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Catfish Population Characteristics in Tailwater and Reservoir Habitats of the Coosa River, Alabama

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Abstract.—Catfish are popular recreational fish in Alabama, and management interest has been rising. We hypothesized that tailwater habitat more closely resembling lotic conditions would provide more suitable conditions for catfishes compared to impounded habitats. We examined and compared population characteristics, including abundance, age and size structure, growth, and survival of blue catfish *Ictalurus furcatus*, channel catfish *I. punctatus*, and flathead catfish *Pylodictis olivaris* between tailwater and reservoir habitats in a section of the Coosa River in 2001–2002. Coosa River system tailwater habitats appear to generally provide higher quality environments for abundance and growth of catfishes than reservoir habitat, although results were often not consistent among species. We found no differences for many comparisons of stock descriptors between tailwater and reservoir habitat. We found that blue catfish were larger (48 mm total length larger) and flathead catfish electrofishing catch rates were higher (13 fish/h greater) in tailwater areas. Catfish populations in the Coosa River were characterized by slow growth and high longevity, findings in accord with other recent otolith-based age analyses from populations in the Southeast. All species had moderate to high annual survival (57–88%), likely indicating light exploitation levels. Catfish populations in this section of the Coosa River appear robust, and the tendency for these dam tailwaters to have higher quality catfish populations may warrant management actions to enhance/sustain these fisheries.

Introduction

Catfishes (Ictaluridae) are a commercially and recreationally important group of fishes in Alabama (Michaletz and Dillard 1999; Boschung and Mayden 2004). Dam tailwater areas are often popular for catfishing (Graham and DeiSanti 1999) and may have populations with increased abundance (Walburg et al. 1981; Jacobs and Swink 1982; Jacobs et al. 1987; Jackson and Dillard 1993) and condition (Jackson 1985, 1995) relative to impounded areas. Many of these observations are largely anecdotal and should be substantiated if we are to increase our ability to manage catfish fisheries.

Catfishes may be attracted to abundant prey that is entrained through turbines (Walburg 1971; Sorenson et al. 1998), attracted to increased tailwater velocity (Jackson 1995; Graham and DeiSanti 1999), or attracted to prey that had arrested migration (Hoyt and Kruskamp 1982). Favorable tailwater areas may provide an excellent foraging area for catfishes, thereby enhancing growth and condition. Differential abundance, growth, and condition of catfishes among tailwater, reservoir, and riverine habitats may be related to potential differences in prey density.

Our objective was to examine and compare characteristics of catfish populations (blue catfish *Ictalurus furcatus*, channel catfish *I. punctatus*, and flathead catfish *Pylodictis olivaris*) between reservoir and tailwater habitats. Three tailwater areas on the Coosa River and three sites within Jordan Reservoir (a Coosa River impoundment) were selected for study. The objectives of this study were to describe characteristics (i.e., abundance, age and size structure, growth, and mortality) of catfish populations in a section of the Coosa River. We also compared and contrasted population characteristics between tailwater and reservoir habitats and examine seasonal differences.

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Methods

Study Area

Blue catfish, channel catfish, and flathead catfish were collected from six sites on the Coosa River (Mobile River drainage) in central Alabama (Figure 1). Tailwater sites were located below Walter Bouldin Dam, Jordan Dam, and Mitchell Dam. The Bouldin Dam tailwater is a man-made channel that reconnects to the Coosa River downstream of Jordan Dam and appears to contain appropriate catfish habitat such as rock and cobble substrate and numerous tree snags (J. C. Jolley, personal observation). All dams are owned and operated by the Alabama Power Company and function as hydropower facilities. Flow at all tailwater sites was regulated, and discharge during the study ranged from 0 to 1,100 m^3/s.

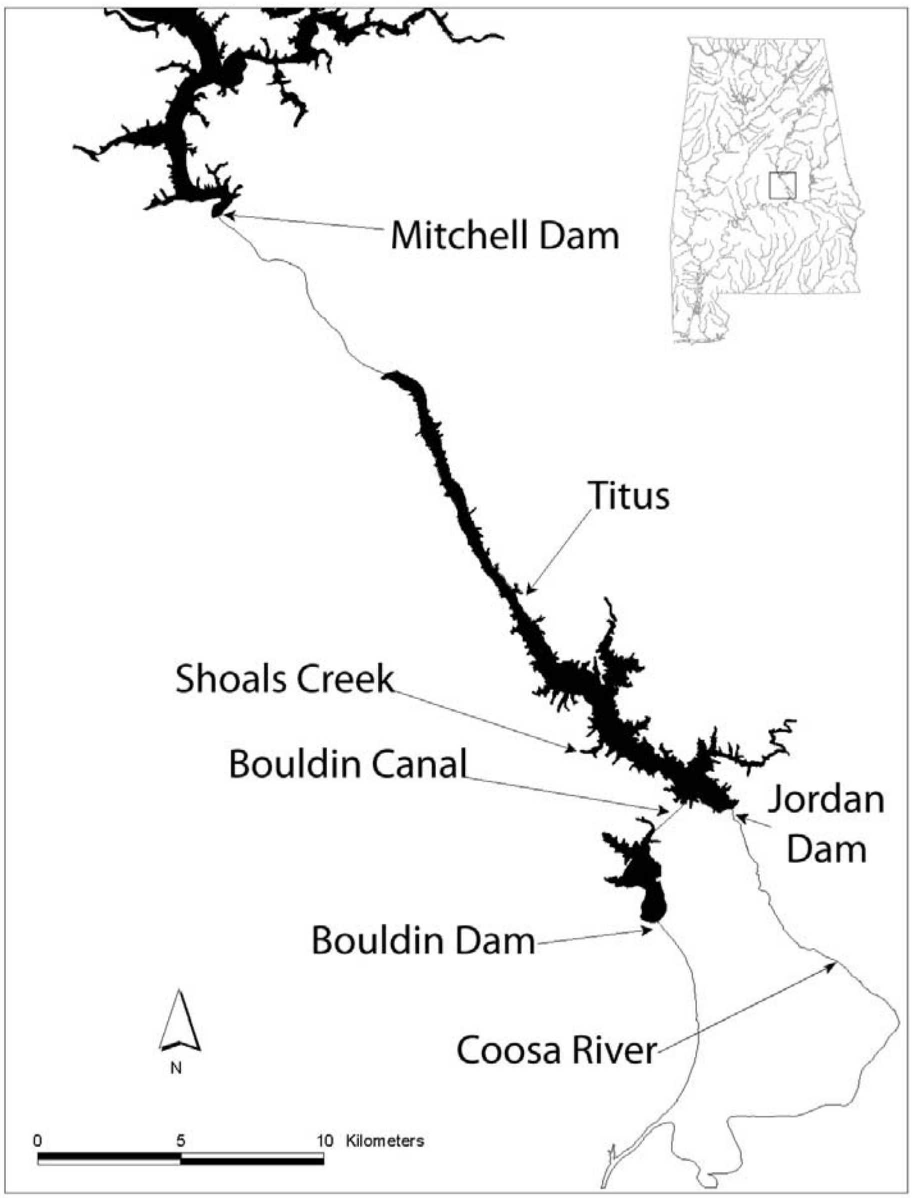

FIGURE 1. Locations of collection sites for catfishes on the Coosa River, Alabama, 2001–2002.

Jordan Reservoir is 29.6 km long (from Mitchell Dam to Jordan Dam), is 2,754 ha at full pool, and drains 26,326 km^2; three reservoir sites were chosen systematically based on access. The reservoir sites were located in the Bouldin Canal, the Shoals Creek embayment, and the main lake of Jordan Reservoir near the town of Titus (Jolley 2003). Titus is located 17.7 km downstream of Mitchell Dam at the approximate head of the reservoir proper where water depth increases and velocity decreases; however, flow is measurable during times of peak hydroelectric generation from Mitchell Dam.

Field Data Collection

Blue catfish, channel catfish, and flathead catfish were primarily collected from April to June, which we assumed was just before or during spawning (Graham 1999; Hubert 1999; Jackson 1999; Marshall et al. 2009a), and additional sampling was conducted through October during 2001 and 2002. Boat electrofishing with a Smith Root Generator Powered Pulsator voltage regulator was used for collecting catfishes (15 pulses/s, 2–5 A). Electrofishing run time varied but was typically less than 20 min. Tailwater areas sampled were arbitrarily defined as within 3 km of any given dam to include that area immediately influenced by dam operations. Catfishes were measured (nearest millimeter total length) and weighed (nearest gram). Large catfish (i.e., >6 kg) were weighed to the nearest 0.25 kg. Fish were euthanatized, placed on ice, and returned to the laboratory for further processing.

Lapilli otoliths (previously incorrectly identified as sagittal otoliths; Long and Stewart 2010) provide an accurate aging structure for ictalurids (Nash and Irwin 1999; Buckmeier et al. 2002; Maceina and Sammons 2006) and were processed following the procedures outlined by Buckmeier et al. (2002). Otoliths were read independently by two readers without knowledge of fish length, and disagreements between readers were reconciled with a concert read.

Statistical Analyses

Catch per unit effort (CPUE = number of fish/h electrofishing) was calculated and compared between tailwater and reservoir habitats and among seasons for each species using two-way analysis of variance (ANOVA) to detect differences in relative abundance. Overall size structure was described and compared for each species in several ways. Mean total length was compared between habitats and among seasons for each species using two-way ANOVA. Posthoc comparisons were conducted using Student-Newman Keuls multiple range test. Individuals of each species were placed into 50-mm length-groups to generate length-frequency distributions that described size structure of the populations. Growth rates for each species of catfish were compared between habitats using analysis of covariance (ANCOVA) to examine slopes of the total length to $\log_{10}$ age regressions (SAS Institute 1999). Age frequencies were generated by species for each habitat, instantaneous annual mortality rate (Z) was calculated as the slope of the descending limb of weighted catch-curve regressions, and the estimate of annual survival (S) is equal to e^{-Z} (Ricker 1975; Maceina 1997). Log transformations were applied to catch data (i.e., CPUE) and total lengths to satisfy assumptions of ANOVA. All statistical tests were performed at $\alpha = 0.05$.

Results

A total of 1,412 catfish was collected from 2001 and 2002 across both habitats, including 287 blue catfish, 219 channel catfish, and 906 flathead catfish (Table 1). Blue catfish from the Jordan Dam tail-

TABLE 1. Number of catfish sampled from two habitats and three seasons on a reach of the Coosa River, 2001–2002.

	Blue catfish	Channel catfish	Flathead catfish
Tailwater	196	198	847
Reservoir	91	21	59
Spring	229	110	432
Summer	54	92	376
Fall	4	17	98
Overall	287	219	906

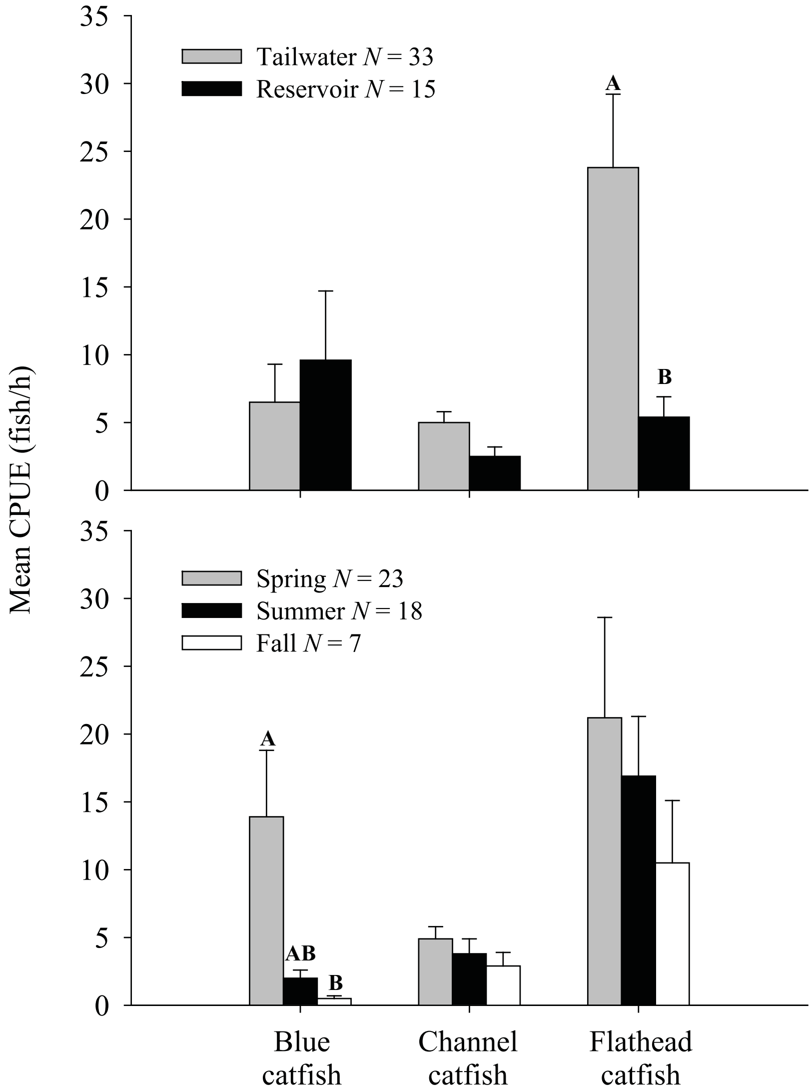

FIGURE 2. Mean catch per unit effort (CPUE; fish/h electrofishing) of catfishes in two habitats and three seasons in a reach of the Coosa River, 2001–2002. Error bars are 1 SE, *N* is number of sampling occasions, and different letters represent statistical differences between habitats; no differences were apparent if no letters are present.

water were omitted from statistical analyses due to low sample size. Mean CPUE was 7 fish/h (SE ± 3) and 4 fish/h (SE ± 1) for blue catfish and channel catfish, respectively. Results of the two-way ANOVA of CPUE by habitat indicated no differences in CPUE for blue catfish ($P = 0.64$) or channel catfish ($P = 0.18$). Flathead catfish (mean CPUE = 18 fish/h, SE ± 4) were 19 fish/h more abundant in tailwater habitats ($P < 0.01$; Figure 2). Catch per unit effort of blue catfish varied by season ($P < 0.01$; Figure 2); they were 13 times more abundant in spring than in fall. There were no differences in CPUE for channel catfish ($P = 0.32$) or flathead catfish ($P = 0.76$) by season (Figure 2), and no significant interactions between habitat and season were apparent for any species ($P > 0.05$). Sampling effort was much higher in tailwater areas, resulting in a higher number of catfish collected (Table 1). We had a concurrent study examining catfish exploitation, and in an effort to maximize individuals tagged, we had a higher sampling effort in tailwater areas where we could readily capture fish (Irwin et al. 2003).

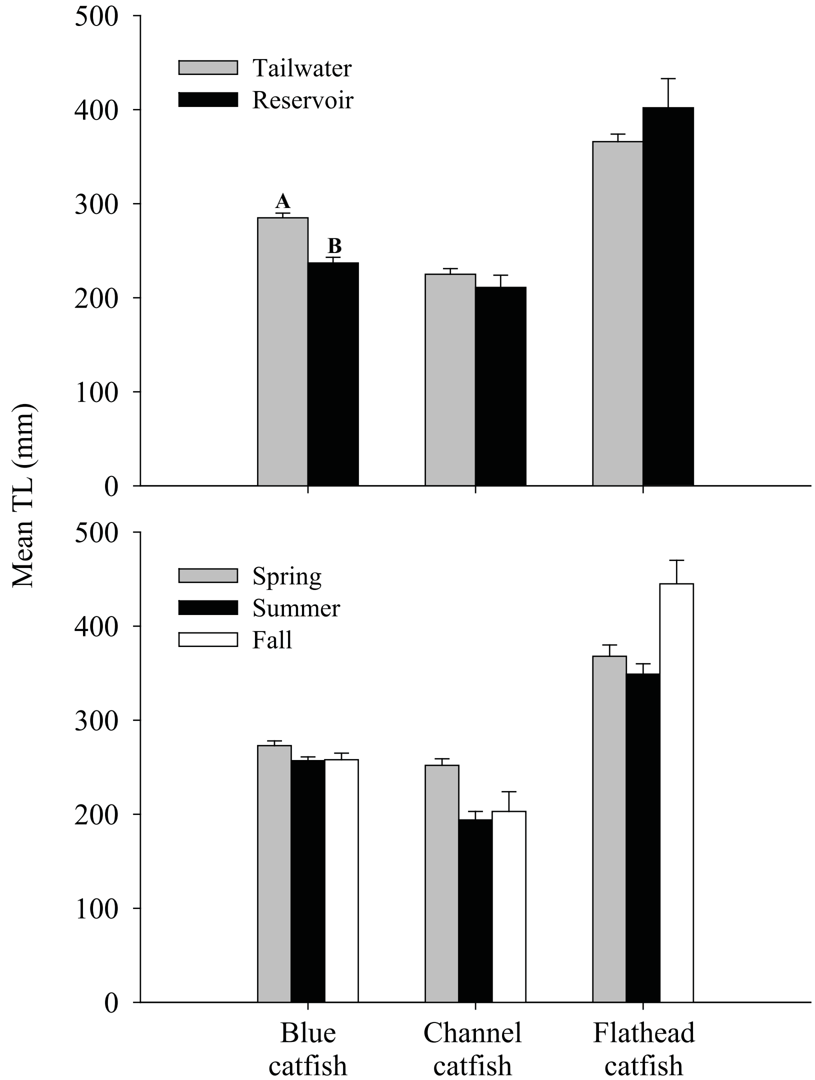

FIGURE 3. Mean total length (TL, in mm) of catfishes in two habitats and three seasons in a reach of the Coosa River, 2001–2002. Error bars are 1 SE, and different letters represent statistical differences between habitats; no differences were apparent if no letters are present.

Blue catfish total length ranged from 128 to 825 mm, and mean total length of blue catfish was higher (i.e., 48 mm) in tailwater areas ($P < 0.05$; Figure 3). Channel catfish total length ranged from 50 to 585 mm, and flathead catfish total length ranged from 67 to 1,137 mm. There were no significant differences in mean total length between habitats for channel catfish ($P = 0.61$) or flathead catfish ($P = 0.52$; Figure 3), nor were there any differences in mean total length for any species by season ($P > 0.05$; Figure 3).

Length-frequency distributions generally showed a protracted size range, notably for flathead catfish (Figure 4). Qualitatively, blue catfish length-frequency distributions appeared to be skewed toward smaller individuals in reservoir relative to tailwater areas. Small sample sizes precluded statistical comparison of length-frequency distributions (Miranda 2007).

Blue catfish age ranged from 1 to 14 years (Figure 5). Slopes of the log-transformed age-to-length regressions approached significance between habi-

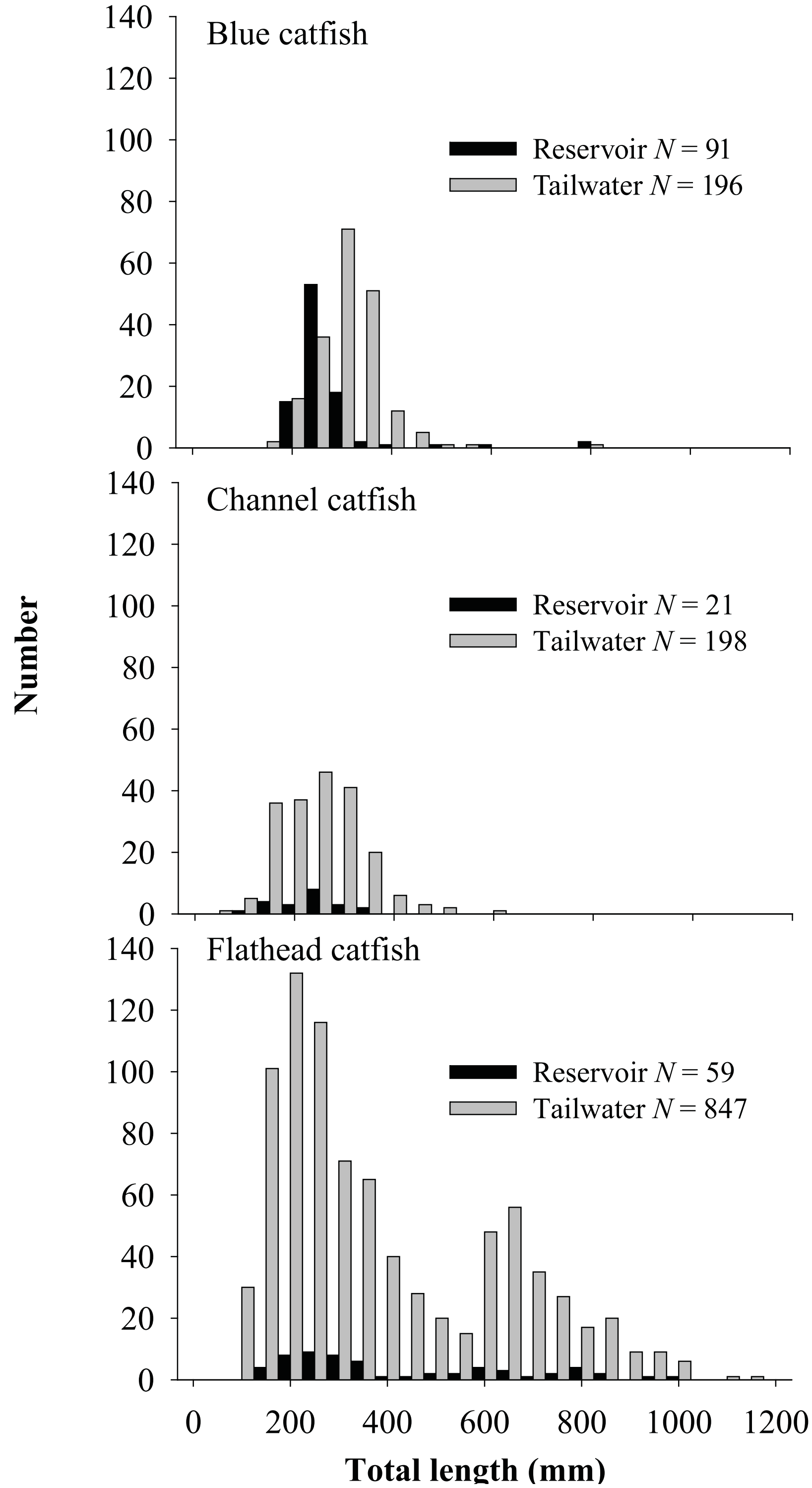

FIGURE 4. Length-frequency histograms for blue catfish, channel catfish, and flathead catfish from two habitats on the Coosa River, 2001–2002.

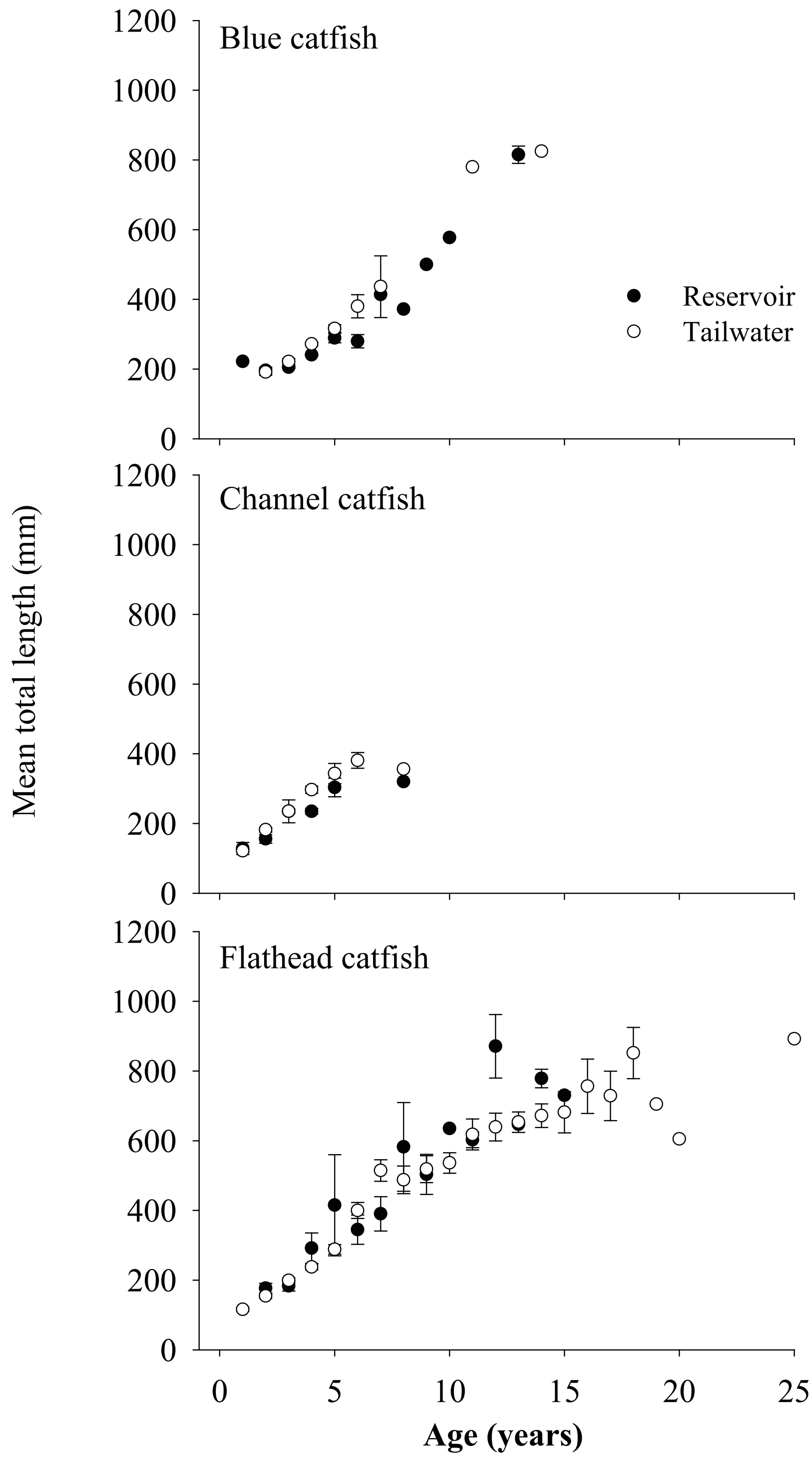

FIGURE 5. Mean total length (mm) at age for blue catfish, channel catfish, and flathead catfish. Vertical bars are 1 SE.

tats for blue catfish (ANCOVA: slope, $F = 3.82$, df = 1,245, $P = 0.052$). Specifically, slope appeared to be higher for tailwater areas than for reservoir areas (Figure 6). Channel catfish age ranged from 1 to 8 years, and flathead catfish age ranged from 1 to 25 years (Figure 5). Slopes and intercepts of the log-transformed age-to-length regressions were similar between habitats for channel catfish (ANCOVA: slope, $F = 3.15$, df = 1,162, $P = 0.08$; intercept, $F = 1.29$, df = 1,162, $P = 0.26$) and flathead catfish (slope, $F = 0.02$, df = 1,400, $P = 0.90$; intercept, $F = 0.57$, df = 1,400, $P = 0.45$).

Annual survival was variable among species and was 57% for blue catfish ($n = 190$), 68% for channel catfish ($n = 112$), and 88% for flathead catfish ($n = 395$) overall.

Discussion

Coosa River system tailwater habitats appear to generally provide higher quality environments for abundance and growth of catfishes than reservoir habitat, although results were often not consistent among species. We found no differences for many comparisons of stock descriptors between tailwater and reservoir habitat. Evidence supporting that tailwaters were more suitable includes our higher catch rates of flathead catfish in tailwater areas compared to reservoir locations and larger sizes of blue catfish from tailwater areas relative to reservoir areas. Our results largely support anecdotal observations that relatively large blue catfish occur below many dams.

Flathead catfish were more abundant in tailwater areas of the Coosa River system. In particular, the Mitchell Dam tailwater had a high abundance of flathead catfish (Jolley 2003) and may be related to habitat features; the area is characterized by an inundated shoals area with a hard, bedrock bottom and increased flows due to dam generation. Trautman (1981) reported that flathead catfish prefer hard bottoms or areas where silt deposition is slow. Flathead catfish have been reported to reside in warmwater release tailraces below dams (Jackson 1985; Jackson and Dillard 1993). Flathead catfish length ranged widely in this area, which likely indicated favorable conditions for spawning and recruitment. The Mitchell Dam tailwater has rocky banks with abundant irregular surfaces suitable for spawning. Flathead catfish have been reported to spawn in rocky rip-rap areas (Layher and Boles 1979). Irwin et al. (1999) reported that juvenile flathead catfish inhabited higher velocity habitats in rivers and move to deeper water as they grow. The Mitchell Dam

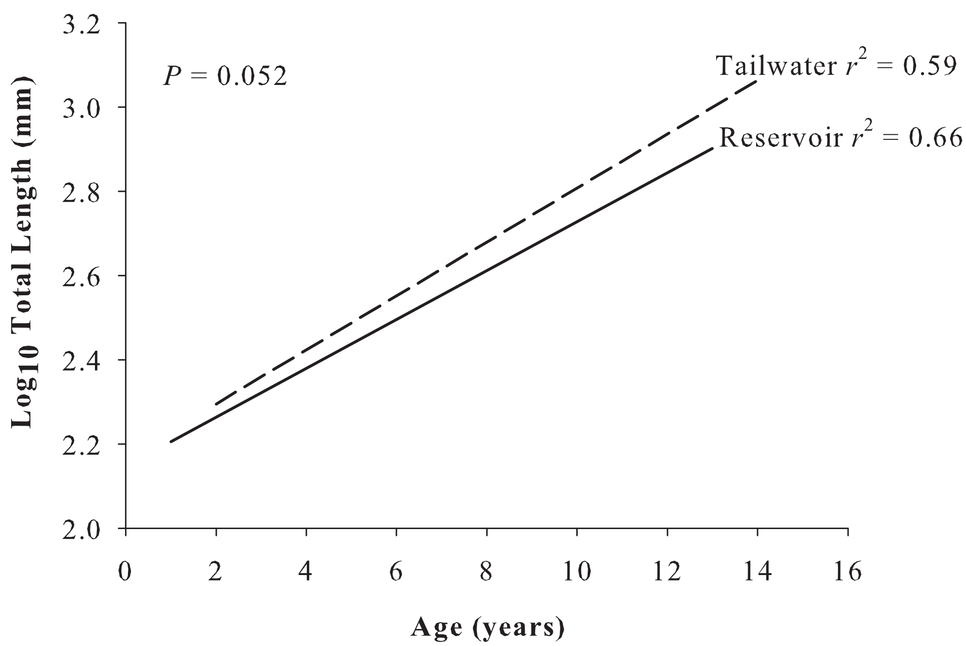

FIGURE 6. Results of analysis of covariance (ANCOVA) examining growth rates of blue catfish from tailwater and reservoir habitats from a reach of the Coosa River, 2001–2002.

tailwater appears to provide excellent physical habitat for flathead catfish, as evidenced by population structure and abundance (Jolley 2003).

Blue catfish have been reported to be the most migratory of the catfishes (Lagler 1956), moving upstream in the spring and downstream in the fall. In our study, blue catfish catch rates were higher in the spring than they were in the fall. In particular, blue catfish were locally abundant in tailwater areas in the spring. Blue catfish may have been exhibiting seasonal migrations or may have been staging before spawning; however, the dams may have blocked their movement. Increased mobility in the spring may have led to increased susceptibility to electrofishing at this time. Fischer et al. (1999) reported that blue catfish moved more in the spring than any other season in a small northwestern Missouri reservoir. Anglers we interviewed noted that the blue catfish fishery below Mitchell Dam was a spring fishery. Like blue catfish, flathead catfish are migratory but likely make directed seasonal movements to wintering areas (Vokoun and Rabeni 2005), yet likely stay in a smaller home range (Travnichek 2004; Vokoun and Rabeni 2006).

Blue catfish had higher average total lengths in tailwaters (i.e., Mitchell Dam and Bouldin Dam) as well as skewed length-frequency distributions toward longer fish. Habitat conditions in these areas may be ideal with increased water velocity and bedrock or gravel substratum, conditions cited as preferable to blue catfish (Boschung and Mayden 2004). Jackson (1995) reported that tailwater areas yielded larger blue catfish on the Tennessee-Tombigbee Waterway. Detection probabilities for large blue catfish (TL > 500 mm) were relatively low in our study (Jolley, unpublished data), although anglers consistently reported catching larger blue catfish. The affinity of blue catfish for swift water and deep channels may explain our inability to effectively capture large individuals, as these conditions preclude effective electrofishing. Water depth immediately below the dams was typically 12–15 m, and depths in reservoir areas were 9–21 m. We collected few blue catfish in the Jordan Dam tailwater; the deep, swift water immediately below the dam (likely blue catfish habitat) was inaccessible by our boat electrofisher. Other areas of the tailwater were accessible, and channel catfish and flathead catfish were collected while blue catfish were not. Thus, blue catfish use immediately below Jordan Dam is unknown but appeared overall to be low in the entire tailwater reach. Future research may investigate the characteristics of the Jordan Dam tailwater that may be related to low catches of blue catfish, and further attempts to adequately assess the area immediately below the dam are warranted. Inadequate sampling for catfishes is a commonly cited challenge to population assessment (Michaletz and Dillard 1999; Vokoun and Rabeni 1999; Rachels and Ashley 2002).

Catfishes grew slowly in the Coosa River. Although comparative otolith-derived growth estimates are scarce, recent studies of catfish age using otoliths (Nash and Irwin 1999; Buckmeier et al. 2002; Kwak et al. 2006; Marshall et al. 2009a, 2009b) indicate greater longevity and slower growth than previously estimated. A concurrent study found that flathead catfish growth in the Coosa River was similar to that of the nearby Tallapoosa River but considerably slower than that of introduced flathead catfish populations in Georgia (Sakaris et al. 2006). A full review of catfish growth across their range was beyond the scope of this study, and we refer readers to Kwak et al. (2006) for flathead catfish and Graham (1999) and Nash (1999) for reviews of blue catfish and channel catfish growth, respectively.

Survival rates were similar to recent investigations in the Southeast for flathead catfish (Kwak et al. 2006; Sakaris et al. 2006; Marshall et al. 2009b), blue catfish (Mauck and Boxrucker 2004; Holley et al. 2009), and channel catfish (Holley et al. 2009), likely indicating light exploitation. Survival rates of blue catfish may be biased low if larger (presumably older) fish were underrepresented in our sampling. Although Alabama does not regulate recreational or commercial fishing for catfish through creel, length, or gear restrictions, they instituted a harvest limit of one catfish (any species) over 864 mm TL per day since completion of our study. Holley et al. (2009) and Marshall et al. (2009b) recommended no further regulation on the lightly exploited catfish fisheries of Lake Wilson, Alabama.

In general, catfishes were in good condition (relative weights ≥ 90) at all locations and populations appeared robust (Jolley 2003). The Coosa River is a productive system with abundant prey availability (Bayne et al. 1989). A concurrent study on health and condition of catfishes by Jolley and Irwin (2008) reported good overall health using a health assessment index and by examining liver lipid content. Other factors may contribute to general wellness of these catfish populations. Increased quantity and quality of prey may contribute to enhanced growth and condition (Bowen et al. 1995), and relative weight may be a good predictor of prey availability (Liao et al. 1995). Jolley and Irwin (2003) found fish to be an important diet item for large channel catfish in tailwater habitats in the Coosa River, although that study did not quantify potential differences in prey between habitats. A concurrent study indicated that flathead catfish recruitment was positively linked to the frequency of spring discharge pulses of 283–566 m^3/s (Sakaris and Irwin 2010).

Rivers of the Southeast are severely fragmented and managed for multiple needs (Irwin and Freeman 2002; Richter and Thomas 2007), and our results do not apply to all systems. Grussing et al. (1999) did not identify differences in habitat use for blue and channel catfishes between tailrace and main-stem habitats in a study of four Alabama rivers. There are a spectrum of conditions created by dams and their associated tailwaters. The tailwaters examined in our study have conditions that are likely hospitable to many warmwater fishes. The dams in our study were run-of-river facilities with frequent warmwater releases, leading to relatively more riverine-like conditions. Walburg et al. (1981) stated that catfish are often abundant in warm tailwaters of turbid main-stem rivers and absent in cool, clear tailwaters. In contrast, there are some animals that cannot survive in tailwaters because physical conditions are inappropriate (e.g., temperature and dissolved oxygen; Clarkson and Childs 2000) or they cannot adapt to extreme water release regimes (Irwin and Freeman 2002). Dams with hypolimnetic releases may exclude catfishes from the tailwaters due to cold water temperatures (Mullan et al. 1976).

Our results indicate high-quality populations of catfishes occurring in tailwater areas, and it is unknown how they may respond to potential increased harvest, especially as recreational catfish angling increases in popularity. Slow-growing, long-lived species such as blue catfish and flathead catfish in these areas, coupled with potential increased susceptibility to harvest in tailwaters, may exacerbate the potential for growth overfishing. Modeling indicated that low exploitation (i.e., 11%) with a minimum length limit of 308 mm led to growth overfishing in a population of blue catfish in Lake Wilson, Alabama (Holley et al. 2009), and future monitoring of the catfish populations of this reach of the Coosa River should focus on harvest patterns.

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