Seasonal Distribution and Movement of Striped Bass in Lewis Smith Reservoir, Alabama

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Abstract: Lewis Smith Reservoir, an 8,583-ha Alabama Power Company impoundment on the Sipsey Fork of the Black Warrior River in north central Alabama, has received annual stockings of Gulf strain striped bass (STB-G) since 1983. Little is known about the distribution and seasonal movement patterns of striped bass in Lewis Smith Reservoir. During a three-year period from 1999–2001, 22 striped bass were captured, surgically implanted with ultrasonic transmitters and released back into the reservoir near their original capture site. Movement patterns of transmitter-equipped striped bass indicate that fish movement in the lake was dependent on fluctuations in seasonal temperature and water quality. During the critical summer months when the reservoir stratifies, striped bass tended to move downstream into cooler and deeper sections of the reservoir, taking advantage of lower water temperatures.

Key words: striped bass, transmitter, distribution, movement, Lewis Smith Reservoir

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Since the 1970s striped bass, *Morone saxatilis*, have been introduced into many southern reservoirs as a sport fish and predator for abundant clupeid populations (Bailey 1975). However, limited summer habitats, declining condition factors, and temperature induced mortality of larger striped bass has become a concern in many southern states (Coutant and Carroll 1980, Matthews 1985, Moss 1985). Work with the Gulf strain of striped bass (STB-G) in the 1980s indicated that it was more resistant to high summer temperatures, expressed increased longevity, and had higher overall condition factors than Atlantic strain fish (Wooley and Crateau 1983). Conse-

quently, STB-G fingerlings were introduced into Lewis Smith Reservoir in 1983 to establish a source of STB-G brood fish for Alabama and other southeastern states.

Several studies have shown that limited availability of suitable summer habitat can concentrate striped bass within restricted areas of a reservoir (Jackson and Hightower 2001). Depending on the habitat present, striped bass have been shown to seek refuge during the summer months in the deeper, more downstream areas of reservoirs (Combs and Peltz 1982, Farquhar and Guetreter 1989), in the tailwaters of an upstream dam, or in tributaries where ground water inflows provide adequate temperature and dissolved oxygen concentrations (Cheek et al. 1985, Moss 1985). Jackson and Hightower (2001) found that striped bass in Lake Gaston, Virginia-North Carolina, utilized all portions of the reservoir during the summer, but tended to concentrate in upstream tailwaters or downstream near the dam. Limited use of mid-lake areas was observed during the hotter months.

Little is known about the distribution and seasonal movement patterns of striped bass in Lewis Smith Reservoir. Striped bass typically prefer open water areas of reservoirs and are difficult to sample with traditional collection equipment. Based on angler catch data, movement patterns appear to change during the spring with fish moving into staging or holding areas as water temperatures approach 16 C. The majority of the angling activity, even during the spring, is in open areas of the lake. The STB-G has been proposed as a candidate for special status because of declining stocks and its unique genetic qualities. Due to its uncertain status and potential value as a broodfish, we conducted a long-term telemetry study to monitor the movement and seasonal distribution of STB-G in Lewis Smith Reservoir.

Study Area

Lewis Smith Reservoir is an 8,583-ha oligotrophic impoundment (Smith et al. 1980) located on the Sipsey Fork of the Black Warrior River in north Alabama. The maximum depth is 88 m, average reservoir depth is 22 m (Webb and Reeves 1975) and the mean annual fluctuation is 6 m (Greene et al. 1999). Thermal stratification begins in late May and the thermocline is typically located between 7–25 m deep. Dissolved oxygen begins to stratify in late June in the upper reaches of Lewis Smith and mid-July for the lower lake (Fig. 1), which also exhibits an oxygenated hypolimnion. Stratification breaks up by mid-October and homeostatic conditions are reached by December (Webb and Reeves 1975).

Methods

Twenty-two striped bass were captured between January 1999 and March 2000 and equipped with ultrasonic transmitters to monitor seasonal distribution and movement in Lewis Smith Reservoir. Of the twenty-two captured fish, nine fish were captured in Ryan Creek, seven in Rock Creek and six in the Sipsey Fork. These tributaries represent the three major arms of the reservoir.

Fish were captured with modified trot lines, commonly called “long lines,” set

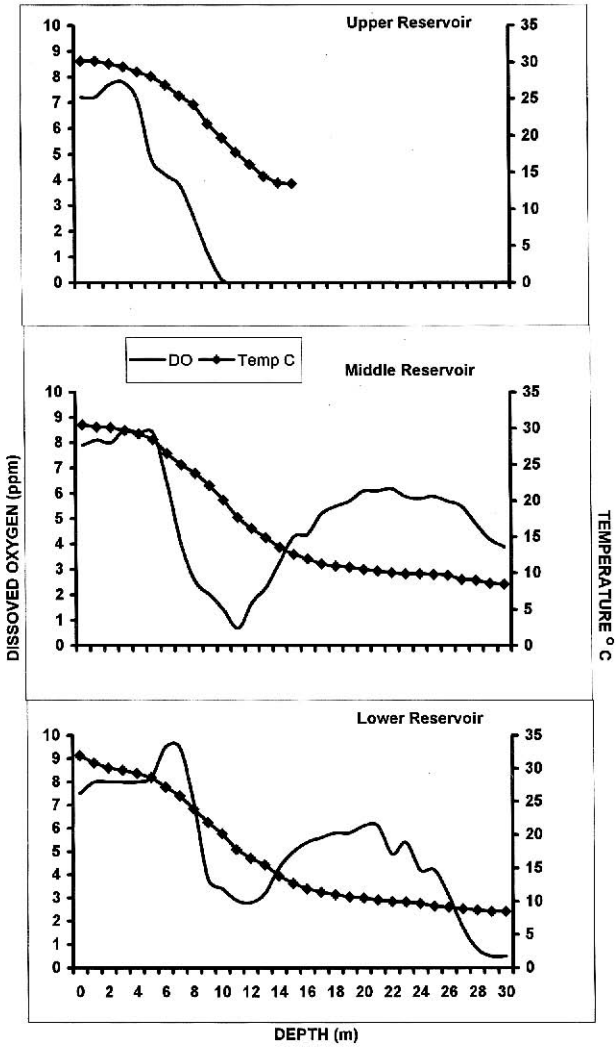

Figure 1. Summer temperature and dissolved oxygen profiles from Lewis Smith Reservoir, Alabama.

in 5–15 m of water near underwater flats or islands, which provide attractive habitat to adult striped bass. Other traditional methods of fish collection such as angling, netting, and electrofishing proved ineffective on this reservoir due to extreme depth and exaggerated shoreline contours. Captured striped bass were removed from long lines and placed into a large tank on the collection vessel where they were stabilized for the surgical procedure.

Striped bass were anesthetized in a large tub with a solution of MS-222. Trans-

mitters were surgically implanted using standard techniques (Dudley et al. 1977, Moss 1985, Walsh et al. 2000). Ultrasonic transmitters were inserted into the abdominal cavity through a ventral incision approximately 3 cm in length and posterior to the pelvic fin. After the transmitter was implanted, a Betadine solution was applied to minimize infection and the incision was closed with 5–6 interrupted Dexon absorbable surgical sutures (American Cyanamid Company, Wayne, New Jersey). Numbered internal anchor tags with orange plastic streamers were inserted in striped bass collected during the second year of the study so anglers could easily identify transmitter equipped fish and notify agency personnel if one was caught. Sonotronics model CT-82-3 ultrasonic transmitters (32–83 kHz) had an advertised battery life of 48 months, a range of 1,000 m, weighed 30 g in air (<2% body weight), and measured 65 mm in length and 18 mm in diameter.

Fish were tracked with a model USR-5W receiver equipped with a DH-2 Directional Hydrophone (Sonotronics, Tucson, Arizona). Individual fish were identified based on an audible pulsed code, which was unique for each transmitter. When signals from tagged striped bass were identified, fish were approached until the underwater signals became omni-directional, indicating close proximity. Water depth was recorded and the location was marked with a handheld global positioning system (GPS) unit (Garmin International, Lenexa, Kansas). Temperature-oxygen profiles were recorded during critical summer months with a Model 57 YSI meter (YSI, Yellow Springs, Ohio). Striped bass were tracked on a bi-weekly basis and position data was transferred to digital maps through a cooperative effort with Alabama Geological Survey personnel.

Transmitter-equipped striped bass were tracked on a weekly basis for the first two weeks following their release to monitor movement and distribution patterns and then at bi-weekly intervals once fish established identifiable home ranges. Personnel from the Swan Creek office monitored fish in the Sipsey Fork arm of the reservoir, while field staff from the Northport District office recorded movement of tagged striped bass in Rock, Ryan, and Simpson creeks.

One striped bass died shortly after being implanted and released. Anglers harvested a minimum of six of our transmitter-equipped fish during the three-year study. Three of the recovered transmitters were re-implanted in other candidate striped bass to collect additional movement data.

A Student's t statistical analysis was performed comparing the movement of male and female instrumented striped bass. A significance level of $P < 0.05$ was used for all analyses.

Results

The seasonal movement and distribution pattern of striped bass in Lewis Smith Reservoir can be described as follows: during late fall, as the reservoir destratified, striped bass generally moved into upstream tributaries and upper reaches of the impoundment. In spring, fish began concentrating in staging areas usually in mid- to upper tributary regions near underwater troughs, islands, or points. From June through

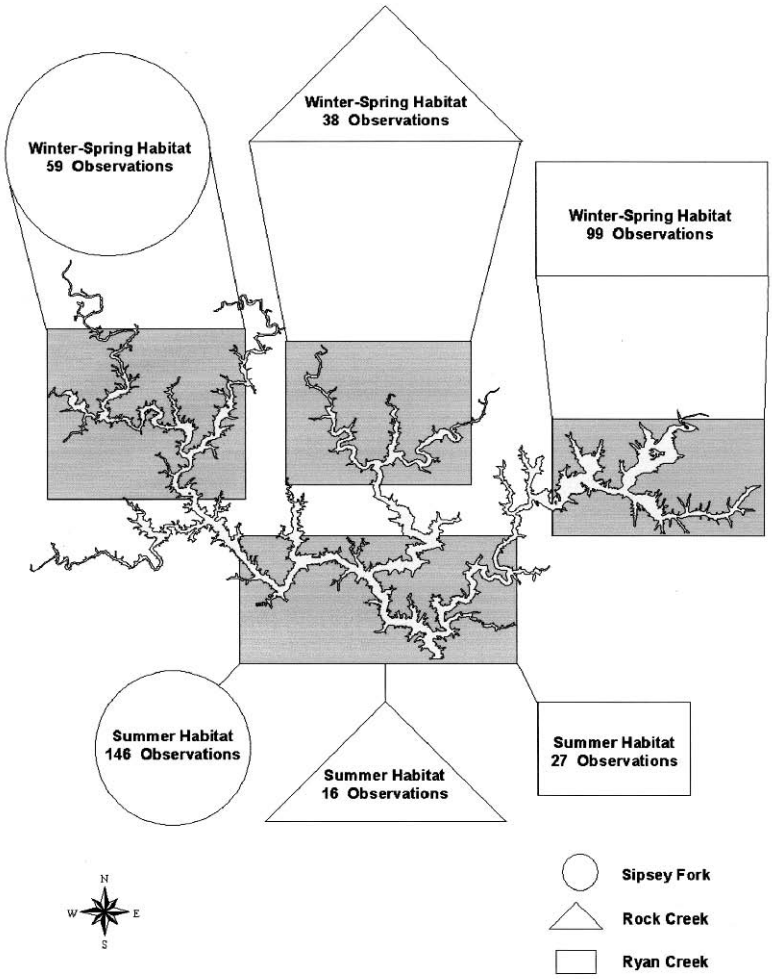

Figure 2. Seasonal distribution of striped bass in Lewis Smith Reservoir, Alabama. Shaded regions indicate areas where 22 striped bass were tagged, tracked and monitored during the three-year study. As the reservoir began to stratify during summer months, striped bass migrated from upstream tributaries to the main reservoir as a result of habitat degradation.

August striped bass typically migrated into the lower section of the reservoir taking advantage of higher dissolved oxygen levels and lower water temperatures.

Three hundred eighty-five individual observations were recorded from 22 transmitter-equipped striped bass during the three-year study. One hundred eighty-nine observations were from an area of the lower reservoir that we classified as summer habitat while 196 observations were recorded from three winter–spring habitat regions located in upper tributaries of the reservoir (Fig. 2). Data from our study sug-

gests that striped bass begin downstream movement when water temperatures in upper strata (<15 m) approached 25 C and dissolved oxygen concentrations measured <4 ppm (Fig. 1).

Transmitter-equipped striped bass in Lewis Smith Reservoir exhibited a high degree of mobility during periods of translocations, often moving distances of ≥35 km within a few days (Table 1). Mean daily movement for male and female striped bass was 319 and 538 m, respectively; however, this was not significantly different ($P > 0.05$). Data indicates that striped bass had greatest mean movements during winter and early spring months when fish were widely distributed throughout the lake and beginning to congregate in staging areas. Fish moved least during late summer months when surface water temperature exceeded 30 C and habitat in upstream tributaries degraded forcing fish downstream into the main arm of the reservoir until mid- to late October when temperatures decreased to 25 C or lower. This suggests that water temperature may be the most important determining factor of habitat suitability for striped bass and their movement and distribution patterns are related to behavioral thermoregulation.

Striped bass showed a tendency to stay within an average of 6 km of where they were captured during the winter and spring months. Although distinct home ranges were established, striped bass made short forays from their home range into other arms of the reservoir. These movements consisted of distances as far as 40 km, but were of short duration, lasting less than two weeks.

As summer progressed and the reservoir began to stratify, striped bass showed a tendency to move downstream into the lower reservoir where water quality and dissolved oxygen were more favorable. This downstream movement occurred within a matter of days and summer home ranges were established. Summer home ranges were not as large as that observed during the other seasonal periods. Most movement during the summer was <1.5 km. Tagged striped bass generally stayed in the lower reservoir through September. When the reservoir destratified, fish would move upstream into the major tributaries. By November the fish had returned to their original home ranges in the upper reservoir.

Four striped bass that were followed for the entire study showed distinct homing patterns to specific areas of the reservoir. These fish would establish home ranges during the fall, winter, and spring in the same locations each year. During the summer, home ranges would also be established in downstream sites, varying little from year to year.

In our study, mortality of tagged striped bass resulting from handling and surgical procedures was low. Only one fish died as a result of post-surgical complications; however, mortality resulting from angler harvest appeared to be relatively high. Anglers caught 27% of our transmitter-equipped fish and seven additional striped bass may have been harvested (59%) suggesting this species has relatively high exploitation rates in Lewis Smith Reservoir.

Table 1. Sex, total length, weight, number of observations *(N),* months tracked, movement, and maximum distance between relocations of striped bass in Lewis Smith Reservoir, January 1999–September 2001.

Tag number	Sex	Total length (cm)	Weight (kg)	Observations *(N)*	Months tracked	Movement (m/day)	Maximum distance between relocations (km)
266	M	58.4	2.7	41	30.7	318	35.5
293	M	71.0	5.5	5	3.0	840	58.0
377	M	71.1	3.6	12	14.4	270	50.0
467	M	73.0	5.5	16	19.2	315	34.7
284	M	76.2	6.8	10	6.0	199	11.3
269	M	76.2	5.9	14	19.5	336	55.5
368	M	76.2	4.5	21	20.3	257	37.0
356A	M	76.2	6.4	22	8.2	188	8.8
239	M	77.0	5.4	11	5.3	48	1.6
338	M	77.5	4.0	11	4.0	250	5.6
359	M	96.5	9.1	24	20.3	492	41.9
566	F	76.0	5.5	20	12.4	394	36.3
449	F	76.0	8.6	5	18.6	87	32.3
278	F	78.0	6.4	19	18.7	89	12.1
347	F	81.0	7.7	12	1.6	2600	38.7
446	F	91.0	9.1	47	31.3	261	55.6
257	F	94.0	13.6	42	32.0	334	43.5
356B	F	96.5	11.3	24	19.4	165	23.3
248	F	101.0	17.0	48	27.8	372	44.4

Discussion

Information about striped bass distribution and movement in relation to changes in water quality and temperature in Lewis Smith Reservoir provides a model for evaluating previous studies and predicting the behavior of striped bass in large southern impoundments and reservoirs. Research in other southeastern reservoirs has indicated that distribution and movement patterns of striped bass are influenced by factors such as water temperature, dissolved oxygen concentrations, water flows, and spawning cycles (Cheek et al. 1985, Moss 1985, Schaffler et al. 2002). Previous studies have shown the behavior of striped bass populations in other southern reservoirs was similar to that found in Lewis Smith Reservoir. Cheek et al. (1985) reported that distribution of striped bass in Watts Bar Reservoir, Tennessee, was influenced by water temperature and dissolved oxygen levels and during summer months fish were less mobile and limited to areas within the reservoir where temperatures were less than 24 C. Movement of striped bass in J. Strom Thurmond Reservoir, Georgia-South Carolina, was in direct response to behavioral thermoregulation, and fish migration from tributaries to the main reservoir resulted from habitat degradation (Young and Isely 2002). Radio equipped striped bass in Lake Murray, South Carolina, tended to concentrate in the lower embayment of the reservoir during mid-summer but dispersed into upstream headwater regions in the fall as temperatures dropped (Schaffler et al. 2002). Downstream migration of striped bass in response to

higher water temperatures and unfavorable habitat has also been reported from Lake Whitney, Texas (Farquhar and Gutreuter 1989); Keystone Reservoir, Oklahoma (Combs and Peltz 1982); Lake Texoma, Oklahoma-Texas (Matthews et al. 1989); and Percy Priest Reservoir, Tennessee (Stooksbury 1977). However, during summer months in some reservoirs, striped bass are known to utilize tailwater regions that provide cool oxygenated waters which are occasionally impacted by hypolimnetic discharges from upstream dams (Moss 1985, Cheek et al. 1985, Wilkerson and Fisher 1997).

The capability of tracking several fish for multiple years provides insight on the site fidelity of striped bass. Several fish that were tracked for two years showed a tendency to return to the area of original capture after fall dispersal. Although fish were found in other tributaries during the winter and spring, these movements were of short duration and the fish returned to their home tributaries. Several fish also showed strong site fidelity during the summer, relocating to the same areas each year. These movement patterns are similar to that observed by Young and Isely (2002) for striped bass in J. Strom Thurmond Reservoir, South Carolina/Georgia.

Other tracking studies involving striped bass indicate that mortality was a significant factor in reduction of sample size (Jackson and Hightower 2001, Schaffler et al. 2002). Mortality estimates for transmitter equipped striped bass ranged from 50% at Lake Murray, South Carolina, to <10% in Kerr Reservoir Oklahoma (Schaffler et al. 2002). Our study indicated that mortality of tagged striped bass was between 27% and 59%, primarily from angler harvest.

In summary, the distribution and movement patterns of transmitter-equipped Gulf striped bass in Lewis Smith Reservoir over a three-year period indicate these fish prefer the cooler deeper sections of the reservoir during the warmer summer months when stratification occurred. During the winter, late fall, and early spring months, striped bass were typically distributed throughout the reservoir. Tracking results indicated that tagged striped bass were very mobile and could travel long distances (30–35 km), relocating in various tributaries of the reservoir during seasonal transitions, but would frequently establish 2–10 km home range patterns during summer periods.

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