LOOKOUT SHOALS LAKE LARGEMOUTH BASS SURVEY, 2008–2010

Mountain Fisheries Investigations

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Abstract.—Boat-mounted electrofishing gear was used to sample largemouth bass *Micropterus salmoides* in Lookout Shoals Lake during April of 2008, 2009, and 2010. Catch rates of largemouth bass declined from 86 (SE = 8.2) to 61 (SE = 5.3) fish per hour over this period. Size distributions in 2008 and 2009 were similar and contained primarily fish > 240 mm in total length, with the largest mode of fish being between 320 and 380 mm. In contrast, the distribution of largemouth bass in 2010 was bimodal, with the largest modes between 180–260 mm, and 340–400 mm. Stock index values for PSD, PSD-P, and PSD-M averaged 69, 31, and < 1, respectively. Relative weights averaged 97 during the three years of the study. Largemouth bass predominantly ranged in age from 1–12, although one fish older than age 12 was observed (age 18) in 2010. In addition to several age classes being observed, 27% of fish aged were > 5 years old. As a result of unequal recruitment caused by the presence of abnormally strong year classes formed in 2001 and 2002, two mortality estimates were provided. The first estimate, based on a linear regression of pooled age groups 2-11, resulted in an estimate of 26%. A second mortality estimate of 53% was obtained by using just the pooled age groups 2-5, thereby eliminating the influence of the strong 2001 and 2002 cohorts. Growth rates were slower for fish ≤ 2 years old collected in 2010 compared to fish collected in 2008 and 2009. In contrast, growth rates of fish age 4–8 collected in 2010 appeared to be faster than in 2008 and 2009. Using length at age data averaged across all three years of the study, L_∞ was estimated to be 436 mm.

Lookout Shoals Lake was impounded in 1915 on the Catawba River by Duke Energy Corporation (DEC) near the City of Statesville, North Carolina. Operated primarily for hydropower production, the reservoir covers 514 ha with an average depth of 7.3 m and an average retention time of only 7 days. Lookout Shoals Lake supports fisheries for largemouth bass *Micropterus salmoides*, striped bass *Morone saxatilis*, crappie *Pomoxis spp*., sunfish *Lepomis spp*., and several species of catfishes *Ictalurus* and *Ameiurus spp*.

Biologists with the North Carolina Wildlife Resources Commission (NCWRC) have collected data concerning the Lookout Shoals Lake largemouth bass population on only a few occasions. Largemouth bass density, biomass, and scale-derived growth rates were obtained using a variety of gear types to survey the fish community from 1957–1959, in 1965, and again in 1981 (Tebo 1958; Tebo 1959; McNaughton 1966; Mickey 1982). In 1990, NCWRC and DEC biologists conducted electrofishing surveys that focused on largemouth bass, which yielded indices of abundance, size structure information, body condition, and scale-derived growth data (Mickey 1993). Since these surveys, largemouth bass have been collected as part of periodic fish community surveys conducted by DEC biologists, but no further comprehensive stock assessment work has been undertaken. Therefore, the objectives of this survey are to gather updated information on the relative abundance, size structure, and body condition of Lookout Shoals Lake largemouth bass and to obtain estimates of age structure and growth rates using otoliths.

Methods

Boat-mounted electrofishing gear was used to collect largemouth bass from ten fixed transects throughout Lookout Shoals Lake during daytime hours in late April 2008, 2009, and 2010. All transects were 300 m in length and located between the confluence of Elk Shoals Creek and Lookout Shoals Dam (Figure 1). Electrofishing settings of 1000 V, 4 A, and 120 pulses per second (pps) were used throughout the study. All bass collected were measured for total length (mm) and weight (g). In 2008 and 2009, fish from randomly selected sites were kept for age determination, while all others were released after measuring. In 2010, all fish were kept for age determination. Catch per unit effort (CPUE) was indexed as the number of bass collected per hour of electrofishing time. Length distribution histograms were constructed and proportional size distribution (PSD) and relative stock density values of preferred (PSD-P) and memorable (PSD-M) sized fish were calculated for each collection as described by Gabelhouse (1984) and modified by Guy et al. (2007). Relative weights were computed using the equation of Wege and Anderson (1978).

Sagittal otoliths were removed from all largemouth bass kept for age determination. In most cases, otoliths from fish ≤ 3 years old were submerged in a shallow dish of water and read in whole view using a dissecting microscope. For fish > 3 years old, otoliths were prepared for reading by breaking them in half perpendicular to their longest axis and polishing the broken end using 320–400 grit sandpaper. The otolith section was then submerged in a shallow dish of water, with the unbroken end embedded in a layer of clay lining the bottom of the dish. The otolith section was illuminated from the side with a fiber optic light and read under a dissecting microscope. Otoliths were read independently by two readers, and discrepancies in annuli counts between readers were rectified at a joint reading.

The reported age of the fish in this survey is not always equal to the number of annuli that were present on the otoliths. Previous work in Illinois has shown that annulus formation in largemouth bass occurs between April and June (Taubert and Tranquilli 1982). For most fish collected in this survey, the annulus for the year in which they were collected had not yet begun to form and there was significant growth between the last annulus and the otolith radius. In these cases, fish were assigned an age equal to the number of annuli plus one since annulus formation was imminent. For all fish aged in this survey, it was assumed that length at age at time of capture was approximately equal to true length at age since the survey coincided with the period of annulus formation.

Age distribution histograms were constructed and mean length at age was determined for all year classes. The average maximum length attainable by Lookout Shoals Lake largemouth bass (L_∞), was calculated using the average mean lengths for each age during the three years of the survey. To determine L_∞, length at age n was plotted against length at age $n + 1$. Using the intercept and slope from this line, L_∞ was figured using the following equation:

$$L_\infty = \text{intercept} / 1 - \text{slope}$$

Annual mortality rate (A) was calculated for largemouth bass using an unweighted catch curve regression. 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 (age 12 and age 18) were not used to estimate annual mortality.

Results

Abundance

Catch rates of largemouth bass declined during each successive year of the survey (Table 1). For 2008, 2009, and 2010, CPUE values were 86 (SE = 8.2; N = 187), 79 (SE = 5.6; N = 191), and 61 (SE = 5.3; N = 131) fish/hr, in that order. While CPUE declined over the three years, the lowest value obtained is comparable to the largemouth bass electrofishing survey conducted by NCWRC and DEC biologists on Lookout Shoals Lake during dusk and nighttime hours in 1990, when 60 fish/hr (SE = N/A; N = 322) were collected (Mickey 1993).

CPUE values for largemouth bass were much higher during this study than those recorded by DEC in 2005, when only 25 fish/hr (SE = 3.6; N = 76) were collected (DEC unpublished data). Additionally, DEC provided largemouth bass survey data from Lookout Shoals Lake in 2000, but electrofishing time was not recorded. However, CPUE comparisons between the DEC 2000 and 2005 surveys, as well as the 2008–2010 surveys collected during this study, are possible based on the length of shoreline sampled. In the DEC 2000 survey, the mean number of largemouth bass captured per 300 m of shoreline was 13, which is much higher than the 8 fish/300 m observed in 2005 by DEC. While CPUE from the DEC 2000 survey is lower than observed during this study in 2008 and 2009 (19 fish/300 m in both years), it is comparable to the 13 fish/300 m observed in 2010.

Given the variability associated with electrofishing catch rates (Van Horn et al. 1991), it is not clear why the DEC 2005 CPUE was much lower than other reported values, or why the 2008 and 2009 CPUE values were much higher. Furthermore, it is unclear if the decline in our catch rates from 2008–2010 are indicative of an actual decline in population densities. During a similar stock assessment conducted between 2004 and 2006 on Lake Hickory, largemouth bass CPUE declined each year (96, 86, and 74 fish/hr respectively; Hodges 2007a), but then improved drastically to 98 fish/hr the following year (Hodges 2007b). Additional sampling in future years will help validate any trends in the relative abundance of the Lookout Shoals Lake largemouth bass population.

Size Structure

Stock indices during the survey were variable from year to year (Table 1), and averaged 69, 31, and < 1 for PSD, PSD-P, and PSD-M, respectively. These values are higher than reported by Mickey (1993) in 1990 (PSD = 47; PSD-P = 19), similar to those obtained by DEC in 2000 (PSD = 69; PSD-P = 29; PSD-M = 3), but lower than reported by DEC in 2005 (PSD = 83; PSD-P = 44; PSD-M = 3) from Lookout Shoals Lake (DEC unpublished data). The values obtained were also lower than the averages reported between 2004 and 2006 on Lake Hickory (Hodges 2007a) and Lake James (Rash 2006). However, the average PSD values obtained during this study were within desired ranges for largemouth bass (40-70% for PSD; 10-40% for PSD-P; 0-10% PSD-M).

The 2008 and 2009 length-frequency distributions were dominated by fish > 240 mm in length, with the largest mode of fish being between 320 and 380 mm during both years (Figure 2). In contrast, the distribution of largemouth bass in 2010 was bimodal, with the largest modes being between 180–260 mm and 340–400 mm. The increase in the percentage of smaller fish during the 2010 survey may be a result of stronger year classes in recent years, and/or declines in the number of larger, and presumably older fish.

Condition

Relative weights for Lookout Shoals Lake largemouth bass averaged 97 during the three years of the study, but declined each year from a high of 102 in 2008 to 91 in 2010. In all three years, relative weights were not related to fish size (Figure 3). The mean relative weight values obtained during this study are higher than the mean relative weight values of 85 and 87 obtained by DEC in 2000 and 2005, respectively (DEC unpublished data), and similar to those obtained in recent surveys on other Catawba River reservoirs (Rash 2006; Hodges 2007a; Hodges 2007b: Rash 2007).

The decline in mean relative weight throughout the study period is surprising since CPUE declined as well. However, the difference observed between these relative weight values, and as previously mentioned for CPUE values as well, may be largely due to random variability. Furthermore, the variability between these values could be due to factors not indicative of true changes in condition, such as timing of the largemouth bass spawn in relation to the timing of surveys. Additional surveys in future years are needed to determine if relative weights have improved or if it they are continuing to decline.

Age Structure

Largemouth bass collected during this survey ranged in age from 1–12, with the exception of one fish older than age 12 (age 18) collected in 2010, and 27% of the fish aged were > age 5 (Figure 4). The age structure of fish collected in this survey is roughly comparable to the age structure of Lake Hickory largemouth bass collected during 2004–2006 (Hodges 2007a), but the Lookout Shoals Lake age distributions were comprised of more fish older than age 5. This may be due to the presence of the stronger than normal 2002 and 2001 year classes, which were present during all three surveys. An additional difference between this survey compared to the 2004–2006 Lake Hickory survey is that fish appeared to be fully recruited to the sampling gear at age 2, while in Lake Hickory they do not appear to be fully recruited to the gear until age 3 (Hodges 2007a). Although 2-year-old bass in Lookout Shoals Lake are slightly larger than similar aged fish in Lake Hickory (Hodges 2007a), it is not clear if this factor alone is responsible for their earlier recruitment to electrofishing gear.

It also appears as if recruitment is not constant in Lookout Shoals Lake, as indicated by the presence of more fish from the 2002 and 2001 year classes compared to the younger 2004 and 2003 year classes during all three years of the survey. This finding also suggests that our age structure data is reliable since these year classes all tracked consistently relative to each other during all 3 years of the survey. Given that no historical otolith-derived age structure data is available for largemouth bass in Lookout Shoals Lake, future monitoring is needed to determine if recruitment is usually variable or if the strong year classes formed in 2002 and 2001 were anomalies. Of further interest, surveys on the two impoundments located immediately above Lookout Shoals Lake, Lake Hickory and Lake Rhodhiss, also revealed a strong year class of largemouth bass in 2001 (Hodges 2007a; Rash 2007). This finding suggests that the factors related to the strong year class in 2001 were probably basin-wide rather than lake specific.

Mortality

Running a linear regression of pooled age data for ages 2–11 provided an annual mortality estimate of 26% ($r^2 = 0.83$) for largemouth bass during this survey. This value is lower than the 35% annual mortality rate that was reported for Lake James largemouth bass between 2004 and 2006 (Rash 2006), but similar to the 25% rate reported for Lake Hickory during 2004–2006 (Hodges 2007a). However, Hodges (2007a) reported issues with the Lake Hickory mortality estimate since insufficient portions of the age structure descended steadily. This was also an issue with the pooled age data used to determine the mortality rate for Lookout Shoals Lake during this study.

As with Lake Hickory, the assumption of constant recruitment needed to perform mortality estimates was likely violated, as evident by the dominant 2002 and 2001 cohorts observed during this study. Plotting the pooled age distributions revealed a decline from age 2 fish (when fish first recruited to the gear) through age 12, with the exception of the age 5 group. This suggested an alternate method for estimating mortality, by running a linear regression using just the pooled age groups of 2–5. This method provided a much higher mortality rate of 53%, but also a much higher r^2 value (> 0.99). While this mortality rate is likely artificially high due to poor year classes in 2003 and 2004, the same argument could be made that the original mortality rate of 26% was artificially low as a result of strong year classes in 2002 and 2001. While it is likely that the true mortality rate is somewhere between these two values, the assumption of constant recruitment does not hold true. As a result, these mortality estimates are provided as a best guess scenario, and additional attempts to obtain a more accurate mortality estimate should be made in future surveys.

Growth

Largemouth bass in Lookout Shoals Lake generally reached harvestable size (354 mm) by age 4 (Table 2), which is comparable to values obtained from Lake Hickory from 2004–2006 (Hodges 2007a). Growth rates of fish age 4–8 appeared to grow faster during 2010 than in 2008 and 2009. In contrast growth rates were slower for fish ≤ 2 years old collected in 2010 compared to fish collected in 2008 and 2009. While this observation could be a result of density-dependent factors, caused by more age-2 fish in 2010 than in 2008 or 2009, comparisons of age class abundance between years is not possible since fish were subsampled for aging purposes during the 2008 and 2009 collections.

Fish during all three years of the survey appeared to grow similarly to those collected in in 1990 (Mickey 1993). This is surprising, since fish from the 1990 survey were aged using scales, which generally yield less accurate age data than otoliths. As such, the similarities should be viewed with caution since the reliability of the growth information obtained in 1990 is suspect.

Using average length at age estimates obtained across all three years of the survey, L_∞ for Lookout Shoals Lake largemouth bass was 436 mm, and this value explained 97% of the variation in TL at age of capture for largemouth bass. This is less than the values of 476 mm for Lake Hickory (Hodges 2007a) and 464 mm for Lake James largemouth bass (Rash 2006).

Conclusions and Recommendations

1. Catch rates declined throughout the course of the study. Conduct additional surveys to determine if these decreasing catch rates represent an actual decline in largemouth bass densities.
2. Stock indices and body condition estimates are within the range of those previously reported for other lakes in the region. However, relative weights declined over the three year survey. Additional surveys are needed to determine if relative weights improve or continue to decline.
3. Recruitment of largemouth bass in Lookout Shoals Lake appears to vary between years, as evidenced by the strength of the 2002 and 2001 year classes. This, and future strong year classes, should be monitored to gain insight into the mortality rate experienced by Lookout Shoals Lake largemouth bass.

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Table 1.—Catch rates and size structure indices for Lookout Shoals Lake largemouth bass, 2008–2010. Catch per unit effort (CPUE) values represent the number of fish collected per hour, with standard error values in parentheses. Size structure indices describe the proportional size distribution of quality (PSD), preferred (PSD-P), and memorable (PSD-M) length fish.

Year	CPUE	PSD	PSD-P	PSD-M
2008	86 (8.2)	70	25	0
2009	79 (5.6)	76	29	0
2010	61 (5.3)	60	38	2

Table 2.—Mean length at age, with range, standard error (SE), and sample size (N), for Lookout Shoals Lake largemouth bass, 2008–2010.

	2008				2009				2010			
Age	Mean	Range	SE	N	Mean	Range	SE	N	Mean	Range	SE	N
1	180	137–223	10.2	7	153	86–194	8.6	16	134	118–150	3.3	9
2	272	195–316	4.5	31	282	204–338	5.1	36	231	173–314	4.5	57
3	337	288–384	5.0	26	350	317–392	5.3	15	340	287–377	7.1	11
4	344	322–376	10.4	5	350	324–373	6.8	6	372	315–462	8.6	15
5	362	359–365	3.0	2	381	368–393	12.5	2	406	384–469	9.2	9
6	382	337–456	6.6	18	428			1	461	410–509	28.6	3
7	393	328–453	11.5	10	399	356–446	9.9	10	496			1
8	390	367–408	12.1	3	409	384–423	9.1	4	418	368–473	9.5	11
9	416	410–426	3.1	5	472			1	438	365–522	23.2	6
10	491	489–492	1.5	2	458	428–487	17	3	433	394–471	38.5	2
11	412			1	415	371–458	43.5	2	458	422–510	26.6	3
12					408			1	455			1

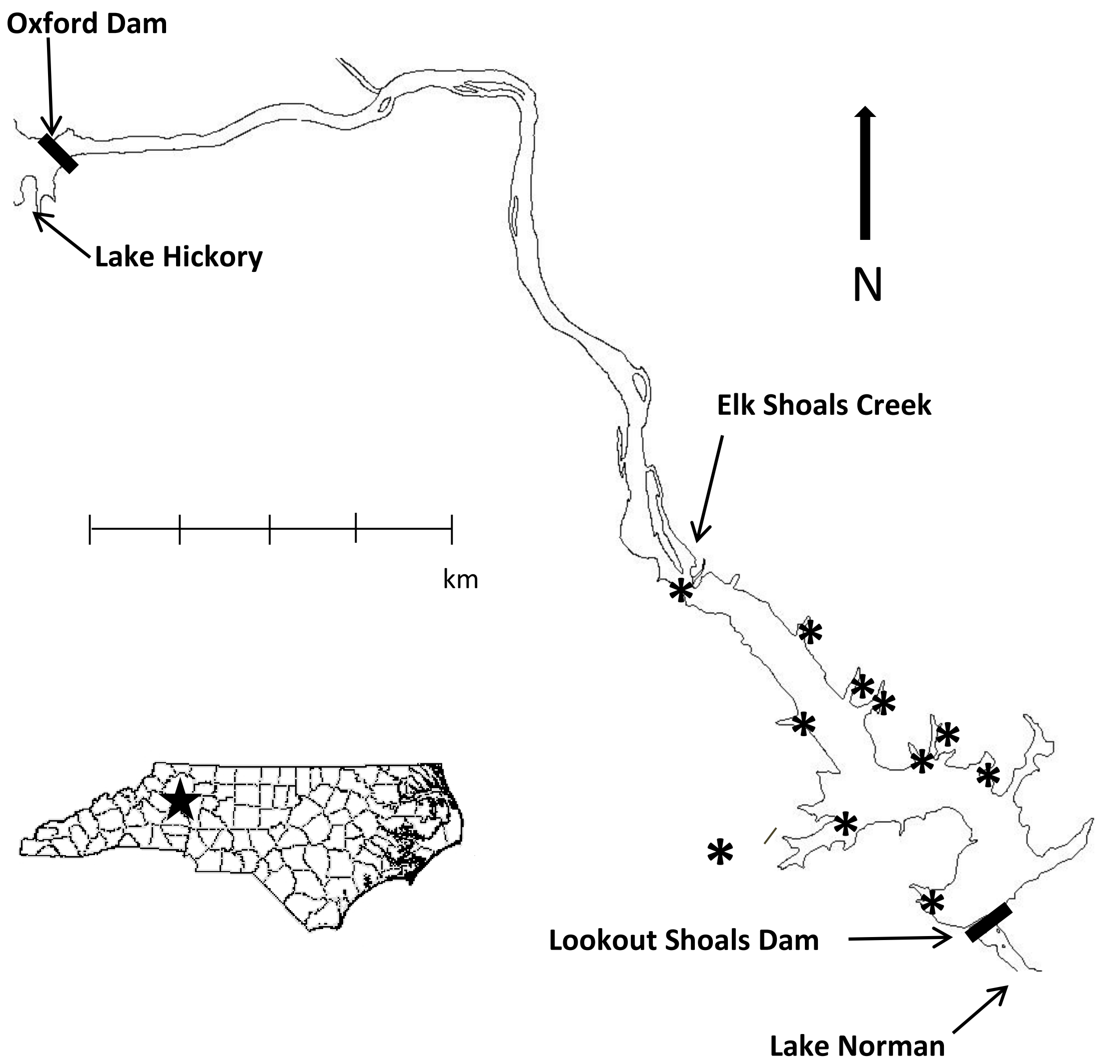

Figure 1.—Map showing largemouth bass sample sites (asterisks) on Lookout Shoals Lake, 2008–2010, and the lake's proximity to adjacent Catawba River reservoirs.

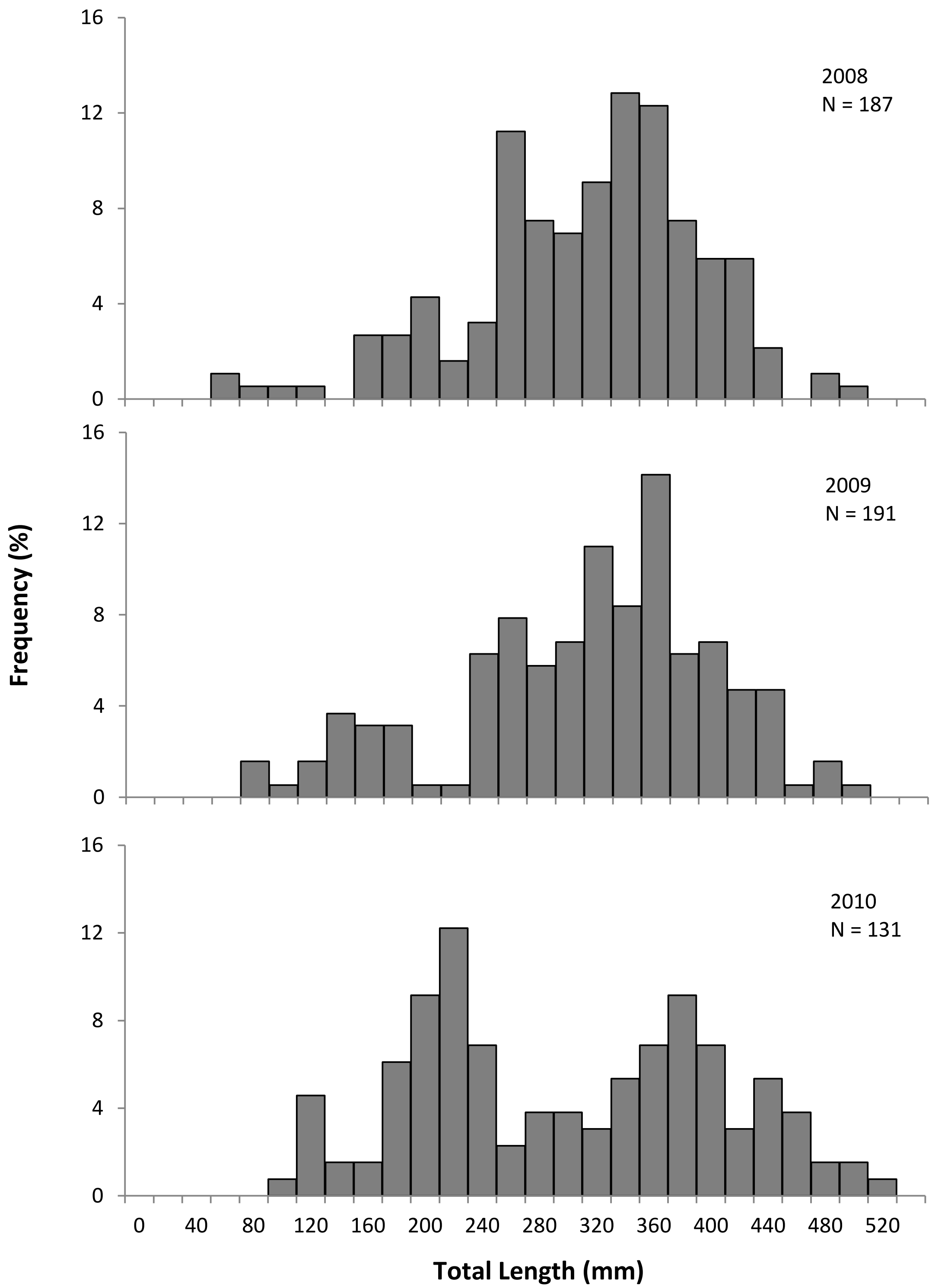

Figure 2.—Length-frequency distributions for Lookout Shoals Lake largemouth bass, 2008–2010.

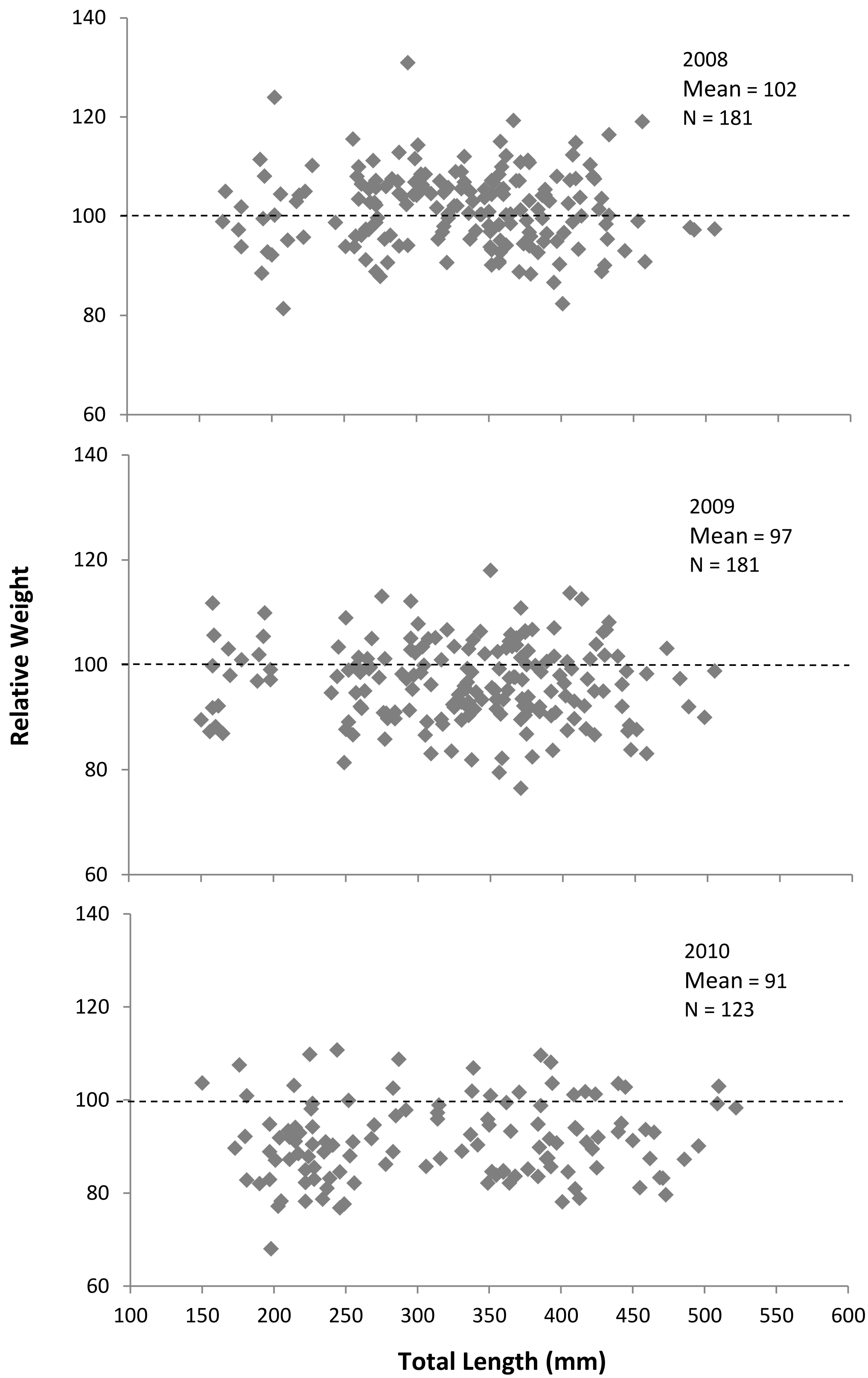

Figure 3.—Relative weights of Lookout Shoals Lake largemouth bass, 2008–2010.

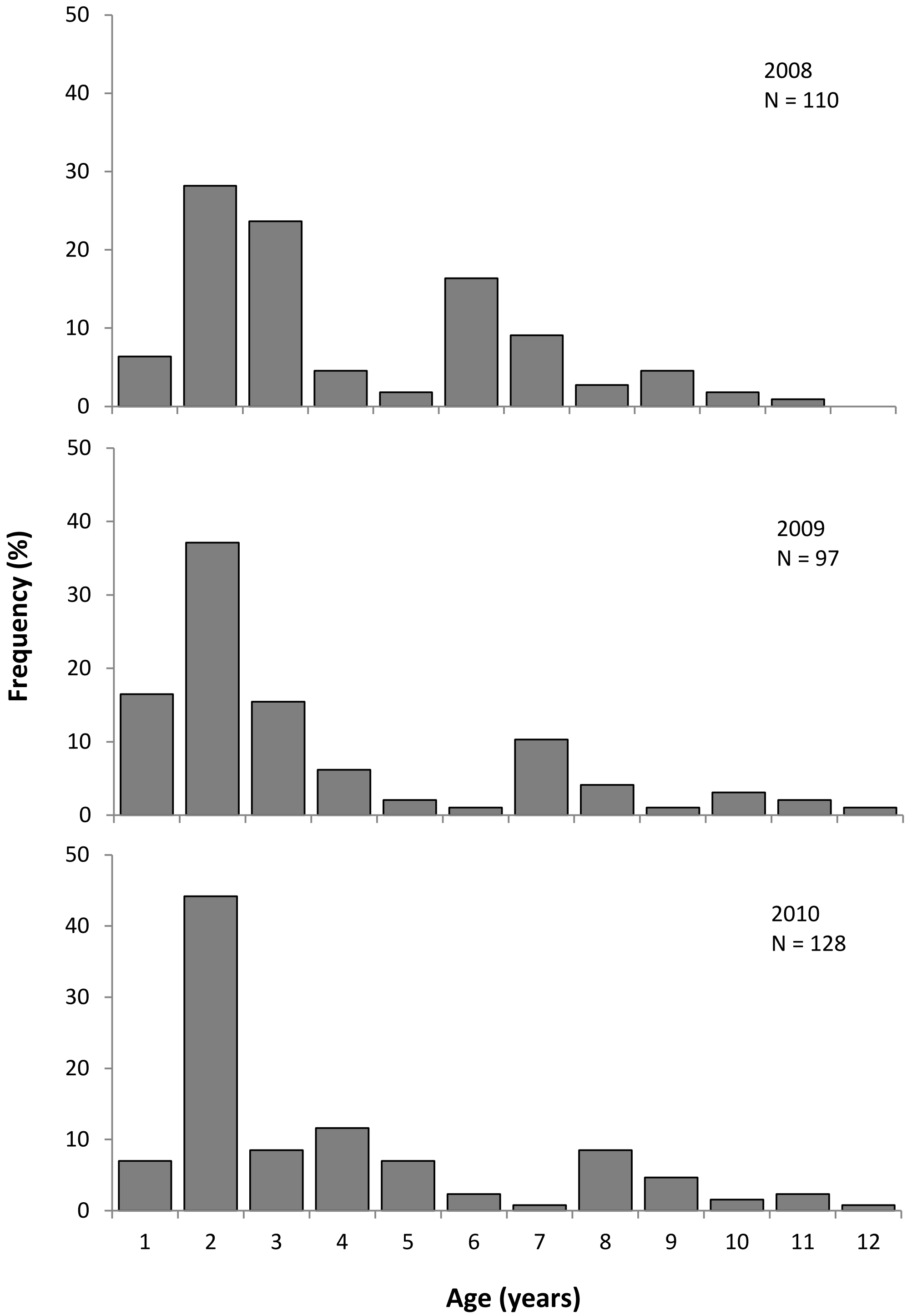

Figure 4.—Age structure of Lookout Shoals Lake largemouth bass, 2008–2010.