LAKE HAMPTON LARGEMOUTH BASS SURVEYS, 2015–2016

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Abstract.—Boat-mounted electrofishing gear was used in May 2015 and April 2016 to collect baseline data on the Largemouth Bass population in Lake Hampton for the first time since its impoundment in 2010. Relative abundances were high in 2015 and 2016 with CPUEs of 115 and 136 fish/hr, respectively. The size structure of the population shifted from desirable in 2015 (PSD = 60) to undesirable in 2016 (PSD = 21). Body condition among fish followed a similar pattern, with mean relative weight declining from 90 in 2015 to 86 in 2016. Five year-classes were observed in 2015 and six year-classes were observed in 2016. Strong recruitment occurred in 2010, 2011, 2014, and 2015, whereas weak recruitment occurred in 2012 and 2013 despite the stocking of 6,900 fingerling Largemouth Bass in 2012. Growth among fish collected in 2015 was comparable to other reservoirs (i.e., harvestable size [356 mm] reached around age 4), but it took fish collected in 2016 nearly an additional year to reach the same size. Mortality appeared to be high based on estimates derived by tracking cohorts from one year to the next, especially for larger fish that were more susceptible to angling. Overall, population dynamics of Largemouth Bass in Lake Hampton were largely unsatisfactory, especially in 2016. Water quality testing and additional sampling are necessary to learn more about the issues affecting the population.

Lake Hampton was formed in fall 2010 when the Yadkin County Soil and Water Conservation District impounded South Deep Creek, a tributary of the Yadkin River located near Yadkinville, North Carolina. The concrete dam spans 230 m and has a maximum height of 23 m. At full pool, Lake Hampton covers approximately 57 ha at a surface elevation of 263 m. The reservoir was primarily built to serve as flood control, but additional uses of the reservoir include recreation and future drinking water supply (up to 22,700,000 L/day) for Yadkin County residents.

The North Carolina Department of Environmental Quality's Division of Water Resources has not incorporated Lake Hampton into its Ambient Lake Monitoring Program as of 1 January 2017. Therefore, in-depth water quality data for Lake Hampton are lacking. However, unusually large algal blooms have been observed in late summer by North Carolina Wildlife Resources Commission (NCWRC) personnel. Evaluations of dissolved oxygen levels near the dam in August of 2012 and 2015 indicated that the thermocline was shallow (approximately 3 m; NCWRC unpublished data). Furthermore, land use in the watershed is largely agricultural. These factors suggest that the reservoir is eutrophic or possibly even hypereutrophic.

First opened in November 2014, Yadkin Memorial Park at Lake Hampton provides recreational opportunities such as boating (non-motorized), kayaking, fishing, and waterfowl hunting. Largemouth Bass (LMB) *Micropterus salmoides*, crappies *Pomoxis* spp., sunfishes *Lepomis* spp., and catfishes *Ictalurus* and *Ameiurus* spp. comprise the sport fisheries of Lake Hampton. Lake Hampton was stocked with 6,900 fingerling LMB in 2012, and Threadfin Shad *Dorosoma petenense* have been stocked annually since 2014 to supplement the forage base. Park staff reported that the lake was subjected to abnormally high fishing pressure during 2015, the first full year it was open to angling. Although angler effort may not be directed toward catching a single species, black basses (*Micropterus* spp.) are the most sought after species group in North Carolina (Linehan 2013). Therefore, this report will specifically focus on the black bass (i.e., LMB) fishery of Lake Hampton.

This report represents the first information collected and analyzed for the black bass fishery of Lake Hampton. A benefit of this document is the establishment of baseline data to improve understanding of population dynamics in newly-created reservoir habitat. These data will allow for future comparisons as resources become limiting and the population stabilizes. Finally, information gathered from this report will help determine if current management of the fishery is appropriate and direct future research.

Methods

Field collections.—Boat-mounted electrofishing gear (Smith-Root 7.5 GPP) was used to collect LMB from four sites throughout Lake Hampton on 5 May 2015 and 19 April 2016 (Figure 1). All transects were 300 m in length and were evenly distributed throughout the lake. Electrofishing settings of 500–1000 V, 4 A, and 120 pulses per second were used on both sampling occasions for all sites. All LMB collected were measured for total length (TL; mm) and weighed (g). Finally, sagittal otoliths were removed from all LMB for age determination and placed in labeled vials.

Abundance.—Relative abundance was indexed by catch per unit effort (CPUE), which was calculated as the number of LMB collected per hour of electrofishing time.

Size structure.—The size structure of the population was graphically assessed by constructing length-frequency distributions and numerically assessed by calculating size-structure indices (proportional size distributions [PSDs]; Guy et al. 2007). The lengths for stock-, quality-, and preferred-size LMB were those proposed by Gabelhouse (1984).

Condition.—Body condition of individuals ≥ 150 mm TL was indexed by calculating relative weights using the equation from Henson (1991).

Age, growth, and mortality.—Whole otoliths were immersed in water in a black dish and viewed using a dissecting microscope. Because annuli can be obscured in whole view as early as age 2 (Hoyer et al. 1985), otoliths with two or more annuli present in whole view were broken perpendicular to the longest axis, and the broken end was polished with 400 grit sandpaper (Besler 1999). With the polished end facing upward, each otolith was embedded in clay, immersed in water, and illuminated from the side using a fiber optic light. Buckmeier and Howells (2003) reported 97% accuracy using this approach for aging LMB up to age 16. Otoliths were read independently by two readers, and discrepancies in annuli counts were rectified at a joint reading.

The reported age of fish in this survey was not equal to the number of annuli that were present. Previous work in Illinois has shown that annulus formation in LMB occurs between April and June (Taubert and Tranquilli 1982). For 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 margin. As such, fish were assigned an age equal to the number of annuli plus one because additional annulus formation was imminent. Age-frequency distributions were constructed to graphically assess population age structure.

To assess growth, mean length at age was determined for each year-class and compared against data from other populations. It was assumed that length at time of capture was approximately equal to actual length at age because the surveys coincided with the period of annulus formation. Additionally, because growth was linear (i.e., no asymptote) in both years, presumably due to a lack of older year-classes, the standard approach of using a von-Bertalanffy growth function to assess growth was not utilized. Instead, the equation from linear regression of total lengths at each age was used to determine the time, in years, to attain harvestable size.

Mortality could not be estimated using the standard approach of catch-curve regression due to inconsistent recruitment and mortality (Miranda and Bettoli 2007). However, declines in the raw numbers of individuals from the 2010, 2011, and 2014 year-classes from 2015 to 2016 were determined and expressed as a percentage to serve as a coarse measure of mortality.

Results and Discussion

Abundance.—In 2015, 90 LMB were collected in 0.78 hrs of electrofishing effort for a cumulative CPUE of 115 fish/hr; mean CPUE among sites was 117 (SE = 18) fish/hr. In 2016, 124 LMB were collected in 0.91 hrs of electrofishing effort for a cumulative CPUE of 136 fish/hr; mean CPUE among sites was 135 (SE = 13) fish/hr.

Relative abundances of LMB in Lake Hampton were much higher than the long-term average CPUE for other Piedmont reservoirs, where catch rates typically average 30–60 fish/hr (Oakley and Dorsey 2013). The long-term average catch rate in Salem Lake, a 148-ha impoundment located approximately 50 km away from Lake Hampton, was 63 fish/hr (Johnson 2017). However, despite use of the same electrofishing gear, young LMB are not effectively collected in Salem Lake. Therefore, catch rates of LMB in Salem Lake may underestimate the true population density. Although much larger (1,400 ha), Randleman Lake represents the most similar reservoir to Lake Hampton in terms of age (impounded in 2006). Cumulative CPUE of LMB in Randleman Lake six years post-impoundment was 91 fish/hr (Fisk and Baumann 2013).

High relative abundance of LMB was expected in Lake Hampton due to its age and presumed trophic state, but the abundance of LMB was even higher than expected. Six years after the impoundment of each lake, relative abundance was 49% higher in Lake Hampton than in Randleman Lake. However, within that timeframe, the Randleman Lake fishery was subjected to angler harvest for two full years, whereas Lake Hampton was only open to fishing for one year. As such, the additional angling pressure exerted on Randleman Lake may have reduced LMB abundance, although data describing harvest rates are not available for either reservoir.

Size structure.—Largemouth Bass collected in 2015 ranged in length from 97 to 493 mm TL, and in 2016, lengths ranged from 105 to 515 mm TL (Figure 2). The 2015 length-frequency distribution was multi-modal and revealed at least three distinct age-classes. In contrast, age-classes were less distinct among LMB collected in 2016, and noticeably fewer fish > 300 mm TL were present. Each mode from the 2015 length-frequency distribution should have shifted right and been apparent in the 2016 length-frequency distribution, but this was not observed.

The disparity in size structures between 2015 and 2016 was further represented by the PSD values for both years. In 2015, PSD and PSD-P were 60 and 31, respectively. These values were within the desired ranges for balanced LMB populations (40–70, PSD and 10–40, PSD-P; Willis et al. 1993). However, in 2016, PSD and PSD-P declined drastically to 21 and 15, respectively, and were either below or barely within the desired ranges of values.

Nearly 50% of all LMB collected from Randleman Lake were of harvestable size (356 mm TL) by six years post-impoundment (Fisk and Baumann 2013). In contrast, only 7% of all LMB collected from Lake Hampton six years post-impoundment were of harvestable size. Several factors may be responsible for low numbers of harvestable-size individuals, including overabundance of LMB and resultant slow growth, inconsistent recruitment, excessive natural mortality, and angler harvest of larger fish.

Condition.—Mean relative weights of LMB in 2015 and 2016 were 90 (SE = 1.1) and 86 (SE = 0.9), respectively (Figure 3). Overall, there was no clear relationship between relative weights and total lengths for both years, with the exception of a negative relationship for fish collected in 2016 that were between 150 and 300 mm TL. This corresponded with a substantial increase in abundance of fish within that size range from 2015 to 2016. Mean relative weights for 2015 and 2016 were below the recommended range for balanced fish populations (95–105; Anderson 1980) and were below those reported from Salem Lake, where mean relative weight in 2016 was 100 (Johnson 2017), and Randleman Lake, where mean relative weights in 2012 ranged among length categories from 94 to 110 (Fisk and Baumann 2013).

Relative weights of LMB have been shown to be correlated with prey biomass (e.g., Wege and Anderson 1978). Therefore, the low relative weights of LMB in Lake Hampton may indicate that the forage base is inadequate to support the high density of LMB within the lake. However, without forage assessment, it is indeterminable whether forage is the predominant issue or if other factors are affecting body condition of LMB (e.g., poor water quality). Forage assessment, in combination with water quality data, will aid in understanding the cause(s) of poor condition of LMB.

Age, growth, and mortality.—LMB ranged in age from 1 to 5 in 2015 and from 1 to 6 in 2016 (Figure 4). Age-1 individuals comprised 45 and 50% of the catches in 2015 and 2016, respectively. Because the youngest cohort made up the greatest proportion of the sample in both years, this suggests that age-1 fish fully recruited to the electrofishing gear.

Among the cohorts older than age 1 collected in 2015 and 2016, the next largest year-classes appear to have been formed in 2010 and 2011. Given that the initial stocking of LMB into Lake Hampton did not take place until 2012, this demonstrates that enough wild fish were already present in South Deep Creek prior to its impoundment to establish the LMB population once the lake began to fill. Conversely, recruitment appears to have been very low for the 2012 and 2013 year-classes, despite the 2012 LMB stocking.

Reasons for the variability in year-class formation are unknown. LMB recruitment has been linked to various hydrological variables (e.g., Maceina and Bettoli 1998; Sammons et al. 1999). In general, LMB recruitment is negatively affected by wet years with abundant precipitation and resultant elevated discharges and shorter retention times. Unfortunately, there are no usable surface elevation data from Lake Hampton, nor are there discharge data available specifically for South Deep Creek.

Growth of LMB was faster among individuals collected in 2015 than in 2016 (Table 1). Using 2015 data, the average LMB attained harvestable size at 4.1 years of age (Figure 5). Using 2016 data, the average LMB attained harvestable size at 4.8 years of age (Figure 5). The slower growth among fish collected in 2016 was most pronounced beyond age 3 (Table 1).

Fish growth is often fastest in the early years after impoundment of a new reservoir (e.g., Patriarche and Campbell 1958), and this was the case in Randleman Lake where LMB reached harvestable size between only 2 and 3 years of age (Fisk and Baumann 2013). Growth rates of Lake Hampton LMB were substantially slower than at Randleman Lake, despite being measured at a similar interval post-impoundment. Looking at other nearby reservoirs, harvestable size was attained by age 4 in W. Kerr Scott Reservoir, Lookout Shoals Lake, and Lake Hickory (Hodges 2007, 2014; Hining 2011; Figure 6). These growth rates are also faster than those observed in Lake Hampton for most age-classes, especially in 2016. If growth rates of Lake Hampton LMB do not improve, they have the potential to limit the abundance of quality-size fish in the lake.

The causes of slow growth among LMB from Lake Hampton are unknown. For LMB, electrofishing catch rate is directly related to fish density (McInerny and Degan 1993). Therefore, the high LMB catch rates in Lake Hampton should correspond to high LMB densities, which may be resulting in density-dependent growth. Additional research on the relationship between growth and density, forage availability, and water quality is necessary to determine which factor(s) may be leading to poor growth among individuals.

The decline of young fish not subject to harvest (i.e., 2014 year-class) from 2015 to 2016 was minimal (2.5%), whereas the older 2011 and 2010 year-classes that were subject to harvest experienced greater declines at 59 and 78%, respectively. Although these numbers do not represent true mortality estimates, they still provide insight regarding higher proportional removal of older individuals from the population, either through natural mortality, fishing mortality, or both.

If the declines observed from 2015 to 2016 continue into 2017, the strong year-classes of 2010 and 2011 are likely to dwindle to such small numbers that they will effectively disappear from the population, leaving only the weak year-classes of 2012 and 2013 as catchable-size cohorts. As a result, low catch rates of larger fish (> 300 mm) are expected over the next few years. However, successful reproduction appears to be occurring as evidenced by the large 2014 and 2015 year-classes observed in 2016. Over time, fish populations can naturally recover from weak year-class formation through continued production of younger year-classes. As those strong year-classes age and progress through the population, previously existing voids are filled. However, excessive mortality and slow growth can hinder the recovery process by counteracting the positive effects of strong recruitment.

Factors contributing to mortality of LMB in Lake Hampton may include natural causes such as disease or poor water quality. During the spring of 2016, a gradual low-level fish kill of crappies *Pomoxis* spp. and Gizzard Shad *Dorosoma cepedianum* occurred over a period of several weeks. Bluegill *L. macrochirus*, Black Crappie *P. nigromaculatus*, Yellow Bullhead *A. natalis*, Gizzard Shad, and LMB were collected and sent to the U.S. Fish and Wildlife Service Warm Springs Fish Health Center for testing. Test results were negative for all species except LMB, which tested positive for Largemouth Bass Virus. Because die-offs of LMB have not been observed in the reservoir, the virus does not adequately explain high mortality among older fish. Park staff at Lake Hampton have been notified to contact NCWRC biologists if a LMB die-off occurs. Alternatively, mortality can also occur through angler harvest. Due to the high amount of fishing pressure exerted on Lake Hampton in 2015 and the poor survival of year-classes subject to harvest, the statewide 356-mm minimum length limit and five fish creel limit, with an exception allowing harvest of two fish under 356 mm, was altered in August 2016 to exclude possession of any fish between 406 and 508 mm. Additional survey work in 2017 should provide insights as to whether mortality was reduced by the protected slot length limit.

Conclusions and Recommendations

Overall, the population dynamics of the Largemouth Bass population in Lake Hampton were unsatisfactory. However, the population is in its infancy and may improve in quality through time. Additional sampling is needed to further investigate and confirm these observations. Specific conclusions and recommendations are included below:

1. Catch rates of LMB in Lake Hampton were high. Observed catch rates exceeded those from another recently impounded reservoir, Randleman Lake, and a similar-size reservoir, Salem Lake, with a well-established bass population.
2. Size structure of LMB was satisfactory for 2015, but shifted from a mixture of large and small fish to predominantly small fish by 2016.
3. Body condition of bass was moderate in 2015 and worsened in 2016.
4. LMB recruitment was erratic with strong cohort formation in 2010, 2011, 2014, and 2015, and weak cohort formation in 2012 and 2013.
5. Growth of LMB was slower than expected for a new reservoir.
6. In response to the poor body condition and slow growth of Lake Hampton LMB, forage surveys should be conducted to evaluate prey availability, and Threadfin Shad stockings should be continued.
7. Mortality of older year-classes appeared to be high. Additional sampling is needed to determine whether the cause(s) of mortality are related to harvest, disease, or poor water quality.
8. Water quality data are needed to determine the trophic state of Lake Hampton and to identify any problems such as low dissolved oxygen levels.

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TABLE 1.—Mean length at age ([TL]; in mm), range, standard error (SE), and sample size (n), for Largemouth Bass collected with electrofishing from Lake Hampton, 2015–2016.

Age	TL	Range	SE	n
		2015		
1	141	97–188	3.8	40
2	220	191–250	10.0	5
3	273	236–303	8.0	8
4	337	241–480	12.5	27
5	444	370–493	11.8	9
		2016		
1	145	105–188	2.5	60
2	214	173–260	3.5	39
3	256	-	-	1
4	278	252–299	5.1	8
5	375	231–515	24.4	11
6	414	381–447	33.0	2

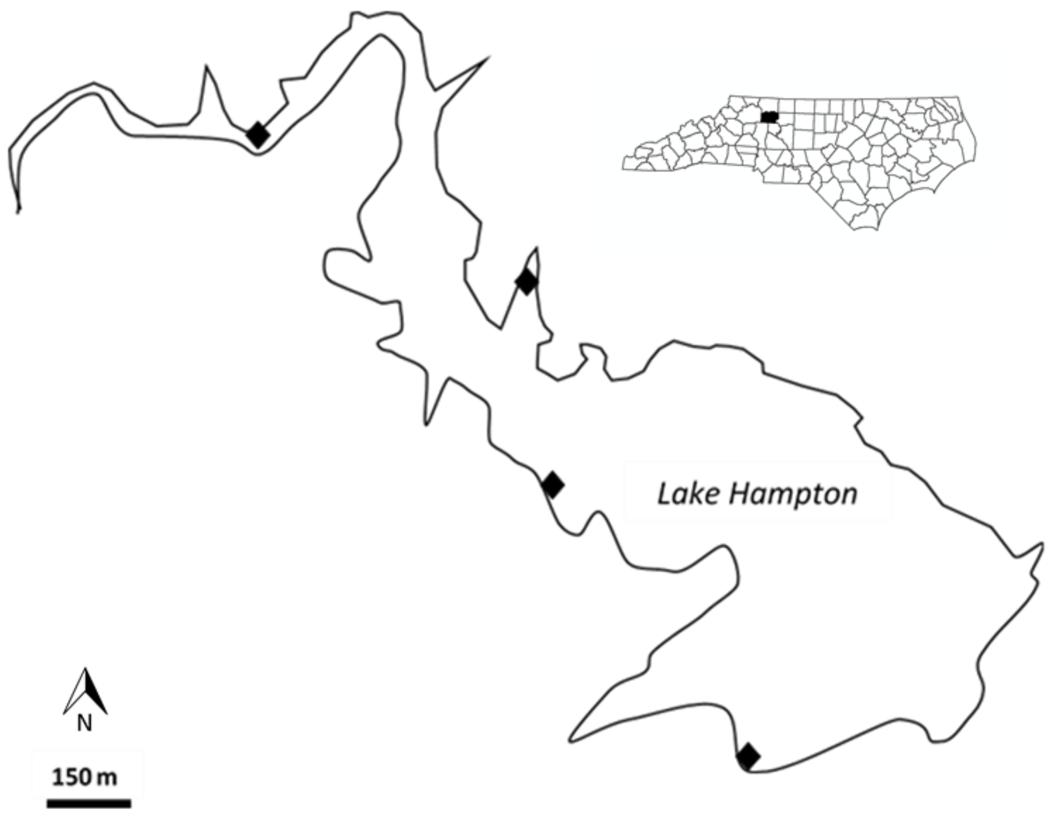

FIGURE 1.—Map depicting 2015–2016 electrofishing sites in Lake Hampton, Yadkin County, NC.

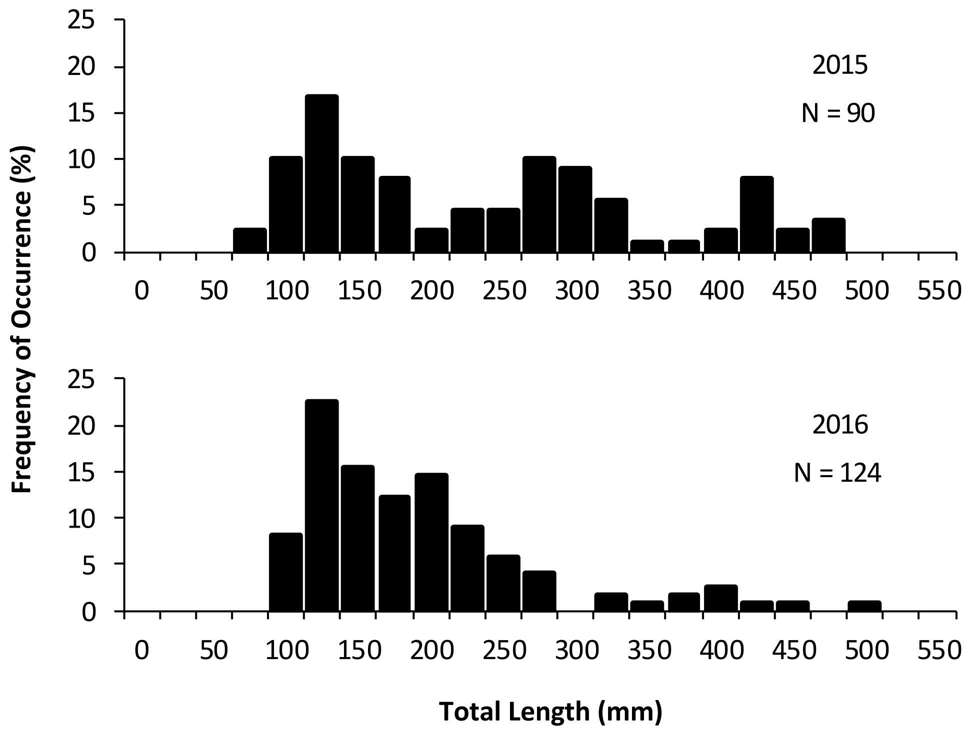

FIGURE 2.—Length-frequency distributions of Largemouth Bass collected with electrofishing from Lake Hampton, 2015–2016.

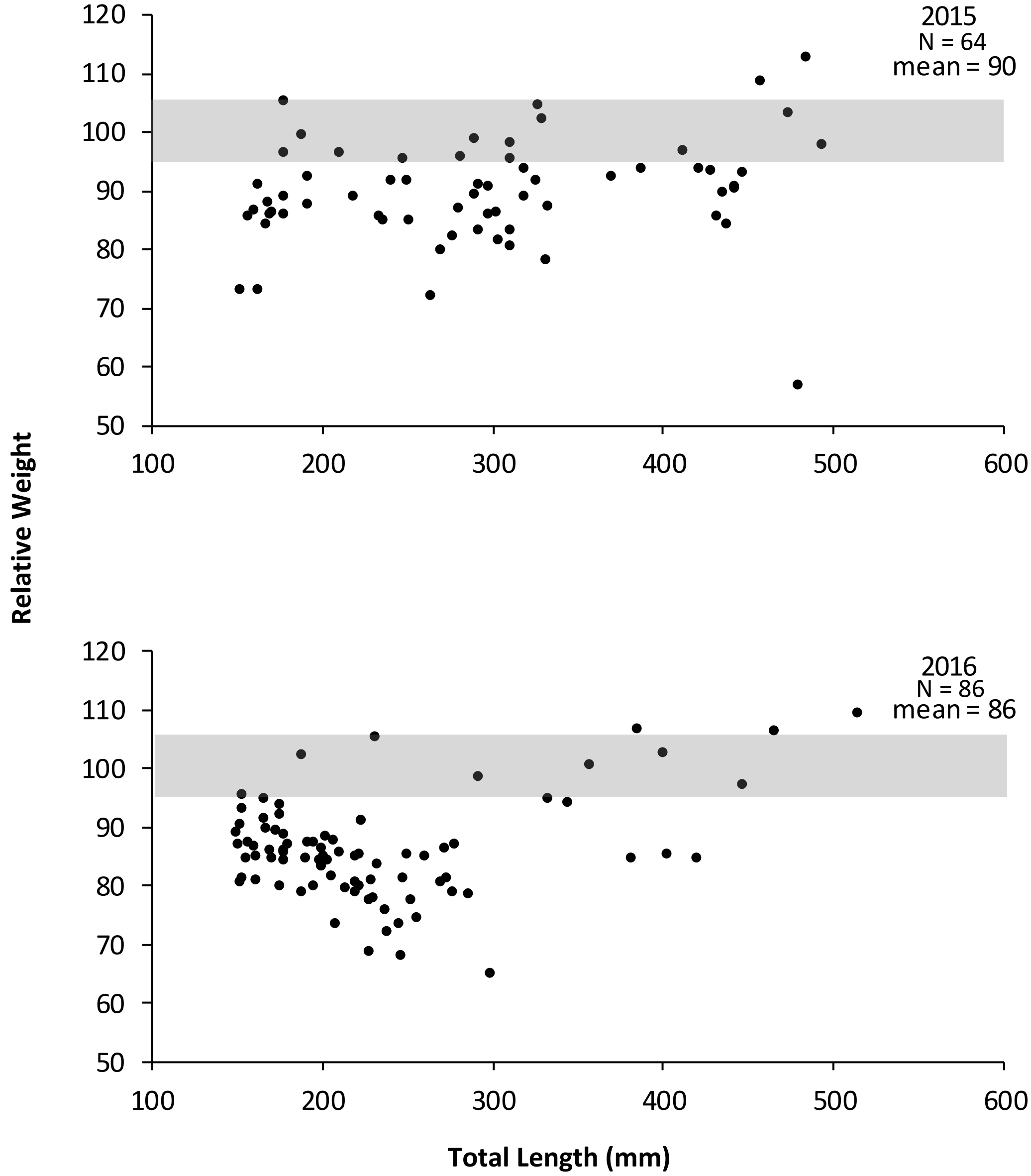

FIGURE 3.—Relative weights of Largemouth Bass collected with electrofishing from Lake Hampton, 2015–2016. The gray area of each panel in the figure represents the desired range of relative weights (95–105).

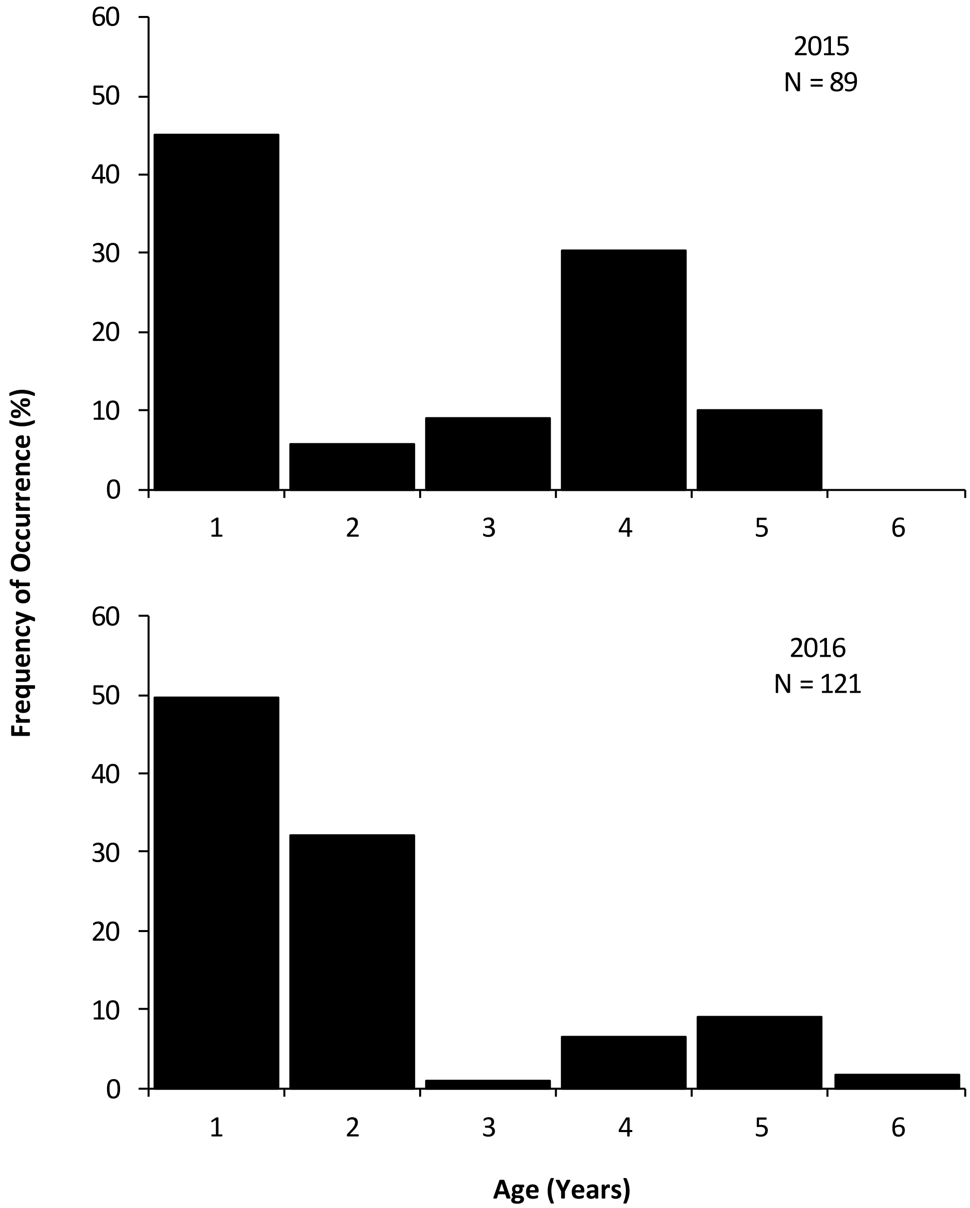

FIGURE 4.—Age-frequency distributions of Largemouth Bass collected with electrofishing from Lake Hampton, 2015–2016.

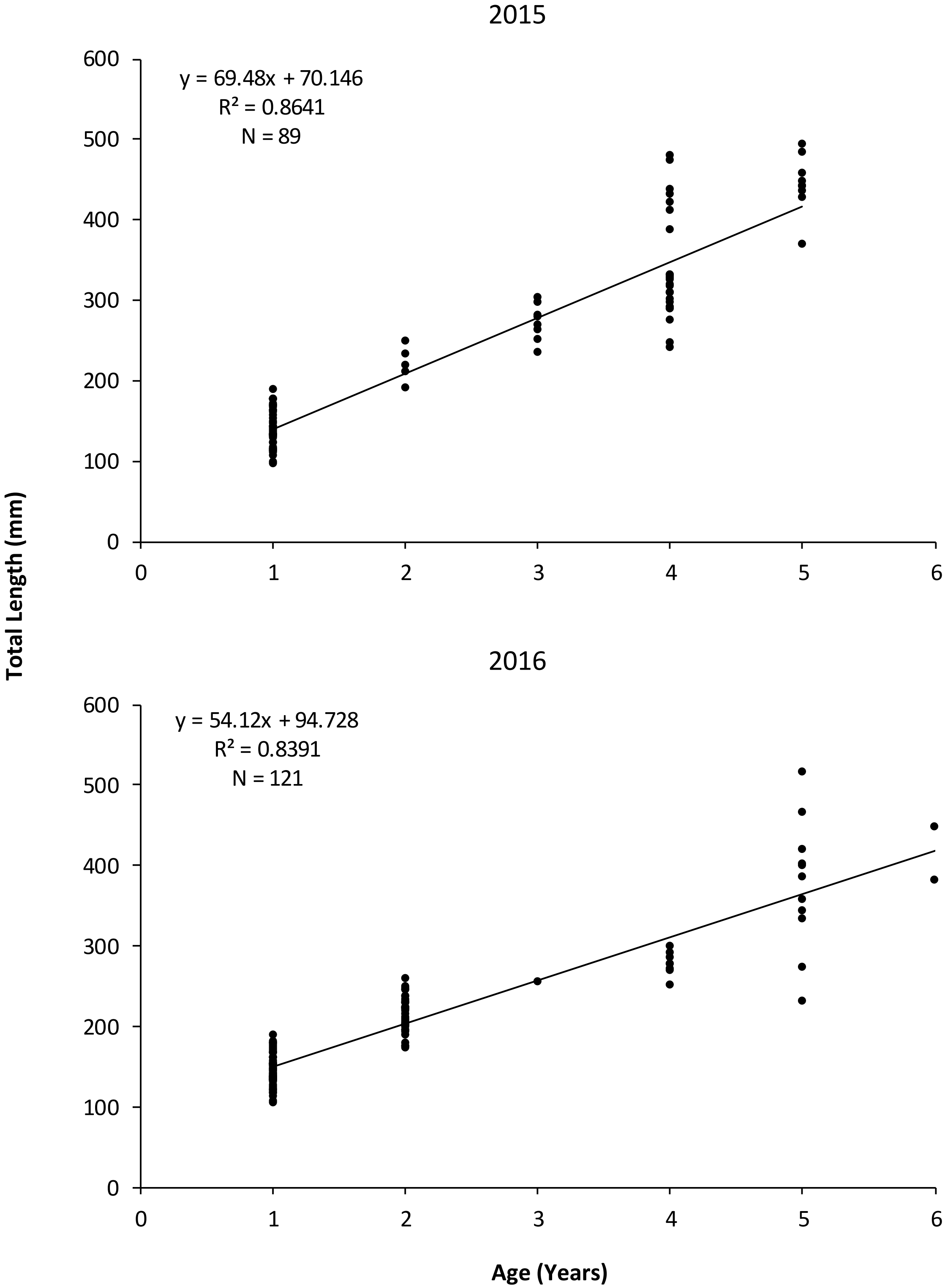

FIGURE 5.—Length at age (i.e., growth) of Largemouth Bass collected with electrofishing from Lake Hampton, 2015–2016.

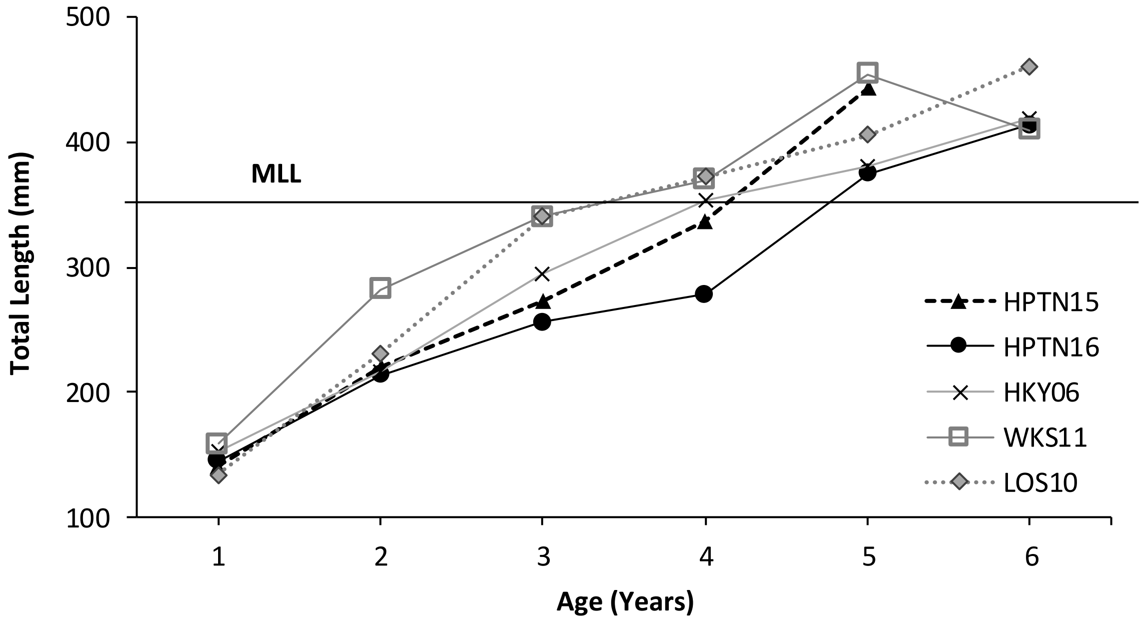

FIGURE 6.—Comparison of mean lengths at age of Largemouth Bass collected with electrofishing from Lake Hampton in 2015 (HPTN15) and 2016 (HPTN16), Lake Hickory in 2006 (HKY06), W. Kerr Scott Reservoir in 2011 (WKS11), and Lookout Shoals Lake in 2010 (LOS10). The solid horizontal line represents the minimum length limit (MLL) or harvestable size for Largemouth Bass (356 mm).