

INVENTORY OF FISHES AT GUILFORD COURTHOUSE NATIONAL MILITARY PARK



Semotilus atromaculatus—Creek chub

© Noel Burkhead & Virginia Dept of Game and Inland Fisheries
(Fishes of Virginia)

Photographer: Noel Burkhead; **Image ID#:** 136

Location: Pauls Creek, Carroll Co., VA; **Date:** 20 June 1984

Gender: male; **Life Stage:** adult

FINAL REPORT SUBMITTED TO:

CUMBERLAND/PIEDMONT INVENTORY AND MONITORING NETWORK
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EXECUTIVE SUMMARY

In 2004, I conducted a fish inventory of Guilford Courthouse National Military Park by sampling three reaches of the two streams that occur within the park; Hunting Creek and an unnamed tributary. Reaches consisted of a 91.44-meter section in the upper portion of the unnamed tributary, a 182.88-meter in the lower portion of the unnamed tributary, and 152.4-meter section of Hunting Creek. Surveys of each reach were conducted in summer and winter 2004 with a backpack electrofishing unit. In each survey, all fish species stunned by the electrofisher were collected and identified. In summer, I measured total length of up to 50 individuals of each species and calculated an index of biotic integrity (IBI) for each stream reach according to the protocols established by the North Carolina Department of Environment and Natural Resources.

Overall, a total of 14 fish species were found; 542 individuals of 11 species in summer and 359 individuals of 14 species in winter. The most abundant species were creek chub *Semotilus atromaculatus*, bluehead chub *Nocomis leptocephalus*, and bluegill sunfish *Lepomis macrochirus*. The IBI for the both reaches of the unnamed tributary were “poor” and the IBI for Hunting Creek was “fair”.

INTRODUCTION

Guilford Courthouse National Military Park (GUCO) is located in Greensboro, North Carolina and preserves and interprets a revolutionary battle that took place in 1781 that helped hasten the end of the Revolutionary War (Hiatt 2003). The 91.9 hectare park is located within the geologic piedmont province, where the Appalachian Mountains transition to the Atlantic coastal plain, in the upper Cape Fear drainage basin (Menhenick 1991). No previous inventories of fishes have been documented for the park, although aquatic habitat for fishes is present and has been described, albeit with some contradictions. Meiman (2002) describes the aquatic environment as a small stream (incorrectly identified as Richland Creek) made up of two tributaries, and a small spring originating from the adjacent Forest Lawn Cemetery (Figure 1). Hiatt (2003) depicts 3 streams, but only identifies Hunting Creek. Stephen Ware, GUCO Chief Ranger, indicated that only Hunting Creek is properly named and is a tributary of Richland Creek further downstream (Figure 2), which was probably the source of confusion. The southern-most of the other two water bodies, described by Meiman (2002) as a spring and by Hiatt (2003) as a stream, was found during this inventory to be a losing stream; one that originates from the cemetery, flows north, disappears underground for several hundred feet, and re-appears approximately mid-way through the park to become one of the unnamed tributaries identified by Hiatt (2003) (Figure 1). Hunting Creek enters from the south at Greensboro County Park, where it is impounded twice, and flows north through the park. Hunting Creek is also impounded downstream of the park (Lake Townsend) after it enters into Richland Creek, but is free flowing within the park. High levels of fecal coliform and fecal streptococci have been documented previously in the Hunting Creek (Meiman 2002).

It is not surprising that there has been confusion regarding the names of streams in the park because the park has seen numerous alterations to its aquatic habitats. Hiatt (2003) provides a good description of past alterations including depictions of several springs and other streams in the park that are not readily apparent today. In 1893, a tributary of Hunting Creek (apparently the current unnamed tributary at the southern portion of the park) was impounded (Lake Wilfong) and a canal dug around for drainage. The Lake Wilfong dam was removed sometime after 1936 when the National Park Service took over administration of the park. In the 1960's, the park acquired property on its eastern boundary that contained part of Hunting Creek that had been previously impounded (Lake Caldwell). Lake Caldwell's dam ruptured in 1959 due to Hurricane Gracie. Hiatt (2003) further indicated significant hydrologic alterations in his recommendation to the park for cultural landscape management: "Reestablish the battle-era drainage courses to the extent possible..." Apparently, past land-management practices have led to significant erosion and other alterations to the hydrology of the park. Furthermore, the many bridges and culverts that exist over these streams from past road building projects continue to contribute to aquatic habitat alterations.

The objective of this study was to inventory the fishes that occur within the boundaries of Guilford Courthouse National Military Park. Furthermore, I wanted to conduct an assessment of the condition of the waterbodies in the park based on the fishes found in them.

METHODS

I sampled for fishes in August and November/December 2004 with a backpack electrofishing unit (Smith Root model LR-24) in three stream reaches of GUCO using standard operating procedures for biological monitoring developed by North Carolina Department of Environment and Natural Resources (NCDENR; 2001). The NCDENR (2001) methodology establishes sampling a 182.88-meter (600-ft) reach of stream that is wadeable for its entire length and electrofishing upstream then downstream. Based on field reconnaissance and barriers (e.g., culverts) already in place in each stream, not all reaches sampled at GUCO could be 182.88 meters in length and I only used one pass in the upstream direction to collect fishes. As a result, I sampled a 91.44-meter reach of upper unnamed tributary (UUT), a 182.88-meter reach of lower unnamed tributary (LUT), and a 152.4-meter reach of Hunting Creek (HC) for sampling. The UUT reach entered the park from the south, flowed under a culvert at the South Tour Loop Road, and continued for approximately 91.44 meters until it disappeared under ground (Figure 1; Photograph 1). The LUT site was located upstream of where it entered Hunting Creek at the northern end of the park and continued 182.88 meters upstream to a culvert at the North Tour Loop Road. The Hunting Creek reach began at the confluence with the LUT and continued upstream (south) for 152.4 meters to a culvert at the Historic New Garden Road, which was also the old Lake Caldwell dam (Photograph 2, 3, and 4). All fish captured were identified (Menhinick 1991) and released except those individuals who were stored in 10% formalin and identified later in the laboratory (Table 1 is a list of fish species and numbers that were stored in formalin and identified in the lab). Every effort was made to identify fish in the field to reduce mortality.

The NCDENR (2001) procedures establishes sampling that allows for an index of biotic integrity (IBI) to be calculated, which rates water bodies as “Excellent”, “Good”, “Good-Fair”, “Fair”, or “Poor”. Briefly, an IBI is a method whereby data from the fish community are used to assess the relative “health” of their aquatic environment (Karr 1981, Karr et al. 1986) and these indices have been modified according to various geographic regions throughout the nation. The NC IBI was modified specifically for North Carolina streams and is based on the calculation of several metrics, the inclusion of which is determined by the watershed of the stream being assessed. For the upper Cape Fear watershed where the streams of GUCO are located, the NC IBI is based on 12 metrics (e.g., number of species, percentage of insectivorous individuals, etc.) and I calculated the IBI for each stream reach based on the August 2004 sampling. In August 2004, up to 50 individuals of each species from each reach were measured for total length (TL; mm) to determine multiple age classes, which is a metric for the NC IBI (NCDENR 2001). For the predominate species found in each stream reach during August 2004 sampling, I constructed length-frequency histograms to examine the population structure.

To compare the inventory of fish in the park to the surrounding region (Figure 3), I obtained a spreadsheet of NCDENR standardized samples collected in streams in surrounding Guilford County from 1998 to 2003 (also accessible on the internet at <http://www.esb.enr.state.nc.us/NCIBI.htm>). I used this regional dataset to compare with data collected from within the park from this survey. I used BioDiversity Pro software (© 1997 The Natural History Museum / Scottish Association for Marine Science) to perform a cluster analysis (complete linkage) based on the Jaccard index of community similarity (Krebs 1989). The

Jaccard index is based on presence/absence data and ranges from 0 (complete dissimilarity) to 100 (complete similarity). The Jaccard index was chosen because the methods used for this study deviated from the ones used to construct the regional dataset (i.e., 182.88 meters of stream sampled upstream and downstream), essentially decreasing the amount of sampling effort by at least half making estimates of absolute abundance incomparable between the two datasets. The regional dataset was a combination of samples sometimes taken from the same stream reach but at different times. Therefore, the dataset represented the fish communities in that reach over a longer time period than a single day.

To determine if 90% of the fish species found in the park were documented from this survey (Nichols et al. 2001), I performed a re-sampling analysis of the dataset by stream reach using EcoSim software (version 7.0; Gotelli and Entsminger 2001). The fish community data for each reach were pooled between sampling efforts and I iteratively resampled 100 and 200 individuals 500 times from each stream reach dataset and calculated the median species richness. The ratio (percentage) of the median resampled species richness to the observed species richness is comparable to the ratio of the observed species richness to the actual (unknown) species richness that occurs in the reach. For NPS inventories, the goal is to determine if 90% of actual species were found (Nichols et al. 2001) and this method provided a means to determine if this goal was met and to predict the actual (unknown) species richness.

In August 2004, I assessed the habitat of each stream reach by measuring specific conductance ($\mu\text{S}/\text{cm}$), dissolved oxygen (mg/L), temperature ($^{\circ}\text{C}$), and pH at the beginning (downstream) and end (upstream) of the reach. Additionally, at every 30.48-meter intervals within each reach, I measured stream width (cm), depth (in the thalweg; cm), and flow (cm/second), and described the substrate size (e.g., silt, sand, etc.) and habitat type (e.g., pool, run, etc.). In November/December 2004, I measured specific conductance ($\mu\text{S}/\text{cm}$), dissolved oxygen (mg/L), temperature ($^{\circ}\text{C}$), and pH at the upstream end of the reach only.

RESULTS

The fish community in these three stream reaches was fairly diverse. Overall, I captured 14 species from 5 families (Table 2). Most individuals, in terms of absolute and relative (catch per unit effort, CPUE) abundance, were captured during the August sampling (Table 3) whereas most species were captured during November/December (Table 4). The most commonly encountered species included creek chub, bluehead chub, and bluegill. The fish community in the UUT was monospecific; only creek chub was found. In the LUT, five species were found in August, whereas seven were found in November/December. During both sampling trips, creek chub dominated the fish community in the LUT followed by bluehead chub. The fish community was most diverse in Hunting Creek during both sampling trips; 10 species in August and 13 in November/December. Bluegills were always the most abundant species in Hunting Creek followed by bluehead chub and creek chub. The NC IBI ranged from “poor” in the two unnamed tributaries to “fair” in Hunting Creek (Table 5). An ancillary finding of this inventory was the documentation of numerous freshwater mussel shells and one live individual at the beginning (0 m) of the Hunting Creek reach (Photograph 5) in August 2004, which were identified as *Elliptio complanata* (shells from 5 dead individuals are housed with the author at

Chattahoochee River National Recreation Area, Atlanta, GA). Also, in November/December 2004, numerous bluegills were observed with bulging eyes apparently caused by a parasitic roundworm, most likely *Philometroides* sp. (Bunkley-Williams and Williams 1994), which has been documented in other North Carolina streams (NCDENR 2004). Life history and ecology of the fishes and other aquatic species are summarized in Appendix A and B.

Population structure of the predominate species varied among stream reaches. In the UUT, which contained the monospecific creek chub community, most individuals captured were young-of-year (i.e., less than 50 mm; Figure 4), but this reach also contained the largest individuals of that species (182 mm) captured of the three reaches (in the pool downstream of the culvert at the south Tour Loop Road (Photograph 1)). Mean length of creek chubs in the UUT was 58.33 mm. In the LUT, the population structure of creek chubs was normally distributed about a mean of 79.96 mm, whereas most bluehead chubs were young-of-year (mean length = 46.58 mm; Figure 5) and only two bluegills were found (76 mm and 120 mm; Figure 6). In Hunting Creek, no young-of-year sized creek chubs were found and the size distribution was skewed toward larger individuals (mean length = 93.68 mm; Figure 4). The population structures of bluehead chub (Figure 5) and bluegill (Figure 6) were similarly normally distributed about means of 78.36 mm and 79.40 mm, respectively.

Four large clusters within the regional dataset were evident (Figure 7). The fish community in the Upper Unnamed Tributary of GUCO, which was monotypic, was the most dissimilar community and was contained within a cluster by itself. The fish communities in the Lower Unnamed Tributary and Hunting Creek of GUCO were contained within a cluster of samples from Richland Creek (State Road [SR] 1154) and South Buffalo Creek (SR 2821 and SR 3300). However, the samples from Richland Creek (SR 1154) and South Buffalo Creek (SR 2821) were more similar to each other than to the group with LUT, Hunting Creek, and South Buffalo Creek at SR 3300. The LUT and Hunting Creek shared 5 and 6 of Richland Creek's (SR 1154) 10 species, 4 and 5 of South Buffalo Creek's (SR 2821) 9 species, and 5 and 9 of South Buffalo Creek's (SR 3300) 13 species (Table 6). It should be noted that the Richland Creek described and sampled by NCDENR (1999, 2004) is not the Richland Creek of which Hunting Creek at GUCO is a tributary (Figure 2 and 3).

The probability that 90% of all species that occur within GUCO were documented by electrofishing in August and November/December 2004 depended on stream reach and electrofishing efficiency, which was not measured (Table 7). In the UUT, statistical resampling would not have resulted in anything less than 100% of possible species detected because it was monospecific. Therefore, we did not conduct a resampling analysis on the UUT fish community. In the LUT, statistical resampling ranged from 71.43% to 85.71% of species being detected, which results in from 8 to 10 species predicted to occur. However, due to the low number of observed species ($N = 7$), 85.71% was the highest mathematically achievable short of 100%. In Hunting Creek, statistical resampling ranged from 76.92% to 92.31% of species detected. At these levels of detectability, from 14 to 17 species are predicted to occur in Hunting Creek.

The physicochemistry among the three stream reaches at GUCO was similar during the August 2004 sampling event but more varied during November/December 2004 (Table 8). However, the

data collected in November/December were on separate days for each reach possibly influencing these results. In general though, specific conductance tended to be higher in Hunting Creek than the two unnamed tributary reaches.

Habitat and flow characteristics differed among the three sampled stream reaches (Table 9). Hunting Creek generally contained a greater diversity of substrate and habitat types and was wider than the other two reaches. Hunting Creek was slightly deeper than Upper Unnamed Tributary, and both were deeper than Lower Unnamed Tributary. Flow tended to be higher in Lower Unnamed Tributary than the other two reaches, which were similar. All stream reaches exhibited active and significant stream bank erosion, which probably contributed to the large number of “silt” substrate categories.

DISCUSSION

In spite of the impact to the streams at Guilford Courthouse National Military Park by past hydrologic alterations and current urbanization of surrounding Greensboro, the fish community was surprisingly diverse. Although the NCIBI ratings (“poor” and “fair”) indicated degraded conditions, our sampling deviated from the NCDENR (2001) standardized sampling by not sampling entire 182.88-meter reaches of stream upstream and downstream. As a result, the number of species and individuals were likely under-represented when applying the NCIBI scores to these data and could affect the results. For example, with the addition of one more species to the Hunting Creek community, the NCIBI would have been upgraded from “fair” to “good-fair”. Nonetheless, applying the NCIBI to these streams at GUCO is further complicated because it is applicable to wadeable streams with watersheds ranging from 8 to 850 km² (3.1 to 328 mi²) (NCDENR 2001). The watersheds of the UUT, LUT, and Hunting Creek reaches were approximately 0.48, 0.71, and 1.14 km², much less than what is applicable under the NCIBI.

The species of fish found during this inventory were all native to the watershed (Menhinick 1991; Appendix A), although some were not characteristic of the habitats found at GUCO. Most notably, black crappie and largemouth bass are not known to regularly inhabit first-order streams. Most likely is that these two species come from the upstream reservoirs outside of park boundaries. With regards to black crappie, all of the individuals captured were young-of-year, suggesting that this species is not self-sustaining in the streams and is a result of downstream migration out of the reservoirs. With regards to largemouth bass, the only adult-sized individuals were found in Hunting Creek in deep pools, suggesting that this species may be somewhat naturalized to the system, but likely requires input from upstream to maintain its population. However, since only largemouth bass was documented among the other known host species for the freshwater mussel (*Elliptio complanata*) that co-occurs in GUCO (Bogan 2002), there is some probability largemouth bass does naturally occur in these small streams. Menhinick (1991) indicates that this species does occur in creeks (0-5 m average width). The species most characteristic of the streams in GUCO, and therefore most likely to have historical occurrence without anthropogenic influence, include creek chubsucker, bluegill, redbreast sunfish, rosieside dace, bluehead chub, and creek chub (Menhinick 1991).

The presence of at least one live freshwater mussel was surprising given the apparent large amounts of silt in the stream, which suffocates and kills many of these individuals. However, the identification of this species indicated that it was one of the more tolerant species of freshwater mussels with broad and general habitat requirements (Bogan 2002).

The cluster analysis with the regional dataset was not able to document any clear trends, except perhaps similar impacts due to urbanization. It was clear that the most similar fish communities between streams from the regional dataset and the streams at GUCO were not due to proximity because they tended to come from several different sub-watersheds (i.e., Richland Creek from Deep River sub-watershed, Buffalo Creek sites from Buffalo Creek sub-watershed, and GUCO sites from Brush Creek sub-watershed). The South Buffalo Creek site at SR 3300 contained the most similar fish communities with GUCO streams, but a description of the site was not readily available for comparison (NCDENR 2004). The south Buffalo Creek site at SR 2821 is located immediately downstream of a wastewater treatment facility for the city of Greensboro, has a watershed of 112.66 km², and has been considered the most degraded site in the Cape Fear drainage (NCDENR 1999, 2004). Richland Creek at SR 1154 is also located near a wastewater treatment facility (city of High Point), but it is unclear whether it is above (NCDENR 1999) or below (NCDENR 2004). This site was described as roughly eight meters wide (NCDENR 1999), much wider than the streams of GUCO, with a heavy sediment load of sand and affected in large amounts due to urbanization (NCDENR 1999, 2004), similar to the streams of GUCO.

The probability that this inventory documented 90% of the fish species residing in the streams of GUCO depends mostly on electrofishing efficiency. As efficiency increases, the predicted species richness from resampling more closely resembles the observed richness. For example, if electrofishing efficiency were 100% (i.e., all individuals within the sampling reach were collected), then the list of predicted species is the list of observed species (i.e., 100% detectability). If electrofishing efficiency was 20%-30% (i.e., resampling 100 of 480-297 total individuals) then the true number of species would range from 10-17. If electrofishing efficiency was 40%-60% (i.e., resampling 200 of 480-297 individuals) then the true number of species would range from 8 to 14. Meador and McIntyre (2003) found that species richness estimates based backpack electrofishing varied only an average of 9.5% within a reach among samples, suggesting high electrofishing efficiencies. Also, given the small size of these streams, the efficiency of sampling was likely more high than low. However, the resampling analysis assumes that there is no emigration or immigration of species, which is unlikely. Probably, some species come into the park irregularly from upstream, especially from the reservoirs outside of the park. Moreover, some species likely migrate upstream into the park during spawning in the spring or summer. Further sampling in these streams would aid in assessing the effect of migration on these fish communities and the efficiency of detecting species in these streams with the methods used in this study.

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Table 1.—Collection dates, species, and numbers of fish taken from Guilford Courthouse National Military Park that were stored in 10% formalin and identified in the laboratory. These specimens are housed with the author at Chattahoochee River National Recreation Area, Atlanta, GA.

Collection date	Species name	Common name	Number
8/24/2004	<i>Ameiurus natalis</i>	Yellow bullhead	1
8/24/2004	<i>Ameiurus platycephalus</i>	Flat bullhead	2
8/24/2004	<i>Ameiurus nebulosus</i>	Brown bullhead	2
8/24/2004	<i>Erimyzon olongus</i>	Creek chubsucker	2
12/1/2004	<i>Lepomis macrochirus</i>	Bluegill sunfish	2
12/1/2004	<i>Lepomis gulosus</i>	Warmouth	1
12/1/2004	<i>Lepomis gibbosus</i>	Pumpkinseed	2
12/1/2004	<i>Gambusia holbrooki</i>	Eastern mosquitofish	1

Table 2.—Common and scientific names of fish captured in streams of Guilford Courthouse National Military Park, Greensboro, North Carolina (August and November/December 2004). Life history and ecology of each species are summarized in Appendix A.

Scientific name	Common name
Family Catastomidae (suckers)	
<i>Erimyzon oblongus</i>	Creek chubsucker
Family Centrarchidae (sunfishes)	
<i>Lepomis auritus</i>	Redbreast sunfish
<i>Lepomis macrochirus</i>	Bluegill
<i>Lepomis gibbosus</i>	Pumpkinseed
<i>Lepomis gulosus</i>	Warmouth
<i>Micropterus salmoides</i>	Largemouth bass
<i>Pomoxis nigromaculatus</i>	Black crappie
Family Cyprinidae (minnows)	
<i>Clinostomus funduloides</i>	Rosyside dace
<i>Nocomis leptcephalus</i>	Bluehead chub
<i>Semotilus atromaculatus</i>	Creek chub
Family Ictaluridae (catfishes)	
<i>Ameiurus natalis</i>	Yellow bullhead
<i>Ameiurus nebulosus</i>	Brown bullhead
<i>Ameiurus platycephalus</i>	Flat bullhead
Family Poeciliidae (livebearers)	
<i>Gambusia holbrooki</i>	Eastern mosquitofish

Table 3.—Numbers and species of fish found in three stream reaches of Guilford Courthouse National Military Park, Greensboro, North Carolina, August 2004.

Common name	Number of individuals			
	Hunting Creek	Lower Unnamed Tributary	Upper Unnamed Tributary	Grand Total
Black crappie	1			1
Bluegill	121	2		123
Bluehead chub	88	31		119
Brown bullhead	2			2
Creek chub	37	148	79	264
Creek chubsucker	5			5
Flat bullhead	9			9
Largemouth bass	4	2		6
Redbreast sunfish	5			5
Rosyside dace		4		4
Yellow bullhead	4			4
Grand Total	276	187	79	542
Total electrofishing effort (s)	1409	1126	1204	3739
Catch per unit effort (no/s)	0.20	0.17	0.07	0.14
Number of species	10	5	1	11

Table 4.—Numbers and species of fish found in three stream reaches of Guilford Courthouse National Military Park, Greensboro, North Carolina, November/December 2004.

Common Name	Number of individuals			
	Hunting Creek	Lower Unnamed Tributary	Upper Unnamed Tributary	Grand Total
Black crappie	4			4
Bluegill	117	11		128
Bluehead chub	40	29		69
Brown bullhead	1			1
Creek chub	19	63	45	127
Creek chubsucker	3			3
Eastern mosquitofish	1	1		2
Flat bullhead	2			2
Largemouth bass	6	2		8
Pumpkinseed	4			4
Redbreast sunfish	1	1		2
Rosyside dace		3		3
Warmouth	2			2
Yellow bullhead	4			4
Grand Total	204	110	45	359
Total electrofishing effort (s)	4745	3404	1312	9461
Catch per unit effort (no/s)	0.04	0.03	0.03	0.04
Number of species	13	7	1	14

Table 5.—Metrics and scores of the North Carolina index of biotic integrity (IBI) used for the streams at Guilford Courthouse National Military Park. Only those data from August 2004 were used to calculate the IBI. Discrepancies between data in this table and Table 3 are the result of young-of-year fish excluded for IBI calculations. The final IBI score is a sum of the scores for each metric, which is then assigned a rating. Lower scores result in a lower (poorer) rating.

Metric	Result (IBI score)		
	Hunting Creek	Lower Unnamed Tributary	Upper Unnamed Tributary
Number of species	9 (1)	4 (1)	1 (1)
Number of fish	253 (5)	141 (1)	24 (1)
Number of darter species	0 (1)	0 (1)	0 (1)
Number of sunfish species	3 (3)	1 (1)	0 (1)
Number of sucker species	1 (3)	0 (1)	0 (1)
Number of intolerant species	0 (1)	0 (1)	0 (1)
Percentage of tolerant individuals	22.53% (5)	92.91% (1)	100.00% (1)
Percentage of omnivorous and herbivorous individuals	37.15% (3)	4.26% (1)	0.00% (1)
Percentage of insectivorous individuals	62.45% (3)	95.74% (1)	100.00% (1)
Percentage of piscivorous individuals	0.40% (3)	0.00% (1)	0.00% (1)
Percentage of diseased fish (DELT)	0.00% (5)	0.00% (5)	4.17% (1)
Percentage of species with multiple age groups	55.56% (5)	50.00% (5)	100.00% (5)
IBI Rating	Fair (38)	Poor (20)	Poor (16)

Table 6.—Species found in the Lower Unnamed Tributary (LUT) and Hunting Creek from backpack electrofishing at Guilford Courthouse National Military Park in August and November/December 2004 compared to NCDENR standardized sampling sites that clustered nearby in a cluster analysis based on Jaccard similarity indices (see Figure 7).

Species	LUT	Hunting Creek	Richland Cr SR 1154	S Buffalo Cr SR 2821	S Buffalo Cr SR 3300
Black crappie	0	5	0	0	0
Bluegill	13	238	6	6	5
Bluehead chub	60	128	0	0	2
Brown bullhead	0	3	0	0	1
Creek chub	211	56	87	0	0
Creek chubsucker	0	8	75	0	2
E. mosquitofish	1	1	0	7	21
Flat bullhead	0	11	10	5	5
Golden shiner ¹	0	0	1	1	0
Green sunfish ²	0	0	35	20	7
Largemouth bass	4	10	1	2	2
Pumpkinseed	0	4	0	0	9
Red shiner ³	0	0	0	1	80
Redbreast sunfish	1	6	271	47	304
Rosyside dace	7	0	16	0	0
Snail bullhead ⁴	0	0	0	2	0
Speckled killifish ⁵	0	0	98	0	0
Sunfish sp. ⁶	0	0	0	0	1
Tessalated darter ⁷	0	0	0	0	1
Warmouth	0	2	0	0	0
Yellow bullhead	0	8	0	0	0
Number of species	7	13	10	9	13

¹ *Notemigonus crysoleucas*, ² *Lepomis cyanellus*, ³ *Cyprinella lutrensis*, ⁴ *Ameiurus brunneus*, ⁵ *Fundulus rathbuni*, ⁶ *Lepomis* sp., ⁷ *Etheostoma olmstedii*.

Table 7.—Species richness calculated by resampling the pooled fish community dataset for two stream reaches at Guilford Courthouse National Military Park that was sampled for fishes in August and November/December 2004. The median species richness was calculated over 500 iterations of resampling from 100 to 200 individuals. The predicted richness was calculated by dividing the observed richness (O) by the respective ratio (percentage) of median (M) to observed richness and rounding up to the nearest whole number. The fish community in Upper Unnamed Tributary was monospecific and not included in this analysis.

Stream Reach	Number resampled	Median Richness (M)	Observed Richness (O)	Percentage (M/O*100)	Predicted Actual Richness
Lower Unnamed Tributary	100	5	7	71.43%	10
Lower Unnamed Tributary	200	6	7	85.71%	8
Hunting Creek	100	10	13	76.92%	17
Hunting Creek	200	12	13	92.31%	14

Table 8.—Physicochemical measurements of three stream reaches in Guilford Courthouse National Military Park during fish sampling in August and November/December 2004. Superscript in the reach denotes the number of the photograph later in the report.

Date	Reach	Location within reach	Specific conductance (µS/cm)	Dissolved oxygen (mg/L)	Temperature (°C)	pH
8/24/2004	Upper unnamed tributary	Downstream	113.8	0.30 ^a	20.9	6.90
8/24/2004	Upper unnamed tributary ¹	Upstream	113.9	0.28 ^a	21.3	6.17
8/24/2004	Lower unnamed tributary	Downstream	126.5	0.26 ^a	21.5	6.99
8/24/2004	Lower unnamed tributary	Upstream	125.8	0.28 ^a	20.9	7.12
8/24/2004	Hunting Creek ²	Downstream	143.1	0.16 ^a	21.0	6.94
8/24/2004	Hunting Creek ⁴	Upstream	134.7	0.29	21.3	6.78
11/30/2004	Upper unnamed tributary	Upstream	89.9	7.93	15.7	6.83
12/1/2004	Lower unnamed tributary	Upstream	96.5	10.31	12.4	6.86
12/2/2004	Hunting Creek	Upstream	101.9	10.94	6.6	6.61

^a Dissolved oxygen meter found to be defective making results unreliable.

Table 9.—Habitat and flow characteristics of three stream reaches in Guilford Courthouse National Military Park during fish sampling in August 24, 2004. Superscript in the reach denotes the number of the photograph later in the report.

Reach	Location within reach (meters upstream)	Substrate	Habitat type	Width (cm)	Depth (cm)	Flow (cm/s)
Upper unnamed tributary	0	Silt	Pool	121.92	16.00	0.03
Upper unnamed tributary	30.48	Boulder/silt	Riffle	96.53	2.00	NA
Upper unnamed tributary	60.96	Silt	Run	104.15	10.00	0.91
Upper unnamed tributary ¹	91.44	Silt	Pool	289.56	50.00	0.91
Lower unnamed tributary	0	Gravel	Riffle	55.78	6.00	2.13
Lower unnamed tributary	30.48	Silt/gravel	Pool	172.82	8.00	1.83
Lower unnamed tributary	60.96	Cobble/silt	Riffle	30.48	4.00	1.52
Lower unnamed tributary	91.44	Boulder/silt	Pool	131.98	10.00	0.91
Lower unnamed tributary	121.92	Boulder/silt	Pool	121.92	4.00	1.52
Lower unnamed tributary	152.40	Bedrock/boulder	Riffle	78.64	12.00	0.91
Lower unnamed tributary	182.88	Boulder/silt	Riffle	60.96	3.00	2.44
Hunting Creek ²	0	Gravel/silt	Riffle	259.08	8.00	0.91
Hunting Creek	30.48	Silt	Run	205.74	27.00	0.30
Hunting Creek ³	60.96	Gravel/cobble	Riffle	325.22	6.00	0.61
Hunting Creek	91.44	Gravel/silt	Pool/undercut bank	223.42	40.00	0.91
Hunting Creek	121.92	Boulder/cobble	Riffle	192.94	4.00	0.61
Hunting Creek ⁴	152.40	Gravel/silt	Pool	543.46	44.00	0.30

Figure 1.—Roads and streams of Guilford Courthouse National Military Park, Greensboro, North Carolina. Boxes around streams indicate sampled reaches.

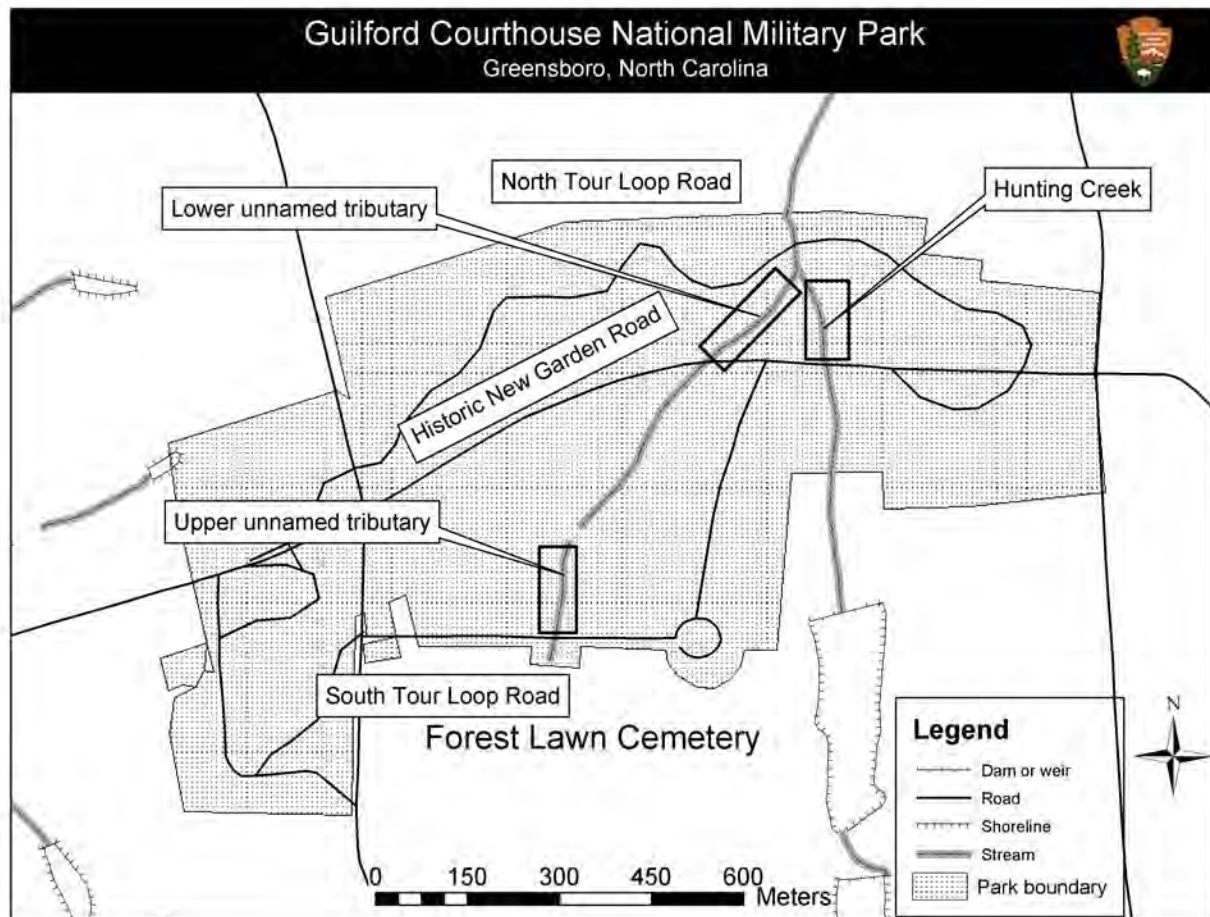


Figure 2.—Location of Guilford Courthouse National Military Park in relation to surrounding landscape and hydrology.

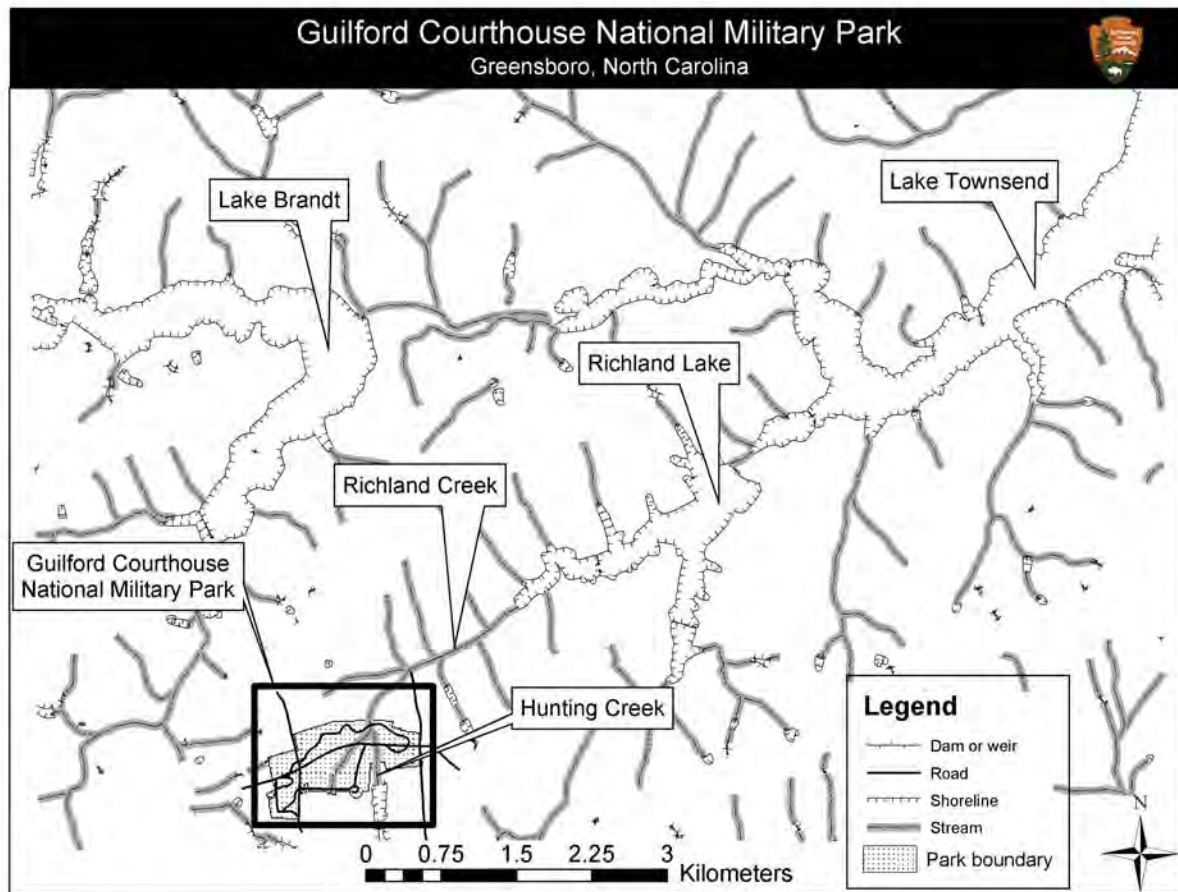


Figure 3.—Map of streams in Guilford County, North Carolina surrounding Guilford Courthouse that have been sampled for fish as part of NCDENR's standardized sampling from 1998 to 2003. Not all stream segments for the sampling sites were available as a GIS layer and are not shown.

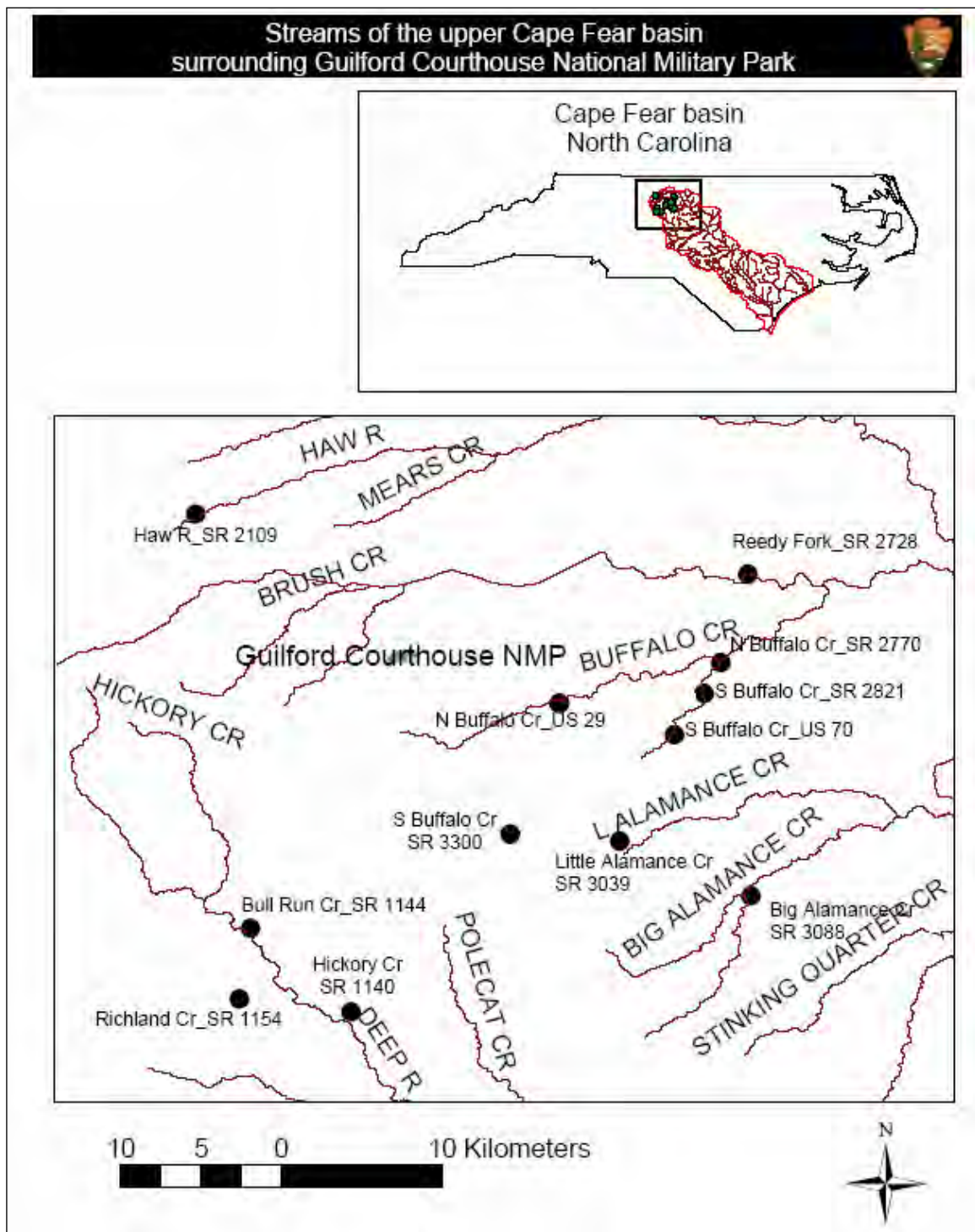


Figure 4.—Length-frequency histograms of creek chub populations in three stream reaches of Guilford Courthouse National Military Park, August 2004. YOY is young-of-year (those fish spawned in the year concurrent with sampling).

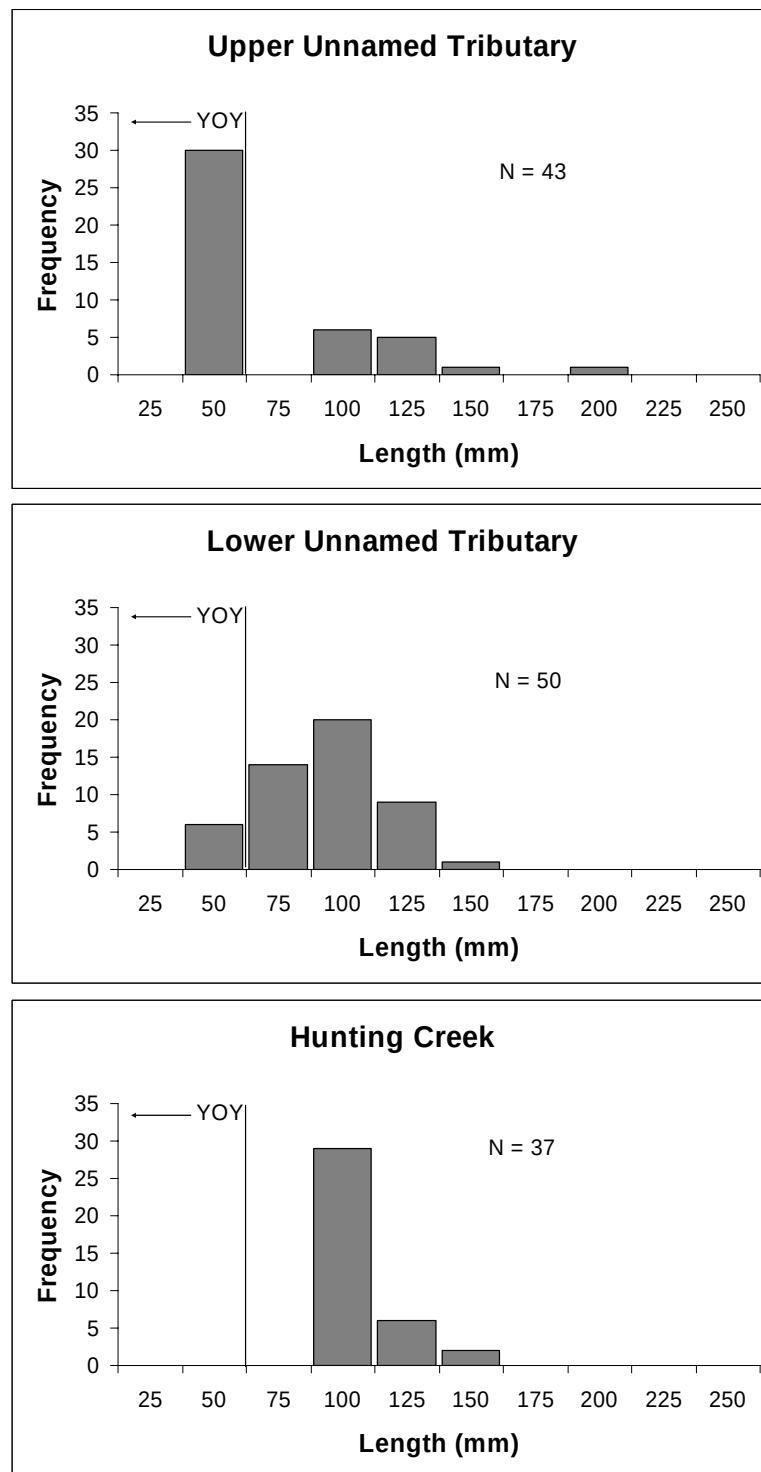


Figure 5.—Length-frequency histograms of bluehead chub populations in two stream reaches of Guilford Courthouse National Military Park, August 2004. Bluehead chubs were absent from Upper Unnamed Tributary. YOY is young-of-year (those fish spawned in the year concurrent with sampling).

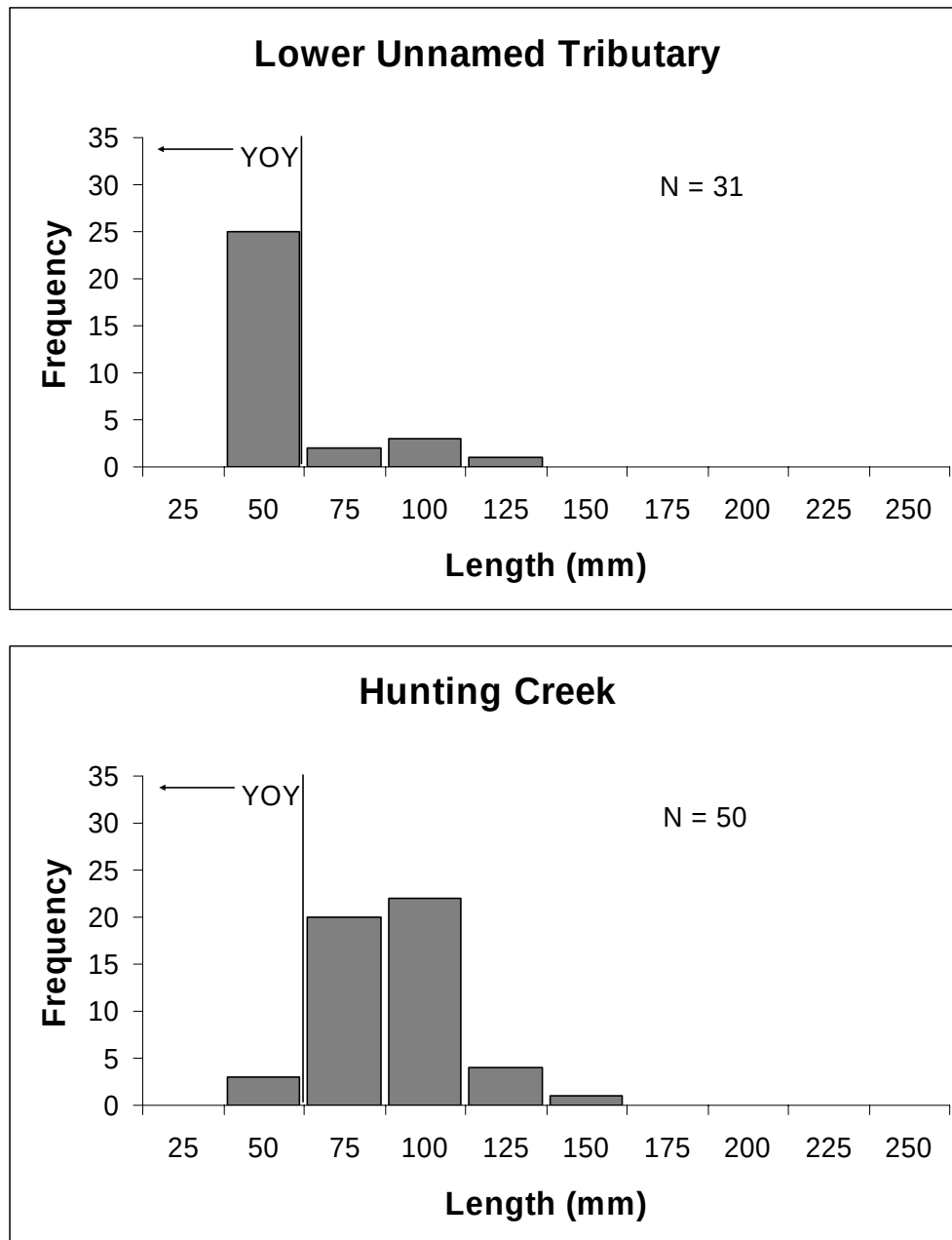


Figure 6.—Length-frequency histograms of bluegill populations in two stream reaches of Guilford Courthouse National Military Park, August 2004. Bluegills were absent from Upper Unnamed Tributary. YOY is young-of-year (those fish spawned in the year concurrent with sampling).

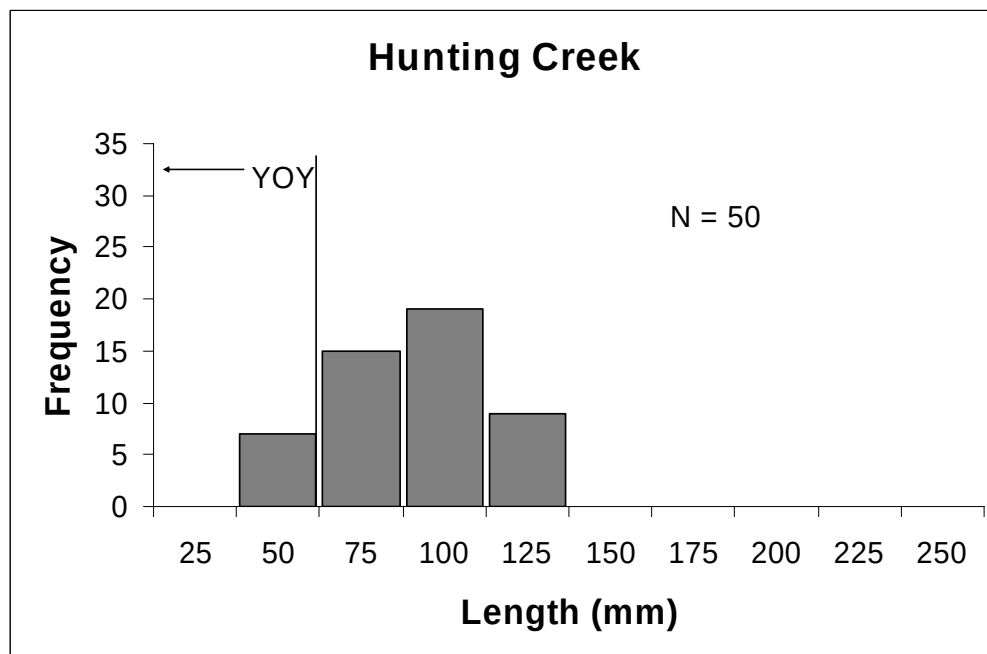
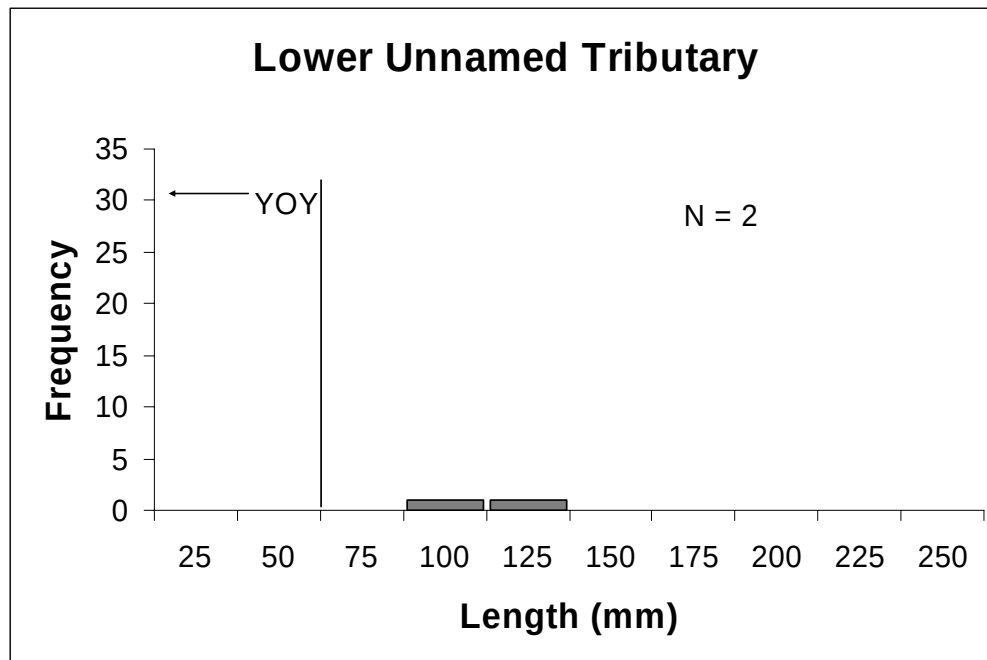
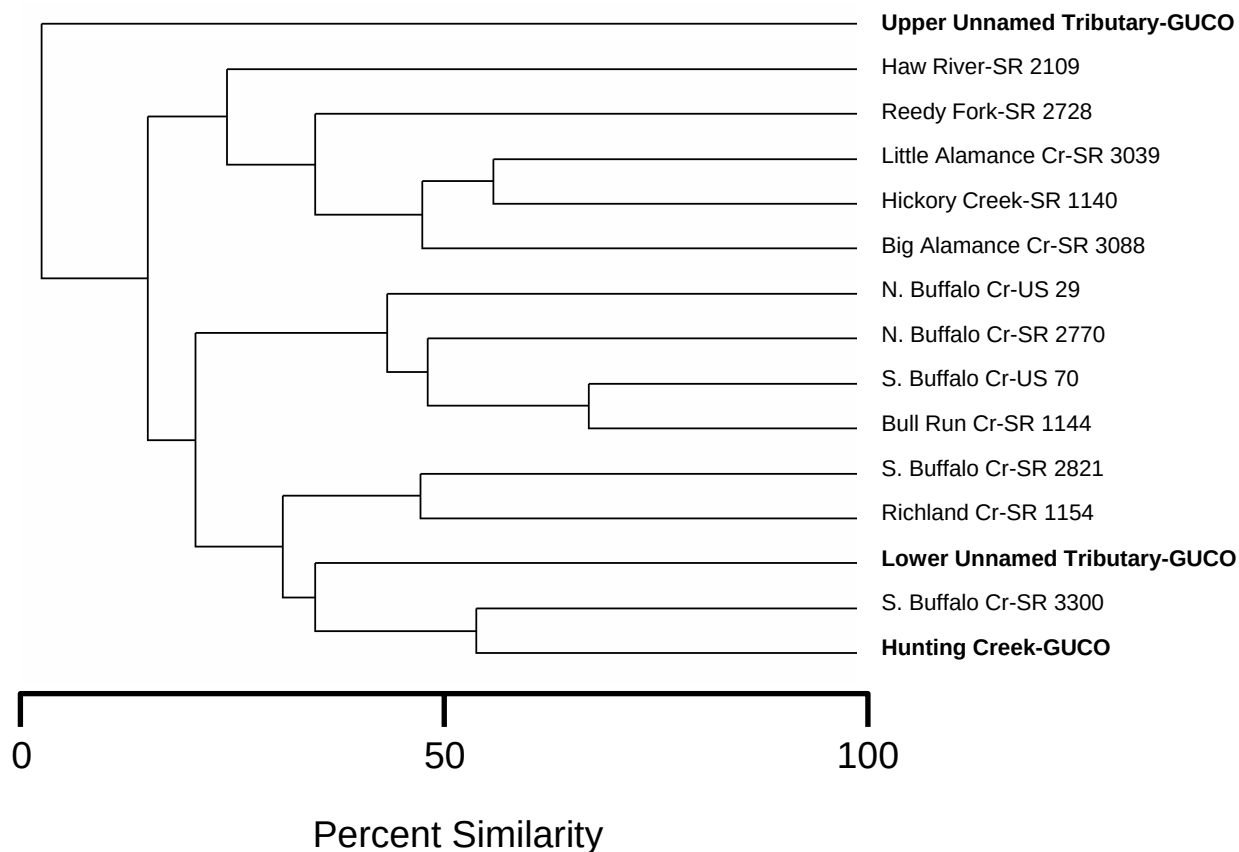


Figure 7.—Cluster analysis dendrogram of Jaccard index similarities (percent) of fish communities in three stream reaches sampled in August and November/December 2004 in Guilford Courthouse National Military Park (GUCO) in relation to fish communities sampled by NCDENR in other streams of surrounding Guilford County. Locations of NCDENR samples are shown in Figure 3.



Photograph 1.—End point (91.44 m) of the upper unnamed tributary (UUT) reach of Guilford Courthouse National Military Park that was sampled for fish in August and November/December 2004. The photograph depicts the downstream end of the culvert at the south Tour Loop Road (Figure 1). Physicochemical characteristics and habitat descriptions are found in Tables 8 and 9. The water level in the stream is approximately 0.33 meters below the bottom of the culvert, making this culvert a barrier to upstream fish passage at all but high flows.



Photograph 2.—Beginning point (0 m) of Hunting Creek reach, Guilford Courthouse National Military Park, that was sampled for fish in August and November/December 2004. Note the incised bank on the right. Physicochemical characteristics and habitat descriptions are found in Tables 8 and 9.



Photograph 3.—Middle point (60.96 m) of Hunting Creek reach, Guilford Courthouse National Military Park, that was sampled for fish in August and November/December 2004. The photograph was taken from a footbridge on a trail north of Historic New Garden Road and is looking upstream. Physicochemical characteristics and habitat descriptions are found in Tables 8 and 9.



Photograph 4.—End point (152.40 m) of Hunting Creek reach, Guilford Courthouse National Military Park, that was sampled for fish in August and November/December 2004. This culvert is located at the site of the defunct Lake Caldwell dam and impedes fish passage upstream except during high flows. Physicochemical characteristics and habitat descriptions are found in Tables 8 and 9.



Photograph 5.—Live native freshwater mussel, *Elliptio complanata*, found at the beginning point (0 m) of Hunting Creek reach, Guilford Courthouse National Military Park, that was sampled for fish in August and November/December 2004. See Photograph 2 and Tables 8 and 9 for physicochemical characteristics and habitat descriptions.



APPENDIX A

LIFE HISTORY AND ECOLOGY OF FISH SPECIES FOUND IN STREAMS OF GUILFORD COURTHOUSE NATIONAL MILITARY PARK GREENSBORO, NORTH CAROLINA

(NatureServe 2004¹)

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NatureServe. 2004. NatureServe Explorer: An online encyclopedia of life [web application]. Version 4.0. NatureServe, Arlington, Virginia. Available <http://www.natureserve.org/explorer>. (Accessed: October 21, 2004).

***Erimyzon oblongus* - (Mitchill, 1814)**

Creek Chubsucker

Range USA:

AL, AR, CT, DC, DE, FL, GA, IL, IN, KY, LA, MA, MD, ME, MI, MO, MS, NC, NH, NJ, NY, OH, OK, PA, RI, SC, TN, TX, VA, WI (exotic), WV

Conservation Status

Global: G5 (secure)

National: N5 (secure)

Ecology & Life History

Inhabits small rivers and creeks of various types; seldom in impoundments; young typically in headwater rivulets or marshes. Sand- and gravel-bottomed pools of clear headwaters, creeks, and small rivers; often near vegetation; occasionally in lakes. Spawns in river mouths or pools, riffles, lake outlets, upstream creeks. Locally migrates upstream in spring to spawn. Eggs hatch in about 4 days. Eats small invertebrates and algae. Attains lengths to 29 cm.



© Noel Burkhead & Virginia Dept of Game and Inland Fisheries (Fishes of Virginia)

Photographer: Noel Burkhead

Image ID#: 80

Location: Craig River, Craig Co., VA

Date: 17 May 1984

Gender: male

Life Stage: adult

***Lepomis auritus* - (Linnaeus, 1758)**

Redbreast Sunfish

Range USA:

AL, AR, CT, DC, DE, FL, GA, KY (exotic), LA (exotic), MA, MD, ME, MS (exotic), NC, NH, NJ, NY, OK (exotic), PA, RI, SC, TN, TX (exotic), VA, VT, WV

Conservation Status

Global: G5 (secure)

National: N5 (secure)

Ecology & Life History

Spawns in spring and summer; male guards nest, fans eggs, and may briefly guard hatchlings; sexually mature when 2-3 years old; nests may be close together. In a large Coastal Plain stream in Georgia, marked individuals usually stayed in a small area (within 33 m of original capture location), but some moved up to 200 m away. Inhabits rocky and sandy pools and margins of creeks and small to medium rivers; rocky and vegetated lake margins. In streams with rapids, occurs in deeper slower areas over rock and gravel, often near cover or obstructions. Aggregates in deeper holes when water temperature fall below about 5 C. Eggs are laid in nests made by male on bottom; nests may be close together in ponds and lakes, usually on downstream side of rock in stream. There is a report of apparently successful nesting in tidal water in Virginia. Eats mainly immature aquatic insects; also other invertebrates. Grows to 16 cm.

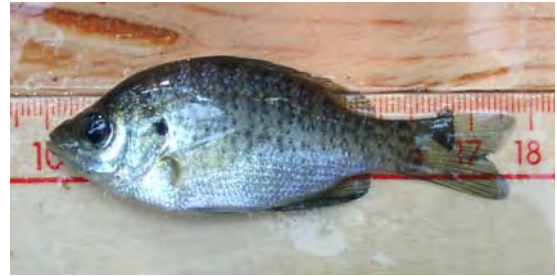


NPS Photo (Jim Long)

***Lepomis macrochirus* - Rafinesque, 1819**
Bluegill

Range USA:

AL, AR, AZ (exotic), CA (exotic), CO (exotic), CT (exotic), DC (exotic), DE (exotic), FL, GA, IA, ID (exotic), IL, IN, KS, KY, LA, MA (exotic), MD, MI, MN, MO, MS, MT (exotic), NC, ND, NE, NH (exotic), NJ (exotic), NM (exotic), NN (exotic), NV (exotic), NY, OH, OK, OR (exotic), PA, RI (exotic), SC, SD, TN, TX, UT (exotic), VA, VT, WA (exotic), WI, WV, WY (exotic)



NPS Photo (Jim Long)

Conservation Status

Global: G5 (secure)

National: N5 (secure)

Ecology & Life History

Spawns in spring and summer; eggs hatch in 2-3 days at 20 C; spawners may be 1 year old, but usually are 2-3 years old; male guards eggs and hatchlings; often nests in colonies. Occurs in warm shallow lakes, reservoirs, ponds, swamps, sloughs, and slow-flowing rivers and streams; often associated with rooted aquatic plants and with bottoms of silt, sand, or gravel. Seldom goes much deeper than 5 m. Large individuals seek more open water than do smaller ones. Eggs are laid in a nest made in shallow water by the male on bottoms of gravel, sand, or mud that contain pieces of debris. After yolk sac absorbed, larvae move from littoral to limnetic zone; 30-40 days later they return to littoral zone. Feeds opportunistically on aquatic insect larvae, planktonic crustaceans, flying insects, snails, and other small invertebrates; small fishes, fish eggs, crayfish, and algae sometimes are eaten. Larvae and juveniles often eat cladocerans and copepod nauplii. Adults eat mainly aquatic insects, crayfishes, and small fishes, or, in some bodies of water, mostly zooplankton. Feeds at all levels of water column. Attains lengths up to 41 cm.

***Lepomis gibbosus* - (Linnaeus, 1758)**

Pumpkinseed

Range USA:

AL (exotic), AZ (exotic), CA (exotic), CO (exotic), CT, DC, DE, GA, IA, ID (exotic), IL, IN, KY, MA, MD, ME, MI, MN, MT (exotic), NC, ND, NE, NH, NJ, NV (exotic), NY, OH, OR (exotic), PA, RI, SC, TN (exotic), TX (exotic), VA, VT, WA (exotic), WI, WV, WY (exotic)

Conservation Status

Global: G5 (secure)

National: N5 (secure)

Ecology & Life History



© Noel Burkhead & Virginia Dept of Game and Inland Fisheries (Fishes of Virginia)

Photographer: Noel Burkhead

Image ID#: 86

Location: Craig River, Craig Co., VA

Date: 17 May 1984

Gender: male

Life Stage: adult

Spawns in spring and summer; eggs hatch in about 3-5 days; male guards eggs; sexually mature in 2nd or 3rd year; may nest in colonies. Lakes, reservoirs, ponds, sloughs, and sluggish streams; prefers quiet, clear water with aquatic vegetation and some organic debris. May occur in large numbers in shallow sheltered situations. Eggs are laid in a nest constructed by the male in shallow water (less than 1 m deep) in bottoms of sand, gravel, or woody debris. Eats snails, aquatic insects, and other invertebrates obtained from bottom or from plant surfaces; pharyngeal jaws are specialized for crushing hard-shelled prey; larvae eat zooplankton. Grows to 40 cm.

***Lepomis gulosus* - (Cuvier, 1829)**

Warmouth

Range USA:

AL, AR, AZ (exotic), DC (exotic), DE (exotic), FL, GA, IA, ID (exotic), IL, IN, KS, KY, LA, MD, MI, MO, MS, NC, NJ (exotic), NM (exotic), NV (exotic), NY (exotic), OH, OK, OR (exotic), PA, SC, TN, TX, VA, WA (exotic), WI, WV



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Conservation Status

Global: G5 (secure)

National: N5 (secure)

Ecology & Life History

Spawns in spring and summer. Eggs hatch in 34.5 hours at 25-26 C. Sexually mature usually in 2nd or 3rd summer. Male guards and fans eggs. May spawn 2 or more times per season. Ponds, lakes, swamps, and streams of low gradient with mud or debris over bottom; a pool species in streams where it often is near beds of vegetation or other cover; weedy turbid areas of rivers and backwaters. Tolerant of low oxygen levels of polluted waters. Common in lowlands, uncommon in uplands (Page and Burr 1991). Eggs are laid in a bowl-like nest made by male often in sand or rubble bottom with thin covering of silt or detritus near a rock, stump, clump of vegetation, or similar object, at depths of 15 cm to 1.5 m. Nests usually are separated from one another. Eats small crustaceans, aquatic insect larvae, and (large individuals) crayfish and fishes. Length to 28 cm.

***Micropterus salmoides* - (Lacepede, 1802)**

Largemouth Bass

Range USA:

AL, AR, AZ (exotic), CA (exotic), CO (exotic), CT (exotic), DC (exotic), DE (exotic), FL, GA, IA, ID (exotic), IL, IN, KS, KY, LA, MA (exotic), MD (exotic), ME (exotic), MI, MN, MO, MS, MT (exotic), NC, ND, NE, NH (exotic), NJ (exotic), NM (exotic), NN (exotic), NV (exotic), NY, OH, OK, OR (exotic), PA, RI (exotic), SC, SD, TN, TX, UT (exotic), VA, VT (exotic), WA (exotic), WI, WV, WY (exotic)



NPS Photo (Jim Long)

Conservation Status

Global: G5 (secure)

National: N5 (secure)

Ecology & Life History

Spawns mainly in spring, also in summer, when temperature in nesting area at least 14-15 C. Eggs hatch in 2-5 days (also reported as at least 4 days). Male guards eggs and hatchlings. Sexually mature in 2-5 years, depending on growth rate, which increases with increasing temperature. May have small summer range or may wander widely. Young have strong schooling tendency. Warm quiet waters with low turbidity, soft bottom, and beds of aquatic plants; farm ponds, swamps, lakes, reservoirs, sloughs, creek pools, and river backwaters. Usually close to shore in lakes and reservoirs. Largest numbers are in mesotrophic to eutrophic lakes or reservoirs. Generally inhabits deeper water in winter. Eggs are laid in a shallow depression nest made by the male in sand, gravel, or debris-littered bottom, often at depths of 1-2 m (also reported as 1.5-7 m, and as shallow as 20-30 cm), often next to submerged objects. Nests usually are more than 9 m apart. Fry feed mainly on zooplankton. Larger young eat insects, crustaceans, and fish fry. Adults eat mainly fishes, though sometimes prefer crayfish or amphibians. Usually relatively inactive at night after intense activity at dusk; active most of day. Length to 70 cm.

***Pomoxis nigromaculatus* - (Lesueur, 1829)** Black Crappie

Range USA:

AL, AR, AZ (exotic), CA (exotic), CO (exotic), CT (exotic), DC (exotic), DE (exotic), FL, GA, IA, ID (exotic), IL, IN, KS (exotic), KY, LA, MA (exotic), MD (exotic), ME (exotic), MI, MN, MO, MS, MT (exotic), NC, ND, NE, NH (exotic), NJ (exotic), NM (exotic), NV (exotic), NY, OH, OK, OR (exotic), PA, RI (exotic), SC, SD, TN, TX, UT (exotic), VA, VT, WA (exotic), WI, WV, WY (exotic)



NPS Photo (Jim Long)

Conservation Status

Global: G5 (secure)

National: N5 (secure)

Ecology & Life History

Spawns in spring and summer; eggs hatch in about 2-5 days; male guards eggs and hatchlings; sexually mature in 2nd or 3rd year; nests in loose colonies. Most abundant in large, warm, clear lakes and reservoirs and clear river backwaters; usually associated with large beds of aquatic plants and sandy to mucky bottoms. Usually in localized schools near submerged objects during day. Eggs are laid in a nest made by the male in bottoms ranging from mud to gravel, usually in water less than 1 m deep near or in beds of aquatic plants. Primarily a midwater feeder; zooplankton and small Diptera larvae predominate in the diet of individuals to 12 cm SL, while fishes and aquatic insects predominate in the diet of larger individuals. Active in winter and attains lengths of 42 cm.

***Clinostomus funduloides* - Girard, 1856**

Rosyside Dace

Range USA:

AL, DC, DE, GA, KY, MD, MS, NC, OH, PA, SC, TN, VA, WV

Conservation Status

Global: G5 (secure)

National: N5 (secure)



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Photographer: Noel Burkhead

Image ID#: 118

Location: Coal Creek, Carroll Co., VA

Date: 4 June 1984

Gender: male

Life Stage: adult

Ecology & Life History

Spawns in late spring. Sexually mature at age 1. Home range averaged less than 20 m of stream length in NC. Typically in small to medium streams with clear to turbid water and moderate current. Rocky flowing pools of headwaters, creeks, and small rivers; most common in small clear streams.

Spawns on gravelly riffles with several shiners. Sometimes uses nests of chubs. Eggs are scattered. Eats small invertebrates taken in the drift. Lengths to 9 cm.

***Nocomis leptocephalus* - (Girard, 1856)**

Bluehead Chub

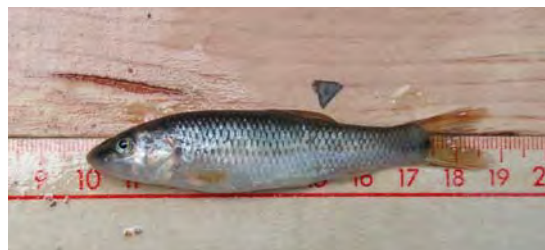
Range USA:

AL, FL, GA, LA, MS, NC, SC, VA, WV

Conservation Status

Global: G5 (secure)

National: N5 (secure)



NPS Photo (Jim Long)

Ecology & Life History

Builds gravel mound nests April to early July, mostly before mid-June. Matures at about 2 years, lives about 4 years at most. An introduced population of rough shiner (*Notropis baileyi*) in the Chattahoochee River system may be responsible for an increase in the abundance of bluehead chub (*Nocomis leptocephalus*, a nest associate), and a decrease in the abundance of weed shiner (*Notropis texanus*), which may be affected by competition for food or habitat. High to low gradient, cool to warm headwaters, creeks, and small to medium rivers that are usually clear to generally turbid and have highly varied substrate, from bedrock to much sand and silt but with some gravel. In swift current and pools. Spawns over gravel mound nest made by male. Eats insects, crustaceans, and, especially, algae. To 21 cm.

***Semotilus atromaculatus* - (Mitchill, 1818)**
Creek Chub

Range USA:

AL, AR, CO, CT, DC, DE, FL, GA, IA, IL, IN, KS, KY, LA, MA, MD, ME, MI, MN, MO, MS, MT, NC, ND, NE, NH, NJ, NM, NY, OH, OK, PA, RI, SC, SD, TN, TX, UT (exotic), VA, VT, WI, WV, WY



NPS Photo (Jim Long)

Conservation Status

Global: G5 (secure)

National: N5 (secure)

Ecology & Life History

Spawns late spring to midsummer, mostly in spring. Male may guard eggs. Eggs hatch in about 6 days at 18 C. Sexually mature at age 1-2 in females, 2-3 in males. May migrate upstream to suitable spawning areas. Clear headwaters, creeks, and small rivers; prefers streams less than 12 m wide and with gravel-sand-silt substrate; occasionally in shallows of small clear lakes. Spawns in small gravelly streams in smooth water near a riffle, or over littoral areas of gravel in lakes. Eggs laid in pit made in bottom by male (or appropriated from stoneroller minnow); covers eggs with stones, forming a ridge. Feeds opportunistically on various plants and animals, from surface drift to benthos; mostly invertivorous but large individuals often picivorous (Becker 1983). Chironomid larvae and other larval insects important in diet of young. Length to 31 cm.

***Ameiurus natalis* - (Lesueur, 1819)**
Yellow Bullhead

Range USA:

AL, AR, AZ (exotic), CT (exotic), DC, DE, FL, GA, IA, ID, IL, IN, KS, KY, LA, MA (exotic), MD, MI, MN, MO, MS, MT (exotic), NC, ND (extirpated), NE, NH (exotic), NJ, NM (exotic), NN (exotic), NV (exotic), NY, OH, OK, OR (exotic), PA, RI (exotic), SC, SD, TN, TX, UT (exotic), VA, VT, WA (exotic), WI, WV



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Conservation Status

Global: G5 (secure)

National: N5 (secure)

Ecology & Life History

Spawns in spring and early summer. Eggs hatch in 5-10 days. Parent guards nest and compact school of young until they are about 50 mm long. Probably sexually mature at age of 2-3 yr. Shallow weedy parts of clear warm lakes, ponds, or slow-moving streams or canals. More tolerant of pollution than are most other ictalurids. Eggs are laid in saucer-shaper depression beside or beneath a bank, log, or tree root, or in burrow or in or under debris on bottom. Young eat mainly entomostracans and insect larvae; adults eat a wide variety of living and dead plant and animal material. Adults primarily piscivorous but also eat aquatic

insect larvae, crustaceans, snails, and algae; immatures are generalists. Activity mostly nocturnal. To 38 cm.

Ameiurus nebulosus - (Lesueur, 1819)
Brown Bullhead

Range USA:

AL, AR, AZ (exotic), CO (exotic), CT, DC, DE, FL, GA, IA, ID (exotic), IL, IN, KS (exotic), KY, LA, MA, MD, ME, MI, MN, MO, MS, NC, ND, NE (exotic), NH, NJ, NM (exotic), NV (exotic), NY, OH, OK, OR (exotic), PA, RI, SC, SD, TN, TX, VA, VT, WA (exotic), WI, WV



© The Native Fish Conservancy

Conservation Status

Global: G5 (secure)

National: N5 (secure)

Ecology & Life History

Spawns in late spring and summer. Eggs hatch in 6-9 days. Parents stay with eggs and hatchlings. Usually first breed in third year. Moves widely in large lakes, as much as 26 km from point of release. Ponds, lakes, sluggish streams, sloughs, backwaters, reservoirs. Usually in vegetated shallows over sand, rock, mud, or silt, in clear to turbid water. May burrow into soft bottom and become inactive in winter. Eggs are laid in open excavation in sand, gravel, or (rarely) mud, often in shelter of logs, rocks, or vegetation, or in holes, burrows, or debris. Nest made by one or both sexes usually around shore or in coves or creek mouths. Young eat chironomid larvae and small crustaceans. Adults eat larger insect larvae and fishes, also fish eggs, mollusks, carrion, and plant material. Mostly nocturnal. May burrow into soft bottom and become inactive at low temperatures. To 53 cm.

Ameiurus platycephalus - (Girard, 1859)
Flat Bullhead

Range USA:

GA, NC, SC, VA

Conservation Status

Global: G5 (secure)

National: N5 (secure)



Ecology & Life History

Spawns in June-July. Females sexually mature in 3rd year. Adults mostly in slow-water areas of large rivers with soft mud, muck, or sand bottom covered with organic detritus. Younger individuals tend to be in smaller clearer streams. Adults frequently occur in small-medium rocky/gravelly streams in Virginia. Occurs also in lakes, ponds, and

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Photographer: Noel Burkhead

Image ID#: 22

Location: Twittys Creek, Charlotte Co., VA

Date: 10 July 1984

impoundments. Adults commonly eat bryozoans throughout year, annelids during spring, and mollusks during summer and fall. Insects important foods in both mature and immature individuals at all seasons, fishes most important item in adult diet. To 29 cm.

Gambusia holbrooki - Girard, 1859
Eastern Mosquitofish

Range USA:

DC, DE, FL, GA, MD, MS, NC, NJ, NY (exotic), PA (exotic), SC, VA

Conservation Status

Global: G5 (secure)

National: N5 (secure)



NPS Photo (Jim Long)

Ecology & Life History

Breeds in spring and summer. Internal fertilization; ovoviviparous. Female produces up to several broods of young each season. Under optimal conditions females can become gravid at 6 weeks of age, produce 2-3 broods in first summer. Gestation 3-4 weeks. Few individuals live more than 15 months. Often in shallow, often stagnant, ponds and shallow edges of lakes and streams where predatory fishes are largely absent and temperatures are high. Also in brackish sloughs and coastal saltwater habitats. Opportunistic omnivore; eats mainly small invertebrates (e.g., zooplankton, insect larvae), often taken near water surface. Also eats small fishes (e.g., small least killifishes) and, in absence of abundant animal food, probably also algae and diatoms. (Length to 5 cm).

APPENDIX B

LIFE HISTORY AND ECOLOGY OF OTHER AQUATIC SPECIES FOUND IN STREAMS OF GUILFORD COURTHOUSE NATIONAL MILITARY PARK GREENSBORO, NORTH CAROLINA

Elliptio complanata (Lightfoot, 1786)¹

Eastern Elliptio

North Carolina Distribution: This species is wide spread in the Atlantic Slope rivers in North Carolina from the Chowan south to the Broad River. It is introduced into the French Broad River in Buncombe County.



Bogan, A.E. (2002)

Description: Shell shape is trapezoidal to rhomboid or subelliptical, compressed to inflated, shell thickness varies from thin to solid, length 120 mm. Anterior margin is rounded, dorsal and ventral margins are roughly parallel, ventral margin is often straight, posterior margin broadly rounded ending at or near the base in a point or biangulation. Posterior ridge is broad and double and rounded to angular. The posterior slope is flat. Beaks are low and uninflated, beak sculpture consists of 5-6 ridges, the first two or three curved and subconcentric, the rest run parallel to the growth lines, nearly straight in the middle and curved up at both ends. Surface with irregular growth lines and varies from smooth to mat.

Left valve has two ragged pseudocardinal teeth and two nearly straight lateral teeth. Right valve has a single pseudocardinal tooth and a single lateral tooth. Interdentum is essentially absent. Beak cavity is shallow. Periostracum is yellowish to brown and blackish, young specimens with indistinct greenish rays present. The rays generally disappear in older shells. Nacre varies from white, pink, salmon, to various shades of purple.

Life History and Ecology: Ortmann (1919:109) commented that the Eastern Elliptio “apparently has no ecological preferences, being found practically in any permanent body of water; in canals and reservoirs with quiet water and muddy bottom, as well as in large rivers with strong current and heavy gravel and rocks. In the small creeks it goes up very far into the headwaters”. *Elliptio complanata* is tachytictic, gravid females have been found from late April through the middle of July. The females expelled their glochidia in conglutinates (Ortmann, 1919). The Banded Killifish (*Fundulus diaphanus*), Green Sunfish (*Lepomis cyanellus*), Largemouth Bass (*Micropterus salmoides*), White Crappie (*Pomoxis annularis*), and Yellow Perch (*Perca flavescens*) have been listed as hostfish for the glochidia for this mussel (Watters, 1994:103).

Status: Currently Stable.

¹Bogan, A.E. 2002. Workbook and key to the freshwater bivalves of North Carolina. North Carolina Freshwater Mussel Conservation Partnership, Raleigh, NC, 101 pp, 10 color plates.

***Philometroides* sp.²**

It is a rather destructive roundworm which causes the eyes of bluegill to bulge.

Diagnostic Characters - It has an elongate red body with rounded ends. The esophagus is bulbous at the anterior end.

Geographic Range - Known from the southeastern USA, it has been confused with other similar roundworms in the past.

Life History - Unknown.

Location in Host - The adult is found in tissues behind the eye. Immature worms may be found migrating through muscle or other tissues.

Size - Female 3.3-12.2 mm, male 2.5-3.4 mm.

Host Specificity - It only occurs in bluegill.

Damage to Host - Migrating immature stages are particularly destructive. Adults usually do little damage, but can cause exophthalmia (bulging eyes) and injure the eyes.

Detection - Removal of the eyes is necessary to find the adults in the tissues. Immature worms are rather difficult to find. "Candling" thin sections of muscle tissue by holding in front of a bright light may reveal the larvae as dark regions. Ascertaining that stocks are free of this parasite is difficult.

Significance to Sportfishing - The amount of damage this parasite causes to the production, survival and growth of bluegill in Puerto Rico has not been determined. Since cleaning food fishes does not require the removal of fish eyes, this parasite usually remains hidden and practically unknown.



³ NCDENR, 2004
Popeye caused by nematode infection
in Bluegill, Hardee Creek (Pitt
County,

²Bunkley-Williams, L. and E.H. Williams, Jr. 1994. Parasites of Puerto Rican freshwater sport fishes. Puerto Rico Department of Natural and Environmental Resources, San Juan, PR and Department of Marine Sciences, University of Puerto Rico, Mayaguez, PR, 168 p., 179 drawings, and 2 maps.

³ North Carolina Department of Environment and Natural Resources. 2004. Basinwide assessment report: Cape Fear River basin. Final Report, Raleigh, NC.