Fisheries Resources of Lake Waccamaw

Federal Aid in Sport Fish Restoration
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Abstract. Lake Waccamaw, the largest Carolina Bay in North Carolina, has been surveyed extensively since 1940. Lake Waccamaw's fishery resources are unique compared to other Carolina Bays, including White Perch *Morone americana*, which are uncommon in other lakes in the region, and several endemic species. Additionally, two aquatic nuisance species, *Hydrilla verticillata* and Flathead Catfish *Pylodictus olivaris*, have been introduced in Lake Waccamaw in the last decade. To ensure the continued viability of Lake Waccamaw's fisheries resources, a survey was conducted in fall 2020 using boat electrofishing, experimental gill nets, and mini-fyke nets. We encountered 1,380 individuals of 22 species, approximately half of which were inland game fish. Florida Bass *Micropterus floridanus* genetics were highly prevalent in the black bass population, the mortality rate was relatively low (Z = 0.38) and an age-9 individual was the oldest encountered. White Perch was the most common inland game fish and would not have been adequately assessed solely using boat electrofishing. Periodic surveys should be conducted to monitor the unique fishery resources of Lake Waccamaw.

Lake Waccamaw is the largest Carolina Bay and has been subject to numerous fisheries investigations. Harrelson (1932) documented considerable harvest fisheries for catfish and White Perch *Morone americana*. Several comprehensive surveys were conducted thereafter, including Frey (1951), Louder (1961), and Shute et al. (1981). Many other surveys (e.g., Hubbs and Raney 1946, Lindquist and Yarbrough 1980, Heise and Jones 2014) have focused on the lake's numerous endemic species, including Waccamaw Darter *Etheostoma perlongum* (Federal Species of Concern; FSC), Waccamaw Killifish *Fundulus waccamensis* (FSC), and Waccamaw Silverside *Menidia extensa* (Federal Threatened; NCWRC 2021).

Hydrilla verticillata was discovered in Lake Waccamaw in 2012 and was subject to a multiyear chemical treatment program for control and eradication (Heise and Jones 2014). The last chemical treatment was conducted in 2019 following two years of *Hydrilla* nondetections in vegetation surveys (Heilman 2017; NCSU 2018). Another aquatic nuisance species, Flathead Catfish *Pylodictus olivaris*, was first collected in 2014 (Heise and Jones 2014; NCSM 2022).

Lake Waccamaw's popularity as a fishing destination and the occurrence of aquatic nuisance species issues since 2012 necessitated an updated sport fish survey. The objectives of this survey were to evaluate the abundance and size structure of inland game fish and compare species occurrence with previous surveys.

Methods

Study site. Lake Waccamaw is a 3,618-ha Carolina Bay located in Columbus County, North Carolina (Figure 1). Similar to other bay lakes, the maximum depth is 3.7 meters (Frey 1949); however, Lake Waccamaw has unique water chemistry characteristics due to exposed calcareous deposits along the north shore of the lake (Frey 1949; Stager and Cahoon 1987). The lake has several feeder streams, although most input is from Big Creek along the northeast shore. A concrete spillway constructed in 1941 at the lake's outlet is the origin of the Waccamaw River. Formerly mesotrophic, the lake is currently classified as eutrophic by the NC Division of Water Resources (NC DEQ Intensive Survey Branch 2018). Along with other large Carolina Bays in southeastern NC, Lake Waccamaw is a state lake managed by the NC Division of Natural and Cultural Resources. The state of North Carolina owns approximately 3,200 ha of land surrounding Lake Waccamaw (Columbus County parcel data). Land use in the 31,162-ha Lake Waccamaw watershed is 31% forest, 25% wetland, 18% shrub/scrub and grassland, 12% open water, 11% row crops, and 3% developed (USDA 2021).

Fish sampling. A generalized-random tessellation stratified (GRTS) survey design, created using package {spsurvey} (Kincaid et al. 2019) in R, was used to select 12 sample sites for boat electrofishing (Smith Root 7.5 GPP; 120-Hz; 4,500–5,500 W), 12 sample sites for experimental gill nets (Miranda and Boxrucker 2009), and 6 sample sites for mini-fyke nets (Bonvechio et al. 2014). Sample sites were selected using non-uniform site selection probabilities for the boat electrofishing and mini-fyke net sites and uniform site selection probabilities for the gill net sites because they were less associated with shoreline areas. Shoreline development was the primary site selection factor; 50–66% of sites were selected in areas with developed shorelines and the rest were in areas with undeveloped shorelines.

Boat electrofishing was conducted for 10 minutes of electrofishing effort at each site with the boat oriented perpendicular to the shoreline or perpendicular to pier structures extending into the lake. All fish were collected as they were encountered by one dip netter using 4-mm net mesh. Gill nets and mini-fyke nets were set perpendicular to shore no earlier than 3 hours before sunset and were retrieved the next day. Mini-fyke net leads were extended onto the shoreline where possible. A YSI Pro2020 meter measured dissolved oxygen concentration (mg/L) and saturation (%), conductivity (µS/cm), salinity (g/L), and temperature (°C).

Collected fish were enumerated and up to 100 individuals of each species (or more for abundant inland game fish) were measured for total length (TL; mm) and weighed (g). Otoliths were removed from Largemouth Bass *Micropterus salmoides* for age estimation. Otoliths were aged independently by two experienced readers using a stereomicroscope. Disagreements were resolved using a concert read. Package {RFishBC} (Ogle 2019) was used by one reader to assess the distance between the origin and each annulus to enable estimation of back-calculated length-at-age using the Dahl-Lea model (Lea 1910; Vigliola and Meekan 2009; Quist and Isermann 2017). A partial pelvic fin clip was taken from 50 Largemouth Bass and preserved in 95% ethyl alcohol for genetic analysis to assess the contribution of *M. salmoides* and *M. floridanus* alleles to the population (Taylor et al. 2019).

Relative abundance was indexed as catch-per-unit effort (CPUE) for each sampling gear (boat electrofishing = fish/hour; gill net and mini-fyke net = fish/net night). Length frequency distributions were analyzed using density plots for species with at least 30 length measurements. Boxplots were used to describe Largemouth Bass age frequency. Largemouth Bass instantaneous total mortality was estimated using a Poisson generalized linear model (Nelson 2019). Catch of each species was compared to previous surveys. Data analyses were conducted using R 4.0.3 (R Core Team 2020), RStudio (version 1.2.5033; RStudio Team 2020), and Microsoft Excel (Version 2206 Build 16.0.15330.20246).

Results

Sampling at Lake Waccamaw in fall 2020 resulted in the collection of 1,380 individual fish representing 22 species. The length frequency distribution for several species of interest by gear is shown in Figure 2.

Boat electrofishing collected 926 individuals of 17 species (Table 2). Inland game fish accounted for 20% of the catch, comprising 189 individuals of 8 species. The most common species of inland game fish captured was Yellow Perch *Perca flavescens* (*n* = 68). Nongame fish accounted for 80% of the catch, with 737 individuals of 9 species captured. The most common species of nongame fish captured was Coastal Shiner *Notropis petersoni* (*n* = 538).

Experimental gill nets collected 392 individuals of 11 species (Table 3). Inland game fish accounted for 70% of the captures, comprising of 276 individuals of 7 species. The most common species of inland game fish captured was White Perch *Morone americana* (*n* = 239). Nongame fish accounted for 30% of the captures, with 116 individuals of 4 species captured. The most common species of nongame fish captured was Gizzard Shad *Dorosoma cepedianum* (*n* = 64).

Mini-fyke nets collected 62 individuals of 10 species (Table 4). Inland game fish accounted for 66% of captures, with 41 individuals representing 4 species. Of those individuals, 13 were *Lepomis* spp. that could not be identified to the species level. The most common species of inland game fish captured was Bluegill *Lepomis macrochirus* (*n* = 19). Nongame fish accounted for 34% of the captures, with 21 individuals of 6 species captured. The most common species of nongame fish captured was Coastal Shiner (n = 7).

Mean (SE) Largemouth Bass CPUE using boat electrofishing was 18.2 (6.2) fish/h (Figure 3). Largemouth Bass CPUE using gill nets was 0.4 (0.3) fish/net night. No Largemouth Bass were collected using mini-fyke nets. Overall, 42 individuals were captured; additional boat electrofishing effort was expended to ensure that fin clips were collected from 50 individual Largemouth Bass. Genetic analysis indicates the Largemouth Bass population contains a high percentage of Florida Bass genetics, with a mean Florida Bass allele frequency of 91% (greater than 95% is considered pure Florida Bass). Based on 50 fin clips, 4 pure (>95%) Florida Bass and no pure Largemouth Bass were present in the sample; further, all Largemouth Bass analyzed had at least 71% Florida Bass alleles.

Otoliths were aged from 39 Largemouth Bass and back-calculated length at age was estimated for the 24 individuals older than age 0. Data from the 39 aged Largemouth Bass indicated an instantaneous (Z) total mortality rate (SE) of 0.38 (0.09). Several age classes were represented, and the standard error of the instantaneous mortality rate suggested the sample size was adequate to approximate the scale of total mortality. Nevertheless, caution should be used with this estimate due to the low sample size. Estimated growth was relatively rapid for Largemouth Bass, with a mean back-calculated length of 191 mm at age-1 for the 24 age-1 and older individuals (Table 5). Back-calculated lengths at age for all individuals are shown together in Figure 5.

Four species of sunfish, including Bluegill, Pumpkinseed *L. gibbosus*, Redear Sunfish *L. microlophus*, and Banded Sunfish *Enneacanthus obesus*, were captured in the survey. Bluegill CPUE was 12.3 (6.4) fish/h using electrofishing (Figure 3), 0.08 fish/net night (only one was captured) using gill nets, and 3.2 (1.7) fish/net night using mini-fyke nets. Pumpkinseed CPUE was 16.3 (5.4) fish/h using electrofishing (Figure 3), 1.4 (0.4) fish/net night using gill nets, and 1.2 (0.6) fish/net night using mini-fyke nets. Redear Sunfish CPUE was 6.9 (3.0) fish/h using electrofishing (Figure 3) and 0.2 fish/net night (only one was captured) using mini-fyke nets. One Banded Sunfish (0.2 fish/net night) was captured using mini-fyke nets.

Three species of catfish, including Brown Bullhead *Ameiurus nebulosus*, White Catfish *A. catus*, and Channel Catfish *Ictalurus punctatus*, were collected. One Brown Bullhead (0.5 fish/h) was captured using electrofishing, while nine White Catfish (0.75 (0.3) fish/net night) and nine Channel Catfish (0.75 (0.2) fish/net night) were captured using gill nets.

Yellow Perch and White Perch were collected using electrofishing and gill nets. One Yellow Perch (0.08 fish/net night) was captured using gill nets, while 68 (33.7 (6.4) fish/h) using electrofishing. Eight White Perch (4.0 (3.5) fish/h) were captured using electrofishing, while 239 (19.9 (2.26) fish/net night) were captured using gill nets.

All three fish species endemic to Lake Waccamaw—Waccamaw Darter *Etheostoma perlongum* (NC Threatened), Waccamaw Killifish *Fundulus waccamensis* (NC Species of Special Concern), and Waccamaw Silverside *Menidia extensa* (Federally threatened) —were encountered. All three species were encountered using boat electrofishing (185 Waccamaw Silversides, 3 Waccamaw Killifish, and 2 Waccamaw Darters) and mini-fyke nets (6 Waccamaw Silversides, 3 Waccamaw Killifish and 1 Waccamaw Darter).

Discussion

Lake Waccamaw has a high species diversity including several endemic species that are threatened or of special concern. With the use of boat electrofishing, gill nets, and mini-fyke nets, 22 species of fish were observed. Since 1947, approximately 44 species of fish have been reported from Lake Waccamaw (Table 6) and its associated canals and feeder streams. Our sampling efforts highlight the need for multiple sampling gears, as different gears captured different fish species (Tables 2, 3, and 4). Electrofishing did capture 17 of the 22 species we encountered.

A couple of notable species were absent from the survey. Redbreast Sunfish *Lepomis auritus* or Tadpole Madtom *Noturus gyrinus* were not observed. Lake Waccamaw Broadtail Madtom *Noturus* sp. or Banded Pygmy Sunfish *Elassoma zonatum*, were also not observed. Lake Waccamaw Broadtail Madtom have been encountered within the past few decades, last being observed in 2019 after not being observed since 2002 (Shute et al. 2000; NCSM 2022; B. Jones, North Carolina Wildlife Resources Commission (NCWRC) Inland Fisheries Division, Aquatic Wildlife Diversity Section, personal communication). Banded Pygmy Sunfish have not been observed recently in Lake Waccamaw (the most recent North Carolina Museum of Natural Sciences record is from 2008; NCSM 2022); however, sampling does not typically occur in the thick vegetation where Banded Pygmy Sunfish reside (B. Jones, NCWRC Inland Fisheries Division, Aquatic Wildlife Diversity Section, personal communication). Many species were only represented by a few individuals.

Largemouth Bass CPUE at Lake Waccamaw in 2020 (18.2 fish/h) was less than in 2014 (25 fish/h; Dycus and Fisk 2014). However, Largemouth Bass growth appeared to be acceptable, with a mean back-calculated length at age-1 of 191 mm, though the sample size was low (N=24). Lake Waccamaw is known for its White Perch fishery, which would not have been adequately assessed if we had not used gill nets. The White Perch population is robust, with White Perch being captured more than any other game fish in this survey. The Yellow Perch population is also thriving, with Yellow Perch having the second highest number of captures of the game fish in our survey. Sunfish populations are sound, with Pumpkinseed, Bluegill, and Redear Sunfish being captured in adequate numbers, and with one Banded Sunfish being captured (Tables 2, 3, and 4). Pumpkinseed were abundant in Lake Waccamaw and represented another unique fishery. Over half of the catfish captured were native catfish, including White Catfish and Brown Bullhead. The remainder of the catfish captured consisted of Channel Catfish. Thus far, Lake Waccamaw's sport fish populations did not appear to have been negatively impacted by aquatic nuisance species. Indeed, no Flathead Catfish were observed, suggesting the species persists at a very low level of abundance, if at all.

Although Hydrilla and Flathead Catfish have not been detected in recent surveys, these invasive species remain a concern due to their current distribution in nearby waterbodies. Most species present (86% of the species we encountered) in Lake Waccamaw are native to southeastern North Carolina, many of the species are small (including the endemic species, making them vulnerable to a variety of predators), and any species introductions could negatively impact the aquatic community through predation or competition. Given the classification change from mesotrophic to eutrophic (NC DEQ Intensive Survey Branch 2022; NC DEQ Intensive Survey Branch 2018; NC DEQ Intensive Survey Branch 2012) nutrient inputs also pose a concern to Lake Waccamaw’s fish community due to vegetation and water quality changes that could be caused by increased nutrient inputs. Periodic surveys utilizing multiple gear types should be conducted to monitor the health of the fish community in Lake Waccamaw and the status of aquatic nuisance species.

Management Recommendations

1. Conduct sampling every three to five years to monitor the condition of Lake Waccamaw’s fisheries resources.
2. Implement preventative efforts to mitigate the introduction of aquatic nuisance species into Lake Waccamaw, including the use of boat wash stations, vessel inspections, and removal.
3. Compare occupancy of species of interest, including Largemouth Bass, Bluegill, Pumpkinseed, and White Perch, within various habitats.
4. Evaluate water quality and habitat conditions to assess changes that may impact fish populations in Lake Waccamaw.
5. Maintain existing fishing regulations for Lake Waccamaw.

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TABLE 1. Sample site information, dates, and gear type for sampling of Lake Waccamaw conducted in November 2020.

Sample date	Site name	Waterbody	Gear Type	Latitude	Longitude
11/12/2020	LKW.92	Lake Waccamaw	EF	34.29400	-78.47581
11/12/2020	LKW.61	Lake Waccamaw	EF	34.26917	-78.47139
11/13/2020	LKWZ7	Lake Waccamaw	GILL	34.30179	-78.49158
11/13/2020	LKWAF12	Lake Waccamaw	GILL	34.28808	-78.47672
11/13/2020	LKWAH16	Lake Waccamaw	GILL	34.27653	-78.47102
11/13/2020	LKWAD19	Lake Waccamaw	GILL	34.26585	-78.48099
11/13/2020	LKWY20	Lake Waccamaw	GILL	34.26255	-78.49165
11/13/2020	LKWR21	Lake Waccamaw	GILL	34.26081	-78.51053
11/18/2020	LKW.184	Lake Waccamaw	EF	34.30588	-78.55168
11/18/2020	LKW.161	Lake Waccamaw	EF	34.31684	-78.53368
11/18/2020	LKW.127	Lake Waccamaw	EF	34.31049	-78.50358
11/18/2020	LKW.134	Lake Waccamaw	EF	34.31280	-78.50976
11/18/2020	LKW.198	Lake Waccamaw	EF	34.29465	-78.54897
11/19/2020	LKWL3	Lake Waccamaw	GILL	34.31267	-78.52603
11/19/2020	LKWF4	Lake Waccamaw	GILL	34.30925	-78.54020
11/19/2020	LKWC9	Lake Waccamaw	GILL	34.29368	-78.54834
11/19/2020	LKWE11	Lake Waccamaw	GILL	34.28877	-78.54224
11/19/2020	LKWG14	Lake Waccamaw	GILL	34.28000	-78.53697
11/19/2020	LKWL17	Lake Waccamaw	GILL	34.27155	-78.52501
11/20/2020	LKW.45	Lake Waccamaw	EF	34.25971	-78.48253
11/20/2020	LKW.39	Lake Waccamaw	EF	34.25800	-78.48789
11/20/2020	LKW.18	Lake Waccamaw	EF	34.25736	-78.50751
11/20/2020	LKW.245	Lake Waccamaw	EF	34.26156	-78.52342
11/20/2020	LKW.209	Lake Waccamaw	EF	34.28566	-78.54420
11/20/2020	LKW.238	Lake Waccamaw	TRAP	34.2652	-78.52470
11/20/2020	LKW.32	Lake Waccamaw	TRAP	34.25688	-78.49461
11/20/2020	LKW.41	Lake Waccamaw	TRAP	34.25850	-78.48608
11/20/2020	LKW.85	Lake Waccamaw	TRAP	34.28880	-78.47267
11/20/2020	LKW.159	Lake Waccamaw	TRAP	34.31716	-78.53150
11/20/2020	LKW.190	Lake Waccamaw	TRAP	34.30052	-78.55094

TABLE 2. Total catch and total length (TL) by species during boat-mounted electrofishing sampling of Lake Waccamaw conducted in 2020.

Common name	Scientific name	Number	Percent	Min TL (mm)	Max TL (mm)	Mean TL (mm)
Inland game fish						
Bluegill	*Lepomis macrochirus*	27	2.9	60	222	132
Brown Bullhead	*Ameiurus nebulosus*	1	0.1	318	318	318
Chain Pickerel	*Esox niger*	1	0.1	214	214	210
Largemouth Bass	*Micropterus salmoides*	37	4.0	108	464	207
Pumpkinseed	*Lepomis gibbosus*	33	3.6	64	228	110
Redear Sunfish	*Lepomis microlophus*	14	1.5	138	308	151
White Perch	*Morone americana*	8	0.9	98	170	135
Yellow Perch	*Perca flavescens*	68	7.3	38	234	122
Nongame fish						
Bowfin	*Amia calva*	2	0.1	578	768	610
Common Carp	*Cyprinus carpio*	1	0.1	302	302	443
Coastal Shiner	*Notropis petersoni*	538	58.1	-	-	59
Gizzard Shad	*Dorosoma cepedianum*	3	0.3	324	336	331
Longnose Gar	*Lepisosteus osseus*	3	0.3	354	396	651
Taillight Shiner	*Notropis maculatus*	1	0.1	-	-	-
Waccamaw Darter	*Etheostoma perlongum*	2	0.2	56	60	58
Waccamaw Killifish	*Fundulus waccamensis*	3	0.3	30	36	33
Waccamaw Silverside	*Menidia extensa*	185	20.0	36	78	53
Total		927	100			

TABLE 3. Total catch and total length (TL) by species during gill net sampling of Lake Waccamaw conducted in 2020.

Common name	Scientific name	Number	Percent	Min TL (mm)	Max TL (mm)	Mean TL (mm)
Inland game fish						
Black Crappie	*Pomoxis nigromaculatus*	4	1.0	254	294	265
Bluegill	*Lepomis macrochirus*	1	0.3	104	104	
Largemouth Bass	*Micropterus salmoides*	5	1.3	322	560	207
Pumpkinseed	*Lepomis gibbosus*	17	4.3	142	214	110
White Catfish	*Ameiurus catus*	9	2.3	242	432	151
White Perch	*Morone americana*	239	61.0	132	348	135
Yellow Perch	*Perca flavescens*	1	0.3	170	170	122
Nongame fish						
Bowfin	*Amia calva*	1	0.3	742	742	610
Channel Catfish	*Ictalurus punctatus*	9	2.3	514	670	443
Gizzard Shad	*Dorosoma cepedianum*	64	16.3	248	432	331
Longnose Gar	*Lepisosteus osseus*	42	10.7	454	1198	651
Total		392	100			

TABLE 4. Total catch and total length (TL) by species during trap net sampling of Lake Waccamaw conducted in 2020.

Common name	Scientific name	Number	Percent	Min TL (mm)	Max TL (mm)	Mean TL (mm)
Inland game fish						
Banded Sunfish	*Enneacanthus obesus*	1	1.7	44	44	44
Bluegill	*Lepomis macrochirus*	19	32.2	30	194	81
Pumpkinseed	*Lepomis gibbosus*	7	11.9	52	132	66
Redear Sunfish	*Lepomis microlophus*	1	1.7	62	62	62
Lepomis spp.	*Lepomis* spp.	13	20.3	28	48	41
Nongame fish						
Bowfin	*Amia calva*	3	5.1	336	364	355
Coastal Shiner	*Notropis petersoni*	7	11.9	28	66	42
Pirate Perch	*Aphredoderus sayanus*	1	1.7	96	96	96
Waccamaw Darter	*Etheostoma perlongum*	1	1.7	31	31	31
Waccamaw Killifish	*Fundulus waccamensis*	3	1.7	36	58	46
Waccamaw Silverside	*Menidia extensa*	6	10.1	42	80	67
Total		62	100			

TABLE 5. Mean back-calculated length (mm) by age for Largemouth Bass captured during sampling of Lake Waccamaw in 2020. Only age-1 and older individuals were included, and the age-9 individual was the oldest encountered.

Age	Number of Individuals	Mean Back-Calculated Length (mm)	Standard Deviation
1	24	191	34
2	13	265	41
3	9	307	53
4	8	344	57
5	4	336	34
6	4	371	39
7	3	408	52
8	3	438	52
9	1	533	-

TABLE 6. Total catch by species for each year sampled by the North Carolina Wildlife Resources Commission, including effort from both the Inland Fisheries and Aquatic Wildlife Diversity divisions. Sources were not included if they only included information related to species endemic to Lake Waccamaw, other than when the species were first described.

Common name	Scientific name	1947[1,2,3]	1957–1959[C][4,5]	1965*[6]	2009[7]	2009-2014[8]	2014[9]	2015[10]	2020
Inland game fish									
Banded Sunfish	*Enneacanthus obesus*		6						1
Black Crappie	*Pomoxis nigromaculatus*	26	31	1					4
Bluegill	*Lepomis macrochirus*	302	253	151	X		26	53	47
Bluespotted Sunfish	*Enneacanthus gloriosus*	5	19						
Brown Bullhead	*Ameiurus nebulosus*						3		1
Chain Pickerel	*Esox niger*	5	13	27			1	1	1
Flat Bullhead	*Ameiurus platycephalus*		1						
Flier	*Centrarchus macropterus*		31						
Largemouth Bass	*Micropterus salmoides*	22	23	22	X		53	252	42
Mud Sunfish	*Acantharchus pomotis*		65						
Pumpkinseed	*Lepomis gibbosus*	79	38	141			54	54	57
Redbreast Sunfish	*Lepomis auritus*	30		3			1	2	
Redear Sunfish	*Lepomis microlophus*						17	36	15
Redfin Pickerel	*Esox americanus*		25	1					
Spotted Sunfish	*Lepomis punctatus*	X[A]							
Warmouth	*Lepomis gulosus*	15	329	8			2		
White Catfish	*Ameiurus catus*	38	12	14			2	2	9
White Perch	*Morone americana*	99	286	40				56	247
Yellow Bullhead	*Ameiurus natalis*		1						
Yellow Perch	*Perca flavescens*	48	75	40			37	45	69
Nongame fish									
American Eel	*Anguilla rostrata*	4	2						
Banded Pygmy Sunfish	*Elassoma zonatum*		4						
Bowfin	*Amia calva*	2	49	6					5
Brook Silverside	*Labidesthes sicculus*				X	X			
Channel Catfish	*Ictalurus punctatus*								9
Coastal Shiner	*Notropis petersoni*	119	X	67[D]	X	X			545

TABLE 6 (continued).

Common Carp	*Cyprinus carpio*		3						1
Creek Chubsucker	*Erimyzon oblongus*	1							
Eastern Mosquitofish	*Gambusia holbrooki*	23	58						
Eastern Mudminnow	*Umbra pygmaea*		6						
Flathead Catfish	*Pylodictis olivaris*					1[E]			
Gizzard Shad	*Dorosoma cepedianum*	7	17	76					67
Golden Shiner	*Notemigonus crysoleucas*	203	381	22	X				
Ironcolor Shiner	*Notropis chalybaeus*		29						
Lake Chubsucker	*Erimyzon sucetta*		4						
Longnose Gar	*Lepisosteus osseus*	6	117	12					45
Pirate Perch	*Aphredoderus sayanus*		56						1
Starhead Topminnow	*Fundulus dispar*								
Swamp Darter	*Etheostoma fusiforme*	X[B]							
Taillight Shiner	*Notropis maculatus*								1
Tadpole Madtom	*Noturus gyrinus*	35	15	47[D]					
Waccamaw Darter	*Etheostoma perlongum*	X[B]		3[D]	X	X			3
Waccamaw Killifish	*Fundulus waccamensis*	X[A]		15	X	X			4
Waccamaw Silverside	*Menidia extensa*	5	276	13	X	X			191

X Captured, but no count of individuals.

[A] Examined, but not listed

[B] The Two Darter Species Were Combined

[C] Darters were captured in 1957-59 but not identified

[D] Species was not specified, or the count was combined with another species of the same genus

[E] Was not captured during the survey, but was mentioned as being captured in 2014 in the report

[1] Hubbs and Raney 1946

[2] Hueske 1948

[3] Frey 1951

[4] Louder 1961

[5] Louder 1962

[6] Davis 1966

[7] Heise and Jones 2010

[8] Heise and jones 2014; was focused on Waccamaw Silversides

[9] Dycus and Fisk 2014

[10] Unpublished data

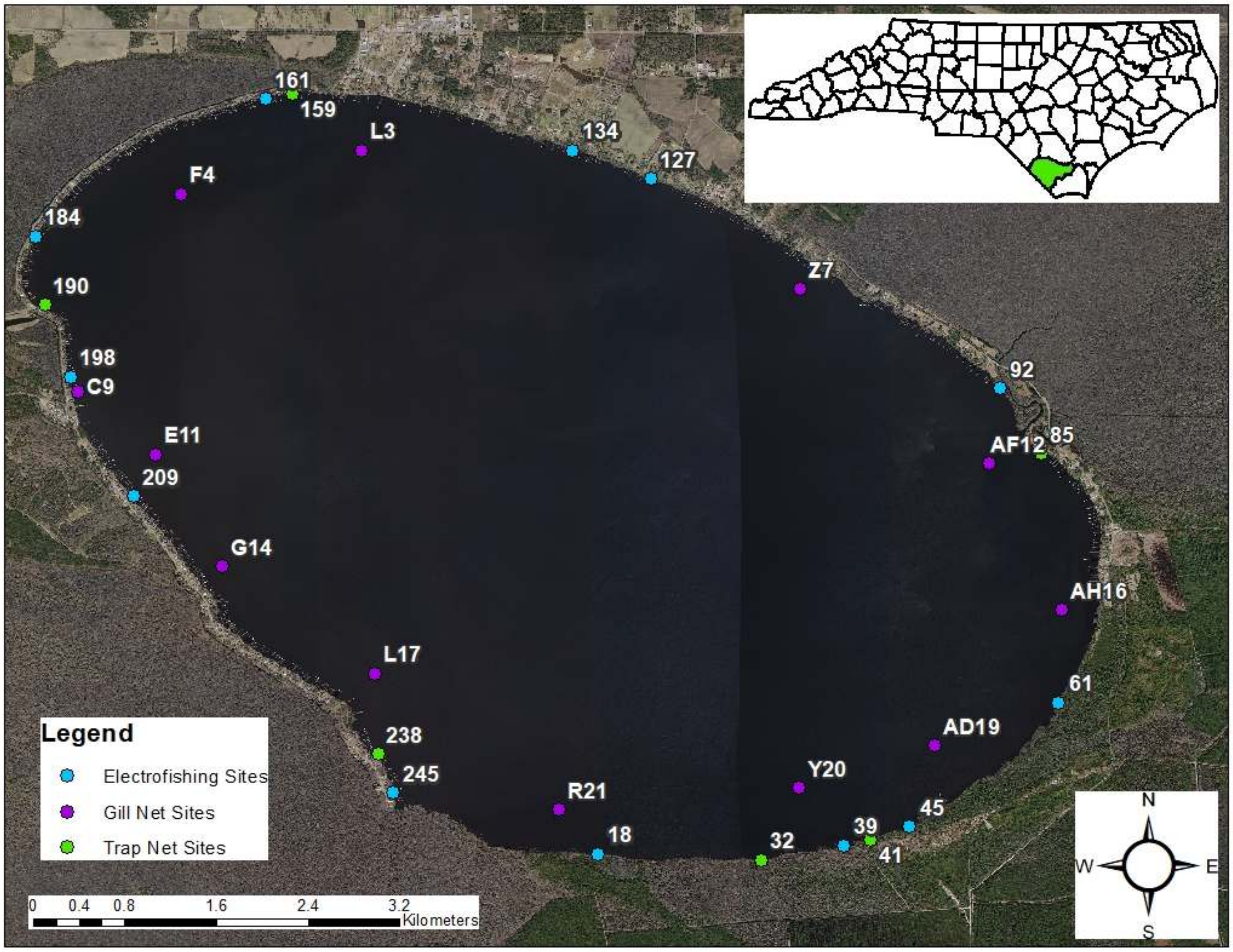

FIGURE 1. Map of sites sampled on Lake Waccamaw by gear type in 2020.

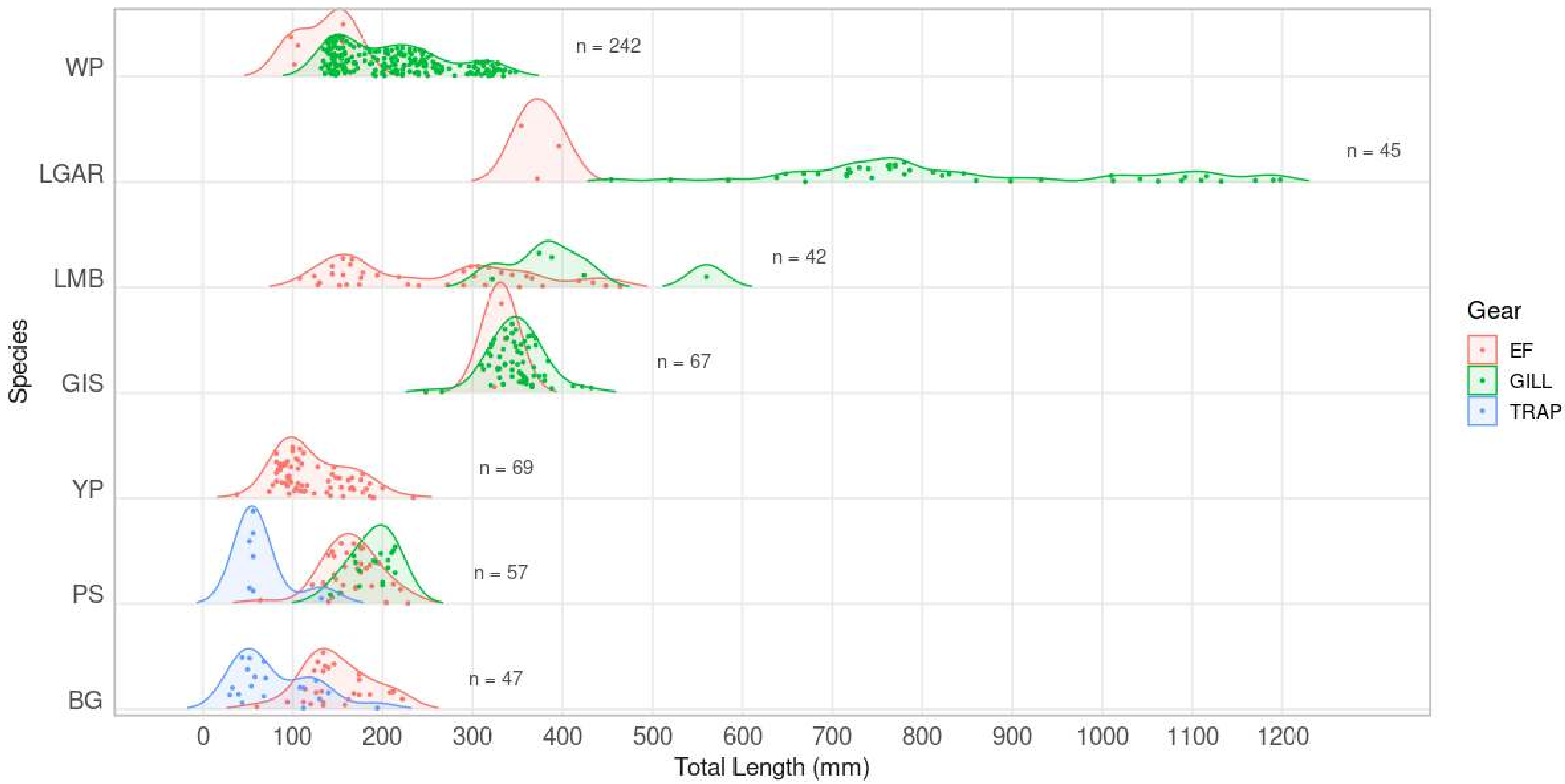

FIGURE 2. Length frequency distribution by gear type for Bluegill (BG), Gizzard Shad (GIS), Longnose Gar (LGAR), Largemouth Bass (LMB), Pumpkinseed (PS), White Perch (WP), and Yellow Perch (YP) captured in November 2020.

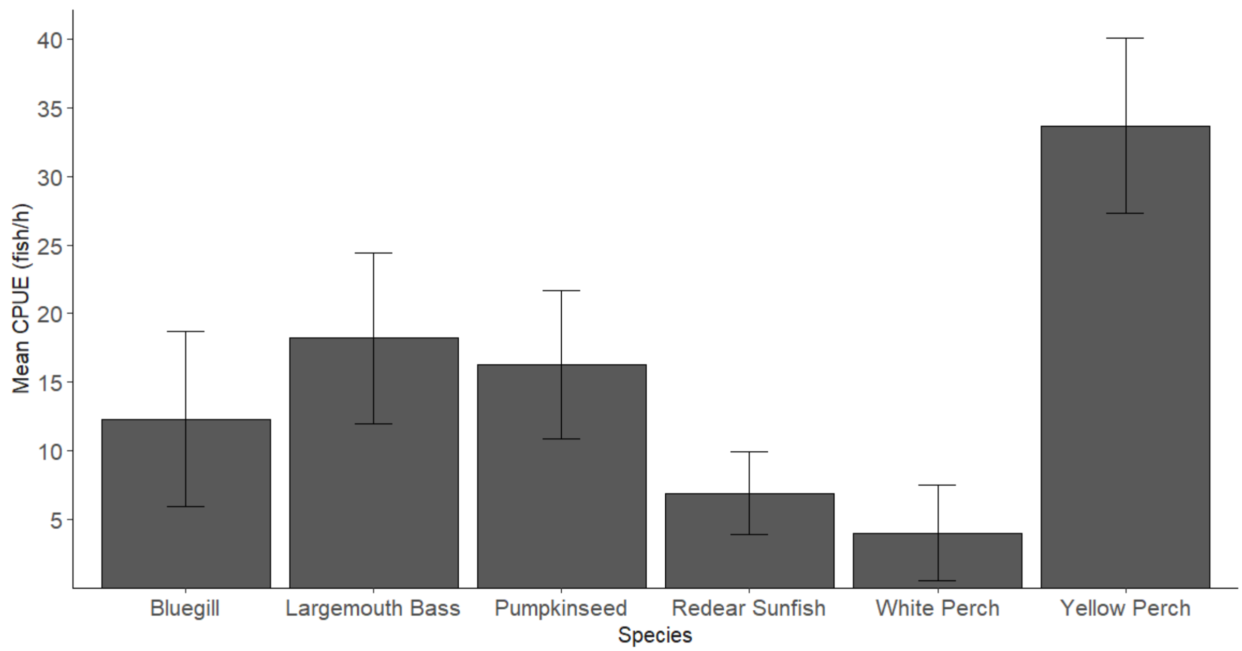

FIGURE 3. Catch per unit effort (CPUE)(±SE) for the most commonly observed inland game fish during boat electrofishing of Lake Waccamaw, 2020.

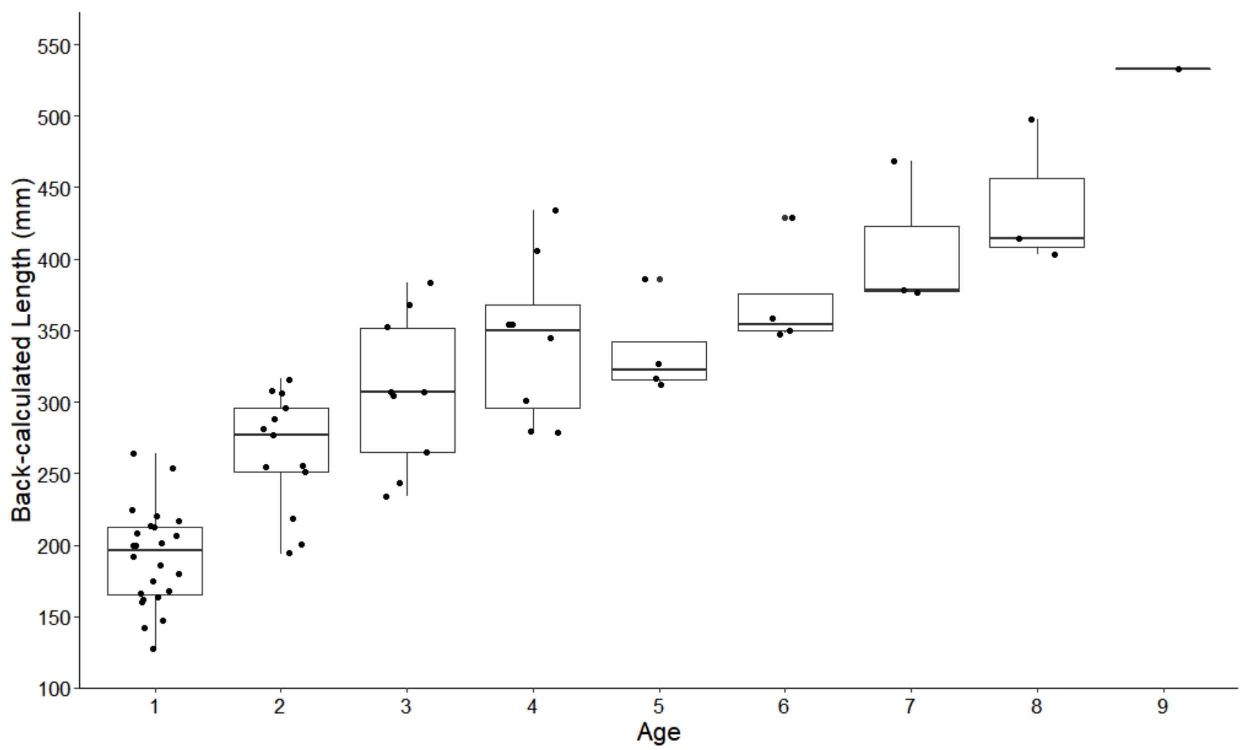

FIGURE 4. Box plots of back-calculated length at age for 24 Largemouth Bass aged from Lake Waccamaw, 2020.