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Characteristics of the Adult Segment of the Savannah River Population of Shortnose Sturgeon[1]

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Abstract: During 1984–1992, 626 adult shortnose sturgeon (3.5 male:1 female) were captured in the Savannah River. Significantly more fish were captured in the lower (rkm 42–75) than the upper (rkm 160–299) river. Radio telemetry data indicated that spawning appeared to occur upriver, between rkm 179 and rkm 278, and that the specific location and time of spawning varied annually. Some individuals spawned in consecutive years, but others apparently did not. Nonspawning fish appeared to remain in the vicinity of the fresh/brackish water interface (ca. rkm 30–40) throughout the spawning season. Most shortnose sturgeon left the freshwater reaches of the river in Spring soon after the spawning season (January–April) and probably did not return until late Autumn/early Winter, just prior to the spawning season.

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The shortnose sturgeon, *Acipenser brevirostrum*, inhabits large coastal rivers from New Brunswick, Canada, to northern Florida (Vladykov and Greeley 1963). Prior to 1973 this species was harvested concurrently with, and not distinguished from, Atlantic sturgeon (*A. oxyrinchus*). Today it is listed as an endangered species in the United States, but recent undercover law enforcement work indicates that it is still illicitly taken for its flesh and eggs (caviar).

The biology of shortnose sturgeon in the northern portion of its range has been the focus of several studies (Dadswell 1979, Taubert 1980, Buckley and Kynard 1985), but relatively little information is available concerning the biology

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of this species in southern rivers. During 1984–1992 the South Carolina Wildlife and Marine Resources Department (now the S. C. Department of Natural Resources) and the United States Fish and Wildlife Service conducted a cooperative study of shortnose sturgeon in the Savannah River. This paper reports on various aspects of the biology of adult shortnose sturgeon inhabiting the Savannah River.

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Methods

The Savannah River was selected as the study site based on reports of incidental captures of adult shortnose sturgeon in the shad gill net fishery. This river delineates much of the South Carolina-Georgia border and flows into the Atlantic Ocean near the city of Savannah, Georgia. The river is impounded at several sites, and the present study was conducted in the ca. 300 km between the mouth and first obstruction, the New Savannah Dam near Augusta, Georgia. The upper river area (URA; river kilometers (rkm) 160–299) is relatively undeveloped with the exception of 2 major nuclear facilities; the Savannah River Site in South Carolina and Plant Vogle in Georgia. The lower river area (LRA; rkm 42–75) is similarly undeveloped, but it is just upriver from the heavily industrialized port and harbor area of the city of Savannah.

Adult shortnose sturgeon (defined as ≥56 cm total length (TL) based on examination of broodstock) were collected during 1984–1992 from the study area by

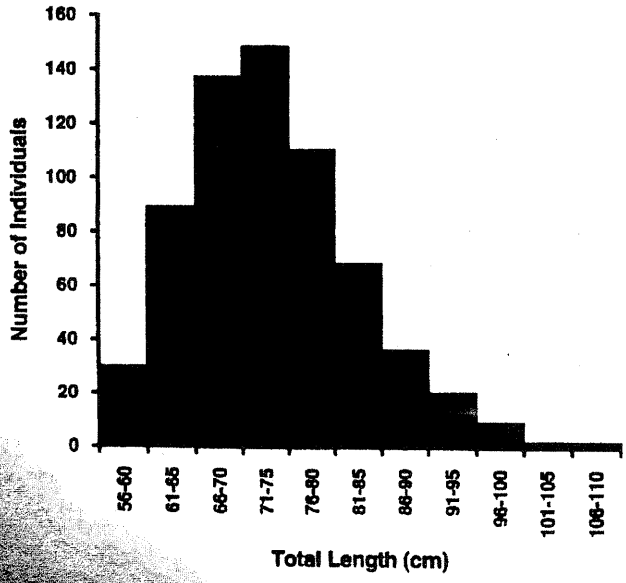

Figure 1. Length frequency of Savannah River shortnose sturgeon captured in gill nets during 1984–1992.

2 commercial shad fishermen. During the legal shad season (typically mid-January to mid-April), 1 individual fished the URA while the other fished the LRA. Fishing effort was similar in all years except 1984, when the LRA was not fished, and 1992, when only minimal effort was expended in the URA. Both fishermen used anchored monofilament gill nets of 14 cm stretch mesh. Nets were checked daily, and all sturgeon were placed in floating, cylindrical pens of plastic mesh. Project personnel removed captured sturgeon from the pens 1 to several times per week, depending on catch rates.

The captured fish were used for a variety of purposes. Many shortnose sturgeon, especially suspected ripe or nearly ripe individuals, were transported to Orangeburg National Fish Hatchery for spawning as part of a stock enhancement program (Smith et al. 1985, 1995). After 1–3 months, these fish were tagged and released into the Savannah River. Prior to 1991 fish were classified as ripe based on degree of abdominal distention, if gametes could be easily expressed, or if the vent was obviously everted. During 1991–1992 gonadal tissue acquired through biopsy was examined grossly and/or microscopically to determine stage of ripeness. Shortnose sturgeon not used as broodstock and some incidentally caught Atlantic sturgeon were marked with one or more tag types and released. When possible these fish were assigned a sex and maturity stage. Data on sex ratios and numbers of fish captured were statistically analyzed using the Chi-square test with $P < .05$ required for significance.

In order to identify spawning areas and other critically important habitats, some shortnose sturgeon were utilized in radio telemetry studies during 1990–1992. Transmitters were 70 mm long × 18 mm diameter and operated in the 48–50 Mhz range. Transmitter lifespan was estimated by the manufacturer to be 475 days. The transmitters were surgically implanted into the abdominal cavity through a ventral,

Table 1. Number of Savannah River shortnose sturgeon captured in lower (RKM 42–75) and upper (RKM 160–299) river areas by commercial shad fishermen from 15 January–15 April 1986–1992 and percentage of sexed fish that were spawning condition (running ripe and or evidence of protruding vent during 1986–1990, and examination of gonadal tissue during 1991–1992). Total number includes fish of unknown sex and maturity stage. Maturity stages were not recorded in 1984 and 1985.

	Lower river					Upper river				
	Total	Females		Males		Total	Females		Males	
Year	*N* fish	*N*	% Ripe	*N*	% Ripe	*N* fish	*N*	% Ripe	*N*	%Ripe
1984	—	—	—	—	—	25	3	—	22	—
1985	49	6	—	43	—	62	15	—	47	—
1986	36	5	40	31	50	11	1	100	10	40
1987	31	7	100	21	10	27	5	100	21	19
1988	53	13	23	31	23	29	8	75	21	67
1989	54	2	50	46	37	40	9	78	30	40
1990	55	5	60	20	25	34	7	71	26	50
1991	99	16	63	22	100	16	2	100	13	100
1992	35	15	47	6	100	1	0	0	1	100

Table 2. Size (total length), site (river kilometer) and date of release, and site and date of the relocation farthest upriver for Savannah River shortnose sturgeon tracked by radio telemetery during 1990–1992; 5 additional individuals were not relocated after the day of release.

Release			Relocation	
TL (cm)	Date	Site (rkm)	Date	Site rkm)
84.0	02 Mar 90	46.1	13 Apr 90	46.8
78.0	15 Mar 90	46.1	29 Mar 90	50.0
80.0	20 Mar 90	46.1	13 Apr 90	218.8
76.8	20 Mar 90	46.1	23 Mar 90	46.1
89.5	20 Mar 90	46.1	21 Mar 90	36.0
106.2	22 Jan 91	46.1	28 Jan 91	227.9
85.5	22 Jan 91	46.1	21 Feb 91	221.6
97.0	22 Jan 91	46.1	20 Feb 91	220.9
70.0	26 Jan 91	46.1	01 Feb 91	41.7
81.2	29 Jan 91	46.1	01 Feb 91	43.2
84.9	05 Feb 91	46.1	25 Feb 91	188.4
83.9	05 Feb 91	46.1	28 Feb 91	212.8
82.1	05 Feb 91	46.1	27 Feb 91	179.3
86.2	05 Feb 91	46.1	27 Feb 91	187.4
89.5	12 Feb 91	46.1	27 Feb 91	134.1
85.2	12 Feb 91	46.1	27 Feb 91	181.6
87.2	12 Feb 91	46.1	19 Feb 91	45.0
87.0	12 Feb 92	48.0	20 Feb 92	208.0

midline incision which was closed with Ethicon 00 sutures. Tracking was conducted both from boat and airplane using programmable scanning receivers (Advanced Telemetry Systems, Isanti, Minn.). Tracking efforts were initiated when transmitter-equipped fish were released. Searches were conducted daily to weekly until approximately mid-April. Weather dependent, bimonthly searches continued through the summer, and thereafter occurred irregularly.

Results

During 1984–1992, 626 adult shortnose sturgeon were captured by the 2 commercial shad fishermen (Table 1). Lengths ranged from 56 to 107 cm TL, and the modal size class was 71–75 cm TL (Fig. 1). Nineteen percent were female, 66% were male, and the remaining 15% were of undetermined sex. Numbers of fish captured per year ranged from 1 to 62 (mean ± sd = 27.2 ± 17.7) in the URA and 31–99 (51.5 ± 21.4) in the LRA. During 1985–1991, significantly ($P < .001$) more fish were captured in the LRA (377) than the URA (219). The ratio of males to females varied annually from 0.4:1 to 23:1 in the LRA and from 2.6:1 to 10:1 in the URA. Overall ratios were not significantly different: 3.2:1 in the LRA and 3.8:1 in the URA. The pooled sex ratio was 3.5 males:1 female. The percentages of females classified as ripe were 81% and 53% in the URA and LRA, respec-

tively, and the percentages for ripe males were 50% and 42%, respectively. Accuracy of the percentages, especially for males, is somewhat in doubt due to the higher percentage (100%) classified as ripe through the biopsy method compared to the method used in previous years (Table 1). Ninety-five percent of the fish of unknown sex and maturity stage were captured in the LRA.

Juvenile Atlantic sturgeon co-occurred with adult shortnose sturgeon during January–April in the LRA, but not in the URA. In 1990, 3 Atlantic sturgeon were captured, while 6 were caught in both 1991 and 1992. Data on capture of juvenile Atlantic sturgeon were not recorded during previous years.

Eight fish were used successfully as broodstock and recaptured in following years. Of these, 1 female and 6 males were again used successfully. The female spawned after an interval of only 1 year (i.e., in 2 consecutive spawning seasons), and 2 males did likewise. Three males were ripe again after 2 years and 1 after 3 years, but whether they spawned in intervening years is not known. The eighth fish was a male which was unripe when recaptured after an interval of 1 year.

Twenty-four radio transmitters were implanted into adult shortnose sturgeon. With the exception of 1 individual captured and released in the URA in 1990, all fish used in radio telemetry efforts were captured and released in the LRA (Table 2). Ten of the 23 fish from the LRA ascended to the URA, and 1 ascended part way (to rkm 134) where contact was lost. Seven fish were relocated in or just below the LRA, while contact was lost immediately with 5 fish. Nine of the 15 fish (60%) implanted and released prior to mid-February ascended to the URA, compared to only 1 of the 8 (12.5%) released afterward. The maximum upriver locations (rkm) of these 10 fish were: 179, 182, 187, 188, 208, 213, 219, 221, 222, and 228. The 7 fish that were only detected in the LRA vicinity were recorded between rkm 36 and rkm 46 for 1 to 42 days. No fish were located later than mid-April in either the LRA or URA, and no fish were located in years other than that of release.

Discussion

Relative abundance of shortnose sturgeon was significantly greater in the LRA than in the URA. This may be due in part to the fact that fish migrating upriver to spawn are vulnerable to capture in the LRA during both the upriver and downriver segments of the migration. Nearly all fish that were considered not suitably ripe for use as broodstock were captured in the LRA, suggesting that each year some portion of the population neither spawns nor participates in the upriver migration. These fish possibly remain in the LRA, or just below in slightly brackish water, throughout the spawning season and are therefore vulnerable to capture over an extended period. It is also possible, however, that fishing effort of 1 or both of the commercial shad fishermen varied without our knowledge in some instances, thus confounding our interpretation of the relative abundance data.

Telemetry data also suggest that only a portion of the population participates in the upriver spawning migration. For example, 30% of telemetered fish remained in or just downriver from the LRA, while 22% were never relocated after the day of re-

lease. Although failure to locate these fish may be attributable to transmitter failure in some instances, it is likely that at least some individuals crossed to the saline side of the fresh/brackish water interface, thereby attenuating the radio signals. Thus, the hypothesis that the fresh/brackish water interface area and the downriver portion of the LRA serve as a staging area for the spawning migration and a holding area for fish that do not participate in the upriver migration is supported by telemetry, relative abundance, and maturity stage data collected in this study.

Migrating shortnose sturgeon began moving upriver in late January to mid-March, traveling at average speeds of up to 50 km per day. Hall et al. (1991) reported upriver migration in the Savannah River during February and March at speeds of 1–33 km per day. Assuming that maximum upriver locations of telemetered shortnose sturgeon indicate sites of spawning activity, spawning in the Savannah River took place between rkm 179 and 228, primarily during late February but as late as mid-April, and at temperatures of 9.8°–16.5° C. In the Saint John River, Canada, shortnose sturgeon spawn later (May–June), but at similar temperatures (Dadswell 1976). Hall et al. (1991) reported spawning behavior during March in the Savannah River, and identified 2 probable spawning areas: rkm 179–190 and rkm 275–278. Four of 10 fish that migrated upriver in the present study were recorded in the lower of these 2 areas. However, the other 6 fish moved to rkm 208–228. The stretch of river between rkm 208 and 228 is similar to the probable spawning areas above and below (Hall et al. 1991), as it contains sharp bends with strong currents, submerged timber, and a substrate of gravel, clay, and sand. Areas of strong currents and scoured, coarse substrate provide the conditions believed necessary for successful spawning, egg attachment, and hatching. Sites with similar conditions and substrate are utilized as spawning habitats by shortnose sturgeon in the Saint John River, Canada, and the Connecticut River (Dadswell 1979, Buckley and Kynard 1985).

Telemetry data suggest that most shortnose sturgeon left the freshwater portion of the Savannah River by mid-April. This was also reported by Hall et al. (1991), who noted that shortnose sturgeon in the Savannah River had left fresh water by early May, although some remained in the vicinity of the fresh/brackish water interface through the summer. In contrast, in the northern portion of this species' range, from the Hudson River to the Saint John River, shortnose sturgeon apparently utilize freshwater habitats more extensively, with segments of some populations remaining in fresh water throughout the year (Dadswell 1979, Buckley and Kynard 1985). Juvenile Atlantic sturgeon are occasionally captured at and just above the fresh/brackish water interface, but not upriver near spawning areas, during the shortnose sturgeon spawning season.

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