Population characteristics of Largemouth Bass in the Roanoke and Cashie rivers, 2018–2019

Federal Aid in Sport Fish Restoration
Project F-108

Christopher A. Smith
Kathryn M. Potoka

North Carolina Wildlife Resources Commission
Inland Fisheries Division
Raleigh

2020

Keywords: Roanoke River, Largemouth Bass, Population Characteristics, Boat Electrofishing

Recommended Citation

Smith, C. A., and K. M. Potoka. 2020. Population characteristics of Largemouth Bass in the Roanoke and Cashie rivers, 2018–2019. North Carolina Wildlife Resources Commission, Federal Aid in Sport Fish Restoration, Project F-108, Final Report, Raleigh.

This project was funded under the Federal Aid in Sport Fish Restoration Program utilizing state fishing license money and federal grant funds derived from federal excise taxes on fishing tackle and other fishing related expenditures. Funds from the Sport Fish Restoration Program are used for fisheries management and research, aquatic education, and boating access facilities. The program is administered cooperatively by the N.C. Wildlife Resources Commission and the U.S. Fish and Wildlife Service.

Abstract. To monitor Largemouth Bass *Micropterus salmoides* population in the Roanoke and Cashie rivers following hypoxic events in 2018 and 2019, shoreline transects were surveyed with boat-mounted electrofishing gear during November of 2018 and September and October of 2019. We collected 25 and 98 Largemouth Bass in 2018 and 2019, respectively. In 2018, relative abundance in the lower Roanoke stratum was 16.1 fish/h (SE = 41.8) and increased to 24.8 fish/h (SE = 8.0) in 2019. The middle Roanoke stratum was not sampled in 2018; however, relative abundance in 2019 was 20.0 fish/h (SE = 4.3). The Cashie River had a low relative abundance of 3.6 fish/h (SE = 2.4) and 8.8 fish/h (SE = 5.3) in 2018 and 2019, respectively. Hypoxia and fish kills following Hurricane Florence in 2018 had a greater impact on Largemouth Bass populations than the hypoxia and fish kills following Hurricane Dorian in 2019. These fish kills were not as severe as those seen following Hurricane Isabel (2003) and Hurricane Irene (2011). While population characteristics in the lower and middle Roanoke strata seemed to have rebounded in 2019, population characteristics in the Cashie River were still well below desirable levels in 2019.

Coastal rivers in North Carolina provide anglers with a diversity of target species. Of the finfish that inhabit coastal rivers, Largemouth Bass *Micropterus salmoides* is often the most sought-after sportfish species (Dockendorf et al. 2004; Rundle et al. 2004; Homan et al. 2006). The Largemouth Bass fishery in the Roanoke and Cashie rivers is managed with a five fish per day creel limit and a minimum length limit of 356 mm (14 inches). The majority of angling effort for Largemouth Bass in these two rivers is likely from recreational tournament anglers, who utilize catch and release practices; McCargo et al. (2007) estimated only 1.8% of the Largemouth Bass caught were harvested.

Like other coastal river systems, the Roanoke and Cashie rivers are impacted by tropical cyclones. In 2003, heavy rains and storm surge associated with Hurricane Isabel caused short term (several days) hypoxic and anoxic conditions, which resulted in extensive and multi-species fish kills. McCargo et al. (2008) documented post-hurricane recovery in the relative abundance of Roanoke River Largemouth Bass, and concluded the population nearly recovered to pre-hurricane conditions three years after landfall of Hurricane Isabel. Long term (nearly one month) anoxia and large-scale fish kills were again observed following landfall of Hurricane Irene in 2011. Annual improvements in population metrics were documented during previous surveys, with relative abundance similar to pre-hurricane levels four years after the initial fish kills (Smith et al. 2016). On September 14, 2018, Hurricane Florence made landfall in Wrightsville Beach, NC. While the highest rainfall totals were in the southeastern part of the state, the Roanoke River basin experienced 2–10 inches of rain (NCDENR 2018). Hypoxic conditions in the Roanoke River occurred three days after landfall and lasted approximately five days (Figure 1). Fish kills associated with the hypoxia, were seen from the mouth of the Roanoke River upstream past Plymouth, NC, and from the mouth of the Cashie River, upstream to Windsor, NC (NCDENR 2018). Hurricane Dorian made landfall at Cape Hatteras on September 6, 2019, as a category-1 hurricane. The Roanoke River watershed experienced 3–7 inches of rainfall (National Weather Service, unpublished data). Hypoxic conditions following Hurricane Dorian were observed September 10–17, 2019 (Figure 2). The intensity of the fish kills following Hurricane Dorian was less than Hurricane Florence, Isabel, or Irene. While mortality of Largemouth Bass, White Perch *Morone americana*, and sunfish species was observed in the lower Roanoke River, the majority of the fish mortality was comprised of suckers *Moxostoma spp.* The objective of these surveys was to assess the Largemouth Bass populations in the Roanoke and Cashie rivers following the hypoxic conditions and fish kills in 2018 and 2019.

Methods

Study site. The Roanoke River flows approximately 600 km from the mountains of western Virginia to the Albemarle Sound in eastern North Carolina. The Roanoke River drainage basin is approximately 25,000 km^2, with a relatively small portion within North Carolina. Over 18,000 km of tributaries drain into the Roanoke River from portions of 16 counties in Virginia and 15 counties in North Carolina. Three reservoirs were formed on the Roanoke River for flood control and hydroelectricity: John H. Kerr Reservoir, Lake Gaston, and Roanoke Rapids Lake. Water flow in the North Carolina portion of the river is controlled mainly by the uppermost reservoir in the system, John H. Kerr reservoir. The portion of the Roanoke River below Roanoke Rapids Lake is known as the lower Roanoke River (hereafter Roanoke River). The

Roanoke River is unique in that it flows through the largest intact and least-disturbed bottomland hardwood forest floodplain in the mid-Atlantic region (NCDENR 2006). The Cashie River is located entirely in Bertie County, NC, and is adjacent and connected to the Roanoke River. Sportfish populations in the Cashie and Roanoke rivers, referred to as the Roanoke River complex, are managed as one unit due to the similarity, location, and connectivity of these river systems that form a delta flowing into the western Albemarle Sound.

The study area was divided into three strata: lower Roanoke, middle Roanoke, and Cashie. The lower Roanoke stratum extended from the mouth of the Roanoke River (rkm 0) up to Williamston, NC (rkm 71). The middle Roanoke stratum included the area from Williamston upstream to Scotland Neck, NC (rkm 103). The Cashie River stratum was defined as the area below Windsor, NC, to Cashoke Creek near the mouth of the river. Effort in 2018 and 2019 was limited due to hypoxic conditions associated with Hurricane Florence (2018), and Dorian (2019). In each stratum, five out of the 30 routine sample sites selected by Smith and Potoka (2017) were randomly selected (Figure 3).

Fish sampling. Boat-mounted electrofishing gear (Smith-Root 7.5 GPP; 170–1000 V pulsed DC; 2–4 A) was used to collect fish during November 2018 and in September and October of 2019, as a part of annual sportfish monitoring conducted by the North Carolina Wildlife Resources Commission (NCWRC). Boat electrofishing was conducted during daylight hours by a two-person crew (one netter and one driver) and electrofishing time (s) was recorded at each site. Dissolved oxygen (mg/L) and water temperature (°C) was also recorded at each site (Table 1). Largemouth Bass were netted as they were encountered and held in a live well until the completion of the sampling site. Individuals were then measured (total length, TL; mm) and weighed (g) before being released alive.

Data analysis. Data from the Roanoke River were separated by stratum for analysis. Several population parameters were used to characterize Largemouth Bass populations in each stratum. Relative abundance of Largemouth Bass was indexed as catch-per-unit-effort (CPUE; number of fish ≥ 200-mm TL collected/hour of electrofishing). To characterize size structure, length frequency histograms (length bins of 10 mm) were constructed for each stratum. Length categories for Largemouth Bass were defined as stock-length (200–299 mm), quality-length (300–379 mm), preferred-length (380–509 mm), and memorable-length (510–629 mm; Anderson and Neumann 1996). Relative weight (*Wr*) was calculated as:

$$Wr = \frac{W}{Ws} * 100$$

where *W* is the measured weight (g) of each fish, and *Ws* is a length specific standard weight. The *Ws* equation for Largemouth Bass was $\log_{10}(Ws) = -5.316 + 3.191 \log_{10}(TL)$ (Murphy et al. 1991). Fish less than stock-length were excluded from the relative weight analysis.

Results

Lower Roanoke stratum. In 2018 and 2019, we collected 18 and 46 Largemouth Bass from the lower Roanoke stratum, respectively. Mean CPUE was 16.1 fish/h (SE = 1.8) in 2018 and 24.8 fish/h (SE = 8.0) in 2019 (Figure 4a). In 2018, CPUE across three sample sites ranged from

12.5 to 18.1 fish/h, while CPUE across five sample sites in 2019 ranged from 3.8 to 40.0 fish/h. Total Length of Largemouth Bass ranged from 144 mm to 484 mm in 2018 (Figure 5a) and from 70 mm to 530 mm in 2019 (Figure 5b). Relative weight in 2018 was similar for stock- (86.8, SE = 2.0), quality- (89.8, SE = 3.6), and preferred-lengths (89.2, SE = 4.3;Figure 6a). Relative weights, except for quality-length fish, were all higher in 2019 (Figure 6b) than in 2018. Dissolved oxygen at the time of collection ranged from 6.4 mg/L to 8.3 mg/L in 2018 and from 5.7 mg/L to 7.2 mg/L in 2019 (Table 1).

Middle Roanoke stratum. Sampling did not occur in fall 2018 due to hypoxic conditions. We collected 27 Largemouth Bass in 2019. Mean CPUE in 2019 was 20.0 fish/h (SE = 6.4; Figure 4b). Catch-per-unit-effort in the middle Roanoke stratum ranged from 0.0 to 40.0 fish/h. Total lengths of Largemouth Bass in the middle Roanoke stratum ranged from 98 mm to 483 mm (Figure 7). Preferred-length Largemouth Bass (95, SE = 1.7) had a higher relative weight than stock-length Largemouth Bass (88, SE = 3.9), while a single memorable-length Largemouth Bass had a relative weight of 99 (Figure 8). Dissolved oxygen ranged from 5.7 mg/L to 7.2 mg/L in 2019 (Table 1).

Cashie River stratum. In 2018 and 2019, we collected 7 and 25 Largemouth Bass in the Cashie River, respectively. Mean CPUE in 2018 was 3.6 fish/h (SE = 2.4) and ranged from 0.0 to 11.8 fish/h. In 2019, CPUE ranged from 0.0 to 28.0 fish/h with a mean of 8.8 fish/h (SE = 5.3; Figure 4c). Largemouth Bass ranged from 235 mm to 456 mm in 2018 (Figure 9a) and from 79 mm to 504 mm in 2019 (Figure 9b). Relative weight values in 2018 for stock-length fish (85.1, SE = 2.4) were lower than quality- and preferred-length Largemouth Bass (Figure 10a). Relative weights for stock- and quality-length Largemouth Bass were higher in 2019 (Figure 10b) than in 2018. Dissolved oxygen ranged from 2.0 mg/L to 7.0 mg/L in 2018 and from 0.6 mg/L to 5.2 mg/L in 2019 (Table 1).

Discussion

Relative abundance of Largemouth Bass in 2018 was depressed across all strata when compared to relative abundance of Largemouth Bass in 2016 (Figure 4; Smith and Potoka 2017). This decrease is likely caused by hypoxia and subsequent fish kills associated with Hurricane Florence. However, the limited number of sample sites surveyed may have influenced relative abundance metrics. Brown et al. (2015) showed that Largemouth Bass stayed just outside hypoxic zones until conditions improved. It is likely that low abundance in some of the sample sites near the mouth of the Roanoke and Cashie rivers was a function of displacement as Largemouth Bass left the sample stratum to seek refuge from hypoxic conditions. Relative abundance in the lower Roanoke stratum following hypoxia in 2018 was similar to 2012 observations collected one year after the passage of Hurricane Irene (Smith et al. 2016). The 2018 relative abundance in the Cashie River mimicked the relative abundance immediately following Hurricane Irene in 2011 (Smith et al. 2016); however, it is important to note that hypoxic conditions were still present in the Cashie River during the 2018 sampling period. Relative abundance increased in 2019 across all three strata. During the 2019 sampling period, the relative abundance in the lower Roanoke stratum increased to close to the 25 fish/h management standard for coastal NC rivers. The 24.8 fish/h in the lower Roanoke stratum was similar to 2013 (2 years following Hurricane Irene; Smith et al. 2016), 2015, and 2016 (Smith

and Potoka 2017). Relative abundance in the Cashie River was still lower in the fall of 2019 than previous years (2015 and 2016; Smith and Potoka 2017). Hypoxic conditions were once again present in the Cashie River during the sampling period, likely impacting estimates of relative abundance. The relative abundance in the middle Roanoke stratum in 2019 was similar to pre-2018 levels (Smith and Potoka 2017). In the absence of real-time water quality monitoring in the Cashie River, extended water quality surveys are warranted following cyclonic events to determine the extent and duration of hypoxic conditions; this information will better inform timing of electrofishing surveys.

There were no discernable trends in length distribution in 2018 across any strata due to the limited number of individuals captured. However, the size distribution in the lower Roanoke stratum seemed to be more expanded than in the Cashie River. The 2019 length distribution in the lower Roanoke stratum was more expanded than in 2018. Successful and adequate spawning, which occurred in the spring of 2019, was evident by the large number of young-of-year bass captured during the fall sampling period. The middle Roanoke stratum had an expanded length distribution in 2019. Young-of-year and preferred to memorable fish were present, indicating a relatively healthy distribution. The Cashie River length distribution was slightly more truncated than the other strata. While there was a high abundance of young-of-year fish present, the Cashie River lacked sufficient abundance of quality to memorable fish.

Relative weights in the lower Roanoke stratum were lower for all size classes than in previous years, while the relative weights in the Cashie River were similar to the fall of 2015 and 2016 (Smith and Potoka 2017). However, the low number of individuals collected in both the lower Roanoke stratum and the Cashie River stratum during the fall of 2018 made it difficult to examine trends in the relative weight of Largemouth Bass. Relative weights in the lower Roanoke stratum during the fall of 2019 were similar to the fall of 2015 and 2016 (Smith and Potoka 2017), with the exception of quality-length fish. The lower relative weights for quality-length fish were likely due to the low abundance of prey following the fish kills in 2018. Relative weights in both the middle Roanoke stratum and the Cashie River were similar to previous years before the 2018 fish kills occurred.

The hypoxia in 2018 had more of an impact on Largemouth Bass than the hypoxic event in 2019. However, neither of these events resulted in the extended anoxic conditions observed following Hurricane Irene. The lower Roanoke stratum rebounded more quickly than the Cashie River, which has been impacted the hardest by hypoxic events throughout the last two decades. It is likely that fish move from the middle Roanoke stratum and the Albemarle Sound to repopulate the lower Roanoke stratum. The Cashie River only has the Albemarle Sound and a small connection to the Roanoke River to repopulate the entire river. The impact of the fish kills in 2018 on the middle Roanoke stratum cannot be determined due to the lack of sampling in that stratum. However, relative abundance and length distributions were close to pre-2018 levels at the conclusion of the survey period. Continued monitoring of the Roanoke and Cashie rivers annually and following fish kill events is needed to determine population health and recovery times.

Management Recommendations

1. Maintain the current minimum length limit of 356 mm TL (14 inches) and five fish per day creel limit for the Roanoke-Cashie complex.
2. Continue to monitor Largemouth Bass populations in the Roanoke-Cashie complex annually and following hurricanes or other fish kill events. Collection of data following these events will allow managers to determine population health and inform anglers of potential improvements in abundance and size and age distributions.
3. Conduct extended water quality surveys on the Cashie River during and following hypoxic events to compare water quality recovery times to the real-time data on the main stem of the Roanoke River.

Acknowledgments

We would like to thank William Ridgeway, Northern Coastal Region conservation technician supervisor, for coordination of conservation technicians for assistance in field collections during the fall of 2018 and 2019. We would also like to thank Jeremy McCargo, Kevin Dockendorf, and Chad Thomas for their comments and edits to improve this report.

References

Anderson, R. O., and R. M. Neumann. 1996. Length, weight, and associated structural indices. Pages 447–481 *in* B. R. Murphy and D. W. Willis, editors. Fisheries Techniques. 2nd Edition. American Fisheries Society, Bethesda, Maryland.

Brown, D. T., D. D. Aday, and J. A. Rice. 2015. Responses of coastal Largemouth Bass to episodic hypoxia. Transactions of the American Fisheries Society 144:655–666.

Dockendorf, K. J., C. D. Thomas, and J. W. Kornegay. 2004. Chowan River Recreational Angling Survey, 2001-2002. North Carolina Wildlife Resources Commission, Federal Aid in Sport Fish Restoration, Project F-22. Final Report, Raleigh.

Homan, J. M., R. D. Barwick, and K. R. Rundle. 2006. Tar-Pamlico River basin sport fishery creel survey, 2004-2005. North Carolina Wildlife Resources Commission, Federal Aid in Sport Fish Restoration, Project F-22, Final Report, Raleigh.

McCargo, J. W., K. J. Dockendorf, and C. D. Thomas. 2007. Roanoke River recreational angling survey, 2005-2006. North Carolina Wildlife Resources Commission, Federal Aid in Sport Fish Restoration, Project F-22, Final Report, Raleigh.

McCargo, J. W., K. J. Dockendorf, and C. D. Thomas. 2008. Fish assemblage response following a hurricane-induced fish kill in the lower Roanoke River, North Carolina. North Carolina Wildlife Resources Commission, Federal Aid in Sport Fish Restoration, Project F-22, Final Report, Raleigh.

Murphy, B. R., D. W. Willis, and T. A. Springer. 1991. The relative weight index in fisheries management: status and needs. Fisheries 16(2):30–38.

NCDENR (North Carolina Department of Environment and Natural Resources). 2006. Roanoke River basin wide water quality plan. North Carolina Department of Natural Resources. Division of Water Quality, Basinwide Planning Program, Raleigh.

NCDENR (North Carolina Department of Environment and Natural Resources). 2018. North Carolina Division of Water Quality annual report of fish kill events 2018. Division of Water Quality, Final Report, Raleigh.

Rundle, K. R., C. T. Waters, and R. D. Barwick. 2004. Neuse River Basin sport fishery creel survey, 2002-2003. North Carolina Wildlife Resources Commission, Federal Aid in Sport Fish Restoration, Project F-22, Final Report, Raleigh.

Smith, C. A., J. W. McCargo, and K. M. Potoka. 2016. Recovery of Largemouth Bass in the Roanoke and Cashie rivers following Hurricane Irene. North Carolina Wildlife Resources Commission, Federal Aid in Sport Fish Restoration, Project F-108, Final Report, Raleigh.

Smith, C. A., and K. M. Potoka. 2017. Population Characteristic of Largemouth Bass in the Roanoke and Cashie Rivers 2015–2016. North Carolina Wildlife Resources Commission, Federal Aid in Sport Fish Restoration, Project F-108, Final Report, Raleigh.

USGS (U.S. Geological Survey). 2012. National Water Information System data available on the World Wide Web (Water Data for the Nation). Available: http://waterdata.usgs.gov/nc/nwis/current/?type=flow&group_key=basin_cd (May 2020).

TABLE 1. Range and average dissolved oxygen (mg/L) and water temperature (°C) across electrofishing collections for each stratum in 2018 and 2019.

		Dissolved Oxygen (mg/L)			Water Temperature (°C)		
Year	Stratum	Minimum	Maximum	Average	Minimum	Maximum	Average
2018	Lower	6.4	8.6	7.3	16.5	17.5	17.0
2018	Middle	–	–	–	–	–	–
2018	Cashie	2.0	7.0	4.1	14.6	16.9	15.8
2019	Lower	5.7	7.2	6.5	22.6	26.7	24.4
2019	Middle	5.7	7.2	6.4	22.5	26.7	24.4
2019	Cashie	0.6	5.2	2.1	20.9	23.4	22.2

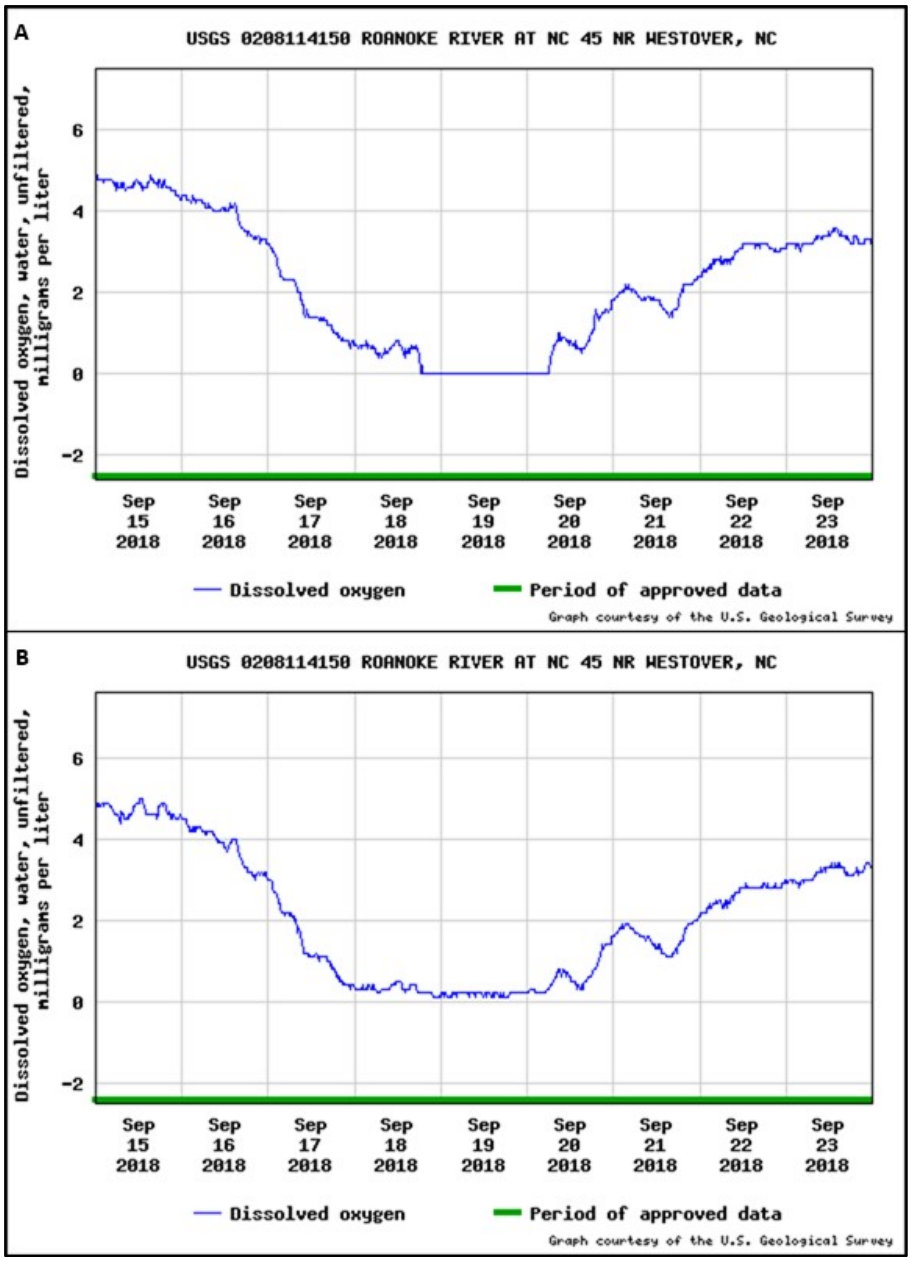

FIGURE 1. Top (A) and bottom (B) dissolved oxygen readings (mg/L) from the USGS Gage # 0208114150 in the Roanoke River at NC Highway 45 following Hurricane Florence in 2018. Graphs are courtesy of the U.S. Geological Survey (USGS 2012).

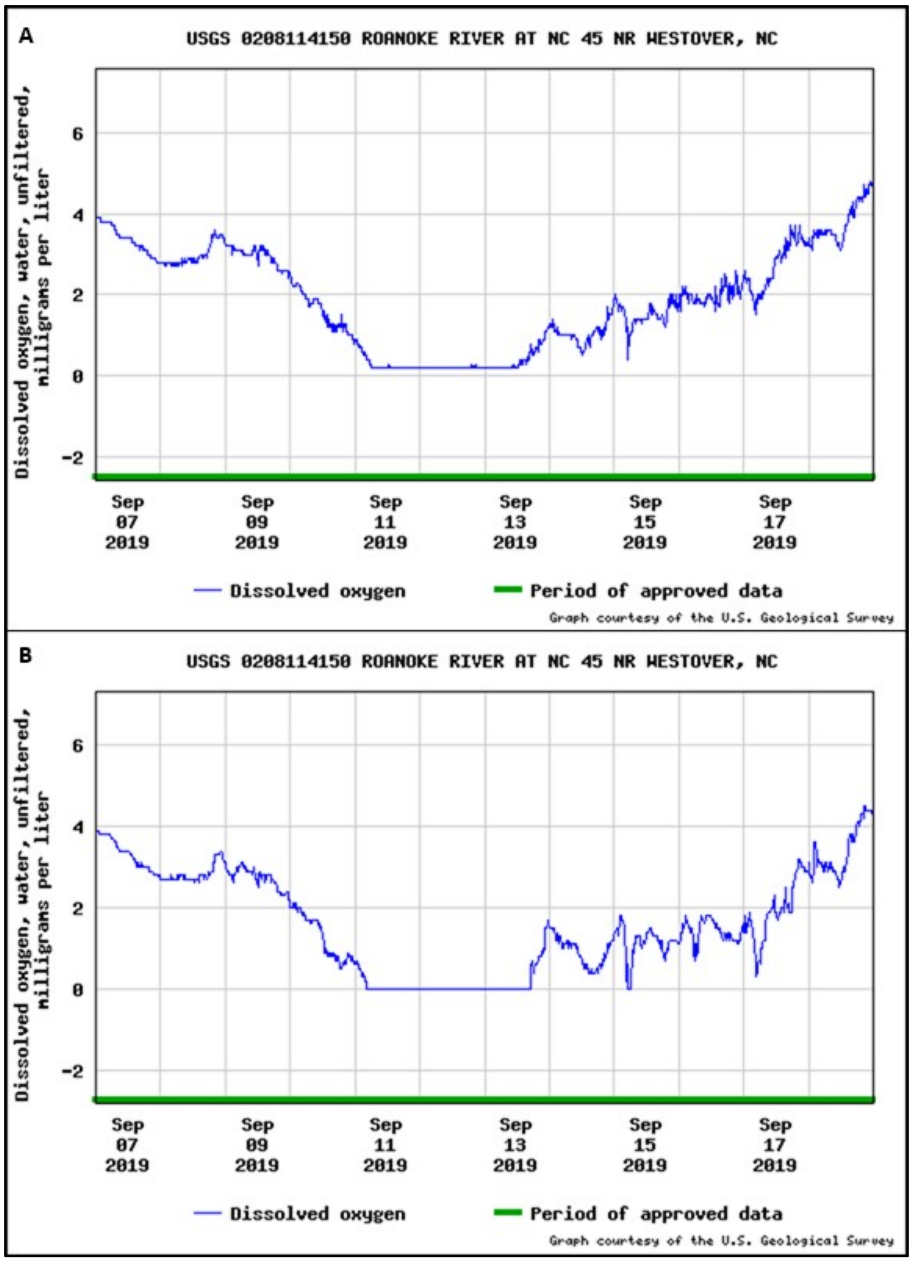

FIGURE 2. Top (A) and bottom (B) dissolved oxygen readings (mg/L) from the USGS Gage # 0208114150 in the Roanoke River at NC Highway 45 following Hurricane Dorian in 2019. Graphs are courtesy of the U.S. Geological Survey (USGS 2012).

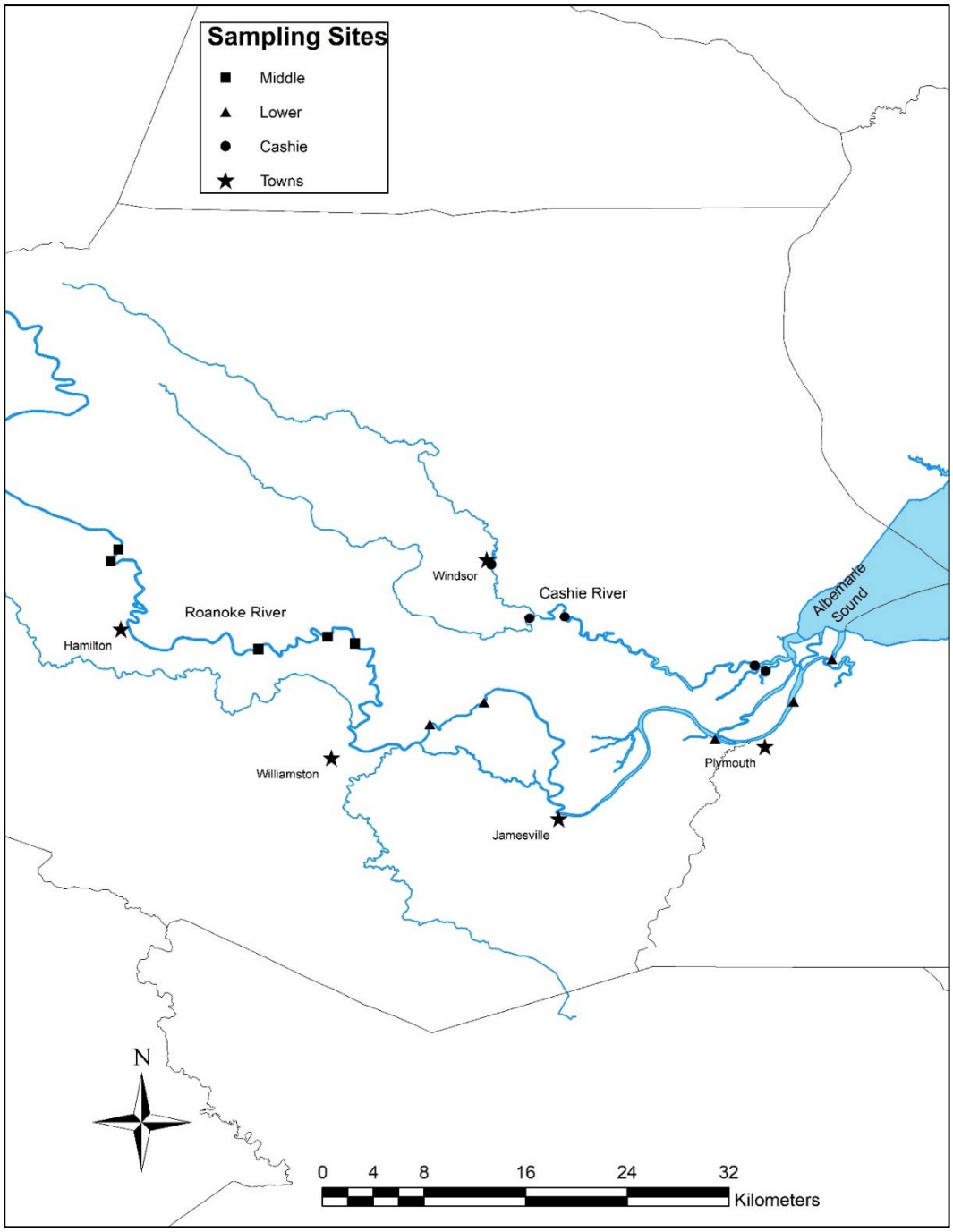

FIGURE 3. Boat electrofishing sites sampled in 2018 and 2019 in the Roanoke and Cashie rivers.

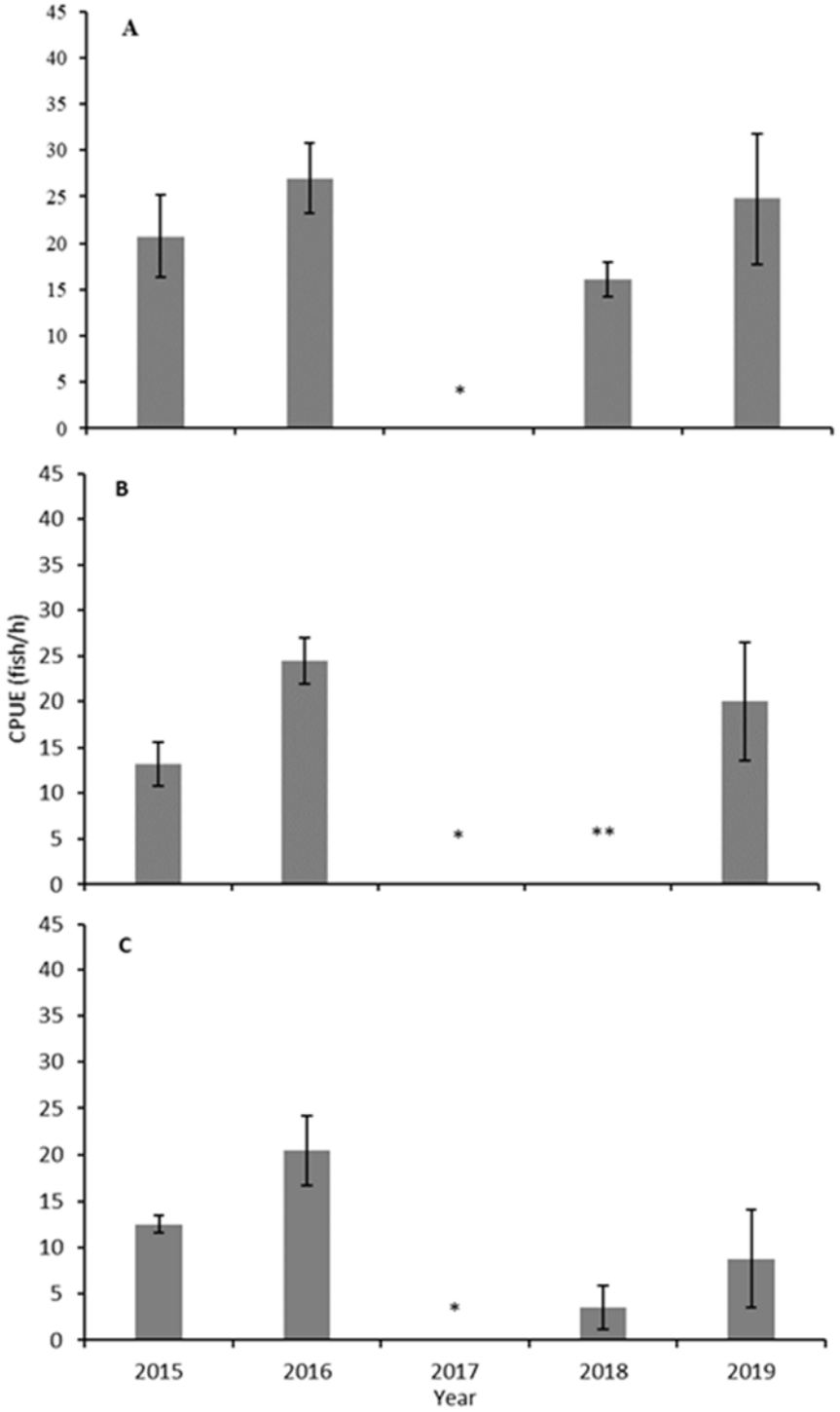

FIGURE 4. Mean CPUE of Largemouth Bass (≥ 200-mm TL) from the (A) lower Roanoke stratum, (B) middle Roanoke stratum, and (C) Cashie River. Data from 2015 and 2016 was reported by Smith and Potoka (2017). Error bars indicate ± 1 standard error. Single asterisk indicates no data available due to data logger failure. Double asterisk indicates sampling did not occur.

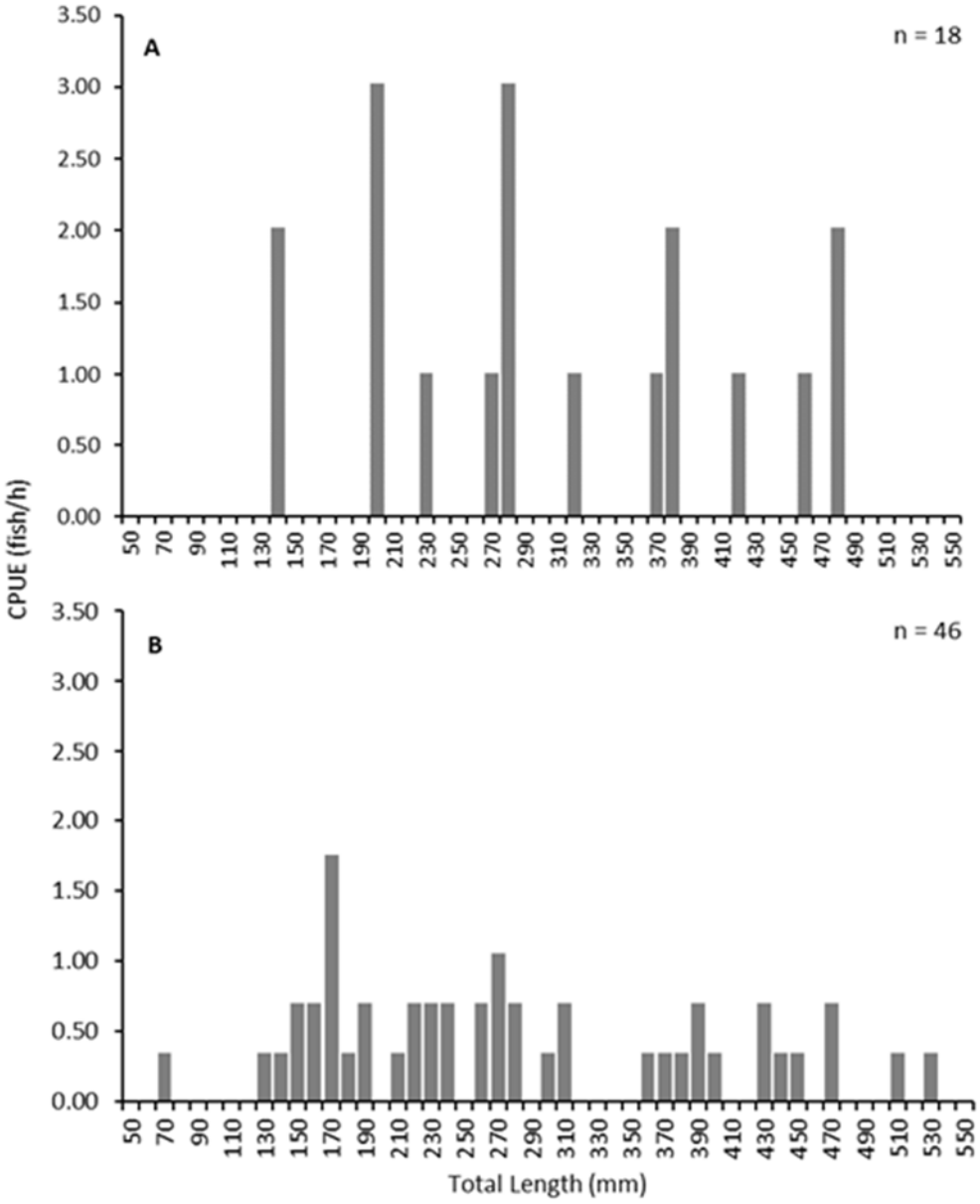

FIGURE 5.—Length frequency distributions for the lower Roanoke stratum from the fall of (A) 2018 and (B) 2019.

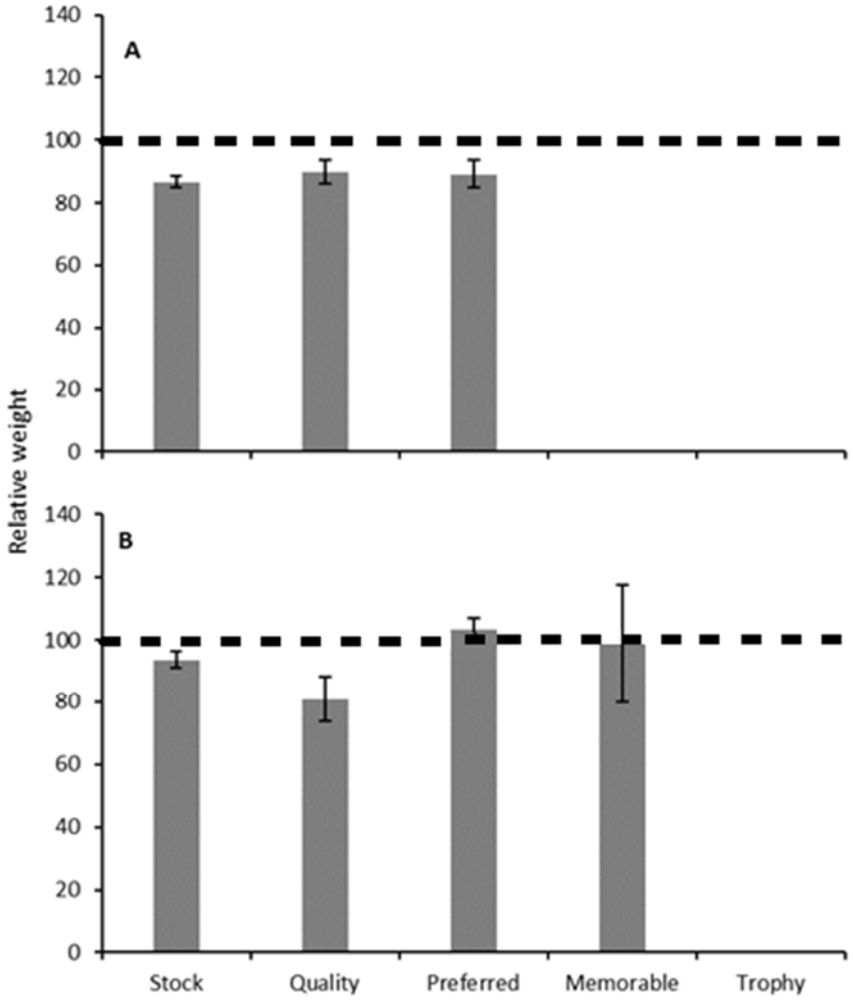

FIGURE 6. Relative weight of each length category from the lower Roanoke stratum in (A) 2018 and (B) 2019. The dashed line at 100 denotes the 75th percentile of weights at given length categories of Largemouth Bass across its entire range. Error bars indicate ± 1 standard error.

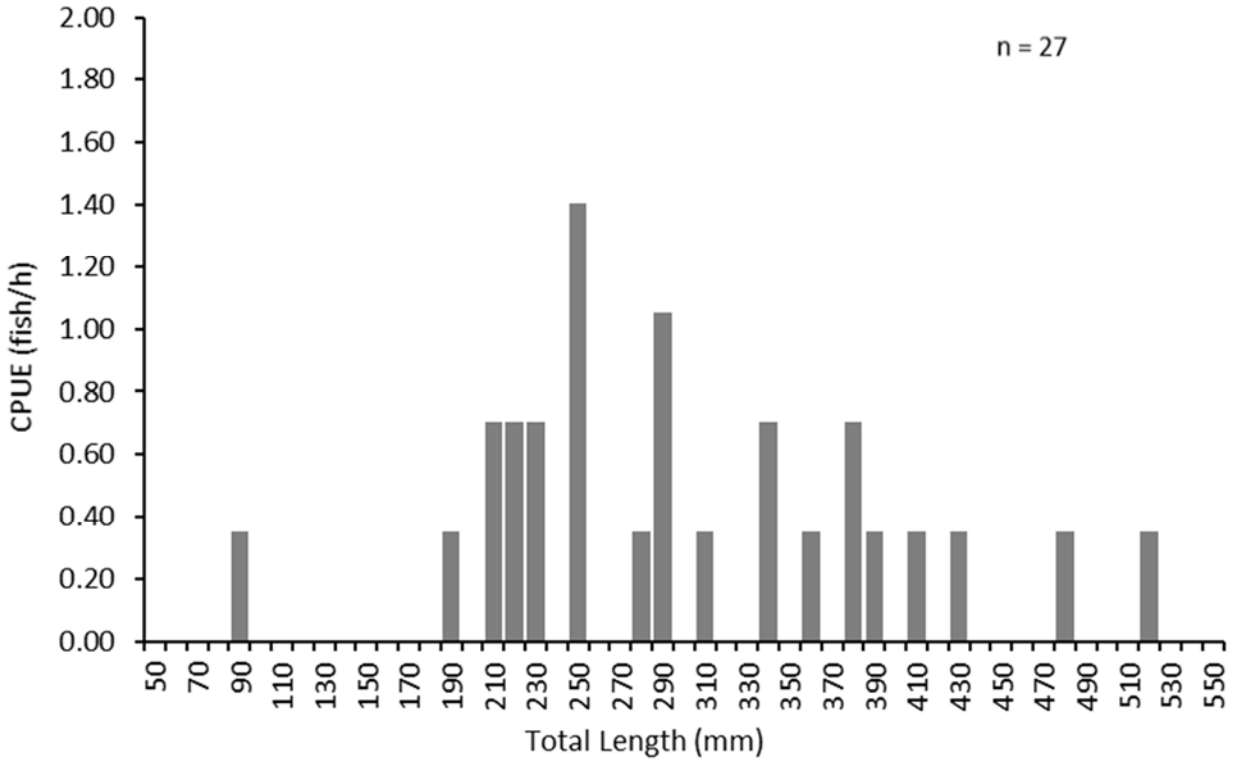

FIGURE 7. Length frequency distribution for the middle Roanoke stratum from the fall of 2019.

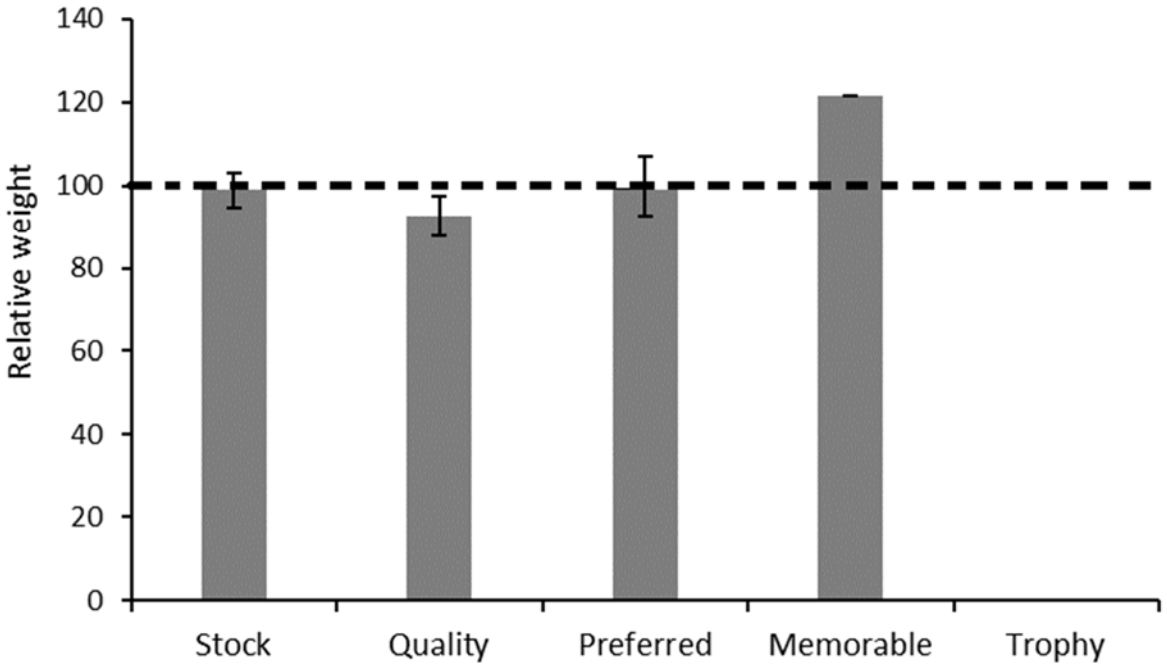

FIGURE 8. Relative weight of each length category from the middle Roanoke stratum in 2019. The dashed line at 100 denotes the 75th percentile of weights at given length categories of Largemouth Bass across its entire range. Error bars indicate ± 1 standard error.

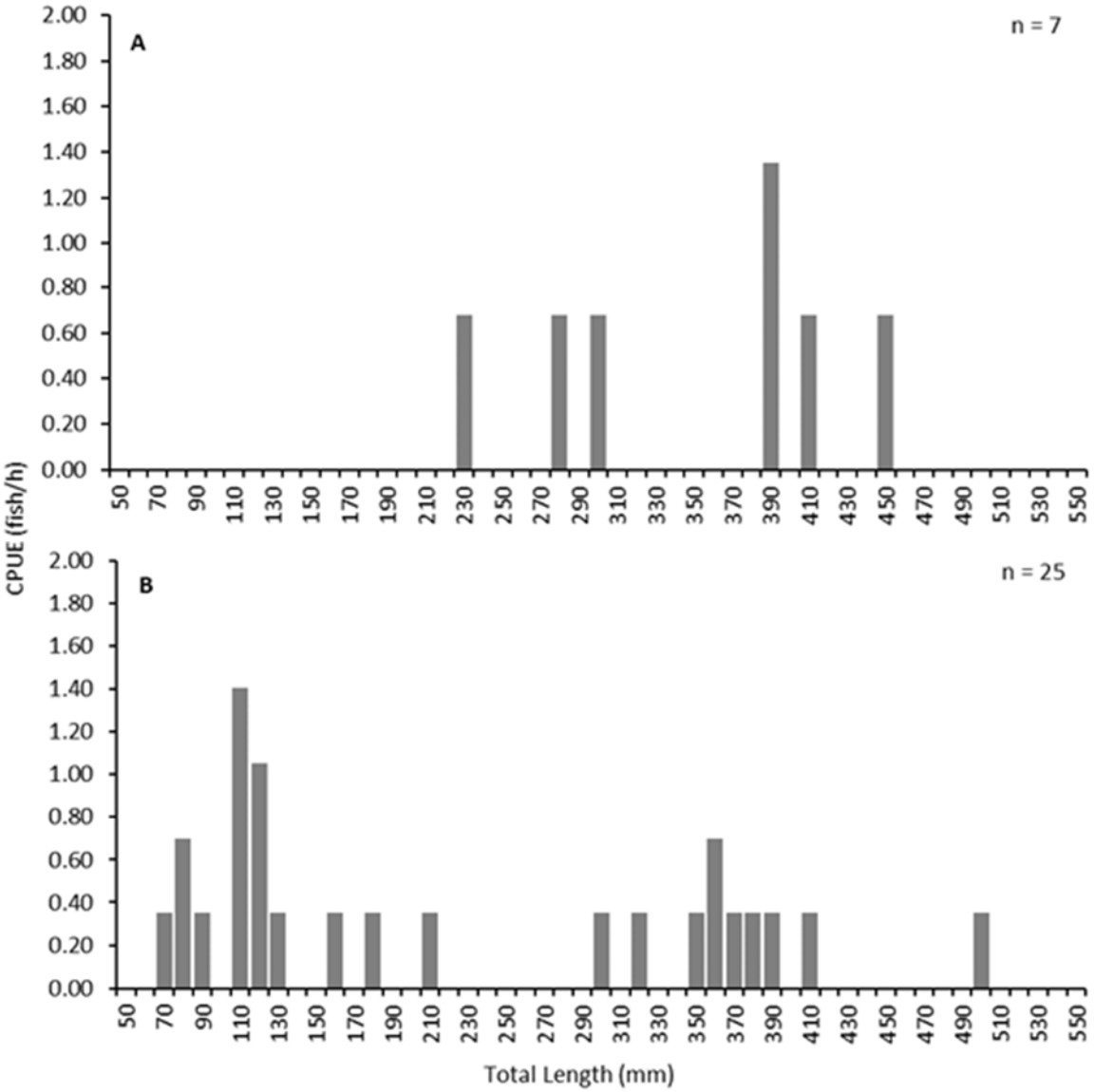

FIGURE 9. Length frequency distributions for the Cashie River from the fall of (A) 2018 and (B) 2019.

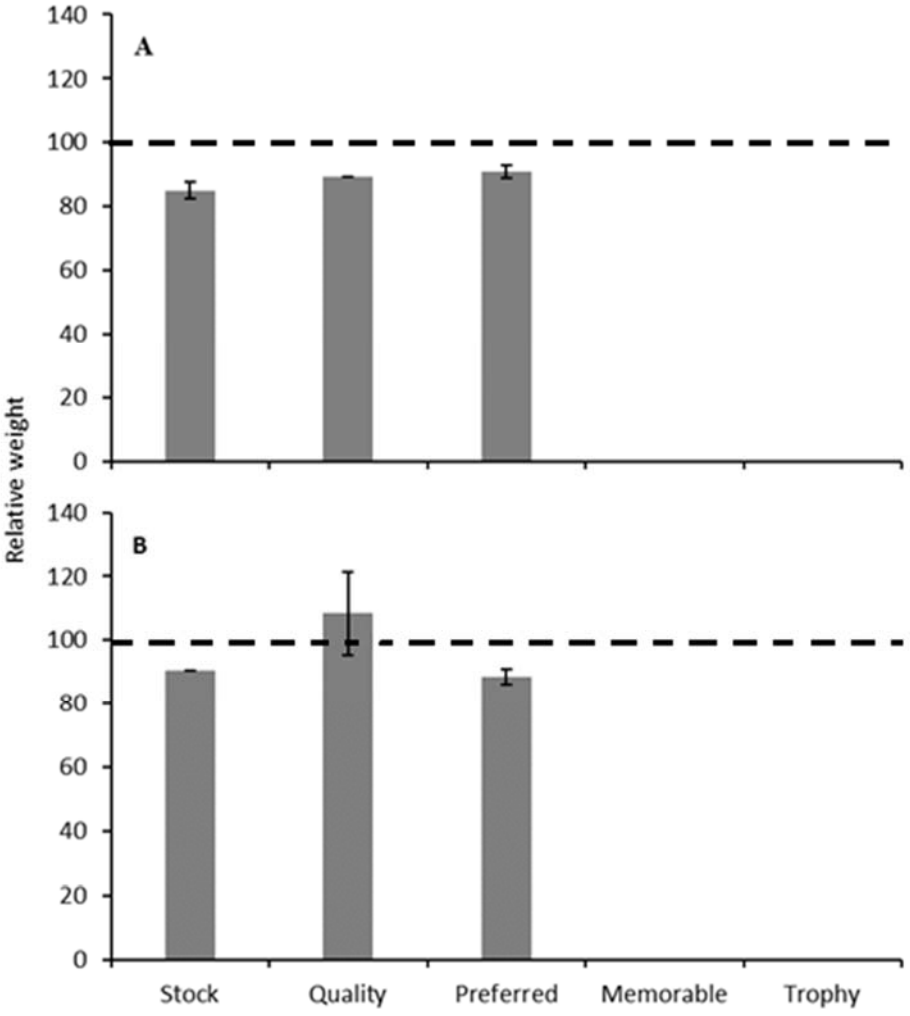

FIGURE 10. Relative weight of each length category from the Cashie stratum in (A) 2018 and (B) 2019. The dashed line at 100 denotes the 75th percentile of weights at given length categories of Largemouth Bass across its entire range. Error bars indicate ± 1 standard error.