however, that at its maximum extent (10,000 meters (32,808 feet, or 6.2 miles)), in radius for impact driving of 96-inch steel pipe piles) the 150 dB isopleth exceeds the approximately 7.2 km (4.5 mi) width of the Bay at the project site. As a result, during periods when the largest pile types are installed at full power, the ensonified area could extend across the full width of the Bay at the bridge, and we cannot conclude that a fully unensonified, below-threshold corridor spanning this area would necessarily remain available at that specific time and location. In addition, where pile driving during the ZSFP window limited to pile types smaller than the 96-inch steel pipe piles, FHWA and MDTA's committed maintenance of a 2,133.6 m (7,000 ft)-wide ZSFP from January 15 through May 15 (the anadromous fish migratory period) would provide a corridor of below-threshold acoustic habitat during the period of greatest migratory sensitivity, encompassing both shallow and deep-water habitat types. This January 15–May 15 window reflects a seasonal habitat-protection commitment tied to the anadromous fish migratory period; it is not a separate time-of-year restriction on pile driving itself, and pile driving may occur during that window subject to maintenance of the ZSFP corridor. Outside of the January 15 through May 15 window, pile

driving may occur during other months when sturgeon opportunistically forage and make seasonal movements. Pile driving occurs on only approximately 5.4 to 6.5 percent of days within a given construction period (as described above) and is followed each day by a 12-hour quiet period. As a result, while an individual sturgeon may encounter active pile driving at some point over the multi-year construction schedule, the likelihood of exposing the same individual on consecutive days, or repeatedly within a short period, is low, because an overnight quiet period follows each exposure and, on most days, additional intervening quiet days pass before pile driving resumes.

A short-term behavioral disruption of foraging, resting, or migratory movement will not have any detectable effect to any individual sturgeon and therefore no effect on the overall health, condition, or fitness of individual Atlantic or shortnose sturgeon. Foraging activity resumes as soon as pile driving ceases or the individual exits the ensonified area and encounters suitable benthic invertebrate prey, which is broadly distributed throughout the action area. Migratory movement continues on a rerouted or briefly delayed basis, with no information available to suggest that a disruption in daily movements that lasts no more than a few hours would have a detectable effect on the individual. This would also be too short to have any impact on timing of movements for spawning or overwintering, or to experience any energetic deficit measurable against normal seasonal variation. Resting behavior also resumes as soon as the noise ends or the individual moves beyond the disturbing noise level.

6.1.7 Summary of Behavioral Effects

Because behavioral modification at the 150 dB RMS threshold is expected to occur at sustained swim speeds after, perhaps, an initial speed burst from a startle response, no increase in metabolic expenditure beyond normal activity levels is anticipated. Accordingly, no decrease in individual condition or body reserves is expected to result from avoidance behavior. Therefore, we do not anticipate any effects to growth, reproduction, immune function, or long-term survival of any individual sturgeon attributable to pile driving-related behavioral modification. This is consistent with the regulatory definition of insignificant effects – effects that could reasonably occur but that would never be expected to rise to a level that could result in take – because the behavioral modification described here does not reach a magnitude capable of causing injury and would not be expected to produce any measurable change in an individual's growth, reproduction, or survival.

Based on the analysis above, behavioral modification from pile driving noise will not preclude any sturgeon from completing essential behaviors - including foraging, resting, and migration - within the action area or within adjacent suitable habitat. Thus, effects are too small to be meaningfully measured, detected, or evaluated and, therefore, consequences are insignificant.

6.2 Dredging

As described above, all dredging will be carried out with a mechanical (bucket) dredge, targeting a depth of 9 feet below mean lower low water (MLLW) across a total footprint of approximately 50.2 acres (approximately 308,800 cubic yards). The estimated dredging duration is 14 days for

the eastbound bridge (construction years 1–2) and 7 days for the westbound bridge (construction years 7–8).

6.2.1 Interactions between Dredge Equipment and sturgeon

Mechanical dredging entails lowering the open bucket through the water column, closing the bucket after impact on the bottom, lifting the bucket up through the water column, and emptying the bucket into a barge. The bucket operates without suction or hydraulic intake, moves relatively slowly through the water column and affects only a small area of the aquatic bottom at any time. To be captured in a dredge bucket, an animal must be on the bottom directly below the dredge bucket as it contacts the substrate and remain stationary as the bucket closes. Species captured in dredge buckets can be injured or killed if entrapped in the bucket or buried in sediment during dredging and/or when sediment is deposited into the dredge scow. Species captured and emptied out of the bucket can suffer stress or injury, which can lead to mortality.

In addition to capture, a sturgeon could be struck by the dredge bucket, cable, or associated rigging without being captured or retained. Such a non-capture interaction could cause injury or mortality that would not be reflected in the incident records discussed below, since the animal would not be brought to the surface or observed by dredge monitors. However, we are not aware of documented non-capture strike records separate from the capture incidents described below; however, the absence of such records likely reflects the limited ability to detect an interaction that does not result in retrieval, rather than confirmation that the risk does not occur.

In 2012, the USACE provided us with a list of all documented interactions between dredges and sturgeon reported along the U.S. East Coast; reports dated as far back as 1990. The list includes five incidents of sturgeon captured in dredge buckets. We are not aware of any additional records that postdate this report. These five incidents include the capture of a decomposed Atlantic sturgeon in Wilmington Harbor in 2001. The condition of this fish indicated it was not killed during the dredging operation and was likely dead on the bottom or in the water column and merely scooped up by the dredge bucket. Another record was the reported lethal capture of an Atlantic sturgeon in Wilmington Harbor in 1998; however, this record was never verified. An Atlantic sturgeon was captured in a clamshell bucket, deposited in the dredge scow, and released apparently unharmed during dredging operations at Bath Iron Works (BIW) in 2001. On April 30, 2003, a shortnose sturgeon was captured in a clam-shell bucket dredge operating in the BIW sinking basin; the fish was nearly cut in half. This fish was killed during the last hour of a 24 hour a day dredging operation that had been ongoing for approximately six weeks. One shortnose sturgeon was captured in a clamshell bucket and detected in the dredge scow on June 1, 2009, during dredging operations at BIW. Observer coverage at dredging operations at the BIW facility has been 100 percent for approximately 20 years, with dredging occurring every one to two years.

Monitoring occurred at dredging projects associated with the Tappan Zee Bridge replacement project on the Hudson River. The first stage of dredging occurred in 2013. Two dredges were used between August 2 and October 30, 2013, and a total of 844,120 CY of material were removed using a bucket dredge. NMFS-approved observers were present to monitor 100 percent

of all dredging. All dredge observer forms were submitted to us on December 31, 2013. While fish and other biological materials were observed in 279 loads (out of approximately 1,500), no shortnose or Atlantic sturgeon were observed. Dredging occurred again in 2015 with approximately 150,000 CY of material removed; observer coverage was 100 percent and no shortnose or Atlantic sturgeon were observed. The area where dredging occurred is a high use area for shortnose and Atlantic sturgeon.

We expect the risk of interactions between sturgeon and mechanical dredges to be highest in areas where large numbers of sturgeon are known to aggregate. The behavior of sturgeon in the area may also affect the risk of capture. While foraging, sturgeon are at the bottom of the river interacting with the sediment. This behavior may increase the susceptibility of capture with a dredge bucket. We also expect the risk of capture to be higher in areas where sturgeon are overwintering in dense aggregations as overwintering sturgeon may be less responsive to stimuli which could reduce the potential for a sturgeon to avoid an oncoming dredge bucket. Telemetry data indicate that while sturgeon may forage opportunistically within the dredging footprint, individuals do not exhibit long-term residency in this area, and the area is not a known aggregation site for sturgeon. This transient pattern of use limits the duration over which any individual sturgeon would be present within the footprint at a given time, correspondingly reducing the cumulative probability of an interaction with dredge equipment. Given the slow rate of bucket descent and closure and the small area of bottom substrate affected during each pass, as described above, a mobile organism in the vicinity of a descending bucket would generally be expected to detect and move away from the disturbance before contact. For a bucket dredge to capture a sturgeon, the sturgeon has to be immediately below the bucket and remain stationary as the bucket jaw closes. The slow movement of the dredge bucket through the water column and the relatively small area of bottom impacted by each pass of the bucket makes the likelihood of interaction between a dredge bucket and an individual fish unlikely.

Considered together, the risk of a sturgeon being captured by a mechanical dredge bucket - which requires the animal to be positioned directly beneath the bucket and remain stationary as it closes - is extremely low given the slow rate of bucket descent and closure and the small area of bottom affected during each pass. The risk of a non-capture strike, while more difficult to characterize because such an interaction would not be reflected in observer or incident records, is likewise expected to be low: the same slow, localized nature of bucket operation that limits capture risk also limits the opportunity for a sturgeon to be struck without being captured, and mobile sturgeon in the vicinity of the descending bucket would generally be expected to move away from the disturbance before contact. Telemetry data further indicate that sturgeon use of the area is limited, which suggests they may use the area for opportunistic foraging rather, which reduces the duration of exposure and the corresponding cumulative probability of either type of interaction. Based on the available evidence regarding both capture and non-capture interaction pathways, we conclude that the risk of a mechanical dredge affecting Atlantic or shortnose sturgeon is extremely unlikely to occur, and any such effects are discountable.

6.3 Suspended Sediment/Turbidity

A number of project activities, including dredging, vessel operations, blasting, and pile driving result in temporary, localized increases in suspended sediment and turbidity due to disturbances of bottom sediments. Here, we address anticipated effects on shortnose and Atlantic sturgeon in the action area.

6.3.1 Thresholds for TSS and Turbidity Effects

Literature reviews of the effects of suspended sediment on fish show that effects vary greatly among species and suggest that concentrations of suspended solids can reach thousands of milligrams per liter before an acute toxic reaction is expected (Burton, 1993; Kjelland *et al*., 2015; Wilber & 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 mg/L, 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 mg/L after exposure periods ranging from 24 to 48 hours. Wilber and Clarke (2001) found that for adult estuarine species, TSS effects ranged from "no effect" when exposed to 14,000 mg/L for a duration of three days for two species to the lowest observed concentration that caused mortality at 580 mg/L after one day of exposure for Atlantic silverside. The concentration of suspended sediment is not the only factor determining effects; also relevant is the duration at which a fish is exposed. For example, most studies report response after exposure ranging from 24 to 48 hours.

In general, sturgeon are adapted to living in turbid environments (Hastings 1983; ECORP Consulting 2009), and this can be taken into consideration when evaluating the effects of turbidity and suspended solids on sturgeon species. However, there have been no directed studies on the physiological consequences of TSS on Atlantic or shortnose sturgeon; *Kjelland et al.* (2015) noted that benthic species in general are more tolerant to suspended sediment than pelagic species. As such, Atlantic and shortnose sturgeon are assumed to be at least as tolerant to suspended sediment as other estuarine fish. Based on the study of other species, we regard sublethal and lethal consequences on Atlantic and shortnose sturgeon to occur when exposed to 24 hours of concentrations at or above 580 mg/L. This threshold is derived from Burton (1993) and Wilber and Clarke (2001) data for Atlantic silverside, the most sensitive adult estuarine species reviewed in that literature, and reflects an acute (24-hour) exposure endpoint. We use it here because it is the closest available analog to the short-duration TSS pulses generated by the proposed action's construction activities (see Extent and Intensity of Water Quality Changes, below).

High TSS levels can cause a reduction in dissolved oxygen (DO) levels. 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 time periods. Tolerances may decline if chronic exposure to low dissolved oxygen levels occurs. Johnson (2018), following a comprehensive literature review, found no sturgeon-specific data

establishing a physiological or lethal effects threshold and instead recommends, as a conservative screening benchmark, that TSS concentrations not exceed 1,000 mg/L above ambient for longer than 14 days at a project site in order for effects to be considered insignificant and discountable. This 1,000 mg/L/14-day benchmark addresses a substantially longer, chronic exposure duration than either the acute 580 mg/L/24-hour threshold discussed above or the TSS durations expected from any of the project's construction activities, all of which are measured in minutes to hours rather than days (see Extent and Intensity of Water Quality Changes, below). The two threshold values are therefore not directly comparable and should not be read as points on a single graduated severity scale; each corresponds to a different exposure duration, and project-generated exposures fall well short of the duration basis for either one.

As is the case with physiological effects, behavioral response 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 effects of turbidity on feeding and vulnerability to predation (Kjelland *et al*., 2015; Wilber & 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 effects, is not likely to substantially affect Atlantic and shortnose sturgeon foraging. Sturgeon typically occur in turbid waters and 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). Atlantic sturgeon also actively forage during night (Dadswell *et al*., 1984). Based on foraging method, tolerance to high turbidity and foraging during night it is unlikely that visual detection of prey is of major importance for Atlantic and shortnose sturgeon foraging success. Elevated TSS levels resulting in physiological effects may elicit avoidance behavior and movement away from turbidity plumes. Studies on another anadromous species, striped bass, showed that pre-spawners did not avoid TSS concentrations of 954 mg/L to 1920 mg/L to reach spawning sites (Combs 1979 in Burton, 1993; Summerfelt & Mosier, 1976).

The BA estimates that the duration of levels above ambient TSS conditions is expected to be short (less than 30 minutes). Studies of the effects 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.

6.3.2 Extent and Intensity of Water Quality Changes

6.3.2.1 Mechanical Dredging

Dredging suspends sediment into the water column. Resuspension of sediment may increase Total Suspended Sediment (TSS) load and turbidity[19] above ambient baseline levels. Effects of dredging will vary based on site-specific conditions (Wilber and Clarke 2001). Site-specific conditions (e.g., bathymetry, currents) and material (e.g., sand versus silt) should be taken into consideration as it may influence turbidity and re-suspended sediment at a site. Assessing exposure of listed species to elevated levels of turbidity or TSS concentration requires an understanding of the sources (e.g., dredge type), factors that influence the duration and intensity of exposure (e.g., sediment type and/or current), as well as the individual species tolerance to the anticipated level of exposure at a given life stage. In our analysis, we consider information from earlier studies of sediment resuspension and turbidity to understand the intensity and extent of turbidity impacts. However, we also consider site-specific information to understand how local conditions influence turbidity and re-suspended sediment.

High concentration of suspended sediment or turbidity may affect fish through many pathways (Kjelland *et al*. 2015, Johnson 2018). 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. For all fish species in which effects to early life stages have been measured, it is clear that eggs and larvae (which are not present in the action area) are the most sensitive to suspended sediments and sediment deposition.

TSS concentrations associated with mechanical clamshell bucket dredging operations have been shown to range from 105 mg/L in the middle of the water column to 445 mg/L near the bottom (210 mg/L, depth-averaged) (USACE 2001). Furthermore, a study by Burton (1993) measured TSS concentrations at distances of 152, 305, 610, and 1,006 m (500, 1,000, 2,000, and 3,300 ft) from dredge sites in the Delaware River and were able to detect concentrations between 15 mg/L and 191 mg/L up to 610 m (2,000 ft) from the dredge site. Independent of bucket type or size, plumes dissipated to background levels within 183 m (600 ft) of the source in the upper water column and 732 m (2,400 ft) in the lower water column. Based on these studies, elevated suspended sediment concentrations at several hundreds of mg/L above background may be present in the immediate vicinity of the bucket but would settle rapidly within a 732 m (2,400 ft) radius of the dredge location.

Applying the thresholds established above, the maximum TSS concentrations expected during mechanical dredging (445 mg/L near the bottom, 210 mg/L depth-averaged) do not reach the 580 mg/L threshold associated with sublethal and lethal effects, nor the 1,000 mg/L (above ambient)

[19] 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).

threshold associated with behavioral effects. We therefore do not identify a lethal, sublethal, or behavioral zone of impact for dredging-related turbidity based on these thresholds. Elevated TSS levels are expected to remain within an approximately 732 m (2,400 ft) radius of the dredge location in the lower water column and 183 m (600 ft) in the upper water column, dissipating to background levels beyond these distances (Burton 1993).

6.3.2.2 Pile Driving

The installation of piles will disturb bottom sediments and may cause a temporary increase in suspended sediment in the action area. Using available information collected from a project in the Hudson River, we expect pile driving activities to produce TSS concentrations of approximately 5.0 to 10.0 mg/L above background levels within approximately 91 m (300 ft) of the pile being driven (FHWA, 2012). Using a vibratory hammer to extract piles allows sediment attached to the pile to move vertically through the water column until gravitational forces cause it to slough off under its own weight. The small resulting sediment plume is expected to settle out of the water column within a few hours.

Applying the thresholds established above, the TSS concentrations expected during pile driving (approximately 5.0 to 10.0 mg/L above background) fall far below both the 580 mg/L threshold for sublethal/lethal effects and the 1,000 mg/L (above ambient) threshold for behavioral effects. We therefore do not identify a lethal, sublethal, or behavioral zone of impact for pile-driving-related turbidity. Elevated TSS levels are expected to be limited to approximately 91 m (300 ft) of the pile being driven and to settle out of the water column within a few hours (FHWA 2012).

6.3.2.3 Vessel Operation

Hayes *et al*. (2010) estimated that tugs supporting dredging and construction activities can cause significant scour and resuspension of bottom sediments, potentially more than the dredging itself, because they often work in shallow water where the riverbed consists of fine, soft sediment. They modeled resuspension of highly erodible bottom sediment of indefinite depth from various types of vessels at various propeller clearance. They estimated that an 1,800 horsepower (HP) tug operating at 25 percent power and moving forward at 1.9 km/h (1 kts) could resuspend from 8,300 kilograms per second (kg/s) at 7.7 m (25.3 ft) propeller clearance to 14,000 kg/s at 1.7 m (5.6 ft) propeller clearance (Hayes *et al*., 2010). A small push boat with a 180 HP engine could potentially resuspend 1,000 to 5,000 kg/s at 1.4 m (4.6 ft) propeller clearance depending on power used. Even with a 3.4 m (11.2 ft) propeller clearance, the small push boat could resuspend up to 70 kg/s if operating at full power. Based on the model results, Hayes *et al*. (2010) concluded that resupension flux by support vessels (tugs) could exceed that of the dredging itself. Although the approximate size and type of vessel is currently unknown, we assume that the project-related vessels will have a draft of approximately up to 3.7 m (12 ft) and the dredge area currently has water depths 0.3 to 0.91 m (1 to 3 ft) that extend channelward approximately 244 to 290 m (800 to 950 ft) from the western shoreline, and approximately 1,200 to 1,300 feet from the eastern shoreline. Areas with depths from approximately 0.91to 3.7 m (3 feet to 12 ft) generally extend from about 640 to 671 m (2,100 to 2,200 ft) from the western shoreline and 1,189 to 1,433 m (3,900 to 4,700 ft) from the eastern shoreline. Based on bathymetric analysis, it is anticipated that dredging would be required to a depth of 2.7 m (9 ft) at

mean lower low water (MLLW). Vessels will not be restricted to the dredge footprint and we expect these to operate within the whole action area.

Similar to most of the sediment transport observations in open-channel flow, the maximum concentration from propeller disturbance of bottom sediment is located near the surface of the bottom with the suspended-sediment concentration gradually decreasing toward the water surface. Additionally, at any level in the water column, the concentration also decreases with time. Clarke *et al*. (2015) measured TSS concentrations after deep draft vessel passage in the Newark Bay, New Jersey, of 90 mg/l over broad areas following vessels maneuvers. TSS levels remained detectable against ambient levels at least 50 minutes where tidal currents could disperse plumes. Residual plumes (maximum 40 mg/l) in the lower two meters remained detectable at least 65 minutes after deep draft vessel passage. Field measurements of suspended sediment concentration behind a container vessel departing through a restricted fairway at a port in Hamburg, Germany, reached 550 mg/l (Stoschek *et al*., 2014). Concentrations at the focal point of propeller scour when a vessel with little clearance is maneuvering (e.g., at start of movement from a still position) can exceed 1,000 mg/l but the plume will quickly dilute as the vessel start moving and the plume disperses (PIANC, 2008; Stoschek *et al*., 2014). Since the vessels described above are larger with more powerful engines and have deeper draft than the tug vessels analyzed here, we expect the measured TSS levels above to be the maximum TSS levels generated by tugs operating in areas with little clearance.

The deep-draft vessels evaluated in these studies were substantially larger than the tugs and support vessels anticipated for project use. The eleven vessels measured by Clarke *et al*. (2015) in Newark Bay ranged from 190 to 294 m (623 to 965 ft) in length, with drafts of 9.2 to 13.5 m (30 to 44 ft) and gross tonnage of approximately 32,957 to 57,255 tons — compared to the maximum project vessel draft of approximately 12 ft (3.7 m) assumed here. The container vessel measurements in Stoschek *et al*. (2014) were likewise based on large containerships with propeller diameters on the order of 9 m (29.5 ft), far exceeding the propeller dimensions of the 1,800-HP tug and 180-HP push boat modeled by Hayes *et al*. (2010) for this project. Because propeller-induced sediment resuspension scales with vessel draft, propeller diameter, and engine power - and RPM in particular, which Stoschek *et al*. (2014) identified as the most sensitive parameter, with a 5 percent increase in RPM producing a 20 percent increase in resuspension - the substantially greater draft, propeller size, and power of the vessels evaluated in Clarke *et al*. (2015) and Stoschek *et al.* (2014) indicate that the TSS concentrations they measured represent a conservative upper bound for the smaller support vessels and tugs anticipated for this project.

Applying the thresholds established above, the TSS concentrations associated with project vessel operation - informed by the conservative upper-bound data from Clarke *et al*. (2015) and Stoschek *et al*. (2014) - do not approach the 580 mg/L / 24-hour threshold for sublethal/lethal effects or the 1,000 mg/L (above ambient) / 14-day threshold for behavioral effects, once duration is accounted for. Concentrations at the focal point of propeller scour during low-speed maneuvering can transiently exceed 1,000 mg/L (up to 1,500 mg/L per Stoschek *et al.* 2014), but such concentrations are localized to the immediate propeller wake and persist for at most several minutes as the vessel gets underway - several orders of magnitude shorter than the 14-day

duration associated with the behavioral threshold. Broader-area concentrations following vessel passage (up to 90 mg/L, with residual plumes detectable for 50 to 65 minutes; Clarke *et al*. 2015) fall far short of either threshold in both magnitude and duration. Based on these thresholds, we therefore do not identify a lethal, sublethal, or behavioral zone of impact for vessel-related turbidity.

6.3.2.4 Blasting

There is no available information on the TSS levels expected after a blast event. However, the BA estimates 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. 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.

Because the elevated TSS levels associated with blasting (350–600 mg/L) are expected to persist for less than 30 minutes - several orders of magnitude shorter than the 24-hour exposure duration associated with the lethal/sublethal threshold and the 14-day duration associated with the behavioral threshold established above - neither threshold is expected to be reached at any distance from the blast site. We therefore do not identify a lethal, sublethal, or behavioral zone of impact for blasting-related turbidity.

6.3.3 Response of Sturgeon to Exposure

Adult and subadult sturgeon are frequently found in turbid water and would be capable of avoiding any sediment plume by swimming higher in the water column. Laboratory studies (Niklitschek 2001, Secor and Niklitschek 2002) have demonstrated shortnose sturgeon are able to actively avoid areas with unfavorable water quality conditions and that they will seek out more favorable conditions when available. As discussed above, none of the project's turbidity-generating stressors are expected to produce TSS concentrations and durations sufficient to reach the sublethal/lethal or behavioral thresholds established in this section. Based on this, and the demonstrated capacity of sturgeon to actively avoid unfavorable water quality conditions, we expect effects to sturgeon exposed to project-related sediment plumes to be too small to be meaningfully measured, evaluated or detected and, therefore, insignificant.

TSS is most likely to affect sturgeon if a plume causes a barrier to normal behaviors. However, the increase in TSS levels expected are below those shown to have adverse effects on fish. Moreover, sturgeon are likely to avoid the sediment plume at the focal point where the propeller jet hits the bottom and suspended sediment concentrations are highest. Thus, we expect sturgeon to either swim through the plumes or make minor evasive movements to avoid them.

Even if sturgeon avoid the turbidity plume, this will not be a barrier to migration. Elevated suspended sediment levels at the Bridge site that may cause avoidance will be the sediment plumes generated by pile driving and mechanical dredging, with radii of 91 m (298.5 ft) and 732 m (2,400 ft), respectively. The sediment suspended during dredging will quickly decrease to low concentrations as the distance increases from the dredging area and the sediment falls out of the

water column. Any TSS levels that may cause avoidance will be closer to the dredging than the full extent of the sediment plume. Thus, any avoidance of the plume will not hinder upstream or downstream movements of sturgeon.

Energy expenditure to avoid turbidity plumes could reduce growth of sturgeon, delaying ocean migration and, eventually, expected lifetime fecundity. Sturgeon feed on a large range of prey and actively move over the bottom in search of prey when foraging. The evasive movements that would be necessary to avoid high TSS concentrations would be within their normal range of movement and we do not expect this to increase substantially normal energy use. Thus, any effects are likely to be so small that they cannot be meaningfully monitored, detected, or evaluated and are therefore insignificant.

6.4 Benthic Habitat Modification

The proposed project will remove and disturb the substrate through construction, demolition, dredging, and scour from the propeller jet of vessels. According to the BA, approximately 134.8 acres of tidal water bottom impacts are expected due to impacts associated with the proposed action (pile driving and removal, demolition and clearing debris, and dredging). This 134.8-acre figure describes the extent of direct physical habitat disturbance from construction activities. It is distinct from the approximately 1,200-acre zone discussed below under Blasting, which describes the outer extent of potential underwater noise detection during blasting rather than an area of direct habitat loss.

Soft substrate supports a variety of benthic invertebrates that are important prey for sturgeon. Therefore, removal and disturbance of the bottom sediment or conversion of the bottom from soft to hard substrate can eliminate or reduce forage for sturgeon.

In this section, we present background information on the existing habitat and the proposed project's impacts; the factors to consider when assessing habitat impact; an analysis of exposure; and a summary of available information on sturgeon habitat use and available information on sturgeon responses to loss of habitat and forage. We then consider the effects of exposure of individual sturgeon to habitat loss and degradation.

6.4.1 Intensity and Extent of Habitat Impacts

Bottom substrates within the action area, based on MDNR's Chesapeake Bay Bottom Survey data (Smith *et al*., 2001), are mapped in the Annapolis Shore, Kent Island True Bay, and Kent Island Shore 12-digit watersheds. Within the action area, substrates in the Lower Severn River, Annapolis Shore, and Kent Island True Bay MD 12-digit watersheds are dominated by mud and natural oyster rubble. The Northwest Lower Chesapeake Bay MD 12-digit watershed contains natural oyster rubble and sand substrates within the action area. The Grasonville South MD 12-digit watershed contains man-made oyster rubble, mud, natural oyster rubble, sand, and sandy mud substrate types within the resource review area. Mud, natural oyster rubble, sand, and sandy-mud substrate is present in the Chester River South MD 12-digit watershed. Finally, the Kent Island Shore MD 12-digit watershed contains only sand substrate, based on MDNR's Chesapeake Bay Bottom Survey data (Smith *et al*., 2001). Table 19 illustrates the predominance

of mud, sand, and natural oyster rubble within the action area. These substrates provide a soft bottom habitat supportive of diverse aquatic life, providing habitat for invertebrates as well as other species that rely on foraging and burrowing.

Table 19. Habitat types within the action area

Habitat Type	Lower Severn River	Annapolis Shore	Northwest Lower Chesapeake Bay	Kent Island True Bay	Kent Island Shore	Grasonville South	Chester River South
Man-Made Oyster Reef	0.68	---	---	---	---	---	---
Man-Made Oyster Rubble	3.31	---	---	---	---	17.02	4.32
Mud	340.43	333.10	---	8.20	---	39.15	44.79
Natural Oyster Rubble	198.62	125.09	88.26	396.49	---	25.12	81.37
Sand	2.03	58.87	46.89	590.97	1.26	6.97	46.47
Sandy Mud	---	---	---	---	---	35.29	56.60
Unclassified	14.07	---	---	---	---	---	3.44
Unspecified Construction Reef	2.54	---	---	---	---	---	---

6.4.1.1 Dredging

Dredging will temporarily remove all benthic invertebrates within the approximately 50.2 acre dredge footprint. We expect that this activity is more likely to disturb or displace non-mobile organisms that occur at the surface of the sediment and is less likely to impact mobile invertebrates (such as crabs) who can avoid the dredge. Dredging is likely to entrain and kill at least some of mobile invertebrates. Further, turbidity and suspended sediments from dredging activities may affect benthic resources in those areas. Some of the TSS levels expected for the proposed activities (up to 445 mg/L) exceed the levels shown to have adverse effects on benthic communities (390 mg/L (EPA 1986)).

Studies done by Wilber and Clarke (2001) demonstrate that benthic communities in temperate regions occupying shallow waters with substrate of sand, silt, or clay reported recovery times between one and 11 months after dredging. Therefore, if a dredge site remains undisturbed after dredging, the benthic invertebrate fauna within the dredged areas could recover to pre-project conditions within one year following completion of the initial dredging. Because sturgeon are

highly mobile and forage opportunistically across the action area rather than depending on a single fixed foraging location, individual sturgeon are not expected to depend on the 50.2-acre dredge footprint specifically for prey during the estimated 1- to 11-month benthic recovery period. Sturgeon encountering reduced prey density within the footprint during this period of time would be expected to forage in adjacent, unaffected areas of comparable habitat that remain available throughout the action area. We therefore do not expect the temporary reduction in benthic prey availability within the dredge footprint to measurably affect individual sturgeon growth, condition, or fitness. Given that maintenance dredging is not proposed and the dredged areas are expected to fill in over time, we expect that the area will recover to pre-dredge conditions over time with a similar composition and density of the invertebrate fauna. As such, effects of dredging on benthic communities in the action area are expected to be temporary and localized.

6.4.1.2 Blasting

Subaqueous explosive demolition impacts the benthic environment through three primary vectors: direct substrate displacement, localized sedimentation, and structural bathymetric alteration. As discussed above (see *Action Area* and the introduction to this section), the BA's reference to a 1,200-acre area of impact from blasting describes the extent of the area potentially ensonified during demolition (see Section 6.6.2 and Figures 9 and 10), not an area of direct habitat disturbance. In terms of habitat disturbance, direct physical disturbance to the bay bottom from blasting is limited to the immediate vicinity of each pier and the associated rubble-placement areas; the majority of the 1,200-acre zone is expected to experience, at most, transient increases in turbidity and sedimentation of the magnitude and duration addressed in the Suspended Sediment/Turbidity section above, rather than direct habitat loss.

The BA describes the proposal to implement confined blasting, which reduces the energy and shock wave released to the water column. Confined blasting ensures that the blast will radiate outward toward the outer edge of the pier so that most of the blast energy is focused on the pier and 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 disposal sites or placed within scour holes. After demolition, if suitable for re-use, the clean concrete rubble from each existing pier will be mechanically pushed into the new pier's scour holes with large excavators attached with buckets, grapple, and clamshells operating from barges, which may kill at least some potential sturgeon forage items. In addition, the re-use of concrete rubble in these locations will raise the elevation of the bay floor from the bottom of the deep scour holes to an elevation close to the river bottom. Leaving space on top of each filled scour hole encourages the deposition of soft sediment over the concrete rubble, which will enable the recolonization of benthic organism. 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).

The width of the bay is 7.2 km (4.5 miles) and effects of blasting are expected to encompass up to a 640-meter area around each of the 15 eastbound and 15 westbound piers. Given the limited spatial extent of potential impacts and the available literature which indicates that benthic communities that serve as forage for sturgeon are expected to be resilient to blasting effects and the anticipated rapid recovery of any loss of benthic resources following blasting (Wilber and Clarke 2007), effects to the forage base are expected to be extremely small and limited in space and time. To contextualize this area, the Chesapeake Bay's total surface area is approximately 2.87 million acres (4,479 square miles). A 1,200-acre zone of potential blasting influence therefore represents approximately 0.04 percent of the Bay's total surface area. We do not rely on this percentage alone to support an insignificance finding. As discussed above, the 1,200-acre figure describes the outer extent of a zone within which underwater noise may potentially be detected, not an area of temporary turbidity, suspended sediments, or direct habitat loss; direct physical disturbance to the bay bottom is limited to the immediate vicinity of each of the 30 piers and the associated rubble-placement areas described above. It is the temporary, non-destructive nature of the effect across the great majority of the 1,200-acre zone - not its size relative to the Bay - that supports our conclusion below. Therefore, any effects of the blasting operations on sturgeon prey items within the action area will be too small to be meaningfully measured, evaluated, or detected, and therefore, insignificant.

6.4.2 Effects to Habitat Modification and Loss of Forage

When added to baseline bottom disturbances, the proposed project will affect a relatively small portion of bay bottom and reduce the availability of benthic invertebrate prey. This will affect sturgeon distribution and foraging within the Bridge area. However, the action area still provides ample available bottom habitat, and the temporary loss of benthic invertebrates within the dredge footprint is small relative to the amount of soft bottom habitat present in the action area and in the Chesapeake Bay. Therefore, we do not expect the proposed project to limit forage for Atlantic and shortnose sturgeon. We also expect that the action area will provide ample forage for Atlantic and shortnose sturgeon as they migrate. As such, we have determined that the effects to sturgeon habitat and forage from dredging and vessel activity is too small to be meaningfully measured, detected, or evaluated. Therefore, effects are insignificant.

6.5 Vessel Strike

In this section of the Opinion, we consider the effects of project vessels on shortnose and Atlantic sturgeon. Specifically, we consider if the increase in vessel traffic, when added to the baseline, is likely to result in effects to individual sturgeon and whether it will increase the risk of interactions between sturgeons and vessels in the action area.

Construction and demolition of the Bridge will cause an increase in vessels operating within the action area. Vessels supporting construction, demolition, and dredging, will operate within the

action area for approximately 15 years. The proposed project will result in the maneuvering and movement of vessels within the project site and the Federal Navigation Channel between the Port of Baltimore and the project site during the lifespan of the project.

To evaluate the potential risk of vessel interactions with Atlantic and shortnose sturgeon when exact details about project vessels are unknown, the effects analysis incorporates the approach established in Section 4.1.1.2. This proxy framework categorizes potential construction traffic into three operational tiers based on transit velocity, displacement, and draft. With respect to vessel trips, we assume a maximum of up to 44 round-trips (88 linear transits) per day during peak construction and demolition seasons, dominated by light-displacement / high-speed vessels.

6.5.1 Increase in Vessel Traffic from the Proposed Action

As explained in Section 3, the approximate size and type of vessel, travel routes, and number of trips is currently unknown. The approach we developed utilizes a surrogate project analysis - drawing from the construction and demolition of the Nice Bridge, the Governor Mario M. Cuomo Bridge, and the Hampton Roads Bridge-Tunnel Expansion projects to classify potential traffic into three distinct operational tiers based on vessel displacement and transit velocity. Spatial and temporal routing models assume low-displacement, high-speed vessels will frequently traverse the shoals flanking the bridge spans during peak summer foraging months (June–September). The draft of the vessels will range from 0.6 to 4.3 m (2 to 14 ft). As described in Section 3 of the Opinion, during all phases of the project, vessels will travel at speeds of up to 5.4 km/h (10 kts) with appropriate safety exemptions, as needed.

As explained in the *Environmental Baseline*, the area to be transited by project-related vessels has relatively high levels of vessel traffic. The best available information indicates there were approximately 34,302 vessel transits[20] during 2023 in the upper Chesapeake Bay and Baltimore approach channels (i.e., the general area that the majority of project vessels will transit to/from the Bridge) (Table 20).

Table 20. 2019-2023 upper Chesapeake Bay vessel traffic (USACE Waterborne Commerce Data 2023)

Calendar Year	Self-Propelled Trips (Ships, Tugs)	Non-Self-Propelled Trips (Barges, Scows)	Total Annual Commercial Trips
2019	24,115	11,407	**35,522**
2020	23,925	10,120	**34,045**
2021	24,082	9,325	**33,407**
2022	23,810	8,195	**32,005**

[20] The vessel traffic numbers from the USACE Waterborne Commerce data do not include most fishing vessels or any recreational vessels; therefore, it is just a portion of the total vessel traffic in the area.

Calendar Year	Self-Propelled Trips (Ships, Tugs)	Non-Self-Propelled Trips (Barges, Scows)	Total Annual Commercial Trips
2023	24,650	9,652	**34,302**
5-Year Median	**24,082**	**9,652**	**34,302**

6.5.2 Factors Relevant to Vessel Strike

A 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 of carcasses found have damage consistent with vessel strike (Balazik *et al*. 2012d, Brown and Murphy 2010; also, see discussion in previous sections of this Opinion). Direct observations of vessel strikes killing sturgeon have also been reported (e.g., Park 2017, personal communication). Therefore, we anticipate that increasing the amount of vessel traffic in a geographic area generally increases the risk of vessel strike for sturgeon in the area.

The timing and location of vessel traffic in the action area may influence the risk of a vessel striking a sturgeon. A significant increase in vessel traffic during spawning periods 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*. 2012d). We note that neither of these risk factors are considerations for the proposed action as it does not overlap with pathways to known spawning rivers and also is not in a narrow channel or passageway.

For sturgeon to interact with vessels and their propellers, they must overlap spatially and temporally. First, a vessel's activity must occur in the same reach of the waterbody where sturgeon is present. Second, a sturgeon must occupy the same portion (lateral location) of the 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 area where project vessels will operate (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. It is well documented that adult sturgeon are killed by interactions with propellers of vessels (Balazik, Reine, *et al.*, 2012; Brown & Murphy, 2010; Demetras *et al*., 2020; Killgore *et al*., 2011). The

available telemetry evidence indicates that sturgeon generally do not respond to an approaching vessel by moving out of its way, and that even when sturgeon do attempt to move, they may be unable to evade the propeller. 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; Balazik, Barber, *et al.*, 2017), and, occasionally, the researchers observed sturgeon move into the path of an approaching vessel (Balazik, Barber, *et al*., 2017). 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; DiJohnson *et al.*, 2015). Both Balazik, Barber, *et al.* (2017) and DiJohnson (2019) concluded that their findings suggest that either Atlantic sturgeon do not consider vessels a threat or they cannot detect a vessel until it is too late.

The hull itself may hit sturgeon that fails 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 would occur 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 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 m/s (19.7 ft/s)) 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.

Entrainment can occur if a sturgeon is exposed to the water being sucked into the propeller and that individual is not able to escape the current velocity as water is drawn through the propeller. The zone of influence, the part of the water body entrained through the propeller, is the depth, width, and length in front of the propeller at which water is drawn through. Models of water entrained during maneuvering of tow vessels in the Mississippi River found the volume of water to be about twice the propeller area times the distance travelled (Wilcox, 1991). Larger propellers draw larger volumes of water, and we therefore expect the likelihood of a propeller

entraining a fish to increase with propeller size. Recreational vessels rarely have propellers exceeding 0.5 m (1.6 ft) in diameter, towboats and tugs commonly have propellers between 2-3 m (6.5-9.8 ft) in diameter, and tankers and bulk carrier vessels with a 12 m (40 ft) draft may have propellers that are 7-8 m (23-26 ft) in diameter. Typically, most vessel types have two propellers, but larger vessels may occasionally have three. Thus, we expect large tugboats, cargo vessels, and tankers to have a substantially larger zone of influence than recreational or smaller fishing vessels. Maynord (2000) showed that the inflow zone of a propeller surrounds the vessel in an area limited to roughly the size of the cross section of the vessel (i.e., similar to the width of the vessel). As an example, a tow with a draft of 2.7 m (8.9 ft) pushing three barges side by side (total width of 32 m (105 ft)) in 4.3 to 12 m (14 to 40 ft) deep water and a speed (relative to water) of 2 m/s (6.6 ft/s) had an inflow zone of about 25 m (82 ft) on either side of the center line. Thus, water within a 50 m (164 ft) wide zone could go through the propeller. Besides vessel specifications, the depth relative to draft determines the propeller's lateral zone of influence. In Maynord's calculations, bottom water at depths of 9.8 m (32.1 ft) or greater were not drawn into the 2.4 m (7.9 ft) diameter propeller (for a towboat with a 2.7 m (8.9 ft) draft) while water at depths of 5.6 m (18 ft) or less was drawn into the propeller, though not all flow within this zone would go through it. Therefore, a demersal sturgeon below a large vessel with a clearance of 6 m (19.7 ft) or less would be exposed to water drawn through the vessel's propeller(s). Further, while sturgeon are benthic feeders, they also use the upper water column during non-foraging movements and migrations and sometimes jump out of the water. Therefore, we consider all sturgeon in the path of a large vessel (the width of the path being equal to the width of the vessel) to be located in the water column where the moving vessel will expose them to the water drawn through its propellers.

Whether a fish can avoid entrainment depends on its location relative to the velocity of the water moved by the propeller and its swimming ability relative to that velocity. It is unclear what the response of a sturgeon will be when exposed to the hydrology around the hull and propeller of a moving or maneuvering vessel. For a vessel at cruising speed, the suction in front of the propeller is moderate, but it is more pronounced if the propeller diameter is relatively small – as it often is for ships designed for operation in rivers (e.g., tugboats) and other areas with draft limitations, or if the forward speed of the ship is slow (Steen, 2021). We do not have calculations of the approach velocity of water in front of the propellers of the delivery and installation vessels or the tugboats; therefore, we cannot evaluate a sturgeon's ability to escape entrainment through the propeller of these specific vessels. However, Steen theorizes that the propellers of large vessels can entrain even large sturgeon.

Not all fish entrained by a propeller will necessarily be injured or killed. Killgore *et al*. (2011) in a study of fish entrained in the propeller wash (two four-blade propellers that were 2.77 m (9.09 ft) in diameter) from a towboat in the Mississippi River found that 2.4 percent of all fish entrained and 30 percent of shovelnose sturgeon entrained showed direct sign of propeller impact (only estimated for specimens ≥12.5 cm (≥5 in) TL). The most common injury was a severed body, severed head, and lacerations. This is consistent with injuries reported for sturgeon

carcasses in the Delaware River and James River (Balazik, Barber, *et al*., 2017; Brown & Murphy, 2010).

Killgore *et al*. (2011) found that the probability of propeller-induced injury (i.e., propeller contact with entrained fish) depends on the propellers revolution per minute (RPM) 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 striking 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) showed a sigmoid (or "S" shaped) relationship between fish length and injury rate at a given RPM. The model estimates probability of injury at about 150 RPM for the towboat in their study increased from 1 percent for a 12.5 cm (5 in) fish to 5 percent for a 35 cm (13.8 in) long fish, and from 50 percent for a 72 cm (28.3 in) long fish to 80 percent for a 90 cm (35.4 in) long fish. However, Killgore *et al*. (2011) did not find that the number of fish entrained by the propeller was dependent on RPM even though the percentage of fish killed increased with increasing RPM.

Recreational and smaller commercial vessels (e.g., fishing boats or vessels used for shellfish husbandry) have smaller diameter propellers, entrain smaller volume of water, and have a shallow draft. Consequently, they are extremely unlikely to entrain a subadult or adult sturgeon. Large vessels have been typically implicated because of their deep draft relative to smaller vessels, which increases the probability of vessel collision with demersal fishes like sturgeon, even in deep water (Balazik, Reine, *et al.*, 2012; Brown & 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.

Miranda and Killgore (2013) indicates that heavy large-towboat traffic on the Mississippi River (vessels with an average propeller diameter of 2.5 m (8.2 ft), a draft of up to 2.7 m (9 ft), and travel at approximately the same speed as tugboats (less than 18.5 km/h (10 kts)), kill a large number of fish by drawing them into the propellers. The study demonstrates that shovelnose sturgeon (*Scaphirhynchus platorynchus*), a small sturgeon (~50-85 cm (~19.7-33.5 in) 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 sturgeon populations in Chesapeake Bay waters, this estimate cannot directly be used for this analysis. We also cannot modify the rate for this analysis because the type of vessels traveling in the two areas differ and we do not know (a) the difference in density of shovelnose sturgeon and Atlantic and shortnose sturgeon and (b) if there are risk factors that increase or decrease the likelihood of strike in Chesapeake Bay waters. However, this information does suggest that high vessel traffic can be a major source of sturgeon mortality. A similarly sized tugboat moving about 20.4 km/h (11 kts)

was observed striking and killing an adult Atlantic sturgeon female in the Federal Navigation Channel of the Delaware River in 2016 (Park, 2017).

Other factors affect the probability of vessel interactions with sturgeon. For example, although not present within the action area, narrow channels can concentrate both sturgeon and vessels into a smaller areas and thus increase the risk of vessel strike. Balazik, Reine, *et al*. (2012) noted that there is an inverse relationship between channel width and vessel mortalities in the James River. Sturgeon are likely to typically use the navigation channels during spawning migrations as well as seasonal movements between summer and overwintering areas (Fisher, 2011; Hondorp *et al*., 2017). Because of these behaviors, a higher number of adult Atlantic sturgeon vessel mortalities occur in the Delaware River during spring months. Besides exposing adults and subadults 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, Barber, *et al.*, 2017; Brown & Murphy, 2010; Fisher, 2011).

6.5.3 Effects of Project Vessel Activity on Sturgeon

The BA does not include the exact parameters for the project's marine fleet (vessel types, sizes, routes, and trip frequencies); therefore, as we did in Section 4.1.1.2, to analyze the effects of project vessels on sturgeon, we used data from comparable projects along with standard marine construction operational assumptions as a proxy for the Bay Crossing Project. As established elsewhere in this Opinion, Atlantic and shortnose sturgeon are present within the action (described in Section 5) and are transient, not resident, within the area; there are no known aggregation or overwintering areas at the location of the Bridge or along the vessel transit route to and from the Bridge.

NMFS maintains records of sturgeon mortalities reported by the public, state agencies, and researchers in a “Sturgeon Salvage Database” (NMFS unpublished data). There are 11 records of salvaged Atlantic sturgeon received between 2022 and 2025 from Maryland. Among these, one report (SALV266) shows definitive signs of a vessel strike (a clean propeller-like cut), and one additional report (SALV137) shows potential signs of impact trauma (cracked bony plates on the head). The closest salvaged fish found north of the bridge - SALV269 (near Earleville) being the closest at 55 km (34.2 mi) away, followed by SALV266 (Elk Neck State Park) at 62.8 km (39.0 mi) away. Some carcasses were not examined and we do not have an estimate of the total number of vessel strikes in this area annually. There were no shortnose sturgeon salvages reported in Maryland during this time period.

While we are not able to use these reports to estimate the total number of sturgeon struck in the action area in any given year, the number of carcasses reported and detected in an area that has high volumes of vessel traffic, accessible and well populated shorelines and waterways, and an established reporting system (through the Sturgeon Salvage Program), indicates that risk of vessel strike in the action area may be considerably lower than in other geographic areas (e.g., the James River). This may be due to the deep depths of the waterways in this area, the rare transient nature of sturgeon in the upper Chesapeake Bay generally and the action area specifically (i.e., there are no documented spawning rivers in the upper Bay north of the Potomac

River), and the lack of constrictions that would increase the potential for co-occurrence of deep draft vessels and individual sturgeon which together are likely to reduce risk of vessel strike generally in the action area.

To evaluate risk in the absence of a finalized description of project vessels, based on our review of previous bridge construction and demolition project, we estimated up to 44 round-trips (88 linear transits) per day during peak construction and demolition periods. We assess the potential for these transits to result in sturgeon interactions across the three operational vessel tiers:

Tier 1: Heavy-Displacement / Slow-Moving Construction Vessels

Vessel Types: Derrick barges, material transport barges (45.7-91.4 m (150–300 ft)), and attendant coastal tugboats (18.3-30.5 m (60–100 ft)).

Risk Characterization: Tier 1 vessels present deep drafts (up to 3.7-4.6 m (12–15 ft) for loaded barges and tugs). However, their operational velocity is exceptionally low, typically ranging from 7.4 to 11.1 km/h (4 to 6 kts) during transit and remaining stationary or tethered during active pile installation. Tier 1 vessels' low speed and low-frequency acoustic signature are, in principle, within the detection range of a sturgeon's lateral line and rheotactic senses (Gibbs and Northcutt 2004, Johnston *et al*. 2017). We do not rely on that theoretical sensory capacity here, however: as discussed above (see Factors Relevant to Vessel Strike), field telemetry studies (Balazik *et al.* 2017a; DiJohnson 2019) found that Atlantic sturgeon generally do not alter their behavior in response to an approaching vessel and may be unable to evade one even when they attempt to move, regardless of vessel speed. We therefore do not expect the slow speed of Tier 1 vessels to meaningfully increase the likelihood that sturgeon detect and evade them. The reduced risk associated with Tier 1 vessels instead derives from their low operational frequency relative to Tier 2 and 3 vessels and, in the event of an encounter, the lower severity of a low-speed strike (see discussion below).

Tier 2: Medium-Displacement Support & Service Craft

Vessel Types: support vessels and supply tenders (12.2-24.4 m (40–80 ft)).

Risk Characterization: FHWA and MDTA have committed to the enforcement of reduced construction vessel speeds (e.g., below 18.5 km/h (10 kts)). However, these intermediate draft (4-8 feet) vessels can operate at moderate speeds of 15 to 22.2 km/h (8 to 12 kts). They navigate dynamically around the bridge bents and within the designated construction zones. While their paths are less predictable than Tier 1 vessels, their moderate speeds and mid-water drafts provide a sufficient reaction window for transiting sturgeon (Gibbs and Northcutt 2004, Johnston *et al*. 2017).

Tier 3: Light-Displacement / High-Speed Crew Transfer Vessels

Vessel Types: Rigid-hull inflatable boats (RHIBs), center-consoles, and small vessels (6.1-12.2 m (20–40 ft)).

Risk Characterization: FHWA and MDTA have committed to the enforcement of reduced construction vessel speeds (e.g., below 18.5 km/h (10 kts)). These vessels are capable of operating at high, planing velocities (>27.8-37 km/h (15–20 kts)), and represent the vast majority of the daily vessel trips (up to 30 round-trips per day). Their high speed significantly compresses the behavioral reaction time available to a surfacing or shallow-swimming animal. However, Tier 3 vessels feature shallow static and dynamic drafts (typically 0.6 to 1.2 m (2 to 4 ft)). The risk of a Tier 3 strike depends entirely on the vessel speed, vertical clearance buffer between the vessel drafts, and the seasonal depth distribution of the sturgeon.

As explained above, we consider the available information to indicate that the baseline risk of vessel strike in the action area is low. We expect the risk of a project-related vessel strike to Atlantic and shortnose sturgeon to be in part influenced by the potential for co-occurrence, which is seasonally variable and directly tied to water temperature and dissolved oxygen dynamics within the estuary (Secor and Niklitschek, 2001; Niklitschek and Secor, 2005). During the spring and fall, sturgeon occupancy of the shallow shoals (< 9.1 m (30 ft)) flanking the bridge is negligible; well-oxygenated bottom waters allow transiting and foraging individuals to remain within the deep navigation channel, thereby reducing vertical and spatial co-occurrence with shallow-draft surface vessels (Welch *et al*., 2013; Hager *et al*., 2014). However, during the summer months (June–August), deep-water benthic anoxia and hypoxia force sturgeon out of the deep navigation channel and onto the shallower, mesohaline flats (Secor and Gunderson, 1998; Niklitschek and Secor, 2005). This localized 'habitat squeeze' (Coutant, 1987) increases sturgeon density in the shallows, bringing individuals into close vertical proximity with vessel hulls and propellers. Consequently, the risk of a project-related vessel strike is expected to be concentrated almost exclusively during the summer months, presenting the highest risk when shallow-draft project vessels are operating outside the maintained, deep navigation channel (Brown and Murphy, 2010; Balazik *et al*., 2012).

While the potential co-occurrence of sturgeon and project-related vessels in the shallow waters during summer increases the risk of interactions, the dispersed nature of Atlantic and shortnose sturgeon in the upper Chesapeake Bay, the lack of known sturgeon use of the Patapsco River, the absence of spawning populations in the upper Bay, and the geography of the upper Bay, which does not restrict Atlantic sturgeon distribution in the way that narrow or constricted river reaches may, reduce many of the factors that are considered to increase risk of vessel strike of Atlantic sturgeon (Gomez and Sullivan Engineers, n.d.; Hondorp *et al*., 2017; Schoeman *et al*., 2020).

A dispersed, non-aggregated distribution reduces the probability that any given vessel transit will spatially and temporally coincide with an individual sturgeon at a specific location, and the transient, mobile nature of sturgeon movements through this reach further limits predictable overlap with vessel routes, as compared to areas of known aggregation such as spawning or overwintering habitat.

In addition, the potential for project-related vessel interactions with Atlantic and shortnose sturgeon during the critical summer hypoxia window is further minimized through the mandatory implementation of the 18.5 km/h (10 kts) speed restriction and the deployment of vessel-based

Protected Species Observers (PSOs) (Schoeman *et al*., 2020). While the telemetry evidence summarized above indicates that sturgeon are unlikely to detect or actively evade an approaching vessel regardless of speed, vessel speed remains relevant to the effects of an interaction. As discussed above (Killgore *et al*. 2011), the probability and severity of propeller-strike injury is a function of blade rotation rate, which scales with vessel speed; a vessel operating at or below 18.5 km/h (10 kts) strikes with substantially less force and lower propeller RPM than one operating at planing speeds of 27.8-37 km/h (15–20 kts). The 18.5 km/h (10 kts) restriction therefore reduces the severity of injury in the event of an encounter, rather than the probability that sturgeon detect and avoid the vessel.

We recognize that due to the benthic nature of sturgeon and the elevated turbidity characteristic of the mesohaline Chesapeake Bay water column, vessel-based PSOs are limited in their ability to visually detect and clear sturgeon directly ahead of a moving hull. However, PSOs maintain real-time oversight of vessel operations, ensuring strict compliance with the 18.5 km/h (10 kts) mandate. Consequently, when evaluated in tandem with the shallow drafts of the vessels, these conservation measures reduce the probability of a lethal vessel collision to an extremely remote and discountable scale.

Project vessels are expected to represent an approximate 5 percent temporary increase over the established baseline of 34,302 annual vessel transits in the upper Chesapeake Bay and Federal Navigation Channel. While not negligible, this temporary increase is distributed across an approximately 15-year construction and demolition program rather than concentrated in a single season, and - for the reasons discussed above regarding dispersed sturgeon distribution and reduced injury severity at restricted speeds - is not expected to appreciably change the baseline risk of vessel strike. Based on the anticipated size and type of vessel, travel routes, and number of trips as informed by relevant data from similar projects, the lack of surface-oriented behavior in sturgeon, and the maintenance of a vertical clearance even during periods of summer benthic hypoxia, the probability of a project-related vessel striking an Atlantic or shortnose sturgeon is extremely remote. Any marginal increase in collision risk relative to the baseline level of commercial and recreational traffic at the bridge span cannot be meaningfully measured or evaluated. Therefore, the potential effects of project-related vessel traffic on Atlantic sturgeon and shortnose sturgeon, are too small to be meaningfully measured, detected, or evaluated, and insignificant.

6.6 Blasting

As described above, demolition of the existing structures occurs in two phases. If required, any blasting will be limited to October 1 – December 15. During this time of year, the majority of adult shortnose sturgeon are located at overwintering areas outside of the action area. For example, shortnose sturgeon overwinter predominantly near the fresh/saltwater interface (SSSRT 2010, Kynard *et al.* 2009). During the winter, the action area lacks the necessary freshwater chemistry and low-velocity benthic habitat features required to support overwintering shortnose sturgeon; however, individual, transient fish may occur within the action area between December and February. Therefore, although unlikely, shortnose sturgeon adults may be present within the action area when blasting occurs.

The majority of adult and subadult Atlantic sturgeon overwinter in estuaries, bays, sounds, and marine environments. For example, a Balazik (2023) telemetry study conducted of Atlantic sturgeon captured in 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. Within the action area, telemetry detections at the bridge span drop off precipitously by mid-November, leaving only a negligible number of late-season stragglers transiting the area. During the core winter months, Atlantic sturgeon are rare in the mainstem Chesapeake Bay in the vicinity of the Bay Bridge (W. Cruz, NOAA, pers. comm. 2026). Although juvenile Atlantic sturgeon are more tolerant of saline waters, near-freezing water temperatures drastically reduce their osmoregulatory efficiency and exposure to the mesohaline waters (5–15+ ppt) at the Bay Bridge during winter would cause lethal osmotic shock. Therefore, we do not expect juvenile Atlantic sturgeon to be present in the action area during blasting activities. Instead, they remain clustered deep within the freshwater or low-salinity oligohaline nursery zones of their natal tidal tributaries (e.g., the James or York rivers). As such, during the blasting window we expect that few, transient Atlantic sturgeon may be present but that generally Atlantic sturgeon would be rare.

Demolition of the existing Bay Bridge eastbound and westbound spans will require subaqueous explosive demolition of deep-water concrete piers located in water depths exceeding 12.2 m (40 ft), where mechanical means of removal are not feasible. There are 15 deep-water piers in the existing eastbound span and 15 deep-water piers in the existing westbound span that will require subaqueous blasting, for a total of 30 blast-subject structures across the two demolition phases. The total length of bridge supported by deep-water piers is approximately 6,132 linear meters (20,117 linear feet), constituting approximately 48 percent of the total bridge length to be demolished.

Blasting is anticipated during 18 blast events occurring over construction years 6 through 7 (eastbound span demolition) and 16 blast events occurring over construction years 14 through 15 (westbound span demolition) for a total of 34 blast events. Blasting will occur concurrently with pile driving operations; if construction of the second new span begins while demolition of the first existing span is underway, all blasting activities will be paused during any concurrent pile driving.

The blast design for the existing Bay Bridge has not yet been finalized; final design will occur during the USACE permitting phase in coordination with us. For planning purposes, and consistent with our approach for this project, the approved blast design parameters from the Nice Bridge project are applied as a proxy, based on the structural and environmental similarities between the two projects. The general planning-level blast parameters assumed are: five decks of explosives per hole; a maximum of 13.6 kilograms (30 pounds) of explosives per delay; a minimum of 9 milliseconds (ms) delay between explosions; and a maximum of 17 ms delay between decks within the same hole. These parameters will be re-evaluated and refined during final design based on actual pier concrete conditions and updated best available science.

Blasting has the potential to cause physical injury or mortality to individual sturgeon and displace 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. Here, we consider that risk to sturgeon in the action area.

As noted above, all blasting will occur between October 1 and December 15, when fish density is at its lowest. As described above, the proposed action incorporates the following measures to monitor and reduce the potential for fish mortality:

- Perform acoustic telemetry monitoring of previously tagged shortnose and Atlantic sturgeon in the action area to continue data collection on the presence of sturgeon and delay blasting until any detected sturgeon leaves the Exclusion Zone (640 m (2,100 ft) around each pier);
- Use of fish deterrent sonar (pulled behind a 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[21] with blast cap detonations (each will contain 0.75 grams (0.03 ounces) 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 Exclusion Zone;
- Maintain a zone of fish passage in the bay during blasting (i.e., the area outside of the Exclusion Zone);
- Post-blasting surface monitoring for injured or dead sturgeon that will occur following each detonation;
- 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 minimize projectiles.

6.6.1 Acoustic Deterrence

The proposed action incorporates both (1) acoustic fish deterrent sonar (pulled behind a vessel) and (2) scare blasts prior to blasting. The applicant has not yet finalized a specific acoustic deterrent system design. However, consistent with our approach elsewhere in this consultation, of the Nice-Middleton Bridge project serves as an analog for blast design and monitoring parameters. For purposes of this analysis, we assume a system with characteristics and performance similar to the system used for the Nice Bridge project described in Section 3.5 of this Opinion. If the acoustic deterrent system incorporated into the final project plan is

[21] 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.

significantly different than this assumption and would result in effects to sturgeon not considered here, reinitiation of consultation may be required

The purpose of a fish deterrent sonar is to behaviorally deter sturgeon from entering or remaining in the blasting area, to minimize the potential for exposure to blasting effects. In July 2015, ERDC (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 10 m (33 ft) 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 operated as close in time to the blast as safety allowed before moving away from the blasting site (approximately 30 minutes).

Blasting plans will also incorporate fish scare charges. The fish scare will be set off 30 seconds prior to the main detonation, followed by a 10-second count down will before detonating the blast. These fish scares will consist of a series of blasting caps, each containing 0.75 grams (0.03 ounces) of explosives, suspended in the water column surrounding the structure. The scare charges will likely be placed in very close proximity to the bridge and likely within the 640 m (2,100 ft) Exclusion 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 and the successful implementation of acoustic deterrent technology during the recent demolition of the Nice Bridge in 2023, the anticipated deterrent methods for this project are expected to effectively encourage sturgeon to leave the project area prior to blasting.

6.6.1.1 Effects of Noise Produced by Acoustic Deterrents

As noted above, the sound source for the fish deterrent sonar produces 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 m (17.4 ft) from the sound source. This results in an ensonified area of approximately 0.4 square kilometers (0.15 square miles), and all Atlantic sturgeon behavioral responses were anticipated to occur within the ensonified area. Based on this, we expect that effects to shortnose and Atlantic sturgeon from exposure to the fish deterrent sonar would be limited to a 0.4 square kilometer (0.15 square miles) area centered around the blasting site.

As described in the pile driving analysis, 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 fish deterrent sonar in the Delaware Deepening project did not exceed 193 dB re 1uPa2·s peak and, therefore, we expect fish deterrent sonar used for this project will not exceed the peak noise exposure threshold of 206 dB re 1µPa. Given the short duration of the blasting event, consideration of the cumulative noise threshold is not relevant for considering effects of exposure to the detonations; however, it is considered as we assess effects of the noise deterrent system.

As described above, the cSEL is not an instantaneous maximum noise level, but is a measure of the accumulated energy over a specific period of time (i.e., in this case, the duration of use of the fish deterrent sonar over the course of a single day). 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). Information from the Delaware project indicates that the distance to the 187 dB re 1uPa cSEL isopleth was less than five meters from the noise source[22]. That means that in order to accumulate enough energy to be injured, a sturgeon would need to stay within 5 meters of the noise source for the entire 10-hour period that the system is

[22] 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).

operational. We do not expect this to happen because sturgeon in the action are highly mobile and expected to be largely using the site for transiting between areas. Shortnose sturgeon do not overwinter in the mainstem of the Bay, but individuals may be migrating through the project area and Atlantic sturgeon are also 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 fish deterrent sonar. 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, ranging from a startle to avoidance or alteration of activities including foraging, are expected to occur in sturgeon exposed to noise above 150 dB RMS. The Nice Bridge project calculated that noise will exceed that threshold in a 1,920 m (6,299 ft) area around the blasting site. The width of the Bay is 7.2 km (4.5 miles); therefore, a 1,920 m (6,299 ft) area leaves at least an 816 m (2,677 ft) zone of passage where noise below this threshold is expected. We expect that sturgeon, upon detecting underwater noise levels at or above the 150 dB thresholds, would modify their behavior such that the fish redirects its course of movement away from the noise source. It is extremely unlikely that these movements would have a measurable or detectable effect on the use of the action area by sturgeon, as the Bay is sufficiently wide enough (approximately 7.2 km (4.5 miles) wide) to allow individuals to avoid the ensonified area while continuing to forage and migrate within the 816 m (2,677 ft) zone of passage. We also note that this increase in noise will be limited to less than 12 hours a day for no more than 34 days spread out over a 15-year period. Therefore, the effects of underwater noise produced by fish deterrent sonar on ESA species would be too small to be meaningfully measured, evaluated, or detected and are therefore, insignificant.

6.6.2 Available Information on Effects of Blasting on Fish

The BA relied on the demolition of the original (1940) Nice-Middleton Bridge (N-MB) performed in late 2023 as a proxy for the proposed demolition of the existing Bay Bridge to obtain a rough estimate for the magnitude of effects of explosive underwater demolition. The N-MB project team determined the most appropriate Mortality Zone and Danger Zone designations based on a review of existing published documents and studies, including the six reference projects/documents forwarded by NMFS for other demolition projects. These zones were then compared to the data from the fish surveys to determine anticipated impacts. The analysis in the BA applied a formula from Hempen *et al.* (2007) to calculate the blasting Mortality Zone (i.e., the distance from the detonation within which a fish would be expected to be seriously injured or killed). Hempen *et al.* (2007) studied rock-confined blasting to gain information on typical

pressure measures from the rock removal program relative to impacts on marine organisms as part of the ongoing Miami Harbor Channel Deepening for the Dodge Island Widening (and Turning Basin). 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[23] of a single, open-water blast

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 53 m (174 ft) around each of the piers to be blasted. To account for the physical dimensions of the piers - and to ensure that the Mortality Zone extends from the outer face of the largest pier rather than from its centerline - the MRC is increased by half the width of the largest pier to be blasted in each span: MRC (EB, adjusted) = 174 + 41 = 215 feet MRC (WB, adjusted) = 174 + 46 = 220 feet.

It is important to note that these calculations assume the full 13.6 kilogram (30 pound) maximum charge weight per delay throughout the pier. In practice, charges located closest to the exterior of the pier will likely be smaller than those in the interior, meaning this Mortality Zone estimate is conservative.

The formula in Hempen *et al.* (2005) was utilized to calculate the Exclusion Zone, which defines the area surrounding each blast event within which effects on fish - including injury, harassment, and potential mortality - are anticipated. The Exclusion Zone is also the operational boundary within which the presence of telemetry tagged individuals will be monitored and blasting will be delayed until any tagged individuals have left the area. The Exclusion Zone is calculated using the Hempen *et al*. (2005) formula for confined blasting, with an additional 152.4 m (500 ft) conservative buffer applied to account for the sensitivity of marine organisms, including vulnerable species:

R (feet) = [520 × W^(1/3)] + 500

[23] 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.

where R is the Exclusion Zone radius in feet and W is the maximum pounds of explosives per delay.

Applying a maximum charge weight of 30 pounds per delay:

R = [520 × (30)^(1/3)] + 500 = **2,100 feet (approximately 640 meters)**

As with the Mortality Zone, this is a conservative estimate; the actual zone of behavioral disturbance is expected to be smaller for each blast event given that maximum-weight charges are confined to the interior of the piers and lesser charges will likely be used nearest the pier exterior. Considering the inputs to the formula and the incorporation of the 152.4 m (500 ft) buffer, we expect that in order to experience any potential for injury a sturgeon would need to be within this exclusion zone during active detonation.

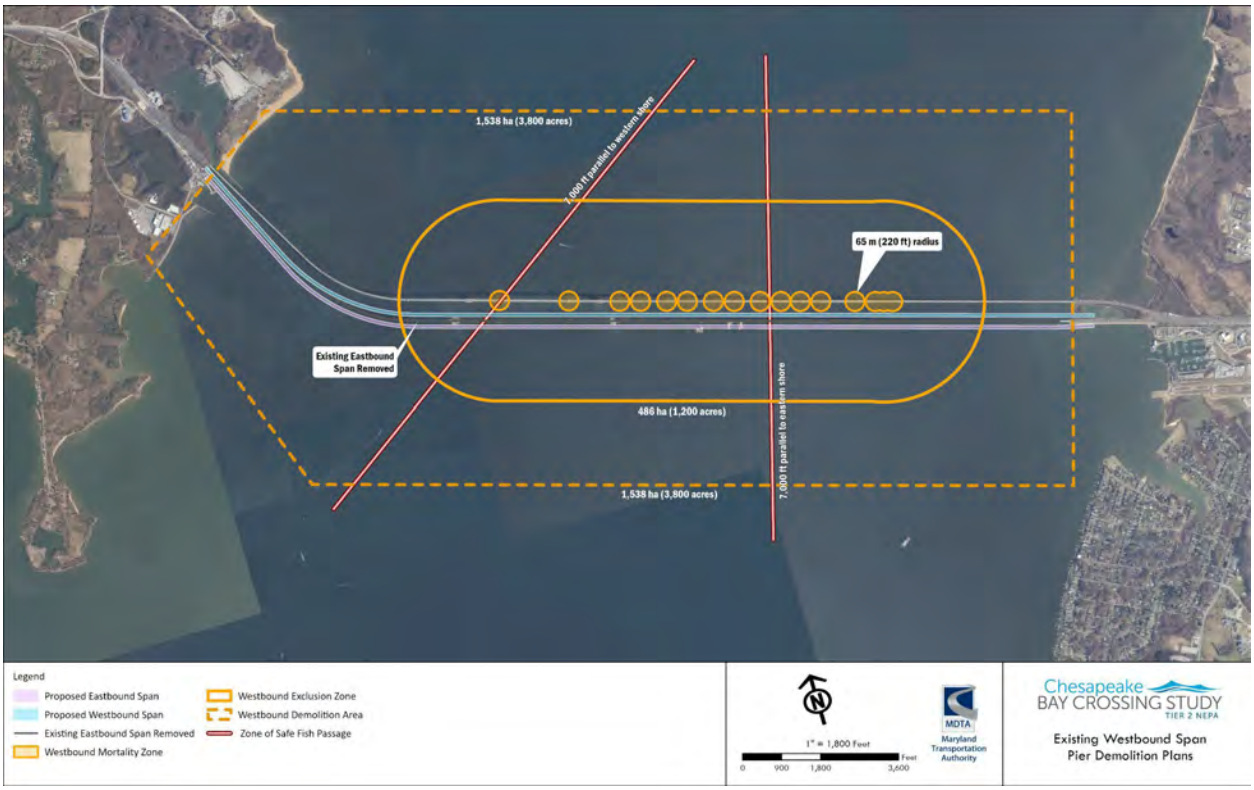
For context, the Exclusion Zone radius of 640 m (2,100 ft) substantially exceeds the Mortality Zone radius 65.5-67 m (215–220 ft) by approximately an order of magnitude. Fish within the Exclusion Zone, but outside the Mortality Zone, at the time of detonation may sustain sublethal injury - including barotrauma, internal hemorrhage not immediately fatal, and temporary or permanent hearing threshold shifts - and are subject to behavioral disturbance resulting from sudden intense acoustic and pressure exposure. The probability and severity of disturbance within the Exclusion Zone is expected to be greatest in the area immediately surrounding the Mortality Zone and diminishes with increasing distance from the blast source.

Previous section 7 consultations on bridge pier demolition projects used this formula and it 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. The zones of influence described above are depicted in Figure 9 and Figure 10 and are consistent with the available information described below on the effects of blasting on fish.

Figure 9. Mortality Zone and Exclusion Zone for the existing eastbound span



Figure 10. Mortality Zone and Exclusion Zone for the existing westbound span



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 loss of hearing sensitivity), 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 m (65.6 to 164 ft) for 22.7 kilogram (50 pounds) per charge and from 45 to 110 m (147.6 to 361 ft) for 272.4 kilograms (605 pounds) per charge (Teleki and Chamberlain 1978). Approximately 201 blasts were detonated in 4 to 8 m (13.1 to 26.2 ft) 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 m (151 ft)) 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 (70.5 pounds) of explosives. For the 32 kilogram (70.5 pounds) 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 m (23 to 36 ft)), 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 (248 and 2,110 pounds) of explosives in depths ranging between 0.5 and 2 m (1.6 and 6.6 ft). 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 m (39.4 ft) (for both charge magnitudes). No fish were killed by the shock wave at the 24 m (78.7 ft) position and beyond.

Hubbs and Rechnitzer (1952) looked at the effects of blasting on the following caged fish: anchovies, jack mackerel, kingfish, sardine, queenfish, pompano, and grunion. The cages were placed anywhere from 3-28 m (10-92 ft) 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 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 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 (53 to 62 pounds) of explosives per hole, and an approximate 25 m/s (82 ft/s) delay after each blast. During test blasting, 50 hatchery reared juvenile striped bass and shortnose sturgeon were placed in 0.64 centimeters (0.25 inches) plastic mesh cylinder cages (0.6 m (2 ft) in diameter by 0.9 m (3 ft) long) 0.9 m (3 ft) from the bottom (worst case scenario for blast pressure as confirmed by test blast pressure results) at 10.7, 21.3, 42.7, 85.3, and 170.7 m (35, 70, 140, 280, and 560 ft) upstream and downstream of the blast location. For each test, 200 caged shortnose sturgeon were held at a control location 0.8 km (0.5 mi) from the test blast area. The caged fish had a mean weight of 55 grams (0.12 pounds).

Several fish within 21.3 m (70 ft) of the drill holes (most within 10.7 m (35 ft)) 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 21.3 m (70 ft) 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 centimeters (11.8 inches) average) as compared to the size of the other species (3 – 20 centimeters (1.2-7.9 inches)). Therefore, mortality for sturgeon 30 centimeters (11.8 inches) or larger may occur less frequently due to their size. However, some fish caged as far as 170.7 m (560 ft) 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 is nearly the same as maximum number of blasts proposed for this project (n=34). However, the maximum amount of explosives used in the Moser (1999) study (24 to 28 kilograms (53 to 62 pounds) of explosives) exceed the maximum amount of explosives for this project (13.6 kilograms (30 pounds) per delay). Therefore, we can conclude that the effects of blasting on fish may be less severe (less injury and mortality, particularly for fish that are 30 centimeters (11.8 inches) or larger) than described in the Moser (1999) study.

The monitoring program implemented for the Nice Bridge replacement project in 2023 examined the potential effects of subaqueous explosive pier demolition on aquatic biota, specifically ESA-listed shortnose and Atlantic sturgeon. In-situ blast pressure monitoring was conducted using underwater noise meters and hydrophones to record water-borne peak overpressures and attenuation from the confined pier blasts. Data was collected from actual blasts to evaluate real-world noise levels against the 206-decibel (dB) peak behavioral and acoustic mortality thresholds. Pressure data was collected across varying distances from the detonations to map acoustic dissipation and confirm the size of the danger zone. The blast pressures recorded at the 640 m (2,100 ft) edge of the designated Danger Zone (or, Exclusion Zone, as defined in the Bay Crossing BA) were noted to be quite low (181.8 dB to 191.3 dB peak) compared to the 206 dB mortality threshold, demonstrating that the established safety boundaries were highly conservative. Close-range hydrophone arrays tracked the rapid reduction of waterborne energy, showing peak pressures dropping from 209 dB at 66.4 m (218 ft) down to 200 dB at 157.3 m (516 ft).

The data inferred that the controlled, stemmed, and delayed confined charges used in the Nice Bridge Demolition Program successfully restricted extreme pressure waves, confining the dangerous 206 dB noise contour to a radius of approximately 123 m (400 ft) from the blast. The fish kill that did occur was highly localized and concentrated within the immediate vicinity of the structural columns. The actual limits of the mortality footprint were determined to tightly match the anticipated 52.4 m (172-ft) mortality zone based on immediate post-blast biological evaluations. Stunned and killed fish (totaling 1,110 individuals across two primary blast events) were recovered by project biologists using hand nets from the surface via specialized Fish Recovery Vessels. No Atlantic or shortnose sturgeon were documented. A real-world assessment of the blast events monitored during this study demonstrated that utilizing minimized charge weights and a 9-millisecond minimum delay sequence appeared to successfully prevent any incidental take of sturgeon.

In addition to the Nice-Middleton Bridge monitoring data discussed above, we also considered empirical blasting-mortality data from a second, independent analog project: the USACE's deepening of the Philadelphia to the Sea Federal Navigation Channel, a project distinct from the Nice-Middleton Bridge demolition. Since 2008, the USACE have been working with us to consider effects of the deepening of the Philadelphia to the Sea Federal Navigation Channel from -12 to -13.7 m (-40 to -45 ft) (with 0.6 m (2 ft) over-dredge) MLLW. The biological opinions issued between 2012 and 2019 considered the effects of blasting on Atlantic and shortnose sturgeon. Over the first four blasting seasons, 506 detonation blasts (shots) occurred (Season 1:

117; Season 2: 211; Season 3: 150; Season 4: 28). Methods to clear sturgeon from the blast zone (500-foot radius), as well as monitoring whether they have entered it, have shown to be very effective. On multiple occasions, active acoustic monitoring (for acoustically tagged sturgeon) detected sturgeon. In all of these instances, scare charges were used (as many as five) until the fish left the blast zone. In all, we have attributed nine takes to blasting activities (8 lethal, 1 non-lethal). Post-blast visual surveys continued at least 305 m (1,000 ft) downcurrent of the blast site. The observers did not recover any injured sturgeon outside of the blast zone (more than 152.4 m (500 ft) from the blast) post-blast.

- 2/6/2016: a stunned Atlantic sturgeon was observed on the surface after a blast, but it swam away when observers attempted to capture it with a dip net.
- 3/12/2016: during relocation trawling, an Atlantic sturgeon carcass was incidentally recovered (i.e., it was previously dead). A necropsy report completed August 9, 2016 concluded that the fish might have died from blast related injuries.
- 2/1/2017: two shortnose sturgeon floated to the surface after a blast. One was killed instantly; the other's condition continued to deteriorate and the biologist euthanized it the following morning after determining that it would not survive.
- 3/1/2017: a shortnose sturgeon floated to the surface after a blast (the sturgeon died that night in a holding tank)
- 12/12/17: An injured shortnose sturgeon, gilling occasionally, but not able to maintain equilibrium, was collected after a blast. The biologist tried to revive the sturgeon but it died approximately 1.25 hours after being collected.
- 01/02/2018: An injured Atlantic sturgeon gilling occasionally but not able to maintain equilibrium was collected after a blast. The biologist tried to revive the sturgeon but it died in the holding tank 22 hours after being collected.
- 01/14/2018: An injured shortnose sturgeon was collected after a blast. The sturgeon gilled a few times but died within a few minutes after being collected
- 01/15/2018: An injured shortnose sturgeon with weak gill movements was collected after a blast. The sturgeon died a few minutes after being collected.

Based on the results of the post-blast surface monitoring from the Delaware Deepening Project, these blasts resulted in the mortality of two juvenile Atlantic sturgeon and six adult shortnose sturgeon, and the injury (stunning) of one juvenile Atlantic sturgeon. We note that the area where blasting occurred is a high use area of the Delaware River where sturgeon of both species are known to aggregate.

The maximum pounds of explosive per delay for the proposed Bridge project is 13.6 kilograms (30 pounds), is equal to the those used in the Nice Bridge (2023) study. However, several variables impact the magnitude of the blasting effects 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 effects on fish (Teleki and Chamberlain 1978, Moser 1999). Given all variables that may influence the effects of blasting on fish, although the area is greater than that calculated in the above study, the

Exclusion Zone of 640 m (2,100 ft) 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 Exclusion Zone) are consistent with the available information on the effects of blasting on fish and are expected to encompass all the underwater areas where the effects of blasting may be experienced.

6.6.3 Effects of Proposed Blasting on Shortnose and Atlantic Sturgeon

During the winter months, transient adult shortnose sturgeon may occur within the project area when blasting will occur. Telemetry detections of Atlantic sturgeon at the bridge span drop off precipitously by mid-November, leaving only a negligible number of late-season stragglers transiting the action area. Therefore, we expect a limited number of subadult and adult Atlantic sturgeon may migrate through the blasting component of the action area until early December (NOAA 2026) and may be within the action area during blasting.

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 effects of blasting on fish described above, we conclude that the Exclusion Zone of 640 m (2,100 ft) around each pier represents the most accurate impact estimate based on the best available information. Therefore, any sturgeon within 640 m (2,100 ft) 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. Recovery of stunned sturgeon following blasting in the Delaware River supports this as several individuals died within hours of collection.

Based on the information presented above, shortnose and Atlantic sturgeon within 640 m (2,100 ft) 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).

6.6.3.1 Estimating Sturgeon Exposure to Blasting Noise

Blasting is anticipated during 18 blast events occurring over construction years 6 through 7 (eastbound span demolition) and 16 blast events occurring over construction years 14 through 15 (westbound span demolition). Measures will be used to minimize the potential for take of sturgeon resulting from blasting. This includes using acoustic telemetry monitoring to determine if tagged sturgeon are within the Exclusion Zone of the blast site (total of 640 m (2,100 ft) from each pier). If a sturgeon is detected or observed, the project will delay the blast until the sturgeon has moved safely out of the Exclusion Zone. As explained above, we estimate that in order to be injured or killed, a sturgeon would need to be within 640 m (2,100 ft) of the bridge (i.e., Exclusion Zone) during the one-second duration of the detonation.

Telemetry data collected by NOAA's Chesapeake Bay Interpretive Buoy System from 2021 to 2024 indicated the presence of Atlantic sturgeon in the Chesapeake Bay North array (located just south of the Bay Bridge), with detections of tagged Atlantic sturgeon occurring mainly during the warmer months (May through July), with additional detections in October through December. The fish were within the vicinity of the Bridge from one to four hours each day (Figure 11). Therefore, by early December, most subadults and adults are likely outside of the action area, either north of the Bridge near the salt front or below the Bridge in the Chesapeake Bay. Although there were no detections of tagged individuals, adult shortnose sturgeon may occur within the action area, and may move throughout the Bay and pass through the action area (SSSRT 2010) but are not expected to overwinter within the project area during this time.

Figure 11. Chesapeake Bay North hourly detections (2021-2024)



Based on the available information, 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 fish deterrent sonar, described above, may act as a behavioral deterrent to at least some sturgeon and reduce the number of sturgeon passing within 640 m (2,100 ft) of the bridge (Exclusion Zone) at the detonation site. We are unable to estimate the number of sturgeon that would be in the Exclusion Zone at the time of blasting because we do not have information regarding the number of shortnose or Atlantic sturgeon in Chesapeake Bay. However, we expect the majority of sturgeon in the Bay will be well above or below the Exclusion Zone at the time of blasting and are most likely to be within rivers with spawning populations outside of the action area. Based on information from the telemetry receiver, we expect that a small number of sturgeon in the Bay 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 (18 blast events during demolition of the first bridge span, to occur during years 6 to 7 of construction, and 16 blast events during demolition of the second bridge span, to occur during years 14 to 15 of

construction), and the use of deterrents and observers (telemetry and visual), we expect that the majority of the already small proportion of sturgeon in the Bay will be effectively outside of the Exclusion Zone. However, despite the implementation of avoidance and minimization measures, there is still the potential for a very small number of sturgeon to be in the Exclusion 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 fish deterrent sonar 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 fish deterrent sonar will be used.

Rather than assuming a fixed rate of one mortality per blast event as was evaluated in the BA, we base our take estimate on empirical monitoring data from comparable confined-shot bridge and channel demolition projects. Monitoring during the Delaware River Main Channel Deepening Project documented 9 sturgeon takes from 506 blasting events (ERC 2015, 2016, 2017), an incident rate of approximately 0.018 per blast. Monitoring conducted during the 2023 Nice-Middleton Bridge demolition program, which used a comparable confined-shot design with the same maximum charge weight (13.6 kilograms (30 pounds) per delay) and comparable BMPs (fish deterrent sonar, scare charges, telemetry and visual observers, TOYR), documented zero Atlantic or shortnose sturgeon among the recovered fish kill across the blasts conducted during that program. As noted above, the Delaware River blasting occurred in a high use area where sturgeon aggregate; thus, the interaction risk is expected to be greater than it would be in the action area for this project.

Applying the Delaware Deepening incidence rate to the 34 total blast events anticipated for this project (18 EB, 16 WB) yields an expected value of approximately 0.6 sturgeon interactions over the life of the project. We round this up to one (1) and as we cannot reasonably predict whether this interaction is likely to be a shortnose or Atlantic sturgeon, and we expect that the proposed action could result in the mortality of up to one Atlantic sturgeon and one shortnose sturgeon over the life of the project.

Outside of the 640 m (2,100 ft) Exclusion 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 m (2,100 m) and increased turbidity and total suspended solids may also extend beyond this area, as discussed above. Behavioral effects, such as avoidance or disruption of foraging activities due to noise, may also occur in sturgeon exposed to noise above 150 dB RMS. However, given that noise from blasting will last only one second at a time, any behavioral response is expected to be extremely short and likely not more than a startle. As such, effects are likely to be so small that they cannot be meaningfully measured, detected, or evaluated and will be insignificant.

6.7 Non-Blasting Demolition Activities

In addition to subaqueous blasting (Section 6.6), demolition of the existing Bay Bridge piers and pile bents will involve mechanical demolition methods not otherwise addressed in this Opinion. These include: mechanical removal of the 156 shallow-water pile bents (67 EB, 89 WB) and 50 moderate-depth piers (39 EB, 11 WB) that will not be blasted; mechanical demolition of the above-water portion of each deep-water pier prior to blast-hole preparation; mechanical removal of deck slabs and girders; and extraction of piles by vibratory or other mechanical means.

Physical strike and debris

Demolition rubble from mechanical removal of piers and pile bents will drop to the Bay bottom in the immediate vicinity of each structure. Unlike blasting, mechanical demolition does not involve a discrete high-energy explosion with a defined injury radius, but the falling debris itself presents a physical strike hazard to any sturgeon in very close proximity to an active demolition structure at the moment material is dropped. Given that sturgeon are not expected to aggregate at or remain beneath an active demolition structure (consistent with the transient, non-aggregating use of the action area described elsewhere in this Opinion), and given that protected species observers already committed to for blasting and pile driving activities could reasonably be extended to cover mechanical demolition, we anticipate the likelihood of a sturgeon being struck by falling debris to be extremely unlikely, and therefore discountable.

Turbidity

Mechanical demolition of piers and pile bents, and mechanical pile extraction, will generate localized turbidity, addressed in the context of the project's overall turbidity effects in Section 6.3. The BMPs committed to for pile removal (preferring vibratory extraction over direct pull, jetting, or clamshell methods, per the Pier Demolition Report) are the same measures already credited in that turbidity analysis for new pile installation and are expected to have a comparable turbidity-reducing effect during demolition.

Vessel traffic

Mechanical demolition will require barges and support vessels at each of the 206 mechanically demolished structures over the life of the demolition program. This vessel activity is encompassed within the overall project vessel traffic analysis in Section 6.5 and does not represent an additional, unanalyzed source of vessel-strike risk beyond what is already quantified there.

6.8 Geotechincal Investigations

Underwater noise

Geotechnical drilling and sampling equipment generate continuous, non-impulsive underwater noise, of the same general category as noise from vessels, dredging, or vibratory pile driving (ANSI, 1995; NIOSH, 1998; see Section 6.1.1). The source levels of drill rigs and sampling equipment used for geotechnical borings are substantially lower than the pile driving equipment analyzed in Sections 6.1 and 6.6.2 and are not expected to approach the injury thresholds developed in this Opinion for impact pile driving or blasting. Any noise generated is expected to

remain below the 150 dB re 1 µPa RMS behavioral threshold used throughout this Opinion (Section 6.1.2) beyond a limited radius of the sampling vessel. Because each boring is conducted at a discrete location for a limited duration, any sturgeon in the vicinity would be exposed only briefly and would be expected to move through or away from the area without difficulty, consistent with the swim-speed and avoidance analysis applied to other continuous noise sources in this Opinion (Section 6.1.5).

Vessel traffic

The vessel(s) used for geotechnical sampling would be stationary or slow-moving while on station at each boring location, rather than transiting at speed, consistent with the vessel-strike analysis in Section 6.5, which found project vessel operations - given their limited speed, shallow draft, and observer protocols - extremely unlikely to result in the strike of a sturgeon.

Physical disturbance and turbidity

Individual boreholes are small in diameter (typically on the order of a few inches) and would affect a negligible area of substrate at each sampling location relative to the area affected by pier construction, dredging, or blasting. Any turbidity generated during drilling or grouting would be minor, localized to the immediate vicinity of the borehole, and of shorter duration and lower magnitude than the turbidity from dredging and pile driving already addressed in Section 6.3. Given the low source levels and short, localized noise exposure, the small physical footprint of individual borings, the stationary or slow-moving nature of the sampling vessel, and the brief duration of activity at any one location, effects to Atlantic sturgeon and shortnose sturgeon from geotechnical investigations are extremely unlikely to occur and are discountable. To the extent any effect does occur (e.g., minor turbidity or a brief startle response), it would be too minor to be measured, evaluated, or detected, and is insignificant.

6.9 Temporary Moorings

Installation noise

To the extent mooring piles (rather than mooring ball anchors) are used, based on the pile size, purpose, and substrate, we assume vibratory installation of small-diameter, temporary piles, rather than the impact driving used for the permanent bridge piles addressed in Sections 6.1 and 6.6. This is expected to produce continuous, non-impulsive noise at or below the lowest vibratory source levels already evaluated in this Opinion (e.g., the 14-inch steel H-pile vibratory installation), for which the 150 dB RMS behavioral threshold extends only a short distance from the pile.

Benthic disturbance

The footprint of individual mooring piles or anchors is far smaller than that of permanent pier construction, and FHWA and MDTA's commitment to avoid oyster beds and SAV further limits any effect on sensitive benthic habitat features relevant to these species. Swing of anchor chains with tide and current could disturb a limited additional area of bottom around each mooring;

because moorings will not be sited in oyster beds or SAV, this incidental disturbance is expected to affect only soft-bottom or previously disturbed sediment.

Vessel traffic
Vessels on station at a mooring are stationary rather than transiting, and consistent with the Section 6.5 vessel-strike analysis, present minimal or no strike risk while moored; the observer and speed-restriction protocols established for project vessels in Section 6.5 apply while vessels transit to and from mooring locations.

Turbidity
Installation of mooring piles or anchors would generate minor, temporary turbidity, similar in kind to but smaller in magnitude than turbidity generated during installation and removal of the bridge's permanent piles (Section 6.3).

Given the small footprint, avoidance of oyster beds and SAV, low noise levels relative to production pile driving, and the stationary nature of moored vessels, effects to Atlantic sturgeon and shortnose sturgeon from temporary mooring installation and use are extremely unlikely to occur and are discountable, or, to the extent any minor effect occurs, insignificant.

6.10 Summary of Effect Determinations

Table 21. Species effect determinations by stressor

Species	Federal Status	Distinct Population Segment (DPS) Potentially Occurring in the Action Area	Stressor	Stressor Effect	Species Determination
Atlantic sturgeon (*Acipenser oxyrinchus*)	Endangered	Chesapeake Bay	Pile driving	NLAA	LAA
			Dredging	NLAA	
			Turbidity and habitat modification	NLAA	
			Increased vessel traffic	NLAA	
			Blasting	LAA	
			Non-blast demo	NLAA	
			Geo borings	NLAA	
			Moorings	NLAA	
Shortnose sturgeon (*Acipenser brevirostrum*)	Endangered	Range-wide	Pile driving	NLAA	LAA
			Dredging	NLAA	
			Turbidity and habitat modification	NLAA	
			Increased vessel traffic	NLAA	
			Blasting	LAA	
			Non-blast demo	NLAA	
			Geo borings	NLAA	
			Moorings	NLAA	
	Threatened	Northwest Atlantic	Pile driving	NLAA	NLAA

Species	Federal Status	Distinct Population Segment (DPS) Potentially Occurring in the Action Area	Stressor	Stressor Effect	Species Determination
Loggerhead sea turtle (*Caretta caretta*)			Dredging	NLAA	
			Turbidity and habitat modification	NLAA	
			Increased vessel traffic	NLAA	
			Blasting	NLAA	
			Non-blast demo	NLAA	
			Geo borings	NLAA	
			Moorings	NLAA	
Kemp's ridley sea turtle (*Lepidochelys kempii*)	Endangered	Range-wide	Pile driving	NLAA	NLAA
			Dredging	NLAA	
			Turbidity and habitat modification	NLAA	
			Increased vessel traffic	NLAA	
			Blasting	NLAA	
			Non-blast demo	NLAA	
			Geo borings	NLAA	
			Moorings	NLAA	
Green sea turtle (*Chelonia mydas*)	Threatened	North Atlantic	Pile driving	NLAA	NLAA
			Dredging	NLAA	
			Turbidity and habitat modification	NLAA	
			Increased vessel traffic	NLAA	
			Blasting	NLAA	
			Non-blast demo	NLAA	
			Geo borings	NLAA	
			Moorings	NLAA	
Leatherback sea turtle (*Dermochelys coriacea*)	Endangered	Range-wide	Pile driving	NLAA	NLAA
			Dredging	NLAA	
			Turbidity and habitat modification	NLAA	
			Increased vessel traffic	NLAA	
			Blasting	NLAA	
			Non-blast demo	NLAA	
			Geo borings	NLAA	
			Moorings	NLAA	

7 CUMULATIVE EFFECTS

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

of the ESA. It is important to note that the definition of "cumulative effects" in the Section 7 regulations is not the same as the NEPA definition of cumulative effects[24].

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 effects 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 effects of these activities over the life of the proposed action will have different effects than those considered in the *Status of the Species* and *Environmental Baseline* sections of this Opinion.

8 INTEGRATION AND SYNTHESIS OF EFFECTS

In the *Effects of the Action* section, we considered potential effects from construction and demolition activities at the 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.

We have estimated that the Bridge project will result in injury and/or morality of up to one shortnose sturgeon and one Atlantic sturgeon over the life of the project that will occur during years 6 to 7 of construction, and years 14 to 15 of construction. These interactions are expected to result in serious injury or mortality. As explained in the *Effects of the Action* section, all other effects to shortnose and Atlantic sturgeon from the project activities, including effects to their prey and habitat, from project-related vessels, and from water quality will be insignificant and/or extremely unlikely to occur.

In the discussion below, we consider whether the effects of the proposed action reasonably would be expected, directly or indirectly, to reduce appreciably the likelihood of both the survival and recovery of 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

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

species 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."

The ESA defines recovery 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.

8.1 Atlantic sturgeon

As explained below, the proposed action is likely to result in the incidental take of up to one Atlantic sturgeon during blasting activities associated with the Bridge project. Because individual Atlantic sturgeon from the five DPSs cannot be reliably distinguished in the field (see Determination of DPS Composition, below), we do not know in advance to which DPS a taken individual would belong. For this reason, our analysis treats the take of this single individual as though it could originate from any of the five DPSs, and separately evaluates the consequences of that loss for each DPS in turn below. This analysis anticipates the take of one Atlantic sturgeon in total - not one take per DPS. We expect that the Atlantic sturgeon killed could be a subadult or adult. No take of eggs, larvae (yolk sac or post-yolk sac), young-of-year, or juvenile Atlantic sturgeon are anticipated, because these life stages do not occur in the action area. All other effects to Atlantic sturgeon, including effects to habitat and prey will be insignificant or extremely unlikely to occur.

8.1.1 Determination of DPS Composition

While the action area lies within the geographic range of the Chesapeake Bay DPS, it is located in the mesohaline mainstem of the Chesapeake Bay rather than in riverine spawning or nursery habitat. Outside of the natal rivers, we expect there to be a mixing of the five Atlantic sturgeon DPSs. Satellite tagging, acoustic telemetry, and genetic mixed-stock studies conducted throughout the species' range demonstrate that subadult and adult Atlantic sturgeon do not remain confined to their natal estuaries after outmigration; individuals from all five DPSs undertake extensive coastal migrations and regularly transit between river systems and DPS boundaries (Dunton *et al*. 2010, 2012; Erickson *et al.* 2011; Wirgin *et al.* 2015a; Kazyak *et al.* 2021a).

Telemetry data collected specifically in Mid-Atlantic waters off Maryland confirm that this mixing extends into the Chesapeake Bay region. For example, Rothermel *et al*. (2020) documented seasonal inshore and offshore movements of acoustically tagged Atlantic sturgeon across the continental shelf off Maryland, and mixed-stock and bycatch studies elsewhere in the

Mid-Atlantic Bight have repeatedly recovered individuals from DPSs other than the one nearest the sampling location (Waldman *et al*. 2013; Wirgin *et al*. 2015b; Kazyak *et al*. 2021a). However, no mixed-stock analysis has been conducted for the action area itself or a comparably situated segment of the upper Chesapeake Bay, so this Opinion does not assign relative proportions to any DPS's contribution here because it is the co-occurrence of multiple DPSs in Mid-Atlantic waters generally, not any specific ranking among them, that is supported by the best available science at this time.

Individuals from the five DPSs cannot be reliably distinguished by external morphology; DPS of origin can only be determined through genetic analysis of a tissue sample, which is why the ITS requires a fin clip from any sturgeon over 75 cm total length (RPM 3, T&C 5). Because sturgeon from any of the five DPSs may be present in the action area at the time of a given blast event, any individual affected by blasting is, therefore, equally likely to belong to any of the five DPSs. The DPS of individuals cannot be determined until the collection and analysis of a tissue sample. Therefore, this Opinion does not attribute the single anticipated Atlantic sturgeon mortality to the Chesapeake Bay DPS and considers that this individual could originate from any of the five DPSs.

8.1.2 Jeopardy Determination by DPS

8.1.2.1 Chesapeake Bay DPS

The Chesapeake Bay DPS is listed as endangered and Atlantic sturgeon occur in and may potentially spawn in several rivers connected to the Chesapeake Bay. There is evidence of spawning in the James River (confirmed); Pamunkey River, a tributary of the York River; and Nanticoke River and its tributary Marshyhope Creek (section 5.2.2.8). In addition, detections of acoustically-tagged adult Atlantic sturgeon in the Mattaponi and Rappahannock Rivers during the spawning window have occurred. Historical evidence for these rivers as well as the Potomac River supports the likelihood that Atlantic sturgeon spawning populations are present in the Mattaponi, Rappahannock, and Potomac Rivers (NMFS 2017). However, information for these populations is limited and the research is ongoing.

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. However, the NEAMAP data indicates that the estimated ocean population of Chesapeake Bay DPS Atlantic sturgeon is, at a minimum, 10,332 sub-adult and adult individuals. The updated estimated annual adult male population for the fall cohort is approximately 3,707 individuals and the estimated annual adult female spawning population is 1,250 individuals (Balazik 2019 pers. comms.) In river estimates include, 75 adult Atlantic sturgeon spawned in the Pamunkey River in 2013 (Kahn *et al*. 2014) and 222 adults from 2013 to 2018, 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) (Secor *et al.* 2022). In the James River, 373 different adult-sized Atlantic sturgeon (*i.e.*, total count does not include recaptures of the same fish) were captured in the from 2009 through spring 2014 (Balazik and Musick

2015). Coleman *et al.* (2024) estimated that 32 (95% confidence interval [CRI] = 23-47) and 70 (95% CRI = 49-105) Atlantic sturgeon used the Marshyhope Creek-Nanticoke River system in 2020 and 2021, respectively. The ASMFC (2024) stock assessment update determined that abundance of the Chesapeake Bay DPS is "depleted" relative to historical levels. The stock assessment update, while noting significant uncertainty in trend data, also determined that there is a relatively low probability (27 percent) that abundance of the Chesapeake Bay DPS has increased since the implementation of the 1998 fishing moratorium, and a 14 percent probability that mortality for the Chesapeake Bay DPS exceeds the mortality threshold used for the assessment (ASMFC, 2024).

As described in the 5-Year Review for the Chesapeake Bay DPS (NMFS 2022), the demographic risk for the DPS is "High" because of its low productivity (e.g., relatively few adults compared to historical levels and irregular spawning success), low abundance (e.g., only three known spawning populations and low DPS abundance, overall), and limited spatial distribution (e.g., limited spawning habitat within each of the few known rivers that support spawning). There is also new information indicating genetic bottlenecks as well as low levels of inbreeding. However, the recovery potential is considered high.

The effects of the action are in addition to ongoing threats in the action area, which include incidental capture in state and federal fisheries, boat strikes, coastal development, habitat loss, contaminants, and changing environmental conditions. As noted in the Cumulative Effects section of this Opinion, we have not identified any cumulative effects different from those considered in the Status of the Species and Environmental Baseline sections of this Opinion

We anticipate the mortality of up to one adult or subadult Chesapeake Bay DPS Atlantic sturgeon as a result of blasting during the demolition of the existing bridges. Thus, here, we consider the effects of the loss of up to one Atlantic sturgeon from the Chesapeake Bay DPS over the lifespan of the project. The reproductive potential of the Chesapeake Bay DPS will not be affected in any way other than through a reduction in number of one individual. The loss of up to one individual will have the effect of reducing the amount of reproduction potential as any dead Chesapeake Bay DPS Atlantic sturgeon has 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, extremely small effects on the strength of subsequent year classes. Even considering the potential future spawners that would be produced by one Chesapeake Bay DPS Atlantic sturgeon that could be killed as a result of the proposed action, any effect to future year classes is anticipated to be extremely small and would not change the status of this species. The proposed action will also not affect the spawning grounds within the rivers where Chesapeake Bay DPS fish spawn, as they are outside of the action area. The action will also not create any barrier to pre-spawning sturgeon accessing the overwintering sites or the spawning grounds used by Chesapeake Bay DPS fish for the same reasons.

Because we do not have a population estimate for the Chesapeake Bay DPS, it is difficult to evaluate the effects of the mortality caused by this action on the species. However, because the

proposed action will result in the loss of an individual over the life of the project, it is unlikely that this death will have a detectable effect on the abundance and population trend of the Chesapeake Bay DPS.

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

Based on the information provided above, the death of one 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. It will also not result in effects to the environment which would prevent Atlantic sturgeon from completing their entire life cycle, including reproduction, sustenance, and shelter. This is the case because: (1) the death of up to one Chesapeake Bay DPS Atlantic sturgeon will not change the status or trends of the species as a whole; (2) the loss of one Chesapeake Bay DPS Atlantic sturgeon is not likely to have effects on the levels of genetic heterogeneity in the population; (3) the action will have only a minor and temporary effect on the distribution of Chesapeake Bay DPS Atlantic sturgeon in the action area and no effect on the distribution of the species throughout its range; and (4) the action will have no effect on the ability of Chesapeake Bay DPS Atlantic sturgeon to shelter and only an insignificant effect 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 at this time. As defined, the Recovery Plan will outline the steps necessary for recovery and the demographic criteria that, once attained, would allow the species to be delisted. In January 2018, we published a Recovery Outline for the five DPSs of Atlantic sturgeon (NMFS 2018). This outline is meant to serve as an interim guidance document to direct recovery efforts, including recovery planning, until a full recovery plan is developed and approved. The outline provides a preliminary strategy for recovery of the species. We know that, in general, to recover, a listed species must have a sustained positive trend of increasing population over time. To allow that to happen for sturgeon, individuals must have

access to enough habitat in suitable condition for foraging, resting, migrating and spawning. Conditions must be suitable for the successful development of early life stages. Mortality rates must be low enough to allow for recruitment to all age classes so that successful spawning can continue over time and over generations. There must be enough suitable habitat for spawning, foraging, resting, and migrations of all individuals. For Chesapeake Bay DPS Atlantic sturgeon, habitat conditions must be suitable both in the natal river and in other rivers and estuaries where foraging by subadults and adults will occur and, in the ocean, where subadults and adults migrate, overwinter and forage. Habitat connectivity must also be maintained so that individuals can migrate between important habitats without delays that impact their fitness. As described in the vision statement in the Recovery Outline, subpopulations of all five Atlantic sturgeon DPSs must be present across the historical range. These subpopulations must be of sufficient size and genetic diversity to support successful reproduction and recovery from mortality events. The recruitment of juveniles to the sub-adult and adult life stages must also increase and that increased recruitment must be maintained over many years. Recovery of these DPSs will require conservation of the riverine and marine habitats used for spawning, development, foraging, and growth by abating threats to ensure a high probability of survival into the future. Next, we consider whether this proposed action will reduce the Chesapeake Bay DPS likelihood of recovery.

This action will not change the status or trend of the Chesapeake Bay DPS and will only result in an extremely small reduction in the number of Chesapeake Bay DPS Atlantic sturgeon and will not affect their overall distribution. Any effects 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. This action 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 effects of the proposed action will not delay the recovery timeline or otherwise decrease the likelihood of recovery. The effects of the proposed action will also not reduce the likelihood that the status of the species can improve to the point where it is recovered and could be delisted. Therefore, the proposed action will not appreciably reduce the likelihood that the 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 effects related to the proposed action. We have considered the effects of the proposed action in light of cumulative effects explained above, and have concluded that, even in

light of the ongoing impacts of these activities and conditions, the conclusions reached above do not change. Based on the analysis presented herein, the proposed action, resulting in the mortality of one Chesapeake Bay DPS Atlantic sturgeon, is not likely to appreciably reduce the survival and recovery of this species.

8.1.2.2 Gulf of Maine DPS

The Gulf of Maine DPS is listed as threatened, and while Atlantic sturgeon occur in several rivers of the Gulf of Maine region, recent spawning has only been physically documented in the Kennebec River. That said, spawning is suspected to occur in the Androscoggin, Piscataqua, and Merrimack Rivers, although not confirmed. Currently we do not have an estimate of the number of Atlantic sturgeon in any river nor is any currently available for the entire DPS; however, NEAMAP data indicates that the estimated ocean population of Gulf of Maine DPS Atlantic sturgeon subadults and adults is, at a minimum, 727 individuals. As discussed in the *Status of the Species* section, this is likely a significant underestimate since (1) the NEAMAP surveys do not extend into the Gulf of Maine and (2) Gulf of Maine DPS fish do not often stray beyond the Gulf of Maine like other DPSs do from their general geographic area (as evidenced by genetic sampling). For in-river estimates, the ASSRT (2007) status review estimated that the number of spawning adults in the Gulf of Maine DPS was less than 300 per year and Wippelhauser and Squiers (2015) reviewed the results of studies conducted in the Kennebec River System from 1977-2001 and 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).

Gulf of Maine origin Atlantic sturgeon are subject to numerous sources of human induced mortality and habitat disturbance throughout the riverine and marine portions of their range. There is currently not enough information to establish a trend for any life stage or for the DPS as a whole. The ASMFC (2024) stock assessment update concluded that the abundance of the Gulf of Maine DPS is "depleted" relative to historical levels. The Commission also noted that the Gulf of Maine is particularly data poor among all five DPSs. The assessment concluded that there is a 45 percent probability that the abundance of the Gulf of Maine DPS has increased since implementation of the 1998 fishing moratorium. The Commission also concluded that there is a relatively high likelihood (55.5 percent probability) that mortality for the Gulf of Maine DPS exceeds the mortality threshold used for the assessment ASMFC (2017); (ASMFC, 2024). However, the Commission noted that there was considerable uncertainty related to these numbers, particularly concerning trends data for the Gulf of Maine DPS. For example, 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.

As described in the 5-Year Review for the Gulf of Maine DPS (NMFS 2022), the demographic risk for the DPS is "moderate"[25] because of its low productivity (i.e., relatively few adults compared to historical levels), low abundance (i.e., only one known spawning population and low DPS abundance, overall), and limited spatial distribution (i.e., limited spawning habitat within the one river known to support spawning). There is also new information indicating genetic bottlenecks as well as low levels of inbreeding. However, the recovery potential is considered high.

Here, we consider the effects of the loss one Atlantic sturgeon from the Gulf of Maine DPS in addition to ongoing threats (e.g., capture in fisheries, coastal development, habitat loss, contaminants, etc.) in the action area. The reproductive potential of the Gulf of Maine DPS will not be affected in any way other than through a reduction in numbers of individuals. The loss one individual will have the effect of reducing reproduction potential within the DPS because any dead Gulf of Maine DPS Atlantic sturgeon has no potential for future reproduction. However, this small reduction in potential future spawners is expected to result in an extremely small reduction in the number of eggs laid or larvae produced in future years and similarly, an extremely small effect on the strength of subsequent year classes. Even considering the potential future spawners that would be produced by the individual that will be killed as a result of the proposed action, any effect to future year classes is anticipated to be extremely small and would not change the status of this species. The proposed action will also not affect the spawning grounds within the rivers where Gulf of Maine DPS fish spawn, because it will occur outside of those identified areas. Additionally, the action will not create any barrier to pre-spawning sturgeon accessing the overwintering sites or the spawning grounds used by Gulf of Maine DPS fish for the same reasons.

Because we do not have a population estimate for the Gulf of Maine DPS, it is difficult to evaluate the effects of mortality on this species caused by this action. However, because the proposed action will result in the loss of one individual over 34 blasting events, or an average of 0.03 mortalities each event, it is unlikely that this death will have detectable effects on the numbers and population trend of the Gulf of Maine 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 Gulf of Maine DPS subadults or adults. Further, the action is not expected to reduce the river-by-river distribution of Atlantic sturgeon. Any effects to distribution will be minor and temporary, and limited to the avoidance of the area where the impacts occur because of the action.

Based on the information provided above, the death of one Gulf of Maine DPS Atlantic sturgeon will not appreciably reduce the likelihood of survival of the Gulf of Maine 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

[25] 84 FR 18243; April 30, 2019 - Listing and Recovery Priority Guidelines.

Gulf of Maine DPS Atlantic sturgeon in a way that prevents the species from maintaining a sufficient population, represented by all necessary age classes, genetic heterogeneity, and number of sexually mature individuals producing viable offspring. Additionally, it will not result in effects to the environment which prevent Atlantic sturgeon from completing their entire life cycle, including reproducing, sustenance, and shelter. This is the case because: (1) the death of one Gulf of Maine DPS Atlantic sturgeon will not change the status or trends of the species as a whole; (2) the loss of one Gulf of Maine DPS Atlantic sturgeon as a result of this action is not likely to have effects on the levels of genetic heterogeneity in the population; (3) the action will have only a minor and temporary effects on the distribution of Gulf of Maine DPS Atlantic sturgeon in the action area and no effect on the distribution of the species throughout its range; and, (4) the action will have no effect on the ability of Gulf of Maine DPS Atlantic sturgeon to shelter with only an insignificant effect on any foraging Gulf of Maine DPS Atlantic sturgeon.

In certain instances, an action that does not appreciably reduce the likelihood of a species' survival might affect its likelihood of recovery or the rate at which recovery is expected to occur. As explained above, we have determined that the proposed action will not appreciably reduce the likelihood that the Gulf of Maine 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 Gulf of Maine DPS can rebuild to a point where listing is no longer appropriate. No Recovery Plan for the Gulf of Maine DPS has been published at this time. As defined, a Recovery Plan will outline the steps necessary for recovery and the demographic criteria, which once attained would allow the species to be delisted. In January 2018, we published a Recovery Outline for the five DPSs of Atlantic sturgeon (NMFS 2018[26]). This outline is meant to serve as an interim guidance document to direct recovery efforts, including recovery planning, until a full recovery plan is developed and approved. The outline provides a preliminary strategy for recovery of the species. We know that in general, to recover, a species must have a sustained positive increasing population trend over time and an increase in population size. To allow that to happen for sturgeon, individuals must have access to enough habitat in suitable condition for foraging, resting and spawning.

Conditions must be suitable for the successful development of early life stages. Mortality rates must be low enough to allow for recruitment to all age classes so that successful spawning can continue over time and over generations. There must be enough suitable habitat for spawning, foraging, resting, and migrations of all individuals. For Gulf of Maine DPS Atlantic sturgeon, habitat conditions must be suitable both in the natal river and in other rivers and estuaries where foraging by subadults and adults will occur and, in the ocean, where subadults and adults migrate, overwinter and forage. Habitat connectivity must also be maintained so that individuals can migrate between important habitats without delays that impact their fitness. As described in the vision statement in the Recovery Outline, subpopulations of all five Atlantic sturgeon DPSs must be present across the historical range. These subpopulations must be of sufficient size and

[26] Available online at: https://media.fisheries.noaa.gov/dam-migration/ats_recovery_outline.pdf

genetic diversity to support successful reproduction and recovery from mortality events. The recruitment of juveniles to the sub-adult and adult life stages must also increase and that increased recruitment must be maintained over many years. Recovery of these DPSs will require conservation of the riverine and marine habitats used for spawning, development, foraging, and growth by abating threats to ensure a high probability of survival into the future. Here, we consider whether this proposed action will reduce the Gulf of Maine DPS likelihood of recovery.

We do not expect the proposed action to modify, curtail or destroy the range of the species, or to change the status or trend of the Gulf of Maine DPS, since it will result in an extremely small reduction in the number and overall distribution. Any effects 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 over the lifespan of the project (one individual) and a subsequent small reduction in future reproductive output. For these reasons, we do not expect the action to affect the persistence of the Gulf of Maine DPS of Atlantic sturgeon. The action will not change the status or trend of the Gulf of Maine DPS of Atlantic sturgeon, nor will a very small reduction in numbers and future reproduction resulting from the proposed action reduce the likelihood of improvement in the status. The effects of the proposed action will not delay the recovery timeline or otherwise decrease the likelihood of recovery. The effects of the proposed action will also not reduce the likelihood that the status of the species can improve to the point where it is recovered and could be delisted. Therefore, the proposed action will not appreciably reduce the likelihood that the Gulf of Maine DPS of Atlantic sturgeon can be brought to the point at which listing as threatened is no longer necessary. 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 Gulf of Maine DPS Atlantic sturgeon inside and outside of the action area, the proposed action will not increase the vulnerability of individual sturgeon to additional threats and exposure to ongoing threats will not increase susceptibility to effects related to the proposed action. We have considered the effects of the proposed action in light of cumulative effects explained above 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 one Gulf of Maine DPS Atlantic sturgeon, is not likely to appreciably reduce the survival and recovery of the species.

8.1.2.3 New York Bight DPS

The New York Bight DPS is listed as endangered and includes the following: all anadromous Atlantic sturgeon spawned in the watersheds that drain into coastal waters (including bays and sounds) from Chatham, MA to the Delaware-Maryland border on Fenwick Island. Our recent status review concluded that the status of the DPS has likely neither improved nor declined from what it was when we listed the DPS in 2012, that the DPS's demographic risk is "High," and that no changes to the listing status and listing recovery priority number are needed (NMFS 2022c). As noted in the 5-year review, low productivity (e.g., relatively few adults compared to historical levels and irregular spawning success), low abundance (e.g., only a few known spawning

populations and low DPS abundance, overall), and limited spatial distribution (e.g., limited spawning habitat within each of the few known rivers that support spawning) puts the New York Bight DPS at risk of extinction. There is also new information indicating genetic bottlenecks as well as low levels of inbreeding in the Hudson and Delaware spawning populations.

Within the New York Bight DPS range, Atlantic sturgeon historically spawned in the Connecticut, Delaware, Hudson, and Housatonic Rivers (ASSRT 2007, Murawski and Pacheco 1977, Secor *et al.* 2002). While Atlantic sturgeon occur in several rivers in the New York Bight, recent spawning has only been physically documented in the Hudson and Delaware Rivers. The essential physical features necessary to support spawning and recruitment are present in all the New York Bight DPS rivers (82 FR 39160, August 17, 2017). However, currently, there is no evidence that spawning is occurring nor are studies underway to investigate spawning occurrence in the Connecticut and Housatonic Rivers; except one recent study where young of year fish were captured in the Connecticut River (Savoy *et al.* 2017). Genetic analysis suggests that the young of year fish belonged to the South Atlantic DPS and at this time we do not know if these fish were the result of a single spawning event due to unique straying of the adults from the South Atlantic DPS's spawning rivers.

New York Bight DPS origin Atlantic sturgeon are subject to numerous sources of human induced mortality and habitat disturbance throughout the riverine and marine portions of their range. The largest single source of mortality appears to be capture as bycatch in commercial fisheries operating in the marine environment. Because early life stages and juveniles do not leave the river, they are not impacted by fisheries occurring in federal waters. Bycatch and mortality also occur in state fisheries; however, the primary fishery that impacted juvenile sturgeon (the shad fishery) has now been closed and there is no indication that it will reopen soon. New York Bight DPS Atlantic sturgeon are killed as a result of other anthropogenic activities in the Hudson, Delaware, and other rivers within the New York Bight as well; sources of potential mortality include vessel strikes, entrainment in dredges, effects from contaminants, habitat loss, and effects of changing environmental conditions.

Small populations are susceptible to threats such as inbreeding, genetic drift (allele frequencies of a population changing over generations due to chance), demographic stochasticity (chance independent events of individual mortality and reproduction, causing random fluctuations in population growth rate), and Allee effect (individual fitness in a population increases/decreases with increasing/decreasing population size because of undercrowding). These factors have substantial influence on the growth of small populations and therefore their extinction risk. The specific biology and life history of a species influence the population size needed to remain viable, but as a rule of thumb, an effective population size, N_e, of 50 breeding individuals are needed for a short-term minimum viable population (MVP) and a N_e size of 500 breeding individuals for retaining evolutionary potential (and long-term MVP) (Franklin 1980). The effective population "rule of thumb" for an N_e of 50 takes into account inbreeding while the latter considers genetic drift.

As noted in the *Status of the Species* section, both the Delaware River and the Hudson River current abundance is believed to be a fraction of historic levels (also see Secor (2002) and Kahnle *et al*. (2007)). An estimated 3,656 age-1 individuals used the Delaware Estuary as a

nursery in 2014 (since oceanward migration begins at age two or older, these juveniles would be of Delaware River origin). An estimate of the mean annual number of mature adults (863 total; 596 males and 267 females) was calculated for the Hudson River riverine population based on fishery-dependent data collected from 1985-1995 (Kahnle *et al*. 2007). In a more recent study, Kazyak *et al*. (2020a) estimated the 2014 Hudson River spawning run size to be 466 sturgeon (95% CRI = 310-745). In our analysis below, we use a Delaware River spawner abundance of between 125 and 250 adults and a Hudson River spawner abundance of between 400 and 500 adults. However, it should be noted that this estimate of Delaware River spawners does not include individuals that failed to spawn (e.g., male to male competition), spawners that did not have offspring surviving to the young of year age stage, and spawners who offspring remained outside of the sampling area. Thus, we expect the actual total number of spawners to be higher. Using the NEAMAP study, we concluded that the DPS consists of, at a minimum, approximately 24,963 adults and subadults. Therefore, we expect the loss of one adult or subadults over the life of the project to be too small to increase variation in abundances over time to such an extent that it can be meaningfully measured or evaluated.

Based on genetic analyses of two different life stages, subadults and natal juveniles, N_e for the Delaware River population has been estimated to be 108.7 (95% CI=74.7-186.1) (O'Leary *et al.* 2014) and 40 (95% CI=34.7-46.2) (Waldman *et al*. 2019), respectively. Estimates for the Hudson River spawning population from the same studies are 198 (95% CI=171.7-230.7; (O'Leary *et al*. 2014)) and 156 (95% CI=138.3-176.1) (Waldman *et al*. 2019), respectively. Given the low N_e, genetic drift poses a threat to future genetic diversity of these populations. O'Leary *et al*. (2014) concluded that the populations likely would retain 95 percent of their alleles over the next century under current conditions. However, a decrease in longevity of mature adults would result in severe loss of genetic diversity (O'Leary *et al.* 2014).

We estimated that demolition of the existing bridges will add one subadult or adult Atlantic sturgeon mortality incidental to blasting from the New York Bight DPS to the baseline mortality rate over the lifespan of the project. Using the best available information, we expect that the Delaware River spawning runs consist of between 125 and 250 individuals and the Hudson River runs consist of approximately 400 to 500 individuals. Based on the above, the demolition of the bridges will remove up to one subadult or adult Delaware River or Hudson River fish due to blasting. We anticipate that this reduction in numbers from either river is too small to affect genetic drift or inbreeding in a way that can be meaningfully evaluated. This is because of variation in the biological characteristics (number of progenies, male contribution, sex ratio, and population size) that affects the N_e and it is not possible to evaluate the contribution of one individual or the effect of losing one individual.

We also expect the reduction of a single fish from either the adult Delaware River population or the Hudson River population over the life of the project to be too small to increase the populations' vulnerability to demographic stochasticity, Allee effect, or other small population impacts on population genetics in a way that we can meaningfully measure or determine for either river or for the DPS as a whole. We expect that any vulnerability to catastrophic events will mostly depend on spatial structure of the populations and life history of the species. Current information from both the Delaware and Hudson River indicates that both rivers have multiple spawning sites. The loss of up to one Delaware River fish or Hudson River fish over the life of

the project is unlikely to measurably increase the vulnerability during an in-river catastrophic event. This is because we expect the effects of a catastrophic event (e.g., oil spill, pollutant release, etc.) to be more related to the concentration of spawners within a particular area than to the total number of spawners, and it is not possible to evaluate how a loss of these spawners spread out over the life of the project will increase the vulnerability from a catastrophic event. Since Atlantic sturgeon adults do not spawn every year, it is unlikely that the lost adults would have participated in the same spawning runs and migrating adults will buffer against catastrophic loss of a spawning population by reintroducing spawning individuals in following years. However, even if there was a catastrophic event affecting Atlantic sturgeon spawning areas, we do not expect that the loss of one fish from either the Delaware River or Hudson River populations over the life of the project would significantly affect the outcome and effects of a catastrophic event in either river considering the number of expected spawners in both the Delaware River and Hudson River together with the fecundity of adult female sturgeon and multiple rearing sites. Also, in the case of a catastrophic event, we do not have enough information to determine if the loss of spawners may affect the vulnerability of young of year fish at the rearing site.

The Commission's 2024 benchmark stock assessment update concluded that there was a relatively high probability (59 percent) that the abundance of the New York Bight DPS has increased since the implementation of the 1998 fishing moratorium (ASMFC 2024). However, there was considerable uncertainty expressed in the stock assessment and in its peer review report. New information suggests that the conclusion about the New York Bight DPS primarily reflects the status and trend of only the DPS's Hudson River spawning population (NMFS 2022c). Annual surveys for Atlantic sturgeon juveniles in the Hudson River conducted by the New York State Department of Environmental Conservation (NYDEC) since 2004 suggests that the catch rate of juvenile Atlantic sturgeon 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). However, recent research by Stich *et al*. (2025) demonstrated that the juvenile population does not show an increasing trend. We do not have enough information to discern the Hudson River population's growth rate, but recent research seems to indicate that it is trending downward (Stich *et al.* 2025). For a population to recover, population growth rate must be positive and a species remains prone to extinction as long as the population remains small and, thus, the rate of population growth, even if positive, will influence survival and recovery. For Atlantic sturgeon, ASMFC (2007) concluded that a 5 percent bycatch mortality of adults was not sustainable. Brown and Murphy (2010) similarly concluded that the loss of 2.5 percent of females per year from vessel strikes would hamper recovery of the Delaware River Atlantic sturgeon population. Variations in mortality, fecundity, and generation time can result in variations in abundance over time, which affects extinction risk. No data exists that can be used to determine productivity for the Delaware River since the time the New York Bight DPS was listed. While DO conditions in the river have improved over past decades, significant vessel traffic, industrial activity, and contaminated bottom substrate in these reaches exposes sturgeon to multiple threats, as discussed in the Environmental Baseline.

Here, we consider how one mortality will affect productivity when added to other anthropogenic mortalities of females from the two river populations. Bycatch in federal fisheries account for one of the largest known numbers of anthropogenic mortalities. Bycatch and mortality also

occur in state fisheries; however, the primary fishery that impacted juvenile sturgeon (the shad fishery) has now been closed in the Hudson River and there is no indication that it will reopen. New York Bight DPS Atlantic sturgeon are killed as a result of other anthropogenic activities in the Hudson, Delaware, and other rivers within the DPS as well, including vessel strikes, entrainment in dredges, and entrainment in cooling water intakes at power stations. We do not have an estimate of the total number of anthropogenic mortalities per year; we do not expect that the additional mortality of adult females from this proposed action will change the status of either river population or the DPS as a whole. This is because they contribute a very small number of mortalities relative to the total populations and these mortalities will occur over time. As previously discussed, individual females do not spawn every year, thus allowing time for new spawning events to occur after mortalities occur over time. Based on the above considerations, we do not expect the proposed project to affect productivity of either the Delaware River or Hudson River populations or the DPS as a whole. In conclusion, even considering the potential future female spawners that would be produced by an individual that would be killed as a result of the proposed action, any effects to future year classes of both riverine populations and the New York Bight as a whole is anticipated to be small and would not change the status of this species.

The proposed action is not likely to reduce distribution because the action will not impede New York Bight DPS Atlantic sturgeon from accessing any seasonal concentration areas, including foraging, spawning or overwintering grounds in the Delaware River or elsewhere. Any effects to distribution will be minor and temporary and limited to the temporary avoidance of areas near in-water construction activities.

Last, we have considered if changing environmental conditions will affect our above conclusions with regard to the effects to survival and recovery of the New York Bight DPS. As described above, over the long term, global environmental changes may affect New York Bight DPS Atlantic sturgeon by affecting the location of the salt wedge, distribution of prey, water temperature and water quality. Any activities occurring within and outside the action area that contribute to changes in environmental conditions are also expected to affect New York Bight DPS Atlantic sturgeon in the action area. However, there is significant uncertainty, due to a lack of specific scientific data, on the degree to which these effects may be experienced and the degree to which New York Bight DPS Atlantic sturgeon will be able to successfully adapt to any such changes. While we can make some predictions on the likely effects of environmental changes on these species and critical habitat, without modeling and additional scientific data, these predictions remain speculative, and we have concluded that changes in environmental conditions will not change our determinations.

Numerous sources of human induced mortality and habitat disturbance affect New York Bight DPS origin Atlantic sturgeon throughout the riverine and marine portions of their range. However, since the proposed action is unlikely to affect the viability of the Delaware River or Hudson River populations, we do not expect the estimated loss of one adult or subadult to diminish the DPS' numbers, reproduction, or distribution so that the likelihood of survival is appreciably reduced.

Based on the above, we have determined that the action will not affect New York Bight DPS Atlantic sturgeon in a way that will change the status of the DPS or prevent the species from achieving a sufficient population represented by all necessary age classes, genetic heterogeneity, and number of sexually mature individuals producing viable offspring. It also will not result in effects to the environment which would prevent Atlantic sturgeon from completing their entire life cycle, including reproduction, sustenance, and shelter. This is the case because: (1) the death of one New York Bight DPS Atlantic sturgeon as a result of this action over the life of the project will not reduce the current status of the Delaware River and Hudson River populations; (2) the death of one New York Bight DPS Atlantic sturgeon will not change the status or trends of the species as a whole; (3) the loss of one New York Bight DPS Atlantic sturgeon is not likely to have effects on the levels of genetic heterogeneity in the species; (4) the loss of one New York Bight DPS Atlantic sturgeon is likely to have such small effects on reproductive output that the loss of one individual will not change the status or trends of the species; (5) the action will have only a minor and temporary effect on the distribution of New York Bight DPS Atlantic sturgeon in the action area and no effect on the distribution of the species throughout its range; and (6) the action will have no effect on the ability of New York Bight DPS Atlantic sturgeon to shelter with only an insignificant effect on individual foraging New York Bight DPS Atlantic sturgeon when considering that the footprint of the dredging site is small relative to available forage within the action area and the mid-to-upper estuary.

In certain instances, an action that does not appreciably reduce the likelihood of a species' survival might affect its likelihood of recovery or the rate at which recovery is expected to occur. As explained above, we have determined that the proposed action will not appreciably reduce the likelihood that the New York Bight 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 New York Bight DPS can rebuild to a point where listing is no longer appropriate. No Recovery Plan for the New York Bight DPS has been published, at this time. As defined, the Recovery Plan will outline the steps necessary for recovery and the demographic criteria, which once attained, will allow the species to be delisted. In January 2018, we published a Recovery Outline for the five DPSs of Atlantic sturgeon (NMFS 2018). This outline is meant to serve as an interim guidance document to direct recovery efforts, including recovery planning, until a full recovery plan is developed and approved. The outline provides a preliminary strategy for recovery of the species. We know that in general, to recover, a listed species must have a sustained positive trend of increasing population over time. To allow that to happen for sturgeon, individuals must have access to enough habitat in suitable condition for foraging, resting, migration and spawning. Conditions must be suitable for the successful development of early life stages. Mortality rates must be low enough to allow for recruitment to all age classes so that successful spawning can continue over time and over generations. There must be enough suitable habitat for spawning, foraging, resting, and migrations of all individuals. For New York Bight DPS Atlantic sturgeon, habitat conditions must be suitable both in the natal river and in other rivers and estuaries where foraging by subadults and adults will occur and, in the ocean, where subadults and adults migrate, overwinter and forage. Habitat connectivity must also be maintained so that individuals can migrate between important habitats without delays that impact their fitness. As described in the vision statement in the Recovery Outline, subpopulations of all five Atlantic sturgeon DPSs

must be present across the historical range. These subpopulations must be of sufficient size and genetic diversity to support successful reproduction and recovery from mortality events. The recruitment of juveniles to the sub-adult and adult life stages must also increase and that increased recruitment must be maintained over many years. Recovery of these DPSs will require conservation of the riverine and marine habitats used for spawning, development, foraging, and growth by abating threats to ensure a high probability of survival into the future. Here, we consider whether this proposed action will reduce the New York Bight DPS likelihood of recovery.

We do not expect the proposed action to modify, curtail or destroy the range of the species, or to change the status or trend of the New York Bight DPS, since it will result in an extremely small reduction in the number and overall distribution. Any effect 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 not limit forage to the species as ample forage exists to support the Atlantic sturgeon using the Chesapeake Bay estuary. The proposed action will result in a small amount of mortality (no more than one individual over the life of the project) and a subsequent small reduction in future reproductive output. For these reasons, the action is not expected to affect the persistence of the New York Bight DPS of Atlantic sturgeon. Additionally, the action will not change the status or population trend of the New York Bight 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 New York Bight DPS of Atlantic sturgeon. The effects of the proposed action will not delay the recovery timeline or otherwise decrease the likelihood of recovery. The effects of the proposed action will also not reduce the likelihood that the status of the species can improve to the point where it is recovered and could be delisted. Therefore, the proposed action will not appreciably reduce the likelihood that the New York Bight 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 New York Bight DPS Atlantic sturgeon inside and outside of the action area, the proposed action will not increase the vulnerability of individual sturgeon to these additional threats and exposure to ongoing threats will not increase susceptibility to effects related to the proposed action. We have considered the effects of the proposed action in light of cumulative effects explained above, including environmental changes and have concluded that even in light of the ongoing impacts of these activities and conditions; the conclusions reached above do not change. Based on the analysis presented herein, the proposed action, resulting in the mortality of one New York Bight DPS Atlantic sturgeon over a the life of the project, is not likely to appreciably reduce the survival and recovery of this species.

8.1.2.4 Carolina DPS

The Carolina DPS is listed as endangered. Atlantic sturgeon from the Carolina DPS spawn in the rivers of North Carolina south to the Cooper River, South Carolina. There are currently seven spawning subpopulations within the Carolina DPS: Roanoke River, Tar-Pamlico River,

Neuse River, Northeast Cape Fear and Cape Fear Rivers, Waccamaw and Great Pee Dee Rivers, Black River, Santee and Cooper Rivers. We estimated adult and subadult abundance of the Carolina DPS based on available information for the genetic composition and the estimated abundance of Atlantic sturgeon in marine waters and concluded that subadult and adult abundance of the Carolina DPS was 1,356 sturgeon (339 adults and 1,017 subadults) (NMFS 2013). This number encompasses many age classes since, across all DPSs, subadults can be as young as two years old when they first enter the marine environment, and adults can live as long as 64 years (Balazik *et al*. 2012; Hilton *et al*. 2016).

Very few data sets are available that cover the full potential life span of an Atlantic sturgeon. The ASMFC concluded for the Stock Assessment that it could not estimate abundance of the Carolina DPS or otherwise quantify the trend in abundance because of the limited available information. However, the Stock Assessment was a comprehensive review of the available information and used multiple methods and analyses to assess the status of the Carolina DPS and the coast wide stock of Atlantic sturgeon. For example, the Stock Assessment Subcommittee defined a benchmark, the mortality threshold, against which mortality for the coast wide stock of Atlantic sturgeon as well as for each DPS were compared[27] to assess whether the current mortality experienced by the coast wide stock and each DPS is greater than what it can sustain. This information informs the current trend of the Carolina DPS.

In the Stock Assessment, the ASMFC concluded that abundance of the Carolina DPS is "depleted" relative to historical levels and there is a relatively low probability (36 percent) that abundance of the Carolina DPS has increased since the implementation of the 1998 fishing moratorium. The ASMFC also concluded that there is a relatively low likelihood (25 percent probability) that mortality for the Carolina DPS does not exceed the mortality threshold used for the Stock Assessment (ASMFC 2017).

Here, we consider the effects of the loss of one Atlantic sturgeon from the Carolina DPS. The reproductive potential of the Carolina DPS will not be affected in any way other than through a reduction in numbers of individuals. The loss of one individual will have the effect of reducing reproduction potential within the DPS because any dead Carolina DPS Atlantic sturgeon has no potential for future reproduction. However, this small reduction in potential future spawners is expected to result in an extremely small reduction in the number of eggs laid or larvae produced in future years and similarly, an extremely small effect on the strength of subsequent year classes. Even considering the potential future spawners that would be produced by the individual that will be killed because of the proposed action, any effect to future year classes is anticipated to be extremely small and would not change the status of this species. The proposed action will also not affect the spawning grounds within the rivers where Carolina DPS fish spawn, because it will occur outside of those identified areas. Additionally, the action will not

[27] The analysis considered both a coast wide mortality threshold and a region-specific mortality threshold to evaluate the sensitivity of the model to differences in life history parameters among the different DPSs (e.g., Atlantic sturgeon in the northern region are slower growing, longer lived; Atlantic sturgeon in the southern region are faster growing, shorter lived).

create any barrier to pre-spawning sturgeon accessing the overwintering sites or the spawning grounds used by Carolina DPS fish for the same reasons.

Because we do not have a population estimate for the Carolina DPS, it is difficult to evaluate the effects of mortality on this species caused by this action. However, because the proposed action will result in the loss of one individual, it is unlikely that this death will have detectable effects on the numbers and population trend of the Carolina 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 Carolina DPS subadults or adults. Further, the action is not expected to reduce the river-by-river distribution of Atlantic sturgeon. Any effects to distribution will be minor and temporary, and limited to the avoidance of the area where the impacts occur.

Based on the information provided above, the death of one Carolina DPS Atlantic sturgeon will not appreciably reduce the likelihood of survival of the Carolina 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 Carolina DPS Atlantic sturgeon in a way that prevents the species from maintaining a sufficient population, represented by all necessary age classes, genetic heterogeneity, and number of sexually mature individuals producing viable offspring. Additionally, it will not result in effects to the environment that prevent Atlantic sturgeon from completing their entire life cycle, including reproducing, sustenance, and shelter. This is the case because: (1) the death of one Carolina DPS Atlantic sturgeon as a result of this action in any year will not change the status or trends of the species as a whole; (2) the loss of one Carolina DPS Atlantic sturgeon as a result of this action is not likely to have effects on the levels of genetic heterogeneity in the population; (3) the action will have only a minor and temporary effects on the distribution of Carolina DPS Atlantic sturgeon in the action area and no effect on the distribution of the species throughout its range; and (4) the action will have no effect on the ability of Carolina DPS Atlantic sturgeon to shelter with only an insignificant effect on any foraging Carolina DPS Atlantic sturgeon.

In certain instances, an action that does not appreciably reduce the likelihood of a species' survival might affect its likelihood of recovery or the rate at which recovery is expected to occur. As explained above, we have determined that the proposed action will not appreciably reduce the likelihood that the Carolina 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 Carolina DPS can rebuild to a point where listing is no longer appropriate. No Recovery Plan for the Carolina DPS has been published at this time. As defined, a Recovery Plan will outline the steps necessary for recovery and the demographic criteria, which once attained would allow delisting of the species. We know that in general, to recover, a species must have a sustained positive increasing population trend over time and an increase in population size. To allow those things to happen, a species

must have enough habitat in suitable condition that allows all normal life functions to occur (i.e., spawning, foraging, resting) and must 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 and overall distribution of Carolina DPS Atlantic sturgeon. Any effects 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 over the lifespan of the project (one individual) and a subsequent small reduction in future reproductive output. For these reasons, we do not expect the action to affect the persistence of the Carolina DPS of Atlantic sturgeon. The action will not change the status or trend of the Carolina DPS of Atlantic sturgeon, nor will a very small reduction in numbers and future reproduction resulting from the proposed action reduce the likelihood of improvement in the status. The effects of the proposed action will not delay the recovery timeline or otherwise decrease the likelihood of recovery. The effects of the proposed action will also not reduce the likelihood that the status of the species can improve to the point where it recovers and could be delisted. Therefore, the proposed action will not appreciably reduce the likelihood of bringing the Carolina DPS of Atlantic sturgeon to the point at which listing as threatened is no longer necessary. Based on the analysis presented herein, the proposed action is not likely to reduce appreciably the survival and recovery of this species.

Despite the threats faced by individual Carolina DPS Atlantic sturgeon inside and outside of the action area, the proposed action will not increase the vulnerability of individual sturgeon to these additional threats and exposure to ongoing threats will not increase susceptibility to effects related to the proposed action. We have considered the effects of the proposed action in light of cumulative effects explained above 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 one Carolina DPS Atlantic sturgeon, is not likely to reduce appreciably the survival and recovery of the species.

8.1.2.5 South Atlantic DPS

The South Atlantic DPS is listed as endangered and Atlantic sturgeon originate from at least six rivers where spawning potentially still occurs. Secor *et al*. (2002) estimates that 8,000 adult females were present in South Carolina prior to 1890. In Georgia, prior to the collapse of the fishery in the late 1800s, the sturgeon fishery was the third largest fishery. Secor *et al*. (2002) estimated from U.S. Fish Commission landing reports that approximately 11,000 spawning females were likely present in Georgia prior to 1890. At the time of listing, only six spawning subpopulations existed in the South Atlantic DPS: Combahee River, Edisto River, Savannah River, Ogeechee River, Altamaha River (including the Oconee and Ocmulgee tributaries), and the Satilla River. Three of the spawning subpopulations in the South Atlantic DPS are relatively robust and are considered the second (Altamaha River) and third (Combahee/Edisto River) largest spawning subpopulations across all five DPSs. Peterson *et al*. (2008) estimated the

number of spawning adults in the Altamaha River was 324 (95% CI: 143-667) in 2004 and 386 (95% CI: 216-787) in 2005. Bahr and Peterson (2016) estimated the age-1 juvenile abundance in the Savannah River from 2013-2015 at 528 in 2013, 589 in 2014, and 597 in 2015. No census of the number of Atlantic sturgeon in any of the other spawning rivers or for the DPS as a whole is available. However, the most up to date NEAMAP data indicates that the estimated ocean population of South Atlantic DPS Atlantic sturgeon sub-adults and adults is, at a minimum, 6,154 individuals.

The 2024 ASMFC stock assessment determined that abundance of the South Atlantic DPS is "depleted" relative to historical levels (ASMFC, 2024). While noting significant uncertainty in trend data, the stock assessment update also determined that there is a relatively low probability (31 percent) that abundance of the South Atlantic DPS has increased since the implementation of the 1998 fishing moratorium. However, it was estimated that there is a 26.5 percent probability that mortality for the South Atlantic DPS exceeds the mortality threshold used for the assessment (ASMFC, 2024). We note that the Commission expressed significant uncertainty in relation to the trends data.

The effects of the action are in addition to ongoing threats in the action area, which include incidental capture in state and federal fisheries, boat strikes, coastal development, habitat loss, contaminants and changing environmental conditions. As noted in the *Cumulative Effects* section of this Opinion, we have not identified any cumulative effects different from those considered in the *Status of the Species* and *Environmental Baseline* sections of this Opinion.

We anticipate the mortality of one South Atlantic DPS adult or sub-adult Atlantic sturgeon as a result of the proposed project. Take of South Atlantic DPS Atlantic sturgeon is only anticipated during the 34 blasting events expected to complete the demolition of the existing bridges. Thus, here, we consider the effects of the loss of one South Atlantic DPS Atlantic sturgeon. The reproductive potential of the South Atlantic DPS will not be affected in any way other than through a reduction in numbers of individuals. The loss of one individual sturgeon would have the effect of reducing the amount of reproduction potential, as dead South Atlantic DPS Atlantic sturgeon have no potential for future reproduction. However, this small reduction in potential future spawners expects to result in an extremely small reduction in the number of eggs laid or larvae produced in future years and similarly, an extremely small effect on the strength of subsequent year classes. Even considering the potential future spawners produced by any individuals killed as a result of the proposed action, any effect to future year classes is anticipated to be extremely small and will not change the status of this species. The proposed action will also not affect the spawning grounds within the rivers where South Atlantic DPS fish spawn because they are outside of the action area. The action will also not create any barrier to pre-spawning sturgeon accessing the overwintering sites or the spawning grounds used by South Atlantic DPS fish for the same reasons.

Because we do not have a population estimate for the South Atlantic DPS, it is difficult to evaluate the effects of the mortality caused by this action on the species. However, because the

proposed action will result in the loss of one individual, it is unlikely that this death will have a detectable effect on the numbers and population trend of the South Atlantic DPS.

The proposed action is not likely to reduce distribution because it will not impede Atlantic sturgeon from accessing any seasonal concentration areas, including foraging areas within the action area used by South Atlantic DPS subadults or adults. Further, the action is not expected to reduce the river-by-river distribution of Atlantic sturgeon. Any effects to distribution will be minor and temporary and limited to the avoidance of the action area where impacts occur.

Based on the information provided above, the death of one South Atlantic DPS Atlantic sturgeon will not appreciably reduce the likelihood of survival of the South Atlantic 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 South Atlantic DPS Atlantic sturgeon in a way that prevents the species from maintaining a sufficient population, represented by all necessary age classes, genetic heterogeneity, and number of sexually mature individuals producing viable offspring, and it will not result in effects to the environment which would prevent South Atlantic DPS Atlantic sturgeon from completing their entire life cycle, including reproduction, sustenance, and shelter. This is the case because: (1) the death of one South Atlantic DPS Atlantic sturgeon will not change the status or trends of the species as a whole; (2) the loss of one South Atlantic DPS Atlantic sturgeon is not likely to have effects on the levels of genetic heterogeneity in the population; (3) the loss of one South Atlantic DPS Atlantic sturgeon is likely to have such a small effect on reproductive output that the loss of these individuals will not change the status or trends of the species; (4) the action will have only a minor and temporary effect on the distribution of South Atlantic DPS Atlantic sturgeon in the action area and no effect on the distribution of the species throughout its range; and (5) the action will have no effect on the ability of South Atlantic DPS Atlantic sturgeon to shelter with only an insignificant effect on any foraging South Atlantic DPS Atlantic sturgeon.

In certain instances, an action that does not appreciably reduce the likelihood of a species' survival might affect its likelihood of recovery or the rate at which recovery is expected to occur. As explained above, we have determined that the proposed action will not appreciably reduce the likelihood that the South Atlantic DPS of Atlantic 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. No Recovery Plan for the South Atlantic DPS has been published at this time. As defined, the Recovery Plan will outline the steps necessary for recovery and the demographic criteria, which once attained, would allow the species to be delisted. In January 2018, we published a Recovery Outline for the five DPSs of Atlantic sturgeon (NMFS 2018). This outline is meant to serve as an interim guidance document to direct recovery efforts, including recovery planning, until a full recovery plan is developed and approved. The outline provides a preliminary strategy for recovery of the species. We know that in general, to recover, a listed species must have a sustained positive trend of increasing population over time. To allow that to happen for sturgeon, individuals must have access to enough habitat in suitable condition for foraging, resting, migration and spawning. Conditions must be suitable for the successful development of

early life stages. Mortality rates must be low enough to allow for recruitment to all age classes so that successful spawning can continue over time and over generations. There must be enough suitable habitat for spawning, foraging, resting, and migrations of all individuals. For South Atlantic DPS Atlantic sturgeon, habitat conditions must be suitable both in the natal river and in other rivers and estuaries where foraging by subadults and adults will occur and, in the ocean, where subadults and adults migrate, overwinter and forage. Habitat connectivity must also be maintained so that individuals can migrate between important habitats without delays that impact their fitness. As described in Recovery Outline's vision statement, subpopulations of all five Atlantic sturgeon DPSs must be present across the historical range. These subpopulations must be of sufficient size and genetic diversity to support successful reproduction and recovery from mortality events. The recruitment of juveniles to the sub-adult and adult life stages must also increase and that increased recruitment must be maintained over many years. Recovery of these DPSs will require conservation of the riverine and marine habitats used for spawning, development, foraging, and growth by abating threats to ensure a high probability of survival into the future. Here, we consider whether this proposed action will reduce the South Atlantic DPS likelihood of recovery.

This action will not change the status or trend of the South Atlantic DPS and will only result in an extremely small reduction in the number of South Atlantic DPS Atlantic sturgeon and will not affect their overall distribution. Any effects 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 (one individual) and a subsequent small reduction in future reproductive output. For these reasons, we do not expect the action to affect the persistence of the South Atlantic DPS of Atlantic sturgeon. This action will not change the status or trend of the South Atlantic 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 South Atlantic DPS of Atlantic sturgeon. The effects of the proposed action will not delay the recovery timeline or otherwise decrease the likelihood of recovery. The effects of the proposed action will also not reduce the likelihood that the status of the species can improve to the point where it is recovered and could be delisted. Therefore, the proposed action will not appreciably reduce the likelihood of bringing the South Atlantic DPS of Atlantic sturgeon to the point at which they are no longer listed as threatened or endangered. Based on the analysis presented herein, the proposed action is not likely to appreciably reduce the survival and recovery of this species.

Despite the threats faced by individual South Atlantic DPS Atlantic sturgeon inside and outside of the action area, the proposed action will not increase the vulnerability of individual sturgeon to these additional threats and exposure to ongoing threats will not increase susceptibility to effects related to the proposed action. We have considered the effects of the proposed action in light of cumulative effects explained above, and have concluded that, even in light of the ongoing impacts of these activities and conditions, the conclusions reached above do not change. Based on the analysis presented herein, the proposed action, resulting in the mortality of one

South Atlantic DPS Atlantic sturgeon, is not likely to appreciably reduce the survival and recovery of this species.

8.2 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 km (248.5 mi). 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% 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% CI=10,228-16,367) suggests that the population is stable but not increasing.

In Chesapeake Bay, shortnose sturgeon occur in the 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 Chesapeake Bay with foraging and overwintering taking place (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. 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 killed in 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 one 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 effects of the loss of one 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 one individual would have the effect 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 effect on the strength of subsequent year classes. Even considering the potential future spawners produced by the individual that would be killed as a result of the proposed action, any effect to future year classes is anticipated to be extremely small and would not change the status of this species. The proposed action will also not affect the spawning grounds within the rivers where 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 one 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 one shortnose sturgeon represents a small percentage of the species as a whole; (2) the loss of one shortnose sturgeon will not change the status or trends of the species as a whole; (3) the loss of

one shortnose sturgeon is likely to have an undetectable effect on reproductive output of the species as a whole; and (4) 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 used by adults. Further, the action is not expected to reduce the river-by-river distribution of shortnose sturgeon. Any effects to distribution will be minor and temporary and limited to the temporary avoidance of the area where the project activities and its impacts occur.

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 action is 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 action will not utilize shortnose sturgeon for recreational or commercial purposes or affect the adequacy of existing regulatory mechanisms to protect this species. The proposed action is likely to result in one mortality, a slight reduction in future reproductive output; therefore, the proposed action is 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 action will not cause any reduction in the likelihood of improvement in the status of shortnose sturgeon. The effects of the proposed action 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 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 of bringing shortnose sturgeon to the point at which they are no longer listed as endangered. Based on the analysis presented

herein, the proposed action is not likely to appreciably reduce the survival and recovery of this species.

9 CONCLUSION

After reviewing the current status of the species, the environmental baseline and the cumulative effects in the action area, and the effects of the Bay Crossing project, it is our biological opinion that the proposed action may adversely affect, but is not likely to jeopardize the continued existence of the New York Bight, Chesapeake Bay, Gulf of Maine, Carolina, and South Atlantic 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.

10 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. 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).

10.1 Anticipated Amount or Extent of Incidental Take

The proposed action has the potential to result in the mortality or injury of one shortnose sturgeon and one Atlantic sturgeon due to blasting. The Atlantic sturgeon could originate from any of the five DPSs. This level of take is expected to occur during the demolition phase of the project (e.g., years 6 to 7 of construction (EB) and years 14 to 15 of construction (WB)), 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 during the blasting phase of the project:

Table 22. Summary of incidental take

Species	Lethal Take
New York Bight, Chesapeake Bay, Gulf of Maine, Carolina, or South Atlantic DPS Atlantic sturgeon	1 subadult or adult from any of the 5 DPSs (blasting)
Atlantic Sturgeon Total	1
Shortnose sturgeon	1 adult (blasting)
Shortnose Sturgeon Total	1

In the event that the identified number of shortnose sturgeon or Atlantic sturgeon takes provided in this Incidental Take Statement is exceeded, reinitiation of this consultation is required.

10.2 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 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 and MDTA must comply with the following T&Cs, which implement the RPMs and outline required reporting/monitoring requirements. These T&Cs are non-discretionary; that is, 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 and MDTA should ensure that the project proponent and their contractors comply with these RPMs and T&Cs.

The RPMs, with their implementing TCs, minimize and monitor the impact of the incidental take resulting from the proposed actions. 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 action and how they represent only a minor change to the proposed action.

In order to effectively monitor the effects 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 captured during 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 by handling, assessing, and ultimately releasing sturgeon as required in the RPMs listed below.

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 NMFS within 24 hours.	1. In the event of any injury of sturgeon (lethal or non-lethal), FHWA and MDTA must follow the Sturgeon Take Standard Operating Procedures (SOPs) that can be downloaded from our website at: https://www.fisheries.noaa.gov/s3/2026-05/sturgeon_take_sops_external_08142024.pdf FHWA or MDTA must submit a completed Take Report Form for ESA-Listed Species within 24 hours of any take. The form can be downloaded from our website: https://www.fisheries.noaa.gov/s3/2026-04/take-report-form-04272026_0.pdf. The completed Take Report Forms, together with any supporting photos or videos must be submitted to nmfs.gar.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.	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 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
2. Any dead sturgeon must be held until	3. In the event you collect or capture a dead sturgeon (e.g., dead sturgeon collected during	

Reasonable and Prudent Measures (RPMs)	Terms and Conditions (T&Cs)	Justifications for RPMs & T&Cs
proper disposal procedures can be discussed with us. The fish should be held in cold storage.	blasting operations) 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. NMFS shall have the final say in determining if the take should count towards the Incidental Take Statement.	RPMs and T&Cs represent only a minor change as compliance will not delay the project or decrease the efficiency of blasting operations.
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 laboratory capable of performing the genetic analysis.	5. FHWA and MDTA must ensure that fin clips from any Atlantic sturgeon captured or collected 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. Fin clips must be taken prior to preservation of other fish parts or whole bodies.	These RPMs and T&Cs are necessary and appropriate to ensure the proper handling and documentation of any interactions with sturgeon, as well as requiring that these interactions are reported to us in a timely manner with all of the necessary information. This is essential for monitoring the level of incidental take associated with the proposed action.

Reasonable and Prudent Measures (RPMs)	Terms and Conditions (T&Cs)	Justifications for RPMs & T&Cs
		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 monitoring indicates that underwater noise levels of 206dB are being exceeded outside of the 640-meter Mortality 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 noise/pressure levels are expected to exceed 206dB.	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

Reasonable and Prudent Measures (RPMs)	Terms and Conditions (T&Cs)	Justifications for RPMs & T&Cs
		plan will be designed by you in 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 submit a final blasting plan prior to demolition that contains final parameters for blasting, outline the final mitigation measures, details of the deterrent system, the noise and fish monitoring plan and require NMFS approval of the plan before it is executed and ensure that any sturgeon killed during blasting are recorded.	7. At least six months prior to the commencement of blasting for demolition of any bridge pier, FHWA and MDTA shall submit a final blasting plan to NMFS for review. The plan shall include, at a minimum: a. Final blast design parameters, including charge weight per delay, number and sequence of charges per pier, and confirmation that these parameters do not exceed the maximum charge weight (30 lb/delay) and resulting Mortality Zone and Exclusion Zone distances analyzed in this Opinion; b. Final mitigation measures to be implemented, including the acoustic/fish deterrent protocol (sequence, duration, and source level of pre-blast sonar sweeps and fish	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

Reasonable and Prudent Measures (RPMs)	Terms and Conditions (T&Cs)	Justifications for RPMs & T&Cs
	scare charges), and any additional avoidance measures; c. Final details of the deterrent system, including equipment specifications, deployment method, and confirmation that source levels will not exceed those analyzed in this Opinion (≤204 dB re 1 µPa peak); and d. A combined noise and fish monitoring plan describing hydroacoustic monitoring methods, the acoustic telemetry protocol for detecting tagged sturgeon within the Exclusion Zone, observer qualifications and deployment, and the post-blast fish search and recovery protocol (search area, duration, and personnel). 8. FHWA and MDTA shall not commence blasting until NMFS has reviewed and approved the final blasting plan in writing. If NMFS identifies deficiencies, FHWA and MDTA shall revise and resubmit the plan for approval prior to any blasting activity. NMFS will provide comments or approval within [30 days] of receipt of a complete submission. 9. If the final blasting plan proposes any parameters, mitigation measures, or monitoring protocols that are less protective than those analyzed in this Opinion (e.g., larger charge weights, shorter time-of-year restrictions, reduced monitoring effort), FHWA and MDTA shall request reinitiation of consultation prior to plan approval. 10. FHWA and MDTA shall record and report to NMFS, within 24 hours, any sturgeon (Atlantic or shortnose) found injured or killed as a result of blasting, estimated size/life stage, location, and date/time relative to the blast event, consistent with the reporting procedures in the Incidental Take Statement.	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.

11 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 effects of a proposed action on listed species or critical habitat, to help implement recovery plans, or to develop information. The BA includes a list of Avoidance and Minimization Measures that are incorporated by reference as Conservation Recommendations. The following additional measures are recommended regarding incidental take and conservation of Atlantic and shortnose sturgeon:

1. The FHWA and MDTA should continue acoustic telemetry monitoring of shortnose and Atlantic sturgeon in the action area to improve data collection on the presence of sturgeon in the Chesapeake Bay.

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

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

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

6. The FHWA and MDTA should fund or support a Chesapeake Bay sea turtle telemetry/home-range study.

7. The FHWA and MDTA should support derelict gear/marine debris removal in the action area, consistent with recognized sea turtle threats (entanglement, ingestion).

12 REINITIATION OF CONSULTATION

This concludes formal consultation on the 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 effects 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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