Spatial and Temporal Movements of Striped Bass in the Upper Alabama River

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Abstract: A radio-telemetry study was conducted to determine spatial and temporal movements of adult striped bass (*Morone saxatilis*) in the Jones Bluff section of the Alabama River. Five fish were successfully implanted with radio transmitters during the summer of 1981 and the spring of 1982. These fish made extensive use of the Thurlow Dam tailwater on the Tallapoosa River. The fish arrived at Thurlow Dam in the spring when temperatures ranged from 16° to 17.5° C and left the tailwaters in late fall and early winter when water temperatures decreased to 19.5° and 18.5° C in 1981 and 1982 respectively. Study fish overwintered in the Alabama River/Jones Bluff Reservoir 145 to 177 km downstream from Thurlow Dam. In Thurlow Dam tailwater, peak striped bass movement occurred at dawn and dusk. One major holding site was used during daylight hours when water was not being released and 3 additional sites were used when it was; movement between sites accounted for most daylight movement. At night, fish made continuous low speed movement, which was primarily oriented toward shallow areas in the tailwater basin.

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The Alabama River, Alabama, once supported a population of Gulf Coast strain striped bass that ascended the system upstream to the fall line dams, Jordan on the Coosa River, and Thurlow on the Tallapoosa River. During the mid-1960s upstream landings of striped bass declined concurrent with the construction of 3 Locks and Dams on the system, the most upstream on the Alabama River forms Jones Bluff reservoir. In 1965 the Alabama Department of Conservation and Natu-

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ral Resources initiated a striped bass stocking program with the release of Atlantic Coast strain striped bass fingerlings into Lake Martin on the Tallapoosa River. The program has expanded and fingerlings have been stocked into nearly every major reservoir in the Alabama River system. Stocking success, relative to harvest rates of larger fish, has been cause for concern (Moss 1985). Although Jones Bluff Reservoir had received the greatest portion of annual stockings, adult striped bass catch rates were lower than expected.

Recent studies have suggested that warm summer temperatures greatly influenced striped bass behavior (Dudley et al. 1977, Coutant and Carrol 1980) and that availability of suitable summer habitat may limit striped bass populations in the southeast (Coutant and Schaich 1980). Earlier work in the Jones Bluff section of the Alabama River (Bryce and Shelton 1982) documented the occurrence of false annuli on 80% of the adult striped bass examined on the Tallapoosa River in Thurlow Dam tailwater. It was postulated that mid-summer growth was impaired by a reduction in available prey for those fish using the Thurlow Dam tailwater as a thermal refuge. The need to further examine striped bass use of this tailwater area resulted in the present study. Its major objective was to examine the spatial and temporal use of the Thurlow Dam tailwater by resident adult striped bass.

Methods

The Alabama River is formed in central Alabama by the union of the Coosa and Tallapoosa rivers (Fig. 1). A lock and dam located 111 km downstream forms Jones Bluff Reservoir; at this point the Alabama River drains 41,441 km^2 (Lawrence 1974). The reservoir's average retention time is 7 days.

Both the Coosa and Tallapoosa rivers have numerous regulatory dams. The most downstream of the dams on the Coosa River form the Lake Jordan-Bouldin complex. Bouldin Dam was built (1971) in order to modernize equipment and to take advantage of a greater hydroelectric head potential. The majority of the Coosa River's discharge passes through Bouldin Dam with minimal discharge through Jordan Dam.

Thurlow Dam forms the last downstream reservoir on the Tallapoosa River. Upstream hypolimnetic release tempers annual temperature fluctuations below Thurlow dam. The lower Tallapoosa has an annual temperature range from 6° to 24° C compared to the lower Coosa which ranges from 4° to 33° C. From Thurlow Dam the river flows on for 81 km to where it joins the Coosa River.

All of the radio-telemetry equipment was commercially purchased and used without modification. The implantable transmitters (Wildlife Materials, Inc., Carbondale, Ill.) consisted of a 1-stage unit at 40 mhz mounted with an 1,800-milliampere hour lithium battery that imparted a 660-plus day life. The transmitters weighed 37 g and displaced 24 ml. The tracking system consisted of a Smith-Root RF-40 radio receiver, antennas, and earphones. Tracking was conducted on foot, by boat, and on 2 occasions by plane. An omnidirectional whip antenna was used during the search phase when a fish's general location was unknown. Fish positions

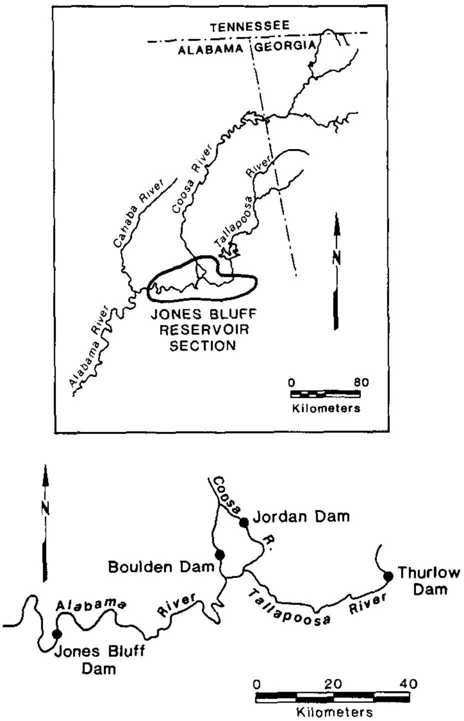

Figure 1. The Alabama River system with an enlargement of the Jones Bluff Reservoir Section.

were determined by triangulation using the directional loop antenna. Individual fish were distinguished by their tag's frequency and pulse rate.

All collection effort extended over the 2-km stretch of the Tallapoosa River immediately below Thurlow Dam. Attempts to collect fish with gill nets and by angling resulted in four mortalities following implantation and release. Collection by electrofishing resulted in 3 successful implants in July 1981 and 2 in June 1982 (Table 1). Stunned fish were placed in a live tank containing quinaldine and provided with oxygen.

Transmitters were internally implanted using a technique similar to that used by Hart and Summerfelt (1975) and Moss (1985). MS-222 was used in concentrations of 100 ppm in the operating box and a solution of 2,000 ppm was sprayed onto the gills as needed. Incisions were made laterally below the ribs and mid-way between the pelvic fin insertion and the anus. Incisions were closed with braided silk tied in 5 to 7 interrupted surgeon's stitches. Aseptic conditions were not maintained and no antibiotic was used. The anesthetized fish were revived in the river and released. Scales removed for aging were taken from the left side of each fish, below the lateral line and beyond the extended pectoral fin. Four to 5 scales from each fish were mounted between glass slides and examined on a projecter under 43× magnification.

Table 1. Summary of radio transmitter tagging of striped bass in 1981 and 1982.

Tag number	Total length (mm)	Age (yr)	Initial tracking date	Final tracking date
704	794	8	7-30-81	5-25-83
805	914	9	7-30-81	8-16-83
855	787	7	8-19-81	3-5-82
755	721	5	6-7-82	6-29-82
904	756	6	6-7-82	2-10-83

Transmitter equipped fish were located a minimum of once weekly while residing in Thurlow Dam tailwater. The area was monitored more frequently during periods of fish immigration and emigration. Monitoring outside the tailwater area was conducted biweekly during the 1981–82 winter and once in 1983. Diel movements of striped bass in Thurlow Dam tailwater were monitored in complete 24-hour blocks. In 1981 diel data was collected once in August and once in September, while in 1982, 2 periods in July and 3 in August were monitored. Fish positions were determined every half hour and were recorded on a grid-coordinate overlay map. Distance traveled per hour was pooled and divided by fish and date in order to produce mean hourly distance traveled. Four-hour intervals (starting with 0000 to 0400) were summed and compared using Duncan's multiple range test.

Results

During the study period from July 1981 to June 1983, approximately 350 individual sightings were made from which a repeated annual movement pattern was noted. Fish overwintering in the Alabama River/Jones Bluff Reservoir began leaving winter holding sites in early March and moved upstream. They arrived at Thurlow Dam from 30 April to 25 May in 1982 when water temperatures ranged between 16° and 17.5° C (Fig. 2). In 1983 they arrived from 14 May to 9 June and remained in the immediate tailwater of Thurlow Dam during the summer and fall.

Fish departed the Thurlow Dam tailwater during the second week of November in 1981 and during the third week of December 1982. All fish monitored both years departed within days of each other and these departures appeared to be associated with declining winter temperatures (Fig. 2). In 1981, departure was associated with a temperature of 19.5° C while in 1982 the temperature at departure was 18.5° C. All study fish relocated downstream in the Alabama River/Jones Bluff Reservoir. Here they typically selected individual holding sites at the edge of the current within 10 meters of shore and remained at these same sites throughout the winter. At no time were any of the study fish found co-occupying a winter holding site, and 1 fish was observed using the same site during 2 successive winters.

Mean hourly movements of all study fish combined over 7 observational periods (N = 20) conducted during 1981 and 1982, in Thurlow Dam tailwater, are shown in Figure 3. Power generation throughout this period of observation typically

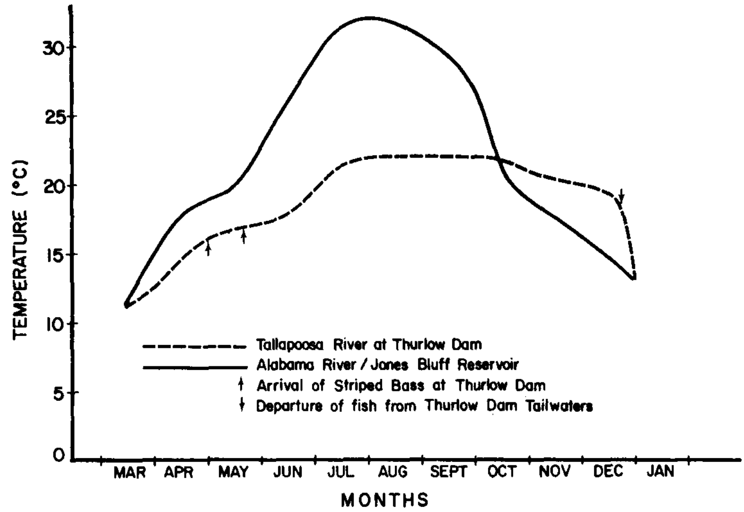

Figure 2. The 1982 surface temperatures of the Tallapoosa River at Thurlow Dam and the Alabama River/Jones Bluff Reservoir.

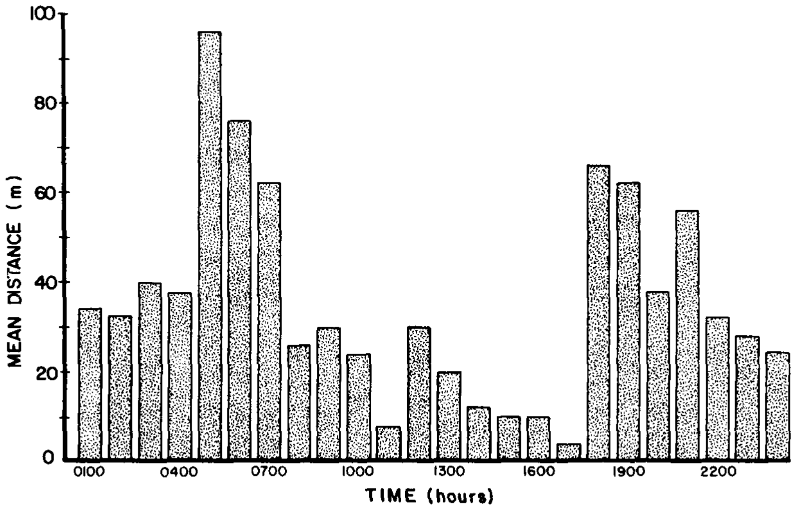

Figure 3. Mean hourly distance traveled by study fish in Thurlow Dam Tailwaters, combined over the 7 observation periods conducted during the fall of 1981 and the summer of 1982.

occurred from 1200–2200 hours. Peak periods of movement occurred between 0500 and 0800 hours and again between 1800 and 2200 hours. The results of a Duncan's multiple range test demonstrated a significant difference ($P \leq .05$) between the 4-hour period from 0400–0800 and the remaining periods of pooled movement.

All study fish used 1 major holding site and 3 minor ones, with movement during daylight hours consisting of movement between these sites (Fig. 4). Movement from dusk to dawn was oriented towards shallow sites, particularly the downstream shoal area. As light intensities increased, these fish moved to deeper areas and remained active until the sun's light shown directly on the river. During times of high light intensities, fish selected the major mid-river site characterized by an abrupt 3 m drop off and having a total depth of 7 m. When water was being released, study fish made additional use of 3 minor sites upstream that offered protection from swift current and presumably access to entrained fish and current influenced prey.

Maximum observed swimming speed during the study was 1.2 km per hour (0.33m/second) but speeds of this magnitude were never maintained for longer than 40 minutes. Daylight movements were characterized by rapid movement over short distances, while night movements were slow and continuous, covering large distances.

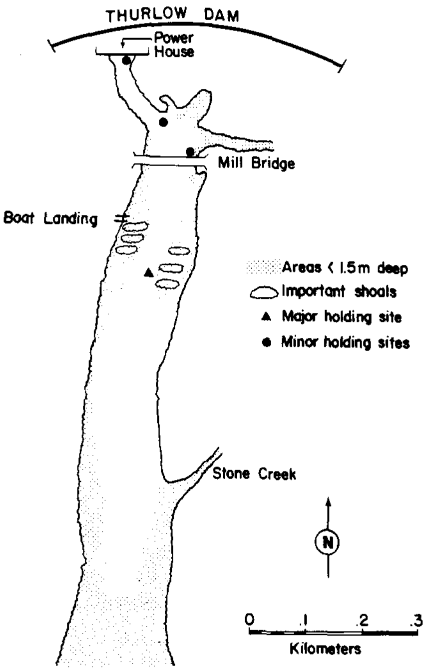

Figure 4. The Tallapoosa River bed immediately below Thurlow Dam during normal generation release.

Discussion

Annual migration

Adult striped bass tagged in this study repeatedly utilized Thurlow Dam tailwater during the spring, summer, and fall. Thermal related selection of the Tallapoosa River by adult striped bass during upstream migration was not obvious, but the divergence of summer temperatures between the Alabama River/Jones Bluff Reservoir and the Tallapoosa River is quite dramatic (Fig. 2). It appears to be physiologically advantageous for adult striped bass to avoid warm summer temperatures by maintaining residency in the Tallapoosa River, yet the radio-equipped fish arrived at Thurlow Dam before temperatures in the Alabama River reached proposed upper limits. The initial selection of the Tallapoosa River is probably made on some basis other than temperature, yet this selection would appear to be beneficial later in the season.

As striped bass ascend the Alabama River/Jones Bluff Reservoir in the spring, they are faced with 3 major alternative paths: the Bouldin Canal, the Coosa River channel, or the Tallapoosa River. At this time, discharge at Bouldin Dam and Jordan Dam produce an attractive flow to migrating striped bass as adult striped bass are angled in this area. While Bouldin Canal has no barriers to fish emigration, return travel down the Coosa River may be prevented by drastic flow reduction following the period of high spring runoff. This could explain the presence of adult striped bass at Jordan Dam during the summer when the water temperature rises above the predicted tolerance level and dissolved oxygen level drops to 25% of total saturation (Jackson, pers. commun.).

Egg and Larval fish collections made during 1976 and 1977 (Pestrak 1977, Cook 1978), when repairs were underway on Bouldin Dam, showed eggs and larvae of striped bass in the lower reaches of the Tallapoosa, but not in the Coosa. The tailwater area of Thurlow Dam is thought to be the system's principal striped bass spawning ground (Bryce 1982). In the present study, arrival of the male preceded that of the female by 3 weeks in succesive years. Between years, group arrival was offset by 2 weeks, but still occurred while water temperature was within the spawning range. The timing of special flow regimes designed to enhance natural reproductive success is important in maximizing their benefit. A combination of water temperture (17.5° C), historical dates, and observed fish presence should be used in making this determination as individually these factors fail to be adequate predictive tools.

Following the spawning season, striped bass typically return to the ocean, but on the Pacific Coast (Radovich 1963) fish remained in the coastal streams. Dudley et al. (1977) showed that striped bass in the Savannah River, Georgia, moved upstream after spawning. After immigrating in the spring, all transmitter-equipped fish remained in Thurlow Dam tailwaters until late in the year. This behavior cannot be explained on the basis of an abundance of either entrained fish or prey. Although gizzard shad (*Dorosoma cepedianum*) are abundant in the early spring, they were rarely collected while electrofishing in mid-summer (Bryce and Shelton 1982), yet the adult striped bass remained within the tailwater area.

Diel Activity Patterns

In this study, diel movement was monitored in a variable flow tailwater area but unlike previous studies, all diel activity was monitored outside of the spawning season and without the influence of temperature stratification. Dudley et al. (1977) reported that postspawning fish in upstream areas generally moved at night. This observation is consistent with the summer behavior of the fish in Thurlow dam tailwater. Coutant and Carrol (1980) found that quarry fish rarely remained in one location and continually cruised the entire shoreline; on the other hand, fish in Cherokee Reservoir, Tennessee, moved about a submerged coolwater stream bed and displayed periods of quiescence. Movements of striped bass in Thurlow Dam tailwaters more closely resembled the behavior of Cherokee Reservoir fish, although no diel pattern of activity versus quiescence was noted in that study. Quiescent fish may still be feeding on entrained fish or current influenced prey. Still, Thurlow Dam fish were inactive during no-flow and high-light intensity periods.

Comparison of mean hourly movement (Fig. 3) was complicated by daylight and flow. Periods from 2300 hours to 1100 hours had no detectable flow, so movement here is unaffected by this factor. Throughout the study, though, flow was generally encountered from 1200 to 2200 hours. At dawn, activity increased as fish ranged widely, then decreased as light intensity increased. The generalized reaction to flow initiation at 1200 hours was seen as a slight increase in distance traveled. This represents movement from the 1 major holding site to minor ones associated with flow. Following this mid-day increase, movement decreased again as fish settle in these sites. Activity increased again at dusk and slowed when flow ceased around 2200 hours. Statistical comparisons of fish movement during flow and non-flow periods could not be made because of the sample size and the associated variance, but a basic difference in orientation was apparent. Fish movement during periods of flow was primarily upstream towards higher turbulence. Rapid movement with short stops characterized dusk flow periods, but when flow ceased fish resumed a steady cruising behavior directed towards shallow areas in the basin below Thurlow Dam. The statistical difference shown between fish movement during 4-hour periods of the day is thus a result of both light intensity and water flow, the effects of which could not be separated.

In summary, it is apparent that adult striped bass in the upper Alabama River make extensive use of Tallapoosa River. That this selection is based on a temperature preference is not clear. If Thurlow Dam tailwaters provide the only suitable summer habitat in this system, late summer prey availability may limit the size of the adult population. Finally, water flow and light intensity appear to be major factors affecting daily behavior of striped bass in Thurlow Dam tailwater.

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