

**Division of Water Quality
Biological Assessment Unit**
July 28, 2006

MEMORANDUM

To: Jimmie Overton

From: Trish Finn MacPherson *Tfm*
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Subject: Benthic macroinvertebrate and fish community sampling of Fishing Creek Watershed for EEP, March and May 2006, Tar Subbasin 01

BACKGROUND

Purpose

The Ecosystem Enhancement Program (EEP), as part of the Memorandum of Agreement (MOA) with the Division of Water Quality (DWQ), requested the Fishing Creek watershed be sampled in order to create a Local Watershed Plan (LWP) for the Fishing Creek Planning Area. The LWP will be used to identify areas suitable for restoration, preservation, and enhancement projects. It will also provide baseline information to assess changes in water quality in the future in response to Oxford WWTP upgrades (to be completed summer 2006), development in the Sand and Gibbs Creek watersheds, and mitigation or restoration projects resulting from the EEP LWP. The overall purpose of this study is to determine the sources and causes of impairment of aquatic communities, identified through previous special studies and regular basinwide assessment sampling by the Biological Assessment Unit (BAU).

General Watershed Description

Fishing Creek drains the town of Oxford in central Granville County (Figure 1). Coon Creek, a major tributary of Fishing Creek, enters into the mainstem from the east. Gibbs Creek and Sand Creek are smaller tributaries of the Tar River located near the mouth of Fishing Creek, but not in the Fishing Creek watershed.

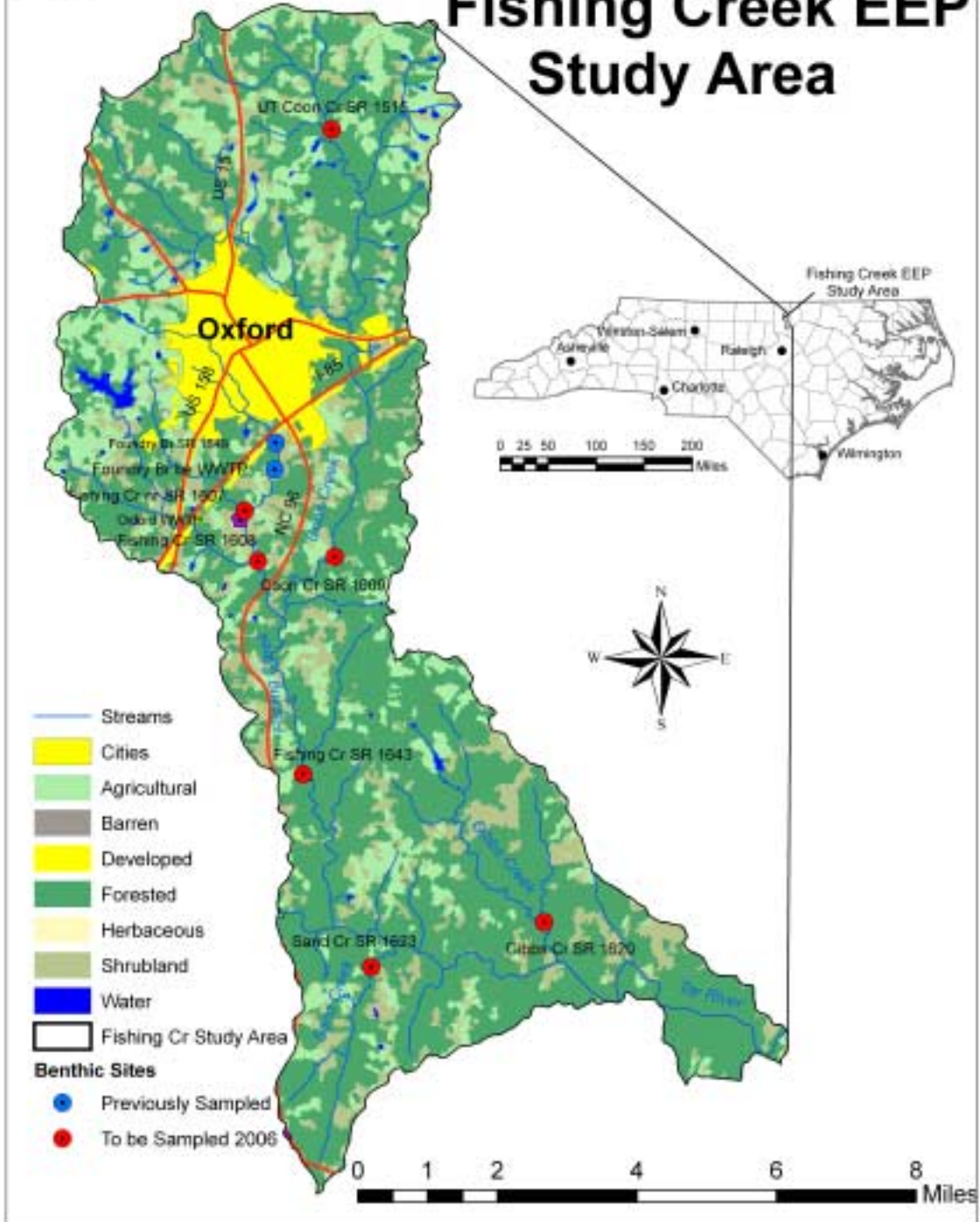
The Fishing Creek watershed is impacted by several stressors, including increased development in the town of Oxford and the I-85 corridor, and agricultural land use. Incision, sedimentation, and habitat degradation are especially evident in Coon Creek. In addition, the Oxford WWTP (NC0025054), moved from Foundry Branch in 1989, now discharges effluent directly into Fishing Creek just above SR 1607, Granville County. Fishing Creek is designated as C NSW waters for aquatic life propagation and survival, fishing, wildlife, secondary recreation, and agriculture as well as nutrient sensitive waters. Based on biological data, Fishing Creek, from its source to the Tar River, is listed on the 303(d) list of impaired waters in the 2002 report, and both the 2004 and 2006 drafts.

Ecoregions

This watershed is contained within the Northern Outer Piedmont Level IV ecoregion. Much of this ecoregion is comprised of gneiss and schist rocks. At the eastern boundary, the Fall Line is a broad transition zone where Piedmont rocks occur with Coastal Plain sediments. Piedmont criteria were used for benthic and fish community bioclassifications. The Carolina Slate Belt and Triassic Basins ecoregions are also found in Granville County near the watershed.

Figure 1

Fishing Creek EEP Study Area



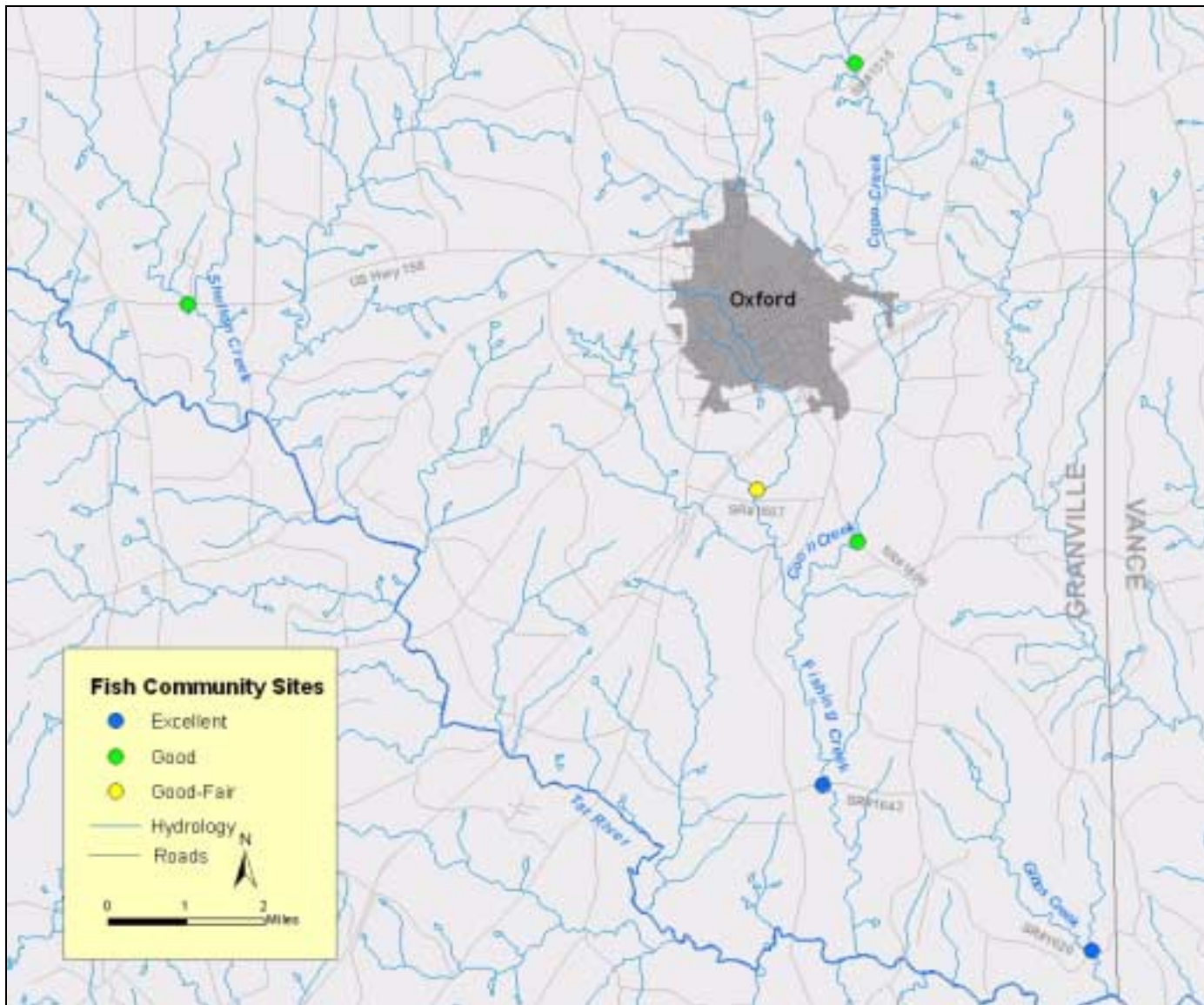


Figure 2. Locations and bioclassification of six fish community sites sampled in the Fishing, Gibbs, and Shelton Creek watersheds, May 17-18, 2006.

METHODS

Benthos

On March 22-24, 2006, benthic macroinvertebrates were collected at five sites using the Division of Water Quality's standard qualitative (Full Scale) method, at one site using the EPT method, and at two small (drainage area less than three square miles) sites using the Qual 4 method. The standard qualitative sampling procedure is comprised of ten composite samples, and includes two kicks, three sweeps, one leaf pack, two rock/log washes, one sand sample, and visual collections. All organisms are picked in the field. The EPT and Qual 4 sampling methods consist of one kick, one sweep, one leaf pack, and visuals, and either just EPT or all taxa are picked.

The purpose of these collections is to inventory the aquatic fauna and produce an indication of the relative abundance for each taxon. Taxa are classified as Rare (1-2 specimens, denoted by "R" on taxa tables), Common (3-9 specimens, "C"), or Abundant (≥ 10 specimens, "A").

Several data summaries (metrics) can be produced from benthos samples to detect water quality problems. These metrics are based on the concept that unstressed streams and rivers have many invertebrate taxa and are dominated by intolerant species. Conversely, polluted streams have fewer numbers of invertebrate taxa and are dominated by tolerant species. The diversity of the invertebrate fauna is evaluated using taxa richness counts; the tolerance of the stream community is evaluated using a biotic index.

EPT taxa richness (EPT S) criteria have been developed by DWQ to assign water quality ratings (bioclassifications) for Full Scale and EPT samples. "EPT" is an abbreviation for Ephemeroptera + Plecoptera + Trichoptera, insect groups that are generally intolerant of many kinds of pollution. Higher EPT taxa richness values usually indicate better water quality. Bioclassifications for Full Scale samples are also based on the relative tolerance of the macroinvertebrate community as summarized by the North Carolina Biotic Index (NCBI). Both tolerance values for individual species and the final biotic index values have a range of 0-10, with higher numbers indicating more tolerant species or more polluted conditions. EPT abundance (EPT N) and total taxa richness calculations also are used to help examine between-site differences in water quality. Criteria for Piedmont streams were used after seasonal corrections were made for EPT taxa richness (winter/spring stoneflies were subtracted as needed based on comparison to prior summer samples). A spring correction of 0.2 was added to the Biotic Index value.

For the Qual 4 method, a Not Impaired rating is given if the stream would receive a bioclassification of Good-Fair or better using DWQ EPT criteria developed for larger streams. Small streams that would have a minimum bioclassification of Fair or Poor are given a bioclassification of Not Rated.

Fish community

The North Carolina Index of Biotic Integrity (NCBI) incorporates information about species richness and composition, trophic composition, fish abundance, and fish condition. The NCBI summarizes the effects of all classes of factors influencing faunal communities (water quality, energy source, habitat quality, flow regime, and biotic interactions). While any change in a fish community can be caused by many factors, certain aspects of the community are generally more responsive to specific influences. Species composition measurements reflect habitat quality effects. Information on trophic composition reflects the effects of biotic interactions and energy supply. Fish abundance and condition information indicates additional water quality effects. It should be noted, however, that these responses may overlap. For example, a change in fish abundance may be due to decreased energy supply or a decline in habitat quality, not necessarily a change in water quality.

The assessment of the biological integrity of a wadeable stream fish community using the NCBI is provided by the cumulative assessment of 12 parameters or metrics. The values provided by the metrics are converted into scores on a 1, 3, or 5 scale. A score of 5 represents conditions which would be expected for least disturbed streams in the specific river basin, while a score of 1

indicates that the conditions deviate greatly from those expected in least disturbed streams of the region. Each metric is designed to contribute unique information to the overall assessment. The scores for all metrics are then summed to obtain the overall NCIBI score. The NCIBI score (an even number between 12 and 60) is then used to determine the ecological integrity class.

Six fish community samples were collected from the Fishing, Gibbs, and Shelton Creek watersheds on May 17-18, 2006. At each site, a 600 ft. section of stream was selected and measured. The fish within the delineated stretch were then collected during a two-pass depletion, using two backpack units with each unit accompanied by 1 or 2 persons dip netting. Seines were also used in some riffle habitats in Shelton Creek (see Figure 2) where dip netting was inadequate for quantitative fish collection. After collection, all identifiable fish (usually sport fishes, catfishes, suckers, and other readily identifiable species) were examined for sores, lesions, fin damage, and skeletal anomalies, measured (total length to the nearest 1 mm), and then released. Once the first 50 specimens of each species were measured, the remaining fish of each particular species were just counted and then also released. Those fish that were not readily identifiable in the field were preserved in 10% formalin and returned to the laboratory for identification, examination, and total length measurement. These preserved fish will be deposited as voucher specimens with the North Carolina State Museum of Natural Science in Raleigh. All young-of-year fish were excluded from all analyses. The resulting data were then analyzed with the NCIBI.

Habitat Evaluation

Habitat evaluations were made using the Biological Assessment Unit's Habitat Assessment Field Data Sheet for Mountain/Piedmont Streams. These assessments assign a numerical score from 0-100 for the reach of stream sampled, based on channel modification, instream habitat, bottom substrate, pool variety, riffle habitats, bank stability and vegetation, light penetration, and width of the riparian zone. No criteria have been developed to rate habitat scores, but the higher the score, the better the overall habitat.

Physical-Chemical

Field measurements were taken at the time of sampling for temperature, dissolved oxygen, specific conductance (conductivity values corrected to 25 degrees Centigrade are reported), using a YSI 85 meter, and for pH using Accumet pH meter from Fisher Scientific.

STUDY SITES

The sites sampled in 2006 are listed below:

2006 Fishing Creek EEP Sites							
Waterbody	Location	Lat	Long	Drainage area (mi ²)	Assessment	Benthos Sample Type	Comments
Fishing Cr	near SR 1607	361641	783526	1.1	B and F	Qual 4	ab WWTP
Fishing Cr	SR 1608	361603	783514	12.4	B	Full Scale	be WWTP
Fishing Cr	SR 1643	361323	783433	47.9	B and F	Full Scale	Recovery site
UT Coon Cr	SR 1515	362127	783404	4.5	B and F	EPT	-
Coon Cr	SR 1609	361606	783403	24.5	B and F	Full Scale	-
Sand Cr	SR 1623	361058	783331	3	B	Qual 4	-
Gibbs Cr	SR 1620	361131	783051	7.6	B and F	Full Scale	-
Sandy Cr	SR 1405	360737	780129	121.5	B	Full Scale	Reference
Shelton Cr	US 158	361847	784316	23.8	F	-	Reference

B = Benthos only.

B and F = Benthos and fish community.

F = Fish community only.

Fishing Creek, near SR 1607, Granville County

This site was the most upstream site on Fishing Creek with a drainage area (DA) of 1.1 square miles and a width of three meters at the time of sample collection. The bottom substrate had some boulder, rubble and gravel, but sand was most abundant. The riparian zone was intact and there was little evidence of erosion. Field notes suggest little to no flow occurs here during the summer. The habitat score for this site was 67. The biggest problems were a lack of riffles and the very sandy substrate. Conductivity was 183 umhos/cm, perhaps reflecting the site's location below the Town of Oxford.



Fishing Creek nr SR 1607 looking upstream ...and downstream

Fishing Creek, SR 1608, Granville County

The second Fishing Creek site was considerably larger (DA = 12.4 square miles) with a width of eight meters. The site is downstream of the Oxford WWTP and below runoff from the town of Oxford. This location had a much less sandy bottom substrate, with boulder and rubble providing good substrate for the benthos. The habitat score was much better (82) than upstream due to extensive riffles and pools, along with little erosion. This location is below Hatcher's Creek, which had a conductivity value of 130 umhos/cm. There was a noticeable chlorine smell at the time of sampling. Conductivity was elevated at 263 umhos/cm.



Fishing Creek below WWTP upstream and ...downstream at SR 1608, Granville Co.

Fishing Creek, SR 1643, Granville County

This most downstream site on Fishing Creek had a watershed size four times the site just below the Oxford WWTP with a drainage area of 50 square miles.

Stream width was 15 meters and the bottom substrate was very rocky with little sand. The habitat score of 89 reflects the extensive riparian zone, good riffles, frequent pools, and minimal erosion. Habitat points came off because sticks, leafpacks and snags were rare. The rocks were very slippery indicating substantial periphyton growth. The conductivity had decreased to 184 umhos/cm at this location.



UT Coon Creek, SR 1515, Granville County

An EPT sample was collected from this Unnamed Tributary (UT) to Coon Creek in the upper part of the watershed. This is the only site in the study located above the town of Oxford. The site had a width of four meters and a drainage area of 4.5 square miles. As seen in the photo, this was a very rocky stream with frequent riffles. Periphyton was also abundant at this site and ponds, agriculture and cattle were noted upstream of the site. The habitat score was 83. Conductivity was measured at 103 umhos/cm.



Coon Creek, SR 1609, Granville County

This site on Coon Creek was located in a rural area with good riparian areas, but poor instream habitat, similar to a Triassic Basin stream. This very sandy stream, had no boulder or rubble and very few riffles. Snags and logs were abundant, but pools were rare. There was more erosion at this site, than at the others. Stream width was 9 meters and drainage area was 24.5 square miles. Habitat score was only 58, the lowest of all the sites sampled. Conductivity was 119 umhos/cm.



Sand Creek, SR 1623, Granville County

This stream is a tributary to the Tar River. It originates near Wilton and flows north to the Tar River. This inappropriately named stream had very little sand in the bottom substrate, and was the rockiest of all the sites sampled. It also had the best habitat score-93-indicating good riffles, good pools, wide riparian zone, no erosion, and good stream shading. This was another small stream with a width of four meters and a drainage area of three square miles. Conductivity was low for this study and was 85 umhos/cm.



Sand Creek looking upstream and

.....downstream showing good habitat.

Gibbs Creek, SR 1620, Granville County

Gibbs Creek is another tributary of the Tar River, but it flows south into the Tar. It has a larger drainage area (7.6 square miles) than Sand Creek, and a width of five meters. Unlike Sand Creek, the substrate here was primarily sand, with few riffles. Though the habitat score was only 66, there was little erosion, a wide riparian zone and good stream shading. Snags and logs were abundant. Beaver activity was noted with dams upstream and downstream of the sampling reach. Conductivity was also low at this site (79 umhos/cm).



Gibbs Creek showing sandbars

.....and abundant logs instream.

Shelton Creek at US 158

The Shelton Creek watershed is a tributary to the Tar River, located about five miles west of the town of Oxford (Figure 2). The drainage area at this location is 23.8 square miles and the stream is approximately 12 meters wide. Because of the high quality instream, riparian, and watershed characteristics at this crossing, this site has been designated a regional fish community reference site for the Tar-Pamlico River basin since 1999. Substrates consisted of cobble, gravel, and sand, and the instream habitats were primarily pools, woody snags, and a few riffles of moderate size. The total habitat score was 79, on account of the creek's wide riparian zone, good shading canopy, and functional instream habitat types. Conductivity at this location was low (73 $\mu\text{mhos/cm}$).



Shelton Creek looking at a riffle



.....and further downstream.

Sandy Creek, SR 1405, Nash County

This reference location was located two counties away in Nash County and had been sampled in 2002 and 2003 as part of the Tar River Outstanding Resource Waters study. This site was unlike all others in this study by having 30% of the substrate as bedrock. The remaining substrate was rubble, gravel, only a little sand and silt. Stream width was 11 meters and drainage area was almost triple the most downstream Fishing Creek site at 121.5 square miles. The habitat score was 77 and conductivity was 72 $\mu\text{mhos/cm}$. Riffles were infrequent, but root mats and snags were easy to find.



RESULTS AND DISCUSSION

Benthic Macroinvertebrates

Summaries of all benthic macroinvertebrate results, habitat scores and chemistry results are presented in Table 1. A complete taxa list of organisms collected is given in Appendix 1.

Fishing Creek

The three Fishing Creek sites indicated water quality problems only below the Oxford WWTP. The upstream site near SR 1607 was rated Not Impaired based on an EPT taxa richness of 19 from a Qual 4 sample. Even with its very small drainage area of 1.1 square miles, the site had 5 more EPT taxa than the SR 1608 site below the WWTP and the lowest NCBI (5.36) of the three sites. The only EPT taxa Abundant at the upstream site were the mayflies, *Caenis* and

Stenonema modestum, and the winter stonefly, *Isoperla namata*. *S. modestum* and *I. namata* were the only EPT taxa Abundant at most sites in the study.

The site below the WWTP at SR 1608 was given a Fair bioclassification. EPT taxa richness was 14 at this site, with 5 winter stoneflies. EPT abundance was low (49), and only the mayfly, *Acentrella*, the stonefly, *Isoperla transmarina*, and the caddisfly, *Cheumatopsyche* were Abundant. *Cheumatopsyche* was the only caddisfly collected at this site, possibly indicating a toxic impact, as well as the impact from increased nutrients from the WWTP. Another indication of toxicity was that *Stenonema modestum*, an ubiquitous mayfly throughout the state was Rare at this site, and all but one or two of the remaining EPT taxa are seasonal. The abundance of nonEPT taxa such as lumbriculid worms, *Argia* and *Calopteryx* (damselflies), *Caecidotea* (an isopod), *Crangonyx* (an amphipod), *Ferrissia* (a limpet), *Sphaerium* (a small clam), and the flatworm, *Dugesia*, clearly indicate increased enrichment and/or lower dissolved oxygen as major stressors at this site. The NCBI at this site was 6.73, much higher than any other site, as was the conductivity.

The most downstream Fishing Creek site at SR1643 was rated Good, showing a recovery of the stream from the WWTP impacts approximately three miles downstream from the discharge. EPT taxa richness increased to 23, mainly due to an increase in the caddisfly fauna from one to eight taxa. EPT abundance was 116 with 9 taxa found to be abundant, including the intolerant caddisfly, *Micrasema bennetti*. The NCBI also improved to 5.53, showing the overall intolerance of the community. This site had a high habitat score of 89, suggesting no instream habitat concerns.

Tributary Sites

The samples from UT Coon Creek, Coon Creek, and Gibbs Creek showed little indication of stressors and were rated Excellent and Good. The sample from Sand Creek was Not Rated, but the benthic data gave confounding results : lower EPT taxa richness, but an NCBI value indicating the most intolerant fauna of all sites, including the reference site.

The UT Coon Creek sample was rated Excellent. This site had 37 EPT taxa collected in an EPT sample, which was one more than the 36 collected from the Sandy Creek reference site location using more intensive Full Scale methods. Caddisflies were especially diverse in this small stream with 14 taxa represented. The EPT BI was 4.61 and EPT abundance 107. The habitat score was 83 reflecting the good instream habitat and riparian buffer.

Coon Creek and Gibbs Creek, tributaries to Fishing Creek and the Tar River respectively, also had a diverse fauna, despite the very sandy substrate in both streams and the low habitat score of 58 for Coon Creek and 66 for Gibbs Creek. Both streams were given a Good bioclassification. EPT taxa richness was 30 for Coon Creek and 36 for Gibbs Creek. The NCBI value was 5.61 for both sites, and EPT abundance values were similar, 158 for Coon Creek and 144 for Gibbs Creek. Gibbs Creek had the most diverse mayfly fauna of all sites in this study, with 21 taxa. Mayflies found only at this site were *Acerpenna pygmaea*, *Baetisca carolina* and *Hexagenia*, a burrowing mayfly. In addition, *Ephemerella needhami* and *E. septentrionalis* were found only in Gibbs Creek and Sandy Creek. It appears that the sandy nature of these streams is exerting a slight stress on the benthic community.

Sand Creek was the most difficult site to evaluate. A Qual 4 sample was taken because the watershed was 3 square miles, which is at the present cutoff for calling a stream too small to evaluate with regular criteria. Therefore the sample was Not Rated. With an EPT taxa richness of 16 (and 5 winter stoneflies giving a seasonal correction of 11), if the watershed had been only slightly larger, a Fair rating would have been given. EPT taxa richness of 14 would have been Good-Fair. Habitat does not appear to be the problem in this rocky stream, since the habitat score was 93. The community also does not appear to be tolerant, or suggest toxic problems as the NCBI value at 4.75 was lower than any site, including the reference site.

The EPT fauna suggest that Sand Creek may dry up at times because the mayfly fauna was all seasonal except for *Stenonema* and *Stenacron* (both only Common), and the caddisflies were represented by only three specimens in three different taxa (*Polycentropus* and *Rhyacophila carolina* and *R. ledra*). No flow dependent taxa present, such as hydropsychids which were found at all other sites. As at most sites, five of the six stonefly taxa were winter taxa, but this was only one of two sites where the long-lived stonefly, *Acroneuria abnormis*, was collected, which is the only indication contradicting the pattern of a stream that dries up. The lack of chironomids is another indicator of lack of flow. Only six taxa were found and all those were Rare, while 16 chironomid taxa were found at the upstream Fishing Creek site which had a much smaller drainage area. Of the 41 taxa found in Sand Creek, 27 were Rare. This is also consistent with a stream that may dry up and be slow to recolonize.

Reference Site

Sandy Creek, at SR 1405 in Nash County was rated Excellent with an EPT taxa richness of 36 and an NCBI value of 4.90. This stream was so different from the study area sites, including size of watershed, substrate composition and number of taxa found only at this site (21 of the 89 taxa collected), that comparisons between Sandy Creek and the study watershed would not be valuable.

Fish communities

A complete list of all fish collected, electrofishing data, NCIBI metric scores, and fish community bioclassifications is given in Appendix 2 and 3.

Fishing Creek above SR 1607

The Fishing Creek fish community sample collected just upstream of the Oxford WWTP outfall is the one fish sample in this study that showed some signs of water quality stressors. This is not surprising, given the urban nature of the upstream watershed that drains Oxford, and a conductivity reading of 170 $\mu\text{mhos/cm}$ at the time of sampling. However, this site produced a lot of fish (total $n = 435$, representing 13 species), despite its small size (3 meters wide). The most abundant species at this location included *Semotilus atromaculatus* (creek chub, $n=97$), *Luxilus albeolus* (white shiner, $n=72$), and *Nocomis leptoccephalus* (bluehead chub, $n=67$). The NCIBI rating for this previously unassessed site was Good-Fair (NCIBI score = 44), which is the lowest rating for all six fish community sites in this study. Most notably, there were no intolerant species collected, such as *Lythrurus matutinus* (pinewoods shiner), *Percina nevisense* (chainback darter) or *Percina roanoka* (Roanoke darter). Also, no piscivores (fish eaters) were collected from this site.

Fishing Creek at SR 1643

The Fishing Creek site at the SR 1643 crossing (located about 6 miles below the Oxford WWTP outfall) showed no signs of water quality stressors, despite a conductivity reading of 186 $\mu\text{mhos/cm}$. This sample received a bioclassification of Excellent with an NCIBI score of 56 (out of a total maximum score of 60), which is an improvement from two previous fish community ratings of Good at this site (1997, and 2002). During this assessment, a total of 22 species were represented among the 621 individuals collected. This site exhibits Carolina Slate Belt type habitats (runs, extensive riffles, pools with boulders) that contribute to the highly diverse community of fish. The most abundant species was *Notropis procne* (swallowtail shiner, $n=135$), followed by *Lepomis auritus* and *Luxilus albeolus* (redbreast sunfish and white shiner, $n=84$ each), and *Nocomis leptoccephalus* (bluehead chub, $n=83$). Three intolerant species were also collected at this site including *Lythrurus matutinus* (pinewoods shiner, $n=43$), *Percina roanoka* (Roanoke darter, $n=48$), and *Percina nevisense* (chainback darter, $n=2$). The only NCIBI metric that did not receive a maximum score at this site (1 out of 5 points) was the percentage of piscivores or fish eaters, as only one *Ambloplites cavifrons* (Roanoke bass) was collected in this sample.

Table 1. Summary data for benthic macroinvertebrates, site and habitat characteristics for the Fishing Creek Watershed, March 2006.

Station:	Fishing Cr.....			UTCoon	Coon	Sand	Gibbs	Sandy Cr	
Sample Type:	Qual 4	Full	Full	EPT	Full	Qual 4	Full	Full	
Location (SR):	nr 1607	1608	1643	1515	1609	1623	1620	1405	
Ephemeroptera	8	7	9	16	15	7	21	15	
Plecoptera	5	6	6	7	7	6	7	7	
Trichoptera	6	1	8	14	8	3	8	14	
Coleoptera	5	6	5	-	7	4	6	11	
Odonata	4	7	6	-	7	2	7	6	
Megaloptera	1	0	0	-	0	1	1	1	
Diptera: Chironomidae	16	22	23	-	20	6	29	20	
Misc. Diptera	7	5	8	-	6	4	6	2	
Oligochaeta	4	5	6	-	4	3	4	3	
Crustacea	2	4	3	-	3	2	1	2	
Mollusca	3	4	3	-	6	3	6	7	
Other	2	1	2	-	0	0	1	1	
Total Taxa Richness	63	69	79	-	83	41	97	89	
EPT Richness (S)	19	14	23	37	30	16	36	36	
Seasonally Corrected EPT S	16	9	19	31	25	11	31	32	
EPT Abundance	66	49	116	107	158	64	144	150	
Biotic Index	5.36	6.73	5.53	4.61	5.61	4.75	5.61	4.90	
Seasonally Corrected BI	5.56	6.93	5.73	4.81	5.81	4.95	5.81	5.10	
EPT BI									
Bioclassification	NI	Fair	Good	Exc	Good	NR	Good	Exc	
NI=Not Impaired, NR=Not Rated									
Width	3	8	15	4	9	4	5	11	
Depth									
Average	0.2	0.2	0.2	0.3	0.4	0.2	0.2	0.5	
Canopy	60	40	60	70	50	70	80	60	
Substrate (%)									
Boulder	10	15	25	25	0	25	0	0	
Rubble	15	35	35	40	0	40	0	30	
Gravel	15	20	15	15	20	25	20	15	
Sand	60	25	10	15	70	10	70	10	
Silt	0	5	5	5	10	0	10	15	
Bedrock								30	
County	Granville.....						Nash.....		
Latitude	361640	361603	361323	362113	361604	361058	361124	360737	
Longitude	783526	783514	783433	783404	783403	783332	783049	780129	
Habitat characteristics									Max score
Channel modification	5	5	5	5	5	5	5	5	5
Instream habitat	16	16	15	16	13	17	15	17	20
Bottom substrate	4	12	13	13	3	13	3	11	15
Pool variety	9	8	9	7	6	8	8	3	10
Riffle habitats	4	15	16	15	4	16	3	10	16
Bank stability and vegetation	12	13	14	14	10	14	12	14	14
Light penetration	7	6	7	7	7	10	10	7	10
Riparian zone width	10	7	10	9	10	10	10	10	10
Total Score	67	82	89	83	58	93	66	77	100
Temperature (°C)	12.4	11.7	9.9	7.0	6.9	11.2	8.9	9.0	
DO (mg/l)	11.5	12.4	12.4	11.4	10.8	10.3	11	11.2	
Conductivity (µmhos/cm)	183	263	184	103	119	85	79	72	
pH	6.5	7.7	6.9	6.2	6.4	6.9	6.5	6.7	

Tributary Sites

UT Coon Creek at SR 1515

The fish community of this small headwater stream (4.5 square miles) had never been sampled by DWQ before, and received a bioclassification of Good with an NCIBI score of 48. A total of 232 individuals were collected here, representing 14 fish species. The most abundant of these was *Lepomis macrochirus* (bluegill, n=57), followed by *Lepomis auritus* (redbreast sunfish, n=45), *Notropis procne* (swallowtail shiner, n=30), and *Nocomis leptocephalus* (bluehead chub, n=28). No intolerant species were collected here, which may be associated with agricultural runoff in the upstream watershed. There was an abundance of silt present in the slower velocity pools and the conductivity was 118 µmhos/cm during this assessment.

Coon Creek at SR 1609

This site also received a bioclassification of Good with an NCIBI score of 46. However, this creek received a bioclassification of Excellent (NCIBI score of 54) at the same location in the 2002 basinwide monitoring cycle. Although, a slightly higher diversity of fish was collected this time (426 individuals representing 20 species vs. 390 individuals and 18 species in 2002), a slight shift in the trophic structure caused the drop in NCIBI score and bioclassification. Specifically, the percentage of omnivores plus herbivores (metric #8) dropped 5% and the percentage of insectivores (metric #9) increased by 4%, which was just enough to lower the NCIBI score and bioclassification. Even so, this section of Coon Creek is still supporting a healthy population of fish. In fact, it is possible that the bioclassification here may return to Excellent upon future assessments based upon normal variations within the fish community. The most abundant species collected were *Etheostoma nigrum* (Johnny darter, n=88), and *Notropis procne* (swallowtail shiner, n=71). Those fish that were previously collected, but not present during this assessment include *Percina nevisense* (chainback darter, intolerant species) and *Clinostomus funduloides* (rosyside dace, intermediately tolerant species). In addition, four species collected in this sample but not in 2002 include *Lepomis cyanellus* (green sunfish), *Lepomis microlophus*, (reardear sunfish), *Esox americanus* (redfin pickerel), and *Gambusia holbrooki* (Eastern mosquitofish).

Gibbs Creek at SR 1620

Gibbs Creek is another relatively small tributary to the Tar River with no previous DWQ fish community data. Although the second lowest number of fish for this study was collected at this location, this stream is supporting a diverse community of fish (total individuals = 240 representing 22 species). The sample received a bioclassification of Excellent (NCIBI score of 54). The most abundant fish species collected include *Luxilus albeolus* (white shiner, n=44), *Nocomis leptocephalus* (bluehead chub, n=42), and *Lepomis auritus* (redbreast sunfish, n=40). The low conductivity (87 µmhos/cm) and the healthy fish community here are perhaps benefiting from the good instream habitats (deep pools and undercut banks) and high quality riparian zone in this watershed.

Reference Site

Shelton Creek at US 158

This fish community reference site has been sampled on four occasions now, with three previous bioclassifications of Excellent (1992, 1997, and 1999). The current sample earned Shelton Creek a slightly lower bioclassification of Good with an NCIBI score of 50. The most abundant species include *Nocomis leptocephalus* (bluehead chub, n=186), and *Luxilus albeolus* (white shiner, n=95), which echos the last sample collected here. Those fish that were present in all three of the previous samples but absent in this assessment included *Lepomis gulosus* (warmouth) and *Notropis altipinnis* (highfin shiner). *Percina nevisense* (chainback darter) was also collected in the 1997 and 1999 samples but not in the current sample. Similar to the Coon Creek site at SR 1609, this fluctuation in bioclassification is perhaps a result of natural variation in the fish community, and does not necessarily mean that water quality is declining in this watershed. For example the number of species collected at this location in successive years has been 19 (1992), 24 (1997), 19 (1999), and 18 (current).

Habitat Results

Habitat evaluations during benthic macroinvertebrate sampling ranged from a low score of 58 to a high of 93. Sandy bottomed streams had lower scores; Coon Creek was 58, upstream Fishing Creek was 66, and Gibbs Creek was 67. Coon Creek also suffered from fewer pools and slightly more bank erosion. All other sites in the study watershed scored between 82 and 93 (Sand Creek), suggesting few habitat or riparian zone problems. The reference site had a habitat score of 77.

Physical-Chemical Results

Field measurements of temperature, dissolved oxygen and pH during benthic macroinvertebrate sampling were fairly consistent at all sites, except for the pH value at Fishing Creek below the Oxford WWTP which was 7.7 compared to the range of 6.2 to 6.9 found at the other sites. Conductivity values were highest in Fishing Creek: 183, 263 and 184 umhos/cm from upstream to downstream, reflecting nonpoint urban runoff and WWTP discharge. The Coon Creek watershed sites had the next highest conductivities – 103 and 119 umhos/cm where there was some residential land use. The sites with visible land use that was all forest (Sand Creek, Gibbs Creek and Sandy Creek) had values of 85, 79 and 72 umhos/cm.

SUMMARY

Benthos

Seven sites in subbasin 01 of the Tar River basin were sampled for benthos in March 2006 for the EEP program to determine baseline conditions before a planned WWTP upgrade and development of a Local Watershed Plan by EEP. These samples showed very few water quality problems, except for the site on Fishing Creek below the Oxford WWTP, where nutrients and low dissolved oxygen may be stressors. Three sites on Fishing Creek were rated Not Impaired, Fair and Good going from upstream to downstream. Two sites in the Coon Creek watershed were rated Excellent and Good. Gibbs Creek also received a Good bioclassification. Sand Creek, a tributary to the Tar River, had a reduced but very intolerant benthic fauna which suggested that the stream may periodically dry up and be slow to recolonize. Streams with a primarily sand substrate, had lower habitat scores, but still had Good bioclassifications.

Fish communities

Six sites in subbasin 01 were also sampled for their fish communities for the same purpose. Five of these sites were the same as benthos sites. These samples also showed very few water quality issues. Although there was no fish site located just below the Oxford WWTP, the Fishing Creek site located just above the outfall (above SR 1607) did show signs of water quality stressors, which are likely due to urban runoff from the town of Oxford. This was the only fish community site that received a bioclassification of Good-Fair, the lowest NCIBI rating in the study. Three of the six fish sites were rated Good (UT Coon, Coon, and Shelton Creeks). NCIBI scores and bioclassifications for the previously sampled sites on Coon and Shelton Creeks dropped, perhaps because of natural variations in the fish communities. The other two sites (Fishing Creek at SR 1643, and Gibbs Creek) were rated Excellent.

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Appendix 1. Benthic Macroinvertebrates collected during Fishing Creek EEP study, March 2006.

	FISHING CR.....	UTCOONCOON	SAND	GIBBS	SANDY CR
	3/22/06	3/2/06	3/23/06	3/22/06	3/22/06
	SR 1607	SR 1608	SR 1643	SR 1515	SR 1609
				SR1623	SR 1620
					SR 1405
EPHEMEROPTERA					
ACENTRELLA SPP		A		R	A
ACENTRELLA AMPLA			R	R	A
ACERPENNA PYGMAEA					A
AMELETUS LINEATUS					C
ACENTRELLA ALACHUA					C
DIPHETOR HAGENI	C			R	R
BAETIS INTERCALARIS					C
PSEUDOCLOEON PROPINQUUM				R	
BAETISCA CAROLINA					R
CAENIS SPP	A	C	C	R	C
CENTROPTILUM SPP		R		R	C
DANNELLA SIMPLEX					R
DRUNELLA WALKERI					R
EPHEMERELLA DOROTHEA	C	R	C	R	A
EPHEMERELLA INVARIA (GR)					A
EPHEMERELLA NEEDHAMI					R
EPHEMERELLA SEPTENTRIONALIS					R
EURYLOPHELLA DORIS	C	C	A	C	A
EURYLOPHELLA ENOENSIS		R	R	C	C
EURYLOPHELLA VERISIMILIS				R	
HEXAGENIA SPP					A
ISONYCHIA SPP	R		A	A	C
LEPTOPHLEBIA SPP			R	C	A
LEUCROCUTA SPP			C	C	A
NEOEPHEMERA YOUNGI					R
PARALEPTOPHLEBIA SPP					C
PLAUDITUS DUBIUS GR				A	A
STENONEMA EXIGUUM					A
STENONEMA FEMORATUM	R				
STENONEMA MODESTUM	A	R	A	A	A
SIPHONURUS SPP					C
STENACRON INTERPUNCTATUM	C			A	C
PLECOPTERA					
ACRONEURIA ABNORMIS					C
AMPHINEMURA SPP	C	R	R	C	A
CLIOPERLA CLIO	C			C	C
DIPLOPERLA DUPLICATA					R
ECCOPTURA XANTHENES	C		C		R
HAPLOPERLA BREVIS			R		
ISOPERLA NAMATA (GR)	A	C	A	A	A
ISOPERLA TRANSMARINA (GR)		A	C	C	A
PARAGNETINA FUMOSA					C
PERLESTA SPP	C	C	A	C	C
PROSTOIA SP		R		R	A
STROPHOPTERYX SPP		R		R	C
TRICHOPTERA					
BRACHYCENTRUS SPP					
CERACLEA NR EXCISA					
CERACLEA TRANSVERSA				C	C
CHEUMATOPSYCHE SPP	C	A	A	R	R
CHIMARRA SPP			A	C	
DIPLECTRONA MODESTA	R				
HYDROPSYCHE BETTENI			A	C	
HYDROPSYCHE VENULARIS					
HYDROPTILA SPP				R	
IRONOQUIA PUNCTATISSIMA			R	C	A
MICRASEMA BENNETTI			A		
MICRASEMA WATAGA			C		
NECTOPSYCHE EXQUISITA					
NEOPHYLAX CONSIMILIS	R			R	
NEOPHYLAX FUSCUS					
NEOPHYLAX OLIGIUS	C			R	C

	FISHING CR.....			UTCOONCOON		SAND	GIBBS	SANDY CR
	3/22/06	3/2/06	3/23/06	3/22/06	3/22/06	3/22/06	3/24/06	3/23/06
	SR 1607	SR 1608	SR 1643	SR 1515	SR 1609	SR1623	SR 1620	SR 1405
NEOPHYLAX ORNATUS	R			R	R		R	
PARANYCTIOPHYLAX MOESTUS							R	
PHYLOCENTROPUS SPP				R				
POLYCENTROPUS SPP			R	C	R	R	C	C
PYCNOPSYCHE SPP			R	R	R		C	C
PYCNOPSYCHE LEPIDA							C	
RHYACOPHILA CAROLINA						R		
RHYACOPHILA LEDRA	R				C	R		
TRIAENODES IGNITUS				R				R
WORMALDIA SPP					R			
COLEOPTERA								
AGABUS SPP								R
ANCYRONYX VARIEGATUS		R	R		C		C	
COPTOTOMUS SPP								R
DINEUTUS SPP							R	
DUBIRAPHIA SPP			R		R			
ENOCHRUS SPP		R						R
GYRINUS SPP					R			R
HELICHUS SPP	C	C			C		C	
HELICHUS BASALIS								R
HELICHUS LITHOPHILUS								R
HYDROPORUS SPP							R	R
MACRONYCHUS GLABRATUS			C		R		C	A
NEOPORUS SPP	R	R				R		C
OPTIOSERVUS SPP						C		
PELTODYTES SPP	R				R			C
PSEPHENUS HERRICKI	A	A	A			C	R	
SPERCHOPSIS TESSELLATUS								R
STENELMIS SPP	A	A	A		C	R		
ODONATA								
ARGIA SPP	C	A	C		A	R		A
BOYERIA VINOSA	R	R	R		C		A	C
CALOPTERYX SPP	R	A	C		C		A	C
CORDULEGASTER SPP						R		
ENALLAGMA SPP		R	R		C		R	
GOMPHUS SPP					R		C	
HELOCORDULIA SPP					R			
ISCHNURA SPP								R
LANTHUS SPP	C							
MACROMIA SPP							C	R
NEUROCORDULIA SPP		R						
NEUROCORDULIA OBSOLETA								R
PROGOMPHUS OBSCURUS			C				C	
SOMATOCHLORA SPP		R	R		R			
STYLOGOMPHUS ALBISTYLUS							R	
TETRAGONEURIA SPP		R						
MEGALOPTERA								
CORYDALUS CORNUTUS								C
NIGRONIA SERRICORNIS	R					C	R	
DIPTERA: CHIRONOMIDAE								
ABLABESMYIA MALLOCHI	R	R	C		C		C	C
BRILLIA SPP							R	
BRILLIA SERA								R
CRICOTOPUS BICINCTUS: C/O SP1		C						
ORTHOCLADIUS ROBACKI: C/O SP12	C		A		A	R	A	A
ORTHOCLADIUS (EUORTHOCL.): C/O SP3		R	R					
ORTHOCLADIUS CLARKEI GR: C/O SP54	A	A						
CRICOTOPUS VARIPES GR: C/O SP6								C
CRICOTOPUS/ORTHOCLADIUS SP7		A	A		A		C	
CHAETOCLADIUS SPP						R		
CLADOTANYTARSUS SPP					R			
CLINOTANYPUS PINGUIS					R			

	FISHING CR.....			UTCOONCOON		SAND	GIBBS	SANDY CR
	3/22/06	3/2/06	3/23/06	3/22/06	3/22/06	3/22/06	3/24/06	3/23/06
	SR 1607	SR 1608	SR 1643	SR 1515	SR 1609	SR1623	SR 1620	SR 1405
CONCHAPELOPIA GROUP	C	A	A		C		A	C
CORYNONEURA SPP	R	R					C	R
CORYNONEURA SP C EPLER			C					
CRYPTOCHIRONOMUS SPP		R	C				C	R
DIAMESA SPP	R		A					
DICROTENDIPES NEOMODESTUS		R	R		R		C	
DIPLOCLADIUS CULTRIGER	R	R						
TVETENIA BAVARICA GR (E SP1)	R		R		C		R	
EUKIEFFERIELLA CLARIPENNIS GR (E SP11)		C			R			R
EUKIEFFERIELLA BREVICALCAR GR (E SP6)			C					
HYDROBAENUS SPP			R					
MICROTENDIPES SP1		R					R	C
NATARSIA SPP		C	R				R	
NILOTANYPUS FIMBRIATUS			R		R			R
ORTHOCLADIUS LIGNICOLA	R							
POLYPEDILUM AVICEPS							C	
POLYPEDILUM FALLAX		R					A	R
POLYPEDILUM FLAVUM			C		C		C	A
POLYPEDILUM HALTERALE GR						R	A	
POLYPEDILUM ILLINOENSE GR	A	A	C		R		C	R
POLYPEDILUM SCALAENUM		C					C	
POLYPEDILUM TRITUM					R			
PARACLADOPELMA UNDINE			R					
PARAKIEFFERIELLA SPP	R						R	
PARAKIEFFERIELLA SP4								R
PARAMETRIOCNEMUS LUNDBECKI	A	R				R	C	
PARATANYTARSUS SPP		R			R			
PARATENDIPES SPP					C		R	C
POTTHASTIA LONGIMANUS		R	A		R		C	R
PROCLADIUS SPP							C	
PSECTROTANYPUS SPP							R	
RHEOCRICOTOPUS ROBACKI	R	R			R		C	
RHEOCRICOTOPUS UNIDENTATUS	R							
RHEOTANYTARSUS SPP	R		C			R	C	C
ROBACKIA DEMEIJEREI							R	
SAETHERIA TYLUS			R					
STEMPELLINELLA SPP					R			
TANYTARSUS SPP	R	A	A			R	A	A
THIENEMANIELLA SPP			C		C		A	C
TRIBELOS SPP		R	R		R		A	R
MISC. DIPTERA								
ANTOCHA SPP	R		R			R		
CHRYSOPS SPP		R			R		R	
DIXA SPP							R	
DIXELLA INDIANA	R							
EMPIDIDAE			R					
HEXATOMA SPP	C		R		C		R	
LIMONIA SPP		R	C		R			
PALPOMYIA (COMPLEX)		R	R		R		C	
PROSIMULIUM SPP			C					C
PSEUDOLIMNOPHILA SPP	C					R		
SIMULIUM SPP	C	R	R		A	R	C	
TABANUS SPP	R							
TIPULA SPP	C	C	C		R	R	R	R
HEMIPTERA								
CORIXIDAE		R						
OLIGOCHAETA								
CAMBARINICOLIDAE		R	C			R		
ILYODRILUS TEMPLETONI		R	R		R			
LIMNODRILUS HOFFMEISTERI					R	R		
LUMBRICULIDAE	R	A	C		R	C	R	R
MEGADRILE OLIGOCHAETE		R	C		C		C	R
NAIS SPP	C	C	C					

	FISHING CR.....	UTCOONCOON	SAND	GIBBS	SANDY CR
	3/22/06	3/22/06	3/22/06	3/24/06	3/23/06
	SR 1607	SR 1608	SR 1643	SR 1515	SR 1609
				SR 1623	SR 1620
					SR 1405
PRISTINA SPP					R
SLAVINA APPENDICULATA	R				
SPIROSPERMA NIKOLSKYI			R		R
TUBIFICIDAE	R				
CRUSTACEA					
CAECIDOTEA SPP (STREAMS)		A	A		R
CAMBARIDAE	R	C	R	C	R
CRANGONYX SPP	C	A	R	C	C
HYALELLA SPP		R		R	
PALAEONETES PALUDOSUS					R
PELECYPODA					
CORBICULA FLUMINEA			C	A	R
PISIDIUM SPP			R	R	R
SPHAERIUM SPP		A		R	
GASTROPODA					
AMNICOLA SPP				R	R
CAMPELOMA DECISUM				C	A
ELIMIA SP					C
FERRISSIA SPP	R	A		R	C
FOSSARIA SPP		R			
HELISOMA ANCEPS					C
LEPTOXIS SPP			A	R	A
MICROMENETUS DILATATUS	R				R
PHYSELLA SPP	R	C		R	C
OTHER					
CURA FOREMANII	R				
DUGESIA TIGRINA		A	R		
HYDRACARINA			R		C
PLACOBDELLA ORNATA	R				R

Appendix 2. Abundances of individual fish species collected from the Fishing, Gibbs, and Shelton Creek watersheds, May 17 and 18, 2006.

Species	Fishing Cr	Fishing Cr	UT Coon Cr	Coon Cr	Gibbs Cr	Shelton Cr
	above SR 1607 5/17/2006	SR 1643 5/18/2006	SR 1515 5/17/2006	SR 1609 5/18/2006	SR 1620 5/18/2006	US 158 5/17/2006
<i>Clinostomus funduloides</i> (rosyside dace)	49				3	
<i>Cyprinella analostana</i> (satinfin shiner)		14		11	13	
<i>Luxilus albeolus</i> (white shiner)	72	84	15	34	44	95
<i>Lythrurus matutinus</i> (pinewoods shiner)		43		3	7	9
<i>Nocomis leptocephalus</i> (bluehead chub)	67	83	28	14	42	186
<i>Nocomis raneyi</i> (bull chub)		4				
<i>Notropis procne</i> (swallowtail shiner)	4	135	30	71	13	25
<i>Phoxinus oreas</i> (mountain redbelly dace)					1	
<i>Semotilus atromaculatus</i> (creek chub)	97		7	14		2
<i>Catostomus commersonii</i> (white sucker)	4	3	1	8	1	2
<i>Erimyzon oblongus</i> (creek chubsucker)	26	1	2	5	17	12
<i>Hypentelium nigricans</i> (Northern hog sucker)		3			9	1
<i>Moxostoma collapsum</i> (notchlip redhorse)					5	
<i>Scartomyzon cervinus</i> (blacktip jumprock)		6			2	
<i>Noturus insignis</i> (margined madtom)		14	17		12	11
<i>Esox americanus</i> (redfin pickerel)				3	2	
<i>Aphredoderus sayanus</i> (pirate perch)	6	1		1	2	2
<i>Gambusia holbrooki</i> (Eastern mosquitofish)	13	1	3	13	1	3
<i>Ambloplites cavifrons</i> (Roanoke bass)		1				
<i>Lepomis auritus</i> (redbreast sunfish)	18	84	45	69	40	37
<i>Lepomis cyanellus</i> (green sunfish)	9	60	12	12	12	9
<i>Lepomis gibbosus</i> (pumpkinseed)		3	2	6		1
<i>Lepomis macrochirus</i> (bluegill)	37	5	57	58	9	4
<i>Lepomis microlophus</i> (redecor sunfish)				2		
<i>Micropterus salmoides</i> (largemouth bass)			1	1	2	3
<i>Etheostoma nigrum</i> (johnny darter)	33	20	12	88	1	8
<i>Etheostoma vitreum</i> (glassy darter)		6		4		
<i>Percina nevisense</i> (chainback darter)		2				
<i>Percina roanoka</i> (Roanoke darter)		48		9	2	5
Total individuals	435	621	232	426	240	415
Total species	13	22	14	20	22	18

Appendix 3. Electrofishing data, NCIBI scores and bioclassifications of six sites in the Fishing, Gibbs, and Shelton Creek watersheds, May 17 and 18, 2006.

Waterbody	Fishing Cr	Fishing Cr	UT Coon Cr	Coon Cr	Gibbs Cr	Shelton Cr
Location	above SR 1607	SR 1643	SR 1515	SR 1609	SR 1620	US 158
County	Granville	Granville	Granville	Granville	Granville	Granville
Date	5/17/2006	5/18/2006	5/17/2006	5/18/2006	5/18/2006	5/17/2006
No. of electroshocking units	2	2	2	2	2	2
Shocking duration (seconds)	3062	7212	3563	3773	4913	4363
No. fish/100 seconds shock time	14.2	8.6	6.5	11.3	4.9	9.5
Metric Value						
(Metric Score within parentheses)						
No. of Species ¹	13 (3)	22 (5)	14 (3)	20 (5)	22 (5)	18 (5)
No. of Fish ²	435 (5)	621 (5)	232 (5)	426 (5)	240 (5)	415 (5)
No. of Species of Darters	1 (3)	4 (5)	1 (3)	3 (5)	2 (3)	2 (3)
No. of Species of Sunfish ³	3 (3)	5 (5)	4 (5)	5 (5)	3 (3)	4 (5)
No. of Species of Suckers	2 (3)	4 (5)	2 (3)	2 (3)	5 (5)	3 (5)
No. of Intolerant Species	0 (1)	3 (5)	0 (1)	2 (3)	2 (3)	2 (3)
% Tolerants	32 (5)	26 (5)	29 (5)	30 (5)	28 (5)	13 (5)
% Omnivores + Herbivores	22 (5)	15 (5)	13 (5)	6 (1)	25 (5)	48 (3)
% Insectivores	78 (5)	85 (5)	86 (5)	93 (1)	73 (5)	51 (3)
% Piscivores	0 (1)	0.16 (1)	0.43 (3)	0.94 (3)	1.67 (5)	0.72 (3)
% Diseased	0 (5)	0 (5)	1.72 (5)	0.23 (5)	0 (5)	0 (5)
% Species with Multiple Ages ³	85 (5)	64 (5)	57 (5)	80 (5)	55 (5)	67 (5)
Total NCIBI Score	44	56	48	46	54	50
NCIBI Class	Good-Fair	Excellent	Good	Good	Excellent	Good

¹ Excluding hybrids and species represented only by young-of-year fish.

² Excluding young-of-year fish.

³ Excluding *Lepomis* sp. hybrids.