Walleye Spawning, Movements, and Habitat Usage in Tombigbee River Drainages

Roger W. Kingery,[1] *Mississippi Cooperative Fish and Wildlife Research Unit, P.O. Drawer BX, Mississippi State, MS 39762*

Robert J. Muncy, *U.S. Fish and Wildlife Service, Mississippi Cooperative Fish and Wildlife Research Unit, P.O. Drawer BX, Mississippi State, MS 39762*

Abstract: A total of 13 radio-tagged walleyes (*Stizostedion vitreum vitreum*) were monitored from spring through summer in 1986 and 1987 in Luxapalila Creek near Columbus, Mississippi. Movements indicated pre-spawning aggregation in the lower Luxapalila Creek during January and February, upstream spawning March through early April, and widely varying downstream post-spawning movements. Seasonally high water discharges in March were cues for upstream movements to pool areas below spawning sites at shallow (<1.5 m) gravel riffles. High discharges restricted spawning and possibly reproductive success. Three groups of walleyes spawned in Luxapalila Creek: residents of the upper stream, of the Luxapalila Park area, and of the Tennessee-Tombigbee River. Lower Luxapalila Creek was an important summer holding area. Little nighttime feeding occurred during summer high water temperatures (28°–31°C). Walleyes preferred water with high dissolved oxygen and were associated with wooded structure during 73% of daytime observations. Proposed alteration of Luxapalila Creek for flood control includes removal of wooded structure, dredging of gravel spawning areas, and construction of an inflatable dam that could impede the spawning movements of walleyes as well as other species.

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In Mississippi, walleyes were historically and are now distributed throughout the Tombigbee River system and its tributaries. Murphy and Lee (unpubl. transcripts from 48th Midwest Fish and Wildl. Conf. 1986) electrophoretically analyzed walleyes from 13 different states across the United States and found that Tombigbee River walleyes were uniquely fixed for all nine loci examined. The Gulf Coast walleye stock (Cook 1959, Brown 1962) is unusual in that, while self-sustaining in riverine waters, it does not become established in reservoirs. The largest popula-

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[1] Present address: Fairport Fishery Research Station, 421 High St., Fairport, OH 44077.

tions occur in relatively cool streams, particularly below discharges from hydroelectric dams (Hackney and Holbrook 1978).

The purpose of this study was to examine the spawning movements of walleyes from the Tennessee-Tombigbee Waterway (TTW) and its tributary Luxapalila Creek; channels had been modified in both waters and were scheduled for further modifications. Proposed alteration of 30.89 km of the Luxapalila's channel includes the removal of log and brush pile cover, dredging of the gravel riffle areas to a uniform depth and construction of an inflatable dam at the site of old bridge pilings at km 9.58. We used radio-telemetry to observe the movements of adult walleyes through spring and summer, to determine spawning sites, and to identify spring and summer habitats. This research was funded by the Mississippi Department of Wildlife Conservation under Federal D-J Project F-73, through the Mississippi Cooperative Fish and Wildlife Research Unit (sponsored by the U.S. Fish and Wildlife Service, Mississippi State University, Mississippi Department of Wildlife Conservation, and the Wildlife Management Institute).

Methods

The Tombigbee River has undergone extensive channelization and habitat modification by the TTW project, which began in 1971. Realignment of the TTW navigational channel resulted in widened river bends and increased numbers of cutoffs. Completion of locks and dams along the entire TTW has transformed the once free-flowing Tombigbee River into a series of controlled lakes. A 2-lane boat ramp constructed at Luxapalila Park and Recreation Area (river km 0.2) provided ready access to lower channelized Luxapalila Creek and the TTW.

Luxapalila Creek, which has a 207,718-ha watershed, originates near Winfield, Alabama, and flows southwesterly 120.68 km to the TTW, entering just south of Columbus, Mississippi. In Mississippi, it is characterized by a gradient of 0.70 m/km, a mean width of 22.15 m, and a mean bank width of 4.30 m (Arner et al. 1969). Channelization of the lower 3.3 km of Luxapalila Creek was completed in 1973; the remaining unaltered reach consists of classic pool-riffle sequences. Rapid fluctuations in water discharges during fall and spring continually change the physical constituent of the channel. Ranges for dissolved phosphorus were <0.01 to 0.03 mg/liter, total phosphorus as <0.01 to 0.09 mg/liter, and alkalinity as 5 to 8 mg/liter for October 1984 to September 1985 (USGS 1985, 1986). Luxapalila Creek has relatively low turbidity and high dissolved oxygen (Arner et al. 1975).

Gill nets were set in Luxapalila Creek at km 10–12 from 6–13 March 1986 before dusk and lifted every 1 to 2 hours until about 0100 hours. In 1987, the capture area was changed to incorporate the lower 2.4 km of Luxapalila Creek (including Luxapalila Park area) for the periods 27 January–18 February and 23–25 April in order to document upstream spawning movements from this area.

Walleyes collected were weighed and measured, and scale samples were taken on all fish collected; fish weighing <0.90 kg were tagged below the dorsal fin with numbered Floy tags; larger walleyes were implanted with 25-g radio transmitters before being Floy tagged; the ratio of the weight of the transmitter to that of the fish was kept within or below the recommended range of 1.5% to 2% (Advanced Telemetry Systems 1982, Negus 1982).

Anesthetized walleyes were placed head down into an operating trough (Courtois 1981) with head and gills submerged in a 1-mg/liter solution of tricaine methanesulfonate while a cushioned aeration stone in the fish's mouth provided oxygen flow across the gills during surgery. Equipment disinfection and transmitter implantation followed procedures described by Hart and Summerfelt (1975), Pitlo (1978), and Brown and Richards (1979). Walleyes were immediately released into quiet backwater pools containing cover and free river access.

A programmable receiver and directional loop antenna were used to track and pinpoint the locations of radio-tagged walleyes after a search with a boat-based whip antenna or a large loop antenna mounted on the wing strut of an airplane for broad backwater areas of the TTW. Monitoring frequency was at least 3 times per week until late summer, when it was reduced to twice weekly. When the location of a walleye was pinpointed, the location and associated habitat were recorded and plotted on a large-scale map. A Hydrolab unit was used to obtain a weekly surface to bottom water chemistry profile, in 1-m increments, at each fish location for depth (m), dissolved oxygen (mg/liter), temperature (°C), conductivity (mmho/cm), and oxidation-reduction potential (mV). This sampling scheme was modified in 1987 to include water chemistry profiles on each monitoring day at the location of each fish, its previous location, and at 3 fixed stations in lower Luxapalila Creek.

Nighttime movement was monitored from dusk to 2400 hours during alternate weeks from April to July. In view of the absence of daytime movement and the extensive literature documenting nighttime feeding of walleyes, we assumed that nighttime movement patterns were representative of feeding patterns. We tracked each fish continuously to determine its location at 15-minute intervals, and recorded movement, distance, speed, and change in signal strengths to define the fish's activities.

We obtained discharge rates and gauge heights for 1983–1987 from the Water Resources Division of the Department of Interior for the Tombigbee River at Columbus (Site 02441390) and the Luxapalila Creek near Columbus (Site 02443500). During a short low-water period from 30 July to 1 August 1987 we used a chart-type depth recorder to document bottom habitat structure used by walleyes in 1986–1987.

Inasmuch as movement, discharge, bottom dissolved oxygen, and bottom temperature showed skewed seasonal distributions, we transformed the data to normalize distributions (Kingery 1988). Movement data were analyzed with Statistical Analysis Systems (SAS) discriminate function and multiple regression functions for relations between discharge, bottom dissolved oxygen, and bottom temperature. A paired *t*-test of the difference of bottom dissolved oxygen between the present and previous location assessed the preferential choice by walleyes.

Results and Discussion

The walleyes matured at ages of 2 to 3 years for 12 of 13 males and 3 to 4 years for 9 of 10 females during netting in 1986–87. Schultz (1971) found that males reached maturity at age 2 upon attaining total lengths of 355–382 mm. This size range corresponded to the lengths of male walleyes of TTW at age 2 during 1986–87. Ovarian observations led Schultz (1971) to conclude that females probably reached sexual maturity at age 3 when total lengths exceeded 432 mm. Netting data and radio-telemetry observations (1986–87) for 13 walleyes supported Schultz's (1971) report that TTW walleyes spawned from mid-March to early April, when water temperatures were 8.8° to 12.7° C. Walleye movement data in Luxapalila Creek indicated that the fish spawned in shallow (<1.5 m) gravel riffle areas above pools in which they were holding as observed by Schultz (1971).

Elevated discharge rates seemed to serve as cues for walleye spawning movement. The fish responded to higher discharges in late January to mid-February, while using the lower reaches of Luxapalila Creek as a pre-spawning stage area. High discharges from late February to early March coincided with the more consistent high annual discharge levels. Netting data in 1986 indicated upstream movement and spawning during low water periods, and Mississippi Department of Wildlife Conservation fisheries biologists consistently caught spawning walleyes in upper Luxapalila Creek in previous years under similar conditions (C. A. Schultz and W. D. Hubbard, pers. commun.).

The reproductive success of TTW walleyes was proposed by Schultz (1971) to be directly correlated to water levels. Wingo (1982) found that a strong 1978 year class coincided with below-normal discharge rates at the Columbus, Mississippi, gauge for February to April 1978; he suggested that water level during the spawning period is a limiting factor on walleye production in the Tombigbee River Drainage and may also affect growth rate.

No radio-tagged walleyes were believed to have spawned in 1987 because discharge levels were high. None were observed holding near riffle areas; all remained in sheltered backwater areas. Paragamian (1987) reported that downstream movement of walleyes in Iowa was associated with flood discharges and later upstream movement with receding water levels. Pitlo (1985) reported that Mississippi River walleyes in Pool 11 chose calmer areas as discharge rates increased and Faler (1985) found a highly significant relationship between use of embayments and water discharge.

Walleye movements in 1986 and 1987, together with previous and concurrent netting data from Mississippi Department of Wildlife Conservation fishery biologists, indicated that Luxapalila Creek was an important spawning area for walleyes living in the TTW, in Luxapalila Park area, and in the upper portion of Luxapalila Creek. Similar downstream post-spawning movements in 1986 and 1987 are the basis for the assumption that 7 of the 9 walleyes captured in the upper portion of Luxapalila Creek in 1986 came upstream from the TTW and lower Luxapalila Creek. The Luxapalila Park area (river km 0–2.3), which has greater depths, an irregular cluttered bottom, and more lotic conditions, appears to be an important pre-spawning stage area for walleyes from the TTW, as well as a post-spawning and summer holding area.

The wide range of seasonal movements by walleyes in the present study seems characteristic of river or stream run stocks (Smith et al. 1952, Pitlo 1985). Maximum movements of 13 walleyes from release sites in 1986 and 1987 were 4 to 43 km (Fig. 1). With coefficients of variation of less than 5%, the relation between discharge and fish movements suggested individualistic behavior among walleyes, as was also reported by Pitlo (1978). During flood conditions, some walleyes moved into quiet backwaters and showed no correlation between downstream movement and discharge, whereas others moved long distances downstream. Stepwise multiple regression analyses of the movements of our 13 radio-tagged walleyes, when correlated with one or more environmental factors (Ager 1976), revealed no statistically significant pattern.

Backwaters were used only during floods, when walleyes left the confines of the Luxapalila Creek channel. Unlike the behavior observed for northern Wisconsin walleyes (Priegel 1970, Colby et al. 1979), Luxapalila Creek walleyes did not move into shallow, calmer, inundated areas to spawn during periods of high water, where water fluctuations could potentially strand walleye fry and eggs.

Annual walleye growth and survival may be affected by maximum summer temperatures (Wrenn and Forsythe 1978). Bottom temperatures at recorded walleye locations reached a maximum of 31° C on 18 August 1986 whereas most July readings for 1986 and 1987 ranged from 27° to 30° C. Walleye avoidance of areas of high temperatures agrees with Schultz's (1971) speculation that walleyes may not tolerate prolonged water temperatures much in excess of 29.4° C. In Tennessee, water temperature played an important role in habitat selection (Ager 1976, Fitz and Holbrook 1978). Paired *t*-testing of the difference of bottom dissolved oxygen between previous and present locations showed significant ($P = 0.0048$, $N = 108$ observations) choice.

Movement began between 2000 and 2015 hours, usually after the end of the

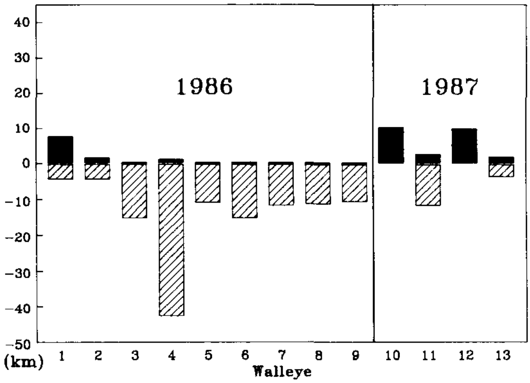

Figure 1. Maximum movements of walleyes upstream (solid) and downstream (segmented) from release sites, for walleyes 1–9 in 1986 from km 12 and walleyes 10–13 in 1987 from km 0.21.

twilight period and setting of the moon, as found by Eschmeyer (1950), Kelso (1976), and Holt et al. (1977). Ager (1976) found that nocturnal walleye activity in reservoirs peaked near midnight from April to September, especially on clear nights. Ryder (1977) suggested light as the principal abiotic environmental variable that determines temporal and spatial dimensions of feeding in walleye. Increasing summer temperatures seemed to influence the amount of feeding movement during nighttime observations. Walleyes showed a steady, cruising foraging style in April; a "rest-and-go" style in May and June, when movements were linear and intermittent in short bursts of about 9.1 m every 15 to 20 minutes, as found by Pitlo (1978); and a "comb-a-confined-area" style in July.

Limited summer movement, especially nighttime activity, by walleyes in the TTW is believed to have resulted from 2 main factors: First, personal observation of small fish breaking the water around tree structures at walleye locations suggested localized concentrations of forage fish: and second, high water temperatures uniformly ranging between 29° and 31° C from top to bottom during the observation period stressed walleye metabolism (Ney 1978). These 2 factors could explain the different summer nighttime movement patterns between walleyes in the TTW and the lower reaches of Luxapalila Creek. Walleyes living in the deepest TTW waters showed the smallest daily movement rates and ranges. Pitlo (1978) found a similar situation in Iowa.

Walleyes use wooded cover associated with the creek bottom for possible shading (Ryder 1977) and deflection of the water current. Walleyes used wooded structure during 73% of 438 observations (Table 1). These structures in turn provide colonization sites for algae and benthos, which may attract forage fishes eaten by walleyes. In a Georgia coastal plain stream, Benke et al. (1985) found that, although snags were only 4% of the total available habitat for fish-food animals, they supported 60% of the total invertebrates and produced about 78% of drifting invertebrates. Snag-based foods were at least 60% of the total diet of sunfish in that stream.

Table 1. Percentages of habitat usage by Tombigbee River Basin walleye.

Habitat	Habitat usage
Bottom Brush	
Light	26.0%
Heavy	23.0
Logpile	12.6
Brushy eddy	5.9
Cypress roots	5.7
Eddy	8.7
Open water	8.7
Quiet pool	3.7
Other	5.7
	100.0%

Much of the walleye fishing pressure is focused on the Luxapalila Park area which is an important walleye pre-spawning staging and summer holding area. Angling mortality during tracking was believed to be 44% (4 of 9) in 1986 and 50% (2 of 4) in 1987. Radio-tracking of walleyes during 1986 in view of nearby construction workers at km 10 in Luxapalila Creek resulted in the loss of 2 walleyes by the next 2-day tracking period, but viewing of tracking procedures by anglers or other public did not contribute to the 1987 mortalities. These rates, if applicable to the population, show heavy angling pressure (40%–50% fishing mortality) on the walleye population.

During 1986 and 1987 upstream and downstream spawning movements, walleyes passed through the proposed dam site at km 9.8. We believe desnagging could remove important walleye cover. Dredging and dam construction could greatly decrease walleye reproduction in Luxapalila Creek by removing suitable spawning substrate and blocking access to spawning grounds. As an important spawning tributary, loss of walleye production in Luxapalila Creek would impact the walleye population of Aliceville Pool in the TTW.

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