STATUS REVIEW OF ATLANTIC STURGEON
(*Acipenser oxyrinchus oxyrinchus*)

Prepared by the

Atlantic Sturgeon Status Review Team

for the

National Marine Fisheries Service
National Oceanic and Atmospheric Administration

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Executive Summary

In 2003, a workshop sponsored by the National Marine Fish Service (NMFS) and U. S. Fish and Wildlife Service (USFWS) (collectively, the Services) was held to review the status of Atlantic sturgeon (*Acipenser oxyrinchus oxyrinchus*). The workshop provided an opportunity to gain additional information to determine if a new review of the status of the species was warranted. The status of Atlantic sturgeon was initially reviewed in 1998 after the Services received a petition to list the species under the Endangered Species Act (ESA), and it was determined, at that time, that listing was not warranted. Also in 1998, the Atlantic States Marine Fisheries Commission (ASMFC) initiated a coast-wide fishing moratorium on Atlantic sturgeon, until 20 year classes of adult females could be established. The 2003 workshop attendees concluded that some populations seemed to be recovering while other populations continued to be depressed. As a result, NMFS initiated a second status review of Atlantic sturgeon in 2005 to reevaluate whether this species required protection under the ESA.

A status review team (SRT) consisting of four NMFS, four USFWS, and three US Geological Survey (USGS) personnel participated in the status review process. The team was supplemented by eight state and regional experts who provided their individual expert opinions on the information contained in the status review report and provided additional data to ensure the report provided the best available data.

The SRT determined that Atlantic sturgeon populations should be divided into five distinct population segments (DPSs). The five DPSs were named: 1) Gulf of Maine, 2) New York Bight, 3) Chesapeake Bay, 4) Carolina, and 5) South Atlantic. These Atlantic sturgeon populations are markedly separated based on physical, genetic, and physiological factors; are located in a unique ecological setting; have unique genetic characteristics; and would represent a significant gap in the range of the taxon if one of them were to become extinct.

The SRT evaluated the status of Atlantic sturgeon using the five-factor analysis described in section 4(a)(1) of the ESA. The SRT identified 15 stressors within these five factors and summarized their impacts on Atlantic sturgeon using a semi-quantitative extinction risk analysis (ERA), similar to that used by other status review reports (e.g. *Acropora*). Of the stressors evaluated, bycatch mortality, water quality, lack of adequate state and/or Federal regulatory mechanisms, and dredging activities were most often identified as the most significant threats to the viability of Atlantic sturgeon populations. Additionally, some populations were impacted by unique stressors, such as habitat impediments (e.g., Cape Fear and Santee-Cooper rivers) and apparent ship strikes (e.g., Delaware and James rivers).

The outcome of the ERA concluded that three of the five DPSs (Carolina, Chesapeake, and New York Bight) were likely (> 50% chance) to become endangered in the foreseeable future (20 years). The SRT recommended that these three DPSs should be listed as threatened under the ESA. The remaining DPSs (South Atlantic and Gulf of Maine) were found to have a moderate risk (<50% chance) of becoming endangered in the next 20 years. However, the SRT did not provide a listing recommendation for these remaining DPSs as available science was insufficient to allow a full assessment of these populations.

Introduction

1.1. Background of the Review

This document provides a summary of the information gathered for an Endangered Species Act (ESA) status review for Atlantic sturgeon (*Acipenser oxyrinchus oxyrinchus*). Initial reviews of the Atlantic sturgeon status began in 1977 when the Research Management Division of NMFS sponsored the preparation of a report on the biology and status of Atlantic sturgeon to assess the status of the stock and serve as a historical database and information library (Murawski and Pacheco 1977). Three years later, at the request of NMFS, another document was prepared by Hoff (1980) to assist in making future Atlantic sturgeon fisheries decisions and to determine what action was required, if any, to conserve the species under the ESA. In 1988, NMFS announced they would develop a "list of candidate species" under the ESA and requested information regarding the status of Atlantic sturgeon. At that time, a "candidate species" was any species being considered by the Secretary for listing as an endangered or a threatened species under the ESA, but not yet the subject of a proposed rule. NMFS added Atlantic sturgeon to its candidate species list published in 1997 (62 FR 37560). In April 2004, NMFS published a subsequent notice announcing that the NMFS "candidate species list" was being changed to the "Species of Concern (SOC) list" to better reflect the ESA definition of candidate species while maintaining a separate list of species potentially at risk (69 FR 19975). At that time, NMFS transferred 25 species from the candidate species list to the SOC list (including Atlantic sturgeon), placed 20 additional species on the SOC list, and removed 12 other species from the candidate species list. Candidate Species are those petitioned species that are actively being considered for listing as endangered or threatened under the ESA, as well as those species for which NMFS has initiated an ESA status review that it has announced in the *Federal Register*. NMFS SOC are defined as species about which NMFS has some concerns regarding status and threats but for which insufficient information is available to indicate a need to list the species under the ESA. NMFS believes it is important to highlight species for which listing may be warranted in the future so that Federal and state agencies, Native American tribes, and the private sector are aware of unlisted species that could benefit from proactive conservation efforts. Inclusion of a species on the SOC list is intended to stimulate voluntary conservation efforts that, if effective, may prevent an ESA listing. Currently, Atlantic sturgeon is a candidate species and by default, a SOC.

On June 2, 1997, a petition dated May 29, 1997, was received by the Services from the Biodiversity Legal Foundation. The petitioner requested that the Services list Atlantic sturgeon, where it continues to exist in the United States, as threatened or endangered and designate critical habitat within a reasonable period of time following the listing. The Services reviewed the request and determined that the petition presented substantial information indicating that the petitioned action may be warranted and announced the initiation of a status review (62 FR 54018). A review of the status of a species is required by section 4(b)(1)(A) of the ESA whenever a listing petition is found to contain substantial information. A status review consists of reviewing all the available information on a species to determine if protection under the ESA is warranted.

According to CFR424.11, a species shall be listed or reclassified if the Secretary determines, on the basis of the best scientific and commercial data available after conducting a review of the species' status, that the species is endangered or threatened because of any one or a combination of the following factors:

1) The present or threatened destruction, modification, or curtailment of habitat or range.
2) Overutilization for commercial, recreational or educational purposes.
3) Disease or predation.
4) The inadequacy of existing regulatory mechanisms.
5) Other natural or manmade factors affecting its continued existence.

The Services completed their status review in 1998 and concluded at that time Atlantic sturgeon were not threatened or endangered based on any of the five factors (NMFS and USFWS 1998). Concurrently, the Atlantic States Marine Fisheries Commission (ASMFC) completed Amendment 1 to the 1990 Atlantic Sturgeon Fishery Management Plan (FMP) that imposed a 20-40 year moratorium on all Atlantic sturgeon fisheries until the Atlantic Coast spawning stocks could be restored to a level where 20 subsequent year classes of adult females were protected (ASMFC 1998A). NMFS followed this action by closing the Exclusive Economic Zone (EEZ) to Atlantic sturgeon take in 1999. In 2003, a workshop on the "Status and Management of Atlantic Sturgeon" was held to discuss the current status of sturgeon along the Atlantic Coast and determine what obstacles, if any, were impeding the recovery of Atlantic sturgeon (Kahnle et al. 2005). The results of the conference reported "mixed" reviews where some populations seemed to be recovering while others were declining. Bycatch and habitat degradation were noted as possible causes for some population declines.

Based on the information gathered from the 2003 workshop on Atlantic sturgeon, NMFS decided that a second review of Atlantic sturgeon status was needed to determine if listing as threatened or endangered under the ESA was warranted. This document addresses the status of the species, addresses the five factors as they pertain to Atlantic sturgeon, and considers the effects of efforts underway to protect the species.[1]

1.2. Life History

While intensely studied since the 1970s, many important aspects of Atlantic sturgeon life history are still unknown (Murawski and Pacheco 1977, Van den Avyle 1983, Smith and Dingley 1984, Smith and Clugston 1997, Bain 1997, Bemis and Kynard 1997, Kynard and Horgan 2002). Although specifics vary latitudinally, the general life history pattern of Atlantic sturgeon is that of a long lived, late maturing, estuarine dependent, anadromous species.[2] The species' historic range included major estuarine and riverine systems that spanned from Hamilton Inlet on the coast of Labrador to the Saint Johns River in Florida (Reviewed in Murawski and Pacheco 1977, Smith and Clugston 1997). Interestingly, genetic, morphological, and archaeological evidence also suggest that Atlantic sturgeon once colonized the Baltic during the Middle Ages, and

[1] Since this document is an updated review of the status of Atlantic sturgeon, portions of the text were taken directly from the 1998 review to expedite the writing process (NMFS and USFWS 1998).
[2] An anadromous species is defined as a species that spends the majority of its life cycle in marine waters but reproduces in freshwater habitat.

replaced the native European sturgeon (*Acipenser sturio*) there, before recently becoming extinct itself in Europe as a result of human activities and climate change (Ludwig et al. 2002).

Atlantic sturgeon spawn in freshwater, but spend most of their adult life in the marine environment. Spawning adults generally migrate upriver in the spring/early summer; February-March in southern systems, April-May in mid-Atlantic systems, and May-July in Canadian systems (Murawski and Pacheco 1977, Smith 1985, Bain 1997, Smith and Clugston 1997, Caron et al. 2002). In some southern rivers, a fall spawning migration may also occur (Rogers and Weber 1995, Weber and Jennings 1996, Moser et al. 1998). A fall migration of ripening adults upriver in the Saint John River, NB is also observed; however, this fall migration is not considered a spawning run as adults do not spawn until the spring. Atlantic sturgeon spawning is believed to occur in flowing water between the salt front and fall line of large rivers, where optimal flows are 46-76 cm/s and depths of 11-27 meters (Borodin 1925, Leland 1968, Scott and Crossman 1973, Crance 1987, Bain et al. 2000). Sturgeon eggs are highly adhesive and are deposited on the bottom substrate, usually on hard surfaces (e.g., cobble) (Gilbert 1989, Smith and Clugston 1997). Hatching occurs approximately 94-140 hrs after egg deposition at temperatures of 20° and 18° C, respectively, and larvae assume a demersal existence (Smith et al. 1980). The yolksac larval stage is completed in about 8-12 days, during which time the larvae move downstream to rearing grounds over a 6 – 12 day period (Kynard and Horgan 2002). During the first half of their migration downstream, movement is limited to night. During the day, larvae use benthic structure (e.g., gravel matrix) as refugia (Kynard and Horgan 2002). During the later half of migration when larvae are more fully developed, movement to rearing grounds occurs both day and night. Juvenile sturgeon continue to move further downstream into brackish waters, and eventually become residents in estuarine waters for months or years.

Upon reaching a size of approximately 76-92 cm, the subadults may move to coastal waters (Murawski and Pacheco 1977, Smith 1985), where populations may undertake long range migrations (Dovel and Berggren 1983, Bain 1997, T. King supplemental data 2006). Tagging and genetic data indicate that subadult and adult Atlantic sturgeon may travel widely once they emigrate from rivers. Subadult Atlantic sturgeon wander among coastal and estuarine habitats, undergoing rapid growth (Dovel and Berggren 1983, Stevenson 1997).[3] These migratory subadults, as well as adult sturgeon, are normally captured in shallow (10-50m) near shore areas dominated by gravel and sand substrate (Stein et al. 2004a). Coastal features or shorelines where migratory Atlantic sturgeon commonly aggregate include the Bay of Fundy, Massachusetts Bay, Rhode Island, New Jersey, Delaware, Delaware Bay, Chesapeake Bay, and North Carolina, which presumably provide better foraging opportunities (Dovel and Berggren 1983, Johnson et al. 1997, Rochard et al. 1997, Kynard et al. 2000, Eyler et al. 2004, Stein et al. 2004a, Dadswell 2006). Despite extensive mixing in coastal waters, Atlantic sturgeon return to their natal river to spawn as indicated from tagging records (Collins et al. 2000a, K. Hattala, NYSDEC, Pers. Comm. 1998) and the relatively low rates of gene flow reported in population genetic studies (King et al. 2001, Waldman et al. 2002). Males usually begin their spawning migration early and leave after the spawning season, while females make rapid spawning migrations upstream and quickly depart following spawning (Bain 1997).

[3] Juveniles and subadults are used interchangeably throughout this report and are defined within this report as any sturgeon that is not considered a young-of-year (Age-0) or mature adult.

Atlantic sturgeon have been aged to 60 years (Mangin 1964); however, this should be taken as an approximation as the only age validation study conducted to date shows variations of ±5 years (Stevenson and Secor 1999). Vital parameters of sturgeon populations show clinal variation with faster growth and earlier age at maturation in more southern systems, though not all data sets conform to this trend. For example, Atlantic sturgeon mature in South Carolina at 5 – 19 years (Smith et al. 1982), in the Hudson River at 11 – 21 years (Young et al. 1998), and in the Saint Lawrence River at 22 – 34 years (Scott and Crossman 1973). Atlantic sturgeon likely do not spawn every year, where multiple studies have shown that spawning intervals range from 1-5 years for males (Smith 1985, Collins et al. 2000a, Caron et al. 2002) and 2-5 for females (Vladykov and Greeley 1963, Van Eenennaam et al. 1996, Stevenson and Secor 1999). Fecundity of Atlantic sturgeon has been correlated with age and body size (ranging from 400,000 – 8 million eggs) (Smith et al. 1982, Van Eenennaam and Doroshov 1998, Dadswell 2006). The average age at which 50% of maximum lifetime egg production is achieved estimated to be 29 years, approximately 3-10 times longer than for other bony fish species examined (Boreman 1997).

1.3. Distribution and Abundance

Assessment of the current distribution and abundance of Atlantic sturgeon is based on a comprehensive review of the literature and interviews with provincial, state, and Federal fishery management personnel regarding historic and ongoing sampling programs which targeted or incidentally captured Atlantic sturgeon. Water bodies where no information is available, either historic or current, were assessed as to whether Atlantic sturgeon could use the present habitat based on the geomorphology of the system and expert opinion. Riverine systems where gravid Atlantic sturgeon or young-of-year (YOY)(< age-1; ≤ 41 cm TL or 35 cm FL)[4] have been documented within the past 15 years were considered to contain extant spawning populations, as this is the average period of time to achieve sexual maturity. The presence of juveniles greater than age-0 (YOY) does not provide evidence of spawning within a river because subadults are known to undertake extensive migrations into non-natal riverine systems.[5]

Comprehensive information on current or historic abundance of Atlantic sturgeon is lacking for most river systems. Data are largely available from studies directed at other species and provide evidence primarily of presence or absence. Historic and current spawning populations of Atlantic sturgeon in East Coast estuarine systems of the United States are summarized in Table 1. Size and age data were used to indicate how a particular habitat (i.e., spawning, nursery, or migrating habitat) is utilized by sturgeon. The presence of multiple year classes demonstrates successful spawning in multiple years but not necessarily in that system. Available quantitative data on abundance and, where available, data that document changes in abundance of sturgeon populations are included in the text.

[4] Lengths of 41 cm total length (TL) and 35 cm fork length (FL) represent the mean length of age-1 Atlantic sturgeon reported in Secor et al. (2000), that reviewed the FL of Atlantic sturgeon at age-1 from the Saint Lawrence, Saint John, Hudson, Delaware, Chesapeake Bay, Winyah Bay, and Suwannee watersheds. To calculate the TL of age-1 Atlantic sturgeon, the following equation was used: TL = (FL / 0.86) + 2.01.

[5] Subadults and juveniles are used interchangeably throughout this document and are defined as any sturgeon that is not considered a YOY or mature adult.

1.3.1. Historic Overview

Historically, Atlantic sturgeon were present in approximately 38 rivers in the United States from St. Croix, ME to the Saint Johns River, FL, of which 35 rivers have been confirmed to have had a historical spawning population. Atlantic sturgeon are currently present in 35 rivers, and spawning occurs in at least 20 of these rivers (Table 1). In the mid-1800s, incidental catches of Atlantic sturgeon in the shad and river herring haul seine fisheries indicated that the species was very abundant (reviewed in Armstrong and Hightower 2002). Massachusetts and Maine have reports dating back to the early 1600s noting an important sturgeon fishery (Wheeler and Wheeler 1878, Jerome et al. 1965). However, a major fishery for this species did not exist until 1870 when a caviar market was established (reviewed in Smith and Clugston 1997). Record landings were reported in 1890, where over 3350 metric tons (mt) of Atlantic sturgeon were landed from coastal rivers along the Atlantic Coast (reviewed in Smith and Clugston 1997, Secor and Waldman 1999).[6] The majority of these landings (75%) were dominated by the Delaware River fishery that presumably supported the largest population along the Atlantic Coast (reviewed in Secor and Waldman 1999). Ten years after peak landings, the fishery collapsed in 1901, when less than 10% (295 mt) of its 1890 peak landings were reported (Figure 1). The landings continued to decline to about 5% of the peak until 1920 and have remained between 1-5% since then. During the 1950s, the remaining fishery switched to targeting sturgeon for flesh, rather than caviar. The Atlantic sturgeon fishery was closed by ASMFC in 1998, when a coast-wide fishing moratorium was imposed for 20-40 years, or at least until 20 year classes of mature female Atlantic sturgeon were present (ASMFC 1998A).[7] Presently, there are only two U.S. populations for which an abundance estimate is available; the Hudson (~870 spawning adults/yr) and Altamaha (~343 spawning adults/yr) (Schueller and Peterson 2006, Kahnle et al. *In* press,). The Hudson and Altamaha are presumed to be the healthiest populations within the U.S. Thus, other spawning populations within the U.S. are predicted to have less than 300 adults spawning per year.

The Atlantic sturgeon fishery in the Saint Lawrence River is somewhat different from that of the U.S. and Saint John River[8] market as it has never been a caviar market, instead focusing on the flesh market and local sales. Thus, large gravid females and males are rarely taken (Trencia et al. 2002). Landings have increased slightly from approximately 35 mt in the 1940s to 60 mt in the 1990s (Figure 1). Since 1993, harvest/fishing restrictions have been implemented and landings have averaged approximately 60 mt/year (the harvest quota) since 2000 (Figure 2). The Saint Lawrence fishery did experience a crash, however, during the late 1960s and 1970s. The cause of the crash is unknown. However, it is suspected to be related to the massive use of DDT above Montreal during 1966 and 1967 to eliminate the mayfly bloom for the 1967 Worlds Fair, which has also been linked to the extinction of striped bass in the river (Tremblay 1995; M. Dadswell, Acadia University, Pers. Comm. 2006).

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[6] Though shortnose and Atlantic sturgeon were not differentiated in the landing records at this time, it is believed that the larger Atlantic sturgeon were targeted more so than the smaller shortnose sturgeon for the caviar market (Secor and Waldman 1999).

[7] Some states had initiated a moratorium on the fishery prior to the ASMFC ruling (i.e., Maryland and Virginia 1973, South Carolina 1985, North Carolina 1991, etc.)

[8] All sturgeon captured in the Saint John were exported to the US for caviar and there were no local sales.