Sturgeons Guild

Atlantic Sturgeon *Acipenser oxyrinchus*
Shortnose Sturgeon *Acipenser brevirostrum*

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DESCRIPTION

Taxonomy and Basic Description

The Atlantic sturgeon, *Acipenser oxyrinchus* (Mitchell 1815) belongs to the sturgeon family, Acipenseridae. Atlantic sturgeon are among the longest-lived fish, with a life span approaching 50 years or greater in the northern part of their range. Sexual maturity is not obtained until age 8 to 20, with males maturing younger than females (ASMFC 1990 and 1998). The Atlantic Sturgeon is also the largest fish inhabiting freshwaters on the Atlantic Coast, with females in South Carolina reaching about 2.5 m (8 ft.) total length (TL). Sexually mature female Atlantic Sturgeon, often called ‘cows,’ may weigh several hundred kilograms or pounds. Mature male Atlantic Sturgeons, or ‘bucks,’ are generally smaller than females, rarely exceeding 1.8 m (6 ft.) TL and 45 kg (100 lbs.).

Atlantic Sturgeons, like other sturgeons, are shaped like sharks and have a deeply forked tail in which the upper lobe is longer than the lower. A single, small dorsal fin is located far back toward the tail, and a single anal fin is directly beneath on the underside. Paired pectoral and pelvic fins originate immediately rear of the bony operculum and vent, respectively. The head extends forward into a snout that is pointed in juveniles and blunt and rounded in adults. The protrusible mouth is underneath and at the rear of the snout, and it is preceded by a row of four barbels similar to those on catfishes. The mouth, the width of which is about one-half the distance between the eyes, does not bear teeth, but bony plates in the throat are used to crush food items if necessary (Gilbert 1989; Vladykov and Greeley 1963). The skeleton is partly cartilaginous, with the skull and leading edges of the pectoral fins among the boniest structures. Structural support and protection are provided by thick, tough skin with three rows of bony plates or scutes and much smaller scale-like ‘scutelets.’ The skin is generally rough, and gritty, not unlike that of a shark. Coloration is dark bronze to brownish above, lighter on the sides, and white below (Gilbert 1989).

The Shortnose Sturgeon, *Acipenser brevirostrum* (Lesueur 1818) is also classified in the Acipenseridae family. Adults are much smaller than adult Atlantic Sturgeon, with ‘cows’ reaching 1.2 m (47 in.) TL and reaching a maximum weight of perhaps 18 kg (40 lbs.).

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Mature ‘bucks’ are generally smaller than females, rarely exceeding 0.8 m (32 in.) TL and 7 kg (15 lbs.). The Shortnose Sturgeon is similar in shape and physical characteristics to the Atlantic Sturgeon. The snout is pointed only in young juveniles and is broad, blunt and rounded in adults. The mouth is nearly as wide (70%) as is the distance between the eyes, and wider than for Atlantic Sturgeon of similar size (Gilbert 1989). The body is also protected by three rows of scutes, but compared to those of Atlantic Sturgeon, the bony plates collectively cover less surface area and ‘scutelets’ are small and sparse. The skin, though thick and tough, is less rigid than that of Atlantic Sturgeon and is much smoother and often slimy or mucous-covered (J.W. McCord, SCDNR, pers. obs.). Coloration is generally brownish above with pinkish or salmon tones, lighter on the sides, and white below. Because of this coloration, commercial fishers often refer to this species as ‘salmon sturgeon.’ Shortnose Sturgeon are also long-lived fish, reaching age 55 in the northern part of their range (Dadswell 1979), but this species reaches sexual maturity at an earlier age than Atlantic Sturgeon. In the South, males may mature as soon as age 2 and females at age 6 (Dadswell et al. 1984).

As indicated by the orientation of the mouth, both species of sturgeon are benthic feeders that primarily prey on invertebrates. Aquatic insects such as mayfly and midge larvae and small crustaceans predominate the juvenile Shortnose Sturgeon diets (Dadswell et al. 1984; Carlson and Simpson 1987), whereas mayfly larvae, amphipods and earthworms are most frequently consumed by juvenile Atlantic Sturgeon. Adults of both species consume mollusks, snails and amphipods (Van Den Avyle 1984; Dadswell et al. 1984; Haley 1998). Amphipods are particularly abundant in the lower Edisto River near the fresh-brackish interface (J.W. McCord, SCDNR, pers. obs.); preliminary evidence indicates amphipods and polychaetes as prevalent dietary items for sturgeons in similar habitat in the Savannah River (B. Post, SCDNR, pers. comm., 2005).

Status

Both the Atlantic and Shortnose Sturgeons are identified with rankings of G3 and S3 (NatureServe 2013), meaning that populations for both species are “vulnerable,” both globally and in South Carolina. In general, populations of both species of sturgeon along the entire Atlantic Coast have declined from historical levels in the past half-century (ASMFC 1990; ASMFC 1998; NMFS 1998). The Atlantic Sturgeon was considered for listing under the Endangered Species Act (ESA) in 1998, but the National Marine Fisheries Service (NMFS) determined that listing was unwarranted. On October 6, 2009, NMFS received a petition from the Natural Resources Defense Council to list Atlantic Sturgeon throughout its range as Endangered under the ESA. In January 2010, NMFS announced the petition had merit and it would formally consider whether to list the species under the Act. In October 2010, NMFS proposed listing the species and sought public comment. NMFS received comments from 119 individuals or agencies, which were submitted in writing or during the six public meetings. On February 6, 2011, NMFS listed the Chesapeake Bay, New York Bight, Carolina, and South Atlantic populations of Atlantic Sturgeon as Endangered, while the Gulf of Maine population was listed as Threatened. The listings took effect on April 6, 2012 but will not have an impact on fishing since it has been illegal to fish for, catch, or keep Atlantic Sturgeon, *Acipenser oxyrinchus oxyrinchus*, for more than a decade.

However, the Gulf Sturgeon (*Acipenser oxyrinchus desotoi*), a subspecies of the Atlantic Sturgeon restricted to rivers and adjacent waters of the Gulf of Mexico, remains on the candidate list and is currently listed as Threatened under the ESA. The Shortnose Sturgeon has been listed as Endangered under the ESA since 1967.

POPULATION SIZE AND DISTRIBUTION

Atlantic Sturgeon historically ranged along the Atlantic coast from Labrador, Canada to the St. Lucie River, Florida (ASMFC 1990). The historical range of the Shortnose Sturgeon was very similar—from the St. John River, Canada to the St. Johns River, Florida (Vladykov and Greeley 1963). Currently, both species are thought to be either very rare or extirpated from the extreme southern portion of their ranges.

In South Carolina, Atlantic Sturgeon and Shortnose Sturgeon both occur as relatively distinct populations by river system, as typical for anadromous fishes (Quattro et al. 2002; Wirgin et al. 2000). There are a minimum of 5 populations (presumably for both species) in South Carolina: the Waccamaw-Pee Dee, Santee, Cooper, ACE Basin (Ashepoo, Combahee and Edisto Rivers), and Savannah River drainage Basins. In addition, historical records indicate that Atlantic Sturgeon occurred in the Coosawhatchie River (Smith et al. 1984), but the current status is unknown. Since historical data relative to individual stock status are absent and current information is incomplete, the status of all stocks is poorly understood.

In general, Shortnose Sturgeon stocks are more genetically isolated and dissimilar than are Atlantic Sturgeon stocks, presumably because Shortnose Sturgeon are freshwater amphidromous, (Kynard 1997; NMFS 1998) while Atlantic Sturgeon are truly anadromous and intermingle (Quattro et al. 2002).

Historical data that relate directly to population size for South Carolina stocks are nonexistent, but historical distribution records and anecdotal information on abundance strongly indicate that all populations of sturgeons in South Carolina are reduced from early 20th century levelsand previous levels (USFWS 2001). The current status and trends in stock status over the past 25 years for both sturgeons in South Carolina are based primarily on anecdotal information and short-term datasets. Collectively, stock status of Atlantic Sturgeon throughout the State was considered in decline based on trends of commercial landings in the early 1980s (Smith et al. 1984).

Waccamaw-Pee Dee Basin: This large basin may currently provide Sturgeon access to the vast majority of their historical range of spawning and early nursery habitat, which was identified by Mills (1826); low falls near the fall-line may have prevented further inland access except under high flows. Presumably, spawning of both Atlantic and Shortnose Sturgeon presently occurs over more than 200 km (100 mi.) of river mainstem in suitable channel habitats. Available data indicate the presence of spawning stocks of both sturgeons in the basin, but the extent of basin-wide distribution and habitat utilization is largely unknown. Furthermore, relationships of individual tributary-specific sub-populations, should such exist, are unknown. Presumably fishery impacts are below levels present through 1984, and current conditions should allow populations of both species to recuperate.

Santee Basin: The Santee Basin has the second largest drainage area and total discharge of all river systems on the East Coast of the United States (Hughes 1994). This large watershed has been impacted by damming to a greater extent than most basins on the Atlantic coast of North America, with 88 percent of the river's annual flow diverted into the Cooper River from 1942 through 1985 (Kjerfve and Greer 1978). With the construction of the Santee-Cooper lakes (Moultrie and Marion) in the 1940's, the vast majority of the Santee was closed to migratory fishes. The navigational lock at Pinopolis Dam has been shown to be ineffective at passing Shortnose Sturgeon (Cooke et al. 2002; Timko et al. 2003). However, in the spring of 2011, two Shortnose Sturgeon were observed, using telemetry, passing upstream through the navigation lock into Lake Moultrie. Fish passed at St. Stephen Dam are recorded on videotape, and only 6 sturgeons have been passed at the St. Stephen Dam since 1985 (B. Post, SCDNR, pers. comm., 2011). During the approximately 40 years since the impoundment of the Santee River, average flows in the Santee River seaward of Wilson Dam have been greatly reduced from historical levels (Kjerfve and Greer 1978). Stocks of both sturgeons may have been severely impacted over the 4 decades of generally low flows. Surveys have recorded both adult Shortnose Sturgeon and juvenile Atlantic Sturgeon in rather low numbers through 2001 (Collins and Smith 1996; Cooke and Leach 2004a).

A dam-locked population of Shortnose Sturgeon is present, during low flow conditions, in the Santee-Cooper Lakes, with spawning occurring at least into the Congaree River below Columbia, SC (Collins et al. 2003). Fish passage observations indicate that this population may receive little genetic influx from either river, although it is unknown to what extent sturgeon are able to use the Pinopolis Lock. Sustainability of the population within the lakes is unknown, but dam-locked Shortnose Sturgeon populations tend to be in poorer condition than open river populations (Collins et al. 2003). The relationship of animals from this population to those in the Cooper and Santee Rivers is not yet clear, though a preliminary study shows animals within the lakes and in the Cooper River to be genetically similar (Collins et al. 2003). Recent telemetry studies involving both species of sturgeon should also be able to provide more information from a system perspective (B. Post per comm. 2011).

The Cooper River: Several hundred adults are believed to inhabit the Cooper River, and fertilized eggs have been collected below Pinopolis Dam (Cooke and Leach 2002). However, neither larvae nor juveniles have been collected and successful reproduction has not been confirmed (Cooke and Leach 2004b). The status and viability of sturgeon populations in the Cooper River remains poorly understood, particularly for Atlantic Sturgeon.

The ACE Basin: The rivers that make up the pristine ACE Basin remain unimpounded. Atlantic Sturgeon likely spawn in both the Edisto and Combahee Rivers (Collins et al. 2000). No records exist for adult Atlantic Sturgeon in Ashepoo River. Prior to 1994, there were very few authenticated records of Shortnose Sturgeon in the ACE Basin and only one record in the lower Ashepoo River (Collins and Smith 1996; McCord 2003). The Savannah and Edisto River Shortnose Sturgeon populations are similar genetically (Quattro et al. 2002). Available evidence strongly suggests that the current Edisto River Shortnose Sturgeon population has received a major contribution from Savannah River individuals and has increased over the past 10 to 15 years or more (McCord 2003). The current status of sturgeon stocks in the ACE Basin is poorly understood, but is likely to be better understood through recent biotelemetry studies (B. Post per comm. 2011). If fishery-induced mortality was once the major limiting factor on populations of both species in the ACE Basin, current conditions should promote population growth.

Coosawhatchie and Ashley Rivers: These are small, Coastal Plain drainages. Atlantic Sturgeon were harvested commercially in the Coosawhatchie River in 1982 (Smith et al. 1984). Otherwise, there are no records for this area except reports of juvenile Atlantic Sturgeon taken by shrimp trawls in lower Port Royal Sound. Several juvenile Atlantic Sturgeon have been taken in the Ashley River during shrimp trawl surveys (J. Jenkins, SCDNR, pers. comm.), but no other records exist. There are no records for Shortnose Sturgeon in either of these rivers. The status of both the Atlantic and Shortnose Sturgeon is unknown for these small rivers.

Savannah River: There are spawning populations of both Atlantic and Shortnose Sturgeon in the Savannah River (Hall et al. 1991; Collins and Smith 1996; Collins et al. 2002; Smith and Collins 1998, B. Post per comm. 2011). However, the status of stocks is poorly understood and survival of juveniles and recruitment to the adult population has been identified as a potential limiting factor in population growth, particularly for Shortnose Sturgeon (Smith et al. 1992). According to historical distribution records, much of the historically available spawning and nursery habitat for sturgeons in the Savannah River remains accessible (USFWS 2001).

HABITAT AND NATURAL COMMUNITY REQUIREMENTS

Because of the highly migratory nature of sturgeons, particularly the Atlantic Sturgeon, these fishes require access to an expansive variety of high quality freshwater and marine habitats. Within state waters, adult Atlantic Sturgeon migrate through nearshore Atlantic shelf waters and intracoastal sounds, bays and inlets to access the river basins in which they spawn. Shortnose Sturgeon move primarily from tidal estuarine or brackish channels into freshwater reaches to spawn. Both species spawn in freshwater channel habitats from tidal river reaches to at least as far inland as the fall line in large, unobstructed river basins. Eggs of both species are adhesive, and successful spawning is dependent upon the availability of relatively clean, hard substrates within river channels for egg adhesion and development. Both spawning and egg survival to hatching are dependent upon habitats with low to moderate flows and limited sedimentation. Shortnose Sturgeon, and presumably Atlantic Sturgeon, generally spawn where flow rate is 0.2 to1.8 m/sec. (0.7 to 6.0 ft./sec.) (Kynard 1997). Nursery and foraging habitats for both sturgeons (including adults within rivers) include all channel and adjacent out-of-channel submerged habitats from a few kilometers seaward to estuarine sounds and bays of river basin deltas. During the fall and winter, sturgeon move seaward into brackish and estuarine channels. The Atlantic Sturgeon over-winters in deep channels and holes within coastal sounds and bays. It is during such seaward migrations that Atlantic Sturgeon may transfer into other river basins by traversing coastal Atlantic continental shelf waters (McCord 2003). Atlantic Sturgeon tagged in South Carolina have been found as far south as Mayport, FL and as far north as Manhattan, NY.

CHALLENGES

Dams prevent upstream migration of sturgeons and other species (ASMFC 1990; NMFS 1998; USFWS 2001). Atlantic streams from Maine to Florida have undergone a restriction or loss of access for migratory fishes to about 84% of stream habitat within historic ranges from dams alone (Busch et al. 1998). Obstructed access to a diversity of habitats may limit basin-specific populations of both Atlantic and Shortnose Sturgeon. The Waccamaw-Pee Dee, Santee-Cooper and Savannah Basins in South Carolina are impacted by dams that restrict migrations of Ss into historical habitats (USFWS 2001). Dams can block spawning migrations and severely restrict the availability of spawning and nursery habitat, particularly in large river systems when dams are near the coast (ASMFC 1990), as in the Santee River. Dams and other impediments to migration have eliminated sturgeons from many historical habitats in South Carolina (USFWS 2001), the result being a general reduction in sturgeon populations in even currently accessible river reaches.

The Santee Basin has the second largest drainage area and total discharge (only the Susquehanna is larger) of all river systems on the East Coast of the US (Hughes 1994). However, this large watershed has been impacted by damming to a greater extent that most basins on the Atlantic Coast of North America, with nearly 45 dams in the South Carolina portions of the basin alone (USFWS 2001). The original Santee-Cooper diversion project, completed in 1942, shifted approximately 88% of the historical Santee River flow into the Cooper River, changing the average Cooper River flow rate from 2 cubic meters per second (cms) or 7 cubic feet per second (cfs) to 442 cms (1,560 cfs) (Kjerfve 1976).

Prior to re-diversion in 1985, water releases at Pinopolis Dam on the Cooper River were generally continuous. A weekly average flow of 122 cms (430 cfs) has been maintained in the Cooper River since rediversion to protect water supplies (Orlando et al. 1994), but generation time has been restricted to as little as 10 hours per day. The original diversion of Santee River historical flows into the Cooper River caused average freshwater flow in the Santee River seaward of Wilson Dam to drop from 525 to 74 cms (1850 to 260 cfs), and allowed saltwater intrusion (Kjerfve and Greer 1978). The Santee-Cooper Rediversion Project returned about 70% of the Cooper River flow to the Santee, increasing average flow to approximately 367 cms (1,290 cfs) and reducing salinity in the lower Santee (Orlando et al. 1994). However, there is no minimum flow requirement at St. Stephen Dam on the Rediversion Canal (D. Cooke, SCDNR, per. comm., 2005), and the average daily flow from Wilson Dam is only 18 cms (63 cfs) higher (Orlando et al. 1994).

During periods of low inflow into the Santee-Cooper Lakes, water releases can be discontinued at St. Stephen Dam (D. Cooke, SCDNR, per. comm., 2005). In contrast, the average daily discharge from Wilson Dam can approximate 500 cms (1,760 cfs) higher during flood-control releases (Orlando et al. 1994). The net result of flow regimens in both the Cooper and Santee Rivers is flows that are typically in highs and lows with more abrupt changes in flows from peaked power generation, and flood releases than are characteristic of more gradual river flow changes that occur in open rivers where waters expand into, and withdraw from, floodplains.

Dams, and particularly hydropower dams, often produce flow regimens that are not reflective of natural seasonal flows. Dams may reduce minimum flows, thereby potentially dewatering otherwise productive habitats and increasing water temperature (NMFS 1998; USFWS 2001). Pulse flows used for peaking hydropower production can disrupt natural productivity and prey availability for larval and early juvenile fishes (Crecco and Savoy 1987; Limburg 1996), can displace eggs and/or larvae from otherwise highly productive habitats (USFWS 2001), and can disrupt both upstream and downstream migration patterns for adult and juvenile anadromous fishes (ASMFC 1985; ASMFC 1999; Limburg 1996; USFWS 2001). As part of dam relicensing through the Federal Energy Regulatory Commission (FERC), prescribed flows through the Wilson Dam and St. Stephen Dam are likely to be changed to benefit sturgeon in the coming years (B. Post pers. comm).

Atlantic Sturgeon prefer moderate water temperatures, 12 to 24°C (54 to 75°F) as body weight is negatively impacted at higher temperatures (McCord 2003). Reduced flows caused by dams can reduce dissolved oxygen (DO) to levels unsuitable for sturgeon (Secor and Niklitschek 2001). For example, DO within the Santee River Rediversion Canal can reach less than 3.0 milligrams per liter (mg/L) and more frequently reaches less than 4.0 mg/L during summer periods with low or no flows from St. Stephen Dam (Cooke and Leach 2004a). At least 20 adult Shortnose Sturgeon were killed in the Rediversion Canal following a DO crash related to decaying submerged vegetation that had been trapped on trash racks associated with turbines in St. Stephen Dam (Cooke and Leach 2004a). However, dissolved oxygen sensors have since been installed downstream and upstream of that dam and are monitored regularly. If the dissolved oxygen drops below a certain level, water is released from the dam. Water releases from deep reservoirs may be poorly oxygenated and/or of below normal seasonal water temperature, thereby causing loss of suitable spawning or nursery habitat in otherwise suitable river reaches. Deepwater releases in late winter through early spring (the season of spawning) are often below the required temperatures: 13.3-17.8^{o}C for Atlantic (Borodin 1925) and 8.0-15.0^{o}C for Shortnose (Dadswell et al. 1984; Buckley and Kynard 1985).

Dredging and bridge construction may negatively impact sturgeons in several ways (ASMFC 1990). Deepened channels can allow saltwater to intrude further inland, and changes in salinity regimens can dramatically impact prey distribution (ASMFC 1990). Prey availability can also be reduced by the removal of benthic invertebrates within sediments (ASMFC 1990). Dredging can also negatively affect fish populations by producing suspended sediments (Reine et al. 1998). Sediment resuspension from dredging can cause increased turbidity and localized depletion of dissolved oxygen, as well as increased bioavailability of any contaminants that may be bound to the sediments (Clarke and Wilber 2000). High concentrations of suspended sediments, as well as relatively low concentrations sustained for several days, have been shown to cause direct mortality, impaired hatching success, reduced larval feeding, and diminished larval growth in several species of estuarine and anadromous fishes (Clarke and Wilber 2000). Suspended sediments have been linked to a variety of lethal and sublethal responses in juvenile and adult fishes that are consistent with oxygen deprivation due to gill clogging (Sherk et al. 1975; Sherk et al. 1974). Behaviorally, chronic turbidity from frequent or prolonged dredging can affect fish migration, spawning, conspecific interactions, and foraging (Coen 1995). Some fishes avoid waters of high sediment load, even during spawning migrations (ASMFC 1985; Reine et al. 1998). Water quality impacts and/or the reduction or elimination of prey may also disturb sturgeon concentration areas near the freshwater-brackish interface. Dredges, primarily hydraulic or hopper dredge,s may damage or kill sturgeons by entrainment or impingement in drag-arms or impellers (ASMFC 1990; NMFS 1998).

Siltation from dredging and from agricultural, silvicultural, and other land use practices can also reduce spawning success by causing mortality of eggs or by coating substrates needed for attachment of adhesive eggs (NMFS 1998). Pollution, runoff and siltation input contaminants and pollutants into sturgeon habitat that can cause lowered pH or lowered DO, which can reduce survival of eggs, larvae or juveniles (Rogers and Weber 1995, NMFS 1998; USFWS 1998). Bioaccumulation of contaminants, such as dioxin in parts of Winyah Bay, may reduce productivity or increase susceptibility to diseases or stress (Cooper 1989; Sindermann 1994; Varanasi 1992; NMFS 1998).

Erosion from agriculture and silviculture (logging) can significantly lower water quality and cause drastic adverse reactions in aquatic life (Butler 1968). Runoff carries silt, chemicals and nutrients into wetlands that, acting alone or in combination, can be lethal to aquatic life, and particularly to larval forms (Matthews et al. 1980; Aust et al. 1997). Runoff can cause sedimentation while nutrients can encourage algal blooms, both leading to eutrophication and possible dissolved oxygen (DO) depletion (Matthews et al. 1980; Lockaby et al. 1997). Siltation can also cause increased water temperature (Aust and Lea 1991; Perison et al. 1993). Further, siltation results in reduced productivity beginning at lower levels of food-chain relationships upon which juvenile sturgeons are dependent and disturbance of food-web relationships in adjacent and downstream waterways (Batzer et al. 2005). Forestry BMPs for bottomland forests are recommendations to landowners in order to conserve site productivity, primarily for silviculture, and are voluntary (SCFC 1998). When BMPs are not used, braided streams may be obstructed by plant material and disturbed soils, excessive ruts may channel eroded sediments into streams while partially stagnated waters may become nutrient-rich and promote algal growth that can die under extended periods of cloud-cover (J.W. McCord, SCDNR, pers. comm.). These factors contribute to increased water temperature and reduced DO.

Siltation, from erosion due to land use practices or from dredging, physically covers and kills some aquatic life, including submerged aquatic vegetation, and thereby increases BOD (biological oxygen demand) (Funderburk et al. 1991; Valdes-Murtha and Price 1998). Submerged aquatic vegetation provides important ecological functions in freshwater habitats. Submerged aquatic vegetation improves water quality (Rybicki and Hammerschlag) and provides habitat for predator avoidance, foraging, and nursery development for many macro-invertebrates and resident and migratory fishes (Maldeis 1970; Killgore et al. 1989; Monk 1988). Submerged aquatic vegetation is adversely affected by suspended sediments greater than 15 mg/L (Funderburk et al. 1991) and by deposition of excessive sediments (Valdes-Murtha and Price 1998).

Dewatering of freshwater streams from irrigation and other water removal projects decreases habitat availability and contributes to reduced water quality by concentrating non-point source pollution and increasing water temperature (ASMFC 1985). Density-dependent impacts such as predation and competition may also increase. Sturgeons of various sizes can become impinged or entrained by intakes for power plants or by municipal, industrial or agricultural water intakes (NMFS 1998; Hoff and Klauda 1979).

Sturgeon also have been affected by commercial and recreational fishing operations. By-catch from gill nets, trawls, or trotlines may cause excessive mortality on adult Shortnose Sturgeon and on juvenile Atlantic Sturgeon (NMFS 1998). By-catch mortality for Atlantic Sturgeon occurs in fisheries within the Exclusive Economic Zone (EEZ) (the Atlantic Ocean from 3 to 200 miles offshore). There is currently no management plan for sturgeon in the EEZ. (ASMFC 1998; Kahnle et al. 1998) Evidence of impingement in crab traps has been observed for juvenile Atlantic sturgeon (J. W. McCord, SCDNR, pers. comm.), and abandoned or lost traps may be problematic as potential sources of injury or mortality for both species of sturgeon. Illegal harvest of both species is likely, particularly for animals captured incidentally in American shad and shrimp trawl fisheries, but also from directed effort (NMFS 1998). Allowable take of sturgeons, as permitted under the ESA, may allow excessive mortality, particularly for adults in small populations (NMFS 1998). However, in 2010, NMFS required the State of South Carolina to account for and reduce by-catch of both species of sturgeon in fisheries. In response, SCDNR has made changes to their shad fisheries and sent required documentation to NMFS.

Predation and competition between sturgeon and non-native species, such as flathead catfish (*Pylodictis olivaris*) and blue catfish (*Ictalurus furcatus*), may be additive to ‘more natural’ sources of mortality. Both of these non-native catfishes are presumed to be problematic to sturgeons as both competitors and predators (NMFS 1998).

CONSERVATION ACCOMPLISHMENTS

The Shortnose Sturgeon was listed as an endangered species in 1967. In addition, both Atlantic and Shortnose Sturgeon received a high level of protection with the closure of the directed Atlantic Sturgeon gill-net fishery in 1985, which made the possession of any sturgeon illegal in the South Carolina.

Both sturgeon species were incidentally caught in the ocean shad fishery (J.W. McCord, SCDNR, pers. comm.). The Atlantic States Marine Fisheries Commission’s Amendment 1 to the Interstate Fisheries Management Plan (IFMP) for shad and river herring mandated closure by 2005, preceded by an effort phase-out period. Any reduction in shad fishery effort reduces the potential for by-catch and associated mortality. Participation in South Carolina’s American shad gill-net fishery has gradually declined over at least the past 25 years.

An IFMP was developed for the Atlantic Sturgeon under the auspices of the ASMFC (1990 and 1998). In addition to numerous management recommendations, the sturgeon amendment also includes requirements for states to monitor by-catch in all fisheries and to control levels of by-catch if necessary. More importantly, the 1998 amendment required all states to implement a moratorium on sturgeon harvest for 20 to 40 years. Despite the earlier closure of directed Atlantic Sturgeon fisheries in South Carolina, the coast-wide moratorium is important for management of populations in South Carolina because of the migratory behavior of Atlantic Sturgeon.

Additional protection from bycatch mortality was afforded to both Atlantic and Shortnose Sturgeon with the initiation of bycatch reduction devices (BRDs) and turtle excluder devices (TEDs) in shrimp trawl nets, as required by the NMFS. In 1990, TEDs were required and BRDs were required in 1996. According to commercial shrimp trawler captains interviewed by the author in 1995, sturgeon bycatch has been substantially reduced by these devices.

The Santee-Cooper Rediversion Project completed in 1985 also enhanced year-round flows and average late winter and spring water levels in the Santee River, primarily seaward of the Rediversion Canal. These improved flow regimens have presumably produced increases in the quantity and quality of spawning and nursery habitat for both sturgeons seaward of St. Stephen Dam and the Rediversion Canal. Accordingly, both Atlantic and Shortnose Sturgeon may have been positively influenced.

CONSERVATION RECOMMENDATIONS

- Conduct statewide surveys of Atlantic and Shortnose Sturgeon populations, particularly for small rivers where stock status is poor or unknown, to determine abundance (or presence/absence), age structure and recruitment indices of juveniles into spawning populations. Develop standardized sampling protocols for inventorying life stages for both species.
- Expand sturgeon tagging programs to other South Carolina rivers to gather additional information on movements of both species within and between river basins.
- Validate aging techniques for South Carolina sturgeons by analyzing the hundreds of archived hardened fin-rays collected from sturgeons in the lower Edisto River and comparing growth rings with seasonal growth (in length) of recaptured sturgeon.
- Compare the genetic relationship of Shortnose Sturgeon in the Santee-Cooper Lakes and the Cooper River with those from the Santee and Waccamaw-Pee Dee Rivers and determine the genetic relationships of Atlantic Sturgeon for tributary rivers within the Waccamaw-Pee Dee and ACE Basins. Determine genetic relationships for spring and fall spawning Atlantic Sturgeon within individual drainage basins.
- Determine the minimum viable populations for both Atlantic and Shortnose Sturgeon, below which stocking should be considered.
- Develop breeding and stocking protocols for both species of that protect the genetic integrity of unique populations.
- Document seasonal distribution of both sturgeon species throughout the State in order to identify and map essential habitat.
- Inventory existing sources of mortality for sturgeons and formulate remedies where practical.
- Improve quality and scope of coverage for sturgeon by-catch records received from mandatory catch and effort records collected from shad and herring fisheries and expand the program to include non-gamefish gill-nets. Additionally, create an observer program or survey to collect sturgeon by-catch information from gill-net fisheries and to determine the reliability of mandatory reports. Create an observer program to record sturgeon by-catch information from shrimp trawl fisheries and require sturgeon by-catch reporting for all trawl fisheries.
- Investigate impacts of logging in swamp forests on water quality and habitat, especially as related to sturgeon spawning and nursery habitat.
- Determine impacts of dewatering of freshwater streams from irrigation and other water supply withdrawal projects. Determine the relation of river discharge rates to sturgeon spawning success.

- Investigate potential success for fish passage at various dams by evaluating upstream spawning and nursery habitat.
- Investigate the potential for improving spawning success of both species by deployment of rock to supplement natural spawning substrate or to create new spawning habitat.
- Conduct an interview survey of past sturgeon fishery participants for the purpose of gathering invaluable information on productive fishing techniques and gear, on most productive sites, and on seasonality of sturgeon spawning runs.
- Determine potential impacts of predation and competition from non-native species on sturgeons and, to the extent possible, control and prevent further distribution of non-native blue and flathead catfish populations.
- Evaluate State water quality standards and BMPs that may impact wetlands to ensure that these practices adequately protect sturgeon habitat.
- Determine minimum flows below dams that are necessary to maintain appropriate dissolved oxygen levels for sturgeons and the response of sturgeons to low dissolved oxygen, particularly within preferred habitats.
- Determine impacts of pollution, contaminants and siltation on all life history stages of sturgeons.
- Evaluate utilization and effectiveness of existing fish passage structures and protocols for Atlantic and Shortnose Sturgeon.
- Determine impacts of biotic and abiotic factors on egg, larval and juvenile survival and development and how such factors relate to spawning stock recruitment.
- Assess the impacts of dredging, open water disposal of sediments and blasting on sturgeons and on their habitat and prey base.
- Determine food habits by habitat type and life stage for both species of sturgeon and the relationships of food habits to availability and density of potential prey.
- Determine contaminant loads in sediments of areas frequented by either sturgeon species, the contaminant loads in sturgeon tissues, and the impacts of contaminants on sturgeon health.
- Participate in FERC-relicensing exercises, and partner with USFWS, NMFS and NGOs (non-governmental organizations) to ensure that cost-effective and efficient designs for providing both upstream and downstream passage of sturgeons are installed in dams that are currently blocking access to suitable spawning and nursery habitats.
- Partner with NMFS, USFWS, ACOE, NGOs, and local governments to improve access to a full diversity of habitats by including fish passage designs wherever appropriate and by removing, breeching, or bypassing impediments to migration such as nonfunctional dams, dikes or causeways.
- Build partnerships with NGOs, permitting authorities, and county and local governments to improve and/or implement the use of Best Management Practices (BMPs) in agriculture, silviculture and urban development activities to reduce siltation and contaminant input.
- Partner with the SCDHEC to develop water removal guidelines for agricultural, civil or industrial purposes that include considerations for the needs of migratory fishes.
- Partner with GADNR to study and manage sturgeon populations in the Savannah River.
- Partner with North Carolina’s natural resource agencies to study and manage Atlantic and Shortnose Sturgeon populations in the Waccamaw-Pee Dee Basin.

- Partner with GADNR, ACOE, USFWS, NMFS and local governments to provide sturgeon passage at New Savannah Bluff Lock and Dam and at dams inland of this point, should passage be deemed appropriate at other barriers.
- Partner with NGOs, state and federal agencies, and industry to discourage deforestation of river floodplains and swamp forests.
- Partner with appropriate permitting authorities, including the ACOE, to design dredging protocols that consider the timing of sturgeon migration and that protect freshwater-brackish interface zones.
- Partner with other coastal states, possibly through the ASMFC, to promote protection of the Atlantic Sturgeon in the EEZ.
- Form an alliance with other state and federal agencies as well as NGOs to implement range-wide conservation and management of sturgeons as described in the ASMFC IFMP for Atlantic Sturgeon and the NMFS FRP for Shortnose Sturgeon.
- Partner with NGOs and other state and/or federal agencies to promote changes in water release protocols for dams that will restore or approximate natural flow regimens, increase minimum flows and improve water quality below dams.
- Partner with SCDHEC, federal agencies and NGOs to develop or revise river basin plans to identify habitat areas of particular concern (HAPCs), to identify degraded or threatened habitats, and to identify preventative or mitigation actions.
- Partner with SCDHEC to designate critical coastal areas, such as freshwater-brackish interface zones.
- Partner with other state agencies to regionally review and manage projects and planning activities that protect sturgeon habitat.
- Partner with the NMFS, USFWS and other groups to confine allowable take of sturgeons by water intake facilities to levels that do not limit population growth, particularly for small stocks.
- Critical habitats and migration patterns for Atlantic and Shortnose Sturgeon should be included in Coastal Zone Management Plans, in BMPs for non-point source pollution, and in State Pollution Discharge Elimination Systems permits. Develop education and outreach programs that distribute information to governments, civic groups, educational systems and NGOs regarding critical habitat needs, threats and potential conservation actions for sturgeons.
- Develop education programs to specifically address by-catch of sturgeons in American shad and other gill-net fisheries, trawl fisheries, and various trap and trot-line fisheries.

MEASURES OF SUCCESS

By improving aquatic ecosystem health and access to and from suitable spawning and nursery habitats, and by monitoring population responses to conservation actions as suggested above, SCDNR will be able to promote and document rebounding populations of both Atlantic and Shortnose Sturgeons.

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