

Assessment of the fisheries resources in South River



Federal Aid in Sport Fish Restoration
Project F-108



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Abstract. South River, classified as an outstanding resource water, is an important resource for local anglers in the Cape Fear River basin. Recent clearing and snagging of South River, as well as the lack of recent fisheries data, necessitated an assessment of the fisheries resources. During June–August 2020, ten sites were sampled in South River for a total of 3.4 h, resulting in the collection of 583 fish representing 31 species. Inland game fish comprised 59% of captures, with Bluegill *Lepomis macrochirus* comprising 19% of the catch and Largemouth Bass *Micropterus salmoides* comprising 8.4% of the catch. Genetic analysis of Largemouth Bass fin clips indicated high levels of introgression of Florida Bass *M. salmoides flordanus* genetics. Catch-per-unit effort (CPUE) declined with decreasing river kilometer for all species combined and for the five species of inland game fish with greater than 40 captures. Data indicated a decline in inland game fish populations in downstream sections of South River. Potential causes of population declines include recent clearing and snagging, fish kills associated with poor water quality following hurricanes, predation, or sampling bias associated with short-term flooding (decreasing the probability of finding fish during the sample). Additional surveys are needed to assess spatial and temporal dynamics of inland game fish populations in downstream sections of South River and to determine if intensive management efforts are warranted.

South River is recognized as an “Outstanding Resource Waters” by the NC Division of Water Resources [15A NCAC 02B .0311(h)(2)] and was historically considered one of the best fishing streams in the Cape Fear River basin (Louder 1963). Fish (1968) reported most angling was directed toward sunfish and catfish in South River. South River remains a destination for local anglers, especially from Bladen, Cumberland, and Sampson counties, who primarily access the river at bridges and private landings (M. Parrish, North Carolina Wildlife Resources Commission (NCWRC) Wildlife Enforcement Division, personal communication). Boating access to the river is restricted due to its low average depth, few public access areas, susceptibility to windfallen trees, and the accumulation of woody debris. Limited access throughout much of the river contributes to a relative lack of quantitative fisheries data.

Stream clearing and snagging (Cobb and Kaufman 1993) projects were conducted along South River in 2019 by local government soil and water conservation services to mitigate the potential for over-bank flooding that was observed during hurricanes Matthew and Florence in 2016 and 2018. These efforts degrade fish habitat in the lower 40 rkm of river due to the removal of large woody debris, stream bank soil erosion, and clearing of riparian vegetation (personal observation). Although not the primary goal of the clearing and snagging projects, boat navigability was enhanced throughout the river.

Due to enhanced navigability, relative lack of recent fisheries data, and concerns of degraded fish habitat, this survey was initiated to evaluate the relative abundance and size structure of the fisheries resources of South River. A secondary objective was to assess the introgression of Florida Bass *Micropterus floridanus* (Taylor et al. 2019) alleles in the Largemouth Bass *M. salmoides* population.

Methods

Study site. South River begins at the confluence of Black River (a third-order stream) and Mingo Swamp in northeastern Cumberland County, NC, and flows approximately 180 km to its confluence with the Black River (fifth-order stream) near Ivanhoe, NC. The river defines much of Sampson County’s border with Bladen and Cumberland counties. The South River catchment drains 1,280 km²; land use is 35% agriculture, 22% wetlands, 20% forested, 16% grassland/shrub, 6% developed, and 1% open water (USDA 2021). Ten sample sites were chosen opportunistically based upon available boat access (Figure 1; Table 1).

Field Collections. Fish were collected June–August 2020 using boat-mounted electrofishing (Smith-Root 7.5 GPP; 120-Hz; 4.5–5.5 kW). Each electrofishing site was approximately 500-m in length, and electrofishing duration (s) was recorded. All fish exhibiting galvanotaxis or narcosis were netted as observed and held in an oxygenated livewell. Following collection, fish were enumerated to species, measured for total length (TL; mm) and weight (g), a fin clip taken (from Largemouth Bass), and released. A partial pelvic fin clip was removed from approximately 25 Largemouth Bass and preserved in 95% ethyl alcohol for genetic analysis. Fish that could not be conclusively identified in the field were preserved in 95% ethyl alcohol and later identified to the lowest possible taxonomic level. A YSI Pro2020 meter was used at each site to measure dissolved oxygen concentration (mg/L) and saturation (%), conductivity (μS/cm), salinity (g/L), and temperature (°C) (Table 2). All field data were recorded in an electronic spreadsheet and archived in project “D4 Rivers” in the NCWRC BIODE database.

Data analyses. Relative abundance was indexed as catch-per-unit effort (CPUE, fish/h). Size structure was summarized using length-frequency histograms for each species of centrarchid with greater than 25 collected individuals (Ogle 2015; Wickham 2016; Wickham et al. 2020). A plot of CPUE by river kilometer (RKM) was created for inland game fish with over 40 captures (Wickham et al. 2019; Oksanen et al. 2020). Analyses were performed using R 3.6.3 (R Core Team 2019) and RStudio (version 1.2.5033; RStudio Team 2020).

Results

Total catch. Sampling resulted in the collection of 583 fish from 31 species (Table 3). Of the 583 fish, one hybrid sunfish and 26 *Notropis* spp. could not be identified to the species level. Inland game fish accounted for 59% of the total catch and comprised 343 individuals of 13 species. Nongame fish accounted for 41% of the total catch and comprised 240 individuals of 18 species. Bluegill *Lepomis macrochirus* was the most abundant species observed and accounted for 19% of the total catch. Ironcolor Shiner *N. chalybaeus*, a species of greatest conservation need (SGCN), was observed (Table 3). Catch-per-unit effort (CPUE) of inland game fish with greater than 40 captures overall, as well as overall CPUE of all fish, decreased with decreasing river kilometer (Figure 2; Table 4).

Largemouth Bass. Mean (SE) Largemouth Bass CPUE was 13.1 (4.1) fish/h. Largemouth Bass comprised 8.4% of the total number of fish collected from South River (Table 3). Total length ranged between 24 mm and 436 mm, with a mean of 207 mm (Table 3). Multiple modes were observed in the Largemouth Bass length frequency, but no individuals were captured in the 100 mm to 175 mm size-classes (Figure 3). Genetic analysis indicates the Largemouth Bass population contains substantial introgression of Florida Largemouth Bass genetics, with a mean Florida Bass allele frequency of 86% (greater than 95% is considered pure Florida Bass). Based on 23 fin clips, no pure (>95%) Florida Bass or Largemouth Bass were present in the sample, but all Largemouth Bass analyzed had at least 70% Florida Bass alleles. Genetic analysis did not indicate the presence of first filial generation (F1) hybrids.

Sunfish. Nine species of sunfish were collected, including Bluegill ($n = 113$), Redbreast Sunfish *L. auritus* ($n = 40$), Redear Sunfish *L. microlophus* ($n = 64$), Warmouth *L. gulosus* ($n = 43$), Spotted Sunfish *L. punctatus* ($n = 14$), Dollar Sunfish *L. marginatus* ($n = 6$), Flier *Centrarchus macropterus* ($n = 3$), Banded Pygmy Sunfish *Elassoma zonatum* ($n = 3$), and Pumpkinseed *L. gibbosus* ($n = 1$). One hybrid sunfish was also captured. Bluegill mean CPUE was 31.5 (14.8) fish/h. Redear Sunfish CPUE was 17.3 (9.1) fish/h. Redbreast Sunfish CPUE was 10.6 (3.2) fish/h. Warmouth CPUE was 11.8 (7.4) fish/h. Relative abundance of other sunfish species was insignificant. Length frequencies varied greatly by species, with lengths ranging from 16 mm for the smallest Banded Pygmy Sunfish to 268 mm for the largest Redear Sunfish (Table 3; Figures 4-7).

Catfish. Three species of ictalurids were collected, including Flathead Catfish *Pylodictis olivaris* ($n = 6$), Channel Catfish *Ictalurus punctatus* ($n = 4$), and Tadpole Madtom *Noturus gyrinus* ($n = 1$), and all three species combined accounted for less than 2% of the total catch (Table 3).

Discussion

The abundance and diversity of species found in South River during this survey is a promising sign for the relative health of the fish community. This survey documented the first collection of Tadpole Madtom in the Cape Fear River basin since 2013 (Rachels 2021). However, fish abundance and diversity decreased substantially in downstream sites, with only six species of fish captured at the four most downstream sites (RKM 21, RKM 20, RKM 17, and RKM 16) during 1 h of sampling. These sites are close to the Ennis Bridge Boating Access Area (near RKM 21), an area also sampled during NCWRC Index of Biotic Integrity (IBI) sampling conducted annually 2003–2005 (NCWRC unpublished data; Table 5). Species richness has declined in the downstream sites, with 19 species captured in 2003 during 0.7 h of sampling, 19 species captured in 2004 during 0.6 h of sampling, and 18 species captured in 2005 during 0.5 h of sampling (NCWRC, unpublished data; Table 5).

For 2020 sampling, the combined CPUE of Largemouth Bass, Bluegill, Redbreast Sunfish, Redear Sunfish, and Warmouth, all of which are common inland game fish caught during the IBI and 2020 sampling events, was 1.9 fish/h at the two sites closest to Ennis Bridge Boating Access Area (RKM 21 and RKM 20), while the CPUE of the same inland game fish was 102.2 fish/h for IBI sampling at two Ennis Bridge Boating Access Area sites in 2005 (Figure 8). Overall, only 1 fish was captured at RKM 21 and RKM 20 in 2020, compared to 170 fish at the Ennis Bridge Boating Access Area during IBI sampling in 2005. The discrepancy between 2003–2005 IBI sampling and 2020 sampling indicates declines in downstream fish populations in South River, though the cause is unknown. Potential causes of presumed fish population decline in South River may be due to fish kills caused by recent hurricanes Matthew and Florence, stream clearing and snagging, and/or predation by invasive species (e.g., Flathead Catfish). Environmental conditions (minor over-bank flooding) at the time of sampling are also a concern, potentially resulting in lower catch rates; however, upstream sites were sampled in similar conditions and showed higher species richness and number of captures. Additional surveys are necessary to determine if the downstream decline in inland game fish populations is temporary or pervasive, which would require corrective management efforts.

Management Recommendations

1. Investigate occupancy of native ictalurids.
2. Conduct electrofishing survey in the Ennis Bridge area by 2023 to assess recovery of inland game fish populations. Evaluate habitat and water quality characteristics to assess if land use or in-water activities have impaired the river.
3. Advocate for monitoring of stream clearing and snagging efforts to ensure appropriate standards are followed (e.g., McConnell et al. 1983; Cobb and Kaufman 1993; USDA NRCS 2016).

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TABLE 1. South River sampling information for boat-mounted electrofishing sampling in 2020.

River kilometer	Sample date	Latitude	Longitude	Access area
153	June 11	35.15511	-78.63896	US HWY 13
117	June 9	34.97454	-78.62789	Private landing
109	June 11	34.94206	-78.58765	Private landing
95	June 9	34.89341	-78.53352	Private landing
57	July 30	34.76101	-78.40854	Sloan's Bridge BAA
43	August 6	34.70869	-78.37448	NC HWY 41
21	August 13	34.64122	-78.31145	Ennis Bridge BAA
20	August 13	34.63663	-78.31488	Ennis Bridge BAA
17	August 13	34.62800	-78.31779	Ennis Bridge BAA
16	August 13	34.62609	-78.31403	Ennis Bridge BAA

TABLE 2. Water quality data by river kilometer for boat-mounted electrofishing of South River in 2020. Dashes indicate water quality data that were unable to be collected.

River kilometer	Dissolved Oxygen		Conductivity ($\mu\text{S}/\text{cm}$)	Salinity (ppt)	Temperature ($^{\circ}\text{C}$)
	mg/L	% Saturation			
153	4.4	57.0	82.0	0	26.4
117	-	-	-	-	-
109	3.6	45.1	74.0	0	25.3
95	4.9	61.0	60.0	0	24.8
57	-	-	75.7	0	28.4
43	5.8	72.0	68.0	0	25.8
21	5.3	64.9	57.2	0	25.9
20	5.0	61.5	56.7	0	26.0
17	5.2	64.5	57.4	0	26.0
16	5.1	63.1	57.5	0	26.1
Average	4.9	61.1	65.4	0	26.1

TABLE 3. Total catch by species during boat electrofishing of South River in 2020.

Common name	Scientific name	Number	Percent	Min TL (mm)	Max TL (mm)	Mean TL (mm)
Inland game fish						
Black Crappie	<i>Pomoxis nigromaculatus</i>	3	0.5	130	234	195
Bluegill	<i>Lepomis macrochirus</i>	113	19.4	30	252	132
Chain Pickerel	<i>Esox niger</i>	4	0.7	102	476	210
Dollar Sunfish	<i>Lepomis marginatus</i>	6	1.0	88	100	93
Flier	<i>Centrarchus macropterus</i>	3	0.5	40	184	117
Hybrid Sunfish	<i>Lepomis spp.</i>	1	0.2	108	108	108
Largemouth Bass	<i>Micropterus salmoides</i>	49	8.4	24	436	207
Pumpkinseed	<i>Lepomis gibbosus</i>	1	0.2	110	110	110
Redbreast Sunfish	<i>Lepomis auritus</i>	40	6.9	34	224	118
Redear Sunfish	<i>Lepomis microlophus</i>	64	11.0	70	268	151
Redfin Pickerel	<i>Esox americanus</i>	1	0.2	112	112	112
Spotted Sunfish	<i>Lepomis punctatus</i>	14	2.4	50	162	106
Warmouth	<i>Lepomis gulosus</i>	43	7.4	56	224	125
White Bass	<i>Morone chrysops</i>	1	0.2	172	172	172
Nongame fish						
American Eel	<i>Anguilla rostrata</i>	21	3.6	114	550	272
Banded Pygmy Sunfish	<i>Elassoma zonatum</i>	3	0.5	16	20	18
Bowfin	<i>Amia calva</i>	20	3.4	502	708	610
Channel Catfish	<i>Ictalurus punctatus</i>	4	0.7	390	504	443
Coastal Shiner	<i>Notropis petersoni</i>	46	7.9	30	76	59
Creek Chubsucker	<i>Erimyzon oblongus</i>	11	1.9	28	284	164
Dusky Shiner	<i>Notropis cummingsae</i>	11	1.9	44	80	55
Eastern Mosquitofish	<i>Gambusia holbrooki</i>	3	0.5	40	44	42
Eastern Shiners	<i>Notropis spp.</i>	26	4.5	22	58	30
Eastern Silvery Minnow	<i>Hybognathus regius</i>	7	1.2	-	-	-
Flathead Catfish	<i>Pylodictis olivaris</i>	6	1.0	298	1042	718
Ironcolor Shiner	<i>Notropis chalybaeus</i>	2	0.3	30	38	34
Longnose Gar	<i>Lepisosteus osseus</i>	11	1.9	482	830	651
Piedmont Darter	<i>Percina crassa</i>	1	0.2	46	46	46
Pirate Perch	<i>Aphredoderus sayanus</i>	32	5.5	22	94	40
Sandbar Shiner	<i>Notropis szepticus</i>	1	0.2	66	66	66
Spotted Sucker	<i>Minytrema melanops</i>	30	5.1	58	514	339
Tadpole Madtom	<i>Noturus gyrinus</i>	1	0.2	94	94	94
Tessellated Darter	<i>Etheostoma olmstedi</i>	3	0.5	54	62	57
Total		583	100			

TABLE 4. Fish captured by river kilometer, including total number of fish collected, overall number of species collected, number of inland game fish collected (only including inland game fish with greater than 40 captures across all sites – Bluegill, Largemouth Bass, Redbreast Sunfish, Redear Sunfish, and Warmouth), sampling effort, overall catch-per-unit effort (CPUE), and CPUE of inland game fish with greater than 40 individuals captured across all sites.

River kilometer	Number of fish collected	Number of species collected	Number of sport fish collected	Effort (h)	CPUE (fish/h)	Sport fish CPUE (fish/h)
153	163	19	126	0.4	431.8	333.8
117	74	14	44	0.5	147.5	87.7
109	93	16	58	0.3	295.8	184.5
95	76	19	18	0.5	146.4	34.7
57	121	20	45	0.3	393.1	146.2
43	45	11	14	0.3	134.0	41.7
21	1	1	1	0.3	3.4	3.4
20	2	2	0	0.2	8.21	0.0
17	1	1	0	0.2	4.6	0.0
16	6	4	3	0.3	20.4	10.2
Total	583	31	309	3.4		

TABLE 5. Number of each species captured for NCWRC Index of Biotic Integrity (IBI) boat-mounted electrofishing sites near the Ennis Bridge Boating Access Area (close to RKM 21) during annual sampling conducted 2003–2005 and number of each species captured during NCWRC (non-IBI) boat-mounted electrofishing.

Common name	Scientific name	Year			
		2003	2004	2005	2020
American Eel	<i>Anguilla rostrata</i>		3	2	21
Banded Pygmy Sunfish	<i>Elassoma zonatum</i>				3
Black Crappie	<i>Pomoxis nigromaculatus</i>		1		3
Blue Catfish	<i>Ictalurus furcatus</i>		1		
Bluegill	<i>Lepomis macrochirus</i>	40	33	32	113
Bowfin	<i>Amia calva</i>	7	6	5	20
Chain Pickerel	<i>Esox niger</i>		2		4
Channel Catfish	<i>Ictalurus punctatus</i>	1	2	5	4
Coastal Shiner	<i>Notropis petersoni</i>	91	45	13	46
Creek Chubsucker	<i>Erimyzon oblongus</i>	6			11
Dollar Sunfish	<i>Lepomis marginatus</i>	5	6	29	6
Dusky Shiner	<i>Notropis cummingsae</i>				11
Eastern Mosquitofish	<i>Gambusia holbrooki</i>	1		1	3
Eastern Shiners	<i>Notropis spp.</i>				26
Eastern Silvery Minnow	<i>Hybognathus regius</i>				7
Flathead Catfish	<i>Pylodictis olivaris</i>	5		2	6
Flier	<i>Centrarchus macropterus</i>			2	3
Hybrid Sunfish	<i>Lepomis spp.</i>				1
Ironcolor Shiner	<i>Notropis chalybaeus</i>				2
Largemouth Bass	<i>Micropterus salmoides</i>	21	4	2	49
Longnose Gar	<i>Lepisosteus osseus</i>	8	1	3	11
Piedmont Darter	<i>Percina crassa</i>	1		1	1
Pirate Perch	<i>Aphredoderus sayanus</i>	61	2	1	32
Pumpkinseed	<i>Lepomis gibbosus</i>				1
Redbreast Sunfish	<i>Lepomis auritus</i>	23	4	11	40
Redear Sunfish	<i>Lepomis microlophus</i>		5	1	64
Redfin Pickerel	<i>Esox americanus</i>	3			1
Sandbar Shiner	<i>Notropis szepticus</i>				1
Sawcheek Darter	<i>Etheostoma serrifer</i>	1			
Spotted Sucker	<i>Minytrema melanops</i>	7	3	37	30
Spotted Sunfish	<i>Lepomis punctatus</i>	21	20	14	14
Tadpole Madtom	<i>Noturus gyrinus</i>				1
Tessellated Darter	<i>Etheostoma olmstedii</i>				3
Warmouth	<i>Lepomis gulosus</i>	24	10	9	43
White Bass	<i>Morone chrysops</i>				1
Yellow Perch	<i>Perca flavescens</i>		1		
Total					

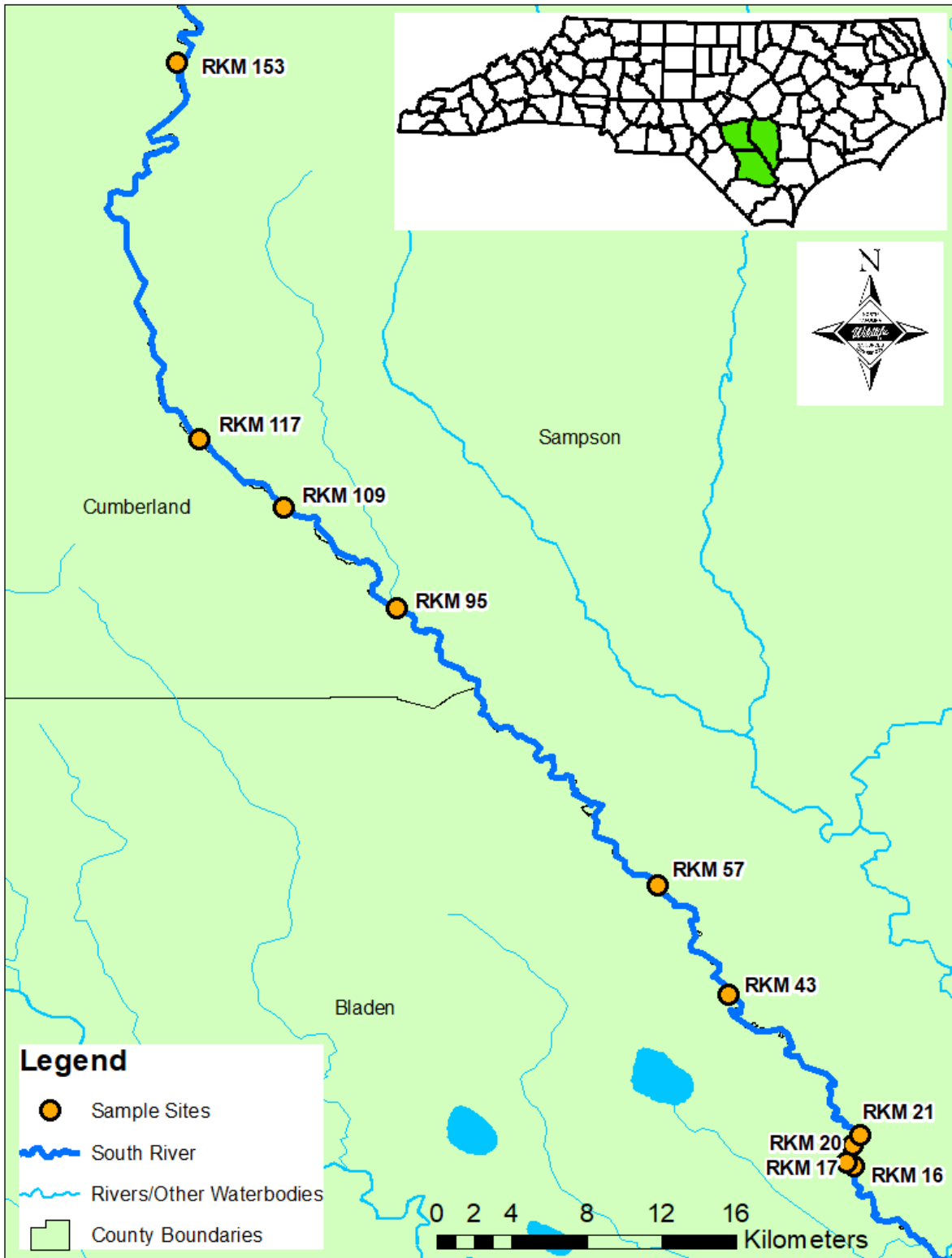


FIGURE 1. Map of ten sampling sites on South River, North Carolina.

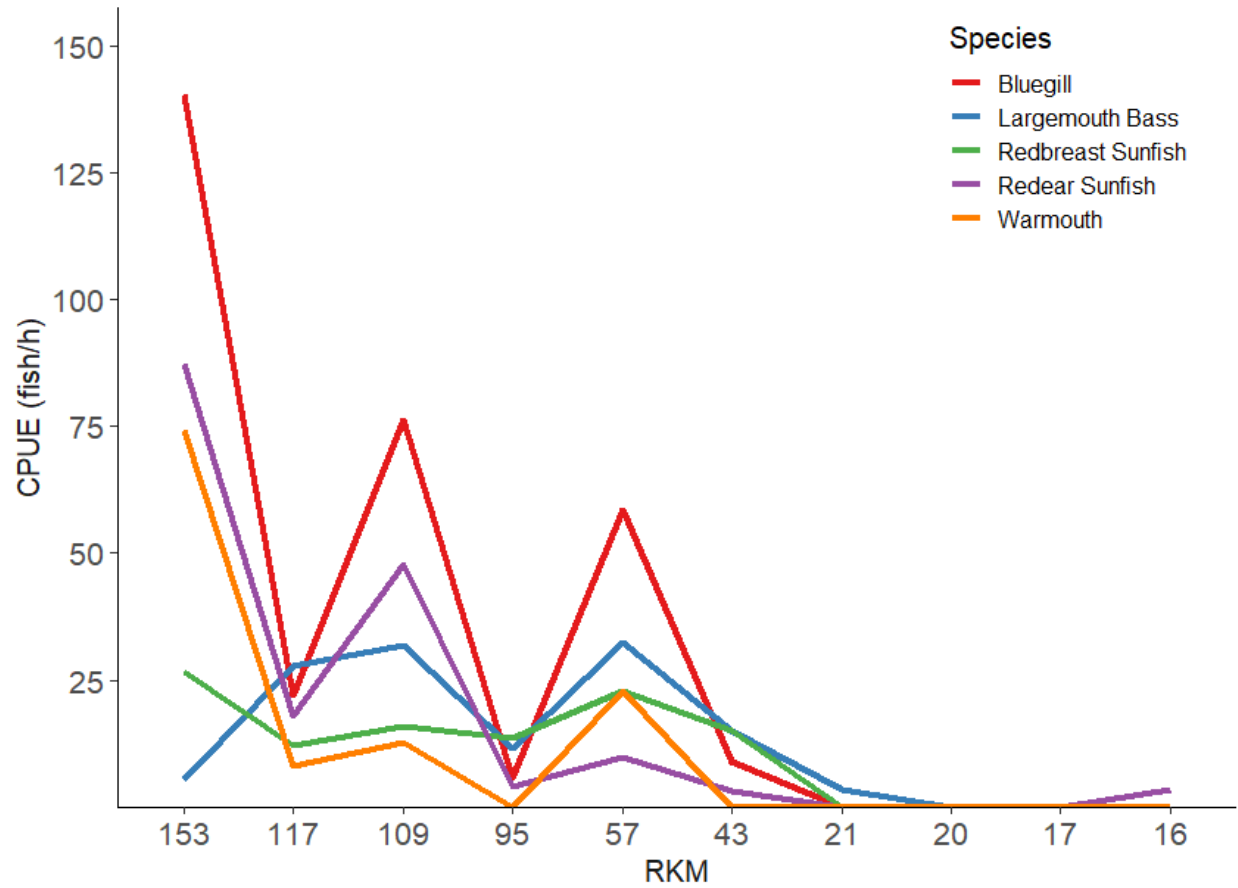


FIGURE 2. Catch-per-unit effort (CPUE, fish/h) by river kilometer (RKM) for inland game fish with greater than 40 individuals captured from South River in 2020.

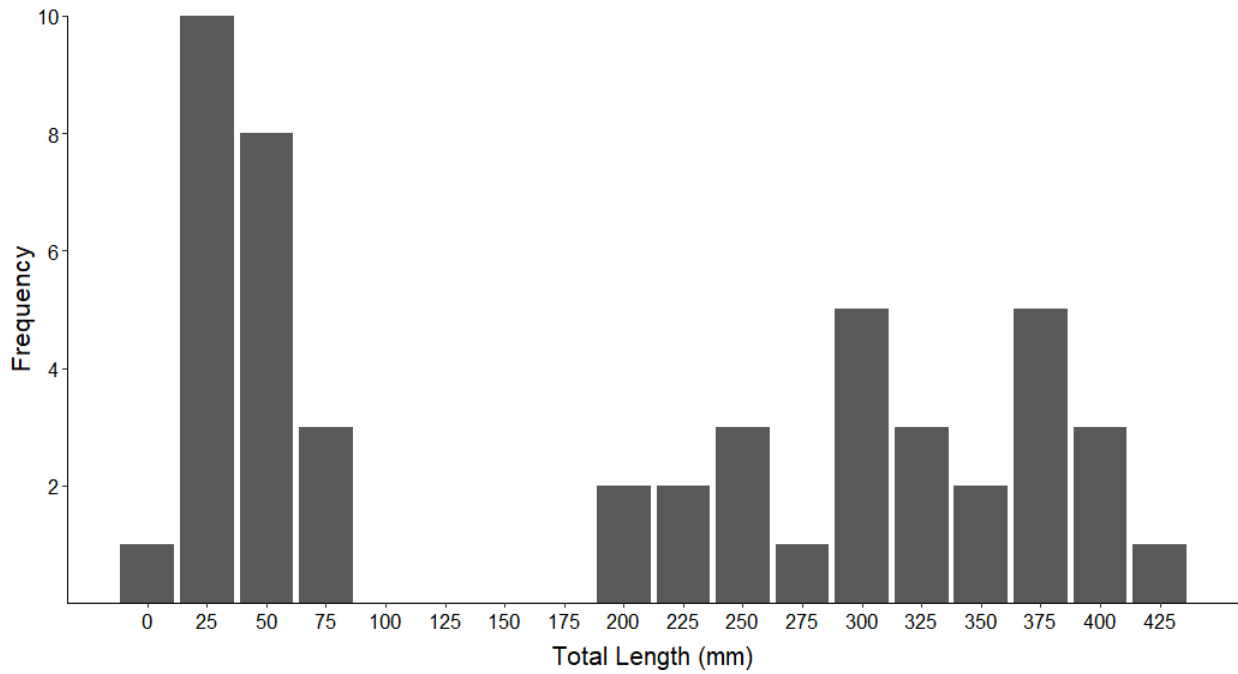


FIGURE 3. Length frequency for Largemouth Bass ($n = 49$) captured from South River in 2020.

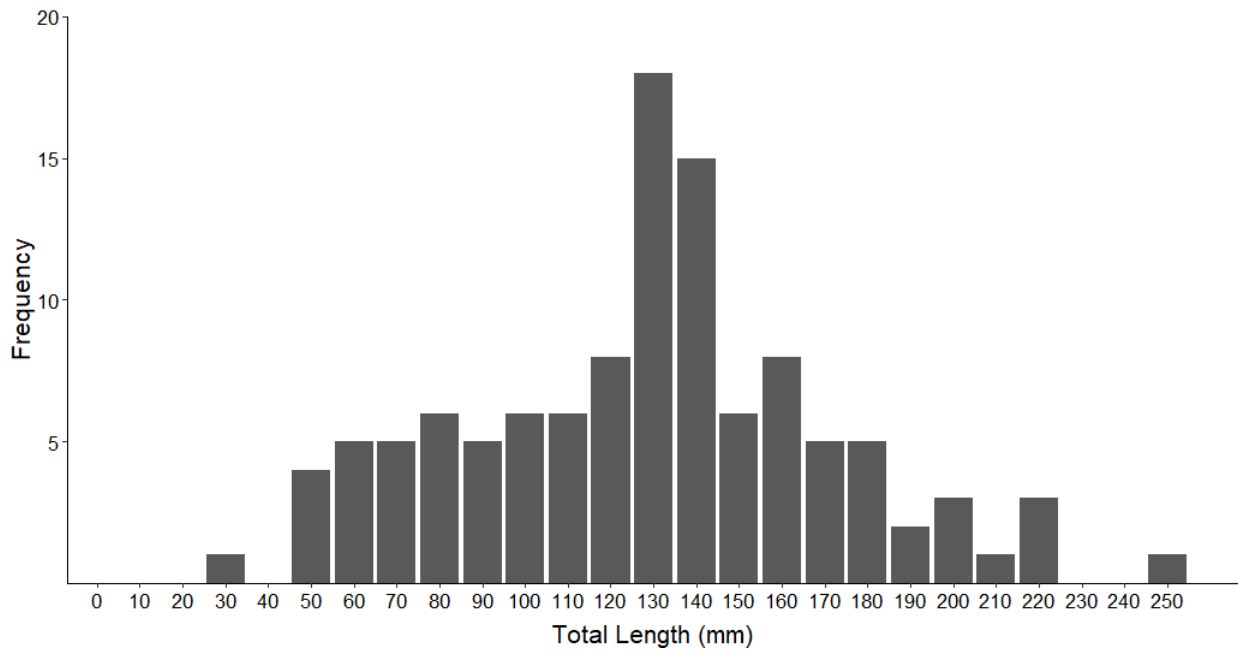


FIGURE 4. Length frequency for Bluegill ($n = 113$) captured from South River in 2020.

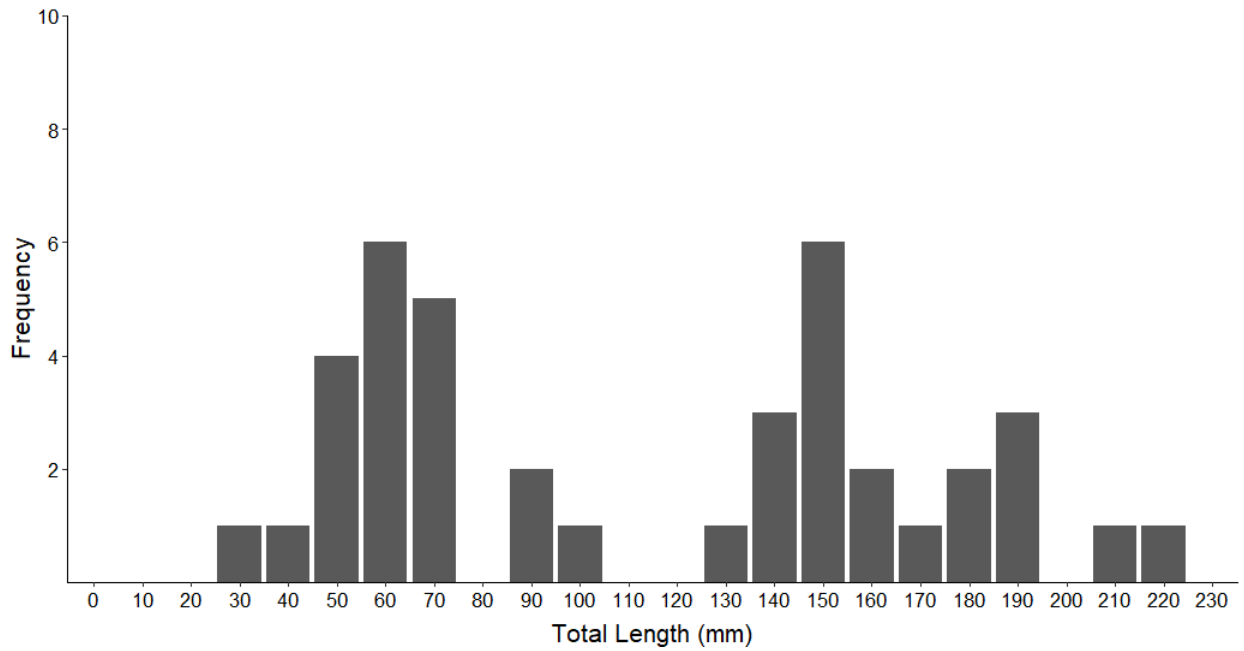


FIGURE 5. Length frequency for Redbreast Sunfish ($n = 40$) captured from South River in 2020.

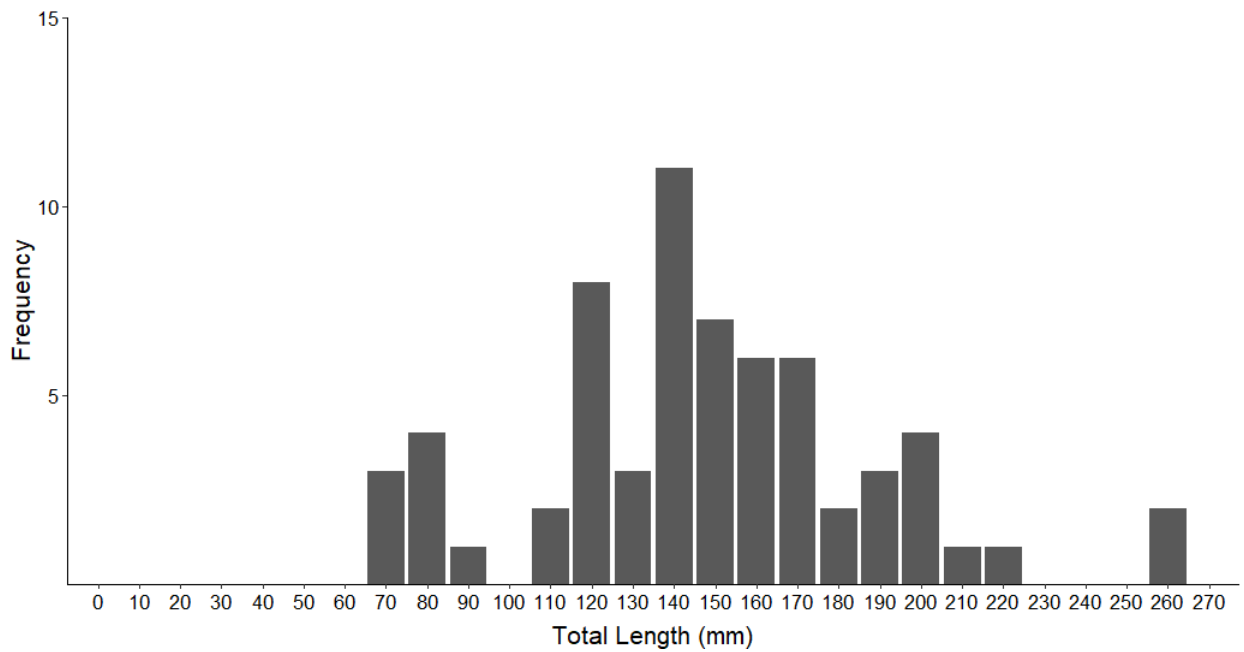


FIGURE 6. Length frequency for Redear Sunfish ($n = 64$) captured from South River in 2020.

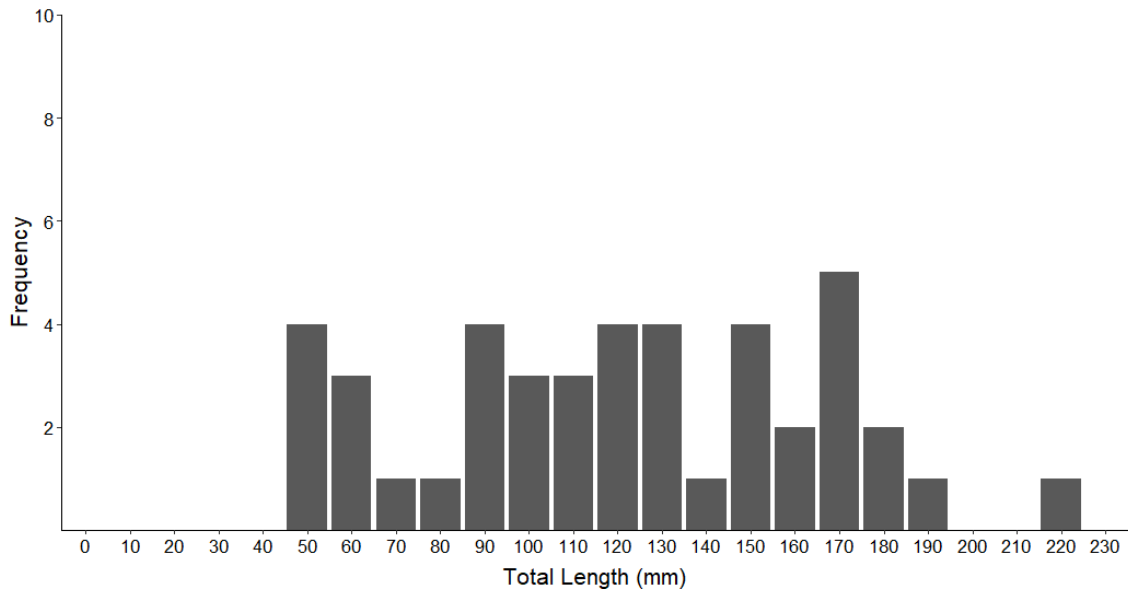


FIGURE 7. Length frequency for Warmouth ($n = 43$) captured from South River in 2020.

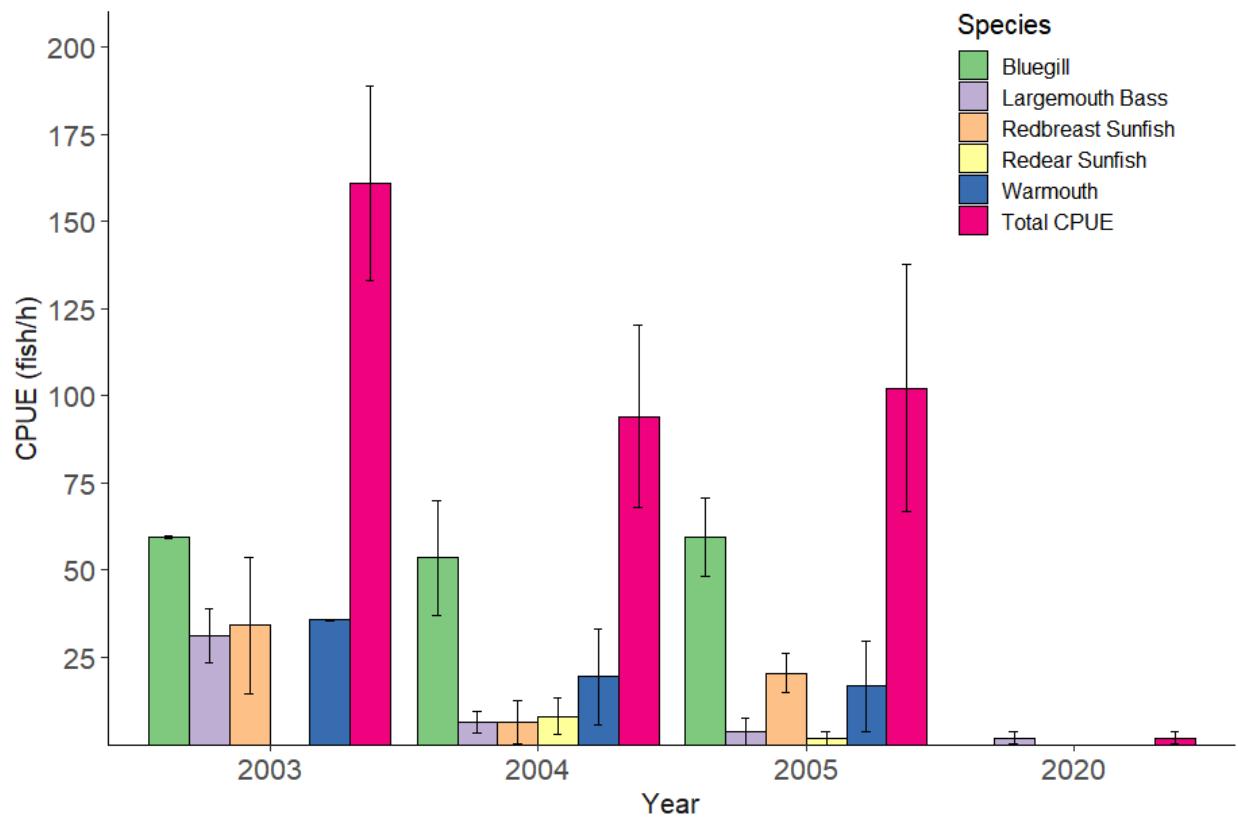


FIGURE 8. Catch-per-unit effort (CPUE, fish/h) by year for five species of sport fish captured from South River during 2003-2005 IBI sampling and 2020 sampling. Error bars represent the standard error of the CPUE for the two sites with similar geographic locations that were sampled each year.