Upstream Migration of Two Pre-Spawning Shortnose Sturgeon Passed Upstream of Pinopolis Dam, Cooper River, South Carolina

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Upstream Migration of Two Pre-Spawning Shortnose Sturgeon Passed Upstream of Pinopolis Dam, Cooper River, South Carolina

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Abstract - Two shortnose sturgeon were artificially passed above the Pinopolis Lock and Dam into the Santee-Cooper Lakes in order to simulate the use of a fish-passage mechanism. Movement patterns and spawning behavior were studied to determine the potential success of future shortnose sturgeon migrations if and when a fish-migration bypass structure is installed. In addition to movement patterns, water temperature was monitored in areas that shortnose sturgeons utilized. Shortnose sturgeon migrated through a large static system to a known shortnose sturgeon spawning area more than 160 km upstream where water temperatures were consistent with known shortnose sturgeon spawning temperatures. No specific movement patterns in the reservoir system were recorded during downstream migrations.

Introduction

Acipenser brevirostrum LeSuerer (shortnose sturgeon) range from St. Johns Bay, Canada, to the St. John's River, FL (Kynard 1997) and the species has been listed as federally endangered since 1967. Reduced access to spawning grounds, overfishing, poor water quality, and habitat degradation have caused populations to decline (Collins et al. 2000, Crance 1986, Moser and Ross 1995).

The shortnose sturgeon is amphidromous or semi-anadromous, spending portions of its life cycle in low salinity estuaries and portions in freshwater rivers (Buckley and Kynard 1985, Kynard 1997, Kynard et al. 2000). Spawning, feeding, and wintering occur in different habitats within a given river system (Bain 1997, Buckley and Kynard 1985, Kiefer and Kynard 1993). Shortnose sturgeon begin migrating to spawning areas in the spring when water temperatures rise above 9 °C (Hall et al. 1991, Kynard 1997). The act of spawning takes place at temperatures of 10–15 °C (Dadswell 1979). Often, only a portion of the adult population migrates during a particular year, while many adult fish remain in wintering areas (Bain 1997, Dadswell 1979, O' Herron et al. 1993). After spawning is completed, some fish may remain in upstream spawning areas for periods of up to several years (Bain 1997, Buckley and Kynard 1985, Dadswell 1979).

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Dams represent significant obstacles to migration and spawning of many species (Beeman and Maule 2001, Moser et al. 2000, Pegg et al. 1997). Historic solutions to the problems of fish passage around dams include breaching the dam and installing specific fish-passage structures (Beeman and Maule 2001). The use of navigation locks has been recently identified as a potential low-cost alternative to the problem of fish passage (Moser et al. 2000). Shortnose sturgeon have been observed in the Pinopolis navigation lock; however, they have not been observed passing upstream into Lake Moultrie (Cooke et al. 2002).

Numerous species have been shown to migrate upstream through reservoirs in order to spawn in historic spawning locations; additionally, the downstream passage of numerous fishes has been studied (see for example Jessop 1990, Pegg et al.1997, Raymond 1979). The upstream and downstream migration behavior of shortnose sturgeon in reservoirs in the southeast has not been documented. The objective of this study was to describe movement of shortnose sturgeon artificially passed above a dam into a large southeastern reservoir.

Study Area

The Santee River was impounded in 1941 for flood control and hydroelectric power and effectively formed the Santee-Cooper Lakes (Morrow et al. 1997), which are comprised of Lake Marion (44,000 ha) and Lake Moultrie (26,000 ha). The Santee-Cooper Lakes, along with portions of the Cooper, Santee, and Congaree Rivers, compose the study site (Fig. 1). The Santee-Cooper Lakes are unique in that the basins were not clear cut before impoundment, leaving standing timber. The lakes contain areas of open water as well as thick bottomland hardwood swamps.

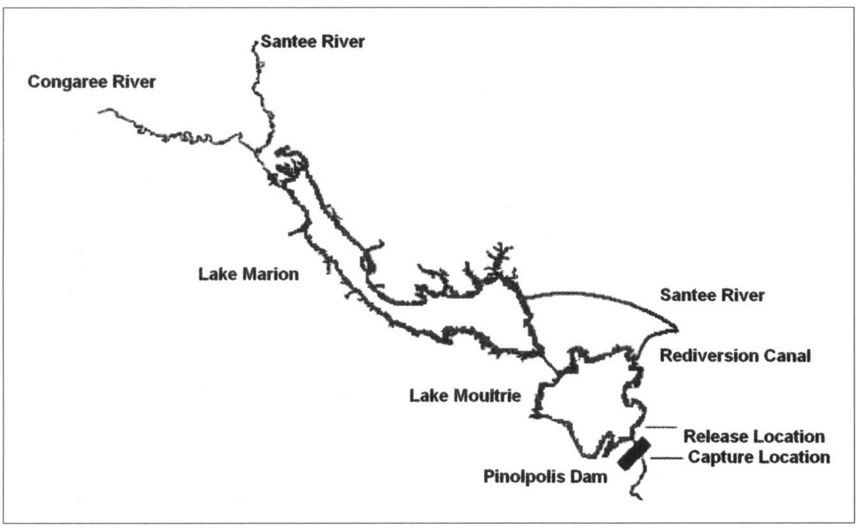

Figure 1. The Santee-Cooper System.

The study site is heavily impacted by anthropogenic effects including the diversion of the Santee River into the Cooper River, the rediversion of the Cooper River back to the Santee River and the presence of numerous dams that act as barriers to migration. There is a fish ladder for anadromous fish passage on the rediversion canal and a navigation lock on the Cooper River. The Pinopolis lock is approximately 18-m wide and 73-m long and the dam's power plant maintains flows of 127 m^3/s (Cooke et al. 2002). The major effect of these structures is that one river flows into a lake system and two flow out, a unique feature of reservoirs on the Atlantic Coast.

Methods

Two adult shortnose sturgeon were collected using monofilament drift gillnets (5–9-cm stretch mesh, 2.5-m deep by 50-m long) on February 20, 2002, in the Pinopolis Dam tailrace canal, a known shortnose sturgeon spawning aggregation area (Duncan et al., 2004). Fish were removed immediately to avoid stress and surgically implanted with radio transmitters using techniques described by Isely et al. (2002). Transmitters weighed 30 g, were frequency coded (148–151 mHz), featured internal antennas, and possessed a minimum battery life of 500 d (Advanced Telemetry Systems, Inc., Isanti, MN). The fish were coded with tags 149.504 and 149.384. Weight, fork length, and total length were recorded during tag implementation and an attempt to sex fish was made (Table 1).

After implantation, fish were transported to a location approximately 5 km north of Pinopolis Dam and released into Lake Moultrie. Care was taken to allow fish to fully recover and to release the fish when the dam was not releasing water. Attempts were made to relocate fish daily by boat, or semimonthly by air using a directional antenna in selected areas of Lakes Marion and Moultrie, and the Wateree, Congaree, and upper Santee Rivers as far upstream as the next barriers to migration. Water temperature at the location of each fish was recorded. Movements were not statistically analyzed, but only graphically represented.

Results

The two shortnose sturgeon were released 1 h 4 min after their initial capture. Continuous monitoring of the sexually mature sturgeon proved problematic. The short range of the transmitters, combined with signal

Table 1. Total length, fork length, weight, and sex of the two released shortnose sturgeon.

Tag code	Total length (mm)	Fork length (mm)	Weight (kg)	Sex
149.054	1002	898	8.96	F
149.384	935	826	6.04	M*

*Sex not determined with certainty, fish may have been a small female.

attenuation resulted in the inability to detect the fish when they were in deep (> 10-m) water. Despite extensive effort, these fish could not be located when in the main body of Lakes Marion and Moultrie. Fish could only be consistently located when they were in the upper Santee or Congaree Rivers.

Within two weeks of release, both fish had traversed Lake Moultrie, the Diversion Canal, Lake Marion, and the Congaree River, and were relocated in the vicinity of Columbia, SC, near river kilometer 161, where they remained for at least 14 d (Fig. 2). While in this area, fish were consistently located near the only gravel deposit in the study area; however, the opportunistic deployment of three egg mats failed to document spawning. Both fish were located once above Granby Lock and Dam, a structure previously thought to block anadromous fish migration. Due to logistical difficulties, the area above Granby Lock and Dam was not routinely searched. Water temperatures during the period the fish were near Columbia, SC, ranged from 9.0–17.3 °C. After release, the mean upstream migration rate of these fish was 22.4 km/d.

By the end of March, both fish rapidly migrated back down river, where they were located near the confluence of the Santee River with Lake Marion.

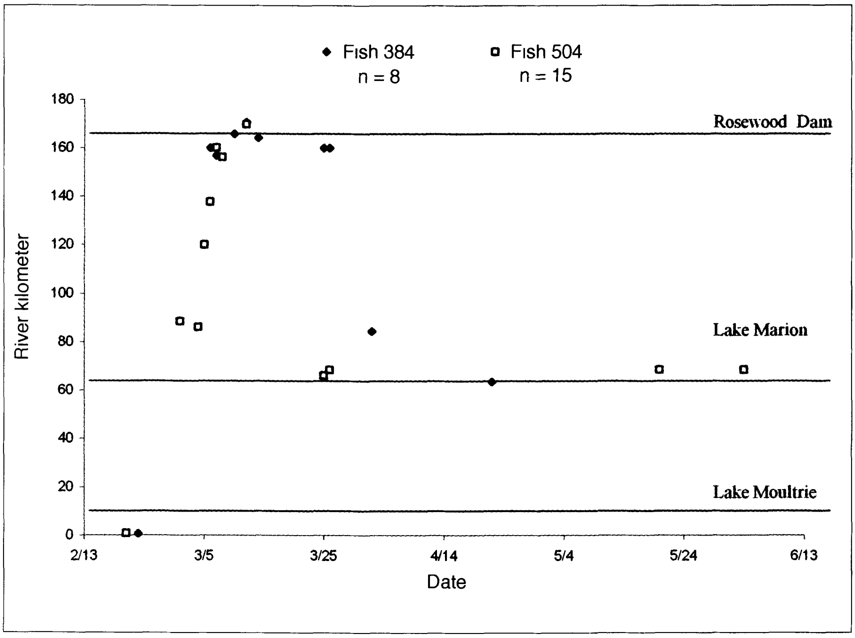

Figure 2. Locations for two adult shortnose sturgeon released above Pinopolis Dam in February 2002. Distance in river miles is measured from Pinopolis Dam along the main channel of the historic Santee River and Congaree River. Horizontal reference lines illustrate the boundaries between Lakes Moultrie and Marion, Lake Marion and the Santee River, and the position of Rosewood Dam. The upper limit of the figure (193 river kilometers) represents the location of the next barrier to migration.

One fish was located on April 2, but not located again—the final time—until April 22, despite extensive efforts to find it. Also, the other fish could not be located between March 26 and May 20. On that date, that fish was again located near the confluence of Lake Marion and the upper Santee River, where it remained through the end of the study. During the periods when fish could not be found, they were not located in the Wateree or Congaree Rivers, or in the Santee or Cooper Rivers below Pinopolis or St. Stephens Dam. It is presumed that the fish inhabited a depth beyond the range of detection in some portion of Lake Marion or Lake Moultrie. It may also be possible that fish inhabited an undescribed deep area of one of the rivers, or that tag 149.384 failed after April 22.

Discussion

The shortnose sturgeon faces many problems. Passage in order for fish to reach their natal spawning grounds is one of the problems that are being actively examined. It is likely that adult shortnose sturgeon have a behavioral drive to reach historical spawning grounds located upstream (Kynard 1997).

A dam built downstream of a spawning reach will block the migration of anadromous spawners, but may divide amphidromous populations into upstream and downstream segments (Kynard 1997). This appears to be the case in the Santee-Cooper system. If so, two questions related to the passage of shortnose sturgeon in a divided population must be asked. Is it good management practice to pass fish that may not be able to survive the return downstream through a manmade dam, and will any larvae or juveniles produced survive to recruit to the adult population? Lack of riverine habitat upstream will negatively impact divided shortnose sturgeon populations, and reservoirs upstream of dams provide no useful habitat (Kynard et al. 2000). Persistence of upstream fish depends on spawning, summer foraging, and wintering habitats (Kynard et al. 2000). Limited exchange between upstream and downstream populations may already be occurring (Cooke et al. 2002).

It is likely that increased passage of shortnose sturgeon at Pinopolis Dam will result in additional spawning activity at upstream locations. Kynard et al. (1999) found that shortnose sturgeon passed above Holyoke Dam, CT, would successfully move upriver to known spawning locations and successfully outmigrate through the dam. The failure to locate our fish in the Cooper River suggests that these fish will require assistance in order to outmigrate past Pinopolis Dam. Additional monitoring is needed to evaluate outmigration after spawning.

In summary, the high-frequency transmitters with internal antennae performed poorly in the Santee-Cooper Lakes, which resulted in a limited ability to locate the fish and track their movements. Although only two sturgeon were tracked, their behavior demonstrated that passed shortnose sturgeon can navigate the relatively still waters of Lakes Marion and Moultrie and rapidly migrate to areas nearly 161 km upstream, where shortnose sturgeon spawning was recently documented by other investigators (B. Post, South Carolina Department of Natural Resources, pers. comm.). After a period when the fish could not be located, they re-appeared in a location in Lake Marion where a dam-locked population is known to reside (Quattro et al. 2002). Study fish also likely attempted to out-migrate; however, migration back to Pinopolis Dam could not be verified.

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