Lake Hickory Black Bass Surveys, 2008–2018

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Abstract. Boat electrofishing gear was used to collect Largemouth Bass (LMB) *Micropterus salmoides* and Alabama Bass (ALB) *M. henshalli* from Lake Hickory, NC in spring 2008, 2012–2014, and 2018. Relative abundance of LMB was high, with mean CPUE ranging from 73 fish/h in 2018 to 96 fish/h in 2012. No ALB were collected in 2008, but CPUE increased from 3 fish/h in 2012 to 13 fish/h in 2018. Size structure was consistently skewed toward individuals > 300 mm TL for LMB, whereas most ALB were < 300 mm TL. Proportional size distribution (PSD) and PSD-P values for LMB were 80–91 and 45–60, respectively, whereas PSD and PSD-P for ALB in 2018 were 30 and 8, respectively. Body condition of LMB was consistently high, with mean relative weights of 92–103. In contrast, ALB had a mean relative weight of 88 in 2018. Age ranges of LMB in 2013 and 2018 were 1–15 and 1–11, respectively. Alabama Bass had shorter lifespans, with age ranges of 1–8 and 1–5 for 2013 and 2018, respectively. Growth of both LMB and ALB was rapid, with fish reaching harvestable size (356 mm TL) at just over 3 years old. Annual mortality (A) of LMB was low, with estimated rates of 17 and 27% for 2013 and 2018, respectively. Population metrics for LMB were similar and in some cases improved from earlier surveys, suggesting the unauthorized introduction of ALB had not yet had a detectable impact on the population.

Lake Hickory was formed in 1927 when Oxford Dam was constructed on the Catawba River by Duke Energy Corporation (DEC) near Hickory, North Carolina. Operated primarily for power generation, the reservoir covers 1,659 ha at full pool. Mean depth is 10 m, mean hydraulic retention time is 33 d, and trophic state has fluctuated between mesotrophic and eutrophic in recent years (NCDEQ 2018). Lake Hickory supports fisheries for Largemouth Bass (LMB) *Micropterus salmoides*, Striped Bass *Morone saxatilis*, crappies *Pomoxis* spp., sunfishes *Lepomis* spp., and catfishes such as Flathead Catfish *Pylodictis olivaris*, Channel Catfish *Ictalurus punctatus*, and bullheads *Ameiurus* spp. Additionally, anglers began reporting catches of "spotted bass" in 2006 and their presence was confirmed by North Carolina Wildlife Resources Commission (NCWRC) biologists in a gill-net survey in 2008. However, the true identity of this *Micropterus* sp. was unconfirmed until summer 2022, when results from the genetics lab at Auburn University were received. The primary finding from those analyses was that the Lake Hickory "spotted bass" are actually Alabama Bass (ALB) *M. henshalli* (NCWRC unpublished data). It should be noted, however, that some individuals in the 50-fish sample (13 out of 50) had minor introgression (<30%) of Spotted Bass *M. punctulatus* alleles.

Due to its diverse fishing opportunities and proximity to metropolitan areas, Lake Hickory is heavily utilized by anglers. According to a creel survey conducted by DEC during 1997–1998, total fishing pressure for the reservoir was estimated at 291,755 angler-h, which equates to 176 angler-h/ha (Baker 2002). By comparison, anglers only expended 95 angler-h/ha on W. Kerr Scott Reservoir in 2001 (Yow 2016) and 88 angler-h/ha on Lake James during 1997–1998 (Yow 2005). Largemouth Bass received the greatest amount of directed effort from anglers on Lake Hickory, accounting for 45% of the total fishing effort during the 1997–1998 DEC creel survey (Baker 2002). This pattern holds true at the state-wide scale, with anglers fishing for black bass more than any other species group (Finke and Van Horn 1993; Linehan 2013).

Biologists with the NCWRC have collected data concerning the LMB population in Lake Hickory on multiple occasions. Largemouth Bass density, biomass, and scale-derived growth rates were obtained during gill-net and cove-rotenone surveys of the total fish community conducted during 1956–1959 and again in 1983 (Tebo 1959; Mickey 1984). In 1990 and 1991, NCWRC and DEC biologists conducted electrofishing surveys focused on LMB, which yielded indices of abundance, size structure information, body condition, and scale-derived growth rates (Mickey 1993). These data were collected again by electrofishing during 2004–2006, but age and growth data were obtained using otoliths (Hodges 2007a), which are more accurate than scales (Besler 1999). Largemouth Bass catch rates declined each successive year between 2004 and 2006. In response to those declining catch rates, an additional survey was conducted in 2007 (Hodges 2007b), at which time abundance had rebounded and exceeded catch rates from 2004. Since those surveys, LMB have been collected as part of routine stock assessments (2013, 2018), to collect tissues for genetic testing (2014), and as part of evaluations of establishment and expansion of invasive ALB (2008, 2012; see Table 1 for detailed sample history). Therefore, the objectives of this study were to 1) gather updated information on the relative abundance, size structure, body condition, and age and growth of the LMB and ALB in Lake Hickory, and 2) to determine if the ALB were having any discernible effects on the LMB population.

Methods

Field collections. Boat-mounted electrofishing gear (Smith-Root 7.5 GPP) was used to collect LMB and ALB from between 6 and 19 sites throughout Lake Hickory in spring (April–May) 2008 (N = 6), 2012 (N = 6), 2013 (N = 19), 2014 (N = 15), and 2018 (N = 16). The number of sites surveyed each year varied in relation to survey objectives, and in some cases, sites had to be skipped to avoid disrupting activities of the general public. All transects were 300 m in length and were evenly distributed throughout the lake (Figure 1). Electrofishing settings of 500–1000 V, 4 A, and 120 pulses per second were used on all sampling occasions. All LMB and ALB collected were measured for total length (TL; mm) and weight (g). Finally, sagittal otoliths were removed from a random subset of LMB and all ALB collected in 2013 and 2018 for age and growth determination; otoliths were not extracted from either species in 2008, 2012, or 2014.

Abundance. Relative abundance of LMB and ALB was indexed by catch per unit effort (CPUE), which was calculated as the number of fish collected per hour spent electrofishing (fish/h).

Size structure. The size structure of the population was graphically assessed by constructing length-frequency distributions (histograms) and numerically assessed by calculating size-structure indices (proportional size distributions [PSDs]; Guy et al. 2007). The length designations for stock-, quality-, and preferred-size LMB were those proposed by Gabelhouse (1984). Size categories specific to Spotted Bass (Gabelhouse 1984) were applied for ALB since none have been established for ALB yet.

Condition. Body condition of LMB ≥ 150 mm TL was indexed by calculating relative weights using the standard weight equation from Henson (1991). For ALB, the standard weight equation provided in DiCenzo et al. (1995) was used for individuals ≥ 100 mm TL. It should be noted, however, that their equation was derived using data from just 10 populations, which is fewer than has been recommended by several authors (see Blackwell et al. 2000). Nevertheless, as the only option specific to ALB at the time of this writing, it was used in favor of the equation for Spotted Bass (i.e., Wiens et al. 1996).

Age, growth, and mortality. Whole otoliths were immersed in water in a black dish and viewed using a dissecting microscope. Otoliths that had crowded or indistinct annuli in whole view were broken perpendicular to the longest axis (i.e., transverse plane), and the broken end was polished with 200–400 grit sandpaper. With the polished end facing upward, each otolith was embedded in modeling clay, immersed in water, and read while being illuminated from the side using a fiber optic light (Besler 1999). Buckmeier and Howells (2003) reported 97% accuracy of this approach for aging LMB up to age 16. Otoliths were read independently by two readers, and any discrepancies in annuli counts were rectified at a joint reading.

The reported age of fish in these surveys was not equal to the number of annuli that were visible. Previous work in Illinois has shown that annulus formation in LMB occurs between April and June (Taubert and Tranquilli 1982). For fish collected in these surveys, the annulus for the year in which they were collected had not yet begun to form and there was a significant gap between the last annulus and the otolith margin. As such, fish were assigned an age equal to the number of visible annuli plus one because additional annulus formation was imminent.

Age-frequency distributions (histograms) were constructed to graphically assess population age structure, with inferences being drawn on recruitment patterns.

To assess growth, mean TL at age was determined for each year-class and compared against historical data from Lake Hickory as well as 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.

Using catch-curve analysis (Miranda and Bettoli 2007), mortality of LMB was estimated separately for the 2013 and 2018 surveys. Low sample sizes prevented mortality estimation for ALB. The slope of the fitted line from regressing natural log-transformed catch at age data for ages 3–9 corresponded to an instantaneous mortality rate (Z), which was then converted to an annual interval mortality rate (A) using the formula:

$$A = 1 - e^{(-Z)}.$$

Results

Abundance. Largemouth Bass relative abundance varied among years, with mean CPUE ranging from 73 fish/h (SE = 5.9) in 2018 to 96 fish/h (SE = 11.3) in 2012 (Table 1; Figure 2). Alabama Bass were first collected in Lake Hickory by electrofishing in 2012 and their relative abundance more than quadrupled by 2018; mean CPUE was 3 fish/h (SE = 3.0) in 2012 and 13 fish/h (SE = 4.2) in 2018 (Table 1; Figure 2).

Size structure. Throughout the study period population size structure for LMB was negatively skewed toward larger individuals, with the biggest mode of fish generally being between 320 and 440 mm TL (Figure 3). Too few ALB were collected to construct histograms in all survey years except 2018 (although sample size remained suboptimal in 2018), when the size distribution was bimodal with clusters of fish around 100 and 240 mm TL (Figure 3). Stock indices for LMB were consistently high, with PSD and PSD-P values ranging from 80 to 91 and from 45 to 60, respectively (Table 1). In 2018, PSD and PSD-P for ALB were 30 and 8, respectively (Table 1).

Condition. Body condition of LMB was satisfactory throughout the survey period, with mean relative weight ranging from a low of 92 (SE = 0.5) in 2018 to a high of 103 (SE = 0.7) in 2008 (Table 1). Too few ALB were collected to assess body condition in all survey years except 2018, when mean relative weight was 88 (SE = 1.1; Table 1).

Age, growth, and mortality. Largemouth Bass ranged in age from 1 to 15 in 2013 and from 1 to 11 in 2018 (Figure 4), and ALB ranged in age from 1 to 8 in 2013 and from 1 to 5 in 2018. The percentage of LMB ≤ 3 years old in 2013 and 2018 was 34 and 52%, respectively, whereas 98% of the ALB collected in 2018 were 3 and under. Given the low sample size for ALB in 2013 (N = 12), an age-frequency distribution was only constructed for 2018 (N = 60; Figure 4).

Growth of Lake Hickory LMB was rapid with fish attaining harvestable size (356 mm TL) shortly into their third year of life in both 2013 and 2018 (Table 2). Alabama Bass grew slightly slower than LMB at young ages but surpassed them in size at age 5 (Table 3).

Mortality of LMB differed slightly between 2013 and 2018, with estimated annual mortality rates of 17 and 27%, respectively (Figure 5).

Discussion

The abundance of LMB in Lake Hickory during the current study period (2008–2018) was largely unchanged from the previous study period (2004–2007). In the earlier surveys, mean CPUE ranged from 73 to 98 fish/h (Hodges 2007a, 2007b) compared to 73–96 fish/h in the unreported surveys. Despite being reported by anglers in 2006, ALB were not collected in a NCWRC electrofishing survey until 2012. By 2018, their relative abundance had increased more than fourfold. During that same timeframe (i.e., 2012 to 2018), the relative abundance of LMB decreased by 24%. However, it should be noted that a limited number of sites was sampled in 2012, making the catch data from that year less conclusive. In fact, the standard error for 2012 was > 50% higher than any other year except 2008 (another year when fewer sites were sampled). Considering 2013 instead, when more effort was expended and standard errors were lower, ALB catch rates rose by > 300% while LMB catch rates declined by only 10%.

To further investigate trends in LMB abundance, especially as they relate to the expansion of ALB, catch rates were also analyzed using shoreline distance as the effort metric instead of time (i.e., fish/100 m vs. fish/h). Using this approach, LMB catch rates did not differ between 2013 and 2014 (both 7.0 fish/100 m) and actually increased by 6% from 2014 to 2018 (7.4 fish/100 m) despite concomitant exponential population growth (500%) by ALB over the same time period (from 0.2 fish/100 m to 1.2 fish/100 m). Thus, ALB had no apparent impact on LMB abundance. However, because ALB abundance was still relatively low at the time of the last survey in 2018, especially compared to other sympatric populations, continued expansion and increased densities of ALB may eventually cause declines in LMB.

In relation to other reservoirs, LMB relative abundance in Lake Hickory (≥ 73 fish/h) was moderate to high. Regionwide, LMB catch rates average 30–60 fish/h in the Piedmont (Oakley and Dorsey 2013). Considering reservoirs directly adjacent to Lake Hickory, mean CPUE in Lookout Shoals Lake (downstream) in 2015 was lower at 61 fish/h (Hodges 2017), whereas mean CPUE in Lake Rhodhiss (upstream) during 2005–2007 was higher at 103 fish/h (Rash 2007). Unlike LMB, relative abundance of ALB in Lake Hickory was low (< 15 fish/h). By comparison, catch rates of ALB in Moss Lake were between 65 and 126 fish/h during the last three survey years (2017–2019; NCWRC unpublished data). Similarly, the catch rate of ALB in Lake Norman was 47 fish/h in 2010 (Dorsey 2014). For both of these higher density ALB populations, the sympatric LMB have experienced significant declines. Dorsey and Abney (2016) provided an in-depth overview of the inverse relationship between ALB and LMB in Lake Norman. It remains unclear why ALB in Lake Hickory have not reached the densities observed in other lakes. Some research has found dominance and higher densities of ALB in oligotrophic to mesotrophic reservoirs (see Rider and Maceina 2015). Given that Lake Hickory is more productive than Moss Lake and Lake Norman, this may explain why ALB are less abundant (i.e., nutrient levels and water clarities in Lake Hickory may be suboptimal for ALB). One additional possibility is boat electrofishing may be underrepresenting ALB. Most NCWRC electrofishing sample sites in Lake Hickory were delineated over a decade ago and consist of shallow, cove habitat that LMB are known to utilize during springtime. However, ALB occupy deeper water than LMB and tend to occupy areas such as bluffs and rocky points (Rider and Maceina 2015), which are features usually found on the main channel of the lake. These habitat differences may be affecting catches of ALB.

Size structure of the LMB population in Lake Hickory was consistent throughout the study period, with the bulk of the population being made up of large individuals (> 300 mm TL). Similar size structures were obtained in previous surveys conducted between 2004 and 2007 (Hodges 2007a, 2007b). The consistent negative skewing of the population size structure towards individuals > 300 mm TL in all survey years suggests that gear bias, rather than poor recruitment, is responsible for the lack of smaller fish. Stock index values were slightly higher for the current study period than the previous one, except for 2007, when values more closely resembled 2008–2018 (Table 1). These differences were driven by the abundance of preferred-size fish (≥ 380 mm TL), as less than 30% of the overall population was of that size between 2004 and 2006 compared to over 48% for all years after 2007. Unlike LMB size structures, the 2018 ALB size structure was bimodal and very few fish were > 300 mm TL. Proportional size distribution and PSD-P values also highlighted the lack of large ALB, with both values being substantially lower than for LMB.

As with catch rates, size structure metrics for Lake Hickory LMB were generally better than average in relation to other reservoir populations. Across the Piedmont, PSD-P of LMB typically ranges from 30 to 40 (Oakley and Dorsey 2013). In comparison, PSD-P of Lake Hickory LMB in all five unreported survey years was 45 or higher. Of the adjacent reservoirs on the Catawba River, PSD-P was slightly lower for Lookout Shoals Lake LMB in 2015 (PSD-P = 43; Hodges 2017) and much lower for Lake Rhodhiss LMB during 2005–2007 (PSD-P = 33–35; Rash 2007). As stated above, ALB size structure was poor; PSD was only 30 in 2018. In contrast, PSD for Moss Lake ALB was 76–92 during the last three survey years (2017–2019; NCWRC unpublished data). However, the poor size structure of ALB in Lake Hickory was a result of the population's age structure, which was dominated by young fish (discussed further below).

Body condition of Lake Hickory LMB was satisfactory throughout the study period, with mean relative weights ≥ 100 in two of the five survey years and a minimum recorded value of 92. Comparatively, relative weights typically average > 90 among LMB populations in the Piedmont (Oakley and Dorsey 2013). The values recorded during the current study period were comparable to or slightly higher than in previous surveys on Lake Hickory, when mean relative weights were 91–97 (Hodges 2007a, 2007b). Alabama Bass had poorer body conditions than LMB, with a mean relative weight of 88 in 2018. However, body condition of Lake Hickory ALB was higher than in Moss Lake, where mean relative weights were 82–86 during the last three survey years (2017–2019; NCWRC unpublished data). Less intraspecific competition at Lake Hickory may explain why its ALB had better body conditions. Although one would expect relative weight of a given species to decline following the introduction of an interspecific competitor, Dorsey and Abney (2016) found no difference in LMB relative weights after the proliferation of ALB in Lake Norman. To date, it does not appear as though ALB have caused a decline in body condition of LMB in Lake Hickory. Additional data collection is needed to determine if ALB abundance is continuing to increase, and if so, whether that results in poorer condition of LMB.

Age structures of the LMB collected from Lake Hickory in 2013 and 2018 were both multi-modal and exhibited moderate variations in year-class strength among years. The strong 2001 cohort noted in the previous 2004–2006 surveys (Hodges 2007a) was still pronounced in the population as 12-year-olds in 2013. The maximum ages of LMB in 2013 and 2018 were 15 and 11, respectively, which was similar to the previous surveys when maximum ages ranged from

11 to 14 (Hodges 2007a). One difference between the 2018 age structure and all other otolith-derived age structures for Lake Hickory LMB was age 2 was the predominant year-class; past age structures were dominated by fish ≥ age 3. For ALB, the 2018 age structure was truncated and only spanned ages 1–5, and as with LMB, age 2 was the predominant year-class. While abnormally strong recruitment may explain the predominance of age-2 LMB and ALB in 2018, fast growth rates for both species may have also caused them to be more susceptible to the electrofishing gear than in previous years, particularly for LMB.

One concerning aspect of the ALB population was the lack of fish older than age 3 despite their presence in the reservoir for over a decade. In fact, only one individual (age 5) in the entire 2018 sample exceeded age 3. In contrast, nearly 40% of ALB collected from Moss Lake in 2018 were 4–6 years old (NCWRC unpublished data). Biologists have observed a similar phenomenon at Belews Lake, where older ALB are rare (NCWRC unpublished data). The reasons for this are unknown but, as discussed previously, ALB habitat preferences (e.g., greater depths) and electrofishing limitations might be resulting in the collection of skewed data (Rider and Maceina 2015).

Relative to the baseline otolith-derived growth rates for Lake Hickory LMB obtained during 2004–2006 (Hodges 2007a), growth was comparable or even faster in 2013 and 2018, especially for middle-aged fish (e.g., ages 2 to 6). Harvestable size (356 mm TL) was attained one year earlier (roughly age 3) than in the previous study period (roughly age 4). By comparison, age at harvestable size averages 3–4 years among Piedmont populations (Oakley and Dorsey 2013). Growth rates of LMB in Lookout Shoals Lake in 2015 were slower than they were in Lake Hickory, with fish taking four years to reach harvestable size (Hodges 2017). Similarly, Lake Rhodhiss LMB took five years to attain harvestable size during 2005–2007 (Rash 2007).

In Lake Hickory, ALB grew slightly slower than LMB for ages 1–3 during the current study period but grew faster than LMB at those ages during the previous survey period (2004–2006). Moreover, age-5 ALB (2013 and 2018 samples combined) had a greater mean TL than age-5 LMB in any survey year. However, given the small sample size for that age-class (n = 4), additional data are needed to confirm this observation. Regardless of how their growth compares to LMB, ALB growth rates are expected to slow as their density increases and competition intensifies. Also, it is possible that some of the fast-growing ALB were actually ALB x LMB hybrids, as has been documented elsewhere (Godbout et al. 2009; NCWRC unpublished data). Similar to Lake Hickory, ALB in Moss Lake were slightly larger than LMB at ages 3–5 (NCWRC unpublished data). Despite fast growth at early life stages, ALB appear to be limited in their ability to consistently surpass LMB in terminal size due to shorter lifespans.

Mortality estimates for LMB in Lake Hickory (17 and 27% in 2013 and 2018, respectively) were well below the average of 37% reported by Beamesderfer and North (1995) for 698 populations across the United States and Canada. A coarse cohort analysis performed by Hodges (2007a) yielded an annual mortality estimate of 25% for Lake Hickory LMB during the 2004–2006 study period. Similarly, estimated annual mortality of LMB in Lake Rhodhiss was also 25% (Rash 2007). A final observation indicating moderate to high survival of LMB in Lake Hickory was the persistence of the 2001 cohort out to age 12, with all individuals of that year-class being well above the minimum-size limit and eligible for harvest.

Management Recommendations

1. Continue managing Lake Hickory with the existing harvest regulations.
2. Conduct an electrofishing survey consisting of all 19 sample sites in spring 2022 to monitor trends in the relative abundance, growth, and longevity of LMB & ALB.

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TABLE 1. Summary of population metrics for Largemouth Bass and Alabama Bass collected during spring electrofishing surveys on Lake Hickory, North Carolina, 2004–2018. Standard error values given in parentheses.

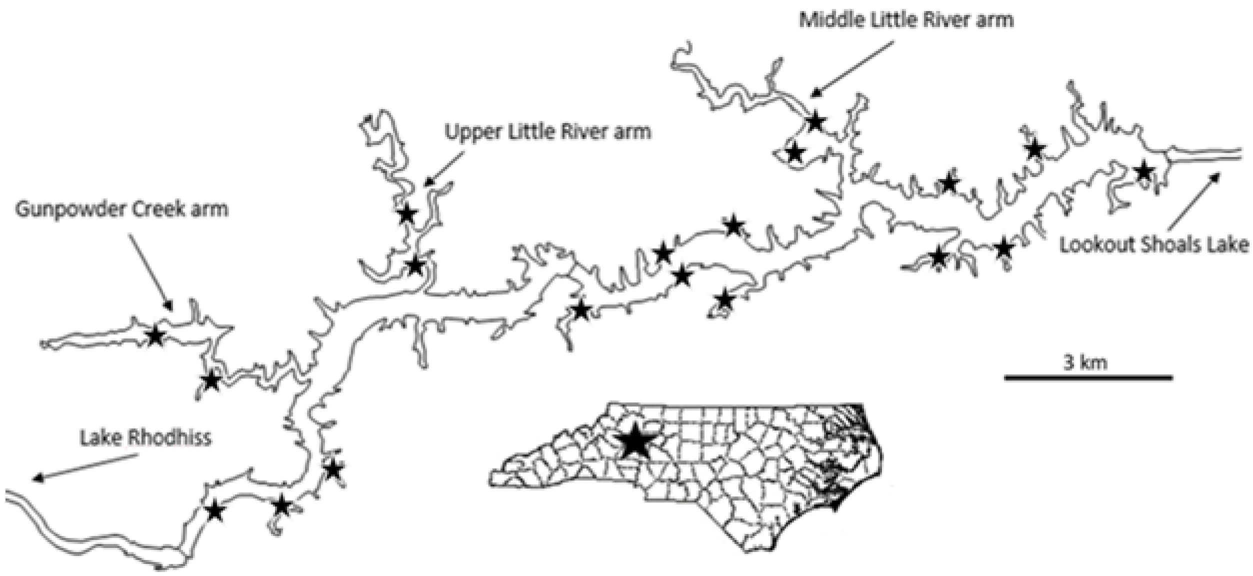
Data Type	Year	Age/Growth Data Collected?	N	Mean CPUE	PSD	PSD-P	Mean Wr
			Largemouth Bass				
Reference	2004	yes	477	94 (6.7)	70	34	91 (0.4)
	2005	yes	440	86 (7.1)	74	32	95 (0.4)
	2006	yes	352	73 (6.2)	77	34	97 (0.5)
	2007	no	375	98 (5.4)	84	52	95 (0.5)
Current study	2008	no	130	91 (14.6)	80	46	103 (0.7)
	2012	no	142	96 (11.3)	91	52	98 (1.1)
	2013	yes	399	81 (4.7)	84	60	100 (0.4)
	2014	no	317	82 (7.3)	81	53	95 (0.6)
	2018	yes	337	73 (5.9)	80	45	92 (0.5)
			Alabama Bass				
Current study	2008	-	0	-	-	-	-
	2012	no	4	3 (3.0)	-	-	-
	2013	yes	12	3 (1.7)	-	-	-
	2014	no	18	5 (2.4)	-	-	-
	2018	yes	60	13 (4.2)	30	8	88 (1.1)

TABLE 2. Mean total length (TL) at age of Largemouth Bass collected by spring electrofishing from Lake Hickory, North Carolina, 2004–2018. Values are only given for age-classes represented by three or more individuals. Data from 2004–2006 are included for reference given that they represent the first dataset derived using otoliths.

	Reference Data (from Hodges 2007a)									New Data (current study)					
	2004			2005			2006			2013			2018		
Age	N	Mean TL	SE	N	Mean TL	SE	N	Mean TL	SE	N	Mean TL	SE	N	Mean TL	SE
1	31	155	4.9	4	151	13.7	3	153	15.9	11	139	11.8	11	150	6.7
2	56	237	4.7	21	234	9.9	15	217	7.7	15	260	9.2	37	278	6.9
3	80	325	4.1	31	311	6.6	19	294	9.6	27	349	7.0	27	352	5.0
4	21	378	5.5	31	356	8.1	17	354	8.9	16	405	9.7	13	388	7.9
5	25	401	5	11	409	7.6	22	381	7.9	24	408	5.2	21	408	6.6
6	15	415	7.9	8	422	8.8	6	419	9.3	17	423	8.1	16	429	7.5
7	5	448	27.9	3	439	16.5	8	406	11.8	9	437	12.3	3	424	28.7
8	9	449	14	3	442	50.0	10	436	9.4	11	462	13.3	8	436	11.4
9	4	442	22.8	4	433	20.7	-	-	-	8	454	11.9	4	441	2.8
10	-	-	-	-	-	-	-	-	-	-	-	-	3	467	13.6
11	-	-	-	-	-	-	-	-	-	7	511	13.8	-	-	-
12	-	-	-	-	-	-	-	-	-	8	463	10.5	-	-	-

TABLE 3. Mean total length (TL) at age of Alabama Bass collected by spring electrofishing from Lake Hickory, North Carolina in 2013 and 2018. Given small sample sizes, data for any cohort with two or more individuals were included.

	2013			2018			Combined		
Age	N	Mean TL	SE	N	Mean TL	SE	N	Mean TL	SE
1	2	112	9.5	20	111	3.5	22	111	3.2
2	4	240	22.8	33	246	5.3	37	245	5.2
3	2	365	4.5	6	333	10.6	8	341	9.3
4	-	-	-	-	-	-	-	-	-
5	3	420	5.8	-	-	-	4	417	5.2



Site #	Latitude	Longitude	Site #	Latitude	Longitude
1	35.789938	-81.390671	11	35.802371	-81.336336
2	35.785112	-81.373258	12	35.794377	-81.305441
3	35.766228	-81.359612	13	35.801419	-81.283850
4	35.810759	-81.337246	14	35.810838	-81.276482
5	35.806655	-81.284932	15	35.820757	-81.266922
6	35.798476	-81.276619	16	35.824470	-81.257100
7	35.816837	-81.232811	17	35.805083	-81.238319
8	35.804531	-81.222195	19	35.825226	-81.218675
9	35.763608	-81.371820	20	35.817859	-81.199075
10	35.770752	-81.350134		** note that there is no site #18*	

FIGURE 1. Map of black bass electrofishing sites on Lake Hickory, North Carolina, 2008–2018. Geographic coordinates for each site are provided for cataloging purposes.

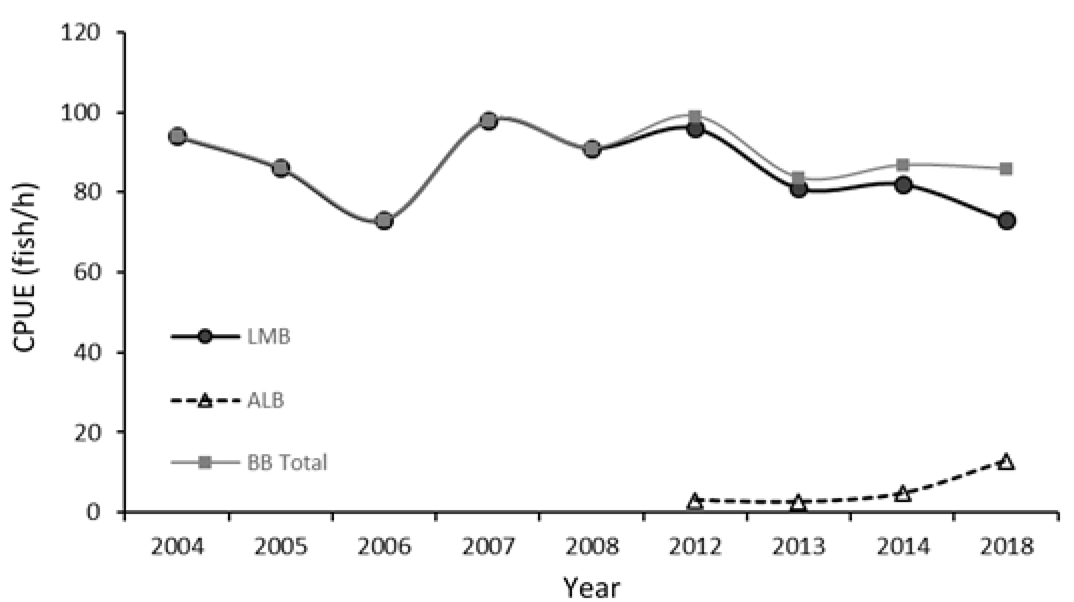


FIGURE 2. Catch per unit effort (CPUE) of Largemouth Bass (LMB), Alabama Bass (ALB), and total black bass (BB) during spring electrofishing surveys on Lake Hickory, North Carolina, 2004–2018. The 2004–2007 data are included for reference as they precede the introduction of ALB in Lake Hickory.

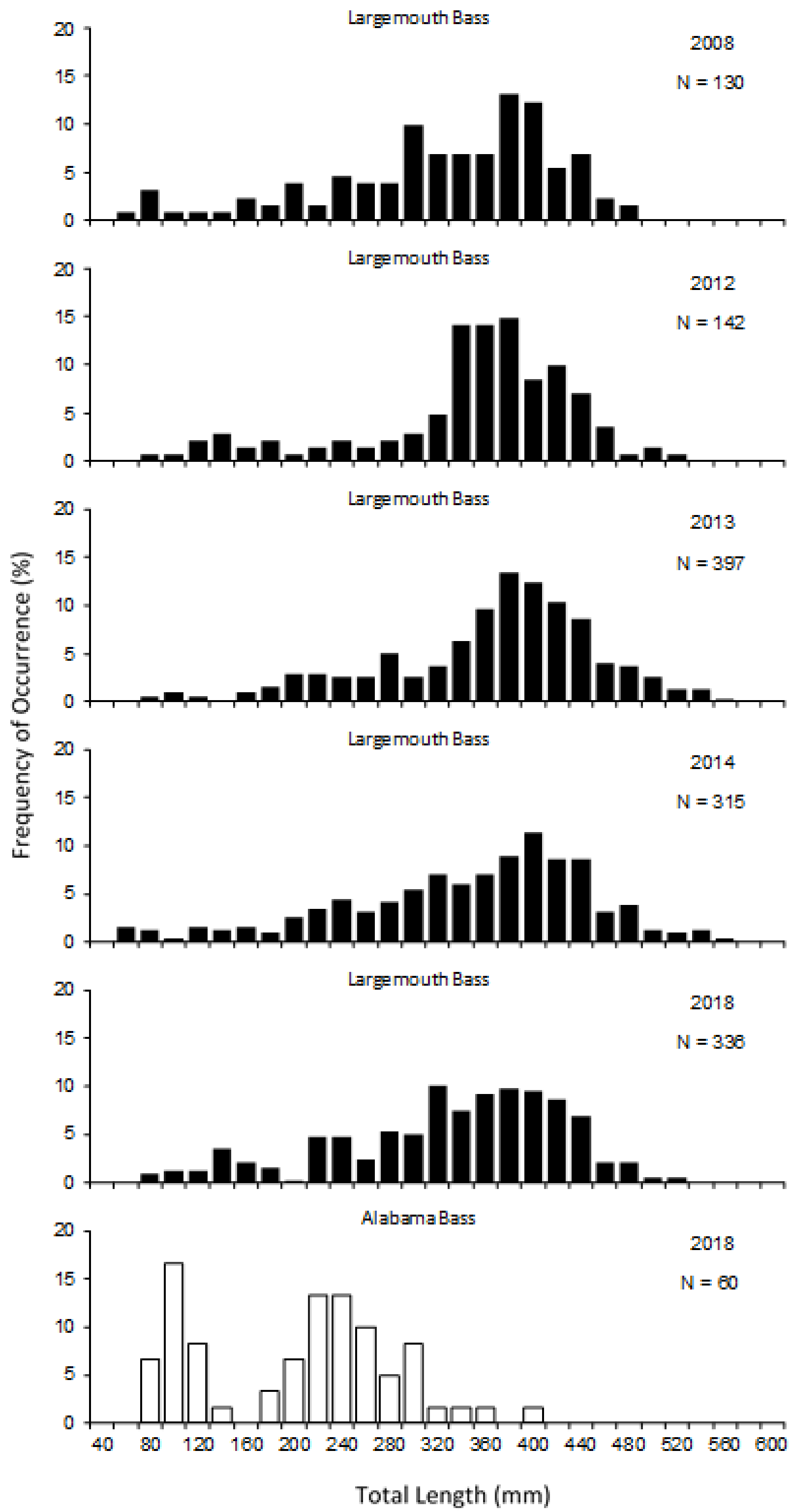


FIGURE 3. Length-frequency distributions of Largemouth Bass and Alabama Bass collected by springtime electrofishing from Lake Hickory, North Carolina, 2008–2018.

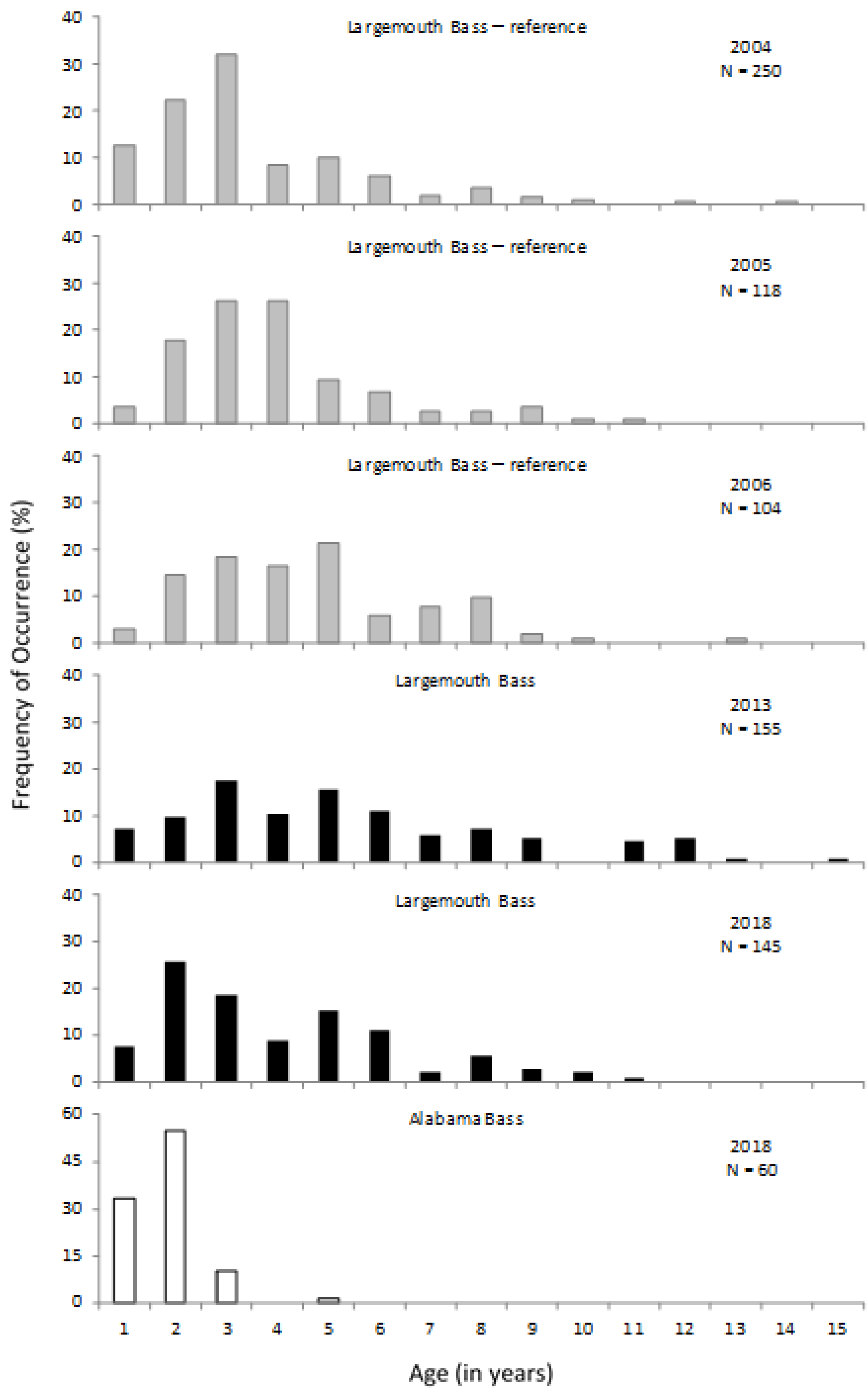


FIGURE 4. Age-frequency distributions of Largemouth Bass collected in spring electrofishing surveys on Lake Hickory, North Carolina during 2004–2006 (reference data from Hodges 2007a; gray bars) and in 2013 and 2018 (black bars). The age-frequency distribution of Alabama Bass collected in 2018 is also included at the bottom (white bars); note the different y-axis scaling.

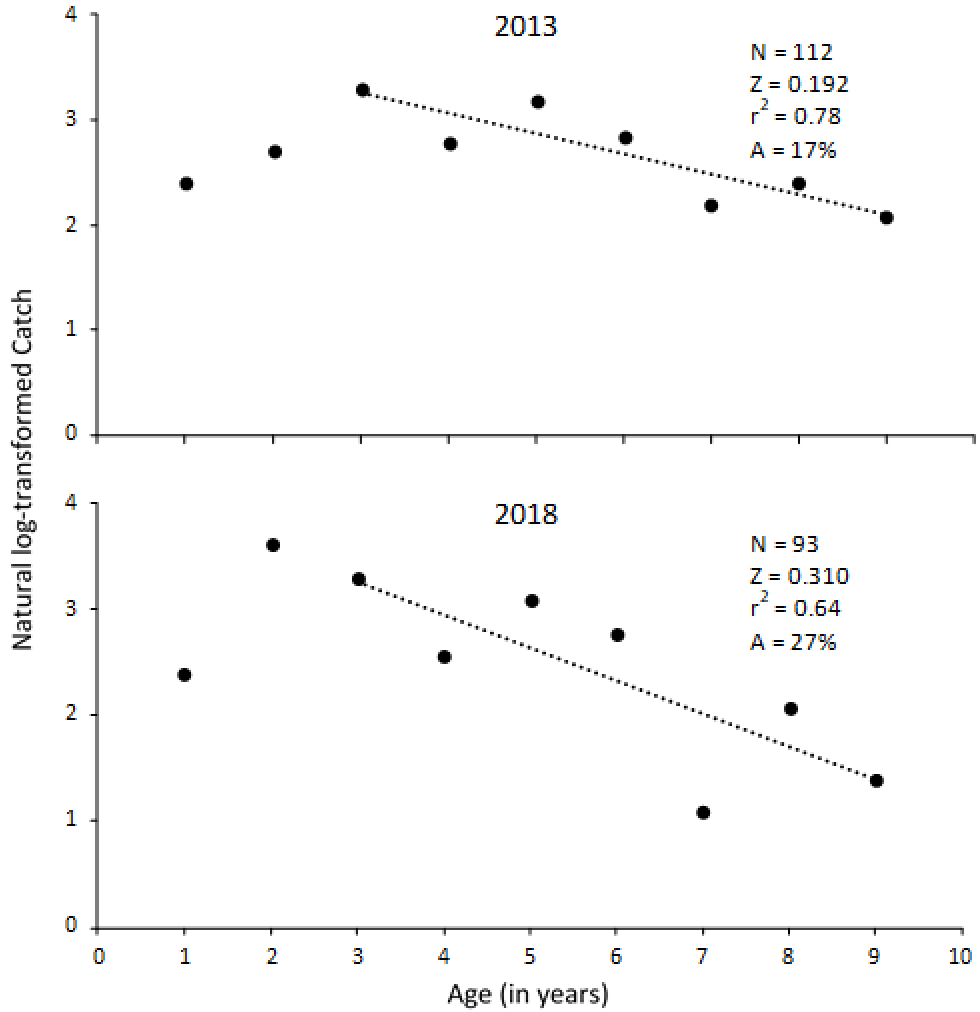


FIGURE 5. Catch-curves of Largemouth Bass collected by springtime electrofishing from Lake Hickory, North Carolina in 2013 and 2018. Instantaneous mortality rate (Z) and annual mortality rate (A) are provided for both survey years.