CONTRIBUTION OF STOCKED WALLEYE IN LAKE FONTANA (2016–2018)

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Abstract.—The Walleye *Sander vitreus* fishery in Lake Fontana has declined in recent years. In 2016, we began an experimental stocking of 50,000 OTC-marked fingerling Walleye to determine if they could recruit to adulthood (age ≥ 1) and restore the adult population size. We assessed the Walleye population with fall gill-net surveys 2004–2018. The population declined 2004–2007 and by 2010 was reduced to about 70% of historical levels. Although the majority of Walleye from the stocked year-classes were verified as stocked, there are too few to maintain the traditional population size. We propose to continue the experimental Walleye stocking until 2023 but change the stocking location to Lemmons Branch Boating Access Area and double the number that we are currently stocking.

Lake Fontana is a large (4,318 ha), deep (146 m at the dam), long (47 km pool), high elevation (521 m above mean sea level), oligotrophic, hydropower reservoir on the Little Tennessee River in Swain County and Graham County, North Carolina (TVA 1954; NCDENR 2005). Lake Fontana was impounded in 1944 and Walleye *Sander vitreus* were first introduced as either fingerlings (Tebo 1961) or fry (Chance 1953) in 1952, and again with adults in 1954 (Tebo 1961). Chance (1953) collected a single 254-mm TL Walleye from the initial stocking in fall of 1952 and Tebo (1961) verified reproduction by collecting age-0 Walleye in cove rotenone samples in 1957 and 1959. These initial introductions established a self-sustaining Walleye population and, until this study, there have been no further Walleye stockings in Lake Fontana.

The Lake Fontana Walleye population expanded slowly. Baker (1966) sampled Lake Fontana with gill nets in 1964 and 1965 and found low catch rates (≤0.7/net-night). In addition, Baker (1966) collected Walleye from four of five cove rotenone samples in 1965. The average density of Walleye in Baker's (1966) samples was 43.5/ha and he believed that the population was still expanding from the initial introductions. Davies (1981) also sampled Lake Fontana with rotenone and gill nets in 1979 and observed an increase in Walleye catch over Baker (1966). Davies (1981) and averaged 246.3 Walleye/ha from three cove rotenone sites and 4.5 Walleye/net-night. Davies (1981) attributed the population increase to the elimination of anoxic water in the reservoir and improved water quality for spawning in the Tuckasegee River following the creation of a municipal sewage treatment plant and the closing of a paper mill in the Town of Sylva, North Carolina.

Walleye population decline—Anglers perceive that the Walleye fishery in Lake Fontana has declined in recent years. The cause of Walleye population decline is unknown but may include increased angler harvest, changes in the fish community, and changes in the reservoir water level management.

History of the Lake Fontana Walleye fishery.—The North Carolina Wildlife Resources Commission (NCWRC) has conducted three angler surveys on Lake Fontana, each of increasing rigor. The surveys revealed that the Walleye fishery is popular and that angler effort and exploitation have increased through time. Baker (1966) surveyed Lake Fontana anglers in 1964 and 1965 and found that, despite their relatively low abundance in the reservoir, Walleye were 16.2 and 13.3% of the total catch and 14.0 and 12.4% of the harvest, respectively. At the time, the catch and harvest rates of Walleye and other Lake Fontana sport fishes (Largemouth Bass *Micropterus salmoides*, Smallmouth Bass *Micropterus dolomieu*, White Bass *Morone chrysops*, Black Crappie *Pomoxis nigromaculatus*, and Channel Catfish *Ictalurus punctatus*) were all similar.

Baker (1966) also described the angler methods for Walleye. Anglers targeted Walleye mostly by fishing at night either during the March spawning run on the Little Tennessee River or by fishing nightcrawlers *Lumbricus terrestris* on the substrate during May. However, most contemporary Walleye anglers use vertical jigging which is effective during daylight and year-round. This transition to a more convenient and more effective gear may have contributed to increasing both the popularity of the Walleye fishery and Walleye harvest as observed by subsequent angler surveys.

Two more recent and more comprehensive surveys by Borawa (1986) and Yow et al. (2019) sought to quantify the effort and harvest of sport fishes in Lake Fontana. Borawa (1986) surveyed 350 anglers over 14 months from March 1984 to April 1985. Yow et al. (2019) surveyed 1,703 Lake Fontana anglers over a two-year period from August 2006 to July 2008. Yow et al. (2019) essentially performed two consecutive 1-year surveys, but unfortunately, the 14-month estimates from Borawa (1986) survey cannot be easily reduced to a more comparable 12-month survey. However, despite the differing durations, comparisons between Yow et al. (2019) and Borowa (1986) are useful for understanding trends in the Lake Fontana Walleye fishery. The extra two survey months, which account for angling during two Walleye spawns, likely increased Borowa's (1986) estimate of Walleye effort and harvest by 24–33% over a one-year survey.

Borowa (1986) and Yow et al. (2019) both found that Walleye and black bass *Micropterus* spp*.* were the top two species targeted by anglers and the effort (angler-h) directed at them was similar (*Z*-tests; Borowa: $z = 0.78$, P-value > 0.4; Yow et al. Year 1 and Year 2: both $z < 0.19$, both P-values > 0.8). Borowa (1986) found that Walleye received 35.4% of angler effort, were 20.2% of the fish caught, and 27.6% of the fish harvested. Comparably, Yow et al. (2019) found that, over the two survey years, Walleye received 36.7% and 35.5% of the angling effort, were 19.3% and 16.8% of the fish caught, and 29.5% and 31.7% of the fish harvested.

Compared to other sport fishes, the relative percentages of Walleye effort, catch, and harvest were similar between Yow et al. (2019) and Borowa (1986); however, the total effort directed towards Walleye and the number harvested increased dramatically between the surveys. Borowa (1986) estimated that Walleye received 26,238 angler-h of effort over 14-months, whereas Yow et al. (2019) calculated that the total effort was 77,113 and 80,401 angler-h over the two survey years. The more recent estimates by Yow et al. (2019) were 2.9 and 3.0 times higher and significantly different from the previous survey (*Z*-tests, both $z > 3.0$, both P-values < 0.003). Correspondingly, Walleye harvest increased by a similar factor between the two surveys. Borowa (1986) estimated that 4,857 Walleye were harvested during his survey, whereas Yow et al. (2019) estimated 15,767 and 15,733. Similar to the trend in effort, the harvest estimates by Yow et al. (2019) were 3.2 times higher and both of estimates were significantly different from the previous survey (*Z*-tests, both $z > 3.0$, both P-values < 0.003).

The higher harvest rate in the most recent survey (Yow et al. 2019) coincides with and is likely a product of the approximately tripled angler-effort. The duration differences in the surveys makes comparisons somewhat tenuous; however, considering that Borowa's (1986) effort and harvest estimates were much lower despite being inflated by an extra two survey months, the actual increase in angler-effort and harvest between the surveys is likely ≥400%.

Recent changes to the Lake Fontana fish community.—Two major changes to the fish community in Lake Fontana in recent decades may have negative consequences for the Walleye population size. First, Spotted Bass *Micropterus punctulatus* (or possibly *Micropterus henshalli*) were initially collected in the reservoir by Tennessee Valley Authority (TVA) in 1998 (Dycus et al. 1999). Since then, the population has steadily increased and is displacing Smallmouth Bass (unpublished data). Previously, Smallmouth Bass were the most common black bass in most Lake Fontana surveys, and had nearly displaced Largemouth Bass in the early 1980s (Borowa 1986). Spotted Bass fill a different ecological niche than the historical black bass community. Whereas Largemouth Bass and Smallmouth Bass often occupy the littoral and benthic zones respectively, Spotted Bass are commonly encountered in the limnetic zone where they prey on limnetic forage fish such as clupeids. As a result, their ecological niche is more similar to Walleye which may encourage competition between the species.

In addition to changes in the black bass community, the forage fish community recently changed also. Gizzard Shad *Dorosoma cepedianum* were stocked and established into the reservoir before the earliest existing fish survey (Chance 1953) and Threadfin Shad *Dorosoma petenense* were introduced 1963 (B. Tatum, 1963 memorandum to G. E. Hall, NCWRC, on recent fish stockings in TVA reservoirs). These two species comprised the forage fish community until Blueback Herring *Alosa aestivalis* invaded the reservoir. The Blueback Herring population expanded quickly following their first collection in spring 2016 and by fall 2017 they were common in gill-net collections (unpublished data). River herring *Alosa* spp. invasions are commonly associated with Walleye recruitment problems in other North Carolina reservoirs including Lake James (Wood et al. 2018), Lake Hiwassee (Wheeler et al. 2004a), and Lake Chatuge (Wheeler and Bushon 2019). Although the mechanism by which river herring reduce sport fish recruitment is unknown, suggested possibilities include larval fish predation (Irwin-Larrimore 1989), egg predation (Wheeler et al. 2004b), induced nutrient deficiencies (Vandergoot et al. 2001), and competition between river herring and juvenile sport fish for prey items.

Recent pool elevation changes to Lake Fontana.—In addition to the recent fish community changes, a series of water-level management changes by TVA has created a more stable pool elevation. From 1933 to 1991, TVA managed their reservoir system primarily for flood control and navigation (TVA 1990; Higgins and Brock 1999) and maintained a very low pool elevation in winter months to increase its capacity to capture spring floods and control downstream flows. During this time Chance (1953), Louder and Baker (1966), TVA and NCWRC (1962), and TVA (1990) described the average annual winter drawdown as 39.0–40.2 m below normal summer pool elevation (518.8 m above mean sea level). TVA began to reconsider their operating priorities in 1987 (TVA 1990) and in 1991 implemented changes to improve water quality below hydropower dams for aquatic life and to maintain more stable pool elevations for recreation (Higgins and Brock 1999). Following these changes, the winter drawdown was reduced to a median of 19.2 m below the normal full pool, the reservoir filled faster after mid-March to reach normal full pool on Memorial Day, and the reservoir was maintained at full pool until August 1 when it dropped more slowly into the winter drawdown period (described in the base alternative in TVA 2004a). Finally, further changes were implemented in 2004 when TVA adopted their Environmental Impact Statement preferred alternative (TVA 2004b), further stabilizing the pool by increasing the water levels during the drawdown period (Labor Day–mid-March) by an additional 2.7–3.4 m (TVA 2004a).

Recent Walleye recruitment problems in North Carolina reservoirs.—Natural reproduction sustained North Carolina Walleye populations from their initial stockings until the past couple decades; however, many of these populations have declined in recent years. Lake James (Wood et al. 2018), Lake Hiwassee (Wheeler et al. 2004a), and Lake Chatuge (Wheeler and Bushon 2019) all experienced Walleye recruitment failures within a few years after river herring invasions. Conversely, Lake Glenville was inhabited by Blueback Herring since at least 1999 and Walleye continued consistent recruitment until 2004, when recruitment abruptly ceased (Wheeler and Bushon 2018a). Finally, anglers also believe that the Walleye fishery on Lake Santeetlah has declined, but no river herring have been collected there (Wheeler and Bushon 2018c) despite annual searches.

Annual fingerling Walleye stockings have successfully compensated for poor and failed recruitment in several North Carolina reservoirs including: Lake Hiwassee (Bushon et al. 2009; Wheeler and Bushon 2018b), Lake Glenville (Wheeler and Bushon 2018a), Lake James (Wood et al. 2018), and Lake Chatuge (Wheeler and Bushon 2019). However, stocking made no substantial contribution in Lake James before there was a Walleye recruitment problem (Besler 2004) and has not helped Lake Santeetlah (Wheeler and Bushon 2018c).

The goal of this research is to increase the Walleye population size in Lake Fontana and our objective is to determine if stocked fingerling Walleye can recruit to adulthood (age ≥ 1) and make a substantial contribution to the adult population size.

Methods

Culture, marking, and stocking.—In 2016, we began an experimental annual stocking of fingerling Walleye in Lake Fontana. Our target stocking quantity is 50,000 which is a similar rate (13/ha) to Walleye stocking in other North Carolina reservoirs (NCWRC 2018). Each March, Walleye broodstock were collected with boat-mounted electrofishing equipment from Lake James tributaries and transported to Table Rock State Fish Hatchery in Morganton, North Carolina. Walleye were strip-spawned at the hatchery and the fertilized eggs were transferred to hatching jars. After hatching, the fry were moved to outdoor ponds and reared to 25–38 mm TL. Walleye fingerlings were then harvested and kept in indoor tanks where they were marked by immersion for 6 h in a solution of 500 mg/L OTC, 1,000 mg/L of sodium chloride, and tris for pH buffering. Within three days of harvesting, the marked Walleye were released upstream of the reservoir into the Little Tennessee River on the Needmore Game Land at the Sawmill Creek Access Area (Bushon and Wheeler 2008; Figure 1). We chose to stock all the fish in the Little Tennessee Arm because stocking upstream in the primary spawning tributary was successful on Lake Hiwassee (Bushon et al. 2009) and the Little Tennessee River was considered the primary spawning ground by Baker (1966).

Fish Sampling.—We used gill-net surveys in October 2004–2007, 2010, 2012, and 2015–2018 to sample the Walleye population in Lake Fontana. The gill net dimensions were 2.4 x 76.3 m and consisted of consecutive, equal-length panels of 25-, 32-, 38-, 44-, and 51-mm bar mesh. The nearshore end (small or large mesh) was randomly selected and the nets were set perpendicular to the shore on points at 12 sites (Table 1; Figure 1) for one 24-h period. The sites were spread throughout the Little Tennessee River arm of the reservoir and selected to avoid gill net hazards such as submerged trees and private boat docks. All captured sport fishes, including Walleye, were bagged by site, placed on ice, and transported to the lab where they were measured for TL (mm), weighed (g), and sexed within 24 h. Sagittal otoliths were removed, placed in individually coded plastic vials, and stored in the dark.

Age estimation and mark verification.—Walleye ages were estimated by counting otolith annuli with a compound microscope. If the otoliths were ≤ age-1, they were aged intact (without breaking or sectioning), whereas older otoliths were aged after removing two, 0.5-mm sections of the focus using a Buehler Isomet low-speed diamond wheel saw. Two readers evaluated the otoliths independently and then assigned ages after disagreements were discussed and resolved.

After aging, the otoliths were checked for OTC marks under a compound microscope with transmitted epiflourescent light. Sectioned otoliths were placed on a glass microscope slide and checked for OTC marks on both sides of the two, 0.5-mm sections. The foci of intact otoliths were exposed by attaching them to microscope slides with cyanoacrylate glue and wet-grinding with 800-grit sandpaper.

Data analysis.—We calculated Walleye relative weight (W_r) according to Murphy et al. (1990). The percentage of stocked Walleye in our samples was used as an estimate of the percentage of stocked Walleye in the entire reservoir, and the Clopper and Pearson (1934) exact binomial method (R Core Team 2019) estimated 95% CIs. Walleye typically do not fully recruit to our gill nets until age-1; therefore, we use age-1 CPUE (Walleye/net-night) to index recruitment. We modeled the CPUE of Walleye 2000–2005 year-classes through time with an ANCOVA. The

ANCOVA model allowed us to back-calculate the year-class strength (as age-1 CPUE) for some year-classes that pre-dated the start of our gill-net collections in 2004.

Results

We intended to stock 50,000 fingerling-sized Walleye annually. However, juvenile fish production in outdoor ponds is inherently difficult to predict and control, and although we stocked 50,000 in 2016 and 2017, we could only stock 28,868 in 2018 (Table 2).

The gill-net samples collected 1,121 Walleye during this investigation from 120 net-nights of effort (Table 3). The CPUE (Walleye/net-night) ranged from 21.5 to 4.8. We assigned ages, and therefore year-classes, to 1,117 of the Walleye. The year-classes represented in our samples ranged 1995–2017. Although, Walleye were fully recruited to our gill nets at age-1, we also collected 104 age-0.

There was a strong linear relationship between the $\log_e$ age-1 Walleye CPUE and the sample year for the 2000–2005 year-classes (Figure 2). An ANCOVA of the relationship (Table 4) was highly significant ($F_{9,8}$=12, *P*-value=0.0009) and explained 93.1% of the variation in CPUE. This relatively precise ANCOVA model allowed us to back-calculate the year-class strength (as age-1 CPUE) of the 2000–2002 year-classes which pre-dated the beginning of our sampling in 2004 (Figure 3).

Overall (all age-classes) Walleye CPUE and age-1 CPUE declined substantially throughout our samples (Table 3; Figure 3). In our first year of sampling (2004) the overall Walleye CPUE was 21.5. The overall CPUE declined in the 2005–2007 samples and has stabilized in the range of 4.8–8.3 since 2010 (Figure 3). This new overall CPUE range is 70% lower than the 2004 sample. The back-calculated estimates of age-1 CPUE, show a strong 2002 year-class followed by an exceptionally strong 2001 year-class (Figure 3). We estimated these year-classes would have produced an age-1 CPUE of 9.7 and 20.8 respectively. These year-classes likely increased the overall Walleye population for several years and, at least initially, masked the overall decline in Walleye reproduction from anglers. From 2004 to 2007, the age-1 CPUE dropped from 7.5 to 2.1 and has remained <2.0 all the following years (Figure 3; Table 3).

The mean W_r of North Carolina Walleye populations typically range 80–95. Lake Fontana Walleye were near the bottom of the range throughout our sampling (Table 3); however, there was no clear increasing or decreasing trend across years.

Our samples included 14 Walleye from the stocked year-classes (2016–2018) and 42.9% of these were verified as stocked by the presence of OTC marks. Walleye were collected from both stocked year-classes (2016 and 2017) that had recruited to age-1 (Table 5; Figure 4).

Discussion

From 2004–2007, the Walleye population size in Lake Fontana declined dramatically. Although the population has stabilized since 2010, it has been reduced by about 70% from 2004. The decline appears to result from diminishing recruitment to age-1 since 2002 and continued poor recruitment is preventing a population recovery. The low percentage of age-1 fish in our samples is a clear indicator that the Walleye population is suffering from a decline in recruitment rather than overfishing.

Unfortunately, we do not have comparable sampling data before 2004, which makes it difficult to understand historical Walleye population trends in Lake Fontana. Due this uncertainty, it is possible that the 2002–2004 Walleye population size was unusually high and anglers responded by quickly increasing their effort to exploit the newly-abundant resource. Effort may have remained very high while Yow et al. (2019) surveyed anglers 2006–2008, although the population was already beginning to decline. However, we believe that this is an unlikely scenario because it contradicts accounts of anglers and because the three-fold increase in Walleye effort between Borowa (1986) and Yow et al. (2019) was similar to effort increases for other species. Therefore, rather than a new pulse of angler effort suddenly focused on Walleye, we believe that the overall effort in the reservoir progressively tripled between angler surveys while the fisheries for the individual species, including Walleye, scaled accordingly,

The cause of the poor Walleye recruitment is unclear. Although river herring are commonly associated with Walleye recruitment problems, they were not collected in Lake Fontana until 2016, 12 years after the decline began in 2004. It is possible that Blueback Herring arrived some time before we collected them; however, Blueback Herring populate new reservoirs quickly, and we believe that it is unlikely they were present in the reservoir earlier than 2014. However, even if Blueback Herring are not responsible for the Walleye decline, their presence in the fish community may impede our recovery efforts.

In contrast to the asynchronous arrival of Blueback Herring, 2004 does coincide with the implementation of a new annual pool level regime for Lake Fontana. TVA's new management strategy (TVA 2004a, 2004b) continues the trend of further stabilizing year-round water levels by reducing the winter drawdowns and more quickly filling the reservoir to normal summer pool levels in the spring. Generally, the NCWRC advocates for stable reservoir water levels, especially during the spring, because fluctuating water levels can desiccate or disrupt the spawning of nest-building sport fishes such as black basses and other centrarchids. The new water levels may have harmed Walleye recruitment by exposing the spawning run to a movement barrier on the Little Tennessee River. For example, below the Needmore Game Land there is a narrow point in the river with a feature that may impede fish passage until the reservoir water level submerges it. Alternatively, a more rapidly rising lake level could inundate spawning areas after spawning has occurred and expose eggs and larval fish to disadvantageous lacustrine conditions.

Despite the coincidental timing, we believe that recent changes to the water level regime are an unlikely cause of poor Walleye recruitment. The spawning behavior of Walleye is well-adapted to erratic river conditions. For example, the timing of the spawning run varies across years and is often protracted over several weeks (D. Goodfred, personal communication, NCWRC) and this behavioral variation likely helps ensure that their spawning effort cannot be decimated by environmental variation year after year. Regardless of TVA's intention and commitment to more stable water level regimes, there is still considerable annual variation in river flows, and thus reservoir levels, due to precipitation events. We believe that, considering the great annual variability in both Walleye behavior and reservoir and river conditions, it is unlikely that the relatively minor pool level adjustment which began in 2004 could so effectively diminish the Walleye spawning run for so many consecutive years. Finally, if the spawning run of Walleye did encounter a migration barrier, it is likely that local anglers would have discovered it and targeted the stalled Walleye, but they have not.

We are concerned about the expansion of the Spotted Bass population. Overlaps in habitat and prey species, make adult Walleye and adult Spotted Bass likely competitors. Competition for forage would likely be indicated by declining W_r values for Walleye. However, the W_r values have remained stable, albeit relatively low, as the Spotted Bass population has increased.

Although some of the stocked Walleye are surviving and recruiting, their contribution is too low to restore the population to 2004 levels. Therefore, we propose doubling the stocking rate to 100,000 beginning in 2019. In addition, a recent experiment on Lake James found that stocking location can influence the recruitment of fingerling Walleye (Wood et al. 2018). Specifically, fish stocked in the deeper and less productive side of the reservoir (Linville River) outperformed the more productive and shallow side (Catawba River). Therefore, we propose moving the stocking location farther down the reservoir to Lemmons Branch Boating Access Area and evaluating if that change improves recruitment and contribution of the stocked fingerlings.

Management Recommendations

1.) Continue annual fingerling Walleye stocking but increase the number stocked to 100,000 and move the stocking location to Lemmons Branch Boat Access Area.

2.) Continue annual fall gill-net sampling until 2023 and then re-evaluate the Walleye stocking program.

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TABLE 1.—The GPS coordinates of the 12 sites used to collect Walleye in gill nets from the Little Tennessee River arm of Lake Fontana 2004–2018.

	GPS Coordinates	
Site	longitude	latitude
1	35.379674	-83.552668
2	35.395210	-83.564828
3	35.407870	-83.553036
4	35.430314	-83.569782
5	35.382807	-83.544352
6	35.383022	-83.552668
7	35.396540	-83.569986
8	35.399501	-83.557669
9	35.410101	-83.560144
10	35.405209	-83.556090
11	35.424177	-83.567358
12	35.436752	-83.579948

TABLE 2.—The stocking date and quantity of Walleye stocked in Lake Fontana. In 2018 Lake Fontana was stocked on two separate days and the combined total number stocked is reported.

Stocking date	*N*
4/28/2016	50,000
4/27/2017	58,000
5/2 & 5/10/2018	28,868

TABLE 3.—Walleye collected with gill nets from Lake Fontana 2004–2018. Mean values for catch rates (CPUE; Walleye/net-night) and other sample statistics (age, TL, weight, and W_r) are reported. Standard deviations are reported parenthetically.

		CPUE					
Year	*N*	All ages	Age-1	Age	TL (mm)	Weight (g)	W_r
2004	258	21.5 (12.2)	7.5 (5.2)	2.1 (1.7)	368 (58)	489 (189)	83 (9.6)
2005	191	15.9 (7.9)	4.3 (4.0)	2.1 (1.7)	362 (66)	425 (188)	82 (7.3)
2006	110	9.2 (8.8)	2.5 (3.3)	2.3 (1.8)	373 (60)	485 (210)	88 (24.3)
2007	102	8.5 (8.0)	2.1 (3.3)	3.1 (2.2)	375 (56)	436 (162)	79 (15.7)
2010	69	5.8 (3.6)	0.8 (1.2)	2.9 (2.2)	370 (62)	464 (207)	83 (7.7)
2012	99	8.3 (4.8)	0.8 (1.1)	2.4 (1.2)	368 (40)	421 (127)	81 (8.3)
2015	77	6.4 (4.4)	1.4 (1.8)	3.8 (2.6)	402 (42)	529 (166)	77 (7.9)
2016	58	4.8 (4.8)	1.4 (2.1)	2.8 (2.4)	377 (53)	459 (173)	80 (6.5)
2017	70	5.8 (4.1)	0.3 (0.5)	3.4 (2.0)	404 (52)	578 (187)	83 (18.9)
2018	87	7.3 (6.4)	0.3 (0.5)	5.0 (2.3)	433 (36)	753 (209)	86 (6.1)

TABLE 4.—The results of an ANCOVA characterizing the relationship between $\log_e$ CPUE (Walleye/net-night) for the 2000–2005 year-classes from 2004–2007 gill-net collections.

Effect	Type III SS	Df	*F*	*P*
Intercept	0.522	1	2.65	0.142
Year-class	0.781	4	0.99	0.464
Age	1.020	1	5.18	0.052
Year-class * Age	1.635	4	2.08	0.176
Residuals	1.575	8		

TABLE 5.—The quantity and percent of OTC-marked Walleye collected from Lake Fontana 2016–2018. This table only includes fish that could be both aged and checked for OTC marks. Ninety-five percent CIs about the marked percentage are reported parenthetically.

	Age					
	0		1		2	
Year	*N*	% Marked	*N*	% Marked	*N*	% Marked
2016	0	—		—		—
2017	4	50 (7–93)	2	50 (1–99)		—
2018	0	—	1	100 (0–100)	7	29 (3–71)

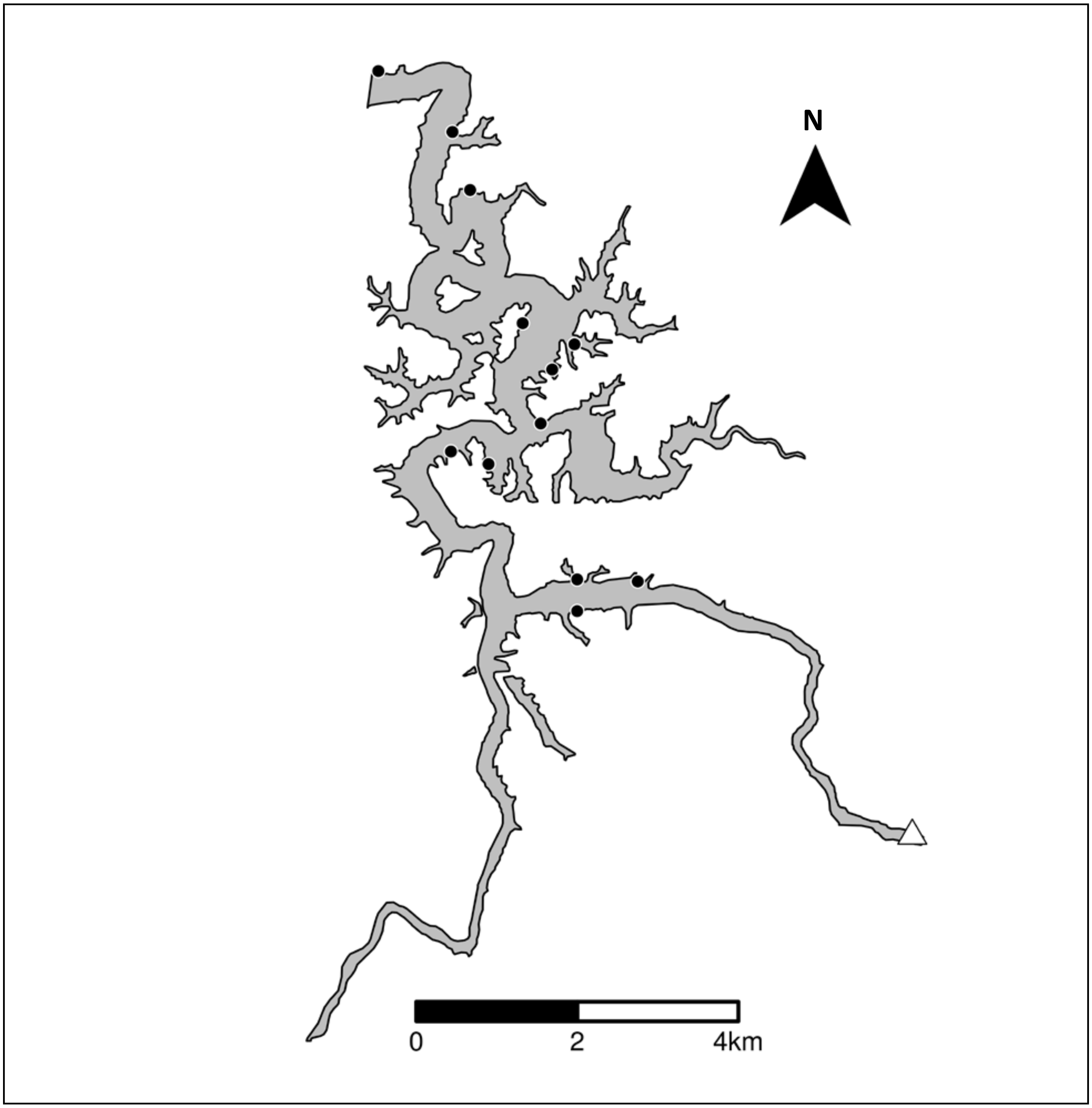

FIGURE 1.—Map of the Little Tennessee River arm of Lake Fontana, Swain County, North Carolina. The dots represent the 12 gill net locations used for Walleye collections in this study (2004–2018). The triangle represents the stocking point on the Little Tennessee River at Sawmill Creek Access Area on the Needmore Game Land.

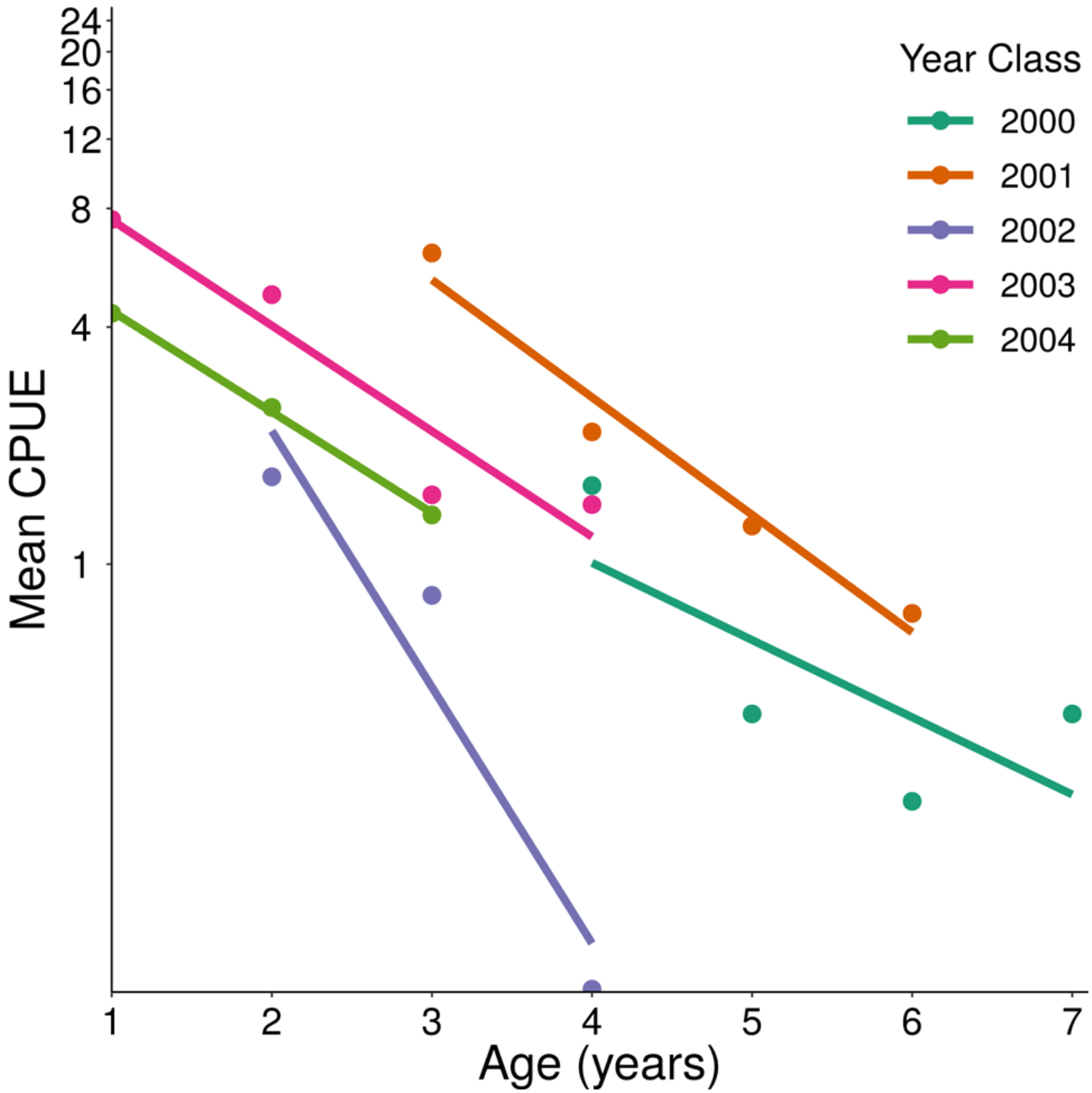

FIGURE 2.—The relationships between age and $\log_e$ CPUE (Walleye/net-night) for the 2000–2004 Walleye year-classes from 2004–2007 gill-net samples from Lake Fontana.

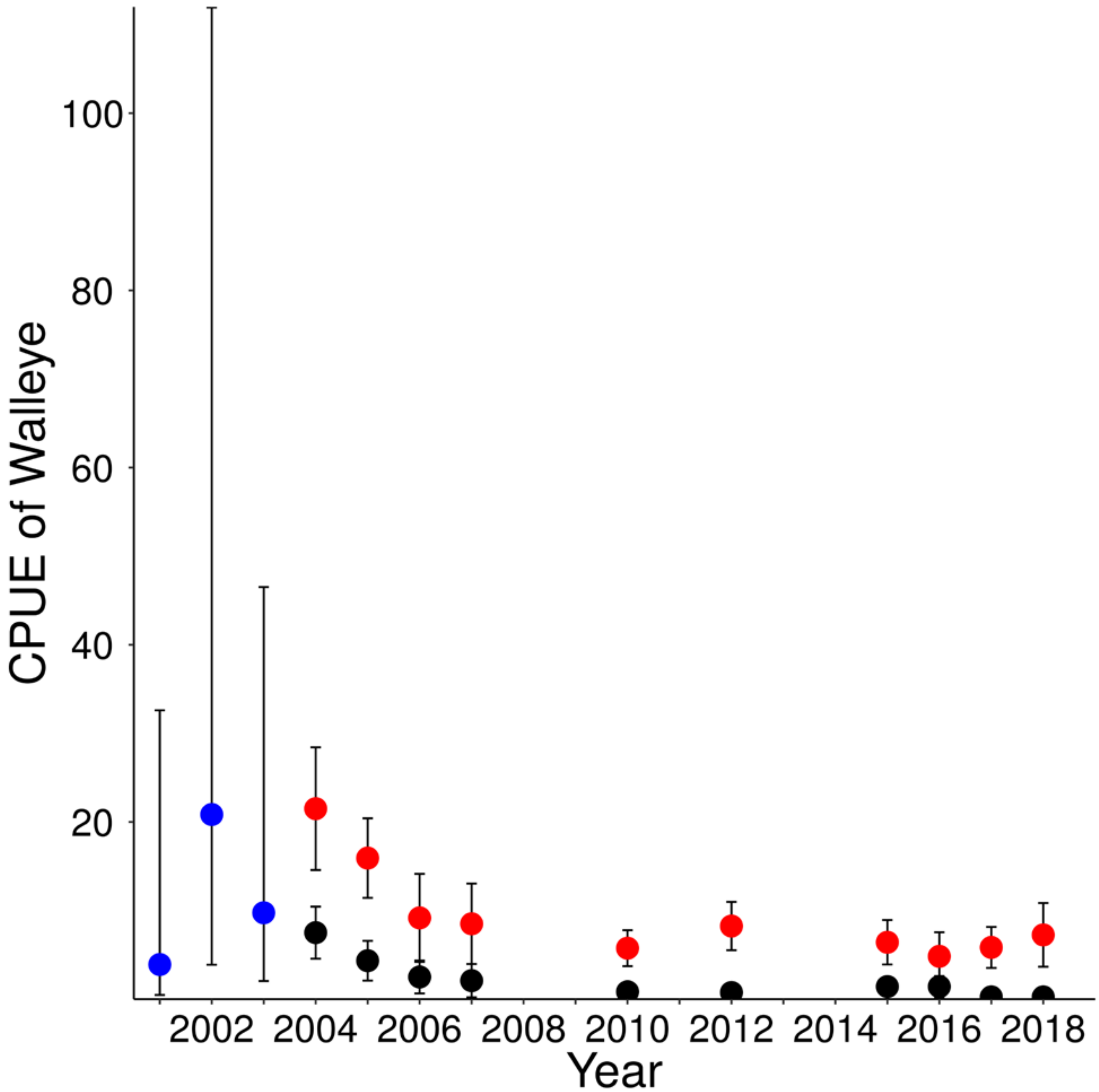

FIGURE 3.—CPUE of Walleye (Walleye/net-night) collected with gill nets from Lake Fontana 2004–2018. The CPUE of Walleye of all age classes (red dots) and age-1 Walleye (black dots) has declined. The CPUE of Age-1 Walleye in years prior to the beginning of sampling (blue dots) were estimated with an ANCOVA model. The error bars represent 95% CIs.

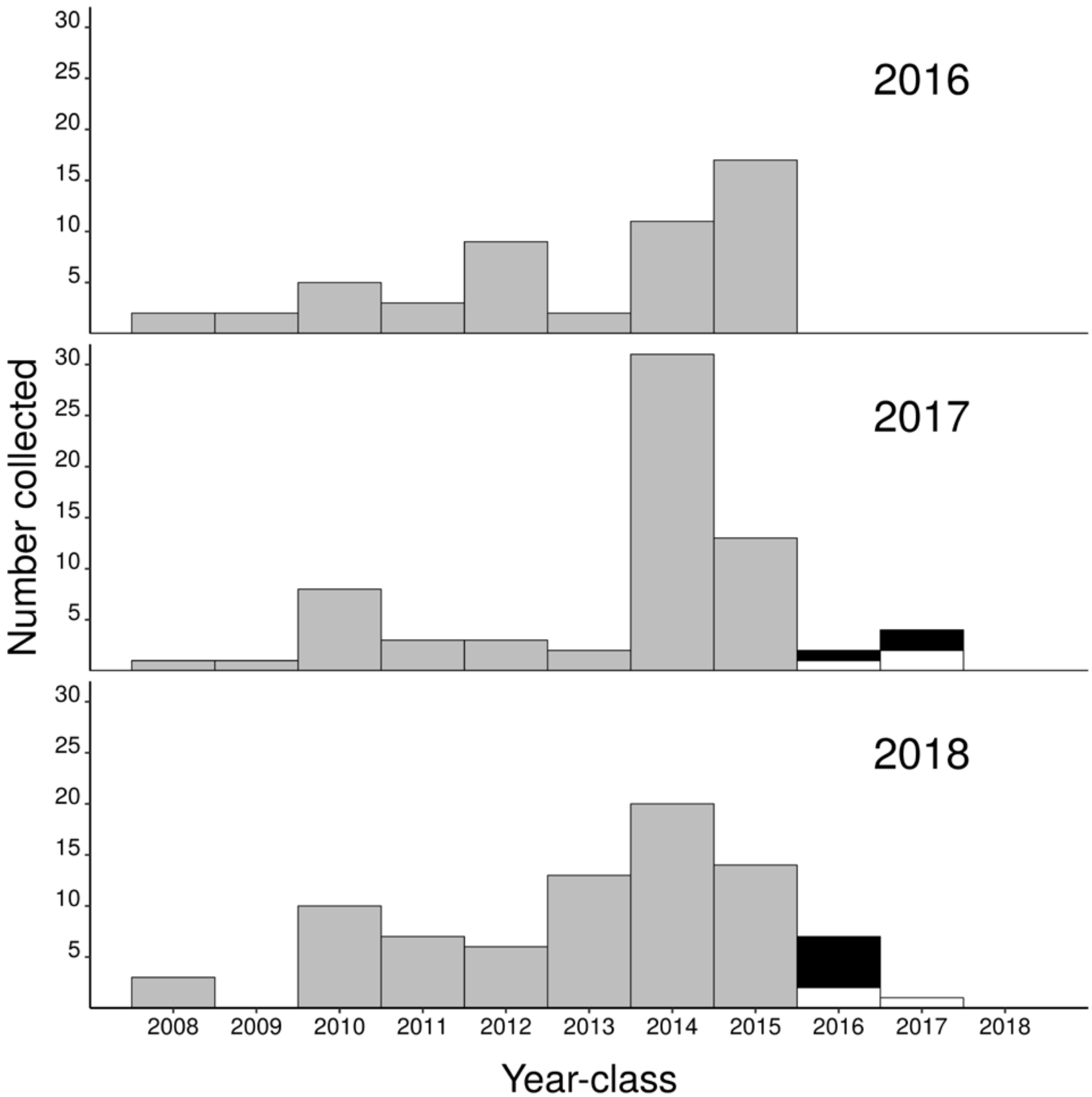

FIGURE 4.—Frequency distributions of Walleye year-classes collected 2016–2018. Walleye from stocked year-classes (≥2016) were checked for OTC marks. White shading represents OTC-marked Walleye and black shading represents unmarked Walleye. Grey shading represents older, unmarked year-classes.