Chesapeake Bay Distinct Population Segment of Atlantic Sturgeon
(Acipenser oxyrinchus oxyrinchus)

5-Year Review:
Summary and Evaluation

National Marine Fisheries Service
Greater Atlantic Regional Fisheries Office
Gloucester, Massachusetts

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5-YEAR REVIEW
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1.0 GENERAL INFORMATION

The Chesapeake Bay DPS of Atlantic sturgeon includes Atlantic sturgeon spawned in the watersheds that drain into the Chesapeake Bay and into coastal waters (including bays and sounds) from the Delaware-Maryland border at Fenwick Island to Cape Henry, Virginia, as well as Atlantic sturgeon held in captivity that are progeny of such fish (50 CFR 224.101).

1.1 Reviewers

Lead Regional or Headquarters Office: Greater Atlantic Regional Fisheries Office, Jennifer Anderson, Assistant Regional Administrator for Protected Resources, 978-281-9226, jennifer.anderson@noaa.gov

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1.2 Methodology used to complete the review

The National Marine Fisheries Service (NMFS), Greater Atlantic Regional Fisheries Office (GARFO) led the 5-year review for the Chesapeake Bay Distinct Population Segment (DPS) of Atlantic sturgeon. NMFS is required to consider new information that has become available since the Chesapeake Bay DPS of Atlantic sturgeon was listed as endangered in February 2012. 16 USC 1533 (4) (c) (2). NMFS reviewed and considered new information for the Chesapeake Bay DPS, specifically, as well as other new information for Atlantic sturgeon because there is still a relatively limited amount of DPS-specific information.

NMFS used several methods to acquire the new information. In addition to reviewing the literature generally made available (e.g., journal articles sent to us by the author, notifications of new publications via a group email list), NMFS requested a literature search from the NOAA Central Library. Ten public comments were received in response to a Federal Register notice (83 FR 11731; March 16, 2018). One of those included comments that were specific to the Chesapeake Bay DPS. NMFS also considered the information provided in the conclusions of the Atlantic States Marine Fisheries Commission (ASMFC) 2017 Atlantic Sturgeon Stock Assessment (hereafter, "Stock Assessment"). NMFS did not request copies of the data compiled by the ASMFC or conduct our own analyses of the data. All of the information in the Stock Assessment that is not yet available through peer-reviewed publications was considered best available information because the Stock Assessment was peer-reviewed in accordance with the ASMFC's procedures. NMFS requested courtesy review and comment from the ASMFC Sturgeon Technical Committee for sections 1.0 through 2.3 of the draft 5-year review to help ensure that we are using the best available information.

1.3 Background

1.3.1 FR Notice citation announcing initiation of this review

83 FR 11731, March 16, 2018 - Initiation of 5-Year Review for the Endangered New York Bight, Chesapeake Bay, Carolina and South Atlantic Distinct Population Segments of Atlantic Sturgeon and the Threatened Gulf of Maine Distinct Population Segment of Atlantic Sturgeon.

83 FR 12942, March 26, 2018 - Initiation of 5-Year Review for the Endangered New York Bight, Chesapeake Bay, Carolina and South Atlantic Distinct Population Segments of Atlantic Sturgeon and the Threatened Gulf of Maine Distinct Population Segment of Atlantic Sturgeon; Correction.

1.3.2 Listing history

Original Listing
FR notice: 77 FR 5880
Date listed: February 6, 2012
Entity listed: Chesapeake Bay Distinct Population Segment of Atlantic sturgeon
Classification: Endangered

1.3.3 Associated rulemakings

Critical Habitat
FR notice: 82 FR 39160
Date designated: August 17, 2017
Determination: Five critical habitat units were designated for the Chesapeake Bay DPS of Atlantic sturgeon encompassing approximately 773 kilometers (480 miles) of tidally-affected waters of the Potomac, Rappahannock, York, Mattaponi, Pamunkey, James, and Nanticoke rivers as well as waters of Marshyhope Creek. All of the critical habitat units are in the geographic area occupied by the Chesapeake Bay DPS.

1.3.4 Review History

1998 Status Review: On June 2, 1997, the U.S. Fish and Wildlife Service (USFWS) and NMFS (collectively, the Services) received a petition from the Biodiversity Legal Foundation requesting that NMFS list Atlantic sturgeon in the United States as threatened or endangered and designate critical habitat within a reasonable period of time following the listing. In 1998, after completing a comprehensive status review, the Services published a 12-month determination in the *Federal Register*, announcing that listing was not warranted at that time (63 FR 50187; September 21, 1998). NMFS retained Atlantic sturgeon on the candidate species list (subsequently changed to the Species of Concern List (69 FR 19975; April 15, 2004)).

2003 Workshop: NMFS sponsored a workshop with USFWS and the ASMFC titled "Status and Management of Atlantic Sturgeon," to discuss the status of Atlantic sturgeon along the Atlantic

Coast and determine what obstacles, if any, were impeding their recovery. The results of the workshop indicated some riverine populations seemed to be recovering while others were declining, and bycatch and habitat degradation were noted as possible causes for continued declines (Kahnle et al. 2005).

2007 Status Review: NMFS initiated a new status review of Atlantic sturgeon in 2005 based on the outcomes of the 2003 Workshop and other new information. The Atlantic Sturgeon Status Review Team (ASSRT) concluded in 2007 that Atlantic sturgeon of U.S. origin comprised five DPSs and recommended identifying these as the Gulf of Maine, New York Bight, Chesapeake Bay, Carolina, and South Atlantic DPSs. The ASSRT further recommended that the New York Bight, Chesapeake Bay, and Carolina DPSs be considered threatened under the ESA but made no listing recommendation for the Gulf of Maine or South Atlantic DPSs because of insufficient data. A Notice of Availability of this report was published in the *Federal Register* on April 3, 2007 (72 FR 15865).

On October 6, 2009, NMFS received a petition from the Natural Resources Defense Council to list Atlantic sturgeon throughout its range as endangered under the ESA. As an alternative, the petitioner requested that the species be listed as the five DPSs described in the 2007 Atlantic sturgeon status review with the Gulf of Maine and South Atlantic DPSs listed as threatened, and the remaining three DPSs listed as endangered. NMFS published a Notice of 90-Day Finding on January 6, 2010 (75 FR 838), stating that the petition presented substantial scientific or commercial information indicating that the petitioned actions may be warranted. NMFS considered the information provided in the 2007 Status Review and all other best available information. Subsequently, the Chesapeake Bay DPS was proposed and listed under the ESA as endangered (77 FR 5880; February 6, 2012).

1.3.5 Species' Recovery Priority Number at start of 5-year review

The recovery priority number for the Chesapeake Bay DPS is 1C based on the Listing and Recovery Priority Guidelines (84 FR 18243, April 30, 2019). Additional information is available in the Recovering Threatened and Endangered Species Report to Congress 2017-2018, available at https://www.fisheries.noaa.gov/feature-story/recovering-threatened-and-endangered-species-report-congress-2017-2018.

1.3.6 Name of Recovery Plan or Outline

Recovery Outline for the Atlantic Sturgeon Distinct Population Segments (available at https://www.fisheries.noaa.gov/species/atlantic-sturgeon#conservation-management)
Date issued: January 2018
Dates of previous revisions, if applicable: N/A

2.0 REVIEW ANALYSIS

2.1 Application of the 1996 Distinct Population Segment (DPS) policy

2.1.1 Is the species under review a vertebrate? **Yes**

2.1.2 Is the species under review listed as a DPS? **Yes**

2.1.3 Was the DPS listed prior to 1996? **No**

2.1.4 Is there relevant new information for this species regarding the application of the DPS policy? **No**

2.2 Recovery Criteria

2.2.1 Does the species have a final, approved recovery plan containing objective, measurable criteria? **No**

2.3 Updated Information and Current Species Status

The biology and life history information for the Chesapeake Bay DPS was reviewed for the 2007 Status Review (ASSRT 2007) and updated for the proposed and final rules when the DPS was listed as endangered (75 FR 61872, October 6, 2010; 77 FR 5880, February 6, 2012). The habitat needs for the DPS were reviewed and described in the critical habitat designation (82 FR 39160, August 17, 2017) and in the supplementary document (https://repository.library.noaa.gov/view/noaa/18671). Section 2.3.1 provides a summary of the previously available information, and then provides updates from new information that has become available since the ESA-listing and critical habitat designation for the Chesapeake Bay DPS.

2.3.1 Biology and Habitat for the Chesapeake Bay DPS of Atlantic Sturgeon at the Time of the ESA-Listing

The Chesapeake Bay DPS of Atlantic sturgeon has the same basic life history characteristics of all Atlantic sturgeon. Atlantic sturgeon are reliant upon freshwater for spawning and embryo and larval rearing habitat, and brackish and marine waters for growth and development of the juveniles as well as sustenance of adults. Atlantic sturgeon are easily distinguished from most other fish species within their range because of their relatively large size, visible bony scutes, protruding snout, and heterocercal tail. Atlantic sturgeon belonging to different DPSs can be distinguished from each other based on the unique genetic characteristics of each DPS and of each spawning river population.

The Chesapeake Bay DPS is comprised of all Atlantic sturgeon 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 (77 FR 5880; February 6, 2012). Within this range, and depending on the information used to determine historical spawning, Atlantic sturgeon likely spawned in the Susquehanna, Choptank, Nanticoke, Wicomico and Pocomoke rivers as well as the Potomac, Rappahannock, York River system and James rivers (Secor 2002; ASSRT 2007). Of these rivers, there was evidence of current spawning only in the James River when the Chesapeake Bay DPS was listed as endangered.

Spawning areas for the Chesapeake Bay DPS within the James River were identified in the listing rule as likely occurring at the Turkey Island oxbow (approximately river kilometer 120) and the Jones Neck oxbow (Bushnoe et al. 2005). There were no known specific location(s) for juvenile rearing habitat. Atlantic sturgeon likely spend two to three years in the natal estuary, using and moving within the brackish waters of the natal estuary that are most suitable for their growth and development, before emigrating to the marine environment.

The directed movement of subadult[1] and adult Atlantic sturgeon in the spring is from marine waters to river estuaries. River estuaries provide foraging opportunities for subadult and adult Atlantic sturgeon in addition to providing access to spawning habitat. Brackish waters of the Chesapeake Bay and the James River are used by subadults, non-spawning adults, and post-spawned adults during the spring through fall. These include subadults and adults that are not natal to the river or to the Chesapeake Bay DPS. The directed movement of subadult and adult Atlantic sturgeon is reversed in the fall as the fish move back into marine waters for the winter.

In the marine environment, subadults and adults typically occur within the 50-meter (m) depth contour. Genetic analyses indicated the presence of Atlantic sturgeon belonging to the Chesapeake Bay DPS in many parts of the marine range including the New York Bight, off the Virginia/North Carolina coastline, and in very small numbers in the Bay of Fundy (77 FR 5880; February 6, 2012).

Life history information for the Chesapeake Bay DPS is relatively sparse and most of the available information was collected from sturgeon belonging to the James River spawning population or from spawning populations for other DPSs. When NMFS listed the DPS, age at maturity for Atlantic sturgeon belonging to the Chesapeake Bay DPS was unknown. However, age at maturity for both sexes was considered as likely within the range of values for age at maturity of Atlantic sturgeon that originated from the Hudson River and age at maturity for Atlantic sturgeon that originated from South Carolina rivers. Spawning periodicity for the Chesapeake Bay DPS was unknown but was described as one to five years for males and two to five years for females based on the best available information for other spawning populations. NMFS considered that the lifespan for Atlantic sturgeon, in general, was approximately 60 years (Mangin 1964; Stevenson and Secor 1999).

There was no abundance estimate for the Chesapeake Bay DPS when NMFS listed it under the ESA. The ASSRT (2007) suggested that most of the spawning populations, including in the James River, likely numbered less than 300 spawning adults per year because the ASSRT considered that the Hudson River spawning population and the Altamaha River spawning population, for which there were estimates of 870 and 343 spawning adults per year, respectively, were likely the most robust of all of the Atlantic sturgeon spawning populations.

[1] NMFS uses the term "subadult" here to refer to immature Atlantic sturgeon that have emigrated from the natal river estuary and uses the term "juvenile" to refer to immature fish that have not yet emigrated from the natal river estuary. Some of the published literature for Atlantic sturgeon uses the term juvenile to refer to all sexually immature Atlantic sturgeon, including sexually immature fish that have emigrated from the natal river estuary.

Therefore, the ASSRT made a reasoned conclusion that all of the other Atlantic sturgeon spawning populations likely numbered less than 300 spawning adults per year.

Studies have shown that Atlantic sturgeon can only sustain low levels of anthropogenic mortality (Boreman 1997; ASSRT 2007; Brown and Murphy 2010). NMFS concluded at the time of the listing that the Chesapeake Bay DPS was at risk of extinction given low abundance, limited spawning, threats to habitat from continued degraded water quality and dredging, anthropogenic mortality of Chesapeake Bay DPS Atlantic sturgeon from bycatch and vessel strikes, the lack of measures to address these threats, and the likelihood that some threats (e.g., bycatch) were likely to increase in magnitude in the future.

2.3.1.1 New information on the species' biology and life history

New information has been collected from the use of acoustic telemetry to detect the presence of Atlantic sturgeon. Use of acoustic telemetry for Atlantic sturgeon requires surgically implanting the tag within the sturgeon's body cavity (Kahn and Mohead 2010), and then placing acoustic receivers in the water which detect and record the unique signal of the tag when the sturgeon is within range of the receiver. Acoustic receivers are often fixed in specific locations but a receiver can also be towed or fixed to a moving object. Researchers use an array of receivers to track the movements of acoustically-tagged sturgeon in areas across the range of each DPS. Since the listing, there is evidence of additional spawning populations for the Chesapeake Bay DPS, and evidence that most of the Chesapeake Bay DPS spawning populations spawn in the late summer to fall (hereafter referred to as "fall spawning") rather than in the spring. Fall spawning activity has been documented in the newly discovered spawning populations in the Pamunkey River, a tributary of the York River, and in Marshyhope Creek, a tributary of the Nanticoke River (Hager et al. 2014; Kahn et al. 2014; Richardson and Secor 2016; Secor et al. 2021). The James River is currently the only river of the Chesapeake Bay DPS where evidence suggests there is both spring and fall spawning with separate spawning populations. The results of genetic analyses show that there is some limited gene flow between the populations but, overall, the spawning populations are genetically distinct (Balazik et al. 2012a; Balazik and Musick 2015; Balazik et al. 2017a). New 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.

There is new information for spawning periodicity and sex ratios for Chesapeake Bay DPS spawning populations. Based on detections of acoustically-tagged sturgeon, there is annual variability in the number of adults that return each year to spawn for the James River, Pamunkey River, and Marshyhope Creek/Nanticoke River spawning populations. However, many acoustically-tagged males have made annual returns to the spawning locations. Tagged females returned to spawning locations about every two to three years but, some females also returned to spawning locations in consecutive years (Balazik et al. 2017a; Kahn et al. 2019; Kahn et al. 2021; Secor et al. 2021). Kahn et al. (2021) also used detections of acoustically-tagged sturgeon, adult males and females, to inform the sex ratio of the Pamunkey River spawning population for

which they estimate males make up approximately 51 percent (95% CI=0.43-0.58) of the adult population.

The discovery and further study of Atlantic sturgeon spawning populations in the Chesapeake Bay tributaries has also provided new information for the range of water temperatures associated with sturgeon spawning, and movements of the fish to and from the spawning grounds (Balazik et al. 2012a; Balazik et al. 2020; Hager et al. 2020; Secor et al. 2021). The research conducted in these separate river systems informs the importance of water temperature as a trigger for Atlantic sturgeon spawning and confirms the relatively narrow temperature range (i.e., 20° C to 25° C) that is most conducive for spawning. While there may be other factors that influence when spawning occurs (e.g., photoperiod; Hager et al. 2020; Secor et al. 2021), the new information clearly demonstrates that water temperature is a key factor for when spawning occurs for the Chesapeake Bay DPS of Atlantic sturgeon.

New information indicates that there is a limited amount of hard-bottom habitat for Atlantic sturgeon spawning in the Chesapeake Bay tributaries (Austin 2012; Bruce et al. 2016; Secor et al. 2021). There is also new information on the upriver range of the DPS in Chesapeake Bay tributaries based on detections of tagged, adult Atlantic sturgeon (Balazik et al. 2012a; Hager et al. 2014; NMFS 2017; Secor et al. 2021). The locations of adults within the river's freshwater reach further informs the location of possible spawning habitat. Seasonal differences in the movements and upriver extent of tracked adult Atlantic sturgeon in the James River indicates that there are two different spawning areas, depending on season, for the two James River spawning populations (Balazik et al. 2012a; Balazik and Musick, 2015).

Although still sparse, there is some new information that supports or further informs basic life history parameters for the Chesapeake Bay DPS. Juvenile Atlantic sturgeon of the Chesapeake Bay DPS remain in the natal estuary for one to four years before emigrating to marine waters (Balazik et al. 2012b). Males mature at about age 10 and females at 15 years old, have at least a 25 year lifespan, and can live as long as 64 years (Balazik et al. 2012b; Hilton et al. 2016), although the natural life expectancy of Atlantic sturgeon belonging to the Chesapeake Bay DPS is still uncertain.

2.3.1.2 New information on the abundance, population trends (e.g. increasing, decreasing, stable), demographic features (e.g., age structure, sex ratio, family size, birth rate, age at mortality, mortality rate, etc.), or demographic trends

There are no abundance estimates for the entire Chesapeake Bay DPS or for the spawning populations in the James River or the Nanticoke River system. 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. There is new information on spawning population abundance in the Pamunkey River. Based on research captures of tagged adults, an estimated 75 Chesapeake Bay DPS Atlantic sturgeon spawned in the Pamunkey River in 2013 (Kahn et al. 2014). More recent information provided annual run estimates for the Pamunkey River from 2013 to 2018. The results suggest a spawning run of up to 222 adults but with yearly variability, likely due to spawning periodicity (Kahn et al. 2019).

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

Another method for assessing the number of spawning adults is through determinations of effective population size[2] which measures how many adults contributed to producing the next generation based on genetic determinations of parentage from the offspring. Effective population size is always less than the total abundance of a population because it is only a measure of parentage, and it is expected to be less than the total number of adults in a population because not all adults successfully reproduce. Measures of effective population size are also used to inform whether a population is at risk for loss of genetic diversity and inbreeding (see section 2.3.1.3). There are several estimates of effective population size for Atlantic sturgeon that are spawned in the James River although only one study examined the effective population size of both the spring and fall spawning populations. Nevertheless, the estimates of effective population size from separate studies and based on different age classes are similar. These are: 62.1 (95% CI=44.3-97.2) based on sampling of subadults[3] 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 2017a); 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 et al. 2017a). There is a single estimate of 12.2 (95% CI = 6.7– 21.9) for the Nanticoke River system (Secor et al. 2021), 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 2017a).

There have not been sufficient captures of juveniles to estimate abundance based on that life stage. In 2018, age-0 juvenile sturgeon were captured in the James River, and were presumably from the fall spawning population based on their size and the time of year when they were captured (Greenlee et al. 2019). Subsequent recaptures of this year class may provide the opportunity to estimate abundance. However, age-0 juveniles were not captured in 2019 despite research effort in the same areas and at the same time as in the previous year (M. Balazik per James River Sturgeon Facebook Page). This outcome further suggests the possibility of low, annual reproductive success in the James River.

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

[3] O'Leary et al. refer to the sampled fish as juveniles. However, NMFS uses the term "subadult" here for immature Atlantic sturgeon that have emigrated from the natal river, and uses the term "juvenile" for immature fish that have not yet emigrated from the natal river.

The estimates of effective population size as well as new genetic analyses of sturgeon collected in mixed aggregations (Wirgin et al. 2015a; Wirgin et al. 2015b; Kazyak et al. 2021) continue to support the conclusion that the Chesapeake Bay DPS is primarily comprised of Atlantic sturgeon that originate from the James River. Section 2.3.1.5 provides additional results of genetic analyses for sturgeon captured from mixed aggregation areas within the marine range.

NMFS estimated adult and subadult abundance of the Chesapeake Bay DPS based on available information for the genetic composition and the estimated abundance of Atlantic sturgeon in marine waters (Damon-Randall et al. 2013, Kocik et al. 2013). NMFS has relied upon these numbers in the ESA section 7 consultation context, and concluded that subadult and adult abundance of the Chesapeake Bay DPS was 8,811 sturgeon (NMFS 2013). This number encompasses many age classes since, across all DPSs, subadults can be as young as one year old when they first enter the marine environment, and adults can live as long as 64 years (Balazik et al. 2012c; Hilton et al. 2016).

Very few data sets are available that cover the full potential life span of an Atlantic sturgeon which could be as much as approximately 40 to 60 years. The ASMFC concluded for the Stock Assessment that it could not estimate abundance of the Chesapeake Bay 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 Chesapeake Bay 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[4] 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 Chesapeake Bay DPS.

In the Stock Assessment, the ASMFC concluded that abundance of the Chesapeake Bay DPS is "depleted" relative to historical levels and there is a relatively low probability (37 percent) that abundance of the Chesapeake Bay DPS has increased since the implementation of the 1998 fishing moratorium. However, the ASMFC also concluded that there is a relatively high likelihood (70 percent probability) that mortality for the Chesapeake Bay DPS does not exceed the mortality threshold used for the Stock Assessment (ASMFC 2017a).

2.3.1.3 Genetics, genetic variation, or trends in genetic variation (e.g., loss of genetic variation, genetic drift, inbreeding, etc.)

There are some indications of genetic bottlenecks in the James River spawning populations and mixed conclusions as to whether there are indications of inbreeding (O'Leary et al. 2014; ASMFC 2017a; Balazik et al. 2017a; Waldman et al. 2019). NMFS does not have information to indicate whether or to what extent the Chesapeake Bay DPS is negatively affected by the reduced genetic variation.

[4] 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).

2.3.1.4 Taxonomic classification or changes in nomenclature

There are no changes in taxonomic classification or changes in nomenclature for the Chesapeake Bay DPS of Atlantic sturgeon. Additional genetic analyses were conducted for the Stock Assessment, which concluded that the genetic designations of the Atlantic sturgeon DPSs are sound, and that the general delineations first suggested in 2007 continue to accurately describe the geographic groups of Atlantic sturgeon encountered along the U.S. Atlantic coast (ASMFC 2017a). As described in section 2.3.1.5, there is additional, new, information that supports our conclusion in the listing rule that the Chesapeake Bay DPS persists in an ecological setting unusual or unique for the taxon, and loss of the DPS would result in a significant gap in the range of the taxon.

2.3.1.5 Spatial distribution, trends in spatial distribution (e.g. increasingly fragmented, increased numbers of corridors, etc.), or historic range (e.g. corrections to the historical range, change in distribution of the species' within its historic range, etc.)

New information is available that better informs the marine range of the Chesapeake Bay DPS. Based on genetic analyses, Atlantic sturgeon belonging to the Chesapeake Bay DPS have been identified among those captured in the Bay of Fundy, Canada as well as in U.S. waters that include Long Island Sound and the lower Connecticut River, and in marine waters off of western Long Island, New Jersey, Delaware, Virginia, and North Carolina. The Chesapeake Bay DPS was most prevalent in Mid-Atlantic marine waters, bays, and sounds, particularly in areas closest to the Chesapeake Bay (Dunton et al. 2012; Wirgin et al. 2012; Waldman et al. 2013; Wirgin et al. 2015a; Wirgin et al. 2015b; Wirgin et al. 2018). A new, comprehensive analysis of Atlantic sturgeon stock composition coast wide provides further evidence that natal origin influences the distribution of Atlantic sturgeon in the marine environment. Atlantic sturgeon that originate from each of the five DPSs and from the Canadian rivers were represented in the 1,704 samples analyzed for the study. However, there were statistically significant differences in the spatial distribution of each DPS, and individuals were most likely to be assigned to a DPS in the same general region where they were collected (Kazyak et al. 2021). For the Chesapeake Bay DPS, the results support the findings of previous genetic analyses that Atlantic sturgeon belonging to the DPS are most prevalent in the Mid-Atlantic Bight, particularly from around Delaware to Cape Hatteras.

New information from Rothermel et al. (2020) provides more detailed information for marine habitats used by Atlantic sturgeon off the coast of Maryland, and the migratory patterns of Atlantic sturgeon through the area. Their findings also provide further information indicating that Atlantic sturgeon occur further offshore in the late fall and winter months than in the spring and summer. Breece et al. (2016; 2018a; 2018b) further investigated the distribution and occurrence of Atlantic sturgeon in the Mid-Atlantic Bight based on associated habitat features, as well as the habitat features associated with presence of adults in the Delaware River, and their distribution and movements within Delaware Bay. The research provides evidence that specific habitat features such as substrate composition and distance from the salt front in the river estuary, water depth and water temperature in Delaware Bay, and depth, day-of-year, sea surface temperature, and light absorption by seawater in marine waters affect where and when Atlantic

sturgeon occur. The Rothermel et al. and the Breece et al. literature do not identify the natal origin of the detected sturgeon. However, their studies likely included detections of Atlantic sturgeon belonging to the Chesapeake Bay DPS because most of the sturgeon were initially captured and tagged off of Delaware, and separate studies (Wirgin et al 2015a; Kazyak et al. 2021) have confirmed the presence of Atlantic sturgeon belonging to the Chesapeake Bay DPS in that area. Therefore, NMFS assumes that the results of Rothermel et al. (2020) and Breece et al. (2016; 2018a; 2018b) are representative of the movement patterns and habitats used by Chesapeake Bay DPS Atlantic sturgeon in mid-Atlantic marine waters.

2.3.1.6 Habitat or ecosystem conditions (e.g., amount, distribution, and suitability of the habitat or ecosystem)

NMFS designated critical habitat for the Chesapeake Bay DPS in tidally-affected riverine waters of the Potomac, Rappahannock, and James rivers as well as in the York River system (including the Mattaponi and Pamunkey rivers) and the Nanticoke River system (including Marshyhope Creek) based on the best available information at the time of designation (82 FR 39160; August 17, 2017). In total, these designations encompass approximately 773 kilometers (480 miles) of aquatic habitat that is essential to the recovery of the Chesapeake Bay DPS.

As described in section 2.3.1.5, there is new information describing the distribution of Chesapeake Bay DPS Atlantic sturgeon in Mid-Atlantic waters. NMFS did not designate critical habitat in marine waters, bays, or sounds despite evidence that Atlantic sturgeon belonging to the Chesapeake Bay DPS are prevalent in certain areas because NMFS is required to designate critical habitat based on the physical or biological features that are essential to conservation of the listed species, and not based solely on the presence of the listed species. The available information was too limited to inform what the physical or biological features are in the marine environment, bays, or sounds that are essential to the conservation of the Chesapeake Bay DPS. Section 2.3.2 provides information for on-going and emerging threats to designated critical habitat and the habitats that are otherwise used by the Chesapeake Bay DPS.

2.3.2 Five-Factor Analysis (threats, conservation measures, and regulatory mechanisms)

Section 4(a)(1) of the ESA requires the Services to determine whether a species is endangered or threatened because of any of the following factors (or threats) alone or in combination:

A. The present or threatened destruction, modification, or curtailment of its habitat or range;

B. Overutilization for commercial, recreational, scientific, or educational purposes;

C. Disease or predation;

D. Inadequacy of existing regulatory mechanisms to address identified threats; or

E. Other natural or human factors.

New information relative to each of these factors and the status of the Chesapeake Bay DPS is described below.

2.3.2.1 Present or threatened destruction, modification or curtailment of its habitat or range

Summary of Factor A: NMFS described in the ESA-listing rule that dredging and water quality (e.g., dissolved oxygen levels, water temperature, and contaminants) are threats that affect the habitat or range of the Chesapeake Bay DPS. NMFS anticipated that potential changes in water quality as a result of global climate change will likely affect the Chesapeake Bay DPS and that effects are likely to be more severe in areas that are already subject to poor water quality as a result of eutrophication.

New information is available on the effects of these threats to the Chesapeake Bay DPS, and the actions taken to address the threats. Since the listing, NMFS has consulted with the United States Army Corp of Engineers (USACE) under section 7 of the ESA to consider the effects of on-going, regular, maintenance of the James River Federal navigational channel (NMFS 2019). There is also new information describing the behavior of Atlantic sturgeon in the James River during dredging operations. The results of Reine et al. (2014) and Balazik et al. (2020) show that dredging in the James River federal navigational channel does not pose a barrier (e.g., from the sound or turbidity plume produced by dredging) to Atlantic sturgeon movements within the river. Even spawning adults made their usual upriver movements past the dredge activity to the spawning grounds. Both studies demonstrated that the sturgeon were neither avoiding nor attracted to the dredge activity. The study results support the conclusions of the most recent biological opinion on the effects of regular, on-going maintenance dredging of the James River Federal navigational channel which concluded that the proposed dredging is unlikely to pose a barrier to Atlantic sturgeon within the James River but that takes (e.g., capture and killing) of Atlantic sturgeon might occur in the dredge gear. The biological opinion describes the anticipated lethal take of Atlantic sturgeon belonging to the Chesapeake Bay DPS which is 43 subadult and juvenile Atlantic sturgeon from dredging entrainment through 2062, as well as the loss of 2.2 percent of the annual Chesapeake Bay DPS Atlantic sturgeon post yolk-sac larvae year class in the river through 2062 (NMFS 2019). A portion of the subadults, all of the juveniles, and all of the post yolk-sac larvae are expected to belong to the James River Atlantic sturgeon spawning populations.

NMFS also consulted with the USACE under section 7 to reconsider the effects of on-going dredging in the Chesapeake Bay navigation channels. The biological opinion considered the effects of proposed new dredging (e.g., to deepen and widen some channels), continued maintenance dredging, and sand borrow operations in several Federal navigation channels located in the Chesapeake Bay and in the Atlantic Ocean (NMFS 2018). The proposed activities also include the Craney Island Eastward Expansion (CIEE) project. The CIEE consists of multiple construction elements within Hampton Roads and the Elizabeth River including construction of a new 522-acre dredged material containment cell and a new marine terminal. The biological opinion describes the anticipated lethal take of Atlantic sturgeon belonging to the Chesapeake Bay DPS which is 23 sturgeon over the lifespan of the project.

Our consultation with the USACE for the James River Federal Navigation Project and for the Chesapeake Bay Navigation Channel Projects concluded that the proposed activities may adversely affect but were not likely to jeopardize the continued existence of the Chesapeake Bay DPS, and were not likely to adversely affect the DPS's designated critical habitat. Additional

information is available at https://www.fisheries.noaa.gov/new-england-mid-atlantic/consultations/section-7-consultations-greater-atlantic-region.

There are continuing efforts to improve water quality for the Chesapeake Bay and its tributaries. In 2017, the United States Environmental Protection Agency (USEPA) issued its latest addendum to the 2003 publication, *Ambient Water Quality Criteria for Dissolved Oxygen, Water Clarity and Chlorophyll a for the Chesapeake Bay*. This addendum further describes the procedures for assessing the water quality criteria that have been adopted by Delaware, Maryland, Virginia, and the District of Columbia (hereafter "Partners") into their respective water quality standards regulations. NMFS considered these standards and previously available information from Niklitschek and Secor (2009; 2010) on effects of salinity, water temperature, and dissolved oxygen on the growth and survival of juvenile Atlantic sturgeon when NMFS identified the physical features essential to the recovery of the Chesapeake Bay DPS (NMFS 2017). NMFS also considered new information that suggests that even if juvenile sturgeon are able to avoid areas of low dissolved oxygen, they may be forced to use habitat that is still not optimal, such as higher salinity waters that are not lethal but, negatively impact their growth (Allen et al. 2014). NMFS determined that an essential feature of critical habitat for the Chesapeake Bay DPS is water between the river mouth and spawning sites, especially in the bottom meter of the water column, with the temperature, salinity, and oxygen values that, combined, support the DPSs spawning, survival, growth, development, and recruitment. NMFS did not establish water quality criteria for this feature of the critical habitat designation because temperature, salinity, and oxygen are ephemeral by nature, fluctuating daily and seasonally in estuaries. However, based on the work of the EPA and its Partners for the Chesapeake Bay, NMFS provided specific oxygen concentration and temperature values as examples and guidance to inform the combinations of temperature, salinity, and oxygen that support successful Atlantic sturgeon reproduction and recruitment.

Additional information is available that informs the effect of climate change on the Chesapeake Bay DPS. There are very few studies that have specifically examined the effects of global climate change to Atlantic sturgeon. However, Hare et al. (2016) provide a method for assessing the vulnerability of Atlantic sturgeon to climate change using the best available information from climate models and what is known of the subspecies life history, biology, and habitat use. Based on their comprehensive assessment, Hare et al. determined that Atlantic sturgeon are highly vulnerable to climate change. Contributing factors include their low potential to change distribution in response to climate change (e.g., spawning locations are specific to a DPS within a specific geographic region), and their exposure to climate change throughout their range, including in estuarine and marine waters. The determinations are supported by the information of Balazik et al. (2010) that suggests individual spawning populations will respond to changing climate temperatures with physiological changes (e.g., changes in growth rate) rather than redistributing to a more southern or northern habitat to maintain their exposure to a consistent temperature regime. Markin and Secor (2020) further demonstrate the effect of temperature on the growth rate of juvenile Atlantic sturgeon, and informs how global climate change may impact growth and survival of Atlantic sturgeon across their range. Their study showed that all juvenile Atlantic sturgeon had increased growth rate with increased water temperature regardless of their genetic origins. However, based on modeling and water temperature data from 2008 to 2013, they also determined that there is an optimal water temperature range, above and below

which juveniles experience a slower growth rate, and they further considered how changes in growth rate related to warming water temperatures associated with global climate change might affect juvenile survival given the season (e.g., spring or fall) in which spawning currently occurs. They also identified that the Chesapeake Bay region currently experiences the most days within the optimum temperature range compared to more northern and southern parts of the Atlantic sturgeon's range. However, the Atlantic sturgeon's low likelihood to change distribution in response to current global climate change will also expose them to climatic effects on estuarine habitat, such as more flood events from increased hurricane activity. Flood events associated with hurricane activity are relevant to the Chesapeake Bay DPS, in particular, given that the hurricane season overlaps with the timing of fall spawning, and the associated effects (e.g., to water temperature, dissolved oxygen, and pH) can affect the duration of spawning, and egg, larval, and even adult survival. In addition, as discussed in Secor et al. (2021), flood events can have a particularly large impact to water quality of the Chesapeake Bay tributaries given their relatively shallow depth and, for some, relatively short river reach.

NMFS continues to consult with federal agencies on other actions that may affect Atlantic sturgeon belonging to the Chesapeake Bay DPS, such as beach renourishment and shoreline stabilization projects. The biological opinions for these consultations are available at https://www.fisheries.noaa.gov/new-england-mid-atlantic/consultations/section-7-consultations-greater-atlantic-region. Federal actions related to the construction and operation of wind farms in marine waters have been proposed or are in development within the Chesapeake Bay DPSs marine range and include Dominion's Coastal Virginia Offshore Wind Project. Currently, there is not enough information to determine whether and to what extent these are an emerging threat to the Chesapeake Bay DPS. To date, all section 7 consultations completed on offshore wind projects have concluded that the proposed construction, operations, and decommissioning of offshore wind projects are not likely to adversely affect any DPS of Atlantic sturgeon. NMFS expects to consult with the lead federal agency, as necessary, as each project develops.

Conclusion for Factor A: Construction projects and maintenance dredging continue to be a stressor for the Chesapeake Bay DPS throughout its range, particularly in the areas nearest to and within the rivers that support spawning habitat. The new information suggests that dredging may pose less of a threat with respect to being a barrier to sturgeon movements. However, injury and mortality of Atlantic sturgeon in dredge gear still occur. Water quality also continues to be a stressor for the Chesapeake Bay DPS. New information shows that Atlantic sturgeon (all DPSs) are highly vulnerable to climate change. Climactic effects, such as flood events, are relevant to the Chesapeake Bay DPS, in particular, because of their impact to the water quality of the Chesapeake Bay tributaries and the timing of fall spawning which overlaps with the Atlantic hurricane season. Therefore, the new information suggests that the DPS will be more negatively affected by climate change than what was anticipated when the DPS was listed as endangered.

2.3.2.2 Overutilization for commercial, recreational, scientific, or educational purposes

Summary of Factor B: A moratorium on the possession and retention of Atlantic sturgeon had already ended directed harvest of Atlantic sturgeon when the five DPSs were listed. However, bycatch in Federal and state regulated fisheries continued to occur and, in the final listing rule

(77 FR 5880), NMFS considered bycatch to be one of the primary threats to the Chesapeake Bay DPS.

New information continues to demonstrate bycatch of the Chesapeake Bay DPS in federally-managed fisheries (NMFS 2021). NMFS completed several biological opinions after the ESA-listings to document our conclusions on the anticipated effects of federally-managed fisheries on the Atlantic sturgeon DPSs. The biological opinion on the continued implementation of the Northeast multispecies, monkfish, spiny dogfish, Atlantic bluefish, Northeast skate complex, mackerel/squid/butterfish, and summer flounder/scup/black sea bass fisheries (aka "batched biological opinion") is the most relevant of the fisheries biological opinions because it includes the fisheries most likely to take Atlantic sturgeon belonging to the Chesapeake Bay DPS, and provides the most comprehensive analysis with respect to the number of fisheries considered in one opinion. In the first batched biological opinion that followed the listing, NMFS determined that, on average, 41 sturgeon (adults and subadults combined) belonging to the Chesapeake Bay DPS were likely to be killed annually as a result of capture in gillnet and trawl gear that is used in the fisheries (NMFS 2013). NMFS concluded that this level of take was not likely to jeopardize the continued existence of the DPS. A new batched biological opinion was completed in May 2021. The conclusions of the new final opinion are unchanged for the Chesapeake Bay DPS; however, the estimate of annual take is different. NMFS concluded that continued operations of the fisheries are likely to result in the average annual lethal take of 17 sturgeon (adults and subadults combined) belonging to the Chesapeake Bay DPS, and that this level of take was not likely to jeopardize the continued existence of the Chesapeake Bay DPS. The take estimates in the original opinion and in the new opinion are not directly comparable because the approach for distributing the total take among the DPSs changed based on the new information in Kazyak et al. (2021), and the models used to estimate total take of Atlantic sturgeon in the fisheries differed in the two opinions. The total take must be estimated because the actual take is primarily recorded by observers that are part of the Northeast Fisheries Monitoring Programs and the At-Sea Monitoring Program, assignment of observer coverage is not specific to monitoring for take of Atlantic Sturgeon, and observers are not present at all times and on all fishing vessels. The biological opinions are available at: https://www.fisheries.noaa.gov/new-england-mid-atlantic/consultations/section-7-biological-opinions-greater-atlantic-region

Research has been conducted since the ESA-listing on gear modifications that could reduce the capture of Atlantic sturgeon in the federally-managed gillnet fisheries, and to examine post-release mortality for sturgeon captured in gillnet gear (Fox et al. 2013; He and Jones 2013; Bouyoucos et al. 2014; Fox et al. 2019). Management measures have not been implemented based on the results. Additional research is proposed to be conducted under ESA permit number 17225. Research has also been conducted to test a modified gillnet for the state managed fishery for Striped Bass in the James River. The raised footrope design had reduced sturgeon bycatch and increased landings of Striped Bass (i.e., the targeted species) compared to the conventional fishing gear (Hager et al. 2021). The batched biological opinion currently includes requirements that: (1) NMFS must continue to work with the fishing industry and partners to promote, fund, conduct, and/or review research on gear modifications to reduce incidental takes, and the severity of interactions that do occur; (2) GARFO's Sustainable Fisheries Division will convene a working group to review all the available information on Atlantic sturgeon bycatch in the federal large gillnet (≥ 7 inches stretched) mesh fisheries; and, (3) within one year of publication

of the batched opinion, the working group will develop an action plan to reduce Atlantic sturgeon bycatch in these fisheries by 2024.

New information also shows that the incidental take of Atlantic sturgeon in state-managed fisheries is still occurring. The reported take of Atlantic sturgeon in each state's managed fisheries is provided annually to the ASMFC. These numbers are likely a minimum count of what actually occurs because many of the state fisheries rely upon voluntary reporting of sturgeon takes (ASMFC 2019). Nearly all of the Atlantic sturgeon takes reported to the ASMFC for the period 2013 through 2017 were attributed to the South Carolina shad fishery, the North Carolina inshore gillnet fishery, and the Georgia shad fishery (ASMFC 2016; ASMFC 2017b; ASMFC 2018; ASMFC 2019). In 2013, South Carolina implemented measures to reduce the take of Atlantic sturgeon in its shad fishery including statewide gear restrictions (i.e., 50 percent statewide reduction in allowable gear; 80 to 90 percent reduction for high priority rivers) (ASMFC 2019). North Carolina and Georgia are each addressing the take of Atlantic sturgeon in their respective fisheries through an ESA section 10 incidental take permit (see section 2.3.2.4 for additional information).

There are anecdotal as well as documented reports of Atlantic sturgeon caught in recreational fishing gear (Dunton et al. 2015; ASMFC 2017a). Regulations are in place for all state waters in which Atlantic sturgeon occur that require that the fish be immediately released from the gear. In addition, NMFS provides information for how to safely release Atlantic sturgeon from recreational fishing gear. Based on social media posts and voluntary reports to us, it appears that many recreational fishermen are complying with the regulations and the guidance. However, NMFS does not have complete information to quantify how often Atlantic sturgeon are caught, the fate of individual fish, or to what extent, if any, poaching may occur.

Eight permits issued under section 10 of the ESA currently exempt the taking of live, wild, Atlantic sturgeon belonging to the Chesapeake Bay DPS for scientific research. In addition, NMFS possesses a permit for the take of opportunistically found dead Atlantic sturgeon or mortalities from other actions (e.g. permitted research, fisheries bycatch, hatchery operations). By maximizing the use of these salvaged specimens through a large network of sturgeon researchers, NMFS provides opportunities to obtain new information while reducing the need for taking (e.g., capture, collecting, sampling) living, wild specimens.

There are currently four permits issued under section 10 of the ESA for the anticipated incidental take of Atlantic sturgeon belonging to the Chesapeake Bay DPS. The activities include: a nature education program in the Hudson River; operation of a power generating facility on the James River; and, operation of the North Carolina inshore gillnet fishery and the Georgia shad fishery described above. NMFS issues incidental take permits if the taking will occur incidental to an otherwise legal activity, the permit applicant minimizes and mitigates the impacts of such taking to the maximum extent practicable, the taking will not appreciably reduce the likelihood of the survival and recovery of the species in the wild, and the applicant ensures that the minimization and mitigation measures will be implemented. Each of the permits is available at https://www.fisheries.noaa.gov/national/endangered-species-conservation/incidental-take-permits.

There are no permits that authorize retention of living Atlantic sturgeon captured from the wild for the purpose of public display or for scientific research. Some Atlantic sturgeon that were brought into captivity before the ESA-listing are on public display for educational purposes or are housed for scientific research. NMFS is unaware of whether any of these belong to the Chesapeake Bay DPS.

Conclusion for Factor B: The available information continues to support our conclusion in the listing rule that overutilization of the Chesapeake Bay DPS is not occurring as a result of educational or scientific purposes. However, overutilization in terms of bycatch remains one of the primary threats faced by the Chesapeake Bay DPS. Based on the best available information, bycatch in federally-managed fisheries remains the highest enumerated source of capture, injury, and mortality of Atlantic sturgeon belonging to the Chesapeake Bay DPS among all known stressors. All of the Atlantic sturgeon that are killed as bycatch in federally-managed fisheries are subadults or adults. Bycatch as a result of state managed fisheries can result in the capture, injury and mortality of any of the Atlantic sturgeon life stages depending on where and when those fisheries occur. There continues to be limited information from which to estimate the number of Atlantic sturgeon belonging to the Chesapeake Bay DPS that are captured and killed as a result of fisheries bycatch. The lack of information hinders our ability to fully address this threat.

2.3.2.3 Disease or predation

Summary of Factor C: NMFS described in the listing rule that very little is known about natural predators of Atlantic sturgeon. After reviewing the limited information, NMFS concluded that neither disease nor predation are considered primary factors affecting the continued persistence of the Chesapeake Bay DPS of Atlantic sturgeon.

Hilton et al. (2016) reviewed diseases and parasites known to affect Atlantic sturgeon. There is no new information for the Chesapeake Bay DPS.

There is new information regarding seal predation on Atlantic sturgeon. On February 9, 2021, a team flying a survey for right whales off of Cape Cod, Massachusetts sighted and photographed a grey seal biting into and eating an apparently fresh dead Atlantic sturgeon (Center for Coastal Studies, pers. comm.). There were no other apparent wounds on the sturgeon which suggests that the seal captured and killed the sturgeon. There are very few documented incidents of seal predation on sturgeon along the U.S. East Coast (Fernandez et al. 2008; SSSRT 2010). There is also new information for bird predation on Atlantic sturgeon. Hilton and McGrath (2021) describe the apparent predation of a juvenile Atlantic sturgeon (512 mm total length) along the York River, Virginia by a bird of prey which was likely an osprey or a bald eagle. This is the first evidence of possible bird predation of a juvenile Atlantic sturgeon. Given the rarity of these predation events, it is not known whether they were unique incidents or if they are indicative of emerging threats from the increased seal populations occurring within and expanding beyond the Gulf of Maine, and from increased populations of osprey and bald eagles throughout the range of the Chesapeake Bay DPS.

Predation of early Atlantic sturgeon life stages by introduced, non-native, catfish species has

been suggested as contributing to the very low capture rates of juvenile Atlantic sturgeon in the James River and in the other Chesapeake Bay tributaries. The extent of the predation, if it occurs, is unknown (Hilton et al. 2016). The ASMFC reviewed but did not find new information that supports or refutes these discussions, and concluded that more research is needed to determine whether invasive species, including non-native catfish, are a threat to Atlantic sturgeon recovery (ASMFC 2017a). Subsequently, Bunch et al. (2020) provided the findings of their work conducted in the Pamunkey River at the Atlantic sturgeon spawning grounds during the 2016 spawning period. Based on DNA analysis of 533 unique samples from gut contents representing 23 other species of fish, Bunch et al. determined that 22 of the samples, representing 8 species of native and non-native fish, contained sturgeon DNA. The highest percentage of sturgeon DNA was found in gut samples from native Striped Bass and non-native Common Carp and Blue Catfish. The authors also concluded that Blue Catfish do not actively select for sturgeon eggs and larvae as a food source given the relatively low percentage of sturgeon DNA compared to other prey items in the gut content samples. The research did, however, demonstrate the efficacy of the methodology using DNA analysis. This method is particularly relevant when investigating predation of early "soft tissue" Atlantic sturgeon life stages (e.g., eggs and larvae) because the sturgeon lack hard parts that could be used as a species identifier for other methods such as microscopic examination of gut contents from known or potential predators.

Conclusion for Factor C: The new, best available, information does not change NMFS' determination from the listing rule that disease is a primary factor affecting the continued persistence of the Chesapeake Bay DPS of Atlantic sturgeon. Additional work is needed to provide further insight into the risk to Atlantic sturgeon early life stages from predation by the introduced catfish species.

2.3.2.4 Inadequacy of existing regulatory mechanisms

Summary of Factor D: The inadequacy of existing regulatory mechanisms was not considered a primary stressor when NMFS listed the Chesapeake Bay DPS because regulatory mechanisms to address many of the known stressors, including bycatch in federally-managed fisheries, were available. However, NMFS noted that a lack of information (e.g., for the DPSs life history, or for enumerating the effects of the stressor upon the DPS) made it more difficult to fully utilize the existing regulatory mechanisms.

Information on bycatch of Atlantic sturgeon in state-managed fisheries is still limited. As noted in the Stock Assessment, bycatch of Atlantic sturgeon is not well monitored by the existing fishery-independent and dependent data collection programs (ASMFC 2017a). For the Chesapeake Bay DPS, there appears to be the potential for take in fisheries that occur near their natal rivers, such as within the Chesapeake Bay and tributaries, as well as in fisheries that occur in other areas of the DPS's range such as the New York Bight (Melnychuk et al. 2017). Incidental capture of Atlantic sturgeon in Delaware and New Jersey fishery surveys using trawl gear also suggests that capture of Atlantic sturgeon may occur in commercial fisheries that operate in the same areas and at times when sturgeon are present.

The existing regulatory mechanism for addressing Atlantic sturgeon bycatch in state-managed fisheries is through issuance of an ESA section 10 incidental take permit. As described in section 2.3.2.2, NMFS has issued section 10 permits for the incidental take of Atlantic sturgeon belonging to the Chesapeake Bay DPS in the North Carolina commercial inshore gillnet fishery, and in the Georgia commercial shad fishery. The permit conditions require each state to implement measures that minimize and mitigate the impacts of such taking to the maximum extent practicable, and to monitor the take of Atlantic sturgeon. Currently, there are no section 10 incidental take permits for fisheries managed by mid-Atlantic states from New York through Virginia, areas where Atlantic sturgeon belonging to the Chesapeake Bay DPS are more likely to occur, or for fisheries managed by any of the Gulf of Maine states. Some of the mid-Atlantic states are working to complete applications for a section 10 incidental take permit. Representatives for Maine, New Hampshire, and Massachusetts state that take of Atlantic sturgeon in their respective state-managed fisheries is not expected to occur (ASMFC 2019). The large mesh gillnet restrictions for waters off of Virginia and North Carolina (71 FR 24775; April 26, 2006) also provide some protection to the Chesapeake Bay DPS. However, these restrictions extend only as far north as Chincoteague, Virginia.

Section 2.3.2.5 provides new information on the threat of vessel strikes to the Chesapeake Bay DPS when the fish are in rivers, bays, and sounds. In general, the three fundamental regulatory mechanisms for addressing threats to ESA-listed species are through rulemaking, section 7 consultation, and permitting. NMFS has not conducted rulemaking to address the threat of vessel strikes for Atlantic sturgeon because it is not yet known what measures are necessary to reduce the number of, or impact from, vessel strikes. NMFS has used rulemaking to require vessel speed restrictions in certain coastal waters (i.e., no more than 10 knots for vessels 19.8 m (65 feet) or greater in overall length) to reduce the likelihood of vessel strikes for North Atlantic right whales at certain times of the year. However, based on the best available information, speed restrictions for vessels in commercialized, navigable rivers (e.g., the James River) are unlikely to reduce the number of vessel strikes for Atlantic sturgeon. Regulations implemented by the U.S. Coast Guard (see 33 CFR 83.06) require that vessels proceed at a "safe speed" within navigable waters but, the regulations do not specify speed limits because many factors can influence what is the safe speed for the conditions. Further, the average swim speed of an adult Atlantic sturgeon is slow (1.27 to 1.86 mph or 0.57 to 0.83 mps; Balazik et al. 2020) relative to vessel speed. Finally, studies conducted in the Delaware River and in the James River indicate that Atlantic sturgeon do not avoid or move away from vessels (Reine et al. 2014; Barber 2017; Balazik et al. 2017; DiJohnson 2019; Balazik et al. 2020). Therefore, in the unlikely scenario that a maximum speed at which large (e.g., commercial) vessels could safely proceed in the James River could be identified, the best available information indicates that vessel strikes may still occur because Atlantic sturgeon are unlikely to avoid or move away from oncoming vessels. Other methods for potentially reducing risk, such as posting a lookout, are not practical because Atlantic sturgeon are not visible below the water surface and a large vessel could not reasonably stop or alter course even if a sturgeon was visible (e.g., jumping out of the water).

Some effects of vessel activity to the Chesapeake Bay DPS can be addressed through section 7 consultation if a federal agency is proposing to authorize, fund, or carry out the vessel-related action (e.g., issuing a license or permit for construction of a commercial port). Depending on the outcome of consultation, and consistent with the section 7 regulations, NMFS can include

reasonable and prudent measures to minimize the amount or extent of taking identified in an Incidental Take Statement; the federal agency must comply with those measures for the exemption from the section 9 prohibitions on take to apply. However, those measures can not alter the basic design, location, scope, duration, or timing of the action and they must involve only minor changes. NMFS does not expect, however, to be able to address all of the effects of vessel activities to the Chesapeake Bay DPS through section 7 consultation because not all activities will have the necessary federal nexus, and even with a federal nexus NMFS may not be able to identify the measures to reduce the amount or extent of that take.

Some effects of vessel activities may also be addressed through a section 10 incidental take permit. To meet the permit issuance criteria, the permit applicant is required to identify measures that will minimize and mitigate the impacts of the incidental taking to the maximum extent practicable. Application for a section 10 incidental take permit is premised, however, on the applicant knowing that take is likely to occur. Operators of either large (e.g., commercial) or small (e.g., recreational) vessels may never anticipate that their vessel will strike a sturgeon because of both a lack of awareness of vessel strike as an issue of concern and the volume of vessel traffic compared to the number of known sturgeon strikes which may make it appear that risk is very low. Additionally, it is unlikely that a vessel operator would know that a sturgeon has been struck because the fish are rarely visible from the surface and the operator could reasonably attribute any sensation of a strike to debris in the water. Discovery of a sturgeon carcass with a vessel strike injury rarely provides information to identify the vessel that struck the sturgeon. Finally, issuance of a section 10 incidental take permit would only address the take attributed to the individual applicant's activity.

Conclusion for Factor D: The inadequacy of existing regulatory mechanisms is a greater stressor for the Chesapeake Bay DPS than NMFS considered when the DPS was listed as endangered. Existing regulatory mechanisms appear to be inadequate to address the threat of vessel strikes for Atlantic sturgeon that belong to the Chesapeake Bay DPS.

2.3.2.5 Other natural or manmade factors affecting its continued existence

Summary of Factor E: Vessel strikes were considered a primary threat to the Chesapeake Bay DPS when NMFS listed the DPS as endangered. NMFS also considered that artificial stocking of Atlantic sturgeon for use in restoration of extirpated riverine populations or recovery of severely depleted wild riverine populations had the potential to be both a threat to the species and a tool for recovery.

As described above, there is new information to show that vessel strikes of Atlantic sturgeon occur more frequently and in more areas than what NMFS anticipated when the Chesapeake Bay DPS was listed as endangered. Multiple studies have shown that Atlantic sturgeon are unlikely to move away from vessels or avoid areas with vessel activity (Reine et al. 2014; Barber 2017; Balazik et al. 2017b; DiJohnson 2019; Balazik et al. 2020).

Based on the information that was available when the DPS was listed, NMFS determined that there was risk of vessel strikes to sturgeon in the James River from large (e.g., commercial) vessels. More than 100 Atlantic sturgeon carcasses have been salvaged in the James River since

2007 and additional carcasses were reported but could not be salvaged (Greenlee et al. 2019). Many of the salvaged carcasses had evidence of a fatal vessel strike. In addition, vessel struck Atlantic sturgeon have been found in other parts of the Chesapeake Bay DPS's range including in the York and Nanticoke river estuaries, within Chesapeake Bay, and in marine waters near the mouth of the Bay since the DPS was listed as endangered (NMFS Sturgeon Salvage Permit Reporting; Secor et al. 2021). The best available information supports the conclusion that sturgeon are struck by small (e.g., recreational) as well as large vessels. However, examination of the salvaged carcasses indicates that most fatalities are the result of the sturgeon being struck by a large vessel causing either blunt trauma injuries (e.g., broken scutes, bruising, damaged soft tissues) or propeller injuries (e.g., decapitation, complete transection of other parts of the sturgeon body, or deep slices nearly through the body depth of large sturgeon) (Balazik et al. 2012d).

NMFS has only minimum counts of the number of Atlantic sturgeon that are struck and killed by vessels because only the sturgeon that are found dead with evidence of a vessel strike are counted. New research, including a study conducted along the Delaware River that intentionally placed Atlantic sturgeon carcasses in areas used by the public, suggests that most Atlantic sturgeon carcasses are not found and, when found, many are not reported to NMFS or to our sturgeon salvage co-investigators (Balazik et al. 2012d, Balazik, pers. comm. in ASMFC 2017a; Fox et al. 2020). There have been an increased number of vessel struck sturgeon reported in the James River in recent years (see Figure 16; ASMFC 2017a). However, it is unknown to what extent the numbers reflect increased carcass reporting.

There have been no artificial stocking programs for Atlantic sturgeon since the listings. While it is possible that these could be a tool for recovery in the future, there is no apparent need for these programs at present because current evidence suggests that remnant, albeit very small, populations may exist in rivers where Atlantic sturgeon were previously believed to be extirpated. In addition, it is uncertain whether an artificial stock would establish in a non-natal river. For example, genetic analyses for the spawning adult sturgeon captured in the Nanticoke River system (Chesapeake Bay DPS) indicates that the fish are a remnant of the historical spawning population and are not the sturgeon or the progeny of the sturgeon that were introduced to the Nanticoke River in the late 1990s (Secor et al. 2021).

NMFS has received a number of reports from members of the Atlantic sturgeon scientific community regarding the advertised sale for the hobbyist aquarium trade of non-native, non-ESA listed, sturgeon species of the genus *Acipenser*. Hybridization between *Acipenser* species is known to occur (Ludwig et al. 2009), and hybridization has even occurred between an *Acipenser* species and American paddlefish (*Polyodon spathula*) (Káldy et al. 2020). Spawning populations of shortnose sturgeon (*Acipenser brevirostrum*) occur in many of the same rivers as spawning populations for the Atlantic sturgeon DPSs. However, spawning for the two species is separated temporally (i.e., different spawning seasons) and geographically (i.e., different spawning areas of the same river). There is no current information that any non-ESA listed *Acipenser* species has been intentionally or accidentally released into habitat used by the Chesapeake Bay DPS of Atlantic sturgeon. However, the known risk of hybridization as well as other potential threats (such as competition for habitat or food resources) is a concern and a

potential threat to the Chesapeake Bay DPS that NMFS was not aware of when the DPS was listed as endangered.

Conclusion for Factor E: New information confirms that vessel strikes are a primary threat to the Chesapeake Bay DPS and that the number of strikes is far greater than what NMFS anticipated when the DPS was listed under the ESA. The sale and trade of non-native *Acipenser* species poses a potential threat to the Chesapeake Bay DPS.

2.4 Synthesis

NMFS recommends classification for the Chesapeake Bay DPS of Atlantic sturgeon as "endangered." The status of the DPS has likely neither improved nor declined from what it was when the DPS was listed in 2012.

The number of spawning adults in the Pamunkey River spawning population is only hundreds per year. There are no spawning run estimates for the James River spawning populations or for the spawning population in the Nanticoke River system. Despite research effort, natal juveniles are rarely captured which suggests that the Chesapeake Bay DPS has low reproductive success. The new information supports our determination in the listing rule that the Chesapeake Bay DPS has low abundance, and that the current numbers of spawning adults are one to two orders of magnitude smaller than historical levels.

Atlantic sturgeon belonging to the Chesapeake Bay DPS are still captured and killed as a result of fishery interactions, vessel strikes, and dredging. There is new information that dredging does not adversely affect Atlantic sturgeon behavior when in the vicinity of dredge gear (e.g., the sturgeon do not avoid areas where dredging is occurring and dredge activity may not pose a barrier to sturgeon that are migrating to and from spawning areas). However, takes of Atlantic sturgeon occur in the dredge gear. As described above, NMFS has issued section 10 permits for the incidental take of Atlantic sturgeon (all DPSs) in the North Carolina commercial inshore gillnet fishery, and in the Georgia commercial shad fishery. The large mesh gillnet restrictions for waters off of Virginia and North Carolina (71 FR 24775; April 26, 2006) also provide some protection to the Chesapeake Bay DPS as far north as Chincoteague, Virginia, and research has identified a raised footrope design that results in reduced sturgeon bycatch and increased landings of the targeted species in Virginia's Striped Bass fishery compared to the conventional fishing gear (Hager et al. 2021). However, capture of Atlantic sturgeon in fishing gear continues to occur in other areas of the DPS's range.

There is a relatively low probability (37 percent) that abundance of the Chesapeake Bay DPS has increased since the implementation of the 1998 fishing moratorium but also a relatively high likelihood (70 percent probability) that mortality for the Chesapeake Bay DPS does not exceed the mortality threshold used for the Stock Assessment (ASMFC 2017a). The Stock Assessment Peer Review Report described that it was not clear if the percent probability for the trend in abundance was a reflection of the actual trend in abundance or of the underlying data quality for the DPS.

Habitat, including critical habitat, for the Chesapeake Bay DPS continues to be lost or altered as a result of anthropogenic activities. New information indicates that all Atlantic sturgeon are highly vulnerable to climate change, and that the Atlantic sturgeon's low likelihood to change distribution in response to current global climate change will also expose them to climate's other effects on estuarine habitat such as changes in the occurrence and abundance of prey species in currently identified key foraging areas.

The new information supports our determination in the listing rule that the Chesapeake Bay DPS continues to be significantly affected by threats from bycatch and vessel strikes as well as threats to habitat from continued degraded water quality, dredging, and global climate change, and that these threats are considered to be unsustainable at present. Further, the new information supports our determinations in the listing rule that there is a lack of existing regulatory mechanisms to adequately address these threats, particularly to address the threat of vessel strikes.

New information better informs the physical features of marine waters and estuaries where Atlantic sturgeon belonging to the Chesapeake Bay occur. The studies demonstrate that the fish preferentially occur in specific habitats with certain features that are often dynamic and only occur at specific times of the year (e.g., sea surface temperature and the degree of light absorption by seawater in marine habitat, and distance from the salt front, substrate composition, and water depth in estuaries). The results may inform NMFS' further consideration of critical habitat designations for the Chesapeake Bay DPS, particularly in marine waters and in the Chesapeake Bay. NMFS could not identify what the specific features are of marine waters, bays and sounds that make them essential to Atlantic sturgeon conservation when critical habitat was designated for the Chesapeake Bay DPS given the limited and confounding information available at the time.

3.0 RESULTS

3.1 Recommended Classification: No change is needed

3.2 New Recovery Priority Number: No change is needed

The Chesapeake Bay DPS's demographic risk 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. Based on the Listing and Recovery Priority Guidelines, meeting any one of these risk conditions ranks the Chesapeake Bay DPS as at high demographic risk (84 FR 18243; April 30, 2019).

The Chesapeake Bay DPS' potential to recover is, however, 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, 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 with

respect to reducing fisheries bycatch even if they require further testing (e.g., gear modifications to minimize dredge or fishing gear interactions).

As described above, the DPS is in conflict with construction projects (e.g., the CIEE, the James River Federal Navigation, and the Chesapeake Bay Navigation Channel projects) which may adversely affect the Chesapeake Bay DPS. Therefore, based on the Listing and Recovery Priority Guidelines (84 FR 18243, April 30, 2019), the recovery priority number for the Chesapeake Bay DPS is 1C, and is unchanged.

4.0 RECOMMENDATIONS FOR FUTURE ACTIONS

NMFS, GARFO, PRD should convene an internal group, with external expert opinion as needed, to identify information needs and next steps to address the threat of vessel strike for the Chesapeake Bay DPS.

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NATIONAL MARINE FISHERIES SERVICE
5-YEAR REVIEW
Chesapeake Bay Distinct Population Segment of Atlantic Sturgeon
(Acipenser oxyrinchus oxyrinchus)

Current Classification: **Endangered**

Recommendation resulting from the 5-Year Review

____ Downlist to Threatened
____ Uplist to Endangered
____ Delist
_X__ No change is needed

Review Conducted By: Lynn Lankshear, Sturgeon Recovery Coordinator, GARFO, Protected Resources Division

REGIONAL OFFICE APPROVAL:

Lead Regional Administrator, NOAA Fisheries

Approve: _____ Date: __October 21, 2021__

HEADQUARTERS APPROVAL:

Assistant Administrator, NOAA Fisheries

__x___Concur _____ Do Not Concur

Signature RAUCH.SAMUEL.D.III.1365850948 Digitally signed by RAUCH.SAMUEL.D.III.1365850948 Date: 2022.02.16 13:37:39 -05'00' Date_____