LAKE HICKORY LARGEMOUTH BASS SURVEY, 2004 – 2006

FINAL REPORT

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Abstract.—Boat-mounted electrofishing gear was used to sample largemouth bass *Micropterus salmoides* in Lake Hickory during April of 2004, 2005, and 2006. Catch rates of largemouth bass declined from 96 (SE = 2.1) to 74 (SE = 2.0) fish per hour over this period. Size distributions each year were dominated by fish >300 mm in total length, with the largest mode of fish being between 300 and 400 mm. Compared to most largemouth bass surveys conducted previously in Lake Hickory, there were relatively few fish <200 mm present. Stock indices were fairly constant between years, with PSD, RSD-P, and RSD-M values averaging 74, 33, and <1, respectively. PSD values were slightly higher than those obtained during earlier surveys, while RSD-M values were lower. Relative weights improved from 90 in 2004 to 95 in 2006. Largemouth bass ranged in age from 1 to 14, with most fish being ≤5 years old. Growth rates were slower for fish collected in 2006 than for fish collected in 2004 and 2005. Using length-at-age data averaged across all three years of the study, L_∞ was estimated to be 476 mm.

Lake Hickory was impounded in 1927 when Oxford Dam was constructed on the Catawba River by Duke Energy Corporation (DEC) near the City of Hickory, North Carolina. Operated primarily for hydropower production, the reservoir covers 1,710 ha with an average depth of 9.45 m and an average retention time of only 32 d. Lake Hickory 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*.

Because it is more productive than most foothills reservoirs, Lake Hickory is heavily utilized by anglers. According to a creel survey conducted during 1997–1998, total fishing pressure for the reservoir was estimated at 291,755 angler hr, which equates to 179.6 angler hr/ha (Baker 2002). Largemouth bass received the greatest amount of directed effort from anglers, accounting for 45.1% of the total fishing effort during the 1997–1998 creel survey (Baker 2002).

Biologists with the North Carolina Wildlife Resources Commission (NCWRC) have collected data concerning the Lake Hickory largemouth bass population on several occasions. Largemouth bass density, biomass, and scale-derived growth rates were obtained during gillnet and cove rotenone surveys of the total fish community conducted from 1956–1959 and again in 1983 (Tebo 1959; Mickey 1984). In 1990 and 1991, NCWRC and DEC biologists conducted electrofishing surveys 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 were to gather updated information on the relative abundance, size structure, and body condition of Lake Hickory 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 fixed transects throughout Lake Hickory during late April in 2004, 2005, and 2006. All transects were 300 m in length and located between NC 321 and Oxford Dam (Figure 1). Twenty sites were sampled in 2004, with 19 sites being sampled in 2005 and 2006. 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 all three years, fish from randomly selected sites were kept for age determination, while all others were released after measuring. A higher proportion of fish were kept for age determination in 2004 to determine if growth rates differed between uplake and downlake sites. After growth rates were found to be similar throughout the entire lake, a smaller proportion of fish was kept for age determination in 2005 and 2006. Catch per unit effort (CPUE) was indexed as the number of bass collected per hour of electrofishing time. Length distribution histograms were constructed and stock indices were calculated. The lengths for stock (200 mm), quality (300 mm), preferred (380 mm), and memorable (510 mm) sized largemouth bass used in determining stock index values were those proposed by Gabelhouse (1984). Relative weights were computed using the equation of Wege and Anderson (1978).

Sagittal otoliths were removed from all largemouth bass kept for age determination. 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 represented by at least three fish. Since the subsample of fish kept for age determination was randomly selected, it was not necessary to use an age-length key to determine overall age structure or mean length at age. The average maximum length attainable by Lake Hickory 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:

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

Results

Abundance

Catch rates of largemouth bass declined during each successive year of the survey. We collected 477, 440, and 352 largemouth bass in 2004, 2005, and 2006, respectively. For 2004, 2005, and 2006, CPUE values were 96 (SE = 6.9), 86 (SE = 7.1), and 74 (SE = 6.2) fish/hr, in that order. Elsewhere on the upper Catawba River, catch rates of largemouth bass from the Catawba River arm of Lake James increased during each successive year of sampling between 2004 and 2006 (Rash 2006), while catch rates at Lake Rhodhiss declined between 2005 and 2006

(NCWRC unpublished data). Given that trends in abundance during the study period were not consistent across all three reservoirs, it appears as if factors affecting bass densities in the upper Catawba are reservoir-specific and not system-wide.

During electrofishing surveys conducted by NCWRC and DEC biologists in 1990 and 1991, 112 fish/hr were collected each year (Mickey 1993). Additionally, DEC biologists conducted general fish community assessments on numerous occasions between 1994 and 2000. Although electrofishing time was not recorded in these surveys, it is possible to compute CPUE based on the length of shoreline sampled. Between 1994 and 2000, the mean number of largemouth bass captured per 300 m of shoreline was 23.4 (range 17.0–27.0). An average of 23.9, 23.2, and 18.5 fish/300 m were collected in 2004, 2005, and 2006, respectively. Although the catch rates obtained between 2004 and 2006 were substantially lower than those obtained in 1990 and 1991, they were within the range of catch rates obtained overall between 1990 and 2000.

Given the variability associated with electrofishing catch rates (Van Horn et al. 1991), it is not clear if the declines in our catch rates are indicative of an actual decline in population densities. Additional sampling will be needed to validate any trends in the relative abundance of the Lake Hickory largemouth bass population.

Size Structure

Largemouth bass captured during this survey ranged in length from 63 to 584 mm. The length-frequency distributions were dominated by fish >300 mm in length, with the largest mode of fish being between 300 and 400 mm during all three years of the survey (Figure 2). Compared to most largemouth bass surveys previously conducted in Lake Hickory (Figure 3), there were relatively few fish <200 mm present between 2004 and 2006. This suggests that recruitment had been poor immediately prior to and during the survey period. Although most previous samples produced fish of a wider range of sizes with more modes, the length distribution in 1991 appeared very similar to what was obtained in this survey, indicating that it may not be unusual to have low numbers of younger fish in Lake Hickory.

However, it is also possible that the size distributions produced in this survey are the result of gear bias. It is interesting to note that in the years when the lowest numbers of largemouth bass <200 mm were collected (1991, 2004–2006), samples were conducted solely by NCWRC staff. In all other years when higher numbers of small fish were collected, samples were collected either partially (1990) or solely (1994–2000) by DEC biologists. Given that different equipment is used by each group, it is possible that gear selectivity could be affecting the size distribution of largemouth bass collected from Lake Hickory. Another observation suggesting that gear selectivity may be affecting our size distributions is that the low numbers of smaller fish in 2004 and 2005 did not result in a lack of mid-sized fish in 2006. If numbers of juvenile fish were really as low as they appeared in the first two years of the survey, then the numbers of larger fish should have declined by 2006. Future surveys will be needed to determine why low numbers of juvenile fish were collected during this survey.

Stock indices during the survey were fairly constant, with PSD, RSD-P, and RSD-M values averaging 74, 33, and <1, respectively (Table 1). During surveys conducted between 1990 and 2000, PSD values averaged 68 (range 56–74), RSD–P values averaged 33 (range 24–40), and RSD-M values averaged 3 (range 1–4). PSD values from 2004–2006 were marginally higher than in 1990–2000, reflecting the high concentration of quality sized fish over 300 mm.

However, the proportion of memorable sized fish in the population from 2004–2006 was lower than it had been during the earlier surveys.

Condition

Relative weights for Lake Hickory largemouth bass averaged 90, 94, and 95 in 2004, 2005, and 2006, respectively. In 2004 and 2005, relative weight increased slightly as fish total length increased, presumably due to size-related differences in fecundity (Figure 4). In 2006, relative weights were not related to fish size (Figure 4). These relative weights are similar to those obtained in other surveys within the region. Relative weights of Lake James largemouth bass averaged 98 between 2004 and 2006 (Rash 2006), and relative weights of W. Kerr Scott largemouth bass averaged 92 in 2000 and 93 in 2001 (Hodges 2002).

Age Structure

Largemouth bass collected during this survey ranged in age from 1–14, with most fish being ≤age 5 (Figure 5). The age structure of fish collected in this survey is roughly comparable to the age structure of Lake James largemouth bass collected during the same time period (Rash 2006). The main difference is that fish in Lake Hickory do not appear to be fully recruited to the sampling gear until age 3, while in Lake James they appear to be fully recruited by age 2.

It also appears as if recruitment is not constant in Lake Hickory, as indicated by the 2001 year class being the predominant class in all three years of the survey. Given that no historical age structure data is available in Lake Hickory, future monitoring is needed to determine if recruitment is usually variable or if the strong year class formed in 2001 was an anomaly.

Mortality

It was not possible to determine total mortality using catch curve analysis since insufficient portions of the age structure descended steadily to permit mortality estimation. Additionally, the assumption of constant recruitment needed to perform catch curve mortality estimates appears to have been violated, as evidenced by the dominant 2001 cohort. Only a qualitative estimate of mortality can be made by tracking the total numbers of fish from the 2001 cohort (ages 3–5) through the survey period. No other cohorts could be followed, since younger age classes were not fully recruited to the gear, and older age classes were represented by too few fish to make reliable assessments of their abundance. Since a higher proportion of fish were kept for age determination in 2004 (52 %) than in 2005 (27%) and 2006 (30%), it is not possible to directly compare the actual numbers of fish from the 2001 year class that were collected between years. To make this comparison possible, the number of fish from the 2001 year class collected in 2005 and 2006 were adjusted upwards to reflect the numbers that theoretically would have been collected had the same proportion of fish been kept as in 2004. Adjusted numbers of fish from the 2001 cohort that were present in the 2004, 2005, and 2006 samples were 80, 61, and 39, respectively. This suggests that the abundance of the 2001 cohort decreased by approximately 50% from 2004–2006, which would correlate with an annual mortality rate of approximately 25%. This rate is lower than the 35% annual mortality rate that was reported for Lake James largemouth bass between 2004 and 2006 (Rash 2006). However, it should be stressed that this figure is too speculative to be considered an actual mortality estimate. Additional attempts to obtain a more accurate mortality estimate will be made in future surveys.

Growth

Largemouth bass in Lake Hickory generally reached harvestable size (354 mm) by age 4 (Table 2). Growth rates of Lake Hickory largemouth bass collected in 2006 were generally less than the growth rates of fish collected in 2004 or 2005. Fish during all three years of the survey were generally faster growing that those collected in the original NCWRC survey of the Lake Hickory largemouth bass population in 1990 (Mickey 1993). Unfortunately, fish from the 1990 survey were aged using scales, which generally yield less accurate age data than otoliths. As such, the reliability of the growth information obtained in 1990 is suspect. Largemouth bass in Lake Hickory appeared to grow somewhat slower than largemouth bass in Lake James during the study period. Largemouth bass in Lake James were aged using otoliths between 2004 and 2006, and their average mean lengths at ages 1–6 were 145, 270, 340, 374, 416, and 434 mm, in that order (NCWRC unpublished data). Using average length-at-age estimates obtained across all three years of the survey, L_∞ for Lake Hickory largemouth bass was 476 mm. This is comparable to the value of 464 mm obtained for Lake James largemouth bass collected from 2004–2006 (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. Size distributions were dominated by fish >300 mm length, while relatively few fish <200 mm were collected. Continue to monitor the size structure of the Lake Hickory largemouth bass population to assess whether recruitment is actually decreasing or if the size distributions produced in this survey are the result of gear selectivity.

3. Stock indices and body condition estimates are within the range of those previously reported for Lake Hickory and other lakes in the region.

4. Recruitment of largemouth bass in Lake Hickory appears to vary among years, as evidenced by the strength of the 2001 year class. This year class should be monitored in the future to gain insight into the mortality rate experienced by Lake Hickory largemouth bass and to determine how overall abundance is affected as this year class begins to diminish.

5. Consider keeping a higher proportion of fish for age determination in future surveys to reduce the variability in age structure between years.

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TABLE 1.— Stock index values for Lake Hickory largemouth bass, 2004–2006.

Year	PSD	RSD-P	RSD-M
2004	70	34	1
2005	74	32	1
2006	77	34	0

TABLE 2.— Mean length (mm) at age, with range, standard error (SE), and sample size (n), for Lake Hickory largemouth bass, 2004–2006.

	2004				2005				2006			
Age	Mean	Range	SE	n	Mean	Range	SE	n	Mean	Range	SE	n
1	155	87–194	4.9	31	151	119–186	13.7	4	153	122–175	15.9	3
2	237	161–342	4.7	56	234	157–364	9.9	21	217	177–294	7.7	15
3	325	248–429	4.1	80	311	235–379	6.6	31	294	224–384	9.6	19
4	378	336–429	5.5	21	356	241–428	8.1	31	354	280–446	8.9	17
5	401	352–456	5.0	25	409	376–451	7.6	11	381	265–447	7.9	22
6	415	373–471	7.9	15	422	377–449	8.8	8	419	387–442	9.3	6
7	448	362–526	27.9	5	439	407–462	16.5	3	406	356–471	11.8	8
8	449	396–508	14.0	9	442	343–492	49.7	3	436	402–494	9.4	10

FIGURE 1.—Map of Lake Hickory, North Carolina with sampling locations (black dots).

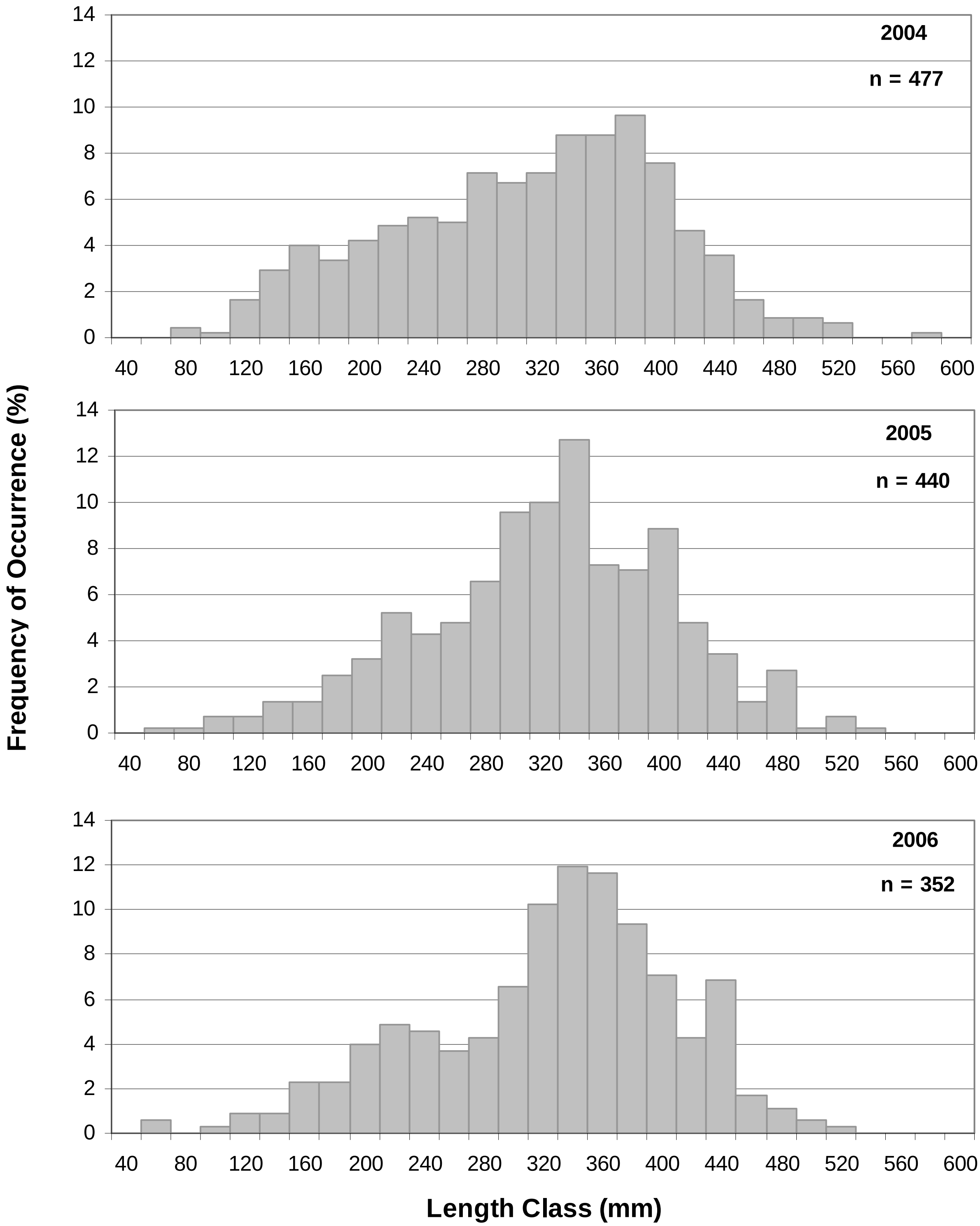

FIGURE 2.— Length-frequency distributions for Lake Hickory largemouth bass, 2004–2006.

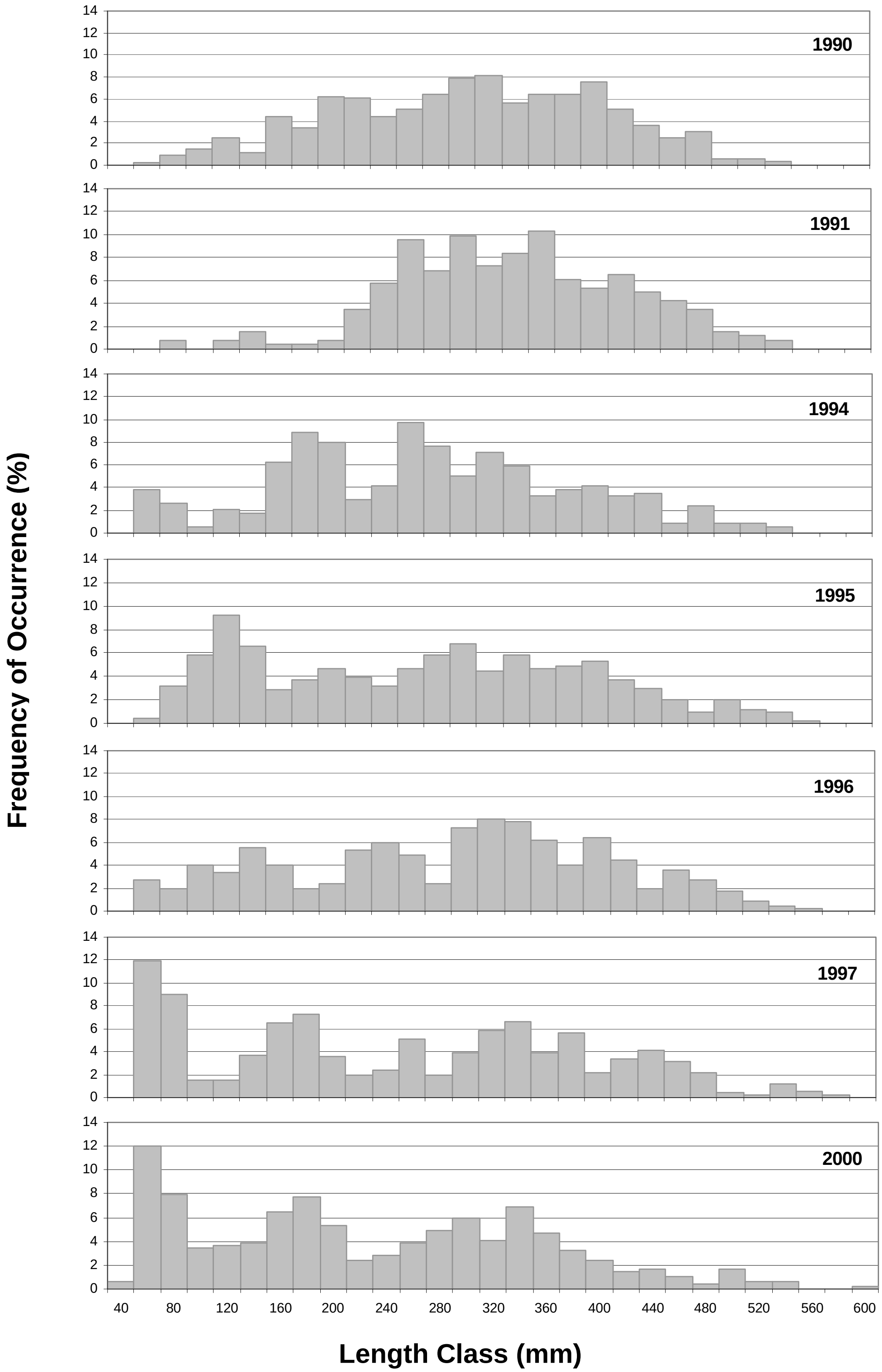

FIGURE 3.— Length-frequency distributions for Lake Hickory largemouth bass, 1990–2000.

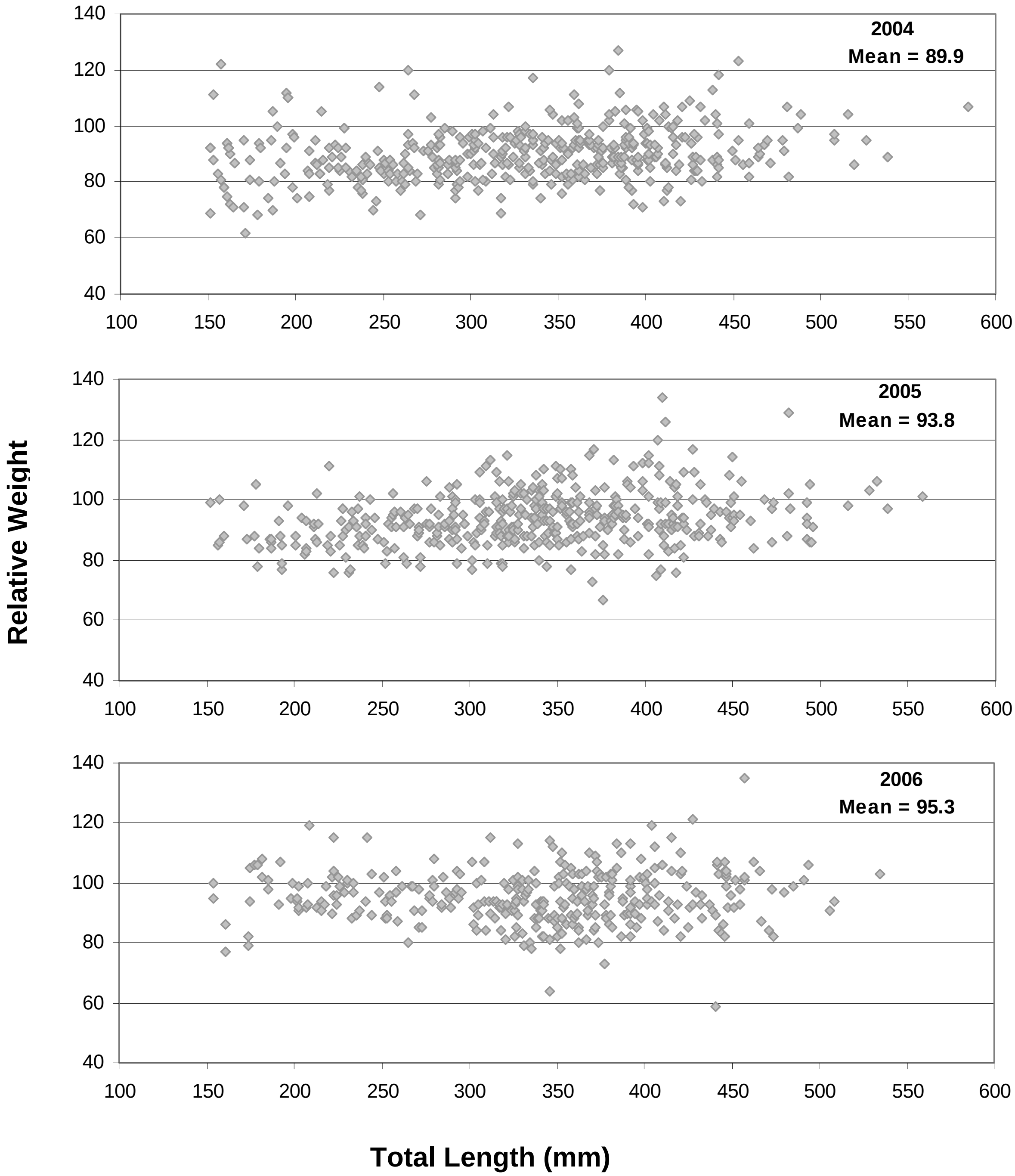

FIGURE 4.— Relative weights of Lake Hickory largemouth bass, 2004–2006.

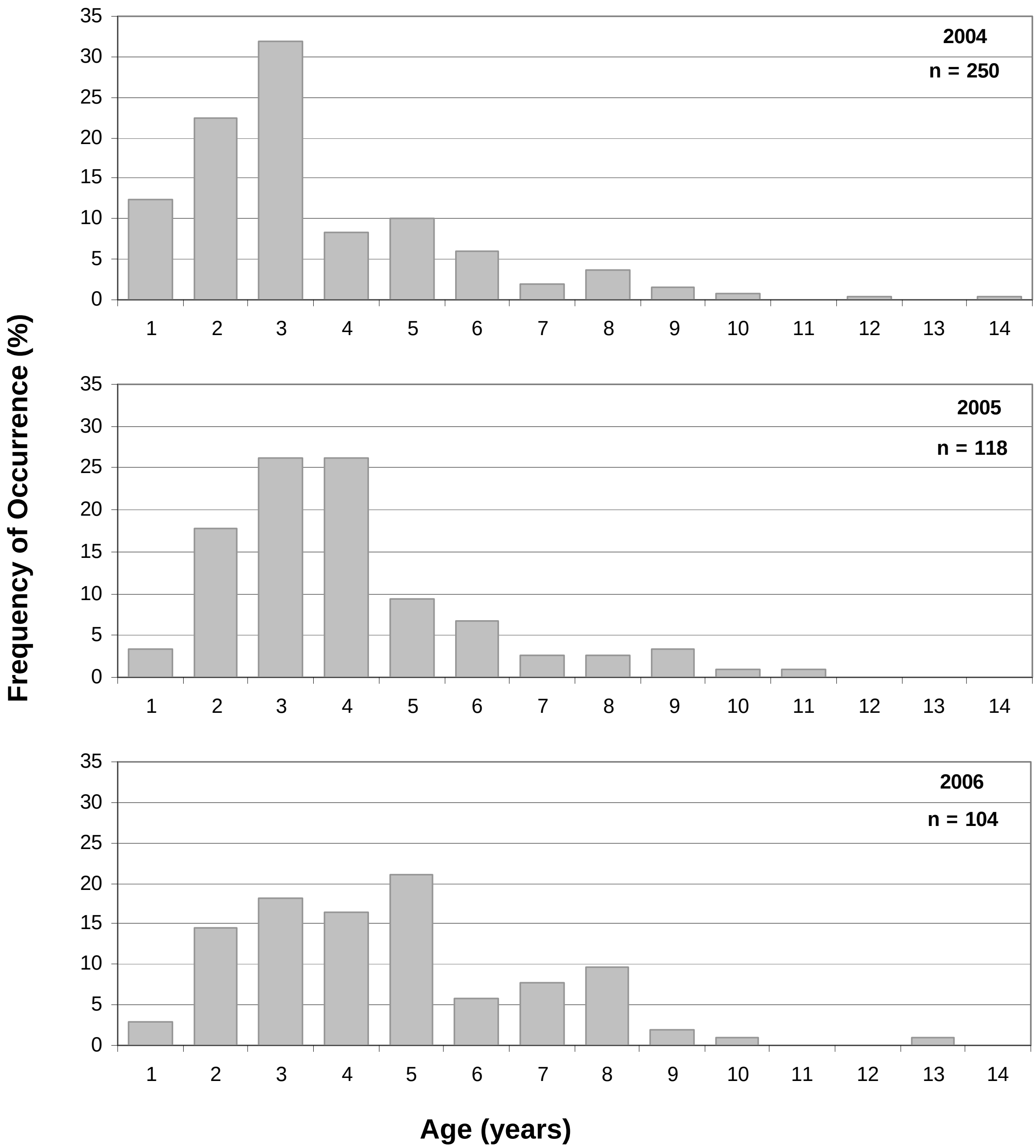

FIGURE 5.— Age structure of Lake Hickory largemouth bass, 2004–2006.