LAKE RHODHISS
LARGEMOUTH BASS SURVEY (2005 – 2007)

FINAL REPORT

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Abstract.—This report summarizes the findings of a largemouth bass *Micropterus salmoides* shoreline electrofishing survey conducted on Lake Rhodhiss in the spring 2005, 2006 and 2007. A total of 661 largemouth bass were collected during this study. Total catch rates of largemouth bass were high; yearly mean catch rates ranged from 86.1 fish/hr (SE = 6.4) in 2006 to 116.9 fish/hr (SE = 4.1) in 2007, with an overall average of 102.8 fish/hr (SE = 4.1). Largemouth bass size structures consisted of individuals with lengths ranging from 76 to 533 mm TL (mean = 320.1 mm TL; SE = 4.1). Largemouth bass stock indices remained relatively consistent between years of the survey; RSD-quality values ranged from 65 to 76 (mean = 69.7; SE = 3.3) and RSD-preferred values ranged from 33 to 35 (mean = 34.3; SE = 0.7). Largemouth bass were collected up to age 16; age-2 fish were the predominant age class of largemouth bass collected within this survey. The von Bertalanffy growth curve, $TL = 515.1 * (1 - e^{(-0.254\ (age\ -\ 0.370))})$, best fit the data and explained 99% of the variation in total length at age at capture for largemouth bass. Individual largemouth bass relative weight values ranged from 51.4 to 158.7 (mean = 98.1; SE = 0.6), while yearly mean relative weight values ranged from 88.2 (SE = 0.6) in 2006 to 112.3 (SE = 0.8) in 2005. Total annual mortality was estimated to be 0.25 (SE = 0.02) for largemouth bass within the survey. The largemouth bass population in Lake Rhodhiss appeared to be comprised of multiple year classes that consist of quality-sized fish in above average condition. In addition, the largemouth bass population was characterized by moderate growth and very low mortality.

Lake Rhodhiss, an impoundment of the Catawba River, is located in Burke and Caldwell Counties. Impounded in 1925, the reservoir covers 1,423 ha at full pool and has 145 km of shoreline, with a watershed area of 2,823 km^2. Average water depth is 6 m, with a maximum depth of 15 m, and a mean hydraulic retention time of 21 d. Lake Rhodhiss is classified as a eutrophic reservoir (NCDENR 1998; NCDENR 2003).

The impoundment supports a variety of sport fishes: largemouth bass *Micropterus salmoides*, striped bass *Morone saxatilis*, crappies *Pomoxis spp*., sunfishes *Lepomis spp*., walleyes *Sander vitreus* and several species of catfishes *Ictalurus* and *Ameiurus spp*. Baker (2002) reported that the majority of the total annual targeted fishing effort in the reservoir was directed towards largemouth bass, with anglers releasing approximately 91% of largemouth bass that were caught.

Initial largemouth bass population assessments in Lake Rhodhiss were based on cove rotenone samples (Brown and Kearson 1985). In the early 1990s, the North Carolina Wildlife Resources Commission (NCWRC) initiated shoreline-electrofishing samples within the reservoir (Goudreau 1990; Goudreau 1993). However, data collected from rotenone and initial electrofishing surveys were highly variable. In 2005, the NCWRC commenced an electrofishing survey to evaluate the largemouth bass population in Lake Rhodhiss. This report summarizes the findings of that three-year investigation.

Methods

Field Collections.—Largemouth bass were collected in April of 2005, 2006 and 2007 via boat-mounted, pulsed-direct current electrofishing equipment (3–4 A). Sample sites consisted of twelve 300-m shoreline transects equally distributed throughout Lake Rhodhiss (Figure 1). All largemouth bass collected were placed in a plastic bag labeled by site, placed on ice, and returned to the Marion State Fish Hatchery, where fish were 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 in size distribution and growth. In addition, total lengths at age of capture for all largemouth bass collected during the study period were pooled to estimate growth rate via the von Bertalanffy growth equation (Van Den Avyle and Hayward 1999), which is defined as:

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

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.

Relative stock density (RSD) indices were calculated for largemouth bass via the following size designations defined by Gabelhouse (1984): stock (200 mm TL), quality (300 mm TL), preferred (380 mm TL), memorable (510 mm TL) and trophy (630 mm TL).

Index of Condition.— Relative weight values were calculated for largemouth 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 equation for largemouth bass is (Anderson and Neumann 1996):

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

Mortality.—Annual mortality rate (A) was calculated for largemouth bass via unweighted catch curve. Age structures for each year of the survey were pooled to estimate the annual mortality rate; however, fish < age 1 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 661 largemouth bass were collected during this study. Total catch rates of largemouth bass were high: yearly mean catch rates ranged from 86.1 fish/hr (SE = 6.4) in 2006 to 116.9 fish/hr (SE = 4.1) in 2007, with an overall average of 102.8 fish/hr (SE = 4.1) (Table 1). Goudreau (1993) reported a similar catch rate (106.4 fish/hr) for largemouth bass in Lake Rhodhiss. Mean yearly catch rates of largemouth bass in Lake Hickory (the impoundment immediately downstream of Lake Rhodhiss) were slightly lower than those observed in this study, where catch rates averaged 89 fish/hr between 2004 and 2007 (Hodges 2007; Kin Hodges, NCWRC, pers. comm.). However, total catch rates of largemouth bass in Lake James (the impoundment immediately upstream of Lake Rhodhiss) were considerably lower than those found in this survey, with mean catch rates in the Catawba River arm of the reservoir ranging from 38.9 fish/hr in 2004 to 59.9 fish/hr in 2006 (Rash 2006).

Age and Growth.—Largemouth bass size structures consisted of individuals with lengths ranging from 76 to 533 mm TL (mean = 320.1 mm TL; SE = 4.1) (Figure 2). Approximately 38% of the largemouth bass collected were of legal harvestable size (≥ 356 mm TL), which is similar to the proportion (40%) observed in Lake James (Rash 2006).

Largemouth bass RSD values remained relatively consistent between years of the survey: RSD-quality values ranged from 65 to 76 (mean = 69.7; SE = 3.3) and RSD-preferred values ranged from 33 to 35 (mean = 34.3; SE = 0.7) (Table 2). These values were analogous to those found by Goudreau (1993) for Lake Rhodhiss, where mean RSD-quality and RSD-preferred values were 77 and 44, respectively. Additionally, stock indices appeared to be similar between the upper three impoundments on the Catawba River, with mean RSD-quality and RSD-preferred values for Lake Hickory of 74 and 33, respectively (Hodges 2007), and mean RSD-quality and RSD-preferred values for Lake James of 73.0 and 33.3, respectively (Rash 2006).

Largemouth bass were collected up to age 16, and age-2 fish were the predominant age class of largemouth bass observed (Figure 3). Fish appeared to be fully recruited to the sampling gear at age 1; largemouth bass did not fully recruit to the sampling gear until ages 3 and 2 in Lakes Hickory (Hodges 2007) and James (Rash 2006), respectively.

The von Bertalanffy growth curve,

$$\mathrm{TL} = 515.1 * (1 - e^{(-0.254\,(\mathrm{age} - 0.370))}),$$

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 predicted that largemouth bass in Lake Rhodhiss recruited to the 356-mm TL length limit by age 5. This was a slower growth rate than that observed in Lakes Hickory (Hodges 2007) and James (Rash 2006), where fish recruited to the 356-mm TL length limit by ages 4 and 3, respectively. Although largemouth bass in Lake Rhodhiss were found to exhibit slower initial growth than populations in Lakes James and Rhodhiss, the estimated asymptotic maximum length for largemouth bass in this survey was 515.1 mm TL, which was higher than the estimate of 476 mm TL for Lake Hickory (Hodges 2007) and 464 mm TL for Lake James (Rash 2006). Density-dependent mechanisms are likely restricting the early growth of largemouth bass in Lake Rhodhiss, but the reservoir's trophic state allows largemouth bass to continue to advance towards the predicted asymptotic maximum length.

Index of Condition.—Individual largemouth bass relative weight values ranged from 51.4 to 158.7 (mean = 98.1; SE = 0.6), while yearly mean relative weight values ranged from 88.2 (SE = 0.6) in 2006 to 112.3 (SE = 0.8) in 2005 (Figure 5). High relative weight values in 2005 possible reflected pre-spawn attributes. Although the sampling dates were similar between years, water temperatures during the 2005 sample were more conducive to pre-spawn conditions, which would likely result in higher tissue accumulation in fishes (Ney 1999). Relative weight values within this study were slightly higher than those calculated in an earlier assessment of black bass in Lake Rhodhiss (Goudreau 1993), where mean relative weight values for 50-mm size classes ranged from 84.0 to 94.0. In addition, relative weight values obtained during this survey were comparable to those from 3-yr studies conducted between 2004 and 2006 on Lakes James (Rash 2006) and Hickory (Hodges 2007). Rash (2006) found relative weight values for largemouth bass in Lake James to range from 71.8 to 132.2 (mean = 97.8), while Hodges (2007) reported yearly mean relative weights for largemouth bass in Lake Hickory that ranged from 90 to 95.

Mortality.—Total annual mortality was estimated to be 0.25 (SE = 0.02) for largemouth bass within the survey. This estimate was identical to the estimated annual mortality rate for the 2001 largemouth bass cohort in Lake Hickory (Hodges 2007); however, it is slightly less than the total annual mortality estimate of 0.35 for largemouth bass in Lake James (Rash 2006). In addition, Beamesderfer and North (1995) evaluated the reported natural 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 0.25 appears to be slightly lower than values reported within the literature.

Conclusions

The largemouth bass population in Lake Rhodhiss appeared to be comprised of multiple year classes that consist of quality-sized fish in above average condition. In addition, the largemouth bass population was characterized by moderate growth and very low mortality.

Largemouth bass in this study were predicted to reach a larger asymptotic maximum length than fishes in Lakes Hickory and James. However, largemouth bass growth in Lake Rhodhiss was found to be slower than these other populations. Catch rates during this study indicated a high density of largemouth bass in the population, and estimates of harvest and mortality revealed that low numbers of these fishes are lost from the population. Therefore, it is possible that density-dependent mechanisms are limiting the growth of largemouth bass in the reservoir. Furthermore, potential interactions with other piscivores – in particular, the emergent white perch *Morone americana* and walleye populations (Rash 2007) – will have the potential to further impact growth.

In addition, sport fishes could be adversely affected by efforts to reduce nutrients in the reservoir. At present, the impoundment's trophic state is driving its sport fish populations; however, elevated nutrient levels have been cited as impairments to water quality (NCDENR 2003). Certainly, some reduction in nutrient loading would be beneficial for both sport fish and municipal water treatment plants, but excessive nutrient reduction (i.e., oligotrophication) would be disastrous for sport fish populations (Ney 1996; Maceina and Bayne 2001). Therefore, all plans to reduce nutrient loading should be predicated on a compromise between ecological requirements of sport fish and cultural requirements of the public (Ney 1996; Maceina and Bayne 2001; Anders and Ashley 2007).

Nevertheless, current reservoir conditions are able to support a very popular recreational fishery. Anglers targeting largemouth bass in Lake Rhodhiss should continue to expect a high quality fishing experience, with frequent landings of quality-sized fish.

Recommendations

1) Continue to manage the Lake Rhodhiss largemouth bass population under the current statewide regulation.

2) Work with municipalities to prevent the oligotrophication of Lake Rhodhiss.

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TABLE 1.—Mean catch-per-unit-effort data for largemouth bass across all sites during the 2005, 2006 and 2007 sampling seasons on Lake Rhodhiss, North Carolina. Catch-per-unit-effort values represent the number of fish collected per hour, with standard error values in parentheses.

Year	Catch per unit effort
2005	105.5 (7.3)
2006	86.1 (6.4)
2007	116.9 (3.8)
All	102.8 (4.1)

TABLE 2.—Relative stock densities (RSD) of largemouth bass collected during the 2005, 2006 and 2007 sampling seasons on Lake Rhodhiss, North Carolina.

Year	Index	Stock density value
2005	RSD-quality	65
	RSD-preferred	33
	RSD-memorable	2
	RSD-trophy	0
2006	RSD-quality	68
	RSD-preferred	35
	RSD-memorable	1
	RSD-trophy	0
2007	RSD-quality	76
	RSD-preferred	35
	RSD-memorable	2
	RSD-trophy	0

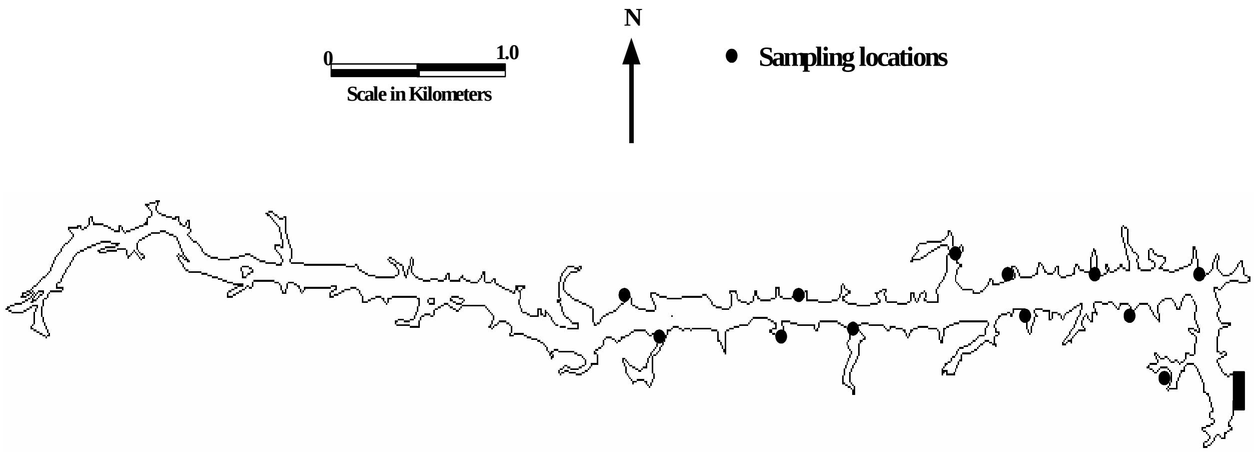

FIGURE 1.—Map of Lake Rhodhiss, North Carolina, with sampling locations.

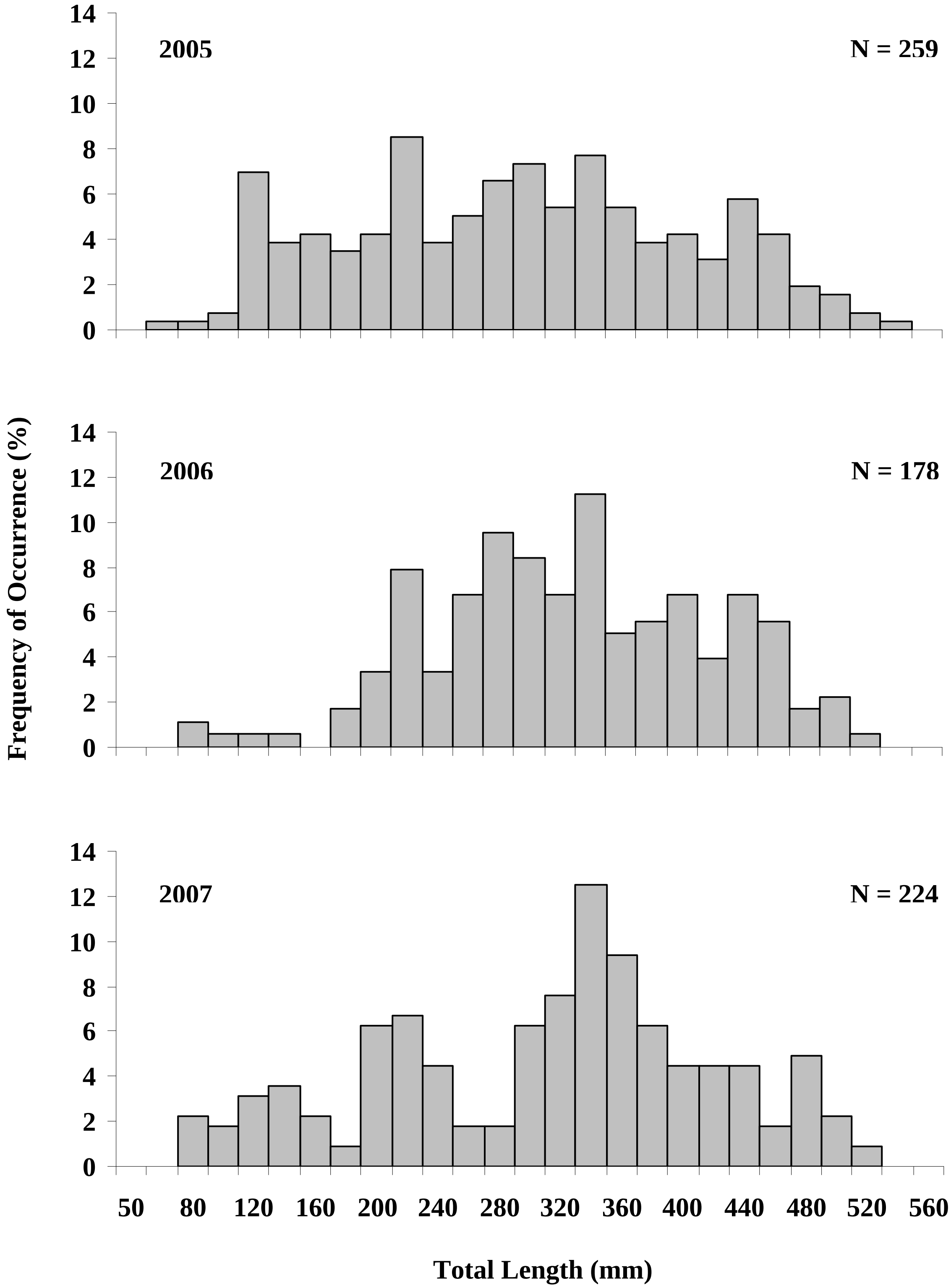

FIGURE 2.—Length-frequency distribution of largemouth bass collected during the 2005, 2006 and 2007 sampling seasons on Lake Rhodhiss, North Carolina. Fish are grouped by 20-mm size class intervals.

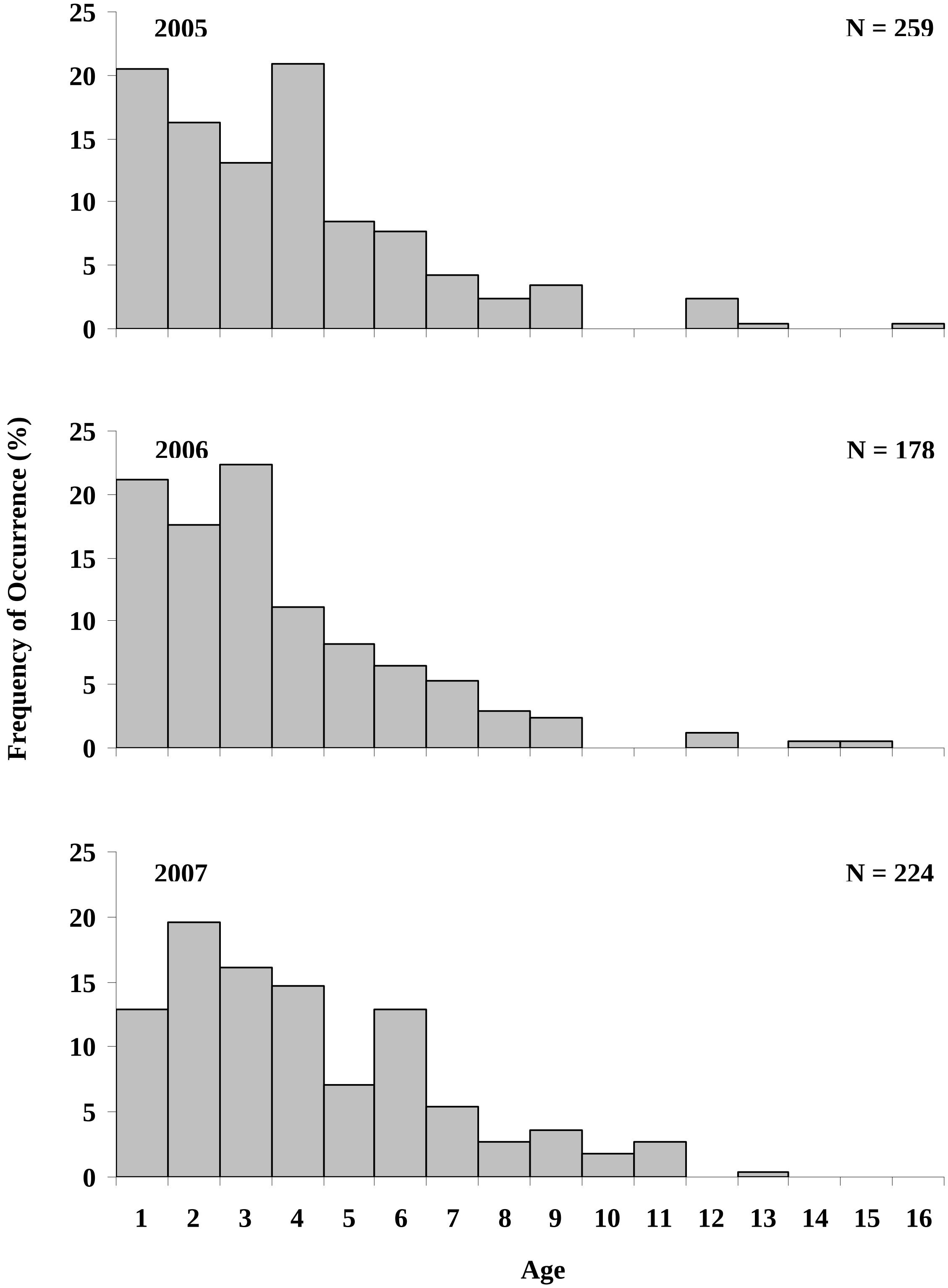

FIGURE 3.—Age distribution of largemouth bass collected during the 2005, 2006 and 2007 sampling seasons on Lake James, North Carolina.

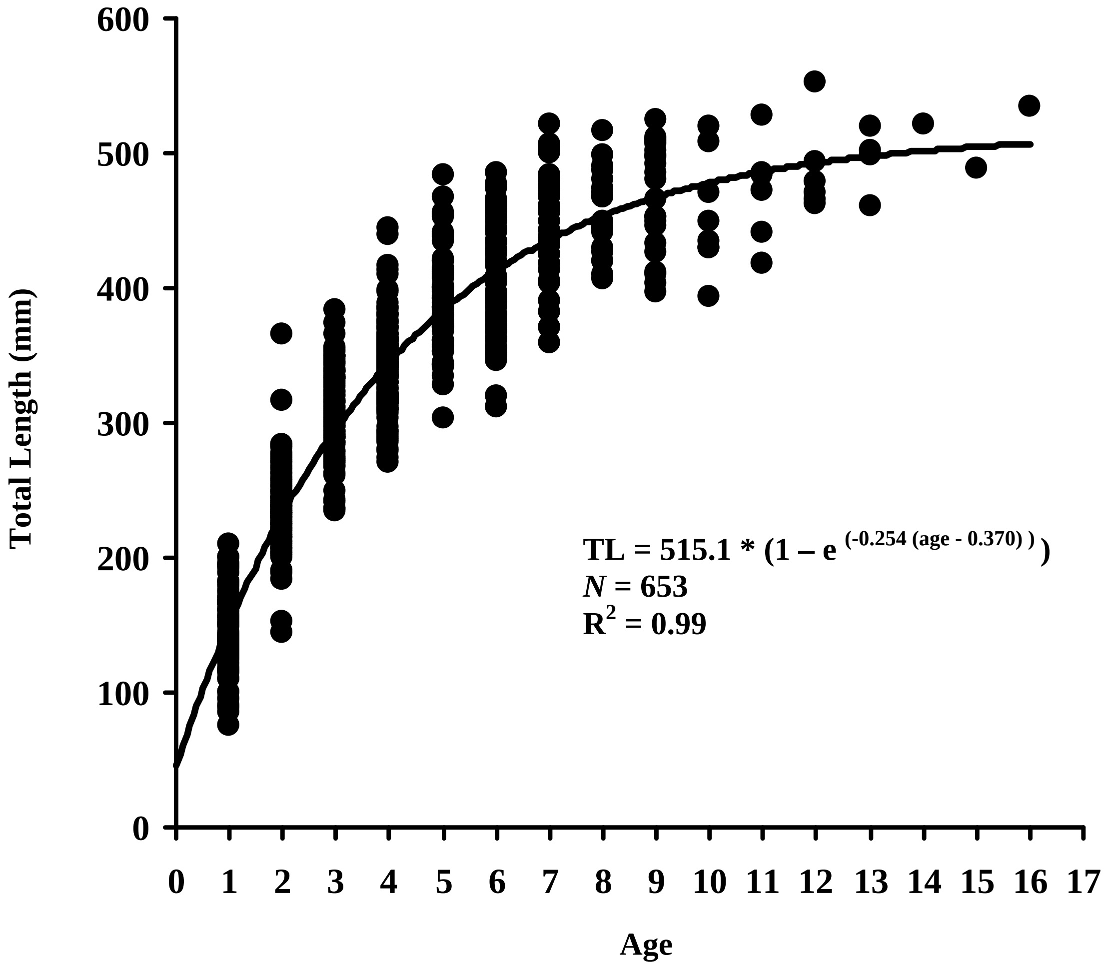

FIGURE 4.—Length at age of capture and von Bertalanffy growth curve (solid line) for all largemouth bass collected during the 2005, 2006 and 2007 sampling seasons on Lake Rhodhiss, North Carolina.

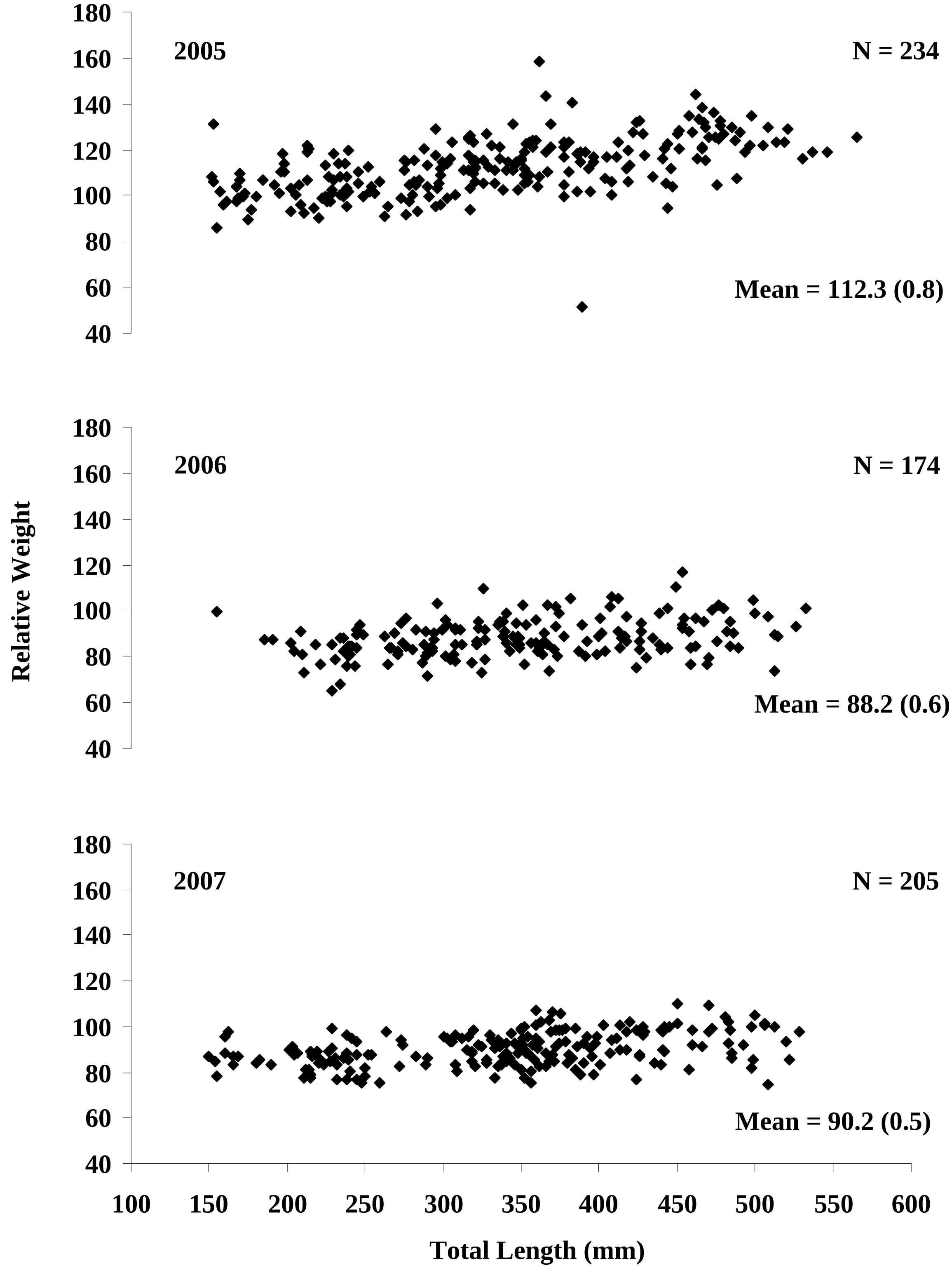

FIGURE 5.—Relative weight values of largemouth bass collected during the 2005, 2006 and 2007 sampling seasons on Lake Rhodhiss, North Carolina. Yearly mean relative weight values are noted, with standard error values in parentheses.