LAKE JAMES BLACK BASS SURVEY (2004–2006)

Final Report

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Abstract.—This report summarizes the findings of a black bass *Micropterus spp*. shoreline electrofishing survey conducted on the Catawba River arm of Lake James in the spring 2004, 2005 and 2006. Largemouth *M. salmoides* and smallmouth bass *M. dolomieu* populations in Lake James are spatially segregated due to water quality differences associated with the two impounded river basins that form the reservoir. The largemouth bass population is primarily confined within the upper, nutrient rich portions of the Catawba River arm of Lake James, while smallmouth bass utilize the oligotrophic zones throughout Lake James – primarily the Linville River arm. Due to equipment failures, night time survey efforts on the Linville River arm were prohibited in 2005 and 2006. A total of 399 largemouth and 158 smallmouth bass were collected during this survey, with mean catch rates in the Catawba River arm ranging from 38.9 fish/hr (SE = 3.8) in 2004 to 59.9 fish/hr (SE = 6.1) in 2006. However, smallmouth bass catch rates within the Catawba River arm remained consistently low throughout the survey; mean smallmouth bass catch rates in the Catawba River arm ranged from 8.7 fish/hr (SE = 2.3) in 2006 to 10.1 fish/hr (SE = 2.8) in 2004. In 2004, mean smallmouth bass catch rates were 19.3 fish/hr (SE = 4.4) in the lone Linville River arm sample. Largemouth and smallmouth bass size structures consisted of individuals with lengths ranging from 69 to 576 mm TL (mean = 324.0 mm TL; SE = 4.8) and 68 to 512 mm TL (mean = 263.9 mm TL; SE = 10.1), respectively. Largemouth bass RSD values remained consistent between years of the survey: RSD-quality values ranged from 68 to 78 (mean = 73.0 and SE = 2.9) and RSD-preferred values ranged from 30 to 35 (mean = 33.3; SE = 1.7). Largemouth and smallmouth bass were collected up to ages 13 and 8, respectively; age-2 fish were the predominate age class of largemouth bass collected, while the majority of smallmouth bass collected were age 1. The von Bertalanffy growth curve, $TL = 464.1 * (1 - e^{(-0.460\,(age + 0.170)})$, best fit the data and explained 99% of the variation in total length at age at capture for largemouth bass. Largemouth bass relative weight values ranged from 71.8 to 132.2 (mean = 97.8; SE = 0.7), while smallmouth bass relative weight values ranged from 57.8 to 130.0 (mean = 89.6; SE = 1.2). Total annual mortality was estimated to be 0.35 (SE = 0.01) for largemouth bass within the survey. Largemouth and smallmouth bass populations within the Catawba River arm of Lake James appear to be comprised of multiple year classes that consist of stock-sized fish in above average condition. In addition, the largemouth bass population appears to be characterized by relatively fast growth and low mortality.

Located in Burke and McDowell counties, Lake James is the uppermost reservoir in the Catawba River chain of Duke Power Company lakes. Impounded in 1923, the reservoir covers 2,634 ha at full pool, has 242 km of shoreline, and a watershed area of 984 km^2. Average water depth within the reservoir is 13.5 m, with a maximum depth of 43 m, and a mean hydraulic retention time of 228 d. Lake James is oligotrophic, with low alkalinity (9–14 mg/l $CaCO_3$), a pH range of 6.4–7.4, typical surface water temperature ranges of 2–30^o C, and an average Secchi depth of 2.8 m (NCDENR 1998; NCDENR 2003).

Initial black bass *Micropterus* spp. population assessments in Lake James were based on cove rotenone sampling and were inefficient at capturing adult black bass; thus, accurate population assessments were not possible (Brown et al. 1989). In 1989, shoreline electrofishing investigations of the reservoir's black bass population were initiated by the North Carolina Wildlife Resources Commission (NCWRC) following a 1987–1988 creel survey that estimated 77% of the black bass were harvested within the 356-mm minimum size limit, two-fish exemption (Borawa 1989). Catch rates from 1989–1991 electrofishing surveys were highly variable between years; however, the data indicated that neither recruitment failure nor over harvest were impacting black bass populations within Lake James (NCWRC, unpublished data). Beginning in 2003, the NCWRC initiated a study to compare day versus nighttime shoreline electrofishing techniques for black bass sampling within three Catawba River reservoirs (Hining 2005).

Based on this initial day-versus-night electrofishing pilot study, a three-year black bass population assessment was initiated on Lake James in the spring of 2004 (Taylor 2005). This report summarizes the findings of a survey conducted on the Catawba River arm of the reservoir in the spring of 2004, 2005 and 2006.

Methods

Field Collections.—Largemouth *Micropterus salmoides* and smallmouth *M. dolomieu* bass were collected in April and May of 2004 to 2006; fish were sampled via boat mounted, 120-V pulsed direct current electrofishing equipment (3–4 A). Sample sites consisted of twelve 300-m shoreline transects equally distributed throughout the Catawba River arm of Lake James (Figure 1). Catawba River arm sites were sampled during the day and water temperatures ranged from 15.6–21.0 ^{o}C. Twelve sites located in the Linville River arm were sampled in 2004, but they were omitted during the 2005 and 2006 surveys due to equipment failures.

Black bass collected were placed in a plastic bag labeled by site, placed on ice, and returned to the Marion State Fish Hatchery. All black bass collected were identified to species, weighed (g), measured (mm, TL) and sexed. Fish were considered immature if the gonads were not developed.

Catch-per-unit-effort.—Abundance was indexed by catch-per-unit-effort (CPUE) of electrofishing time and expressed as number of fish collected per hour.

Age and Growth.—Saggital otoliths were removed from all fish, broken transversely to the dorsal-ventral axis, polished with 400 grit wet-dry sandpaper, and read under a 10X dissecting scope using transmitted fiber optic light (Taubert and Tranquilli 1982; Hoyer et al. 1985; Heidinger and Claudfelter 1987; Hammers and Miranda 1991). Otoliths were read independently by two readers, and any aging discrepancies between the readers were rectified by jointly reading the sectioned otolith; values were omitted from further analysis if agreement was not reached.

In addition, annulus formation is due to substantial changes in fish growth (Devries and Frie 1996). Consequently, newly formed annuli of temperate fishes should become apparent in the spring when growth rates dramatically increase following a winter-time lull. In fact, Taubert and Tranquilli (1982) found that annulus formation for largemouth bass generally occurred between April and June in Lake Sangchris, Illinois. Thus, if fish are collected the period of annulus formation, managers must ensure that the developing annulus is not omitted during age assignment. Therefore, once all visible annuli were enumerated for each fish in our survey, we assigned an additional year to the annuli count; accounting for annulus formation during the period of capture.

Length-frequency histograms were interpreted to describe patterns and size distribution in growth. In addition, total lengths at age of capture for all largemouth bass were pooled to estimate growth rate via the von Bertalanffy growth equation (Van Den Avyle and Hayward 1999), which is defined as:

$$L_t = L_\infty \left(1 - e^{-K\,(t - to)}\right),$$

where L_t is the predicted total length at time t, L_∞ is the mean maximum total length of the population, K is the growth parameter, t is time in years, and t_o is the time at which L_t is zero. Due to the low sample size of smallmouth bass, von Bertalanffy growth curves were not calculated for the species.

Relative stock density (RSD) indices were calculated for largemouth and smallmouth bass (Gabelhouse 1984). Size designations used for largemouth bass were stock (200 mm TL), quality (300 mm TL), preferred (380 mm TL), memorable (510 mm TL) and trophy (630 mm TL); in addition, size designations for smallmouth bass were stock (180 mm TL), quality (280 mm TL), preferred (350 mm TL), memorable (430 mm TL) and trophy (510 mm TL).

Index of Condition.— Relative weight values were calculated for black bass greater than 150 mm TL via the following equation:

$$W_r = W / W_s \times 100,$$

where W_r is the relative weight, W is the wet weight, and W_s is the length-specific standard weight of an individual. The standard weight equations for largemouth and smallmouth bass (Anderson and Neumann 1996) are:

for largemouth bass:

$$\log_{10}W_s = -5.316 + 3.191 \log_{10}TL,$$

for smallmouth bass:

$$\log_{10}W_s = -5.329 + 3.200 \log_{10}TL.$$

Mortality.—Annual mortality rate (A) was calculated for largemouth bass via unweighted catch curve, but mortality rates were not estimated for smallmouth bass due to inadequate sample sizes. Age structures for each year of the survey were pooled to estimate the annual mortality rate; however, fish ≤ age 2 did not fully recruit to the sampling gear and were omitted from consideration. In addition, age classes that contained fewer than five individuals were not used to estimate annual mortality (Ricker 1975; Wheeler et al. 2003).

Results and Discussion

Catch-per-unit-effort.—A total of 399 largemouth and 158 smallmouth bass were collected during this study. Total catch rates of largemouth bass were relatively high, with mean catch rates in the Catawba River arm ranging from 38.9 fish/hr (SE = 3.8) in 2004 to 59.9 fish/hr (SE = 6.1) in 2006 (Table 1). However, smallmouth bass catch rates within the Catawba River arm remained consistently low throughout the survey; mean smallmouth bass catch rates in the Catawba River arm ranged from 8.7 fish/hr (SE = 2.3) in 2006 to 10.1 fish/hr (SE = 2.8) in 2004 (Table 1). In 2004, mean smallmouth bass catch rates were 19.3 fish/hr (SE = 4.4) in the sole Linville River arm sample; again, only the Catawba River arm of the reservoir was sampled in the final two years of the survey (Table 1).

Age and Growth.—Largemouth and smallmouth bass size structures consisted of individuals with lengths ranging from 69 to 576 mm TL (mean = 324.0 mm TL; SE = 4.8) and 68 to 512 mm TL (mean = 263.9 mm TL; SE = 10.1), respectively (Figure 2). Approximately 40% of the largemouth bass collected were of legal harvestable size (≥ 356 mm TL), while approximately 45% of smallmouth bass exceeded the 305-mm TL length limit.

Largemouth bass RSD values remained consistent between years of the survey: RSD-quality values ranged from 68 to 78 (mean = 73.0; SE = 2.9) and RSD-preferred values ranged from 30 to 35 (mean = 33.3; SE = 1.7) (Table 2). However, smallmouth bass RSD values in 2005 and 2006 may be artificially inflated due to the lack of smaller, stock-size fish in Catawba River arm samples (Table 2).

Largemouth and smallmouth bass were collected up to ages 13 and 8, respectively (Figure 3). Age-2 fish were the predominant age class of largemouth bass collected within this survey, while the majority of smallmouth bass collected were age 1 (Figure 3).

The von Bertalanffy growth curve,

$$TL = 464.1 * (1 - e^{(-0.460\,(age - 0.170))}),$$

best fit the data and explained 99% of the variation in total length at age of capture for largemouth bass (Figure 4). The von Bertalanffy growth curve predicts that largemouth bass recruit to the 356-mm TL length limit by age 3.3.

Index of Condition.—Largemouth bass relative weight values ranged from 71.8 to 132.2 (mean = 97.8; SE = 0.7), while smallmouth bass relative weight values ranged from 57.8 to 130.0 (mean = 89.6; SE = 1.2) (Figure 5). Relative weight values for both species were highest in 2005 – likely reflecting pre- or post-spawn attributes; although the sampling dates were similar between years, water temperatures during the 2005 sample were more conducive to pre-spawn fish. Relative weight values within this study are slightly higher than those calculated in an earlier assessment of black bass in Lake James (Goudreau 1989), where largemouth and smallmouth bass relative weight values ranged from 68.8 to 138.0 (mean = 90.6; SE = 1.0) and 71.7 to 97.4 (mean = 84.0; SE = 1.9), respectively.

Mortality.—Total annual mortality was estimated to be 0.35 (SE = 0.01) for largemouth bass within the survey. This value is similar to the total annual mortality rate of 0.34, which was calculated for largemouth bass in Hiwassee Reservoir, North Carolina (Wheeler et al. 2003). In addition, Beamesderfer and North (1995) evaluated the reported annual mortality rates for 698 populations of largemouth bass in North American and found the conditional annual mortality rate of those populations to average 0.35. Therefore, our estimated total annual mortality rate of 0.35 appears to be consistent with values reported within the literature.

Conclusions

Spatial segregation between Lake James black bass species is associated with differences in water quality between the Catawba River and Linville River arms of the lake. The largemouth bass population is primarily confined within the upper, nutrient rich portions of the Catawba River arm of Lake James, while smallmouth bass utilize the oligotrophic zones throughout Lake James – primarily the Linville River arm (Hining 2005). Therefore, Hining (2005) found that to effectively sample smallmouth bass in Lake James, electrofishing efforts should be conducted within the Linville River arm. Thus, the inability to sample the Linville River arm in 2005 and 2006 resulted in the collection of a limited number of smallmouth bass during the survey, and lake-wide comparisons between all years of the survey for all species were not possible due to the failure to consistently sample the Linville arm. Future efforts to assess smallmouth bass within Lake James should focus upon nighttime electrofishing in the Linville River arm of the reservoir. Otherwise, only cursory information will likely be obtained for smallmouth bass.

Data collected within the Catawba River arm of the reservoir was consistent through the duration of this survey. Largemouth and smallmouth bass populations within the Catawba River arm of Lake James appear to be comprised of multiple year classes that consist of stock-sized fish in above average condition. In addition, the largemouth bass population appears to be characterized by relatively fast growth and low mortality.

Recommendations

1) Continue to manage Lake James black bass populations under the current statewide regulation.

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TABLE 1.—Mean catch-per-unit-effort data for largemouth (LMB) and smallmouth (SMB) bass across all sites during the 2004, 2005 and 2006 sampling seasons on Lake James, North Carolina. Only the Catawba River arm of Lake James was sampled in the 2005 and 2006 sampling seasons. Catch-per-unit-effort values represent the number of fish collected per hour, with standard error values in parentheses.

		Species		
Year	Location	All	LMB	SMB
2004				
	Total	34.2 (2.8)	19.5 (3.1)	14.7 (2.7)
	Catawba River arm	38.9 (3.8)	28.8 (4.3)	10.1 (2.8)
	Linville River arm	29.6 (3.9)	10.2 (2.4)	19.3 (4.4)
2005				
	Catawba River arm	48.4 (5.4)	38.7 (6.4)	9.7 (2.1)
2006				
	Catawba River arm	59.9 (6.1)	51.2 (7.5)	8.7 (2.3)

TABLE 2.—Relative stock densities (RSD) of largemouth (LMB) and smallmouth (SMB) bass collected during the 2004, 2005 and 2006 sampling seasons on Lake James, North Carolina.

		Stock density value	
Year	Index	LMB	SMB
2004	RSD-quality	73	63
	RSD-preferred	35	42
	RSD-memorable	2	16
	RSD-trophy	-----	2
2005	RSD-quality	78	86
	RSD-preferred	35	43
	RSD-memorable	1	20
	RSD-trophy	-----	3
2006	RSD-quality	68	86
	RSD-preferred	30	57
	RSD-memorable	1	21
	RSD-trophy	-----	-----

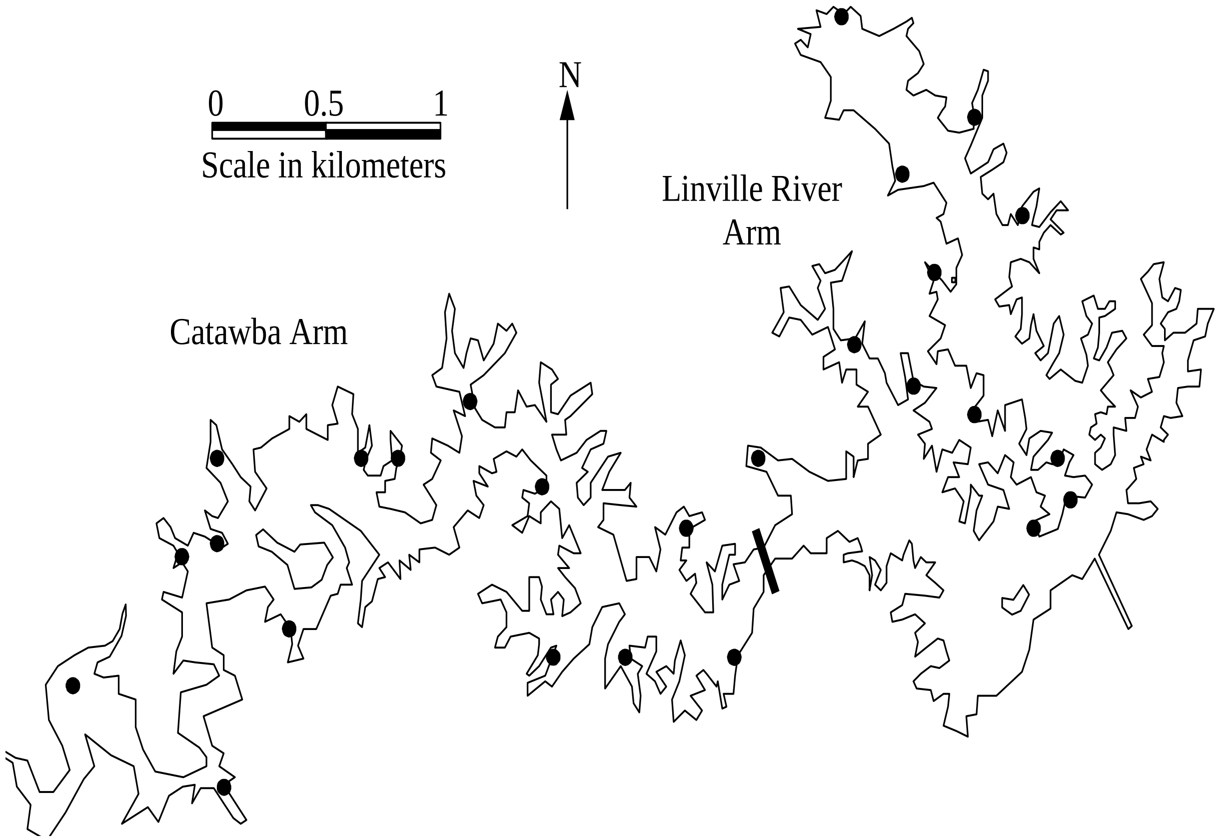

FIGURE 1.—Map of Lake James, North Carolina, with major reservoir zones (dark bars) and sampling locations (dark dots).

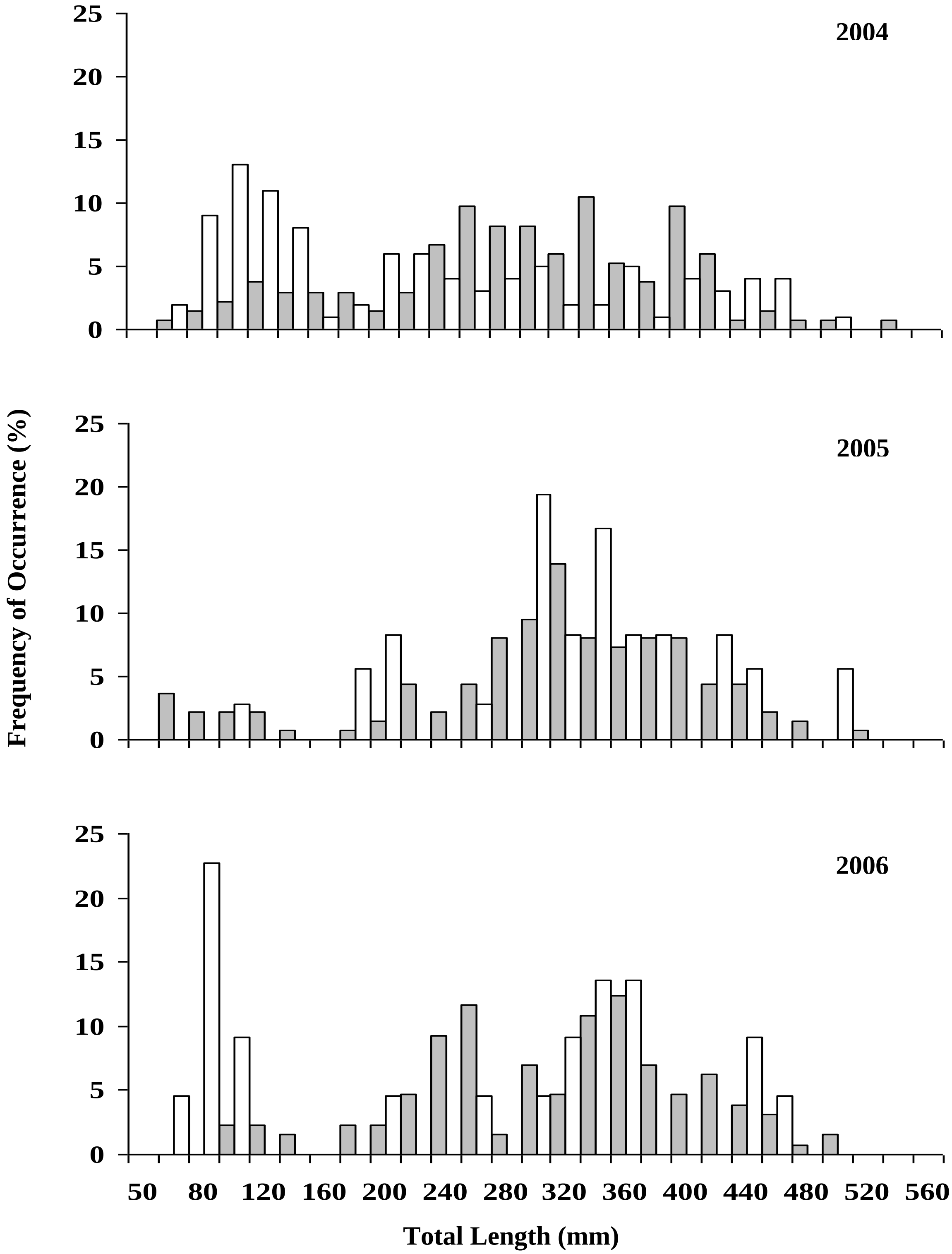

FIGURE 2.—Length-frequency distribution of largemouth (shaded bars) and smallmouth (unshaded bars) bass collected during the 2004, 2005 and 2006 sampling seasons on Lake James, North Carolina. Fish are grouped by 20-mm size class intervals.

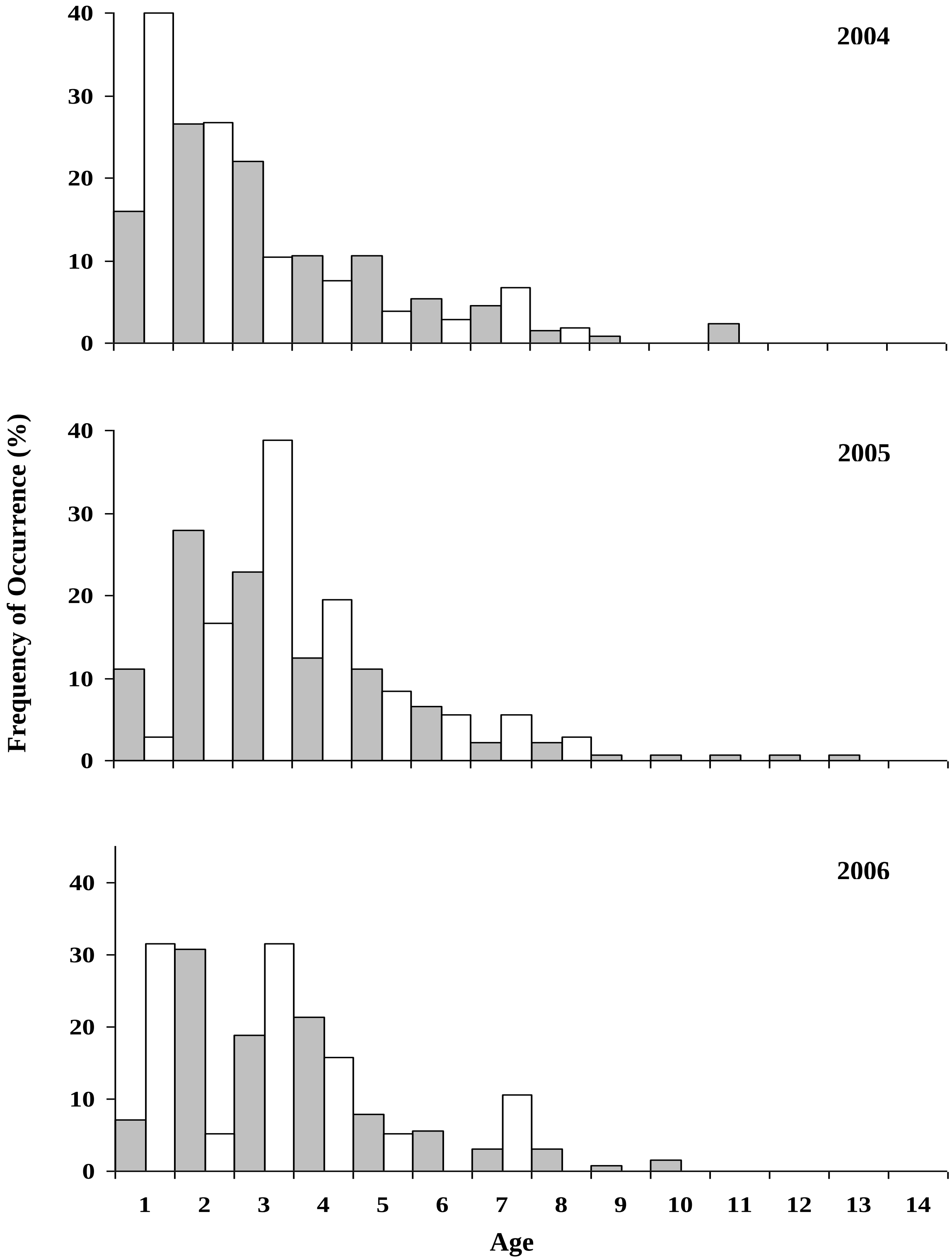

FIGURE 3.—Age distribution of largemouth (shaded bars) and smallmouth (unshaded bars) bass collected during the 2004, 2005 and 2006 sampling seasons on Lake James, North Carolina.

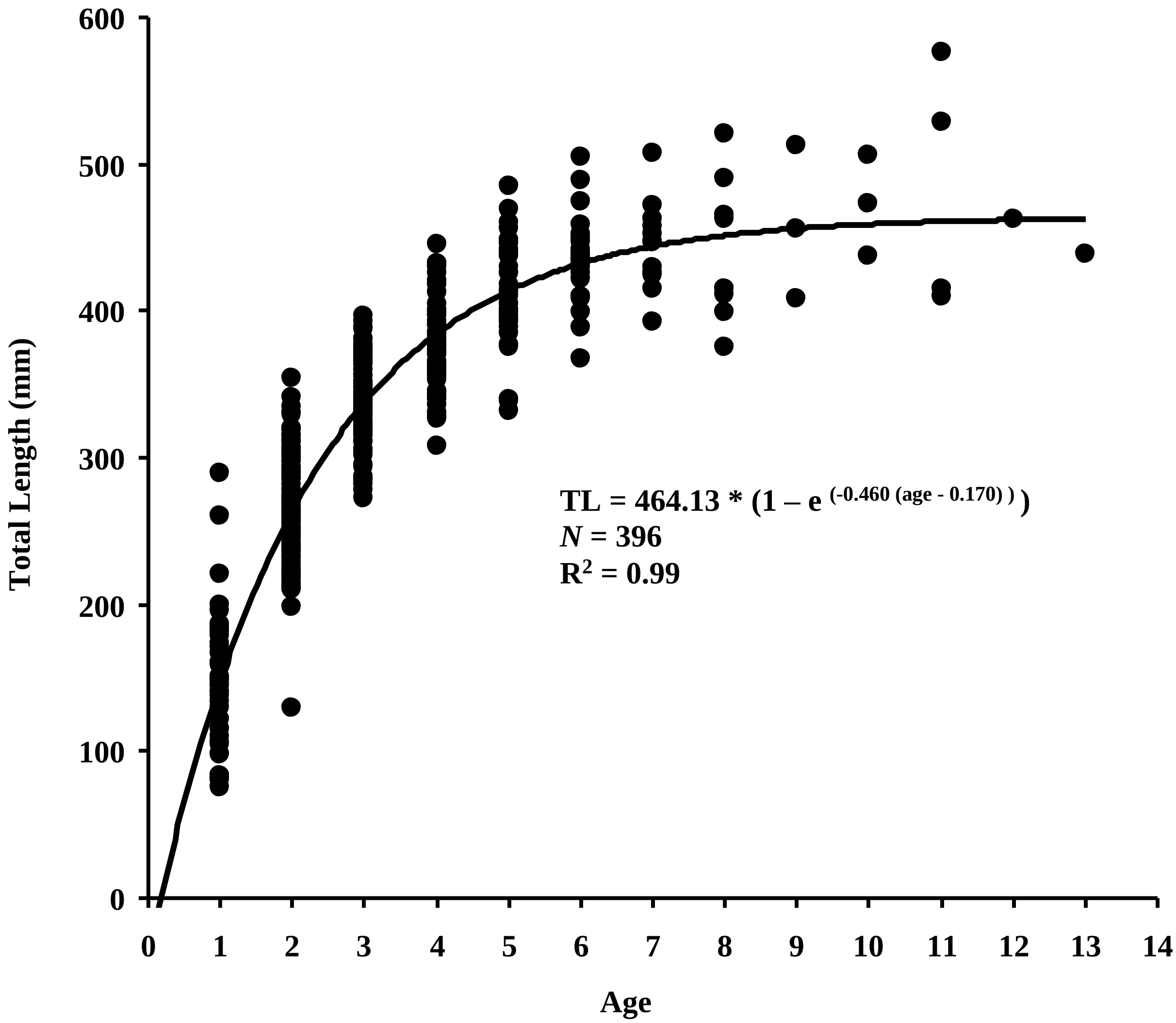

FIGURE 4.—Length at age of capture and von Bertalanffy growth curve (solid line) for all largemouth bass collected during the 2004, 2005 and 2006 sampling seasons on Lake James, North Carolina.

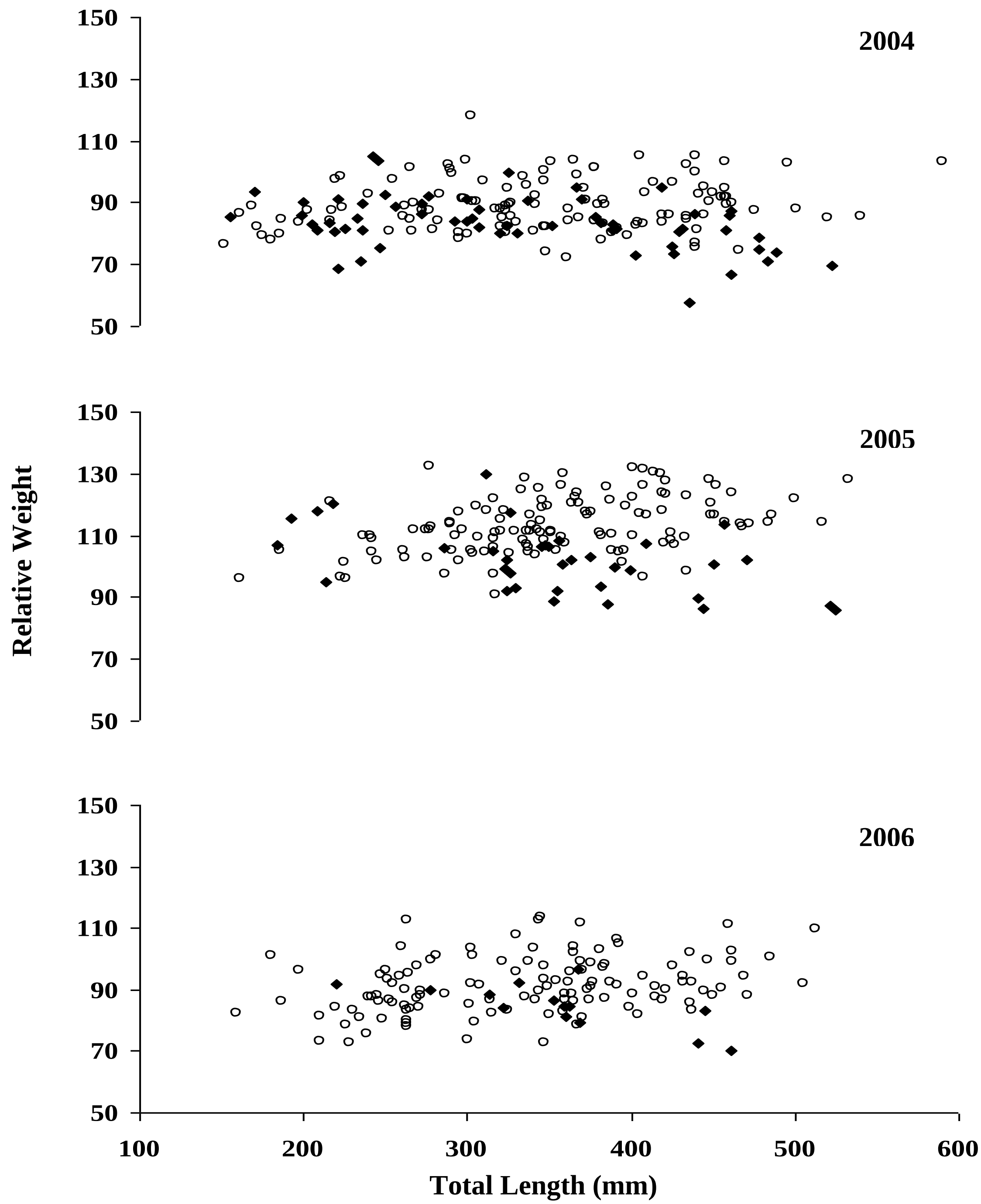

FIGURE 5.—Relative weight values of largemouth (circles) and smallmouth (diamonds) bass collected during the 2004, 2005 and 2006 sampling seasons on Lake James, North Carolina.