# Summary of Biological Information and Economic Analysis Prepared for Consideration of Critical Habitat Designation for the Carolina and South Atlantic Distinct Population Segments of Atlantic Sturgeon

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Prepared by

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# I. Introduction

Critical habitat is defined in section 3 of the Endangered Species Act (ESA or Act) (16 U.S.C. 1532(3)) as: (1) the specific areas within the geographical area occupied by a species, at the time it is listed in accordance with the ESA, on which are found those physical or biological features (a) essential to the conservation of the species and (b) that may require special management considerations or protection; and (2) specific areas outside the geographical area occupied by a species at the time it is listed upon a determination that such areas are essential for the conservation of the species ''Conservation'' means to use and the use of all methods and procedures which are necessary to bring any endangered or threatened species to the point at which the measures provided pursuant to the Act are no longer necessary. Such methods and procedures include, but are not limited to, all activities associated with scientific resources management such as research, census, law enforcement, habitat acquisition and maintenance, propagation, live trapping, and transplantation, and, in the extraordinary case where population pressures within a given ecosystem cannot be otherwise relieved, may include regulated taking. Section 4(a)(3)(A) requires that, to the extent prudent and determinable, critical habitat be designated concurrently with the listing of a species as endangered or threatened. Section 4(b)(6)(C)(ii) of the ESA provides for additional time to promulgate a critical habitat designation if such designation is not determinable at the time of final listing of a species.

In the final rule listing the Carolina and South Atlantic DPS of Atlantic sturgeons (77 FR 5914; February 6, 2012), we found the designation of critical habitat was not determinable "due to the extensive range of the Carolina and South Atlantic Distinct Population Segments (DPSs) and extremely complex biological and physical requirements of Atlantic sturgeon." We acknowledged gathering information during the status review and public comment period, but not having enough information to determine which of the features were essential to the conservation of the DPSs and may require special management considerations or protection. We stated that we will continue to gather information and will perform the required analyses of the impacts of designation. This document is part of that process and contains: (1) the biological information used to determine the specific areas containing the features essential to the conservation of the species and essential features of critical habitat, and (2) the economic impact of designating critical habitat.

# II. Background

## A. Listing History

Historically, Atlantic sturgeon were present in approximately 38 rivers in the United States from the St. Croix River, Maine to the St. Johns River, Florida, of which 35 rivers have been confirmed to have had a historical spawning population. Atlantic sturgeon are currently present in approximately 32 of these rivers, and spawning occurs in at least 18 of them. The marine range of Atlantic sturgeon extends from the Hamilton Inlet, Labrador, Canada, to Cape Canaveral, Florida.

Historical records from the 1700s and 1800s document large numbers of sturgeon in many rivers along the Atlantic Coast. Atlantic sturgeon underwent significant range-wide declines from

historical abundance levels due to overfishing in the late 1800s. Sturgeon stocks were further impacted through environmental degradation, especially due to habitat loss and reduced water quality from the construction of dams in the early to mid-1900s. The species persisted in many rivers, though at greatly reduced levels (1 to 5 percent of their earliest recorded numbers), and commercial fisheries were active in many rivers during all or some of the years 1962 to 1997. Many of these contemporary fisheries resulted in continued overfishing, which prompted the Atlantic States Marine Fisheries Commission to impose the Atlantic sturgeon fishing moratorium in 1998 and NMFS to close the Exclusive Economic Zone to Atlantic sturgeon retention in 1999.

Five separate DPSs of Atlantic sturgeon were listed under the Endangered Species Act (ESA) by the National Marine Fisheries Service (NMFS) effective April 6, 2012 (77 FR 5880 and 5914; February 6, 2012). The New York Bight, Chesapeake Bay, Carolina, and South Atlantic DPSs were listed as endangered. The Gulf of Maine DPS was listed as threatened at the same time. At the time Atlantic sturgeon were listed, the best available abundance information for each of the 5 DPSs was the estimated number of adult Atlantic sturgeon spawning in each of the rivers on an annual basis. The estimated number of annually spawning adults in each of the river populations is insufficient to quantify the total population numbers for each DPS of Atlantic sturgeon due to the lack of other necessary accompanying life history data.

Two of the DPSs spawn in rivers in the NMFS Southeast Region: the Carolina DPS and the South Atlantic DPS. The Carolina DPS is estimated to number less than 3 percent of its historical population size (ASSRT, 2007). Prior to 1890, when a major fishery developed, Secor (2002) estimated there were between 7,000 and 10,000 adult females in North Carolina and 8,000 adult females in South Carolina. At the time of listing, there were estimated to be less than 300 spawning adults annually (total of both sexes) in each of the major river systems occupied by the DPS, whose freshwater range occurs in the watersheds from the Roanoke River southward along the southern Virginia, North Carolina, and South Carolina coastal areas to the Cooper River, South Carolina. After reviewing the best scientific and commercial information available, we found that the Atlantic sturgeon Carolina DPS was in danger of extinction throughout its range as a result of a combination of habitat curtailment and alteration, overutilization in commercial fisheries, and inadequacy of regulatory mechanisms in ameliorating these impacts and threats, and we listed it as endangered.

The South Atlantic DPS is estimated to number less than 6 percent of its historical population size (ASSRT, 2007), with all river populations except the Altamaha estimated to be less than 1 percent of historical abundance. Prior to 1890, when a major fishery developed, Secor (2002) estimated there were 8,000 adult spawning females in South Carolina and 11,000 adult spawning females in Georgia. At the time of listing, there were an estimated 343 spawning adults per year in the Altamaha River and less than 300 annual spawning adults (total of both sexes) in each of the other major river systems occupied by the DPS, whose freshwater range occurs in the watersheds of the Ashepoo-Combahee-Edisto Basin in South Carolina to the St. Johns River, Florida. After reviewing the best scientific and commercial information available, we found that the Atlantic sturgeon South Atlantic DPS was in danger of extinction throughout its range as a result of a combination of habitat curtailment and alteration, overutilization in commercial fisheries, and inadequacy of regulatory mechanisms in ameliorating these impacts and threats, and it was listed as endangered.

## B. Natural History

Atlantic sturgeon are long-lived, late-maturing, estuarine-dependent, anadromous fish distributed along the eastern coast of North America (Waldman and Wirgin, 1998). Historically, sightings have been reported from Hamilton Inlet, Labrador, south to the St. Johns River, Florida (Murawski et al., 1977; Smith and Clugston, 1997). Atlantic sturgeon may live up to 60 years, reach lengths up to 14 ft, and weigh over 800 lb (ASSRT, 2007; Collette and Klein-Macphee, 2002). They are distinguished by armor-like plates (called scutes) and a long protruding snout that has 4 barbels (slender, whisker-like feelers extending from the head used for touch and taste). Atlantic sturgeon spend the majority of their lives in nearshore marine waters, returning to their natal rivers to spawn (Wirgin et al., 2002). Young Atlantic sturgeon may spend the first few years of life in their natal river estuary before moving out to sea (Wirgin et al., 2002). Sturgeon are omnivorous benthic (bottom) feeders and engulf mud along with their prey. Adult sturgeon diets include mollusks, gastropods, amphipods, isopods, and fish. Juvenile sturgeon feed on aquatic insects and other invertebrates (Smith, 1985a).

Age and growth of Atlantic sturgeon populations is clinal, with a general trend of faster growth and earlier age at maturity in more southern systems. Atlantic sturgeon mature between the ages of 5-19 years in South Carolina (Smith et al., 1982), between 11-21 years in the Hudson River (Young et al., 1988), and between 22-34 years in the St. Lawrence River (Scott and Crossman, 1973). Most Atlantic sturgeon adults likely do not spawn every year. Multiple studies have shown that spawning intervals range from 1-5 years for males (Caron et al., 2002; Collins et al., 2000; Smith, 1985b) and 2-5 years for females (Stevenson and Secor, 1999; Van Eenennaam et al., 1996; Vladykov and Greely, 1963). Fecundity of Atlantic sturgeon has been correlated with age and body size, with egg production ranging from 400,000 to 8,000,000 eggs per year (Dadswell, 2006; Smith et al., 1982; Van Eenennaam and Doroshov, 1998). The average age at which 50% of maximum lifetime egg production is achieved is estimated to be 29 years, approximately 3-10 times longer than for other bony fish species examined (Boreman, 1997).

Spawning adult Atlantic sturgeon generally migrate upriver in spring/early summer, which occurs in February-March in southern systems, April-May in mid-Atlantic systems, and May-July in Canadian systems (Bain, 1997; Caron et al., 2002; Murawski et al., 1977; Smith, 1985b; Smith and Clugston, 1997). In some southern rivers, a fall spawning migration may also occur (Moser et al., 1998; Rogers and Weber, 1995; Weber and Jennings, 1996). Atlantic sturgeon spawning occurs in fast-flowing water between the salt front and fall line of large rivers (Bain et al., 2000; Borodin, 1925; Crance, 1987; Leland, 1968; Scott and Crossman, 1973) over hard substrate, such as cobble, gravel, or boulders, to which the highly adhesive sturgeon eggs adhere (Gilbert, 1989; Smith and Clugston, 1997). Hatching occurs approximately 94-140 hours after egg deposition and larvae assume a demersal existence (Smith et al., 1980). The yolk sac larval stage is completed in about 8-12 days, during which time the larvae move downstream to rearing grounds (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 refuge (Kynard and Horgan, 2002). When larvae are more fully developed, downstream 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.

Juvenile and adult Atlantic sturgeon occupy upper estuarine habitat where they frequently congregate around the saltwater/freshwater interface. Estuarine habitats are important for juveniles, serving as nursery areas by providing abundant foraging opportunities, as well as thermal and salinity refuges, for facilitating rapid growth. Some juveniles will take up residency in non-natal rivers that lack active spawning sites (Bain, 1997). Residency time of young Atlantic sturgeon in estuarine areas varies between 1-6 years (Schueller and Peterson, 2010; Smith 1985b), after which Atlantic sturgeon start out-migration to the marine environment. Movement of Atlantic sturgeon from the estuaries to the sea is cued by water temperature and velocity. Adult Atlantic sturgeon will reside in the marine habitat and forage extensively until they move into rivers to spawn. Coastal migrations by adult Atlantic sturgeon are extensive and are known to occur over sand and gravel substrate (Greene et al., 2009). Atlantic sturgeon remain in the marine habitat until the waters begin to warm, at which time ripening adults migrate back to their natal rivers to spawn.

Upstream movement to the spawning grounds is cued primarily by water temperature and velocity. Therefore, fish in the southern portion of the range move into the rivers earlier than those to the north (Kieffer and Kynard, 1993; Smith 1985b). In Georgia and South Carolina, movement begins in February or March (Collins et al., 2000). Males commence upstream migration to the spawning sites when waters reach around 6°C (Dovel and Berggren, 1983; Smith, Smith 1985b; Smith et al., 1982), with females following a few weeks later when water temperatures are closer to 12° or 13°C (Collins et al., 2000; Dovel and Berggren, 1983; Smith, 1985b). In some rivers, predominantly in the south, fall spawning may also occur (Moser et al., 1998; Rogers and Weber, 1995), with running ripe males found August through October and post-spawning females captured in late September and October (Collins et al., 2000).

# III. Critical Habitat Identification

## A. Geographical Area Occupied

Because we wanted to examine distinct portions of the river when examining potential areas for critical habitat, we used the USGS' hydrologic unit (HUC) as the basic unit of area to identify specific riverine sections that may contain essential features. We used the smallest hydrologic unit, the sub-watershed (HUC 6) level, for identifying potential critical habitat areas to consider as critical habitat. We believe the use of HUCs provides for consistency, continuity, and clarity between NMFS's offices and for the public when classifying information and subsequent reference points should critical habitat be designated.

NMFS has long interpreted ''geographical area occupied'' in the definition of critical habitat to mean the range of the species at the time of listing (45 FR 13011; February 27, 1980). We identified specific areas (i.e., all HUC 6s) within the geographical area occupied that contain the essential features. While there are many areas where data indicating presence of Atlantic sturgeon has not been documented, these are often areas where there has been little or no effort to survey Atlantic sturgeon. We have not identified any riverine area within the range of the

collective Atlantic sturgeon DPS's that is accessible but not used by Atlantic sturgeon. For the purpose of this rulemaking we are considering portions of any occupied river that are upstream of a dam or any other impassable (natural or manmade) barrier as unoccupied.

## B. Physical or Biological Features Essential for Conservation

Within the geographical area occupied by Atlantic sturgeon, we considered the various types of habitat utilized by the species for various life functions. Atlantic sturgeon spend the majority of their adult lives in offshore marine waters. They are known to travel extensively up and down the East Coast. Several winter congregations of Atlantic sturgeon in the marine environment are known to occur, though the exact location and importance of those areas is not known, nor whether Atlantic sturgeon are drawn to particular areas based on physical or biological features of the habitat. At this time, very little is known about the marine portion of the Atlantic sturgeon's life cycle and the habitats the species utilizes. Due to the paucity of data on their offshore needs and specific habitat utilization, we could not at this time identify physical or biological features essential to conservation in the marine environment.

Atlantic sturgeon utilize estuarine areas for foraging, movement, and nursery habitat. Subadult Atlantic sturgeon spawned in one riverine system may utilize multiple estuaries for foraging and growth, including those not directly connected to their natal river. Many studies have looked at the diet of Atlantic sturgeon, which consists of benthic invertebrates and mollusks; these prey items are found in soft substrates that are common and widespread in most estuaries. No data are available differentiating areas of preferred prey items or higher prey abundance within or across estuaries. Due to the paucity of data on their estuarine needs and specific habitat utilization, we could not at this time identify physical or biological features essential to conservation in the estuarine environment.

Atlantic sturgeon spawning has been extensively studied and is fairly well understood, though the exact location of spawning sites on many rivers (particularly in the Southeast) is not known. However, there is substantial information in the scientific literature indicating the physical characteristics of Atlantic sturgeon spawning habitat. Therefore, to investigate potential critical habitat, we focused on identifying the physical and biological features that support Atlantic sturgeon spawning. We find these features to be essential to the conservation of the species because even after the moratorium on directed fishing was established in 1998, these populations have failed to recover due to the impacts and threats that limit habitat for spawning and development. Because of these threats on spawning and developmental habitat, these features and areas may require special management considerations.

### i. Substrate

The scientific literature indicates that Atlantic sturgeon spawning occurs well upstream over hard substrate, consisting of rock, pebbles, gravel, cobble, limestone, or boulders (Gilbert, 1989; Smith and Clugston, 1997). Hard substrate is required so that highly adhesive Atlantic sturgeon eggs have a surface to adhere to during their initial development and young fry can utilize the interstitial spaces between rocks, pebbles, cobble, etc., to hide from predators during downstream movement and maturation (Gilbert, 1989; Smith and Clugston, 1997).

### ii. Salinity

Very low salinity (i.e., 0.0 – 0.5 ppt) is another feature of Atlantic sturgeon spawning habitat. The presence of low salinity is partially due to the fact that, geologically, the hard substrate utilized by Atlantic sturgeon for spawning is often found farther upriver in freshwater compared to downstream brackish areas. However, low salinity is also important to the survival of the earliest life stages of Atlantic sturgeon. Exposure to even low levels of salinity can kill Atlantic sturgeon during their first few weeks of life, thus their downstream movement is limited until they can endure brackish waters (Bain et al., 2000; Sulak et al., 2000). Parker and Kynard (2005) noted that long larval/early juvenile downstream movement is common in both shortnose sturgeon from the Savannah River and Gulf sturgeon (a sub-species of Atlantic sturgeon), and that this is may be a widespread adaptation of sturgeon inhabiting river systems in the southern U.S. Shortnose sturgeon tend to spawn 200-300 km upriver, preventing the youngest life stages from salt exposure too early in their development (Parker and Kynard, 2005; Kynard, 1997); due to their similar life history, Atlantic sturgeon most likely adapted a similar spawning strategy. Therefore, it is important the spawning area have low salinity and that the spawning location is far enough upstream to allow newly-spawned Atlantic sturgeon to develop and mature on their downstream movement before encountering saline water.

### iii. Water Depth

The scientific literature indicates that Atlantic sturgeon spawn in water depths from 3-27 meters (Borodin, 1925; Leland, 1968; Scott and Crossman, 1973; Crance, 1987; Bain et al., 2000). However, much of this information is derived from studies of Atlantic sturgeon in northern U.S. and Canadian river systems. Atlantic sturgeon in the Southeast are likely spawning in much shallower water depth based on observations by biologists where sturgeon have lacerations on their undersides from moving into extremely shallow water to spawn on hard substrate. To identify where suitable water depths for spawning may occur, we searched available areas with depths between 1.8-27 meters in Southeast rivers.

Minimum water depths for Atlantic sturgeon spawning are necessary to: (1) allow adult fish to access spawning substrate, (2) adequately hydrate and aerate newly deposited eggs, and (3) facilitate successful development and downstream movement of newly spawned Atlantic sturgeon. Adequate water depths are essential for functional Atlantic sturgeon spawning habitat. However, water depth at these important spawning areas in the Southeast can be dynamic and may be dry or have little water at times due to natural seasonal river fluctuations, temporary drought conditions, and/or regulation by manmade structures such as dams, and thus require protection. Therefore, we are considering areas that have fluctuating water depth conditions for critical habitat. It is essential to the conservation of Atlantic sturgeon to protect important spawning habitats, even if those habitats have seasonally (i.e., outside of spawning season), temporarily, or artificially inadequate water depths. In order to include these areas of dynamic water depth essential for spawning areas when considering critical habitat, we are relying on the ordinary high water mark (OHWM) to delineate where spawning habitat may occur.

Federal regulations at 33 CFR 328.3(e) define OHWM as "that line on the shore established by the fluctuations of water and indicated by physical characteristics such as a clear, natural line impressed on the bank, shelving, changes in the character of soil, destruction of terrestrial

vegetation, the presence of litter and debris, or other appropriate means that consider the characteristics of the surrounding areas." The term also carries regulatory significance. Those regulations at 33 CFR 328.3 indicate the U.S. Constitution gives Congress the authority to legislate for waterways using OHWM as the geographic extent of that authority. The OHWM also defines the lateral limits of Federal jurisdiction over non-tidal water bodies for the purposes of Section 404 of the Clean Water Act, defines U.S. navigable waters related to Sections 9 and 10 of the Rivers and Harbors Act of 1899, and delineates the geographic extent of Federal authority over many other regulatory programs implemented by the U.S. Army Corps of Engineers, the Environmental Protection Agency, and others. To delineate appropriate water depth, we are considering that potential Atlantic sturgeon critical habitat will be identified as areas occurring waterward of the OHWM.

We considered water velocity as another potential essential feature of Atlantic sturgeon spawning critical habitat. The scientific literature provides information on the importance of appropriate water velocity within Atlantic sturgeon spawning habitat and provides optimal flows for some rivers. Atlantic sturgeon spawn directly on top of gravel in fast flowing sections often containing eddies or other current breaks. "Eddies promote position holding between spawning individuals, trap gametes facilitating fertilization, and diminish the probability of egg dislocation by current – facilitating immediate adhesion of eggs to the gravel substrate" (Sulak et al. 2000). However, velocity data are lacking for many rivers, and where data are available, the wide fluctuations in velocity rates on a daily, monthly, seasonal, and annual basis makes it difficult to identify a range of water velocity necessary for the conservation of the species.

### iv. Migratory Pathways

Adult Atlantic sturgeon must be able to safely and efficiently move from downstream areas into upstream spawning habitats in order to successfully spawn. In addition, larvae and juvenile Atlantic sturgeon must be able to safely and efficiently travel from the upstream spawning area downstream to nursery and foraging habitat. Therefore, an essential feature for Atlantic sturgeon spawning is safe and unobstructed migratory pathways necessary for movement of adults to and from upstream spawning areas as well as providing movement for the larvae and juveniles downstream. This means an unobstructed river or a dammed river that still allows for passage.

### v. Critical Habitat Essential Features

Based on the information presented, we are considering two "specific areas" or units of critical habitat within a river: one for spawning and one for reproduction and recruitment. The physical and biological features identified for spawning habitat are: (1) spawning substrate composed of hard substrate that includes rock, pebbles, cobble, gravel, limestone, and boulders, (2) salinity in the 0.0 – 0.5 parts per thousand (ppt) range, and (3) water depth of 1.8 to 27 meters. The function of the reproduction and recruitment habitat is to facilitate movement of adults upstream to spawning areas and both adults and larvae and juveniles downstream from spawning areas to nursery and foraging habitat. The physical and biological features identified for reproduction

and recruitment habitat are: (1) water depth greater than 1.8 meters, (2) adequate water quality[1] , and (3) unobstructed pathways that are free of physical barriers hindering passage up and down the river.

## C. Specific Areas Within the Geographical Area Occupied by the Species

Across the geographic area occupied by the Carolina DPS of Atlantic sturgeon and the South Atlantic DPS of Atlantic sturgeon, we have identified rivers where spawning is known, believed, or may occur as indicated in the Final Listing Rule (77 FR 5914; February 6, 2012). Within each of those rivers, we considered the biological and physical features essential for the conservation of the species as identified above.

Next, to identify "specific areas" where the features exist within the occupied geographical area, we reviewed the best available scientific information on the location of the essential features, we searched the 2007 Atlantic sturgeon status review (ASSRT, 2007), the ESA listing rules (77 FR 5914; February 6, 2012), scientific research reports, and a database developed by USGS for mapping environmental parameters within East Coast Rivers to identify sturgeon habitat. We also considered information on the location of spawning activity by sturgeon as reported in scientific reports, as active spawning in an area would indicate that the essential features necessary for spawning are likely present. Information on documented spawning in specific areas is rare in the Southeast, but some does exist. For example, large sections of the Altamaha River have been found to support Atlantic sturgeon spawning activities for many years (Peterson and Schueller, 2006; Peterson et al., 2008). We reviewed reports from a NOAA-funded Section 6 multi-year, multi-state research project on movement and migration of Atlantic sturgeon (http://www.nmfs.noaa.gov/pr/conservation/states/funded.htm). In these reports, researchers determined which portions of Southeastern rivers support spawning activities by looking at the upriver extent of sturgeon movements during spawning season.

We also considered information that documents spawning of shortnose sturgeon as shortnose and Atlantic sturgeon have very similar spawning habitat requirements. We considered the documented and suspected spawning areas of both sturgeon species as potential Atlantic sturgeon critical habitat areas. Figures 1-4 show HUCs where the essential features may be located, as well as documented Atlantic sturgeon spawning activity. Locations where depth and substrate data were collected are shown in Figures 1-4. Because salinity data were not available for most riverine locations, we indicate approximate locations of the head of tide (the farthest point upstream where a river is affected by tidal fluctuations) and the salt wedge (the intrusion of seawater into an estuary) in Figures 1-4.

[1] Adequate water quality refers to waters that would, in their natural state, be adequate for use by Atlantic sturgeon. Waters that have been rendered less suitable for Atlantic sturgeon (e.g., waters that are seasonally too warm and/or have low dissolved oxygen) due to anthropogenic effects (e.g., water withdrawals, water diversions, contamination) are still part of the critical habitat if those same waters would naturally have been used by Atlantic sturgeon and the other essential features are present.

## i. North Carolina Rivers

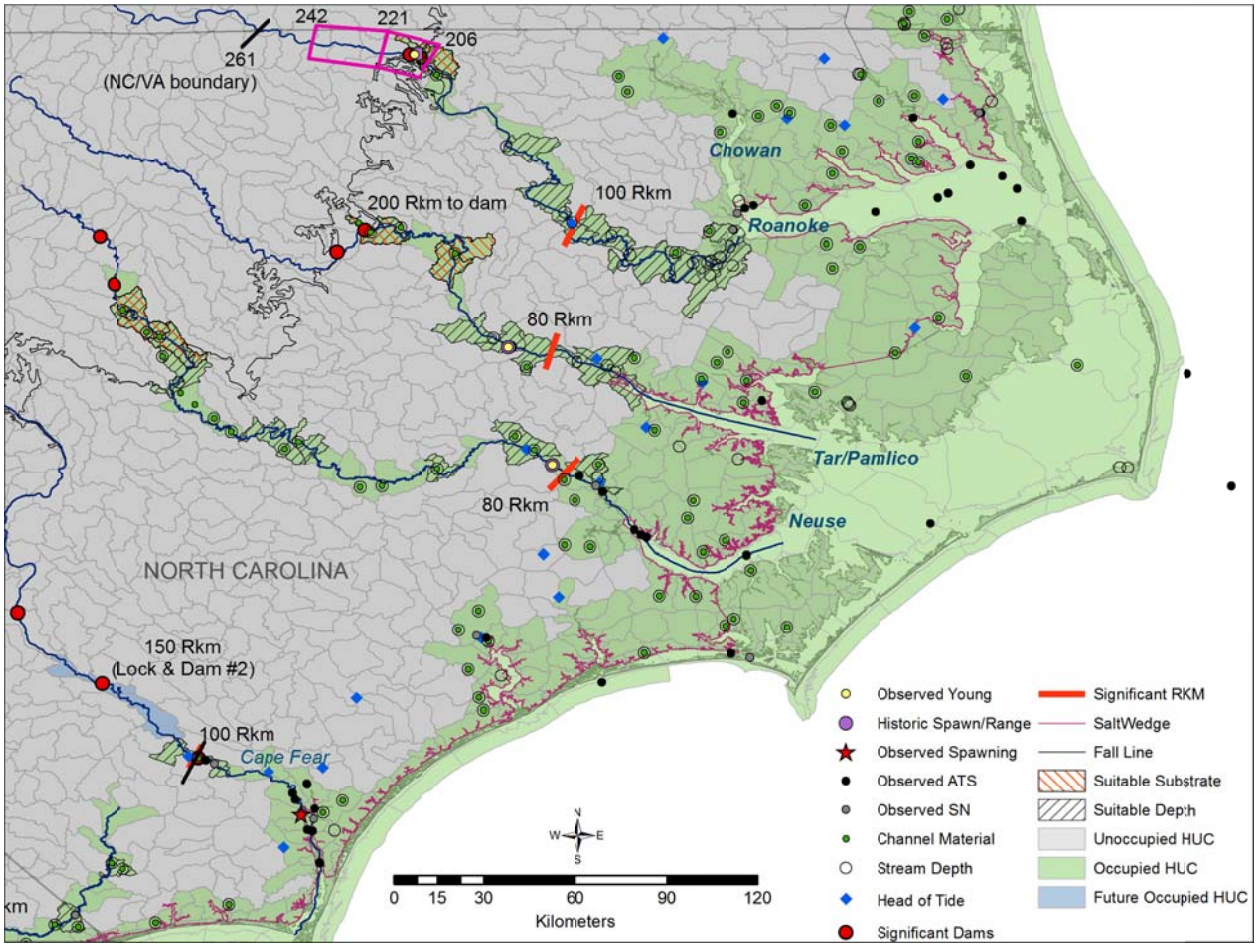


**Figure 1: Map showing known location data for Atlantic sturgeon essential features and Atlantic sturgeon spawning activity in North Carolina rivers. Colored polygons indicate areas where research has been conducted.**

In Figure 1, additional symbols were added at various river kilometers (RKM) to represent information on historical spawning and suitable habitat.

<u>Roanoke River</u>

- Pink polygon (RKM 206-242): Historically, Atlantic sturgeon were caught in great numbers in the fall zone on the Roanoke River, which occurs at approximately RKM 242. Suitable habitat for Atlantic sturgeon spawning is documented to occur between RKM 206 and the Roanoke Rapids Dam at RKM 221 (Armstrong and Hightower, 2002).
- Black slash (RKM 261): Archaeological investigation found Atlantic sturgeon remains up to RKM 261 (above the fall zone) on the Roanoke River (Armstrong and Hightower, 2002).

<u>Cape Fear River</u>

- In 2012, 2 adult Atlantic sturgeon in the Cape Fear River were tracked up to ~ RKM 100 (just below Lock and Dam #1) during a spring spawning run (Post et al., 2012).

**Table 1: Description of spawning information for North Carolina rivers depicted in Figure 1. RKM = river kilometer.**

| River | Number of Atlantic Sturgeon | Life Stage or Other Indicator | Date of Observation | Notes | Reference |
|---|---|---|---|---|---|
| Roanoke (Yellow dot) | Numerous | Larger juveniles | 1904 | Hand's length fish observed in the fall zone | Armstrong and Hightower 2002 |
| Roanoke (Purple dot) | | Historic spawning grounds | pre-1905 | Above the falls | Zarzecki and Hightower 1997 in Kahnle et al 1998 |
| Tar-Pamlico (Yellow and purple dots) | | Historic spawning grounds/Age 0 | | Location ~ RKM) 95; visual verification (04/26/2013) in Bing maps imagery showed evidence of shoals in areas downstream to RKM 80 | Hoff 1980 in USFWS 1998 |
| Neuse (Yellow and purple dots) | | Historic spawning grounds/Age 0 | | RKM 83 | Hoff 1980 in USFWS 1998 |
| Cape Fear (Red star) | 1 | Gravid adult female | 1987 | | Ross et al 1988 in Moser and Ross 1995 |

## ii. South Carolina Rivers

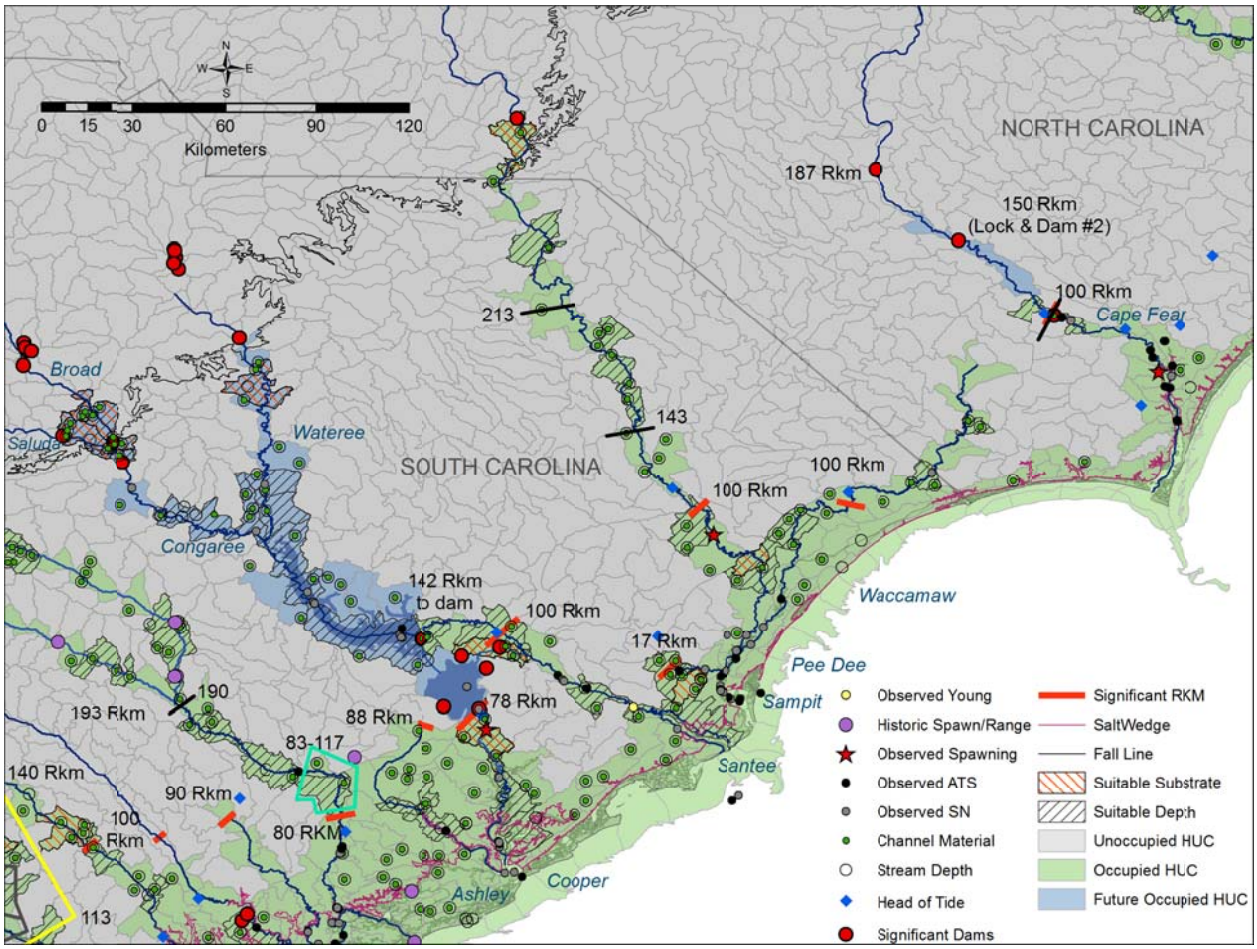


**Figure 2: Map showing known location data for Atlantic sturgeon essential features and Atlantic sturgeon spawning activity in North and South Carolina rivers.**

Recent information on Atlantic sturgeon spawning information in several South Carolina Rivers is depicted in Figure 2.

<u>Pee Dee River</u>

- Black slash (RKM 143): During a suspected fall spawning run, Atlantic sturgeon traveled to "at least" RKM 143on the Pee Dee River (Post et al., 2011b).
- Black slash (RKM 213): A running ripe male was captured at RKM 213 on the Pee Dee River (Kahnle et al., 2005).

**Table 2: Description of spawning information for South Carolina rivers depicted in Figure 2.**

| River | Number of Atlantic Sturgeon | Life Stage or Other Indicator | Date of Observation | Notes | Reference |
|---|---|---|---|---|---|
| Pee Dee (Red star) | 1 | Spawning female | 1967 | Observed during May-August survey, on a sandbar | Leland 1968 |
| Santee (Yellow dot) | Many | Small | 1967 | Taken as bycatch | Leland 1968 |
| Cooper (Red star) | | Adult | 1996 | Shortnose; spawning | Kahnle et al. 1998 |

### iii. Georgia Rivers

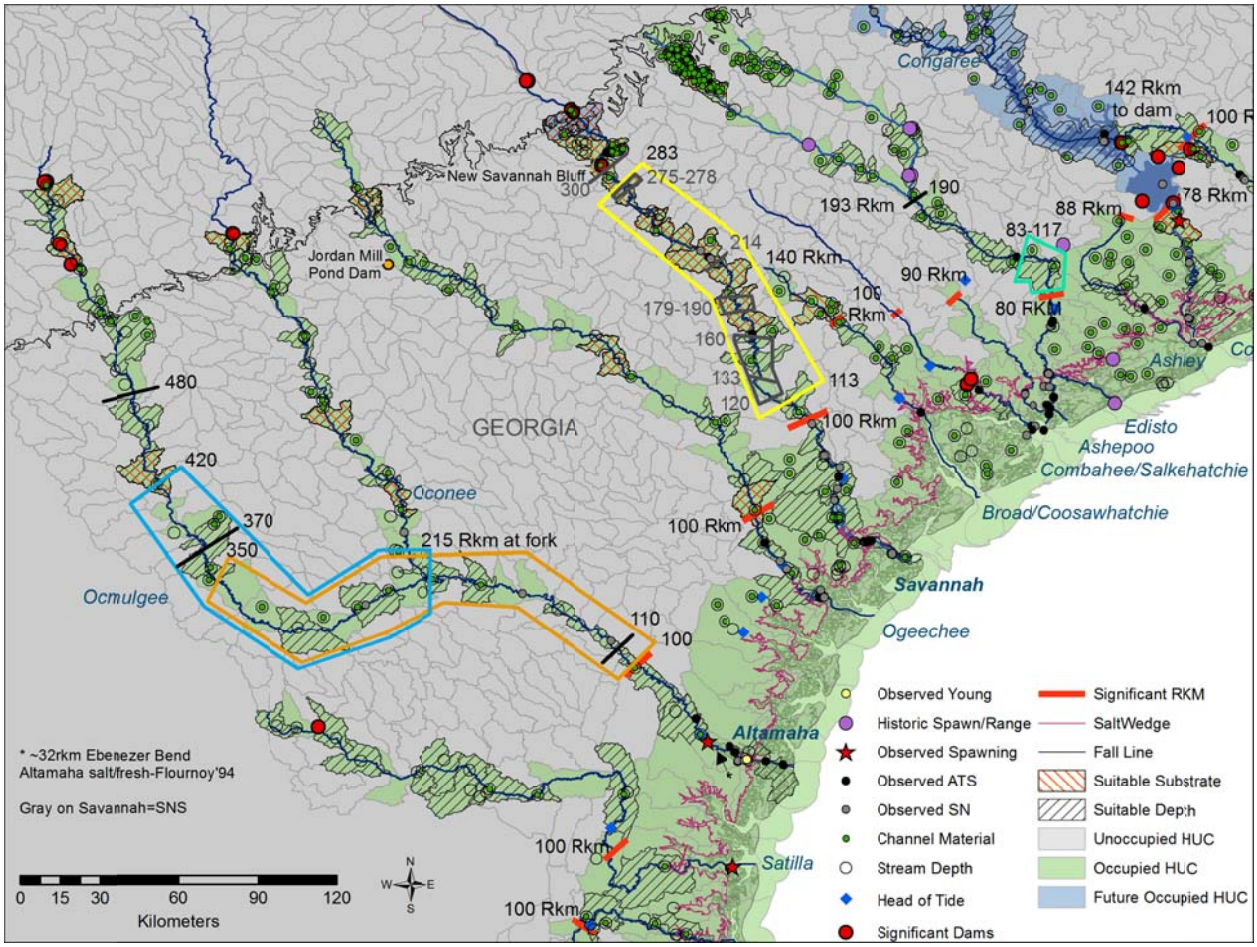

**Figure 3: Map showing known location data for Atlantic sturgeon essential features and Atlantic sturgeon spawning activity in South Carolina and Georgia rivers**. **Colored polygons indicate areas where research has been conducted.**

In Figure 3, additional symbols were added at various river kilometers (RKM) to represent information on spawning and suitable habitat. We describe those specific areas by rivers below.

Edisto River

- Green polygon (RKM 83-117): On the Edisto River, the majority of the Atlantic sturgeon observed during a suspected fall spawning event were between RKM 83-117, with one Atlantic sturgeon traveling all the way up to RKM 183 (Post et al., 2011).
- Black slash (RKM 190): An earlier study noted that 2 Atlantic sturgeon migrated to RKM 190 during a fall spawning event (Collins et al., 2000).

Savannah River

- Yellow polygon (RKM 113-283): Collins and Smith (1997) collected 43 Atlantic sturgeon larvae from RKM 113-283.
- Gray slashes (RKM 214, 300): Suitable spawning habitat for Atlantic sturgeon may be present at RKM 214 and 300 based on shortnose sturgeon spawning activity in those locations (Post et al. 2011a)
- Gray polygons (RKM 120-160): Suitable spawning habitat for Atlantic sturgeon may be present between RKM 120 and 160 based on shortnose sturgeon spawning activity in those locations (Post et al., 2012)
- Gray polygons (RKM 179-190; 275-278): Suitable spawning habitat for Atlantic sturgeon may be present from RKM 179-190 and RKM 275-278 based on shortnose sturgeon spawning activity in those locations (Hall et al., 1991)

Altamaha River

- Black slash (RKM 480): One ATS moved all the way up to ~ RKM 480 within the Ocmulgee during spawning season. (Post et al., 2012)
- Black slashes (RKM 110, 215 [obscured]): Of 17 adult tagged Atlantic sturgeon, 15 moved upstream at least RKM 110. Another 6 of the 15 moved upstream of the confluence of the Altamaha (RKM 215) into the Ocmulgee suggesting fall spawning (Post et al., 2012).
- Orange polygon (RKM 100-350): During spawning season, furthest upstream travels by tagged Atlantic sturgeon were between RKM 100-350 (Figure 3, Post et al., 2012).
- Blue polygon (RKM 215-420): Most tagged adult Atlantic sturgeon were found between RKM 215 and 420 (Altamaha and Ocmulgee Rivers) in October and November when water temperature was right for spawning. Swift currents and rocky substrates in these areas may provide an abundance of potential spawning habitat (Peterson et al., 2006).
- Black slashes (RKM 215 [obscured], 370, and 420 [obscured]): Suspected Atlantic sturgeon spawning areas around RKM 215, 370, and 420 (Peterson et al., 2006).

**Table 3: Description of spawning information for Georgia rivers depicted in Figure 3.**

| River | Number of Atlantic Sturgeon | Life Stage or Other Indicator | Date of Observation | Notes | Reference |
|---|---|---|---|---|---|
| Edisto (Purple dot, mouth) | | Historic range info | 1730 | | Leland 1968 |
| Edisto (Purple dot, due north of dot at mouth) | | Historic range info | 1730 | Younder's Island | Leland 1968 |
| Edisto (Purple dot, next to green box) | | Historic range info | 1730 | Four Hole Spring; possible SNS | Leland 1968 |
| Edisto (Two purples dots together) | | Historic range info | 1730 | Cooper Swamp, Jenning's Quarters; possible SNS) | Leland 1968 |
| Edisto (Purple dot, North Fork) | | Historic range info | 1730 | Cawcaw Swamp; possible SNS | Leland 1968 |
| Edisto (Purple dot, South Fork) | | Historic range info | 1730 | Pou's Mill; possible SNS | Leland 1968 |
| Savannah (not shown on map, near the headwaters) | | Historic spawning extent | | | Leland 1968 |
| Altamaha (Red star) | 213 | Spawning adults | 2004/2005 | | Peterson et al. 2007 |
| Altamaha (Yellow dot) | 37 | Age 0 | | Gillnet capture | King et al 2001 |
| Satilla (Red star) | 4 | Spawning adults | 1985 | | Wirgin et al 2000 |

### iv. Florida Rivers

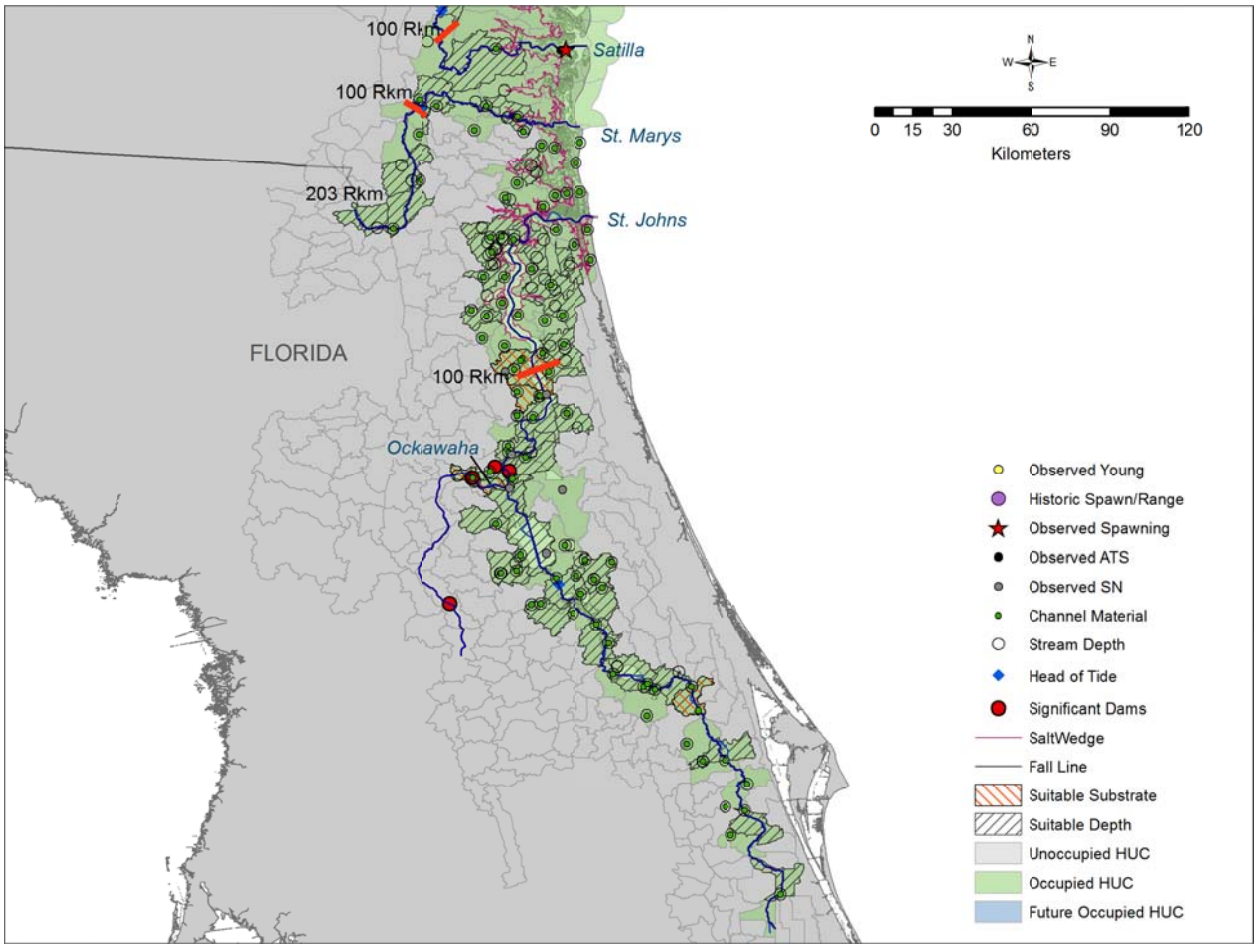


**Figure 4: Map showing known location data for Atlantic sturgeon essential features and Atlantic sturgeon spawning activity in Florida rivers.**

## D. Identification of Specific Areas within the Geographical Area Occupied Containing the Essential Features

The data presented in Figures 1-4 is based on available information; there were large areas of the river where data were missing and the available data for a HUC is often supported by a single datapoint. These data represent a snapshot in time, and the exact location of a feature may change over time (e.g., water depth fluctuates seasonally, as well as annually, and even hard substrate may shift its position). For example, the data showed substrate in a single location changing from year to year; some years it was listed as sand, other years gravel. It is uncertain whether this is due to an actual shift in substrate characteristics or if the substrate sample was collected in a slightly different location between samplings. Though data for each feature varied greatly even at the same location, if one data point in the dataset for that feature fell within the suitable range (i.e., salinity of 0-0.5 ppt, water depths from 1.8-27 meters, or hard substrate [gravel, cobble, etc.]), Figures 1-4 indicate that the essential feature occurs in that HUC.

When data were not available in occupied rivers or portions of occupied rivers, we used our general knowledge of Atlantic sturgeon spawning and applied river-specific information to determine location of features essential to spawning. We considered intolerance of salinity during the earliest life stages, and the known movement of sturgeons upstream hundreds of km for spawning to provide sturgeon larvae appropriate habitat to develop as they mature. Data from the Section 6 multistate sturgeon movement and migration project, data from the spawning season across several major river systems (e.g., the Savannah and Altamaha) indicates that most Atlantic sturgeon spawning activity started around RKM 100; similar evidence from the Edisto, Neuse, and Tar-Pamlico Rivers indicates spawning activity starting around RKM 80.

Based on the best available data, we have a general knowledge of where Atlantic sturgeon spawning is occurring. In some cases, we also have data indicating the location of those physical and biological features we identified as essential to support successful spawning. However, there are gaps in our data. There may be important Atlantic sturgeon spawning areas containing the essential features for which we have no data. Therefore, in order to encompass all areas important for Atlantic sturgeon spawning within rivers where spawning is believed to occur or may occur, we have identified Atlantic sturgeon spawning habitat as areas starting at RKM 100, unless otherwise noted, with the essential features of suitable substrate (gravel, cobble, etc.) in surrounding waters with a depth of 1.8 – 27 meters waterward of the OHWM with salinity between 0.0-0.5 ppt. Because we have specific information that Atlantic sturgeon are spawning at locations lower than RKM 100 in the Edisto, Neuse, and Tar-Pamlico Rivers, for those rivers we identify spawning habitats as occupied areas starting at RKM 80 with the essential features of suitable substrate (gravel, cobble, etc.) in surrounding waters with a depth of 1.8 – 27 meters waterward of the OHWM with salinity between 0.0-0.5 ppt. Reproduction and recruitment habitats are areas where there are safe and unobstructed pathways in waters deeper than 1.8 meters with suitable water quality. These areas occur from the mouth (RKM 0) of each spawning river to the upstream extent of the spawning habitat.

While we have some evidence Atlantic sturgeon may be present in areas upstream of a dam or any other impassable barrier, we are considering those areas as unoccupied for the purpose of this rulemaking. Manmade barriers currently restrict upstream movement of Atlantic sturgeon in the Santee-Cooper and Savannah River systems. However, we believe these areas will be occupied in the future and in any event, the areas are essential to the conservation of Atlantic sturgeon because there is insufficient spawning and recruitment habitat downstream of the barriers to ensure the conservation of the species. The areas above the manmade barriers on the Cape Fear, Santee-Cooper, and Savannah Rivers outside the geographical area occupied by the species are being considered as essential for conservation because conservation of the species will not be successful without protecting these areas through designation of critical habitat. Further, these areas are important because: (1) they contain the essential features, (2) the essential features are limited below the manmade barriers, and (3) efforts to provide fish passage around these manmade barriers are underway. Figures 5-8 indicate by river the spawning unit (in blue) and the reproduction and recruitment unit (in green) identified from North Carolina through Florida. We identify the essential features present in both units for each river or river system and the extent of those features within the river or river system.

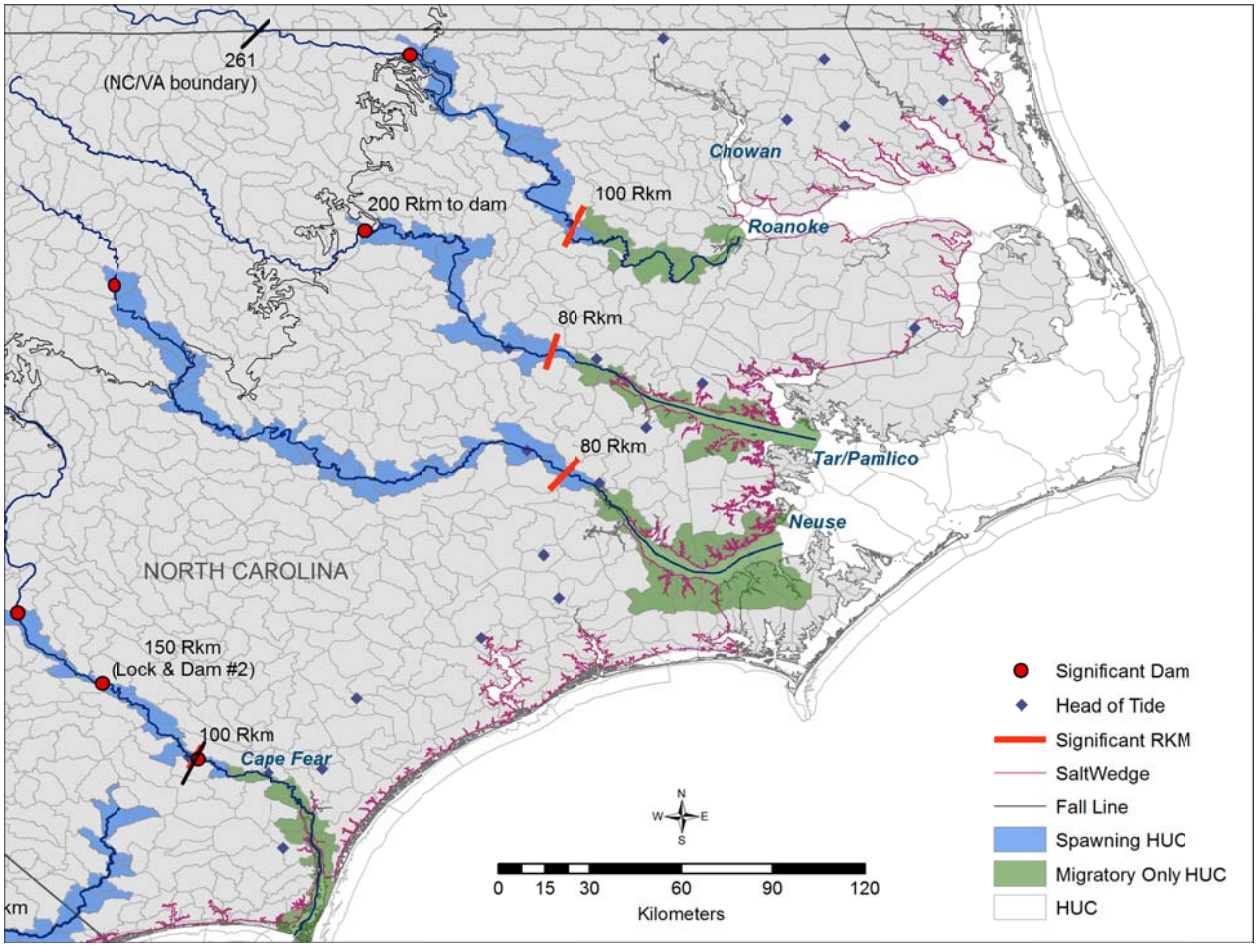


**Figure 5: Map showing essential habitats of Atlantic sturgeon in North Carolina: spawning habitat is in blue, reproduction and recruitment habitat in green.**

Roanoke River: The spawning unit is identified in the Roanoke River between RKM 100 and the Roanoke Rapids Dam with the essential features of: (1) suitable substrate waterward of the OHWM, with (2) salinity between 0.0-0.5 ppt in surrounding waters, and (3) greater than 1.8m in depth. The reproduction and recruitment unit is identified in the Roanoke River from the river mouth (RKM 0) upstream to the Roanoke Rapids Dam to provide for: (1) safe and unobstructed migratory pathways, with (2) suitable water quality, and (3) depths greater than 1.8m.

Tar/Pamlico River: The spawning unit is identified in the Tar/Pamlico River between RKM 80 and the Rocky Mount Mill Pond Dam with the essential features of: (1) suitable substrate waterward of the OHWM, with (2) salinity between 0.0-0.5 ppt in surrounding waters, and (3) greater than 1.8m in depth. The reproduction and recruitment unit is identified in the Tar/Pamlico River from the river mouth (RKM 0) upstream to the Rocky Mount Mill Pond Dam to provide for: (1) safe and unobstructed migratory pathways, with (2) suitable water quality, and (3) depths greater than 1.8m.

Neuse River: The spawning unit is identified in the Neuse River between RKM 80 and the Milburnie Dam with the essential features of: (1) suitable substrate waterward of the OHWM, with (2) salinity between 0.0-0.5 ppt in surrounding waters, and (3) greater than 1.8m in depth. The reproduction and recruitment unit is identified in the Neuse River from the river mouth (RKM 0) upstream to the Milburnie Dam to provide for: (1) safe and unobstructed migratory pathways, with (2) suitable water quality, and (3) depths greater than 1.8m.

Cape Fear River: The spawning unit is identified in the Cape Fear River between RKM 100 and Lock and Dam #3 with the essential features of: (1) suitable substrate waterward of the OHWM, with (2) salinity between 0.0-0.5 ppt in surrounding waters, and (3) greater than 1.8m in depth. The reproduction and recruitment unit is identified in the Cape Fear River from the river mouth (RKM 0) upstream to Lock and Dam #3 to provide for: (1) safe and unobstructed migratory pathways, with (2) suitable water quality, and (3) depths greater than 1.8m.

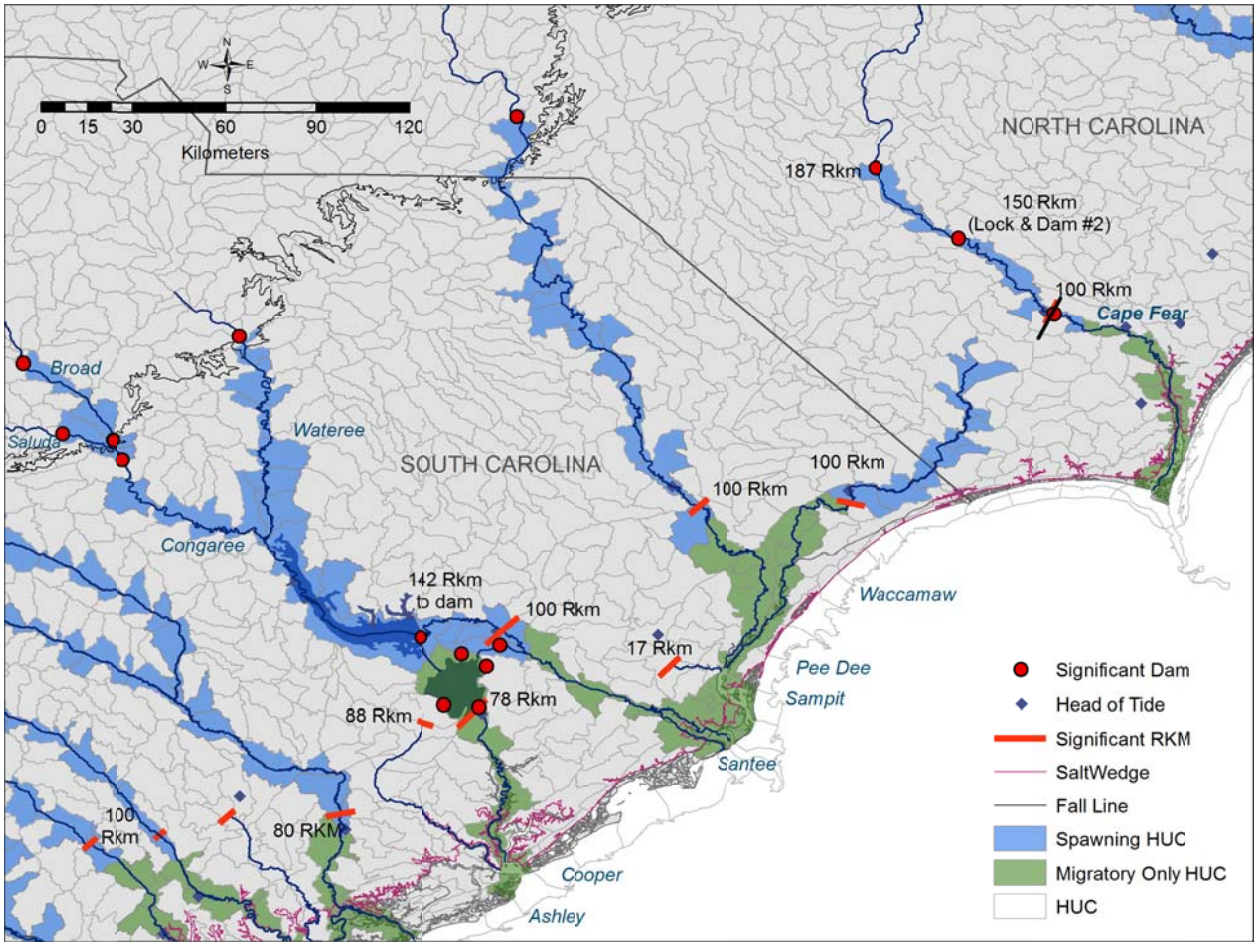


**Figure 6: Map showing essential habitats of Atlantic sturgeon in North and South Carolina: spawning habitat is in blue, reproduction and recruitment habitat in green.**

Waccamaw River: The spawning unit is identified in the Waccamaw River from RKM 100 upstream with the essential features of: (1) suitable substrate waterward of the OHWM, with (2) salinity between 0.0-0.5 ppt in surrounding waters, and (3) greater than 1.8m in depth. The reproduction and recruitment unit is identified in the Waccamaw River from the river mouth

(RKM 0) upstream to provide for: (1) safe and unobstructed migratory pathways, with (2) suitable water quality, and (3) depths greater than 1.8m.

Pee Dee River: The spawning unit is identified in the Pee Dee River between RKM 100 and Blewett Falls Dam with the essential features of: (1) suitable substrate waterward of the OHWM, with (2) salinity between 0.0-0.5 ppt in surrounding waters, and (3) greater than 1.8m in depth. The reproduction and recruitment unit is identified in the Pee Dee River from the river mouth (RKM 0) upstream to the Blewett Falls Dam to provide for: (1) safe and unobstructed migratory pathways, with (2) suitable water quality, and (3) depths greater than 1.8m.

Sampit River: We are not identifying habitat essential for spawning or reproduction/recruitment in the Sampit River as the best available information indicates Atlantic sturgeon spawning is not occurring and there are no essential features present, nor are there expected to be in the future .

Santee-Cooper River System: The spawning unit is identified in the Santee-Cooper as any area in the river system between RKMs 100 on the Santee and Cooper Rivers up to the Wateree Dam on the Wateree River, the Parr Shoals on the Broad River, and the Saluda Dam on the Saluda River with the essential features of: (1) suitable substrate waterward of the OHWM, with (2) salinity between 0.0-0.5 ppt in surrounding waters, and (3) greater than 1.8m in depth. The reproduction and recruitment unit is identified in the Santee and Cooper Rivers from their river mouths (RKM 0) upstream to the Wateree Dam on the Wateree River, the Parr Shoals on the Broad River, and the Saluda Dam on the Saluda River to provide for: (1) safe and unobstructed migratory pathways, with (2) suitable water quality, and (3) depths greater than 1.8m.

Ashley River: The spawning unit is identified in the Ashley River from RKM 80 upstream with the essential features of: (1) suitable substrate waterward of the OHWM, with (2) salinity between 0.0-0.5 ppt in surrounding waters, and (3) greater than 1.8m in depth. The reproduction and recruitment unit is identified in the Ashley River from the river mouth (RKM 0) upstream to provide for: (1) safe and unobstructed migratory pathways, with (2) suitable water quality, and (3) depths greater than 1.8m. We note that the Ashley River historically supported a spawning population, but the status of that population was stated as unknown in the final listing rule. However, we believe that this spawning habitat is essential to the conservation of the DPS and should be designated. We do not currently have specific information (e.g., documented spawning or evidence of suitable substrate) indicating where spawning is occurring on the river, but we know it historically occurred below RKM 100 because the Ashley River is only 88 km long. We applied our knowledge from other systems (i.e., the Neuse, Edisto, and Tar/Pamlico Rivers) that spawning activity in some Southeast rivers begins to occur around RKM 80.

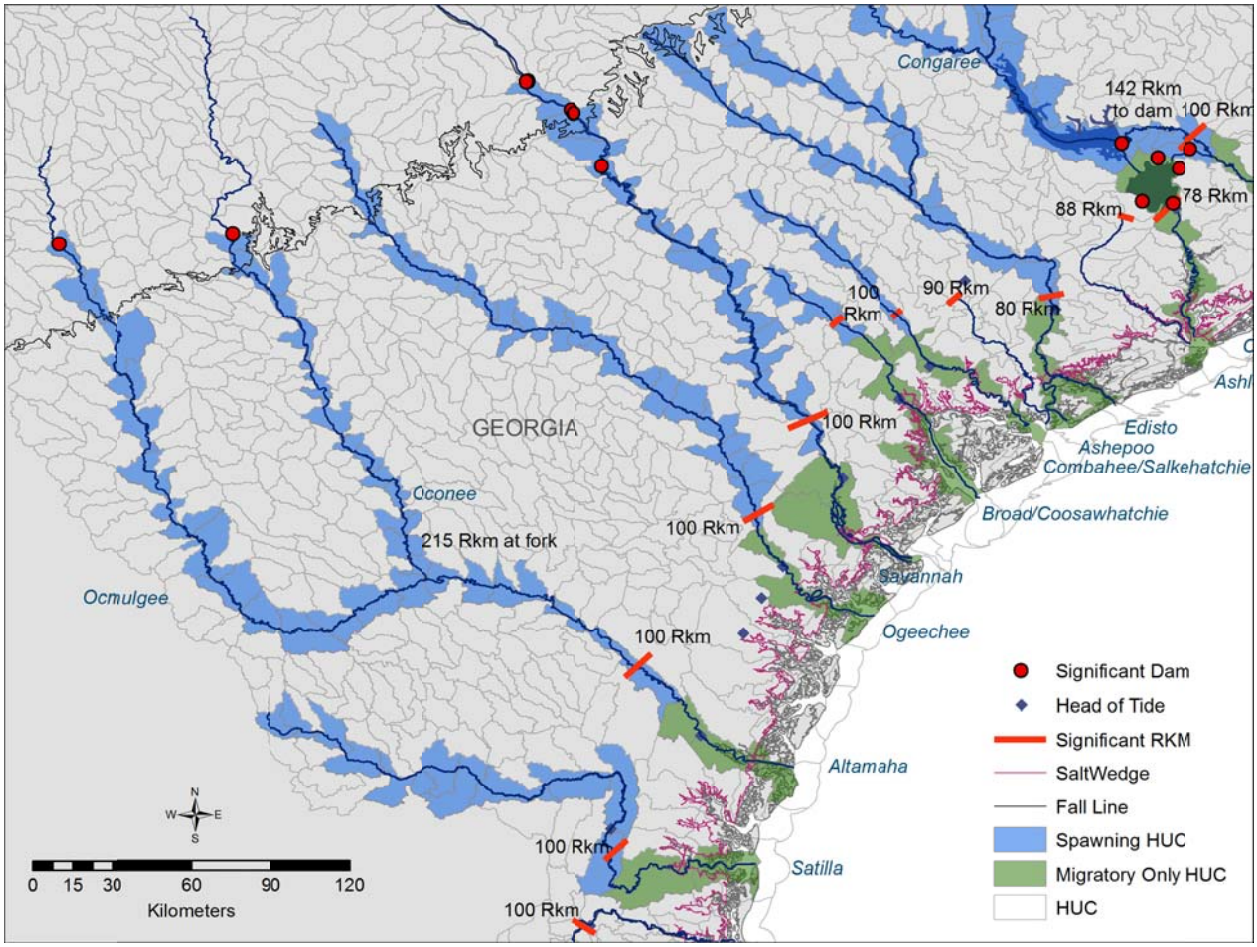


**Figure 7: Map showing essential habitats of Atlantic sturgeon in South Carolina and Georgia: spawning habitat is in blue, reproduction and recruitment habitat in green.**

Edisto River: The spawning unit is identified in the Edisto River between RKM 80 and the fall line with the essential features of: (1) suitable substrate waterward of the OHWM, with (2) salinity between 0.0-0.5 ppt in surrounding waters, and (3) greater than 1.8m in depth. The reproduction and recruitment unit is identified in the Edisto River from the river mouth (RKM 0) upstream to the fall line to provide for: (1) safe and unobstructed migratory pathways, with (2) suitable water quality, and (3) depths greater than 1.8m.

Ashepoo River: The spawning unit is identified in the Ashepoo River from RKM 80 upstream with the essential features of: (1) suitable substrate waterward of the OHWM, with (2) salinity between 0.0-0.5 ppt in surrounding waters, and (3) greater than 1.8m in depth. The reproduction and recruitment unit is identified in the Ashepoo River from the river mouth (RKM 0) upstream to provide for: (1) safe and unobstructed migratory pathways, with (2) suitable water quality, and (3) depths greater than 1.8m. While the ACE Basin supports at least one spawning population of Atlantic sturgeon, the best available science indicates it is more likely that spawning is occurring in the Edisto River and possibly the Combahee River, rather than the Ashepoo. However, the essential features are present, may require special consideration, and we believe that designation of critical habitat in the Ashepoo is essential to the conservation of the DPS. We do not currently have specific information (e.g., documented spawning or evidence of suitable

substrate) indicating where spawning is occurring on the river, but we know it must occur below RKM 100 because the Ashepoo River is only 90 km long. We applied our knowledge from other systems (i.e., the Neuse, Edisto, and Tar/Pamlico Rivers) that spawning activity in some Southeast rivers begins to occur around RKM 80.

Combahee River: The spawning unit is identified in the Combahee River from RKM 100 upstream with the essential features of: (1) suitable substrate waterward of the OHWM, with (2) salinity between 0.0-0.5 ppt in surrounding waters, and (3) greater than 1.8m in depth. The reproduction and recruitment unit is identified in the Combahee River from the river mouth (RKM 0) upstream to the Blewett Falls Dam to provide for: (1) safe and unobstructed migratory pathways, with (2) suitable water quality, and (3) depths greater than 1.8m.

Broad/Coosawhatchie River: The spawning unit is identified in the Broad/Coosawhatchie River from RKM 100 upstream with the essential features of: (1) suitable substrate waterward of the OHWM, with (2) salinity between 0.0-0.5 ppt in surrounding waters, and (3) greater than 1.8m in depth. The reproduction and recruitment unit is identified in the Broad/Coosawhatchie River from the river mouth (RKM 0) upstream to provide for: (1) safe and unobstructed migratory pathways, with (2) suitable water quality, and (3) depths greater than 1.8m.

Savannah River: The spawning unit is identified in the Savannah River between RKM 100 and the J. Strom Thurmond Dam with the essential features of: (1) suitable substrate waterward of the OHWM, with (2) salinity between 0.0-0.5 ppt in surrounding waters, and (3) greater than 1.8m in depth. The reproduction and recruitment unit is identified in the Savannah River from the river mouth (RKM 0) upstream to the J. Strom Thurmond Dam to provide for: (1) safe and unobstructed migratory pathways, with (2) suitable water quality, and (3) depths greater than 1.8m.

Ogeechee River: The spawning unit is identified in the Ogeechee River between RKM 100 and the fall line with the essential features of: (1) suitable substrate waterward of the OHWM, with (2) salinity between 0.0-0.5 ppt in surrounding waters, and (3) greater than 1.8m in depth. The reproduction and recruitment unit is identified in the Ogeechee River from the river mouth (RKM 0) upstream to the fall line to provide for: (1) safe and unobstructed migratory pathways, with (2) suitable water quality, and (3) depths greater than 1.8m.

Altamaha River: The spawning unit is identified in the Altamaha River between RKM 100 and the Juliette Dam with the essential features of: (1) suitable substrate waterward of the OHWM, with (2) salinity between 0.0-0.5 ppt in surrounding waters, and (3) greater than 1.8m in depth. The reproduction and recruitment unit is identified in the Altamaha River from the river mouth (RKM 0) upstream to the Juliette Dam to provide for: (1) safe and unobstructed migratory pathways, with (2) suitable water quality, and (3) depths greater than 1.8m.

Satilla River: The spawning unit is identified in the Satilla River between RKM 100 upstream with the essential features of: (1) suitable substrate waterward of the OHWM, with (2) salinity between 0.0-0.5 ppt in surrounding waters, and (3) greater than 1.8m in depth. The reproduction and recruitment unit is identified in the Satilla River from the river mouth (RKM 0) upstream to

provide for: (1) safe and unobstructed migratory pathways, with (2) suitable water quality, and (3) depths greater than 1.8m.

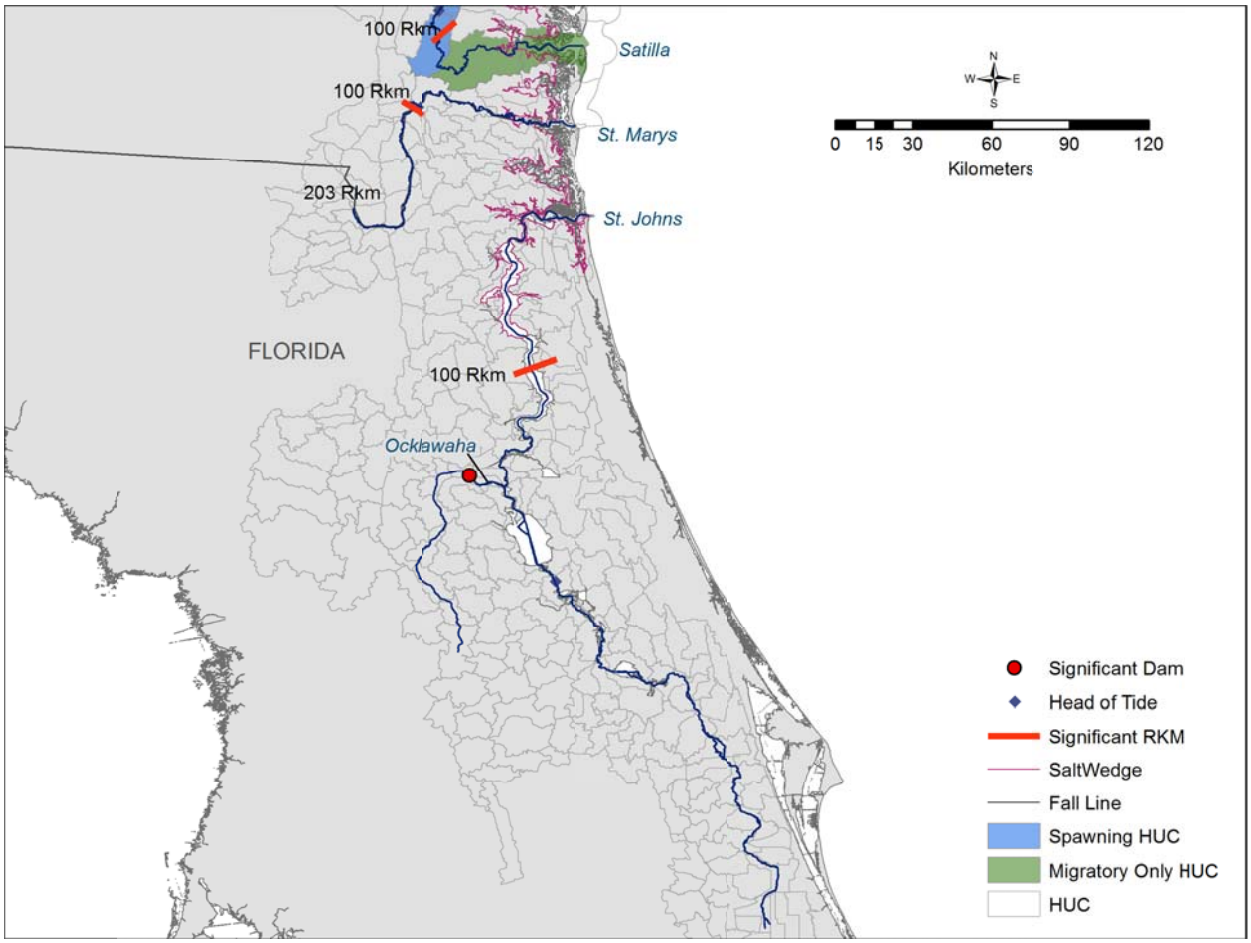


**Figure 8: Map showing essential habitats of Atlantic sturgeon in Florida: spawning habitat is in blue, reproduction and recruitment habitat in green.**

No Atlantic sturgeon critical habitat is proposed for the St. Marys and St. John Rivers in Florida because the Atlantic sturgeon spawning populations in both rivers are believed to be extirpated. Nevertheless, we believe the South Atlantic DPS can be recovered without the designation of critical habitat in these rivers.

# IV. Economic Analysis

## A. Introduction

Using the physical and biological features identified in the previous section along with the rivers determined to support Atlantic sturgeon spawning, we next utilize that scientific information to estimate probable economic impacts of proposing a critical habitat designation. This section documents compliance with parts of Section 4(b)(2) of the ESA regarding the impacts of proposing critical habitat for the Carolina and South Atlantic DPSs of Atlantic sturgeon.

Specifically, Section 4(b)(2) requires consideration of the economic impact, impacts on national security, and any other relevant impact, of specifying a particular area as critical habitat. Section 4(b)(2) also provides us with discretion to consider excluding particular areas from a designation, and areas may be excluded only if the benefits of excluding that area outweigh the benefits of including them in the designation, and if exclusion would not result in the extinction of the species. The following sections examine the economic impact of proposing Atlantic sturgeon critical habitat.

Impacts may result from a critical habitat designation primarily through Section 7 of the ESA (16 U.S.C. 1536). Section 7(a)(2) requires each federal agency to consult with NMFS (or the U.S. Fish and Wildlife Service (USFWS), as applicable) to ensure that any action they authorized, funded, or carried out is not likely to destroy or adversely modify the designated critical habitat of listed species. Federal agencies are required to enter into consultation whenever a proposed action "may affect" listed species or designated critical habitat. If a proposed federal action will likely destroy or adversely modify critical habitat, NMFS must recommend that the federal agency or the project permittee or grantee implement a reasonable and prudent alternative (RPA) to the proposed action that would avoid destruction or adverse modification of critical habitat. Thus, impacts that may result from Section 7 consultation include the administrative costs of performing the consultation, costs of modifications to the proposed action in order to implement an RPA, and secondary costs to local or regional economies that result from the project modification. In addition, because critical habitat is by definition "essential to the conservation" of the species, conservation benefits to the listed species would be expected to result when the consultation process avoids destruction or adverse modification of its critical habitat, or avoids lesser adverse effects to critical habitat that may not rise to the level of adverse modification. Adverse impacts to other components of the ecosystem may similarly be avoided through consultation and implementation of RPAs. Designation and protection of critical habitat could result in project modifications that avoid adverse impacts to critical habitat and other components of the ecosystem may result in continued provision of benefits to user groups and economic sectors that utilize these habitats or ecosystem components.

The numbers and types of potential project modifications resulting from predicted future consultations are described below. As described below, these are not significant enough to have potential large-scale economic impacts, so it is highly unlikely that secondary costs to regional economies will result from the final designation. As a result, potential secondary regional economic impacts of the designation will not be discussed further.

## B. Scope of the Analysis

Section 7 of the ESA requires federal action agencies to ensure that any action authorized, funded, or carried out will not likely jeopardize the continued existence of any endangered or threatened species or result in the destruction or adverse modification of critical habitat. In practice, this requires federal action agencies to consult with NMFS whenever an action may affect a listed species or its designated critical habitat. Because the requirement for Section 7 consultation only applies to activities that are carried out, permitted, or funded by federal agencies, the designation of critical habitat will not require additional costs with respect to

strictly private activities. The focus of this economic impact analysis is the portion of the costs of compliance with Section 7 that is incremental to the designation of critical habitat.

The first step in assessing the economic impacts of Section 7 requirements is to identify activities within or in the vicinity of the areas being proposed for critical habitat that may require ESA Section 7 consultation as a result of the designation. Joint NMFS-USFWS regulations at 50 CFR 424.19 direct us to conduct an "incremental analysis" by considering the probable economic impacts with and without the proposed critical habitat designation and to describe the impacts either qualitatively or quantitatively. Thus, the goal of our impacts analysis was to examine the state of the world with and without the designation of critical habitat for the Atlantic sturgeon. The "without critical habitat" scenario represents the baseline for the analysis, considering habitat protections already afforded to Atlantic sturgeon under its Federal listing and under other Federal, State, and local regulations.

## C. Sources of Economic Impacts

The following sections identify economic impacts that may result from the critical habitat designation. As discussed above, direct economic impacts are associated with the implementation of Section 7 of the ESA which requires consultation among federal agencies to ensure that their proposed actions are not likely to result in the destruction or adverse modification of designated critical habitat. These direct economic impacts are associated with the costs of these Section 7 consultations and the costs associated with any required project modifications that result from these consultations. Indirect economic impacts may result if the critical habitat designation triggers state or local regulations that restrict land or water use decisions, or if concerns about ongoing Section 7 consultation or the need for future consultations and potential project modifications have stigma effects on real estate markets or business investments.

### i. Direct Economic Impacts

Section 7(a)(2) of the ESA requires federal agencies (action agencies) to consult with NMFS or USFWS whenever activities that they undertake, authorize, permit, or fund may affect a listed species or designated critical habitat. For species managed by NMFS, in some cases consultations will involve NMFS and another federal agency only, such as USACE. Often, these consultations will also include third parties involved in projects on non-federal lands with a federal nexus, such as private landowners conducting activities that require a federal permit or public or private entities receiving federal funding. In addition, action agencies may engage in programmatic consultations to develop strategies to consider impacts to Atlantic sturgeon and its habitat at the program level, rather than at the individual project level. For example, USACE conducts programmatic consultations with NMFS to consider endangered and threatened species when reviewing water development or dredging projects.

During such a consultation, NMFS, the action agency, and, if applicable, the private entity applying for federal funding or permitting communicate with one another in an effort to minimize potential adverse effects to the species and/or to the proposed critical habitat. These communications may occur via written letters, phone calls, and in-person meetings. The

number, duration, and complexity of these interactions depend on many factors related to the species of concern, the activity under consideration, the potential effects on the species and/or its critical habitat, and the backgrounds of the parties involved.

In general, the economic impacts of a critical habitat designation depend on the need for and characteristics of four outcomes that are described below and include: (1) technical assistance provided by NMFS prior to a Section 7 consultation, (2) informal Section 7 consultation, (3) formal Section 7 consultation, and (4) project modifications that are required as a result of Section 7 consultation. Some economic impacts may also be associated with costs of initial project design decisions undertaken specifically to avoid the need for technical assistance or Section 7 consultation. The types of direct economic impacts described are associated primarily with public and private sector costs stemming from the four outcomes listed above.

Frequently, NMFS responds to requests for technical assistance from other federal agencies, state agencies, local municipalities, consultants, private landowners, and developers with questions regarding whether specific activities may affect a listed species or its critical habitat. Technical assistance costs represent the estimated economic costs of informal conversations between these entities and NMFS regarding such potential effects. Such conversations will occur primarily between federal action agencies and NMFS regarding lands designated as critical habitat or lands adjacent to critical habitat, though NMFS may also communicate with non-federal entities involved in potential projects. NMFS's technical assistance activities are voluntary. Costs to NMFS of providing technical assistance to private parties are expected to be small relative to other economic impacts to NMFS, action agencies, and third parties; therefore, this analysis does not quantify the instances and costs of technical assistance efforts.

Section 7 consultation with the NMFS or USFWS may be either informal or formal. *Informal consultation* consists of informal discussions among NMFS, the action agency, and the applicant concerning an action that may affect a listed species or its designated critical habitat, and are designed to identify and remove potential impacts at an early stage in the planning process. By contrast, a *formal consultation* is required if the action agency determines that the proposed action may affect a listed species or designated critical habitat in ways that cannot be resolved through informal consultation. Regardless of the type of consultation, Section 7 consultation can require substantial administrative effort on the part of all participants. The costs of these efforts are an important component of the impacts assessment.

There are three circumstances under which the designation of critical habitat can result in Section 7 consultation with NMFS beyond those required by the listing. First, new consultations may occur when activities involving a federal nexus are proposed in or near critical habitat not thought to be currently occupied by the species, including seasonal absence, or which have solely impacts to the critical habitat features and not the species. Second, more intensive consultations may occur when actions that would previously have been resolved during informal consultation based on potential impacts to the species alone must proceed to formal consultation in order to consider critical habitat impacts. Third, the re-initiation of a consultation may occur when new information or circumstances generated by the designation of critical habitat result in potential adverse impacts on the designated critical habitat that were not addressed during previous consultations related to the listing.

The Section 7 consultation process may result in modifications to a proposed project under three circumstances. First, modifications may be a result of voluntary conservation measures suggested by NMFS during the informal consultation process that avoid or minimize impact to a species and/or its habitat (harm avoidance), thereby removing the need for formal consultation. Second, formal consultation may result in project modifications that are agreed upon by the action agency and the applicant and are included in the project description as avoidance and minimization measures. Third, the modifications may be designated in the NMFS's biological opinion on the proposed action as reasonable and prudent measures (RPMs) and/or discretionary conservation recommendations to assist the action agency in meeting its obligations under Section 7(a)(1) of the Act. NMFS's consultation regulations specify that RPMs, along with the terms and conditions that implement them, cannot alter the basic design, location, scope, duration, and timing of the action, and may only involve minor changes (50 CFR §402.14(i)(2)).

In some cases, NMFS may determine that the project is likely to destroy or adversely modify its designated critical habitat. In these cases, NMFS will include reasonable and prudent alternatives (RPAs) to the proposed project that must avoid destruction or adverse modification of the critical habitat. By definition, RPAs must be: consistent with the intended purpose of the action, capable of being implemented in a way that is consistent with the action agency's legal authority and jurisdiction, and be economically and technologically feasible (50 CFR §402.02). The RPAs are typically developed by NMFS in cooperation with the action agency and, when applicable, the applicant. Alternatively, the action agency can develop its own RPAs, or seek an exemption for the project. All of these project modifications have the potential to involve direct cost to NMFS, the action agency and/or the applicant. In certain instances, these modifications can lead to broader secondary impacts involving third parties, related industries and markets, and regional economies.

### ii. Indirect Economic Impacts

The designation of critical habitat, under certain circumstances, may affect actions that do not have a federal nexus and are not subject to the provisions of Section 7 under ESA, in ways that result in indirect economic impacts. These economic impacts may include changes in real estate prices and project values resulting from stigma effects, project delays, and uncertainty resulting from the designation, as well as related indirect impacts on regional markets and economies.

In addition to the indirect effects of compliance with laws triggered by the designation, project proponents, land managers, and landowners may face additional indirect impacts. These can include impacts due to project delays associated with the need to reinitiate consultation or compliance with additional requirements triggered by the designation of critical habitat. In the case of land location within or adjacent to the designation, there may be a loss in property values due to regulatory uncertainty, or a loss or gain in property values resulting from public perceptions regarding the effects of critical habitat. These potential effects are described in greater detail below.

Both public and private entities may experience incremental time delays in implementing projects and undertaking other activities due to requirements associated with the need to

reinitiate the Section 7 consultation process and compliance with other laws triggered by the designation. To the extent that delays result from the designation, they need to be considered in the impact analysis. Specifically, an economic analysis should assign to the critical habitat designation the costs associated with any incremental time delays associated with Section 7 consultation or other requirements that are triggered by the designation and are above and beyond project delays resulting from baseline regulatory processes. The incremental impacts of the designation should not include impacts associated with time delays resulting from the listing, or the application of other federal, state, or local laws or regulations not triggered by the critical habitat designation, which should be assigned to the baseline.

NMFS conducts each Section 7 consultation on a case-by-case basis and issues a biological opinion on formal consultations based on species-specific and site-specific information. As a result, government agencies and affiliated private parties who need to consult with NMFS under Section 7 may face uncertainty concerning whether project modifications will be recommended by NMFS and what the nature and costs of these modifications will be. This uncertainty may diminish as consultations are completed and additional information becomes available on the effects of specific activities on critical habitat and potential avoidance measures. However, a degree of regulatory uncertainty may persist which may result in a project proponent incurring higher costs to fund and implement a proposed activity. Where information is available, the economic analysis should consider the potential impacts associated with regulatory uncertainty resulting from the critical habitat designation.

In some cases, the public may perceive that the critical habitat designation may result in limitations on private property uses above and beyond those associated with anticipated project modifications and regulatory uncertainty described above. Public attitudes about the limits or restrictions that critical habitat may impose can cause real economic effects to property owners, regardless of whether such limits are actually imposed. Perceived or anticipated limitations or restrictions on uses of property designated as critical habitat may result in it having a lower market value than an identical property that is not within the boundaries of critical habitat. As the public becomes aware of the true regulatory burden imposed by critical habitat, the impact of the designation on property markets may change. However, even short-term stigma impacts may result in land cost impacts that will not be recovered. Where data exist that suggests stigma impacts on private property values are real or likely, the economic analysis should consider their implications within or near the areas of the proposed designation. Where a critical habitat designation is not likely to result in stigma impacts, the impact analysis should not speculate about their potential.

Some state laws may require landowners and managers to consider the effects of their actions on sensitive species and habitat. New information about the importance of critical habitat to the recovery of a threatened or endangered species that results from the designation could trigger more stringent state and local regulatory requirements and related compliance costs. Critical habitat designations may also provide new information to nearby communities about the sensitive ecological nature of the geographic region, potentially triggering changes in other state or local laws that could have additional economic impacts. In cases where these state and local regulatory changes would not have been triggered “but for” the critical habitat designation, they are “incremental” impacts of the designation. Such state and local regulatory changes could

have negative impacts associated with stigma effects and project delays similar to those associated directly with the critical habitat designation. However, they may also have positive impacts. For example, increased public awareness of species and habitat conditions, related changes in state and local regulations, and voluntary changes in land and water use that result from the designation can generate significant environmental and economic benefits associated not only with Atlantic sturgeon, but with other fish, bird, and terrestrial species that directly or indirectly benefit from protecting essential sturgeon habitat features.

The consultation process and related project modifications could directly affect the operations of federal agencies and private entities (e.g., dredging by the USACE, maintenance of oil and gas pipelines by private entities) and thereby disrupt regional economic activity enough to have secondary economic impacts associated with business sales, jobs, household incomes, and taxes. For example, changes in dredging activities by the USACE could affect both suppliers of dredging equipment, dredging contractors and their employees, and commercial traffic utilizing dredged waterways, related ports, and port facilities. As a result, project modifications or other restrictions or delays that impose direct cost and revenue impacts on some intermediate commercial enterprises can have subsequent detrimental effects on the industries they support. Some directly and indirectly impacted industries or activities, such as shipping or fishing, may be central to the local economy but will also be linked by their purchases and sales with industries located elsewhere in the region. As a result, any significant local economic impacts in or near a critical habitat area can be expected to generate multiplier impacts throughout the regions where they are located.

## D. Activities That May Trigger Section 7 Consultation

A query of NMFS' Public Consultation Tracking System (PCTS) was conducted to identify past activities that required ESA Section 7 consultations that, if proposed in the future, would trigger consultation because they "may affect" either both Atlantic sturgeon and its critical habitat, or solely the critical habitat. This technique has been used consistently in evaluating the Section 7 impacts of critical habitat designations to produce a reasonable estimation of future federal actions that may require consultation. PCTS includes 15 general categories and 100 more specific sub-categories of land-based and water-based activities that could affect sturgeon habitat, and constitutes the universe of activities that could trigger Section 7 consultation as a result of this critical habitat designation. Because we are considering critical habitat units that extend upriver from the river mouth (RKM 0) and do not include coastal or ocean areas, a number of the activities in the PCTS will not be affected by this designation (e.g., ocean disposal) or are likely to occur only rarely (e.g., mining). Therefore, NMFS identified the 13 activities and 82 sub-activities that are likely to have potential to adversely affect 1 or more of the 6 essential features of critical habitat for Atlantic sturgeon.

This list of potentially affected activities was further refined by limiting the PCTS search of relevant consultations to approximately the last 10 years of PCTS records (January 2003 through June 2013) in each river being considered (Figures 5-7). Similar to previous designations, predictions of impacts were limited to a 10-year time horizon due to the difficulty in estimating activities and costs beyond that timeframe. There may be a growth or decline in a particular type of action, so the past PCTS activity may overestimate or underestimate the number of future

actions undergoing consultation and the aggregate impacts. This review of PCTS records in each river system over the past 10 years, as well as interviews and correspondence with federal action agencies regarding current, pending, and proposed projects, provided the basis for identifying 34 activities as being most likely to trigger Section 7 consultation over the next 10 years as a result of this critical habitat designation. These 34 activities are listed in Table 4.

**Table 4. Categories and activities likely to trigger Section 7 consultation for Atlantic sturgeon critical habitat.**

| Category | Activity |
|---|---|
| Agriculture | Irrigation |
| Fishery | Fishery Management Action |
| Military | Navy training exercises |
| | Pier repairs |
| Mining | Deadhead logging |
| | Phosphate mining |
| Research | Fish monitoring |
| | Fishery |
| | Listed species |
| Restoration | Estuary |
| | Marshes |
| | Riverine |
| | Waterway |
| Transportation | Bridge |
| | Port/ terminal/harbor/ marina |
| | Road/ highway |
| | Ship/ vessel/ aircraft operation |
| Utility | Hydropower |
| | Oil and gas |
| | Pipeline |
| | Power plant |
| | Transmission line |
| | Water supply, municipal |
| Water Quality | Aquatic Criteria |
| | NPDES |
| | Stormwater drainage |
| Waterway | Boat/ dock/pier |
| | Channel reconstruction |
| | Dam |
| | Dredging |
| | Fill |
| | Flood control |
| | Shoreline stabilization |

## E. Projections of Future Section 7 Consultations

Projecting future Section 7 impacts in the case of the Carolina and the South Atlantic DPSs of Atlantic sturgeon critical habitat is unusually complex because of the relatively large number of critical habitat units being considered, their sizes, and the many water-based and land-based activities that could have relevant impacts on essential habitat features. There is also a great deal of uncertainty about the scope and location of projected future federal actions that could trigger Section 7 consultation. In some cases, for example, site-specific pre-consultation surveys may be necessary to determine where essential features exist within a proposed project area before action agencies can determine whether any consultation is required.

The effect of all this uncertainty on economic impact projections based on numbers of Section 7 consultations, however, is mitigated to a significant extent by the fact that many of the types of activities that have been identified as potentially requiring consultations as a result of their effects on Atlantic sturgeon critical habitat are likely to require consultation, even in the absence of the critical habitat designation, due to effects on the species itself or due to other local and state regulations. Therefore, although there is significant uncertainty about the number of proposed future activities that could impact Atlantic sturgeon habitat, it is likely that the number of activities that will require consultation solely due to the designation of Atlantic sturgeon critical habitat will be relatively small. Regulatory baseline conditions and the prior listing of the species, in other words, significantly reduce the importance of errors in predicted numbers of future Section 7 consultations because the numbers of likely consultations will be relatively small.

## F. Potential Project Modifications

This section provides a description of the modifications to various types of projects that NMFS may recommend, through Section 7 consultation, to avoid destruction or adverse modification of Atlantic sturgeon critical habitat. All of the project modifications identified for projects within a category may not be necessary for an individual project within that category. For example, if a shoreline stabilization project were altered to include alternative stabilization methods, relocating the project would not be necessary; however, monitoring conditions to ensure the project does not have adverse effects on essential features may be necessary. Conversely, it is possible that multiple modifications could be necessary for an individual project if it has potential to adversely affect more than one essential feature in ways that cannot be avoided by implementing just one project modification.

In general, project modifications and related costs are associated with legally mandated actions that take place as a result of Section 7 consultation. However, some project proponents or permit seekers may design projects in order to avoid the need for a formal consultation or to minimize any required project modifications that may result from Section 7 consultation. Project design decisions made with Section 7 consultation in mind may result in incremental project costs and/or benefits. However, it is not possible to determine if or how the critical habitat designation will affect future project design decisions or related costs and benefits, so these potential impacts are not addressed here.

### i. In-water Construction Project Modifications

Construction, repair, and modification of boat docks, piers, and breakwaters may be required because of increases in turbidity, suspension of toxins in the sediment, removal or disturbance of suitable spawning substrate, and potential obstruction of fish passage. A variety of project modifications may be implemented, depending on the type of project. For boat docks, typical project modifications include use of silt fences, upland disposal of excavated material, and maintenance of all heavy equipment to minimize pollutant release. Typical project modifications for boat launches include implementation of erosion and pollution control measures, measures to minimize impacts on riparian and instream habitat, and restoration or mitigation of temporary or permanent impacts to riparian and instream habitat. Bulkhead construction projects may be modified through restrictions on the use of heavy equipment, pollution and erosion control, minimization of disturbance and contamination to riverine habitat, site restoration, and post-construction monitoring. Projects involving bank stabilization may be required to implement erosion control, restore disturbed areas to pre-work conditions, and place excavated materials in upland disposal areas.

### ii. Dredging Project Modifications

Dredging projects vary greatly in size and scope, but have the potential to disturb or remove suitable substrates and impact water quality through increased turbidity and suspension of toxins in the sediment. Typical project modifications associated with dredging projects include limitations on dredged material excavation and disposal.

### iii. Road, Bridge, and Culvert Project Modifications

Projects involving construction and repair of roads, bridges, and culverts have varying levels of in-water activity. Typical modifications to these types of projects include isolation of the in-water work area (e.g., coffer dams), implementation of effective erosion and pollution control measures, implementation of stormwater management measures, post-construction restoration of the project site, and on-going monitoring of post-construction conditions.

### iv. Hydropower Project Modifications

FERC initiates or reinitiates ESA Section 7 consultation when hydropower facilities apply for a license or to be relicensed if an existing license is expiring. The FPA stipulates that during the licensing process, FERC must solicit input from relevant federal and state agencies regarding measures that be taken to protect fish and wildlife species (see King and Associates Report pg. 56, Table 2-24 for more information on the FPA). There are generally three categories of project modifications with respect to hydropower projects: operational, capital, and programmatic. Operational project modifications have to do with changes in hydropower production or flow regime, and costs associated with this type of modification stem from foregone power revenues. Capital project modifications deal with investments in new or improved infrastructure, additional investment in operations and maintenance, or dam removal. Programmatic project modifications involve all other types of modifications, including monitoring, mitigation, research, etc.

### v. Utility Line Project Modifications

In this context, utility lines refer to both pipelines and outfall structures at wastewater treatment plants or power plants. Installation and repair of utility lines could impact Atlantic sturgeon habitat through excavation, placement of excavated material, and filling of trenches post-construction. For pipeline projects, typical project modifications include the use of directional drilling (as opposed to open-cut construction), maintenance of pre-construction contours, the stockpiling of soil from excavation for eventual replacement in the trench, minimization of roads associated with construction, restoration of banklines to original slope and vegetation, and implementation of erosion control measures. For outfall structures, typical project modifications include limiting construction access to barges via the waterway, effluent restrictions, and complete site restoration.

### vi. Sand and Gravel Mining Project Modifications

Sand and gravel is mined for use in construction aggregate. Potential impacts from sand and gravel mining projects to Atlantic sturgeon critical habitat are highly dependent on the location and size of the project, as well as the mining technique that would be employed. Different gravel removal methods have different potential impacts on essential features, including the removal of suitable substrate, increased turbidity, increased suspended sediment and siltation, and destabilization of banks. Project modifications to sand and gravel mining would depend on the location of the material to be mined (i.e., whether essential features are present), the type of mining planned, and what types of mitigation measures are already in place. The typical project modification required for this type of activity would be a reduction in the amount of material permitted for removal.

### vii. National Pollutant Discharge Elimination System (NPDES) Project Modifications

Project modifications for NPDES described here refer solely to temperature criteria for effluent discharge. NPDES-permitted facilities are already subject to temperature guidelines, but for Atlantic sturgeon, the existing criteria may not be strict enough for certain life stages. Some modifications require capital expenditures, while others only require changes in operations and maintenance. Modifications that may be employed to control the temperature of effluent include process optimization (i.e., identifying procedures that could be changed to reduce temperatures in wastewater), reducing the volume of discharge by reusing effluent, storage of heated wastewater, the use of off-stream cooling ponds, and the installation of treatment technologies to reduce temperature.

## G. Estimated Section 7 costs

The costs associated with the critical habitat designation have two main components: administrative Section 7 consultation costs and project modification costs that are required as a result of those consultations.

### i. Administrative Section 7 Costs

Estimated unit costs of technical assistance, informal, and formal Section 7consultations related to this critical habitat designation are presented in Table 5. These are updated versions of consultation costs estimated as part of previous economic impact studies prepared for NMFS and USFWS to support earlier critical habitat designations for Gulf sturgeon (2003), American green sturgeon (2008), Atlantic salmon (2009), and North Atlantic loggerhead turtle (2013). As described in those studies, these unit cost estimates were "based on an average level of effort for consultations of low or high complexity (based on NMFS and other federal agency information), multiplied by the appropriate labor rates for NMFS and other federal agency staff and similar labor rates applied to time committed by third party private sector participants." Costs to conduct surveys of the project area to determine the presence and extent of essential features are included in these estimates. For purposes of this analysis, all costs were updated to 2013 dollars using consumer price indices (CPI).

**Table 5. Projected unit costs of Section 7 consultation for Atlantic sturgeon critical habitat (2013 dollars)**

| Consultation Type | NMFS | Federal Action Agency | Third Party | Biological Assessment | Total Costs |
|---|---|---|---|---|---|
| **New consultation resulting entirely from critical habitat designation (Total cost of a consultation considering both Jeopardy and Adverse Modification)** | | | | | |
| Technical Assistance | $570 | n/a | $1,100 | n/a | $1,600 |
| Informal | $2,500 | $3,100 | $2,100 | $2,000 | $9,600 |
| Formal | $5,500 | $6,200 | $3,500 | $4,800 | $20,000 |
| Programmatic | $17,000 | $14,000 | n/ | $5,600 | $36,000 |
| **New consultation considering only Adverse Modification (Unoccupied habitat)** | | | | | |
| Technical Assistance | $430 | n/a | $790 | n/a | $1,200 |
| Informal | $1,900 | $2,300 | $1,500 | $1,500 | $7,200 |
| Formal | $4,100 | $4,700 | $2,600 | $3,600 | $15,000 |
| Programmatic | $12,000 | $10,000 | n/a | $4,200 | $27,000 |
| **Re-initiation of consultation to address Adverse Modification** | | | | | |
| Technical Assistance | $280 | n/a | $530 | n/a | $810 |
| Informal | $1,200 | $1,600 | $1,000 | $1,000 | $4,800 |
| Formal | $2,800 | $3,100 | $1,800 | $2,400 | $10,000 |
| Programmatic | $8,300 | $6,900 | n/a | $2,800 | $18,000 |
| **Additional effort to address Adverse Modification in a new consultation (Additive with baseline costs, shown above, of considering Jeopardy)** | | | | | |
| Technical Assistance | $140 | n/a | $260 | n/a | $400 |
| Informal | $620 | $780 | $510 | $500 | $2,400 |
| Formal | $1,400 | $1,600 | $880 | $1,200 | $5,000 |
| Programmatic | $4,200 | $3,500 | n/a | $1,400 | $9,000 |

**Source: IEc (2013)** Original cost estimates by IEc were based on data from the Federal Government Schedule Rates, Office of Personnel Management, 2013, and a review of consultation records from several USFWS field offices across the country conducted in 2002.

**Explanatory Note from IEc, (2013)** The levels of effort per consultation represent approximate averages based on the best available cost information. The cost estimates in this report are accordingly rounded to two significant digits to reflect this imprecision. The cost estimates presented in this table may therefore not sum to the total costs reported due to rounding. Estimates reflect average hourly time required by staff.

Table 6 provides estimates of overall administrative Section 7 costs in each critical habitat unit. These are based on the projected number of Section 7 consultations presented in Table 6 and the estimates of administrative costs per consultation presented in Table 5. Because of the significant amount of uncertainty, low, medium, and high administrative Section 7 costs are presented based on the following assumptions:

***Low administrative Section 7 cost estimates*** are based on the assumption that the numbers of informal and formal consultations in the future will be the same as they were in the past

(approximately 81% informal across the study area), and that half of the consultations will be co-extensive (i.e., initiated as a result of listing and critical habitat designation) and half will be incremental (i.e., initiated as a result of the critical habitat designation).

***Medium administrative Section 7 cost estimates*** are based on the assumption that the numbers of informal and formal consultations in the future will be the same as they were in the past, and that they will all be incremental.

***High administrative Section 7 cost estimates*** are based on the assumption that all consultations in the next ten years will be formal and incremental.

**Table 6. Projected 10 year and average annual Section 7 consultations and related administrative costs per river for designating Atlantic sturgeon critical habitat (2013 dollars).**

| DPS | Unit | Numbers of Section 7 Consultations[1] | Section 7 Consultation Costs[2] | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Over Ten Years | Annual Average | Total Costs over 10 Years | Annualized 10-year Costs | | | | | | | | |
| | | Informal | Formal | Total | Informal | Formal | Total | Low[3] | Medium[4] | High[5] | Low | Medium | High |
| **Carolina** | Roanoke | 2 | 1 | 3 | 0.2 | 0.1 | 0.3 | $23,600 | $47,200 | $74,400 | $2,360 | $4,720 | $7,440 |
| | Tar-Pamlico | 5 | 9 | 14 | 0.5 | 0.9 | 1.4 | $139,600 | $279,200 | $347,200 | $13,960 | $27,920 | $34,720 |
| | Cape Fear | 17 | 2 | 19 | 1.7 | 0.2 | 1.9 | $120,000 | $240,000 | $471,200 | $12,000 | $24,000 | $47,120 |
| | Waccamaw | 10 | 1 | 11 | 1 | 0.1 | 1.1 | $68,400 | $136,800 | $272,800 | $6,840 | $13,680 | $27,280 |
| | Pee Dee | 18 | 2 | 20 | 1.8 | 0.2 | 2 | $125,600 | $251,200 | $496,000 | $12,560 | $25,120 | $49,600 |
| | Santee-Cooper | 27 | 10 | 37 | 2.7 | 1 | 3.7 | $275,200 | $550,400 | $917,600 | $27,520 | $55,040 | $91,760 |
| | **DPS Total** | **79** | **25** | **104** | **7.9** | **2.5** | **10.4** | **$752,400** | **$1,504,800** | **$2,579,200** | **$75,240** | **$150,480** | **$257,920** |
| **South Atlantic** | Edisto | 3 | 1 | 4 | 0.3 | 0.1 | 0.4 | $29,200 | $58,400 | $99,200 | $2,920 | $5,840 | $9,920 |
| | Combahee | 2 | 1 | 3 | 0.2 | 0.1 | 0.3 | $23,600 | $47,200 | $74,400 | $2,360 | $4,720 | $7,440 |
| | Savannah | 53 | 11 | 64 | 5.3 | 1.1 | 6.4 | $433,200 | $866,400 | $1,587,200 | $43,320 | $86,640 | $158,720 |
| | Ogeechee | 15 | 3 | 18 | 1.5 | 0.3 | 1.8 | $121,200 | $242,400 | $446,400 | $12,120 | $24,240 | $44,640 |
| | Altamaha | 31 | 5 | 36 | 3.1 | 0.5 | 3.6 | $235,600 | $471,200 | $892,800 | $23,560 | $47,120 | $89,280 |
| | Satilla | 8 | 3 | 11 | 0.8 | 0.3 | 1.1 | $82,000 | $164,000 | $272,800 | $8,200 | $16,400 | $27,280 |
| | **DPS Total** | **112** | **24** | **136** | **11.2** | **2.4** | **13.6** | **$924,800** | **$1,849,600** | **$3,372,800** | **$92,480** | **$184,960** | **$337,280** |

[1] Projected number of Section 7 consultations resulting from the critical habitat designation over the 10-year forecasting period; based on past ten year Section 7 consultation records in each critical habitat area and correspondence and consultations with federal action agencies.
[2] Based on Table 6 average costs are projected to be $1,600 for technical assistance, $9,600 for informal consultations and $20,000 for formal consultations. Costs for an informal consultation are assumed to include one technical assistance in addition to informal consultation costs (i.e., $1,600 plus $9.600), and costs for formal consultation are assumed to include 3 technical assistance costs in addition to formal consultation costs (e.g., $4,800 plus $20,000).
[3] Low costs projections are based on the assumption that the same ratio of informal and formal consultations will occur in the next ten years as occurred in the past ten years, and that 50% of the consultations will be incremental to the designation.
[4] Medium cost projections are based on the assumption that the same ratio of informal and formal consultations will occur in the next ten years as occurred in the past ten years, and that 100% of the consultations will be incremental to the designation.
[4] High cost projections are based on the assumption that all future consultations will be formal (cost of $20,000 per consultation) and incremental (i.e., entire cost is due to this critical habitat designation).

Ten-year total administrative consultation cost estimates presented in Table 6 assume the average annual number of consultations will be constant throughout the 10-year period and that consultation costs will be constant throughout the period. Discounting future costs using the Office of Management and Budget (OMB) recommended nominal discount rate of 2% would reduce average annual and 10-year costs presented in Table 6 by about 10%. Assuming cost inflation, and discounting future costs at the OMB recommended real discount rate of -2% would increase these cost estimates by about 11%.

### ii. Project Modification Costs

Table 7 presents low, medium and high cost estimates of project modifications that may need to be made to specific projects in various project categories described in Section D as a result of Section 7 consultation. These are updated versions of project modification costs estimated for use in a previous impact study prepared by NMFS to support the critical habitat designation for "Seven West Coast Salmon and Steelhead ESUs" (NOAA 2005). For purposes of this analysis, the ranges of cost estimates provided in that report were updated to 2013 dollars using CPI indices.

The values presented in Table 7 are intended to be illustrative of the typical costs of these potential project modifications. The project modifications listed in Table 7 do not represent the universe of potential project modifications and the unit cost listed does not represent the full potential range of costs, which could vary widely based on project and site conditions.

**Table 7. Estimates of potential project modification costs projected by activity (CPI used to adjust all cost estimates from 2005 to 2013 dollars)**

| Activity Type | Project Modification Cost Estimate | | |
|---|---|---|---|
| | **Low** | **Medium** | **High** |
| In-water construction | $29,835 | $65,040 | $100,245 |
| Dredging[1] | $396,205 | $979,773 | $1,551,407 |
| Bridges and culverts[1] | $48,929 | $87,117 | $125,306 |
| Roads[1] | $42,962 | $79,360 | $115,759 |
| Hydropower (unknown capacity) | $1,670,746 | $8,986,224 | $16,230,099 |
| Utility lines | $119,339 | $120,532 | $121,726 |
| Sand and gravel mining[2] | $1,208,307 | $1,611,076 | $2,013,845 |
| NPDES - Major projects | $568,053 | $751,835 | $935,617 |
| NPDES - Minor projects[2] | $64,443 | $85,924 | $107,405 |

[1] NOAA (2005) provided only low and high estimates of project modification costs for this activity; the medium cost estimate presented here is the average of the two.
[2] NOAA (2005) provided only one cost estimate for this activity which is presented here as the medium estimate; low and high cost estimates presented here are 25% lower and 25% higher than the medium cost estimate.
**Source: NOAA 2005**