FISHERIES REPORT
REPORT NO. 05-03
WARMWATER STREAM FISHERIES REPORT
REGION IV
2004

Prepared by

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TENNESSEE WILDLIFE RESOURCES AGENCY

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Cover: Two specimens of the Chucky Madtom were collected from Little Chucky Creek in Greene County during cooperative efforts with TVA and the USFWS (photo by Rick Bivens).

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INTRODUCTION

The fish fauna of Tennessee is the most diverse in the United States, with approximately 307 species of native fish and about 30 to 33 introduced species (Etnier and Starnes 1993). Region IV has 7,837 km of streams that total approximately 5,711 ha in 21 east Tennessee counties. There are approximately 1,287 km classified as coldwater streams. Streams in Region IV, except for a few in Anderson, Campbell, and Claiborne counties (Cumberland River System streams) are in the Ridge and Valley and Blue Ridge physiographic provinces of the upper Tennessee River drainage basin. The main river systems in the region are the Clinch, Powell, Little Tennessee, mainstream Tennessee River, French Broad, Nolichucky, and Holston.

Streams and rivers across the state are of considerable value as they provide a variety of recreational opportunities. These include fishing, canoeing, swimming, and other riverine activities that are unmatched by other aquatic environments. Streams and rivers are also utilized as water sources both commercially and domestically. The management and protection of this resource is recognized by Tennessee Wildlife Resources Agency (TWRA) and has been put forth in the Strategic Plan (TWRA 2000) as a primary goal.

This is the eighteenth annual report on stream fishery data collection in TWRA's Region IV. The main purpose of this project is to collect baseline information on game and non-game fish and macroinvertebrate populations in the region. This baseline data is necessary to update and expand our Tennessee Aquatic Database System (TADS) and aid in the management of fisheries resources in the region.

Efforts to survey the region’s streams have led to many cooperative efforts with other state and federal agencies. These have included the Tennessee Department of Environment and Conservation (TDEC), Tennessee Valley Authority (TVA), U.S. Forest Service (USFS), Oak Ridge National Laboratory (ORNL), and the National Park Service (NPS).

The information gathered for this project is presented in this report as river and stream accounts. These accounts include an introduction describing the general characteristics of the survey site, a study area and methods section summarizing site location and sampling procedures, a results section outlining the findings of the survey(s), and a discussion section, which allows us to summarize our field observations and make management recommendations.

METHODS

The streams to be sampled and the methods required are outlined in TWRA field request No. 04-4. A total of 15 rivers/streams were sampled and are included in this report. Stream surveys were conducted from April to October 2004. Thirty-nine (IBI, CPUE, or Qualitative) fish samples and nine benthic samples were collected.

SAMPLE SITE SELECTION

Index of Biotic Integrity (IBI) sample sites were selected that would give the broadest picture of impacts to the watershed. We typically located our sample site in close proximity to the mouth of a stream to maximize resident species collection. However, we positioned survey sites far enough upstream to decrease the probability of collecting transient species. Large river sampling sites (French Broad River, Nolichucky River, Pigeon River, and North Fork Holston River) were selected based on historical sampling locations and available access points. Typically we selected sample areas in these rivers that represented the best available habitat for any given reach being surveyed. Sampling locations were delineated in the field utilizing hand held Geographical Positioning Units (GPS) and then digitally re-created using a commercially available software package.

WATERSHED ANALYSIS

Watershed size and/or stream order has historically been used to create relationships for determining maximum expected species richness for IBI analysis. This has been accomplished by plotting species richness for a number of sites against watershed areas and/or stream orders (Fausch et al. 1984). We chose to use watershed area (kilometer^2) to develop our relationships as this variable has been shown to be a more reliable metric for predicting maximum species richness. Watershed areas **(the area upstream of the survey site)** were determined from USGS 1:24,000 scale maps.

FISH COLLECTIONS

Fish data were collected by employing an Index of Biological Integrity (Karr et al. 1986, Evans 1998). Fish were collected with standard electrofishing (backpack) and seining techniques. A 5 x 1.3 meter seine was used to make hauls in shallow pool and run areas. Riffle and deeper run habitats were sampled with a seine in conjunction with a backpack electrofishing unit (100-600 VAC). An area approximately the length of the seine^2 (i.e., 5 meter x 5 meter) was electrofished in a downstream direction. A person with a dipnet assisted the person electrofishing in collecting those fish, which did not freely drift into the seine. Timed (5-min duration) backpack electrofishing runs were used to sample shoreline habitats. In both cases (seining or shocking) an estimate of area (meter^2) covered on each pass was calculated. Fish collections were made in all habitat types within the selected survey reach. Collections were made repeatedly for each habitat type until no new species was collected for three consecutive samples for each habitat type. All fish collected from each sample were enumerated and in the case of game fish, lengths obtained. Anomalies (e.g., parasites, deformities, eroded fins, lesions, or tumors) were noted along with occurrences of hybridization. After processing, the captured fish were either held in captivity or released into the stream where they could not be recaptured.

Catch-per-unit-effort samples (CPUE) were conducted in four rivers during 2004. Timed boat electrofishing runs were made in pool and shallower habitat where navigable. Efforts were made to sample the highest quality habitat in each sample site and include representation of all habitat types typical to the reaches surveyed. Total electrofishing time was calculated and was used to determine our catch-effort estimates (fish/hour).

Generally, fish were identified in the field and released. Problematic specimens were preserved in 10% formalin and later identified in the lab or taken to Dr. David A. Etnier at the University of Tennessee Knoxville (UTK) for identification. Most of the preserved fish collected in the 2004 samples will be catalogued into our reference collection or deposited in the University of Tennessee Research Collection of Fishes. Common and scientific names of fishes used in this report are after Nelson et al. (2004) and Etnier and Starnes (1993).

AGE and GROWTH

In order to address management questions pertaining to the age and growth characteristics of stream dwelling smallmouth bass, spotted bass, largemouth bass, and rock bass populations, statewide collection of otolith samples was initiated in 1995 by regional stream crews. No otoltihs were collected from black bass or rock bass in 2004 as collections were made from these rivers between 1997 and 2000.

BENTHIC COLLECTIONS

Qualitative benthic samples were collected from each IBI fish sample site (9 total). These were taken with aquatic insect nets, by rock turning, and by selected pickings from as many types of habitat as possible within the sample area. Taxa richness and relative abundance are the primary considerations of this type of sampling. Taxa richness reflects the health of the benthic community and biological impairment is reflected in the absence of pollution sensitive taxa such as Ephemeroptera, Plecoptera, and Trichoptera (EPT).

Large particles and debris were picked from the samples and discarded in the field. The remaining sample was preserved in 70% ethanol and later sorted in the laboratory. Organisms were enumerated and attempts were made to identify specimens to species level when possible. Many were identified to genus, and most were at least identified to family. Dr. David A. Etnier (UTK) examined problematic specimens and either made the determination or confirmed our identifications. Comparisons with identified specimens in our aquatic invertebrate collection were also useful in making determinations. For the most part, nomenclature of aquatic insects used in this report follows Brigham et al. (1982) and Louton (1982). Names of stoneflies (Plecoptera) are after Stewart and Stark (1988) and caddisflies are after Etnier et al. (1998). Benthic results are presented in tabular form with each stream account.

WATER QUALITY MEASUREMENTS

Basic water quality data were taken at most sites in conjunction with the fishery and benthic samples. The samples included temperature, pH, and conductivity. Data were taken from midstream and mid-depth at each site, using a YSI model 33 S-C-T meter. Scientific Products™ pH indicator strips were used to measure pH. Stream velocities were measured with a Marsh-McBirney Model 201D current meter. The Robins-Crawford "rapid crude" technique (as described by Orth 1983) was used to estimate flows. Water quality parameters were recorded on physicochemical data forms and are included with each stream account.

HABITAT QUALITY ANALYSIS

Beginning in 2004, the stream survey unit introduced an experimental habitat assessment form that built on the existing method by incorporating biological impairment and metric modifications to the standardized form. The major advantages of this evaluation procedure include more concise metrics and categories that identify the stream or river based on size, gradient, temperature, eco-region and alterations of flow based on groundwater or hydroelectric influences.

The other issue we wanted to address with this new evaluation was the development of our own biotic index for benthic macroinvertebrates. By assigning an overall value to the water quality, habitat, and biological impairment of a given reach of stream we can begin to assign tolerance values to associated benthic insect species collected during the survey. This will ultimately allow use to develop a more accurate biotic index for benthic macroinvertebrates for the Ridge and Valley and Blue Ridge Eco-regions of east Tennessee. The illustrations below depict the layout of the experimental form including the 14 habitat/water quality metrics, the biotic index adjustment, eco-region classification, and stream type.

We feel that this form allows use to be more precise in our evaluation of the stream habitat quality and gives us a more defined evaluation pertaining to stream morphology and location. We will continue to complete both habitat evaluations for each stream survey for the next couple of field seasons in order to fully evaluate the new form.

Experimental Stream Habitat Assessment Form

STREAM QUALITY ASSESSMENT FORM FORM:SQA-09-2004

Tennessee Wildlife Resources Agency Stream Survey Unit

STREAM:________________ DATE:________________

INVESTIGATOR:________________ SITE CODE:________________

LAT/LONG:________________ ELEVATION:________________

Rate Each Of The Following 14 Metrics:
0(EXCELLENT) 1(GOOD) 2(FAIR) 3(POOR) 4(VERY POOR)
note: 0 = pristine condition and 4 = worst condition

SCORE

1 SILTATION ☐
(fine particles that blanket [smother] the substrate)

2 SUBSTRATE EMBEDDEDNESS ☐
(interstitial spaces between gravel, cobble and boulder have become filled with fine deposits such as sand making the underside habitat unsuitable to aquatic life)

3 BED-LOAD MOVEMENT ☐
(condition pertaining to excessive bed load movement, and frequent formation and destruction of sand and gravel bars)

4 STATE OF SMALL RIPARIAN VEGETATION ☐
(grasses, shrubs, etc. that stabilize the soil surface and serve as runoff filters)

5 STATE OF LARGE RIPARIAN VEGETATION ☐
(canopy trees that provide long-term bank stability and shade)

6 BANK STABILITY ☐
(signs of bank erosion)

7 PHYSICAL DAMAGE TO STREAM HABITAT BY DOMESTIC LIVESTOCK ☐
(obvious signs of damage within riparian zone and instream habitat from livestock traffic)

8 ALTERATIONS OF NATURAL PHYSICAL CHARACTERS OF STREAMBED ☐
(channelization, gravel dredging, channel relocation, bridges, culverts, dams, fords etc.)

9 TURBIDITY ☐
(suspended solids "muddy or cloudy")

10 POINT SOURCE POLLUTION ☐
(FACTORY, MINING SOURCE, etc.)
(pipes or ditches conveying contaminated effluent adversely affecting water quality), chemical odor and/or unusual water or substrate coloration. (reddish algae [organic] or iron oxide [inorganic] often associated with severe earth disturbance)

11 ENRICHMENT ☐
(agricultural livestock waste and/or crop fertilizers, poorly functioning municipal waste water treatment facility or residential septic systems often indicated by filamentous algae etc.)

12 ATYPICAL WATER QUALITY PARAMETERS (BASIC) ☐
(unusually high or low pH, conductivity, dissolved oxygen, or temperature)

13 ENVIRONMENTALLY HARMFUL TRASH ☐
(human refuse including oil filters, engines, batteries, tires, etc. that may be toxic to aquatic organisms)

14 ALTERED STREAM FLOW (CFS) ☐
(abnormal fluctuations in flow volume [e.g. hydroelectric dam regulation], or low flow due to water consumption for municipal water, bottled water, crop irrigation, or other water demands.)

TOTAL ☐

BIOTIC INDEX ADJUSTMENT (BIA) + ☐
(does one or more of the previous 14 metrics seriously inhibit aquatic life?)
0 (no biological impairment) **5** (only the most sensitive taxa impaired)
10 (somewhat diverse but most intolerant forms absent) **15** (low diversity—tolerant forms only)
20 (little or no aquatic life present)

STREAM ASSESSMENT VALUE = TOTAL + BIA → ☐

0 - 10 (EXCELLENT) 11 - 21 (GOOD) 22 - 32 (FAIR) 33 - 43 (POOR) ≥44 (VERY POOR)

INDICATE (CIRCLE) ECOREGION:

STREAM TYPE:	GRADIENT LOW	GRADIENT MOD	GRADIENT HIGH	TEMPERATURE COLD	TEMPERATURE COOL	TEMPERATURE WARM	
	<0.01	0.01-0.05	>0.05	<20°C	<25°C	>25°C	Maximum Summer Temp
HEADWATER (0 - 2 METERS)	☐	☐	☐	☐	☐	☐	
SMALL CREEK (2.1 - 11.0 METERS)	☐	☐	☐	☐	☐	☐	
LARGE CREEK (11.1 - 21.0 METERS)	☐	☐	☐	☐	☐	☐	
SMALL RIVER 1 (21.1 - 111 METERS)	☐	☐	☐	☐	☐	☐	
SMALL RIVER 2 (111.1 - 201 METERS)	☐	☐	☐	☐	☐	☐	
MEDIUM RIVER (202 METERS - 502 METERS)	☐	☐	☐	☐	☐	☐	
LARGE RIVER (>503 METERS)	☐	☐	☐	☐	☐	☐	

CHECK IF STREAM IS:

A SPRING RUN (near source) ☐
A CREEK WITH SIGNIFICANT SPRING INFLUENCE ☐
A TAILWATER ☐

Ecoregion designations follow Griffith (USEPA) et al. Stream Type, and Gradient definitions generally follow Smith, R.K., P.L. Freeman, J.V. Higgins, K.S. Wheaton, T.W. FitzHugh, K.J. Ernstrom, A.A. Das. Priority Areas for Freshwater Conservation: A Biodiversity of the Southeastern United States. The Nature Conservancy. 2002.

DATA ANALYSIS

Twelve metrics described by Karr et al. (1986) were used to determine an IBI score for each stream surveyed. These metrics were designed to reflect fish community health from a variety of perspectives (Karr et al. 1986). Given that IBI metrics were developed for the midwestern United States, many state and federal agencies have modified the original twelve metrics to accommodate regional differences. Such modifications have been developed for Tennessee primarily through the efforts of TWRA (Bivens et al. 1995), TVA, and Tennessee Tech University. In developing our scoring criteria for the twelve metrics we reviewed pertinent literature [North American Atlas of Fishes (Lee et al. 1980), The Fishes of Tennessee (Etnier and Starnes 1993), various TWRA Annual Reports and unpublished data] to establish historical and more recent accounts of fishes expected to occur in the drainages we sampled. Scoring criteria for the twelve metrics were modified according to watershed size. Watersheds draining less than 13 $kilometer^2$ were assigned different scoring criteria than those draining greater areas. This was done to accommodate the inherent problems associated with small stream samples (e.g., lower catch rates and species richness). Young-of-the-year fish and non-native species were excluded from the IBI calculations. After calculating a final score, an integrity class was assigned to the stream reach based on that score. The classes used with the exception of New River drainage streams follow those described by Karr et al. (1986). Scoring criteria for the New River drainage are from Evans (1998).

Karr et al. (1986) criteria

Total IBI score (sum of the 12 metric ratings)	**Integrity Class**	**Attributes**
58-60	Excellent	Comparable to the best situations without human disturbance; all regionally expected species for the habitat and stream size, including the most intolerant forms, are present with a full array of size classes; balanced trophic structure.
48-52	Good	Species richness somewhat below expectation, especially due to the loss of the most intolerant forms; some species are present with less

		than optimal abundance or size distributions; trophic structure shows some signs of stress.
40-44	Fair	Signs of additional deterioration include loss of intolerant forms, fewer species, highly skewed trophic structure (e.g., increasing frequency of omnivores and green sunfish or other tolerant species); older age classes of top predators may be rare.
28-34	Poor	Dominated by omnivores, tolerant forms, and habitat generalists; few top carnivores; growth rates and condition factors commonly depressed; hybrids and diseased fish often present.
12-22	Very poor	Few fish present, mostly introduced or tolerant forms; hybrids common; disease, parasites fin damage, and other anomalies regular.
	No fish	Repeated sampling finds no fish.

Evans (1998) criteria

5th Order Streams IBI	2nd, 3rd, and 4th Order Streams IBI	Classification
44-50	49-55	Excellent
37-43	41-48	Good
30-36	33-40	Fair
23-29	25-32	Poor
≤22	≤24	Very Poor

Catch-per-unit-effort analysis was performed on the four large rivers sampled during 2004. Total time spent electrofishing at each site was used to calculate the CPUE estimates for each species collected. Length categorization analysis (Gabelhouse 1984) was used to calculate Proportional Stock Density (PSD) and Relative Stock Density (RSD) for black bass and rock bass populations sampled.

Benthic data collected for the 2004 surveys were subjected to a biotic index that rates stream condition based on the overall taxa tolerance values and the number of Ephemeroptera, Plecoptera, and Trichoptera (EPT) taxa present. The North Carolina Division of Environmental Management (NCDEM) has developed a bioclassification index and associated criteria for the southeastern United States (Lenat 1993). This technique rates water quality according to scores derived from taxa tolerance values and EPT taxa richness values. The final derivation of the water quality classification is based on the combination of scores generated from the two indices. The criteria used to generate the biotic index values and EPT values are as follows:

Score	Biotic Index Values	EPT Values
5 (Excellent)	< 5.14	> 33
4.6	5.14-5.18	32-33
4.4	5.19-5.23	30-31
4 (Good)	5.24-5.73	26-29
3.6	5.74-5.78	24-25
3.4	5.79-5.83	22-23
3	5.84-6.43	18-21
2.6	6.44-6.48	16-17
2.4	6.49-6.53	14-15
2	6.54-7.43	10-13
1.6	7.44-7.48	8-9
1.4	7.49-7.53	6-7
1 (Poor)	> 7.53	0-5

The overall result is an index of water quality that is designed to give a general state of pollution regardless of the source (Lenat 1993). Taxa tolerance rankings were based on those given by NCDEM (1995) with minor modifications for taxa, which did not have assigned tolerance values.

Spring Creek, Sheehan Branch, Spurling Branch, and Ellis Branch

A qualitative survey for the Tennessee dace was conducted in 2004 in Spring Creek and three tributaries to Spring Creek, Spurling Branch, Sheehan Branch and Ellis Branch (Figure 1). Tennessee dace had been recently reported from Spurling and Sheehan Branch from U.S. Forest surveys. We returned to these localities to collect voucher specimens for the TWRA collection of fishes. The two other streams surveyed, Spring Creek and Ellis Branch had no occurrence records for this species. A total 18 (14 preserved) specimens of Tennessee dace were collected from Spurling Branch, and eight (all preserved) were collected from Sheehan Branch. The surveys in Spring Creek and Ellis Branch were unsuccessful in locating any Tennessee dace. A listing of the species collected from each stream can be found in Table 1.

Figure 1. Sample locations for Tennessee dace surveys in 2004.

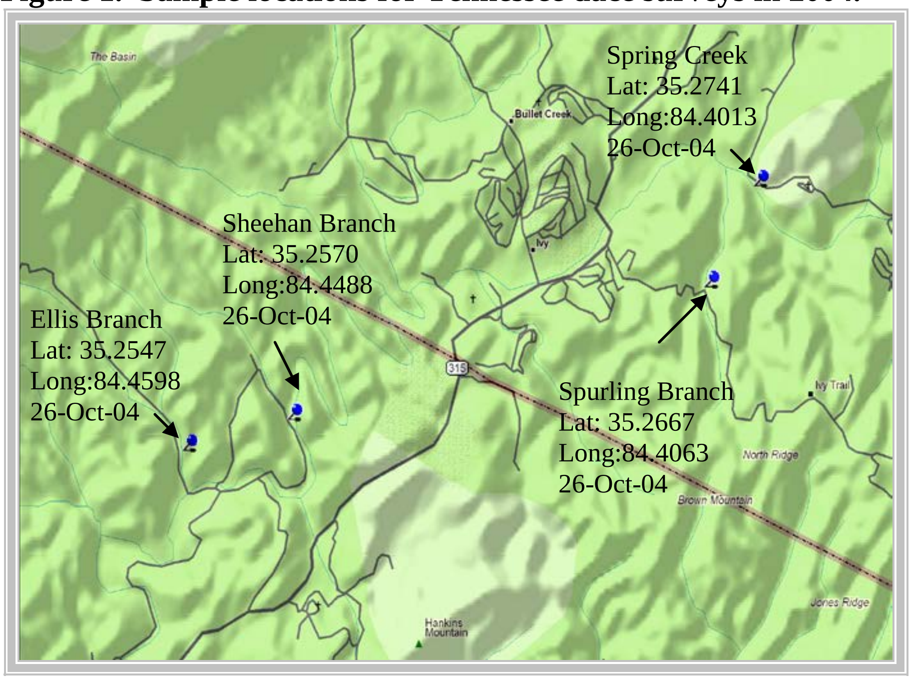


Table 1. Species occurrence and number collected for the four Tennessee dace surveys.

Species	Spring Creek 420043401	Spurling Branch 420043501	Sheehan Branch 420043601	Ellis Branch 420043701
Banded Sculpin	7	-	5	-
Central Stoneroller	20	-	67	-
Creek Chub	15	29	26	57
Green Sunfish	4	-	-	-
Northern Hogsucker	2	-	2	-
River Chub	2	-	-	-
Rock Bass	1	-	-	-
Snubnose Darter	6	-	2	-
Tennessee Dace	-	18	8	-
Tennessee Shiner		-	24	-
Warpaint Shiner	2	-	6	-
Western Blacknose Dace	48	15	20	86
Whitetail Shiner	-	-	6	-

North Fork Holston River

Introduction

The North Fork Holston River has a reputation of being one of the regions best riverine smallmouth bass fisheries. This is supported by frequent reports of quality size smallmouth bass being caught in the 8.3 kilometer section between the TN/VA line and the confluence with the South Fork Holston River near Kingsport. Our interest in surveying the short reach that flows through Tennessee, was to continue compiling baseline catch per unit effort (CPUE) estimates and population size structure data on these populations. The Agency has conducted limited surveys (1 site each) of the river in 1989 and 1997 (Bivens and Williams 1990, Bivens et al. 1998) and more extensive surveys of sport fish populations in 1998 and 2001 (Carter et al. 1999, 2002). Because of the lack of information regarding angler use and harvest in warmwater river fisheries in east Tennessee the TWRA contracted with Tennessee Technological University in 2001 to conduct a creel survey on the North Fork. Between March 1 and October 31, 2001 a roving creel was conducted along the 8.3 km section that flows through Tennessee (Bettoli 2002).

Study Area and Methods

The North Fork Holston River originates in Virginia and flows in a southwesterly direction before emptying into the South Fork Holston River near Kingsport. In Tennessee, the 8.3 kilometer reach of the river courses through the Ridge and Valley province of Hawkins and Sullivan counties. Land use is primarily residential with a few small farms interspersed. Public access along the river is primarily limited to bridge crossing and small “pull-outs” along roads paralleling the river. There are a few primitive launching areas for canoes or small boats on private land.

During April 2004, six fish surveys (CPUE) were conducted on the North Fork between the TN/VA line and its confluence with the South Fork (Figure 2). We repeated our CPUE samples conducted in 1998 and 2001. The riparian habitat along this reach consists primarily of wooded shorelines with interspersed fields and residential lawns. Submerged woody debri was fairly common in most of our sample areas. The river substrate was predominately composed of bedrock and boulders. Perpendicular/parallel (to flow) bedrock shelves were more abundant in the pool habitat, while a combination of boulder and bedrock comprised the majority of the riffle habitat. There were a few riffles within the survey areas that had cobble size substrate as the primary component. Measured mean channel widths ranged from 45.2 m to 68.3 m, while site lengths fell between 250 meters and 1,325 meters (Table 2). Water temperatures ranged from 16 C to 19 C and conductivity varied from 220 to 240 (Table 2).

Figure 2. Site locations for the samples conducted in the North Fork Holston River 2004.

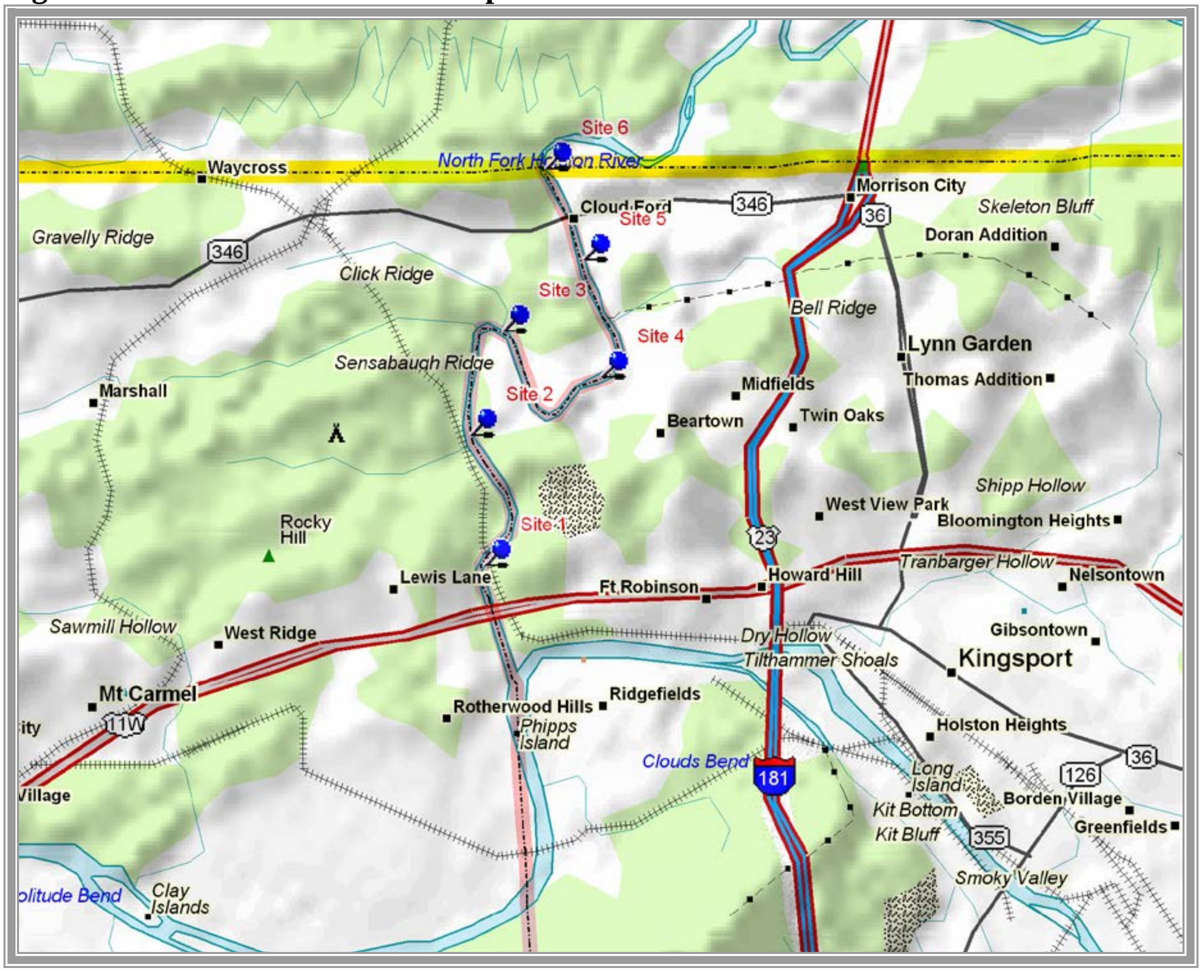


Table 2. Physiochemical and site location data for samples conducted on the North Fork Holston River during 2004.

Site Code	Site	County	Quad	River Mile	Latitude	Longitude	Mean Width (m)	Length (m)	Temp.	Cond.	Secchi (m)
420040501	1	Hawkins/Sullivan	Kingsport 188SE	0.8	36.5580	82.6518	68.3	293	19	240	1.0
420040502	2	Hawkins/Sullivan	Kingsport 188SE	2.0	36.5700	82.6175	54.4	1158	18	240	1.0
420040503	3	Hawkins/Sullivan	Kingsport 188SE	2.7	36.5805	82.6136	48.3	518	18	240	1.0
420040504	4	Hawkins/Sullivan	Kingsport 188SE	4.0	36.5747	82.6025	45.2	1325	18	230	1.0
420040505	5	Hawkins/Sullivan	Kingsport 188SE	4.4	36.5858	82.6044	52.0	953	16	230	1.0
420040506	6	Hawkins/Sullivan	Kingsport 188SE	5.0	36.5941	82.6088	58.0	250	17	220	1.0

Fish were collected by boat electrofishing in accordance with the standard large river sampling protocols (TWRA 1998). Fixed-boom electrodes were used to transfer 4 amps DC at all sites. This current setting was determined effective in narcotizing smallmouth bass and rock bass. All sites were sampled during daylight hours and had survey durations ranging from 634 to 1710 seconds. CPUE values were calculated for each target species at each site. Length categorization indices were calculated for target species following Gabelhouse (1984).

Results

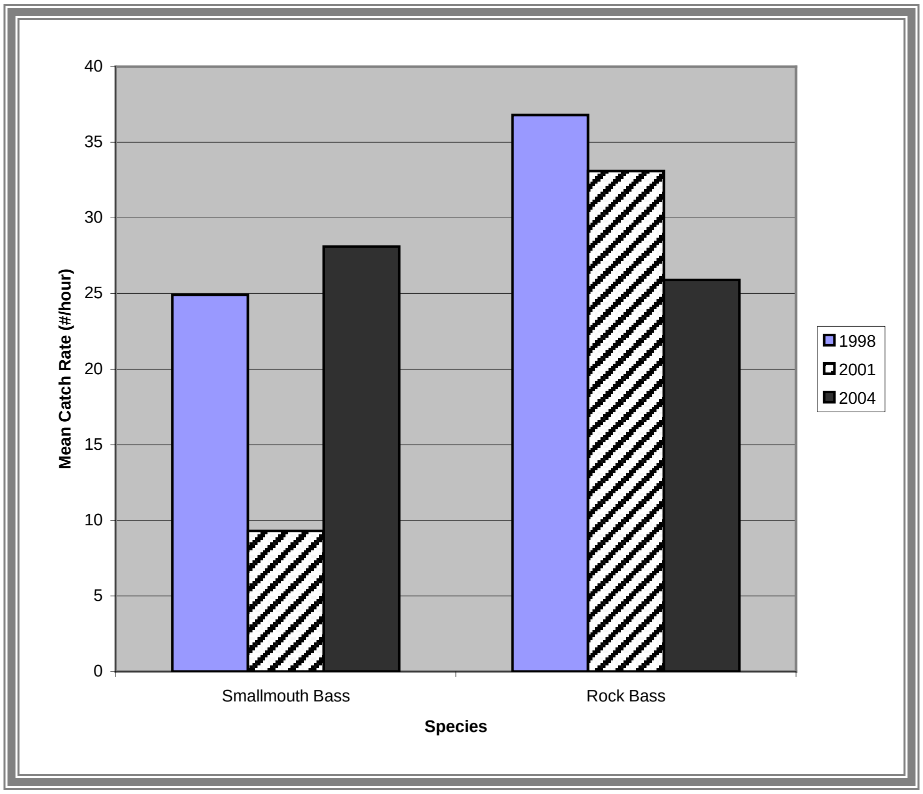
Both smallmouth bass and rock bass were collected from all six sites. Smallmouth bass was the only black bass collected during our surveys. CPUE estimates for this species averaged 28.1/hour at each site (Table 3).

Table 3. Catch per unit effort and length categorization indices of target species collected at six sites on the North Fork Holston River during 2004.

Site Code	Smallmouth Bass CPUE	Rock Bass CPUE
420040501	23.5	11.7
420040502	57.4	40.4
420040503	20.0	42.5
420040504	13.1	28.9
420040505	12.8	2.5
420040506	41.6	29.2
MEAN	28.1	25.9
STD. DEV.	17.8	15.8
	Smallmouth Bass Length-Categorization Analysis	**Rock Bass Length-Categorization Analysis**
	PSD = 67.4	PSD = 11.5
	RSD-Preferred = 45.6	RSD-Preferred = 1.9
	RSD-Memorable = 21.7	RSD-Memorable = 0
	RSD-Trophy = 4.3	RSD-Trophy = 0

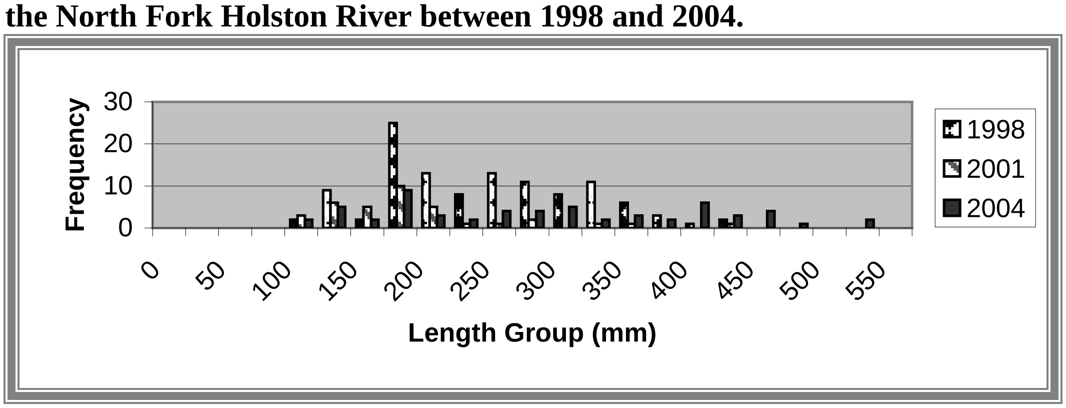
Sites 2 and 6 had the highest catch rates of the six sites sampled and were about 76% higher on average than the total sample average. We feel that this could be related to the higher occurrence of perpendicular/parallel bedrock shelves (and subsequent troughs) in these sites, which appeared to be, preferred habitat (smallmouth would hold in deeper troughs just below or to the side of bedrock shelves). Rock bass were generally less abundant than smallmouth bass encountered in our survey areas and had an average CPUE of 25.9 (Table 3). The sites where the catch rates were highest usually had at least one shoreline that had good boulder cover. The lower reaches of the river had the highest catch rates (sites 2 and 3) where preferred cover was more abundant. As expected the trends observed in other smallmouth bass rivers sampled in the spring held true for the North Fork where our value calculated in 2004 surpassed the values for the samples collected in 1998 and 2001 (Figure 3). Comparatively, rock bass abundance declined 21.7% between 2001 and 2004. This was not unexpected, as we have observed the same trends in rivers sampled during the spring and fall (Carter et al. 2003, 2004).

Figure 3. Trends in mean catch rate of black bass and rock bass collected between 1998 and 2004 from the North Fork Holston River.



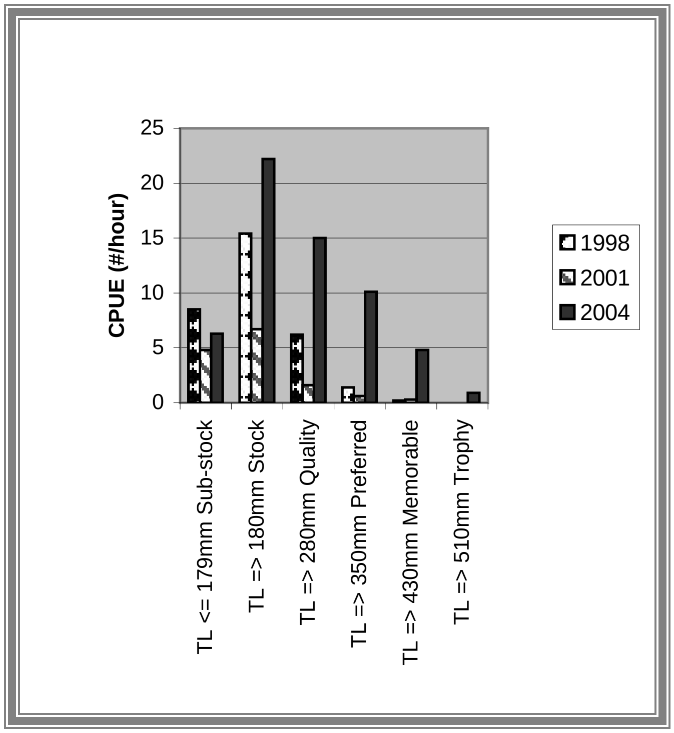
The majority of the smallmouth bass collected in the North Fork Holston River during 2004 fell within the 125 mm to 325 mm length range (Figure 4). The size distribution of smallmouth bass between 1998 and 2004 changed somewhat among our six sampling stations (Figure 4). Generally, there were substantially fewer bass in all size categories in 2004 when compared to the previous surveys, however we did observe an increase in the number of bass over 400 mm.

Figure 4. Length frequency distributions for smallmouth bass collected from the North Fork Holston River between 1998 and 2004.



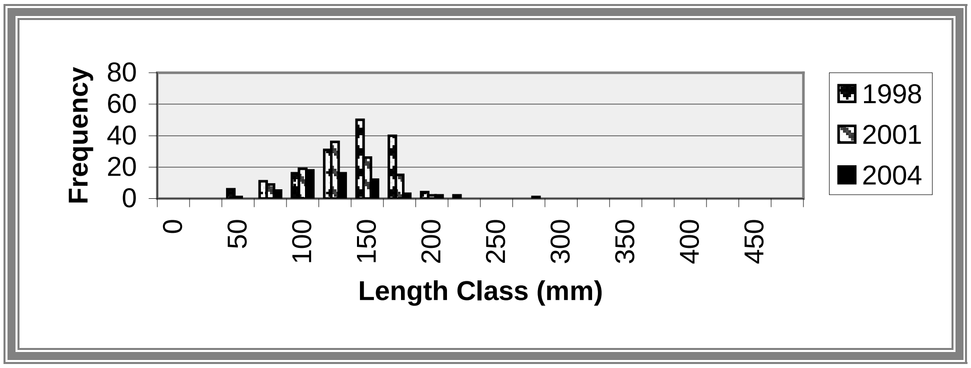
Length categorization analysis indicated the Relative Stock Density (RSD) for preferred smallmouth bass (TL ≥ 350 mm) was 45.6. RSD for memorable (TL ≥ 430 mm) and trophy (TL ≥ 510 mm) size bass was 21.7 and 4.3, respectively. All RSD categories increased significantly between the 2001 sample and the 2004. We believe that this can be explained by the timing of our sample (spring sample), which was more conducive for collecting larger bass. The ratio of quality (TL $\geq$ 280 mm) smallmouth bass to stock size bass (TL $\geq$ 180 mm) was 67.4 (2001 value = 23.8). Catch per unit effort estimates by RSD category indicated the majority of the catch was in the RSD-S (Figure 5). Overall the proportional distribution of catch was higher in most categories when compared to the 1998 and 2001 sample. This is attributable to the increase in size structure and the overall increase in catch rate.

Figure 5. Relative stock density (RSD) catch per unit effort for smallmouth bass collected from the North Fork Holston River between 1998 and 2004.



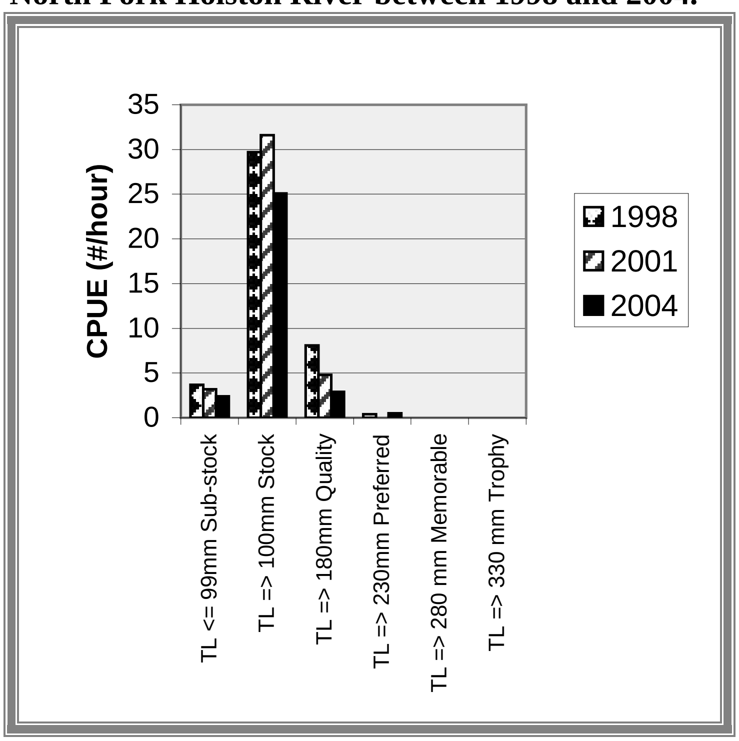
Individuals in the 100 mm to 175 mm range represented the majority of rock bass in our sample (Figure 6). Length categorization analysis indicated the RSD for preferred rock bass (TL $\geq$ 230 mm) was 1.9.

Figure 6. Length frequency distributions for rock bass collected from the North Fork Holston River between 1998 and 2004.



RSD for memorable (TL ≥ 280 mm) and trophy (TL ≥ 330 mm) size rock bass was 0. The ratio of quality (TL ≥ 180 mm) rock bass to stock size rock bass (TL ≥ 100 mm) was 11.5. Catch data by RSD category revealed a high number of rock bass in the RSD-S category with somewhat poor recruitment into the RSD-Q and above during 2004 (Figure 7). These trends were similar to previous sample years although the overall 2004 values were somewhat depressed. This is most likely related to timing of our sample, which has shown to result in lower catches of rock bass in other rivers.

Figure 7. Relative stock density (RSD) catch per unit effort by category for rock bass collected from the North Fork Holston River between 1998 and 2004.



Discussion

The North Fork Holston River provides anglers with the opportunity to catch substantial numbers of quality size smallmouth bass and rock bass. Catches of smallmouth bass in 2004 exceeded those values recorded in 1998 and 2001, which is related to the timing of the sample. Our finding from spring and fall samples have indicated that size structure and catch rates generally increase during these time periods when compared to summer samples. In 2001, a roving creel survey was conducted on the North Fork indicating relatively high angling pressure and moderate harvest (Betolli 2002, Carter et al. 2003). All information from our survey data indicates that the smallmouth bass population, although fluctuating under drought conditions (1998 and 2001 surveys), has continued to produce good numbers of quality fish.

Surveys on the North Fork Holston River will be conducted on a three-year rotation in order to assess any changes in the fishery. The North Fork has been under consideration for some time regarding smallmouth bass regulations. The relatively short reach of river in Tennessee coupled with the relatively high angling pressure and the rivers ability to produce quality size fish makes it a good candidate for management with regulations.

Management Recommendations

1. Develop a fishery management plan for the river.

Kendrick Creek

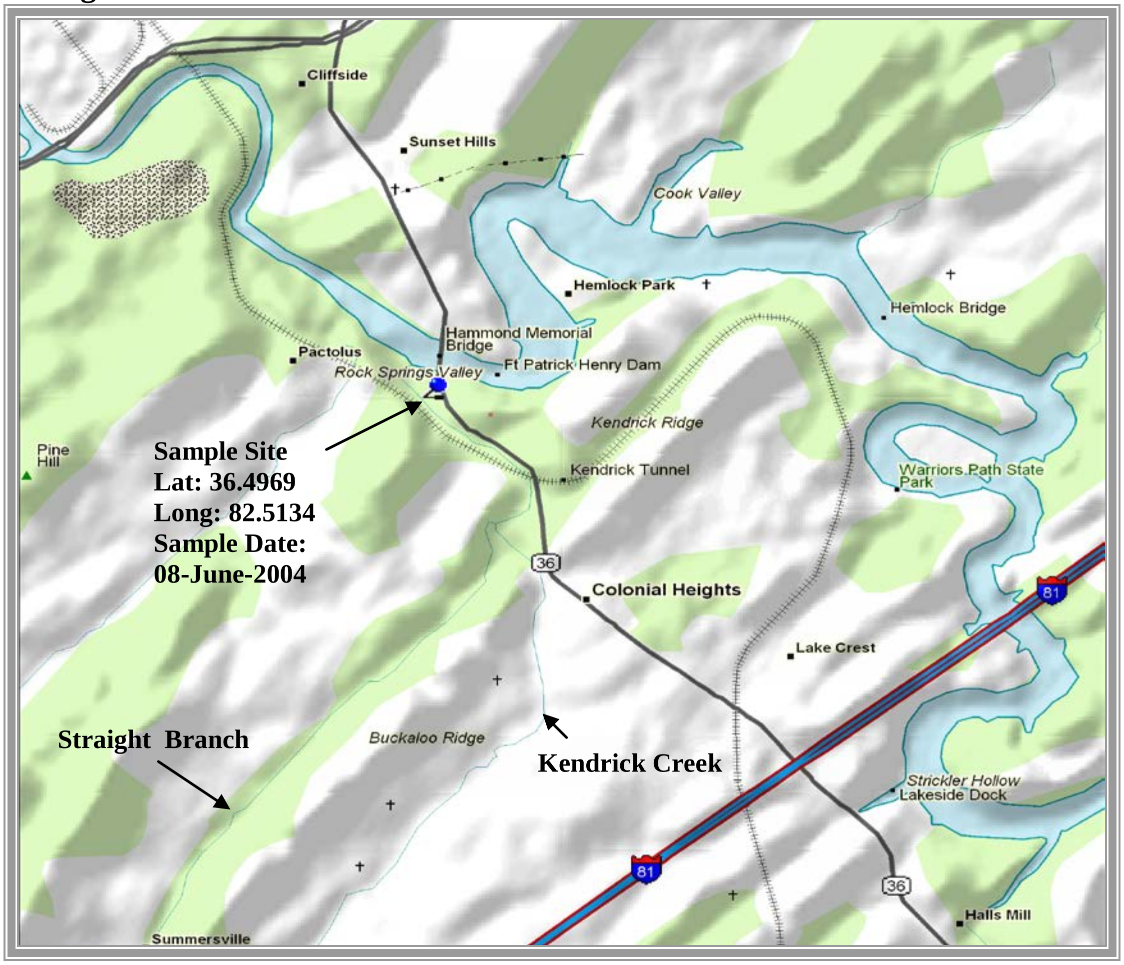
Introduction

Kendrick Creek is located in Sullivan County near the city of Kingsport. The stream flows in a northwesterly direction before joining the South Fork Holston River just downstream of Fort Patrick Henry Dam. Industrial, municipal, and residential runoff into the stream is an everyday occurrence within this watershed and is particularly evident during periods of high flow. We were primarily interested in evaluating the relative health of the stream and comparing the current condition to findings of the TVA in 1993 and 1996 (TVA 1998).

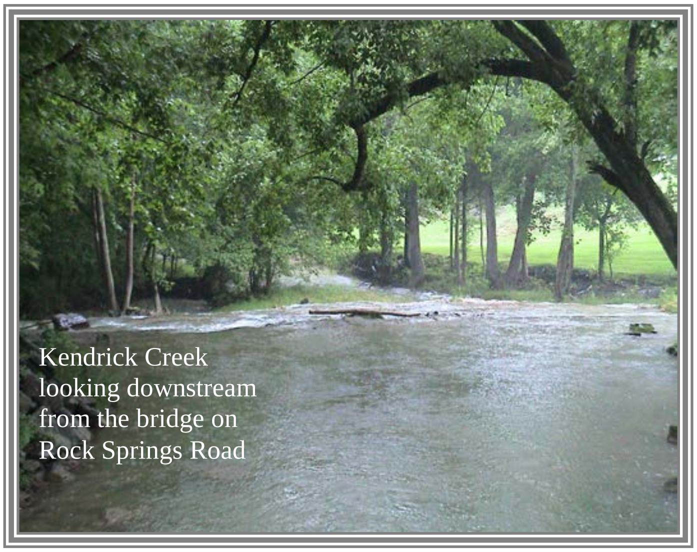
Study Area and Methods

Our survey of Kendrick Creek (Figure 8) was conducted at the bridge crossing on Rock Springs Road. Our survey was slightly upstream from the area surveyed by the TVA.

Figure 8. Sample site location for the survey conducted in Kendrick Creek during 2004.



Our evaluation of the fish community was accomplished through an Index of Biotic Integrity (IBI) survey. Benthic organisms were collected with kick nets during a timed survey. Analysis of the fish and benthic samples followed procedures developed by Karr et al. (1986) and Lenat (1993). At our sample location bedrock and cobble were the dominant substrate components comprising about 50% of the substrate in the pools and about 55% in the riffles. Pools dominated the habitat features contributing about 60% of the available habitat. Our sample site had a well-established riparian zone upstream of the bridge crossing. As seen in the photograph the right descending bank below the bridge had been converted into residential lawn and exhibited some signs of erosion. Basic water quality measurements at this site revealed the following information, temperature 18 C, conductivity 400 µs/cm, flow 21.5 cfs and a pH of 7.2. Enrichment of this stream was evident by the elevated conductivity and the amount of periphyton present in the stream although recent high water had probably eliminated much of the algal growth. There was a consistent smell of sewage from a pumping station located just upstream of the bridge. There was also evidence of overflow from the pumping station during storm events, which evidently was conveyed directly to the stream.



Kendrick Creek looking downstream from the bridge on Rock Springs Road

Results

We collected a total of 380 fish comprising ten species at our sample site (Table 4). There were three game species collected at this site, which included rainbow trout, brown trout, and rock bass. The two most dominant species collected in our sample were the largescale stoneroller and western blacknose dace. Together, these two species comprised 80.5% of the total number of fish in our sample. Two species of darters were collected, swannanoa darter, and snubnose darter. Both the northern hog sucker and white sucker were collected at this site although the white sucker was the predominant species. There were several of the IBI metrics that had a substantial effect on lowering the overall score for this stream. These included the low number of native species and sunfish species, the absence of intolerant species, the high percentage of omnivores, and the relatively low percentage of trophic specialists. Overall, the catch rate of fish was relatively high and there was a low occurrence of anomalies and tolerant species in the fish community. These metrics help elevate the score somewhat which increased the score to the upper range of the poor category. Both rainbow and brown trout were collected from the stream. It was apparent that the brown trout were transients from the South Fork Holston River where recent stockings of this species had taken place. There was evidence of rainbow trout reproduction although very limited (1 individual).

Table 4. Fish species occurrence for Kendrick Creek 2004.

Site Code	Species	Tads Code	Total Number
420040901	Brown trout	284	12
420040901	Creek chub	188	7
420040901	Largescale stoneroller	45	234
420040901	Northern hog sucker	207	1
420040901	Western blacknose dace	184	72
420040901	Rainbow trout	279	2
420040901	Rock bass	342	4
420040901	Snubnose darter	435	18
420040901	Swannanoa darter	442	17
420040901	White sucker	195	13
		Total	**380**

Overall, the IBI analysis indicated Kendrick Creek was in poor condition (IBI score = 34) (Table 5). This was somewhat of an improvement based on the 1996 IBI data collected by the TVA. The major differences observed between the two samples were

Table 5. Kendrick Creek Index of Biotic Integrity analysis.

Metric Description	Scoring Criteria 1 3 5	Observed	Score
Number of Native Species	<10 10-19 >19	8	1
Number of Darter Species	<2 2 >2	2	3
Number of Sunfish Species less Micropterus	<2 2 >2	1	1
Number of Sucker Species	<2 2 >2	2	3
Number of Intolerant Species	0 1 >1	0	1
Percent of Individuals as Tolerant	>59 59-30 <30	5.5	5
Percent of Individuals as Omnivores	>45 45-22 <22	67.4	1
Percent of Individuals as Specialists	<16 16-32 >32	9.5	1
Percent of Individuals as Piscivores	<1 1-5 >5	1.1	3
Catch Rate	<8 8-15 >15	32.7	5
Percent of Individuals as Hybrids	>1 1-TR 0	0	5
Percent of Individuals with Anomalies	>5 5-2 <2	0.5	5
		Total	**34 (Poor)**

the increase in the overall catch rate, and the increase in the percentage of piscivores in the sample. These two metrics had the most influence in elevating the overall IBI score between the 1996 sample and the 2004 sample. The 1996 assessment by TVA resulted in an overall IBI score of 32 (poor) (TVA 1998). Our visual assessment of the habitat quality indicated that this reach of the stream was in poor condition based on an average score of 39.7.

Benthic macroinvertebrates collected in our sample comprised 25 families representing 29 identified genera (Table 6). The most abundant group in our collection was the mayflies comprising 29.2% of the total sample. Overall, a total of 34 taxa were identified from the sample of which 16 were EPT. Based on the EPT taxa richness and overall biotic index of all species collected, the relative health of the benthic community was classified as "fair/good-good" (3.8).

Table 6. Taxa list and associated biotic statistics for benthic macroinvertebrates collected from Kendrick Creek.

ORDER	FAMILY	SPECIES	NUMBER	PERCENT
ANNELIDA				0.8
	Oligochaeta		2	
COLEOPTERA				2.0
	Elmidae	*Optioservus* larva	1	
		Stenelmis larvae	3	
	Psephenidae	*Psephenus herricki*	1	
DIPTERA				16.8
	Chironomidae		36	
	Tipulidae	*Tipula*	6	
EPHEMEROPTERA				29.2
	Baetidae	*Baetis*	41	
	Ephemeridae	*Ephemera* early instars	9	
		Ephemera varia	1	
		Hexagenia	7	
	Heptageniidae	*Stenacron interpunctatum*	7	
		Stenonema mediopunctatum	4	
	Isonychiidae	*Isonychia*	3	
	Leptophlebiidae	*Paraleptophlebia*	1	
GASTROPODA				6.8
	Hydrobiidae		1	
	Pleoroceridae	*Elimia*	16	
HETEROPTERA				0.8
	Gerridae	*Aquarius remigis* Adults	2	
ISOPODA				12.0
	Asellidae	*Lirceus*	30	
MEGALOPTERA				2.0
	Corydalidae	*Nigronia serricornis*	2	
	Sialidae	*Sialis*	3	
ODONATA				6.8
	Calopterygidae	*Calopteryx*	6	
	Gomphidae	*Gomphus lividus*	9	
		Ophiogomphus mainensis	1	
		Stylogomphus albistylus	1	
PELECYPODA				0.8
	Corbiculidae	*Corbicula fluminea*	2	
PLECOPTERA				2.0
	Perlidae	*Perlesta* freckled form	5	
TRICHOPTERA				14.0
	Hydropsychidae	*Ceratopsyche bronta*	1	
		Cheumatopsyche	10	
		Hydropsyche betteni/depravata	2	
		Hydropsyche rotosa	6	
	Leptoceridae	*Triaenodes ignitus*	2	
	Limnephilidae	*Pycnopsyche*	2	
	Rhyacophilidae	*Rhyacophila fuscula*	4	
	Uenoidae	*Neophylax etnieri*	8	
TURBELLARIA			15	6.0
(Flat Worms)		**Total**	**250**	

TAXA RICHNESS = 34
EPT TAXA RICHNESS = 16
BIOCLASSIFICATION = 3.8 (FAIR/GOOD-GOOD)

Discussion

Kendrick Creek is typical of many urban streams in east Tennessee. With the constant run-off and input of undesirable pollutants the fish and benthic fauna in this type of stream is under the constant barrage of urbanization. This allows little chance for recovery of streams such as Kendrick Creek, keeping it constantly depressed. Given the amount of new and established development in the watershed it is unlikely that this stream has much chance of ever recovering to its full potential. The encouraging finding for this stream is that it has shown limited improvement since the survey conducted in 1996 by TVA. The establishment of a permanent trout population in this stream is unlikely as it reaches summer temperatures that are not conducive for trout. The stream habitat was poor in the reach we surveyed with a high prevalence of bedrock.

Management Recommendations

1. Development of a watershed council involving private, local, state and federal entities might prove beneficial in improving conditions within the watershed.

2. Periodically monitor this stream to determine relative health changes.

3. Future survey of upstream reach.

Sinking Creek

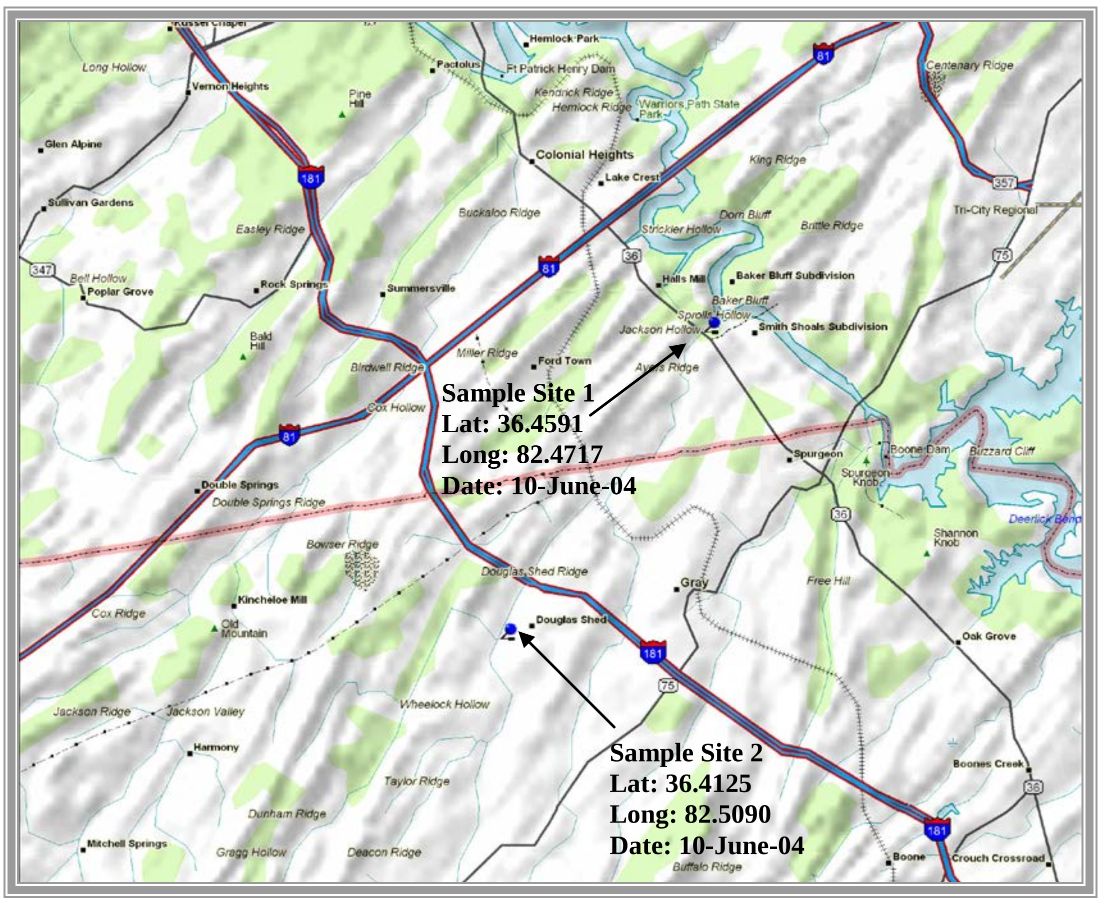
Introduction

Similar to Kendrick Creek, Sinking Creek is subjected to the same degradation associated with urbanization and residential development. Industrial, municipal, and residential runoff into the stream is an everyday occurrence within this watershed and is particularly evident during periods of high flow. Because the TVA surveyed this stream in 1995 (TVA 1998), we were interested in evaluating any changes in the condition of the stream. We were also interested in the fish fauna upstream of this historically surveyed site. We qualitatively surveyed an additional site upstream to determine the fish community composition and evaluate habitat quality.

Study Area and Methods

Our surveys of Sinking Creek (Figure 9) were conducted at the bridge crossing on Hwy. 36 and at the bridge on Hog Hollow Rd. Our survey at Hwy. 36 was in close proximity to the area surveyed by the TVA in 1995.

Figure 9. Sample site locations for the survey conducted in Sinking Creek during 2004.



Our evaluation of the fish community was accomplished through an Index of Biotic Integrity (IBI) survey. Benthic organisms were collected with kick nets during a timed survey. Analysis of the fish and benthic samples followed procedures developed by Karr et al. (1986) and Lenat (1993). At our sample location, gravel and sand were the prevalent substrate components comprising about 55% of the substrate in the pools and about 60% in the riffles. Riffles dominated the habitat features contributing about 70% of the available habitat. Our sample site had established riparian zones upstream and downstream of the bridge crossing, although there were signs of some bank instability in the downstream reaches of our survey area. There was a high occurrence of refuse in and around the stream, which is not untypical for streams in the area. Basic water quality measurements at this site revealed the following information temperature 19.5 C, conductivity 400 µs/cm, flow 13.1 cfs, and a pH of 7.0. Like many others streams in the area enrichment due to residential and municipal run-off was evident. As we investigated further upstream we noticed several area where cattle had access to the stream.


Sinking Creek looking downstream from the bridge.


Sinking Creek upstream of the bridge.

Results

We collected a total of 196 fish comprising seven species at our sample site 1 (420041001) and 136 fish representing eight species at sample site 2 (420041002) (Table 7). The two most common species collected at both of our sample sites were the largescale stoneroller and western blacknose dace. Together, these two species comprised 89% of the total number of fish collected at site 1 and 80% at site 2. The only darter species collected was the snubnose darter, which was equally abundant at both of our sampling stations. White sucker was the only sucker species collected. This species occurred at both sample sites in relatively low numbers. Three game species were collected during our sampling efforts these included largemouth bass (YOY), bluegill, and rock bass. All game species were present in low numbers and would not be considered sufficient in density to constitute a recreational fishery. Our survey at site 1 incorporated the IBI protocol to evaluate the fish community. At our upstream site (site 2) we performed a qualitative catch-effort survey. Total electrofishing time at this site was 15 minutes. There were several IBI metrics that had a substantial effect on lowering the overall score for this stream. These included the lack of darters, the high percentage of omnivores in the sample, low number of native and intolerant species, and the low percentage of trophic specialists.

Table 7. Fish species occurrence for Sinking Creek 2004.

Site Code	Species	Tads Code	Total Number	CPUE (#/hour)
420041001	Creek chub	188	1	-
420041001	Largemouth bass	364	1	-
420041001	Largescale stoneroller	45	81	-
420041001	Western blacknose dace	184	94	-
420041001	Rock bass	342	2	-
420041001	Snubnose darter	435	11	-
420041001	White sucker	195	6	-
		Total	**196**	
420041002	Bluegill	351	3	12.0
420041002	Creek chub	188	1	4.0
420041002	Goldfish	46	3	12.0
420041002	Largescale stoneroller	45	55	220.0
420041002	Western blacknose dace	184	54	216.0
420041002	Rock bass	342	6	24.0
420041002	Snubnose darter	435	11	44.0
420041002	White sucker	195	3	12.0
		Total	**136**	

Table 8. Sinking Creek Index of Biotic Integrity analysis.

Metric Description	Scoring Criteria 1 3 5	Observed	Score
Number of Native Species	<10 10-19 >19	6	1
Number of Darter Species	<2 2 >2	1	1
Number of Sunfish Species less Micropterus	<2 2 >2	1	1
Number of Sucker Species	<2 2 >2	1	1
Number of Intolerant Species	0 1 >1	0	1
Percent of Individuals as Tolerant	>59 59-30 <30	3.6	5
Percent of Individuals as Omnivores	>45 45-22 <22	44.6	3
Percent of Individuals as Specialists	<16 16-32 >32	5.6	1
Percent of Individuals as Piscivores	<1 1-5 >5	1.0	3
Catch Rate	<8 8-15 >15	21.8	5
Percent of Individuals as Hybrids	>1 1-TR 0	0	5
Percent of Individuals with Anomalies	>5 5-2 <2	0	5
		Total	**32 (Poor)**

Overall, the IBI analysis indicated Sinking Creek was in poor condition (IBI score = 32) (Table 8). There was only slight improvement in the health of the fish community based on comparisons with the 1995 IBI data collected by the TVA (IBI score = 30). The major difference observed between the two samples was the higher score for catch rate, which increased by two points between the two samples. Overall, both samples collected the same number of species although composition was slightly different. We collected one small largemouth bass that was not observed by TVA and a northern hogsucker was collected in the TVA sample that was not seen in our 2004 sample. Because of the continued input of pollutants into this stream there is very little hope for sustained improvement in the overall condition of this stream. Our visual assessment of the habitat quality indicated that this reach of the stream was in poor condition based on an average score of 40.6.

Benthic macroinvertebrates collected in our sample comprised 26 families representing 32 identified genera (Table 9). The most abundant group in our collection was the caddisflies comprising 39.1% of the total sample. Overall, a total of 39 taxa were identified from the sample of which 17 were EPT. Based on the EPT taxa richness and overall biotic index of all species collected, the relative health of the benthic community was classified as "fair/good-good" (3.8).

Table 9. Taxa list and associated biotic statistics for benthic macroinvertebrates collected from Sinking Creek.

ORDER	FAMILY	SPECIES	NUMBER	PERCENT
ANNELIDA				0.4
	Oligochaeta		2	
COLEOPTERA				4.4
	Dryopidae	*Helichus* adult	1	
	Elmidae	*Dubiraphia* larva and adults	3	
		Macronychus glabratus adults	2	
		Optioservus larva	10	
		Stenelmis larvae	4	
	Psephenidae	*Psephenus herricki*	1	
DIPTERA				16.6
	Chironomidae		45	
	Simuliidae		24	
	Tipulidae	*Antocha*	1	
		Limonia	2	
		Tipula	6	
EPHEMEROPTERA				29.3
	Baetidae	*Baetis*	37	
	Ephemeridae	*Ephemera*	27	
	Heptageniidae	*Stenacron interpunctatum*	12	
		Stenonema early instars	32	
		Stenonema mediopunctatum	14	
		Stenonema modestum	4	
	Isonychiidae	*Isonychia*	6	
	Leptophlebiidae	*Habrophlebiodes*	2	
		Paraleptophlebia	4	
GASTROPODA				0.2
	Pleuroceridae		1	
HETEROPTERA				1.1
	Gerridae	*Aquarius remigis* male and female	2	
	Veliidae	*Microvelia*	2	
		Rhagovelia obesa male	1	
ISOPODA				1.1
	Asellidae	*Lirceus*	5	
MEGALOPTERA				1.9
	Corydalidae	*Nigronia serricornis*	9	
ODONATA				1.7
	Aeshnidae	*Boyeria vinosa*	2	
	Calopterygidae	*Calopteryx*	4	
	Gomphidae	Gomphus (Genus A) *consanguis*	1	
		Gomphus lividus	1	
PLECOPTERA				4.2
	Perlidae	*Perlesta*	20	
TRICHOPTERA				39.1
	Hydropsychidae	*Ceratopsyche cheilonis*	32	
		Hydropsyche betteni/depravata	59	
		Hydropsyche rotosa	29	
	Limnephilidae	*Pycnopsyche guttifer/scabripennis* groups	2	
	Philopotamidae	*Chimara*	1	
	Rhyacophilidae	*Rhyacophila carolina* pupae	2	
		Rhyacophila fuscula	3	
	Uenoidae	*Neophylax etnieri*	56	
		Total	**471**	

TAXA RICHNESS = 39
EPT TAXA RICHNESS = 17
BIOCLASSIFICATION = 3.8 (FAIR/GOOD-GOOD)

Discussion

Sinking Creek is in a situation similar to that of Kendrick Creek with a majority of its length being affected by some type of urbanization or agriculture. Like Kendrick

Creek, there is little opportunity for this stream to ever fully recover given amount of development within the watershed. We did notice some improvement at our upstream site in the condition of the stream and did collect one additional species (bluegill) at this site. Involvement by landowners and a development of a sense of ownership in this stream is probably the only chance this stream has for sustained improvement.

Management Recommendations

1. Development of a watershed council involving private, local, state and federal entities might prove beneficial in improving conditions within the watershed.

2. Periodically monitor this stream to determine relative health changes.

Red River

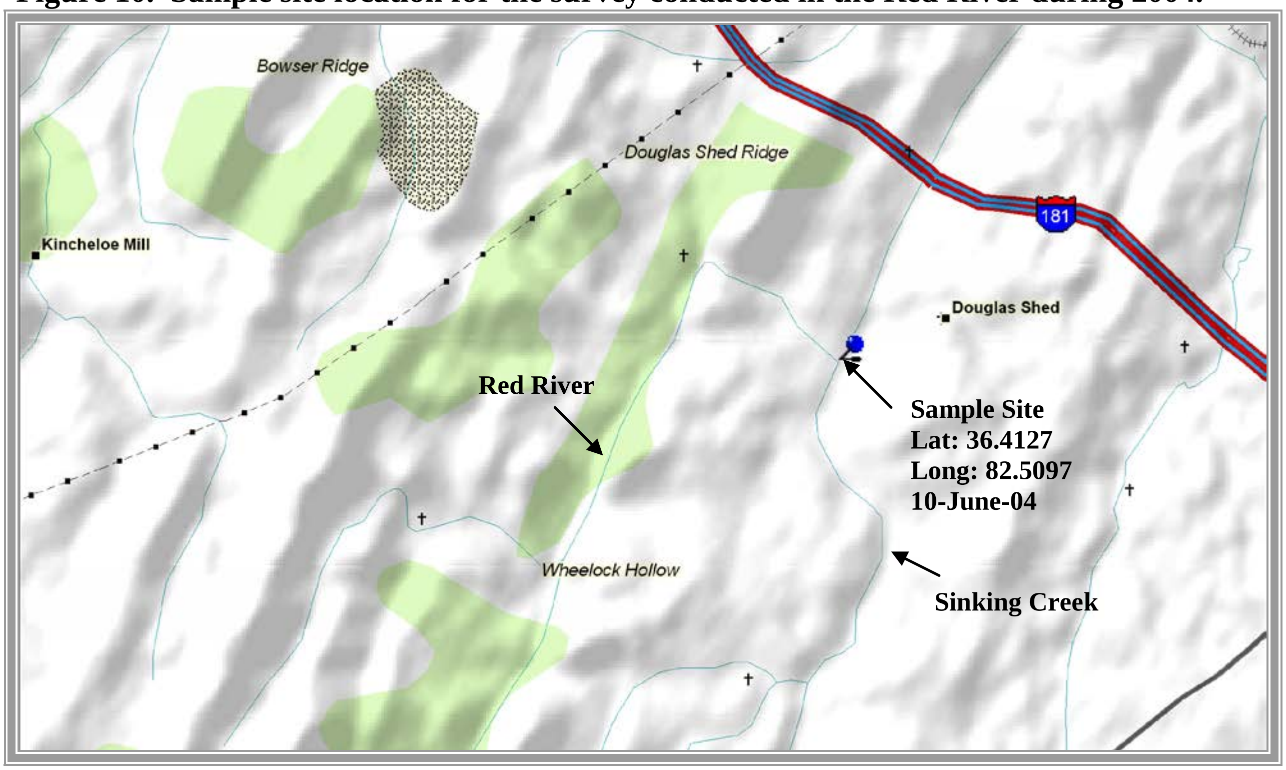
Introduction

The Red River is located in the northeastern portion of Washington County. It flows in a northeasterly direction before joining Sinking Creek just southwest of the I-26 interstate. The Agency has not conducted any historical surveys of this stream and TVA did not survey the stream during their 1993-97 assessment of the Holston River watershed (TVA 1998). We were primarily interested in developing a fish list for TADS and determining the relative health of the stream based on the aquatic communities present.

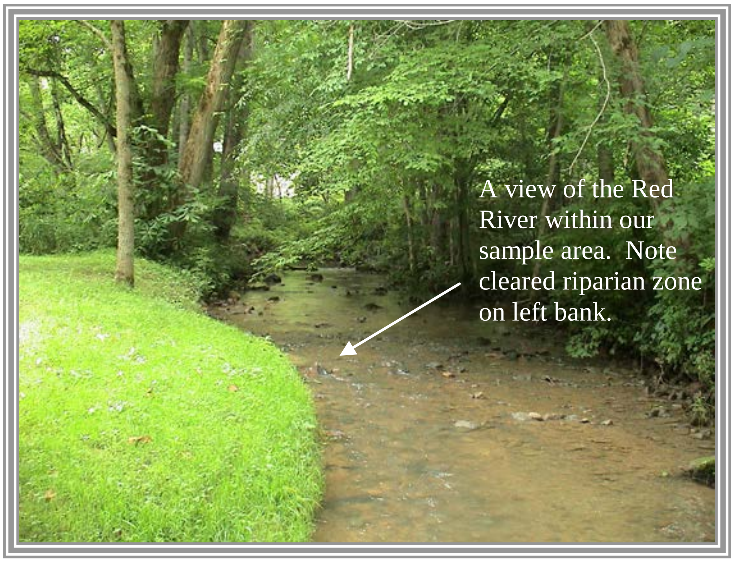
Study Area and Methods

Our survey of the Red River (Figure 10) was conducted just upstream from its confluence with Sinking Creek. The stream at this location was of low grade and had substrate primarily composed of gravel and cobble. This stream has a strong groundwater influence as evidenced by the presence of watercress and the “cherty” type gravel found in the streambed.

Figure 10. Sample site location for the survey conducted in the Red River during 2004.



Our evaluation of the fish community was accomplished through a qualitative catch-per-unit-effort (CPUE) survey. We electrofished for 10 minutes covering a variety of habitats associated with the survey reach. All fish encountered in the survey were



recorded as to species and enumerated. No benthic organisms were collected from this site. At our sample location gravel and cobble were the predominant substrate components comprising about 50% of the substrate in the pools and about 60 % in the riffles. Pools dominated the habitat features contributing about 60% of the available habitat. Our sample site had well established riparian zone on the left descending bank, however, the right descending bank had been converted to a residential lawn. Although treeless in some areas of the sample site, the bank was relatively stable and showed no signs of serious erosion. Water clarity was good as this stream receives a substantial amount of groundwater input. Basic water quality measurements at this site revealed the following information, temperature 18.5 C, conductivity 435 µs/cm, and a pH of 7.0.

Results

We collected a total of 87 fish representing seven species (Table 10). All species collected were common and were expected in this type of stream. The most abundant species were western blacknose dace and largescale stoneroller, which accounted for 79.3% of the total fish encountered during our survey. The only game species collected were bluegill and rock bass, comprising 6.9% of our total catch.

Table 10. Species occurrence and associated catch rates (#/hour) for the Red River 2004.

Site Code	Species	Tads Code	Total Number	CPUE (#/hour)
420041101	Bluegill	351	3	18.7
420041101	Creek chub	188	3	18.7
420041101	Largescale stoneroller	45	27	168.7
420041101	Western blacknose dace	184	42	262.5
420041101	Rock bass	342	3	18.7
420041101	Snubnose darter	435	5	31.2
420041101	White sucker	195	4	25.0
		Total	**87**	

Discussion

The Red River was relatively clean and siltation was not as evident as in Sinking Creek. The influence of springs on this system was apparent and probably has a regulatory effect on the maximum number of species that would inhabit this type of system. Unlike its name, the Red River is a small headwater stream that averages about 6 meters in width and appeared to size down rather quickly in areas upstream of our sample site. The quality of the water is good, given the area that this stream flows through and had adequate habitat to sustain the species present.

Management Recommendations

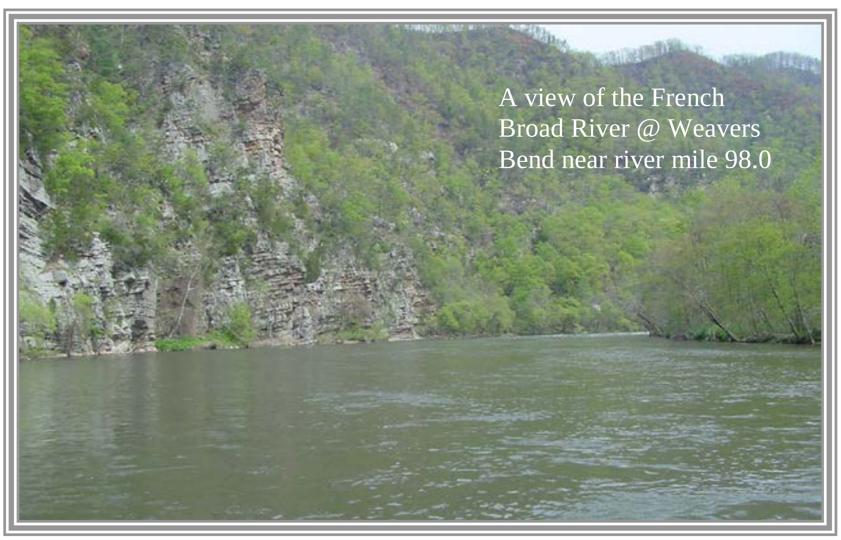
1. Periodically monitor the stream to document changes from development etc.

French Broad River

Introduction

Like many of the larger rivers in east Tennessee, the French Broad has a long history of pollution related problems stemming from the paper industry, urbanization, and agricultural activities within the watershed. Ichthyological studies within the watershed date back to the mid to late 1800's when Cope and Jordan made some of the first collections in the river (Harned 1979). The most recent fisheries collections by the TWRA were conducted in 1990 near river mile 78 (Bivens and Williams 1991) and multiple survey sites between the state line and Knoxville in 2000 (Carter et al. 2001). The TVA (Harned 1979) probably conducted the most comprehensive survey of the river and watershed tributaries to date. One hundred seventeen sample stations were surveyed on the main stem French Broad and four of its tributaries during the summer of 1977. This was our second trip to the French Broad after an extensive survey during 2000. Because we were unable to sample that portion of the river above Douglas Reservoir in 2003, we returned to this area in 2004 to assess the sport fish populations in this more remote reach of the river.

Study Area and Methods

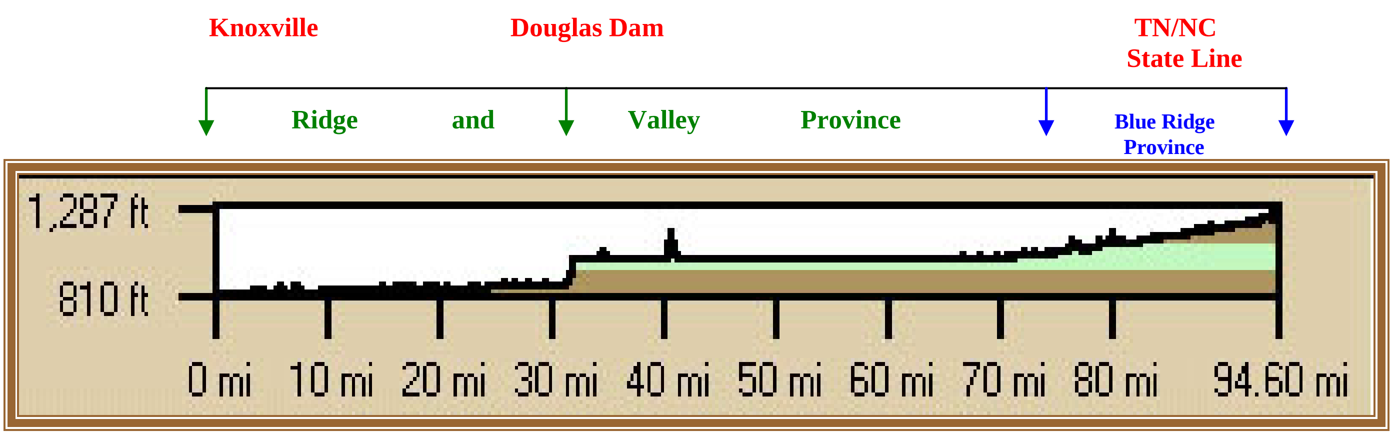


The French Broad River originates near Rosman, North Carolina and flows in a southwesterly direction before combining with the Holston River to form the Tennessee River. The French Broad has a drainage area of 13,177 km^2 and courses some 349 km from its headwaters to the confluence with Holston River (Harned 1979). The French Broad is located in the Blue Ridge physiographic province in North Carolina and a small portion of Tennessee (Cocke Co.). The river transitions into the Ridge and Valley physiographic province near Newport. There is one large reservoir located on the French Broad in Tennessee, Douglas Reservoir, located in Jefferson and Sevier counties. The reservoir impounds approximately 69 km of river channel and spreads out over 12,302 hectares (Harned 1979). The elevational profile of the river is quite impressive with the steepest fall observed from Asheville, North Carolina to Newport, Tennessee. Within Tennessee, the river descends about 477 feet between the state line and Knoxville (Figure 11).

The river downstream of Douglas Dam is one of the few warmwater tailwaters in east Tennessee. It is managed under a minimum flow regime by the Tennessee Valley Authority to provide recreational opportunities and to ensure that water quality remains at acceptable levels. Since the improvements in water quality below the dam, several restoration projects have been initiated. These include the introduction of the lake sturgeon and selected species of mollusks. The snail darter has in recent years, colonized the river from stockings made in the Holston River and has established a resident population. The snail darter is currently listed as threatened by the U.S. Fish and Wildlife Service.

On April 21, 2004 we re-sampled five of 10 sites established above Douglas Dam in 2000 (Figure 12). We were scheduled to conduct these surveys in 2003; however, high water flows prevented us from performing a worthwhile survey. We did shift our sampling strategy to the spring however; as this has been shown to more accurately describe the size structure and density of sport fish when compared to a summer sample.

Figure 11. Longitudinal profile of elevation along the French Broad River from Knoxville to the TN/NC state line.



In the reach of river we sampled, most of the landscape is under the management of the U.S. Forest Service. Riparian zones on public and private land appeared to be in good condition, as no areas of significant bank erosion were observed. The majority of the river in this area flows through forested terrain although some farmland and residential development increased in the lower reaches of our sample area (sites 4 and 5). Submerged woody debris was scarce in most of our sample areas, although hard structure such as bedrock shelves and boulder cover were prevalent. The river substrate was predominately bedrock and boulder with some cobble in the riffle areas. Measured channel widths ranged from 61 to 109 m, while site lengths fell between 230 and 500 m (Table 11). Water temperatures ranged from 16 to 19 C. Conductivity varied from 45 to 49 µs/cm (Table 11).

Figure 12. Locations of samples conducted in the French Broad River during 2004.

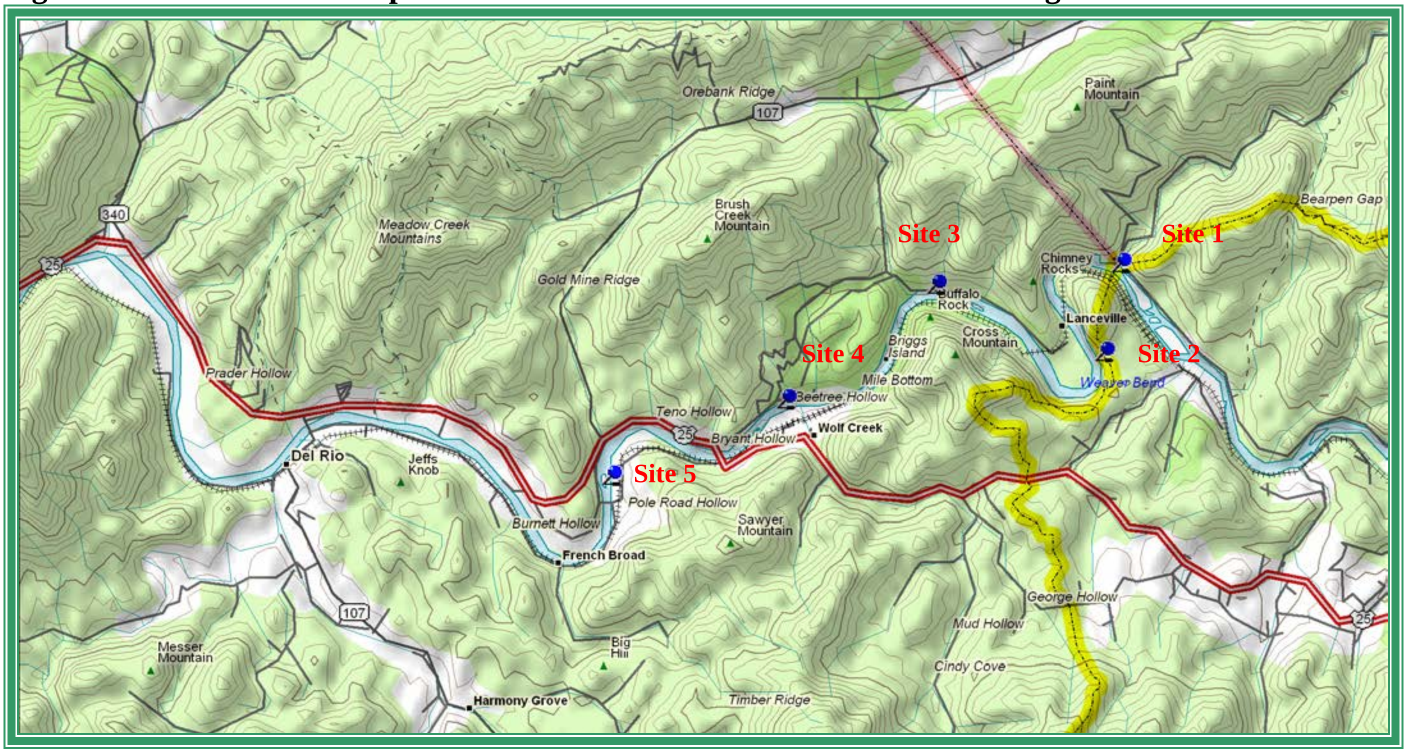


Table 11. Physiochemical and site location data for samples conducted on the French Broad River during 2004.

Site Code	Site	County	Quad	River Mile	Latitude	Longitude	Mean Width (m)	Length (m)	Temp.	Cond.	Secchi (m)
420040601	1	Cocke	Paint Rock 182NW	99.5	35.9439	82.8983	109	500	16	45	0.8
420040602	2	Cocke	Paint Rock 182NW	98.9	35.9327	82.9016	86	494	17	48	0.8
420040603	3	Cocke	Paint Rock 182NW	97.3	35.9411	82.9277	72	496	18	48	0.8
420040604	4	Cocke	Paint Rock 182NW	95.3	35.9268	82.9506	85.5	431	19	49	0.8
420040605	5	Cocke	Paint Rock 182NW	93.6	35.9173	82.9773	61	230	19	49	0.8

Fish were collected by boat electrofishing in accordance with the standard large river sampling protocols (TWRA 1998). Fixed-boom electrodes were used to transfer 4-5 amps DC at all sites. This current setting was determined effective in narcotizing all target species (black bass and rock bass). All sites were sampled during daylight hours and had survey durations ranging from 721 to 1,194 seconds. Catch-per-unit-effort (CPUE) values were calculated for each target species at each site. Length categorization indices were calculated for target species following Gabelhouse (1984).

Results

Smallmouth bass was the only species of black bass collected from our five sample areas in the upper French Broad. CPUE estimates for this species averaged 22.9/hour at each site (Table 12). Sites 2 and 5 had the highest catch rates of the five

Table 12. Catch per unit effort and length categorization indices of target species collected at five sites on the French Broad River during 2004.

Site Code	Smallmouth Bass CPUE
420040601	21.2
420040602	40.0
420040603	25.7
420040604	0.0
420040605	28.0
MEAN	22.9
STD. DEV.	14.6
	Smallmouth Bass Length-Categorization Analysis
	PSD = 54.5
	RSD-Preferred = 9.1
	RSD-Memorable = 9.1
	RSD-Trophy = 0

sites sampled and were about 21% higher on average than the total sample average. No smallmouth bass were collected at sample site 4, which was surprising as this one of our better sample during 2000. We are unsure at this point what has changed other than the timing of the sample. Rock bass were not collected and have not been collected from the upper French Broad River in recent history. Several factors, with siltation being the major factor are believed to be hindering the colonization of the river. There are tributary stream populations in Tennessee and mainstream and tributary populations in North Carolina. We collected rock bass from the Powell River in 2001 in an attempt to artificially propagate fry at TWRA's Eagle Bend Hatchery in Clinton. The attempt was fairly unsuccessful and no rockbass were introduced to the river. If and when water quality in the French Broad improves, we will attempt to try and collect brood stock from streams within the watershed and try to establish a population within the river. With the absence of smallmouth bass at one of sampling stations the overall average catch for smallmouth was down 27% from the previous sample collected in 2000 (Figure 13). In general, the overall catch was lower at all of our sampling stations with the exception of site 2. We had expected to see increases in our catch simply based on the time of year were sampled. Both 2003 and 2004 were very wet years in east Tennessee, which caused several high water events in the French Broad River (Figure 14). This may have had a deleterious effect on the smallmouth bass populations due to the rearrangement of habitat and displacement of fish.

Figure 13. Trends in mean catch rate of smallmouth bass in the upper French Broad River (above Douglas Reservoir) between 2000 and 2004.

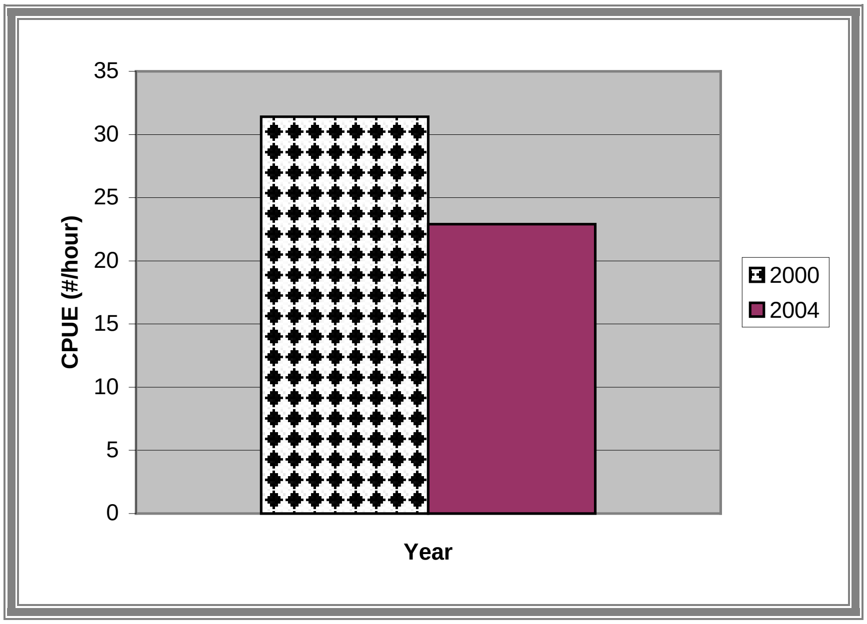
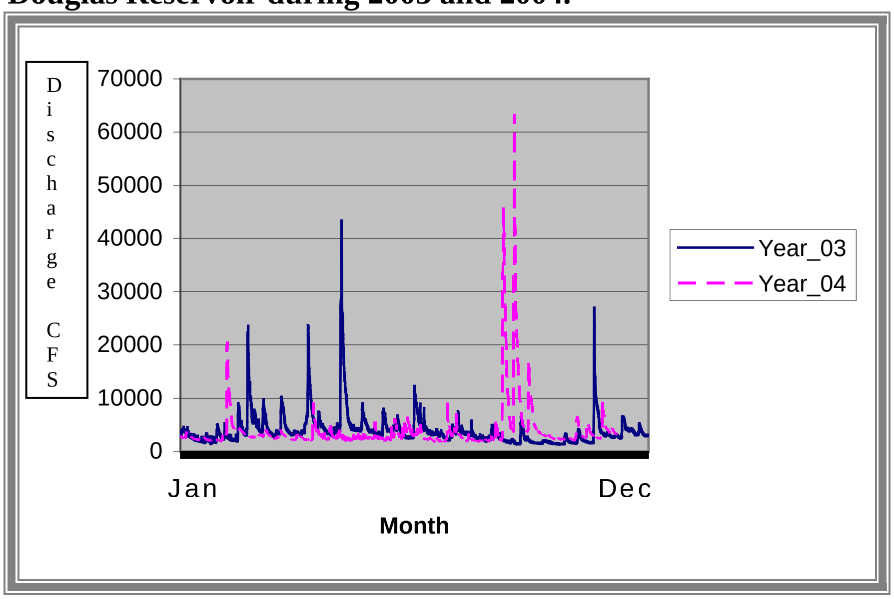
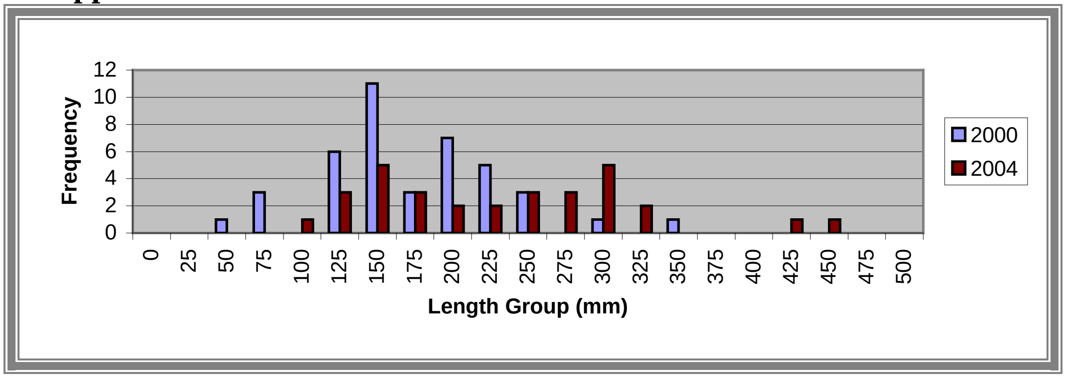


Figure 14. Trends in discharge for the French Broad River above Douglas Reservoir during 2003 and 2004.



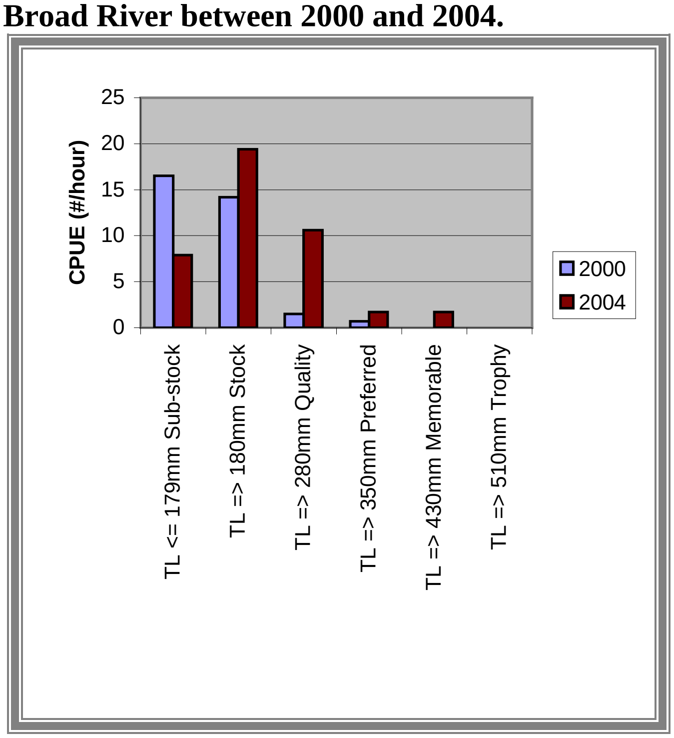
The majority of the smallmouth bass collected in the French Broad River during 2004 fell within the 125 mm to 300 mm length range (Figure 15). The size distribution of smallmouth bass between 2000 and 2004 changed somewhat among our five sampling stations (Figure 15). Generally, there were substantially fewer bass in all size categories in 2004 when compared to the previous surveys, however we did observe an increase in the number of bass over 275 mm.

Figure 15. Length frequency distributions for smallmouth bass collected from the upper French Broad River between 2000 and 2004.



Length categorization analysis indicated the Relative Stock Density (RSD) for preferred smallmouth bass (TL $\geq$ 350 mm) was 9.1. RSD for memorable (TL $\geq$ 430 mm) and trophy (TL $\geq$ 510 mm) size bass was 9.1 and 0, respectively. All RSD categories increased substantially between the 2000 and 2004. We believe that this can be explained by the timing of our sample (spring sample), which was more conducive for collecting larger bass. The ratio of quality (TL $\geq$ 280 mm) smallmouth bass to stock size bass (TL $\geq$ 180 mm) was 54.5 (2000 value = 10.5). Catch per unit effort estimates by RSD category indicated the majority of the catch was in the RSD-S (Figure 16). Overall the proportional distribution of catch was higher in most categories when compared to the 2000 sample. This is attributable to the overall increase in the size structure of fish captured.

Figure 16. Relative stock density (RSD) catch per unit effort for smallmouth bass collected from the French Broad River between 2000 and 2004.



Seven spotted bass were observed in our 2000 survey of river at the same locations sampled in 2004. None were collected in 2004, which is not surprising, as population densities of spotted bass tend to be more variable than smallmouth bass in riverine habitats.

Discussion

The French Broad River represents a valuable resource for the state. Although degraded over the years from residential, municipal, and agricultural growth, the river has seen improvement in water quality and maintains many of its scenic and natural characteristics. It supports and active whitewater rafting industry and is an important recreational resource for local residents. The fishery of the river is probably not the best within the region, but does provide adequate angling opportunities that deserve management consideration. Probably the most abundant species we encountered that would be sought by anglers is the channel catfish. This species was abundant at the majority of our sites and most of the fish collected were of quality size. Water quality improvements to the tailwater section of the river by TVA have allowed for the recovery of selected species of fish and mussels. The snail darter, listed as threatened, is the most notable success story in the tailwater. Lake sturgeons are also being introduced into the tailwater and annual monitoring efforts are undertaken to monitor their progress. Mussel reintroductions by the TWRA, U.S. Geological Survey, and Tennessee Tech University have also been implemented.

Electrofishing boats from TWRA, TVA, USFWS, and UT span the width of the French Broad River as an annual Lake Sturgeon survey gets underway

The establishment of a musky fishery in the reach of river upstream of Douglas Reservoir could be worthwhile. The North Carolina Wildlife Resource Commission currently stocks 1,000 to 1,500 musky (Ohio Strain) in the French Broad River every other year (Scott Loftis, NCWRC, pers comm.). Harned (1979) documented musky at one of his sampling stations just upstream from the TN/NC line in Madison County. We did not encounter any musky in our surveys; however, the potential for them to occur in Tennessee is good.

Access along the river is somewhat limited, although a good portion of the upper reach of the river is located on U.S. Forest Service land. There is one developed access point upstream of Douglas Reservoir that is maintained by the USFS. Developed public access downstream of Douglas Reservoir is limited to ramps at Douglas Dam (TVA) and Highway 66 Bridge (TWRA) near Sevierville. There are a few primitive ramps and pull-outs along some of the roads paralleling the river above and below Douglas Reservoir.

Management Recommendations

1. Develop a fishery management plan for the river.

2. Consider the feasibility of rock bass re-introductions.

3. Consider experimental musky introductions.

Pigeon River

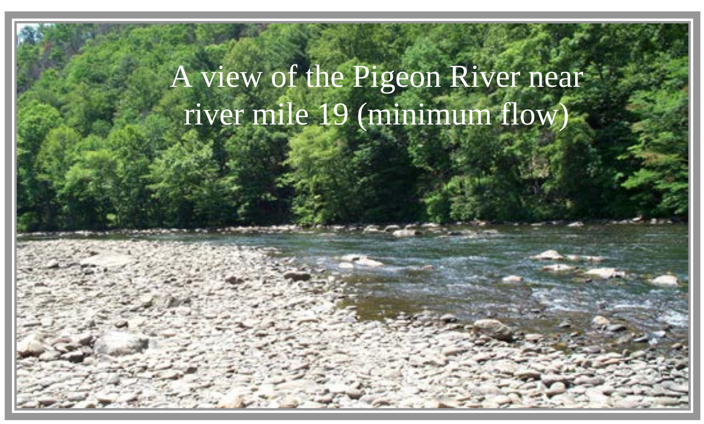
Introduction

The Pigeon River has had a long history of pollution problems, stemming primarily from the 80 plus-year discharge of wastewater from the Champion Paper Mill in Canton, North Carolina. This discharge has undoubtedly had a profound effect on the recreational use of the river and after the discovery of elevated dioxin levels in the 1980's raised concerns about public health (TDEC 1996). Although the river has received increased attention in recent years, the recreational use of the river has not developed its full potential. In terms of the fishery, consumption of all fish was prohibited up until 1996 when the ordinance was downgraded, limiting consumption of carp, catfish, and redbreast sunfish (TDEC 1996). In 2003, all consumption advisories were removed from the river. Since 1988, inter-agency Index of Biotic Integrity samples have been conducted at two localities near river mile 8.2 (Tannery Island) and river mile 16.6 (Denton).

Our 2004 surveys focused on continuing our collection of catch effort data for black bass and rock bass. Catch effort data along with otolith samples from rock bass and black bass were collected from three sites in 1997 (Bivens et al. 1998) and five sites in 1998 (Carter et al. 1999). Since 1999, data has been collected at six sites between river mile 4.0 and 20.5 (Carter et al. 2000, 2001, 2002, 2003). During 1998, a 508 mm minimum (20-inch) length limit on smallmouth bass with a one fish possession limit was passed by the Tennessee Wildlife Resources Commission (TWRC). This regulation was implemented on March 1, 1999.

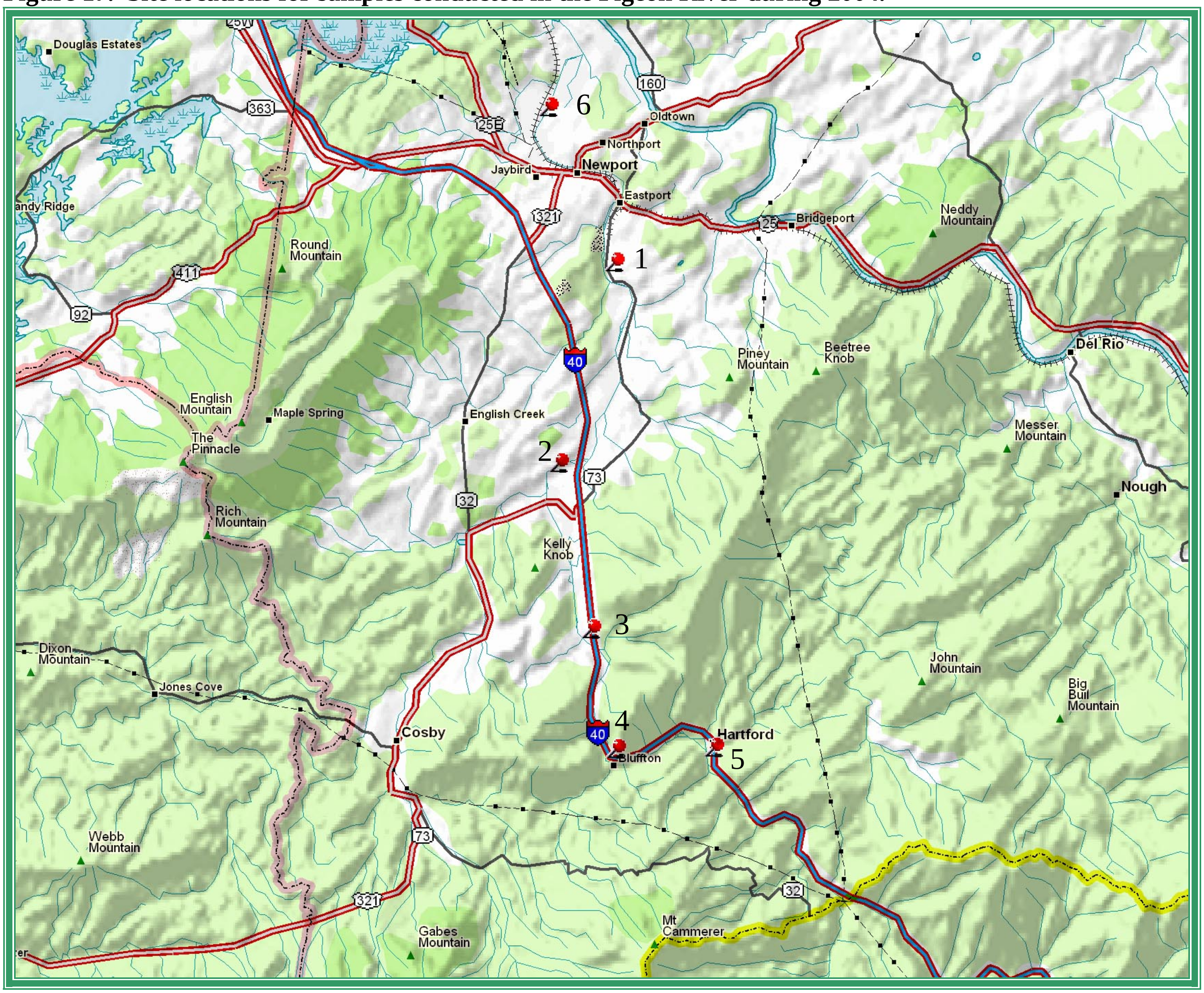
Study Area and Methods

The Pigeon River originates in North Carolina and flows in a northwesterly direction before emptying into the French Broad River near river mile 73.8. The river has a drainage area of approximately 1,784 km^2 at its confluence with the French Broad River. In Tennessee, approximately 35 kilometers of the Pigeon River flows through mountainous terrain with interspersed communities and small farms before joining the French Broad River near Newport. Public access along the river is primarily limited to bridge crossings and small "pull-outs" along roads paralleling the river. There are a few primitive launching areas for canoes or small boats. Between July 17 and October 13, 2004, we conducted seven fish surveys at six sites between Newport


A view of the Pigeon River near river mile 19 (minimum flow)

and the community of Hartford (Figure 17). We were unable to complete one of our CPUE survey sites (site 2) due to flood damage at this location. Our historical access to the river had all but been obliterated from a flood that hit the watershed in late summer 2004. Because this portion of the river is a tailwater, habitat availability fluctuates with water releases. However, in our survey sites during low flow, the habitat consisted primarily of wooded shorelines with interspersed rock outcroppings. Submerged woody debris was fairly common in most of our sample areas. The river substrate was predominately boulder/cobble in riffle areas and bedrock with interspersed boulder/cobble in the pool areas. Measured channel widths ranged from

Figure 17. Site locations for samples conducted in the Pigeon River during 2004.



35.3 to 64.3 m, while site lengths fell between 80 and 839 m (Table 13). Water temperatures ranged from 16 to 17 C and conductivity varied from 90 to 93 µs/cm (Table 13).

Table 13. Physiochemical and site location data for CPUE samples conducted in the Pigeon River during 2004.

Site Code	Site	County	Quad	River Mile	Latitude	Longitude	Mean Width (m)	Length (m)	Temp.	Cond.	Secchi (m)
420043301	1	Cocke	Newport 173NW	8.1	35.9425	83.1786	53.6	392	17	91	1.5
420043303	3	Cocke	Hartford 173SW	16.6	35.8441	83.1844	-	414	16.5	93	1.2
420043304	4	Cocke	Hartford 173SW	19	35.8130	83.1780	35.3	80	16	90	1.1
420043305	5	Cocke	Hartford 173SW	20.5	35.8136	83.1625	47.3	839	16.5	90	1.2
420043306	6	Cocke	Newport 173NW	4.0	35.9825	83.1988	54	193	17	93	1.5

Catch-per-unit-effort fish samples were collected by boat electrofishing in accordance with the standard large river sampling protocols (TWRA 1998). Fixed-boom electrodes were used to transfer 4-5 amps DC at all sites. This current setting was determined effective in narcotizing all target species (black bass and rock bass). All fish collected were returned to the river. Additionally, efforts were made to identify non-target species encountered at each survey site. All sites were sampled during daylight hours and had survey durations ranging from 738 to 2,808 seconds. Catch-per-unit-effort values were calculated for each target species at each site. Length categorization indices were calculated for target species following Gabelhouse (1984). Index of Biotic Integrity samples were collected using both backpack and boat electrofishing in accordance with standardized protocols.

Results

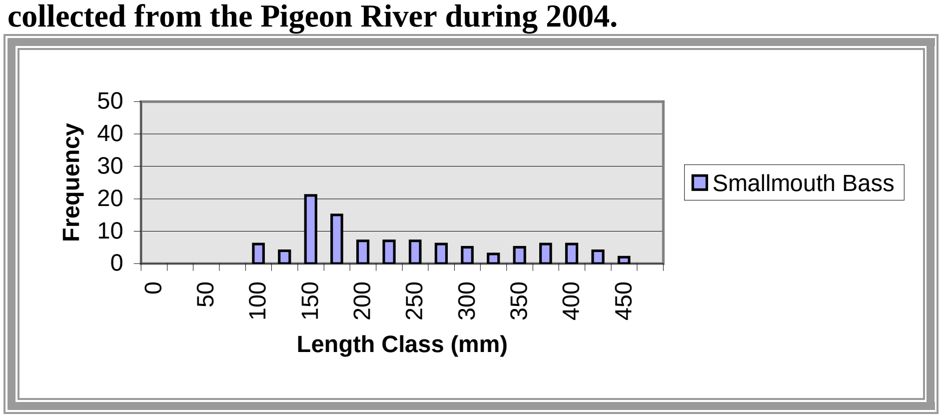
During our surveys, smallmouth bass were collected from all sample sites. Rock bass were collected from all sites with the exception of site 6. Spotted bass were only collected at site 3 and largemouth bass were absent from all of our surveys. Smallmouth bass was the most abundant black bass species at any of the survey sites. CPUE estimates for this species averaged 61.2/hour (SD 51.5), while the spotted bass estimate was 0.9/hour (SD 1.9) (Table 14). Our highest observed catches of smallmouth bass were recorded at site 3 (Denton) and site 4 (Bluffton). Rock bass CPUE was highest in sites 1,3, and 5, averaging 7.4/hour (SD 6.3). The highest catch rate for this species was recorded at site 3 (17.4/hour), which also had the highest value in 2003. Overall, we observed an increase of 107% in the catch rate of smallmouth bass between the 2003 sample and the 2004 sample. This is attributable to the timing of the samples (2003 summer, 2004 fall). Spotted bass catch remained relatively constant, while largemouth bass numbers declined to zero during the 2004 survey. This fluctuation is not uncommon for the Pigeon River and has been observed in previous samples. We have noticed that the spotted bass population in this river has declined and remained in a depressed condition for several years.

Table 14. Catch per unit effort and length categorization indices of target species collected at five sites on the Pigeon River during 2004.

Site Code	Smallmouth Bass CPUE	Spotted Bass CPUE	Largemouth Bass CPUE	Rock Bass CPUE
420043301	63.3	-	-	6.7
420043303	67.4	4.3	-	17.4
420043304	140.0	-	-	5
420043305	32.0	-	-	7.7
420043306	3.2	-	-	-
MEAN	61.2	0.9	0	7.4
STD. DEV.	51.5	1.9	0	6.3
	Smallmouth Bass Length-Categorization Analysis	**Spotted Bass Length-Categorization Analysis**	**Largemouth Bass Length-Categorization Analysis**	**Rock Bass Length-Categorization Analysis**
	PSD = 48.6	PSD = 0	PSD = 0	PSD = 29.4
	RSD-Preferred = 31.9	RSD-Preferred = 0	RSD-Preferred = 0	RSD-Preferred = 0
	RSD-Memorable = 8.3	RSD-Memorable = 0	RSD-Memorable = 0	RSD-Memorable = 0
	RSD-Trophy = 0	RSD-Trophy = 0	RSD-Trophy = 0	RSD-Trophy = 0

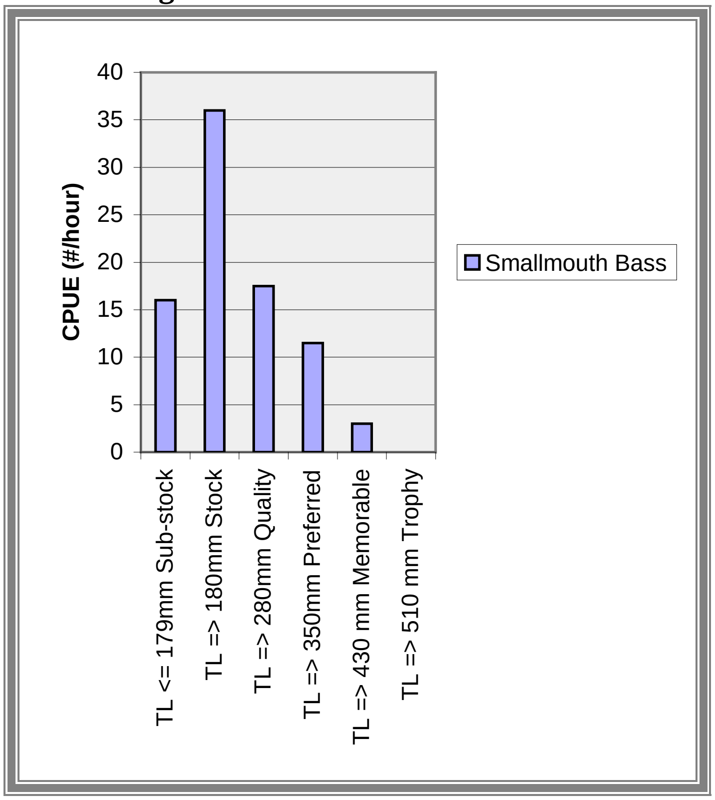
The majority of the smallmouth bass collected from the Pigeon River during 2004 fell within the 150 to 250 mm length range (Figure 18). Our data indicated that bass less than 100 mm were not completely vulnerable to the sampling gear and were probably lower in number due to flooding prior to our survey. Length categorization analysis indicated the Relative Stock Density (RSD) for preferred smallmouth bass

Figure 18. Length frequency distribution for smallmouth bass collected from the Pigeon River during 2004.



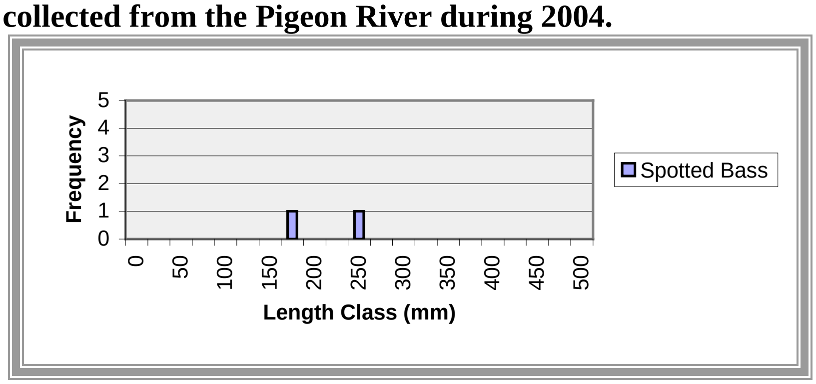
(TL ≥ 350 mm) was 31.9, which was up 34% (23.8) from the previous year. RSD for memorable (TL ≥ 430 mm) and trophy (TL ≥ 510 mm) size bass were 8.3 (48% increase from 2003) and 0, respectively. The PSD of smallmouth bass (ratio of quality size bass to stock size bass) was 48.6. Catch per unit effort estimates by RSD category indicated smallmouth bass had the highest catch rates of any of the black bass species collected for the category RSD-S and above (Figure 19). Both sub-stock and stock categories were strong during 2004 indicating good reproduction and recruitment from previous year classes. We also observed increases in the number of quality, preferred, and memorable size bass.

Figure 19. Relative stock density (RSD) catch per unit effort for smallmouth bass collected from the Pigeon River during 2004.



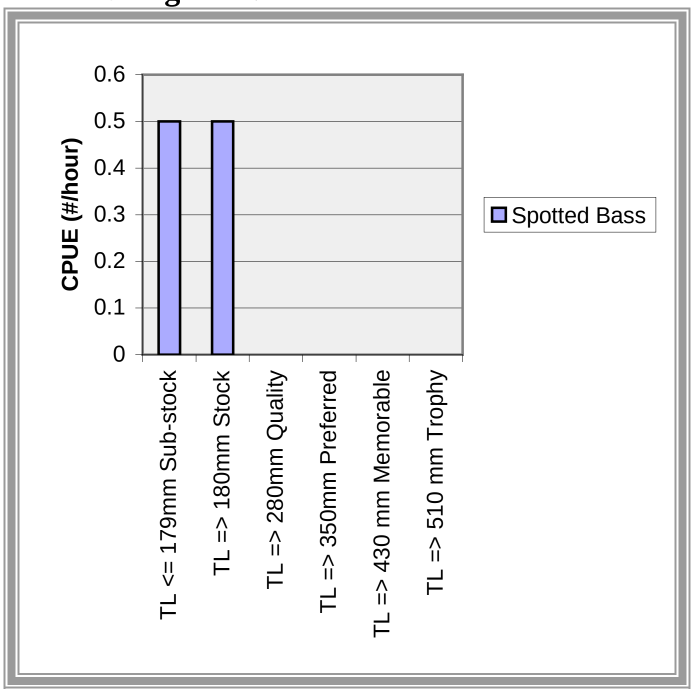
There were very few spotted bass collected from the Pigeon River in 2004. A total of two (7 in 2003) spotted bass were collected in all of our samples. Because there were so few spotted bass collected in the sample, no useful information could be derived regarding the size structure of this species. The two bass collected were 179 mm and 255 mm, respectively (Figure 20).

Figure 20. Length frequency distribution for spotted bass collected from the Pigeon River during 2004.



Length categorization analysis indicated the RSD for preferred spotted bass (TL $\geq$ 350 mm) was 0. RSD for memorable (TL $\geq$ 430 mm) and trophy (TL $\geq$ 510 mm) size bass was 0 (Figure 21). Because no quality size spotted bass were collected, PSD could not be calculated. Catch per unit effort estimates by RSD category in 2004 does not have much meaning given the low number of bass collected. We were unable to sample the site that typically has higher numbers of this species, which could have given us a better indication of size structure. Because of the relatively low number of spotted bass collected in 2004 we cannot speculate and how they are contributing to the fishery. We do feel however, that the spotted bass in the Pigeon River have contributed less to the overall fishery in the last three years.

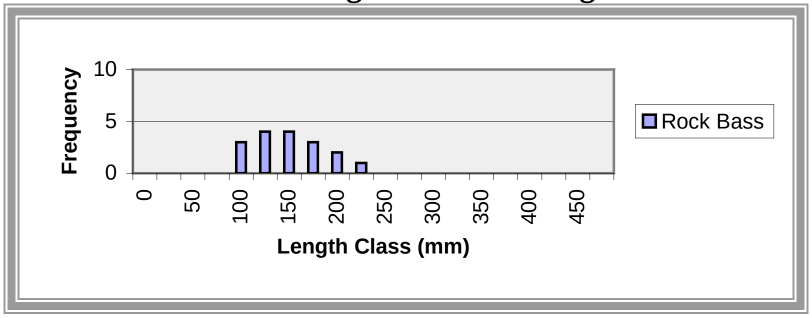
Figure 21. Relative stock density (RSD) catch per unit effort for spotted bass collected from the Pigeon River during 2004.



No largemouth bass were collected at any of our sites in 2004. Largemouth bass have always been fairly scarce at all of our sample stations and it is not unexpected that we did not collect any largemouth, particularly given the time of year that we sampled the river.

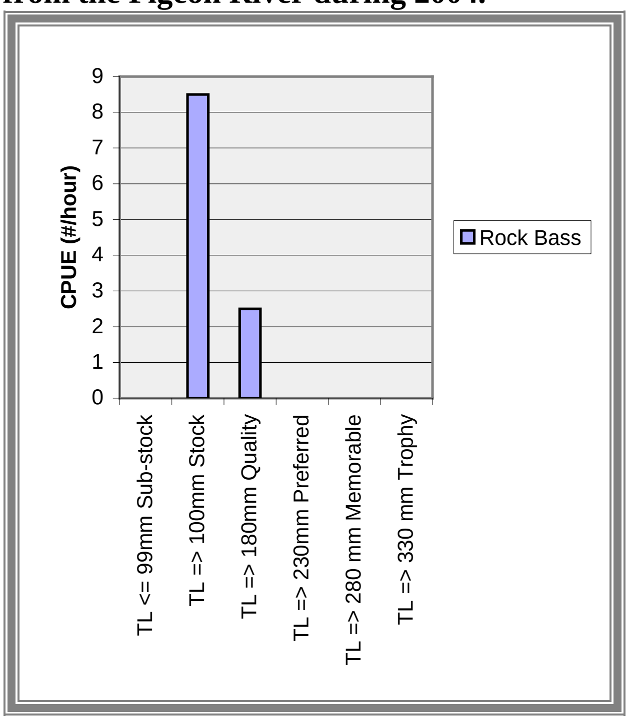
Individuals in the 100 to 175 mm range represented the majority of rock bass in our sample (Figure 22). Length categorization analysis indicated the RSD for preferred rock bass (TL $\geq$ 230 mm) was 0, which was a decline from the previous year sample (0.8). RSD for memorable (TL $\geq$ 280 mm) and trophy (TL $\geq$ 330 mm) size rock bass was 0.

Figure 22. Length frequency distribution for rock bass collected from the Pigeon River during 2004.



The PSD of rock bass was 29.4, which was down 39% from the sample taken in 2003. Catch per unit effort estimates by RSD category indicated the majority of our catch was stock size fish (Figure 23) with about 22.7% of the catch representing quality size fish. The sub-stock catch of rock bass was low, but probably does not indicate poor recruitment due to the fact that sampling efficiency is usually lower with this size group. Our catch of rockbass was somewhat lower in 2004, probably due to the time we sampled the river and the influence of flooding. Lower catch rates for this species have been observed in other systems when sampled in the early spring or fall.

Figure 23. Relative stock density (RSD) catch per unit effort by category for rock bass collected from the Pigeon River during 2004.



Linear and curvilinear length-weight regression analysis has been calculated for previous years data (Carter et al. 1999), and is assumed to be similar for the 2004 data.

No age and growth data was collected from this population in 2004; age and growth characteristics for rock bass in the Pigeon River are well documented from recent surveys (Carter et al. 1999, 2000).

During 2001 we had a sample of black bass and rock bass tested for disease by the U.S. Fish and Wildlife Service as part of the wild fish health survey. We were primarily interested in determining if there was a high incidence of disease among these species due to prolonged exposure to pollutants in the river. We were also interested in screening largemouth bass for largemouth bass virus (LMBV), which has been identified in some Tennessee reservoir populations. Our sample from the Pigeon River in 2001 did not indicate any disease commonly associated with the species tested.

Several other species were collected or observed (41) during our cooperative IBI surveys at Tannery Island and Denton. None of the fish collected in the 2004 sample were listed by the U.S. Fish and Wildlife Service or the TWRA as threatened or endangered. A list of species occurrence at these two sites can be found in Table 15.

Table 15. Distribution of fish species collected in the Pigeon River during 2004.  **= presence**

Pigeon River Mile	**8.1**	**16.6**
Site Code	4 2 0 0 4 3 3 0 1	4 2 0 0 4 3 3 0 3
Species		
Catostomidae		
Black buffalo		
Black redhorse		
Golden redhorse		
Northern hog sucker		
River carpsucker		
River redhorse		
Silver redhorse		
Smallmouth redhorse		
Smallmouth buffalo		
Centrarchidae		

Table 15. Continued.

Pigeon River Mile	8.1	16.6
Site Code	420043301	420043303
Species		
Bluegill	X	X
Largemouth bass	X	X
Redbreast sunfish	X	X
Rock bass	X	X
Smallmouth bass	X	X
Spotted bass	X	X
White crappie	X	X
Clupeidae		
Gizzard shad	X	X
Cottidae		
Banded sculpin	X	X
Cyprinidae		
Bigeye chub	X	X
Carp	X	X
Central stoneroller		X
Creek chub	X	
Longnose dace		X
Rosyface shiner	X	X
River chub	X	
Silver shiner	X	X
Spotfin shiner	X	X
Largescale stoneroller	X	
Telescope shiner	X	X
Whitetail shiner	X	X
Ictaluridae		
Channel catfish	X	X

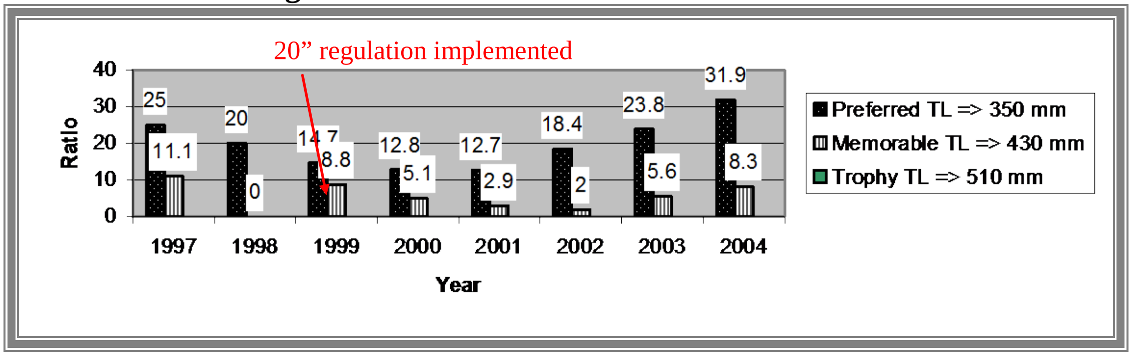
Table 15. Continued.

Pigeon River Mile	**8.1**	**16.6**
Site Code	420043301	420043303
Species		
Yellow bullhead		
Moronidae		
White bass		
Percidae		
Gilt darter		
Greenside darter		
Logperch		
Redline darter		
Sauger		
Snubnose darter		
Walleye		
Petromyzontidae		
Ohio lamprey		
Sciaenidae		
Drum		

Discussion

The Pigeon River provides anglers with the opportunity to catch all species of black bass as well as rock bass. Perhaps the greatest potential for elevating this river's "trophy" status lies in the smallmouth bass population. Given that a fair percentage of smallmouth bass are reaching the preferred category (average 20% between 1997-2004) and that these fish are growing slightly slower than the statewide average (Carter et al. 1999), there would appear to be good potential for trophy management of the smallmouth bass population in this river. We are currently tracking trends in this segment of the smallmouth bass population (Figure 24).

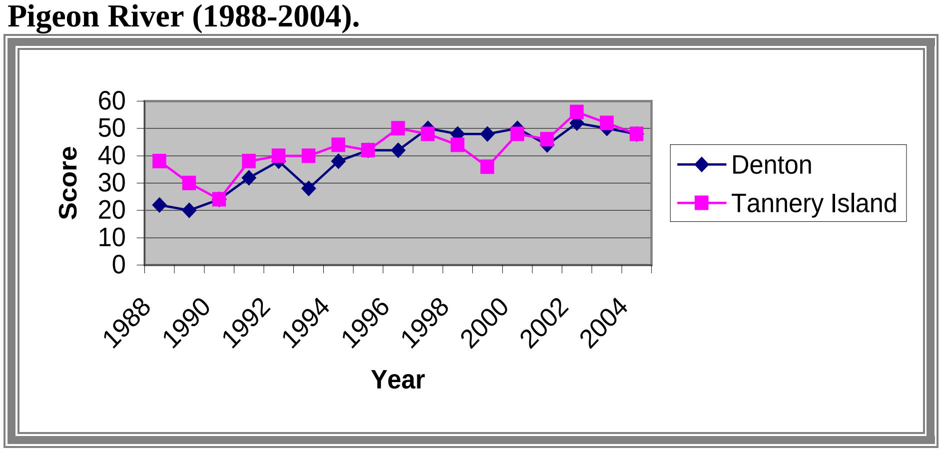
Figure 24. Trends in the ratio of preferred, memorable, and trophy smallmouth bass collected from the Pigeon River 1997-2004.



With the increase in recreational use on the river, it is important that angler use and harvest be profiled. The collection of this type of data will aid in evaluating angler use of the resource and help in evaluating the current size and creel limit restrictions.

Over the last 17 years the IBI scores (TWRA and TVA data) at two stations on the Pigeon River have been steadily increasing (Figure 25). This has primarily been the result of improved wastewater treatment at the Champion Paper Mill in Canton, North Carolina. The improved water quality has undoubtedly had an affect on the amount of recreation that is currently taking place, particularly whitewater rafting. It has also resulted in the return of a few species (e.g. silver shiner, telescope shiner) previously not encountered in the annual surveys. The continuation of improvements to the water quality of the Pigeon River will in all likelihood have dramatic impacts on the use of the river in the future. Surveys on the Pigeon River will be conducted on an annual basis in order to assess any changes in the fishery that may result from the new regulation. Currently, there are ongoing projects to re-introduce selected fish, common mussel, and snail species.

Figure 25. Trends in Index of Biotic Integrity (IBI) at two stations on the Pigeon River (1988-2004).



Based on our findings from our 2002 and 2004 fall surveys, we have become convinced that sampling the river at this time of year gives us a better indication of the actual smallmouth bass population composition and size structure. We will monitor black bass and rock bass populations in the Pigeon River during late September or October in order to increase our efficiency in characterizing the smallmouth bass populations in the river.

Management Recommendations

1. Implement an angler-use and harvest survey.

2. Continue monitoring the sport fish population, with detailed analysis focusing on the smallmouth bass fishery and timing of sampling efforts.

3. Continue the cooperative IBI surveys at the two established stations (Denton and Tannery Island).

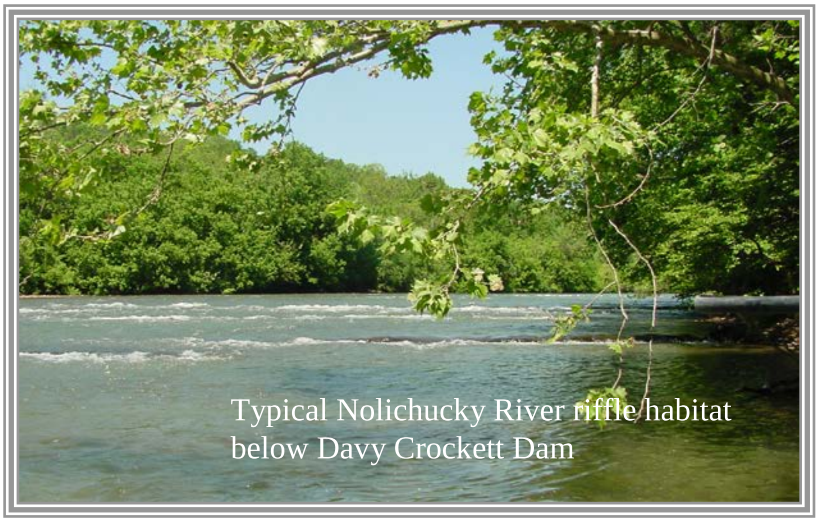
4. Develop a management plan for the river.

5. Continue cooperative efforts to reintroduce common species.

Nolichucky River

Introduction

The Nolichucky River represents an important recreational resource for the state both in consumptive and non-consumptive uses. It provides critical habitat for species of special concern and is home to approximately 50 species of fish and has historically contained at least 21 species of mussels (Ahlstedt 1986). Additionally, it supports one of east Tennessee's better warmwater sport fisheries. The Nolichucky River and its tributaries have been the subject of numerous biological and chemical investigations that span some 40 years. These investigations have concentrated on evaluating pollution levels and documenting sources for mitigation. Much of the upper reach of the Nolichucky River has been consistently impacted by sand dredging and mica mining in North Carolina and extensive agricultural development along the entire length in Tennessee. However, in recent years, the Nolichucky River has improved in water quality as a result of mitigation and education conducted during these early studies. The Agency has made limited surveys of the river that focused primarily on collecting basic fish, benthic, and water quality data (Bivens 1988). Extensive sport fish population surveys were conducted in 1998 (Carter et al. 1999) from the North Carolina state line to the French Broad River. Our survey of the Nolichucky River focused on re-evaluating the sport fish populations and developing long-term community assessment sites. Our 2001 assessment of the sport fish populations was derived from 10 sample sites between river mile 27.9 and mile 99.1. Our 1998 survey consisted of 31 sample sites, falling between river mile 7.6 and mile 99.1. After our initial evaluation in 1998, the Nolichucky River was put into a 3-year rotational sampling schedule with eight other rivers. Sport fish sampling sites were reduced to those that would best characterize these populations.



Typical Nolichucky River riffle habitat below Davy Crockett Dam

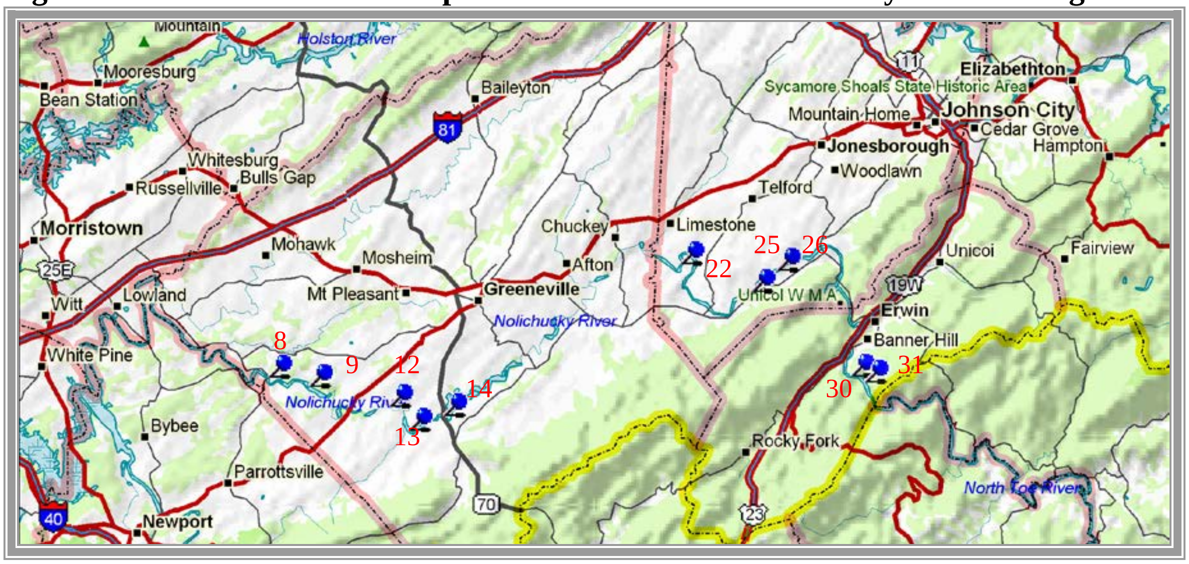
Study Area and Methods

The Nolichucky River originates in North Carolina and flows in a southwesterly direction before emptying into the French Broad River near river mile 69.0. The river has a drainage area of approximately 2,827 kilometers². In Tennessee, approximately 159 kilometers of the Nolichucky River flows through the Blue Ridge and Ridge and Valley provinces of east Tennessee, coursing through or by the towns of Erwin, Greeneville, and Morristown before joining the French Broad River near the community of White Pine.

Public access (found in Unicoi, Washington, Greene, Cocke, and Hamblen counties) along the river is primarily limited to bridge crossings and small "pull-outs" along roads paralleling the river. There are several primitive launching areas for canoes or small boats and five developed launching areas managed by the Tennessee Wildlife Resources Agency (Easterly Bridge, Birds Bridge, and Davy Crocket State Park), the City of Greeneville (Kinser Park), and the U.S. Forest Service (Chestoa).

Between April and May 2004, we conducted 10 fish surveys between the North Carolina state line and the French Broad River (Figure 26).

Figure 26. Site locations for samples conducted on the Nolichucky River during 2004.



In our survey sites, the riparian habitat consisted primarily of wooded shorelines with interspersed agricultural fields. There were several reaches of the river where one or both sides of the river were confined within rock palisades. Submerged woody debri was fairly common in most of our sample areas. The river substrate was predominately boulder/cobble in riffle areas and bedrock with interspersed boulders/cobble in the pool habitat. Measured mean channel widths ranged from 50 meters to 100.6 meters, while site lengths fell between 241 meters and 1,224 meters (Table 16). Water temperatures ranged from 13 C to 21 C and conductivity varied from 40 to 160 (Table 16).

Table 16. Physiochemical and site location data for samples conducted on the Nolichucky River during 2004.

Site Code	Site	Quad	River Mile	Latitude	Longitude	Mean Width (m)	Length (m)	Temp. C	Cond.	Secchi (m)
420040708	8	Parrottsville 172SE	27.9	36.0970	83.0513	87.3	1094	21	156	1
420040709	9	Parrottsville 172SE	30.9	36.0903	83.0084	57.3	321	21	160	1
420040712	12	Cedar Creek 181SW	39.1	36.0734	82.9231	59.6	663	20	142	1
420040713	13	Cedar Creek 181SW	42.5	36.0539	82.9038	100.6	650	21	140	1.1
420040714	14	Davy Crockett Lake 181SE	45.7	36.0654	82.8688	80.5	1224	18.5	130	1.1
420040722	22	Telford 190NE	71.4	36.1932	82.6208	66.3	300	15	70	0.8
420040725	25	Telford 190NE	80.3	36.1700	82.5467	57.7	890	13.5	52	0.8
420040726	26	Telford 190NE	82.9	36.1883	82.5196	50	769	13	48	0.8
420040730	30	Chestoa 199SW	98	36.0991	82.4433	53.3	241	14	50	0.35
420040731	31	Chestoa 199SW	99.1	36.0944	82.4285	80.3	426	13	40	0.35

Fish were collected by boat electrofishing in accordance with the standard large river sampling protocols (TWRA 1998). Fixed-boom electrodes were used to transfer 4-5 amps DC at all sites. This current setting was determined effective in narcotizing all target species (black bass and rock bass). All sites were sampled during daylight hours and had survey durations ranging from 1,379 to 3,434 seconds. Catch-per-unit-effort (CPUE) values were calculated for each target species at each site. Length categorization indices were calculated for target species following Gabelhouse (1984).

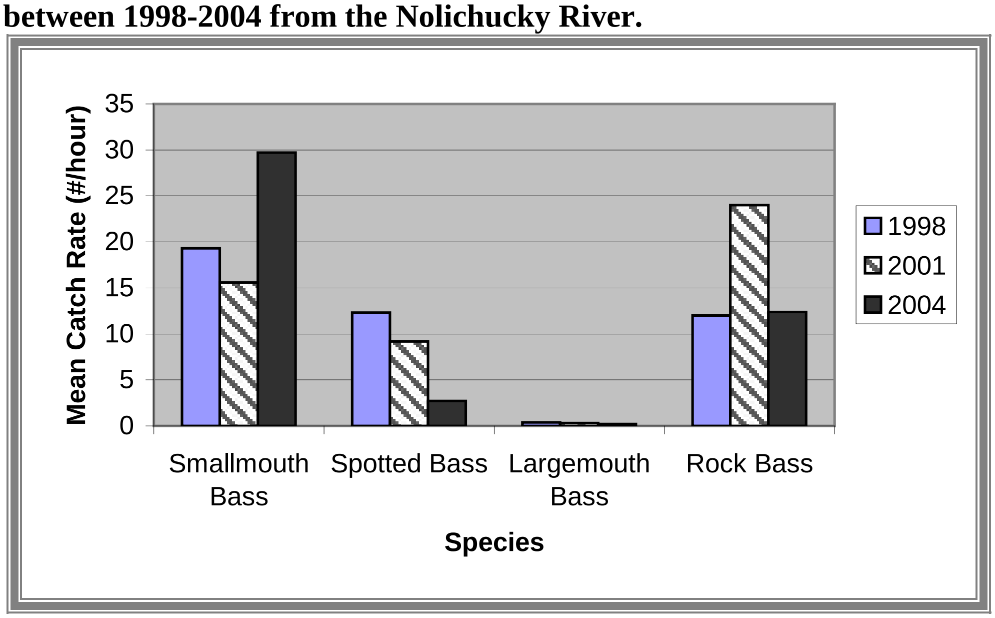
Results

CPUE estimates for smallmouth bass averaged 29.7/hour (SD 14.2), while the mean spotted bass estimate was 2.7/hour (SD 5.4). Largemouth and rock bass estimates were 0.2/hour (SD 0.6) and 12.4/hour (SD 7.9), respectively (Table 17). Comparatively, there was an overall decline in the mean catch rate of black bass species except for smallmouth bass, which increased 90% over our 2001 survey and 54% over the sample taken in 1998 (Figure 27). Rock bass catch declined by 48% from the sample collected in 2001. This was not unexpected, given the timing of our sample (spring). We have observed that spotted bass, largemouth bass, and rock bass numbers are somewhat lower in samples taken in the spring and fall probably due to habitat preferences at this time of year which makes them difficult to capture.

Table 17. Catch per unit effort and length categorization indices of target species collected at 10 sites on the Nolichucky River during 2004.

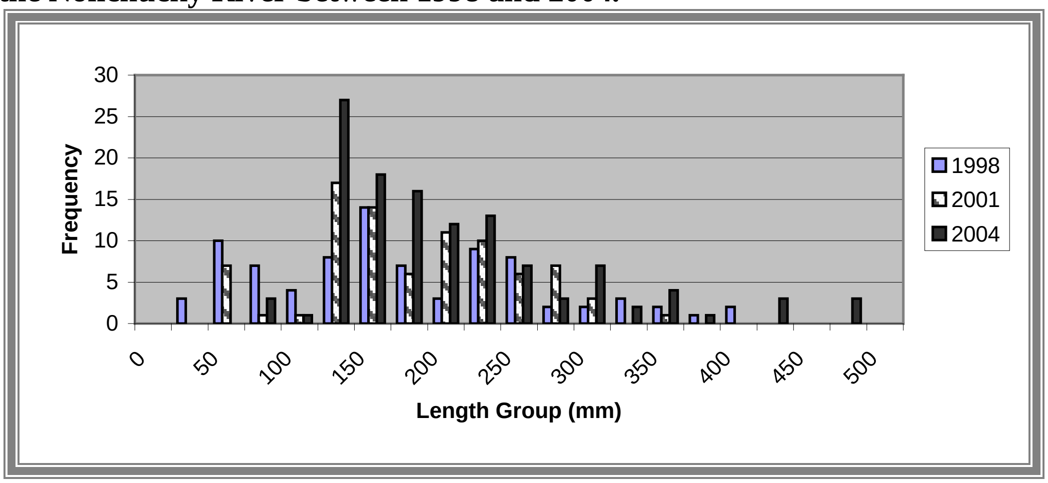
Site Code	Smallmouth Bass CPUE	Spotted Bass CPUE	Largemouth Bass CPUE	Rock Bass CPUE
420040708	48.3	-	-	3.4
420040709	44.1	-	-	20.5
420040712	26.7	6.7	-	15.5
420040713	50	-	-	2.7
420040714	20	16.4	1.8	18.2
420040722	19.2	-	-	7.7
420040725	13.2	-	-	5.3
420040726	12	-	-	18
420040730	36.1	-	-	25
420040731	27.2	-	-	7.8
MEAN	29.7	2.7	0.2	12.4
STD. DEV.	14.2	5.4	0.6	7.9
	Length-Categorization Analysis	**Length-Categorization Analysis**	**Length-Categorization Analysis**	**Length-Categorization Analysis**
	PSD = 35.4	PSD = 11.1	PSD = 0	PSD = 30.7
	RSD-PREFERRED = 16.9	RSD-PREFERRED = 0	RSD-PREFERRED = 0	RSD-PREFERRED = 0
	RSD-MEMORABLE = 7.7	RSD-MEMORABLE = 0	RSD-MEMORABLE = 0	RSD-MEMORABLE = 0
	RSD- TROPHY = 0	RSD- TROPHY = 0	RSD- TROPHY = 0	RSD- TROPHY = 0

Figure 27. Trends in mean catch rate of black bass and rock bass collected between 1998-2004 from the Nolichucky River.



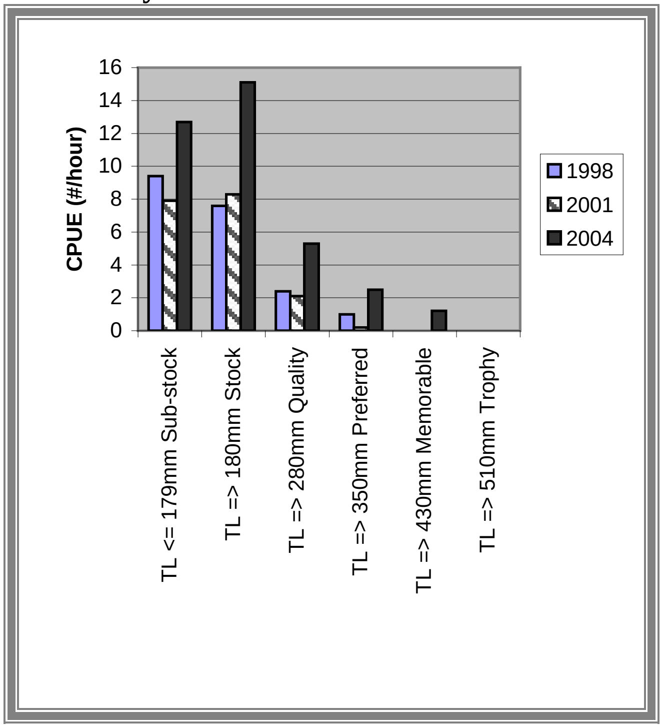
The size distributions of smallmouth bass between 1998 and 2004 changed somewhat among our 10 sampling stations (Figure 28). Generally, we observed increases in all respective size categories above the 150 mm class when compared the previous sample in 2001. Our catch of larger bass also increased in 2004 with three bass in the 18 inch class being collected. There were very few fish below the 150 mm size range in 2004, probably due to the timing of our sample, which did not allow us to collect fish from the 2004 year class. Overall, the length frequency distribution created from the 2004 sample was probably more reflective of the actual size structure of the bass population than the previous distributions collected from the river. Only one bass over 14 inches was collected in 2001. Nine bass over 14 inches were collected in 2004 including three that were approaching 19 inches.

Figure 28. Length frequency distributions for smallmouth bass collected from the Nolichucky River between 1998 and 2004.



Length categorization analysis indicated the relative stock density (RSD) of preferred smallmouth bass (TL $\geq$ 350 mm) was 16.9 (Table 17). RSD for memorable (TL $\geq$ 430 mm) and trophy (TL $\geq$ 510 mm) size bass were 7.7 and 0, respectively. The PSD of smallmouth bass (ratio of quality size bass to stock size bass) was 35.4. In comparison to the 2001 survey we observed significant increases in the number of preferred and memorable size bass. Probably the most dramatic comparison was in the catch rate by RSD category. With the exception of sub-stock and stock bass we observed a doubling in the catch rates of quality, preferred, and memorable size bass (Figure 29). This was the first sample collected from the Nolichucky that contained memorable size bass. Although no trophy bass were collected, we are certain that there is a component to the fishery that comprises bass in excess of 20 inches. We have not been able to collect these fish by electrofishing although our new approach to sampling these rivers may rectify this deficit in the near future.

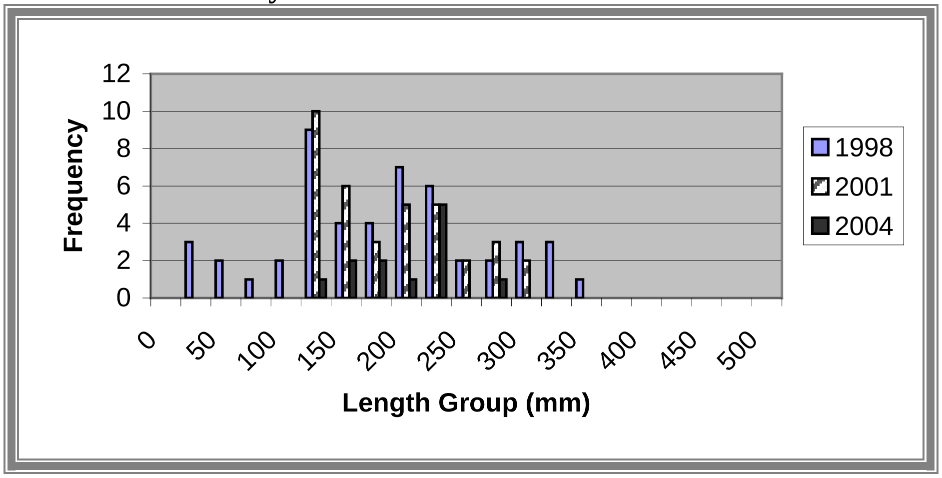
Figure 29. Relative stock density (RSD) catch per unit effort for smallmouth bass collected from the Nolichucky River between 1998 and 2004.



Age and growth characteristics for the smallmouth bass population in the Nolichucky River were characterized in 1998 (Carter et al. 1999). For the most part, the Nolichucky River has had growth rates similar to other large river populations with the same age structure. We did not collect otoliths from smallmouth bass in 2004, assuming that the values generated from the 1998 survey typify the general growth characteristics of this population. In general, it takes a smallmouth bass in the Nolichucky River about 3.8 years to reach 305 mm (12 inches), and about 7.8 years to attain a length of 406 mm (16 inches).

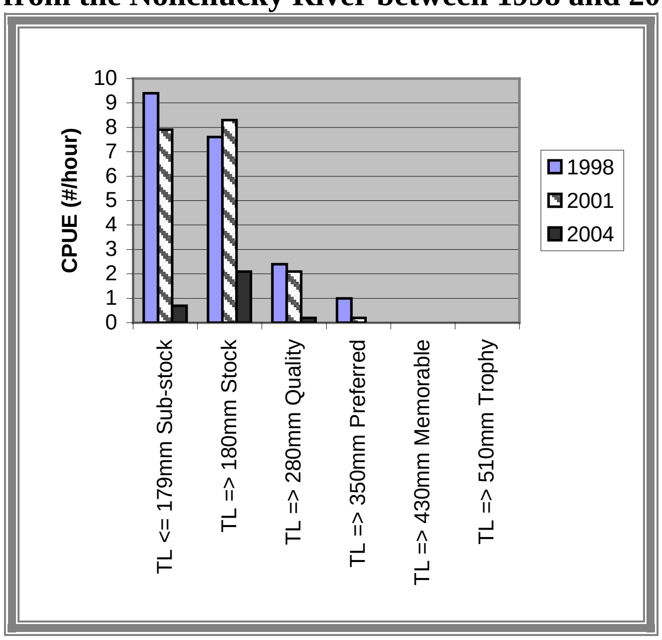
The majority of spotted bass from the Nolichucky River were within the 150 mm and 250 mm size groups (Figure 30). We have observed a slow decline in the number spotted bass collected from the river since our initial survey in 1998. Based on the length frequency distributions between 1998 and 2004, there appears to have been very little spotted bass reproduction in 2001 when compared to 1998. Our sample time in 2004 would have prevented use from collecting any information on reproduction, however, given the trends in the population it would appear that the spotted bass in the Nolichucky have declined significantly from there levels in 1998. Several years of drought between the sampling periods probably had the most influential effect on this species. Spotted bass densities tend to fluctuate considerably in riverine habitats in east Tennessee, although the Nolichucky historically harbored a stronger population than other rivers in the region.

Figure 30. Length frequency distributions for spotted bass collected from the Nolichucky River between 1998 and 2004.



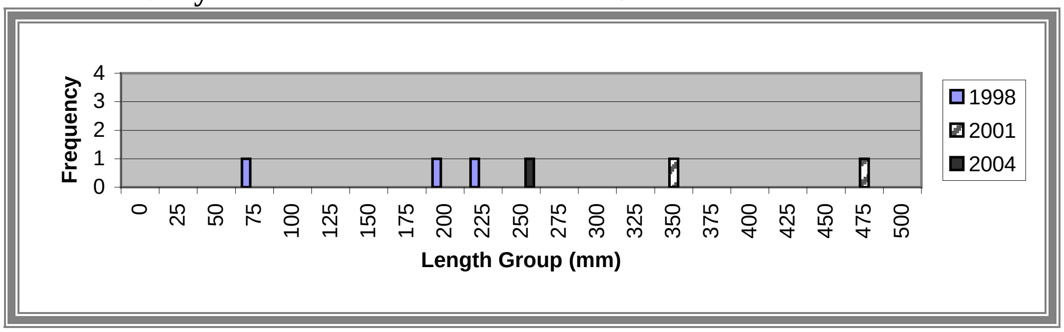
Length categorization analysis indicated the RSD for preferred spotted bass (TL ≥ 350 mm) was 0 in 2001 and 2004 compared to 3.7 in 1998. RSD for memorable (TL ≥ 430 mm) and trophy (TL ≥ 510 mm) size bass was 0. The PSD for spotted bass decreased from 25.0 in 2001 to 11.1 in 2004. Catch per unit effort estimates by RSD category revealed very few spotted bass in any of the RSD categories (Figure 31). The spotted bass population has continually decreased in the Nolichucky, and for 2004 was most likely associated with our sample timing which was compounded by several years of drought prior to our survey. Spotted bass numbers may return to the Nolichucky, given we have entered into a more normal hydrologic cycle.

Figure 31. Relative stock density (RSD) catch per unit effort by category for spotted bass collected from the Nolichucky River between 1998 and 2004.



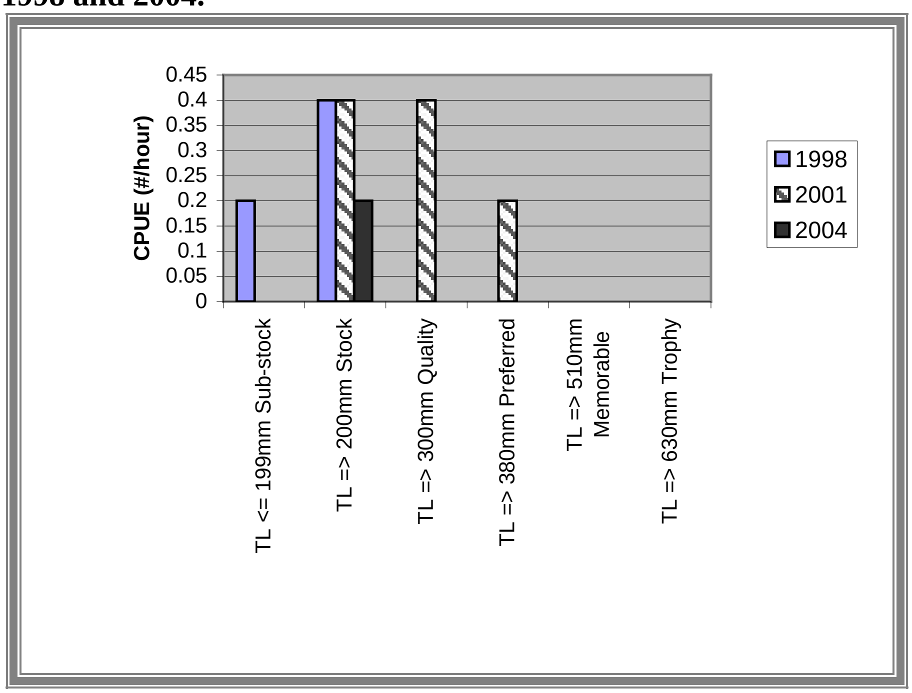
Only one largemouth bass was collected in the 2004 sample. It was 258 mm long and was collected just downstream of Davy Crockett Dam (Figure 32). The collection of largemouth bass in the Nolichucky River between 1998 and 2004 has been sporadic and generally restricted to the lower reaches of the river where preferred habitat occurs. This is fairly typical of most large river systems in east Tennessee where largemouth bass contribute very little to the overall fishery.

Figure 32. Length frequency distributions for largemouth bass collected from the Nolichucky River between 1998 and 2004.



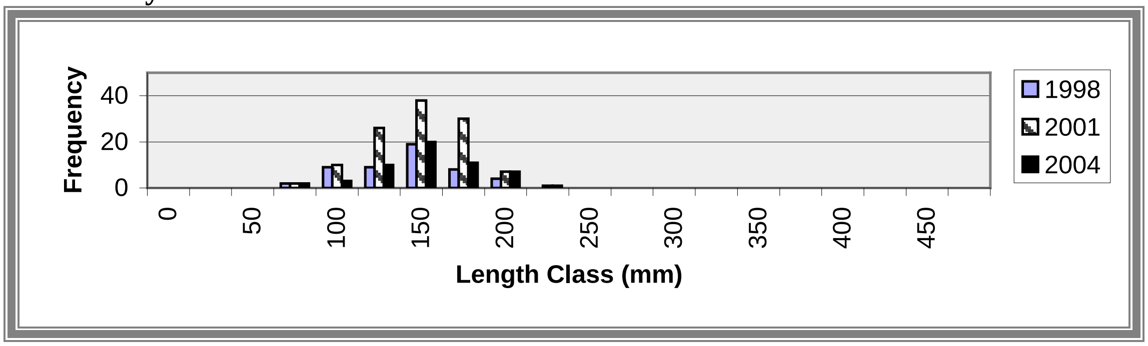
Not much can be said about the state of the largemouth bass population in the Nolichucky other than it exists there and probably does not contribute much to the fishery. In 2001, we observed our strongest contribution to the fishery by largemouth bass, which was extremely low (Figure 33). As with spotted bass our sample timing may have had a substantial effect on the number of largemouth bass we were able to collect.

Figure 33. Relative stock density (RSD) catch per unit effort for largemouth bass collected from the Nolichucky River between 1998 and 2004.



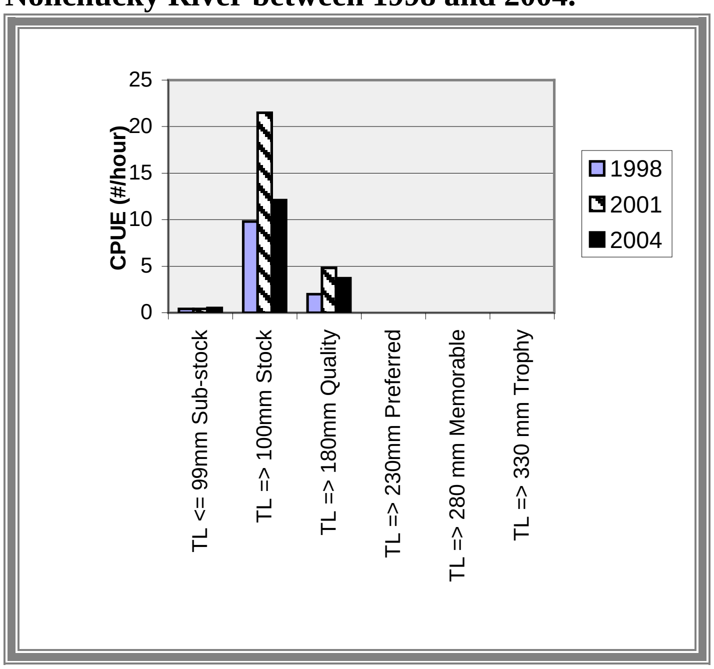
Individuals in the 125 to 200 mm range represented the majority of rock bass in our samples collected between 1998 and 2004 (Figure 34). The length frequency distribution for 2004 was fairly similar to the previous samples although the numbers in each respective size class decreased. We had undesirable sampling conditions at our best rock bass station (30) due to turbid water conditions. This undoubtedly had an effect on the overall number of rock bass collected; however, we feel that the size distribution represented by the 2004 sample is accurate for the river.

Figure 34. Length frequency distributions for rock bass collected from the Nolichucky River between 1998 and 2004.



RSD analysis indicated the RSD for preferred rock bass (TL $\geq$ 230 mm) was 0. RSD for both memorable (TL $\geq$ 280 mm) and trophy (TL $\geq$ 330 mm) size rock bass was 0. The PSD of rock bass was 30.7. Catch per unit effort estimates by RSD category indicated the majority of our catch was stock size fish with few quality size rock bass represented in the sample (Figure 35).

Figure 35. Relative stock density (RSD) catch per unit effort by category for rock bass collected from the Nolichucky River between 1998 and 2004.



Because of our confidence in determining age and growth characteristics (based on previous samples) we did not collect any otolith samples from rock bass in 2004. Therefore, no mortality or potential population growth statistics could be calculated. Age and growth and mortality of rock bass in the Nolichucky River are assumed to be similar to those reported from our 1998 assessment (Carter et al. 1999).

In 2004, we were asked to participate in a nationwide genetics inventory of blue sucker. The blue sucker is limited in distribution in the region and recent collections have been only from the Nolichucky and French Broad rivers. Michael Bessert of the Univeristy of Nebraska has been compiling and analyzing genetic samples collected from populations throughout the country. We supplied him with tissue samples from the Nolichucky and French Broad rivers in 2004 to be included in the survey. Preliminary results indicate the fish from the Nolichucky River are *Cycleptus elongates* and not *C. meridionalis.*

Carl Williams displays a tuberculate Blue Sucker collected from the Nolichucky River.

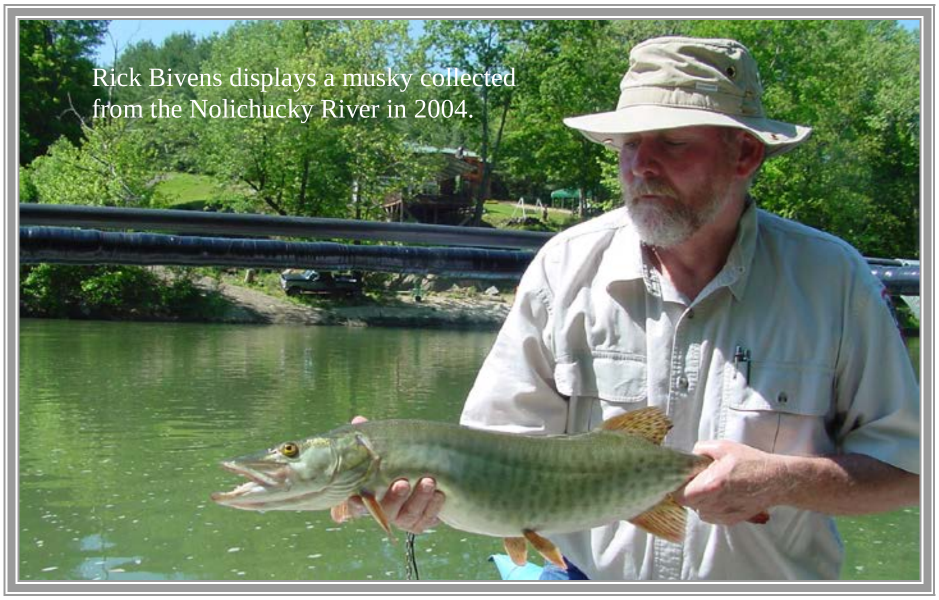
Detailed view of a tuberculate Blue Sucker

Discussion

The Nolichucky River provides anglers with the opportunity to catch all species of black bass, rock bass, muskellunge, channel catfish, and flathead catfish. During the winter months the upper reaches of the Nolichucky are stocked with rainbow trout from the U.S. Fish and Wildlife Service hatchery in Erwin. This provides additional recreational opportunities for winter anglers frequenting the river. In recent years, the river has seen an increase in use, with the establishment of several rafting companies and the increased recognition of the river's sport fishery.

Currently we have no angler use/harvest data on the river to aid in evaluating the effects that angler use may or may not have on the sport fishery. It is imperative that we obtain this data in order to answer fish management questions as well as public inquiries.

The occurrence of musky in the river warrants continued stocking when fish become available. Based on our observations and information from anglers the stocking program has met with some success and there have been rumors of reproduction in the river although these claims have not been verified. We have requested 1,000 fish for the 2005 stocking season and would like to see stocking continue at some level.


Rick Bivens displays a musky collected from the Nolichucky River in 2004.

Surveys on the Nolichucky River will be conducted on a three-year rotation in order to assess any changes in the fishery. Our return trip in 2007, will in all likelihood repeat the surveys conducted in 2004.

Management Recommendations

1. Initiate an angler use and harvest survey.
2. Develop a fishery management plan for the river.
3. Continue to stock musky when available.

Little Chucky Creek

On May 3, 2004 we cooperated with TVA, USFWS, and Conservation Fisheries Inc. (CFI) in conducting a comprehensive survey for an undescribed species of madtom commonly called the Chucky madtom. This fish was first discovered in 1991 during a cooperative survey effort involving TWRA and TVA. Since this collection, several survey efforts have been undertaken to document the population status and distribution of this undescribed species. Until this year, the fish had not been collected in several attempts and the fate of this species did not look promising.

The surveys in 2004, focused on the historical collection locations as well as some new localities further upstream from the original collection sites. We were able to collect two specimens of the Chucky madtom at a location that had not been previously surveyed. These fish were transported to CFI in hopes of obtaining information regarding life history and the possibility of captive breeding. Recent conversations with Pat Rakes (CFI) revealed that the pair of madtoms taken to the facility were male and female, however, the female died after a spawning attempt of unknown causes. The Chucky madtom is listed as state endangered.

Chucky madtom collected from Little Chucky Creek, Greene County.

Mud Creek

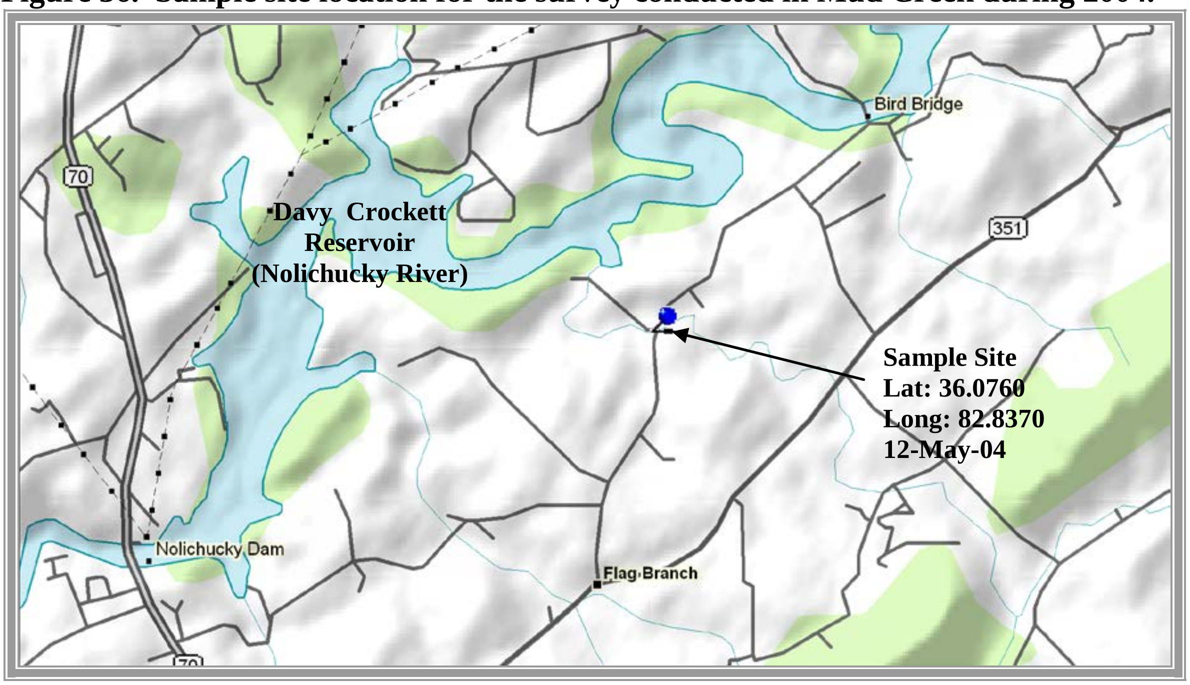
Introduction

Mud Creek originates just south of Greeneville and flows in a northeasterly direction before joining the Nolichucky River (Davy Crockett Lake). The Agency has not surveyed this stream and we were primarily interested in characterizing the fish community and assessing the relative health of the stream. The stream flows through rural farmland and is subjected to a variety of activities associated with this type of land use. The Agency has historically stocked trout in this stream.

Study Area and Methods

Our survey of Mud Creek (Figure 36) was conducted along Farnsworth Lane. The stream at this point is fairly narrow averaging about 4 meters in width. Cattle activity upstream and downstream of the road crossing had resulted in unstable stream banks and much of the riparian zone upstream of the bridge had been removed.

Figure 36. Sample site location for the survey conducted in Mud Creek during 2004.



Our evaluation of the fish community was accomplished through an Index of Biotic Integrity (IBI) survey. Benthic organisms were collected with kick nets during a timed survey. Analysis of the fish and benthic samples followed procedures developed by Karr et al. (1986) and Lenat (1993). At our sample location sand and silt were the dominant substrate components in pools comprising about 60% of the substrate. In the riffle areas gravel and cobble were dominant accounting for 70% of the available substrate. Pools dominated the habitat features contributing about 70% of the available habitat. The riparian zones both upstream and downstream of the bridge crossing had been altered. Stream bank erosion was fairly common in our survey reach, but it was less common in the downstream section. In both cases residential lawns had been established in portions of our sample area. Erosion was prevalent where cattle had access to the stream. Basic water quality measurements at this site revealed the following information, temperature 19 C, conductivity 252 µs/cm, and a pH of 7.0. Enrichment of this stream was evident by the elevated conductivity and the amount of periphyton present in the stream.

A downstream view of Mud Creek

Results

We collected a total of 619 fish comprising 12 species at our sample site (Table 18). There were two game species collected at this site, which included the bluegill and redbreast sunfish. The two most dominant species collected in our sample were the snubnose darter and western blacknose dace. Together, these two species comprised 76% of the total number of fish in our sample. Two darter species were collected from the stream, snubnose darter and gilt darter. There were two of the IBI metrics that had a substantial effect on lowering the overall score for this stream. These included the low number intolerant species and the absence of piscivores.

Table 18. Fish species occurrence for Mud Creek 2004.

Site Code	Species	Tads Code	Total Number
420040801	Bluegill	351	5
420040801	Creek chub	188	23
420040801	Gilt darter	467	1
420040801	Green sunfish	347	8
420040801	Largescale stoneroller	45	55
420040801	Northern hog sucker	207	24
420040801	Redbreast sunfish	346	9
420040801	Snubnose darter	435	234
420040801	Spotfin shiner	57	4
420040801	Western blacknose dace	184	239
420040801	Western mosquito fish	309	2
420040801	White sucker	195	15
		Total	**619**

Overall, the IBI analysis indicated Mud Creek was in fair to good condition (IBI score = 46) (Table 19). Mud Creek was quite diverse and had several metrics that scored well. The gilt darter we collected was in all likelihood a transient from the Nolichucky River, which was about 1.2 miles from our sample location. The influences from the agricultural practices upstream were prevalent in this stream as indicated by the amount of siltation and visible indicators of enrichment. Our visual assessment of the habitat resulted in a score of "poor" 36.2. This was primarily based on the state of the riparian zones and the alterations to the stream caused by cattle.

Table 19. Mud Creek Index of Biotic Integrity analysis.

Metric Description	Scoring Criteria 1 3 5	Observed	Score
Number of Native Species	<7 7-13 >13	10	3
Number of Darter Species	<2 2-3 >3	2	3
Number of Sunfish Species less Micropterus	0 1 >1	2	5
Number of Sucker Species	0 1 >1	2	5
Number of Intolerant Species	<2 2 >2	1	1
Percent of Individuals as Tolerant	>38 38-20 <20	8.2	5
Percent of Individuals as Omnivores	>47 47-24 <24	11.5	5
Percent of Individuals as Specialists	<14 14-27 >27	38.6	5
Percent of Individuals as Piscivores	<1.9 1.9-3.6 >3.6	0	1
Catch Rate	<29.2 29.2-58.2 > 58.2	52.2	3
Percent of Individuals as Hybrids	>1 Tr-1 0	0	5
Percent of Individuals with Anomalies	>5 5-2 <2	0.3	5
		Total	**46 (Fair-Good)**

Despite the surrounding agricultural conditions in the watershed, the aquatic insect community in Mud Creek was surprisingly diverse and in relatively good condition. Benthic macroinvertebrates collected in our sample comprised 31 families representing 37 identified genera (Table 20). The most abundant group in our collection was the mayflies comprising 31.5% of the total sample. This was an encouraging finding as this group is the first to be effected by pollutants. Caddisflies (17.5%) and isopods (17.7%) were almost equal in abundance. The abundance of isopods in the sample attests to the amount of spring influence this stream is receiving. There are several spring sources in the upper reaches of the watershed that contribute substantially to the volume of this stream. Stoneflies only accounted for 4.2% of the sample. Overall, a total of 45 taxa were identified from the sample of which 19 were EPT. Based on the EPT taxa richness and overall biotic index of all species collected, the relative health of the benthic community was classified as "good" (4.0).

Table 20. Taxa list and associated biotic statistics for benthic macroinvertebrates collected from Mud Creek.

ORDER	FAMILY	SPECIES	NUMBER	PERCENT
ANNELIDA				0.4
	Oligochaeta		3	
COLEOPTERA				8.3
	Dryopidae	*Helichus* adults	2	
	Elmidae	*Dubiraphis vittata* larvae and adults	6	
		Macronychus glabratus adult	1	
		Optioservus trivittatus larvae and adults	7	
		Stenelmis larvae and adults	40	
	Eubriidae	*Ectopria*	1	
DIPTERA				9.0
	Chironomidae	larvae and pupae	40	
	Empididae	larva and pupa	2	
	Ephydridae		1	
	Simuliidae		6	
	Tabanidae	*Tabanus*	4	
	Tipulidae	*Antocha*	4	
		Hexatoma	1	
		Limnophila	1	
		Tipula	3	
EPHEMEROPTERA				31.5
	Baetidae	*Baetis*	32	
	Baetiscidae	*Baetisca berneri*	1	
	Ephemerellidae	*Ephemerella*	6	
	Ephemeridae	*Ephemera*	6	
	Heptageniidae	*Epeorus rubidus/subpallidus*	1	
		Stenacron interpunctatum	3	
		Stenonema early instars	52	
		Stenonema mediopunctatum	67	
		S. meririvulanum	18	
		S. vicarium	2	
	Isonychiidae	*Isonychia*	24	
	Leptophlebiidae	*Habrophlebiodes*	4	
GASTROPODA				4.1
	Pleuroceridae	*Elimia*	28	
ISOPODA				17.7
	Asellidae	*Lirceus*	121	
MEGALOPTERA				0.4
	Corydalidae	*Corydalus cornutus*	3	
ODONATA				5.7
	Aeshnidae	*Boyeria vinosa*	12	
	Calopterygidae	*Calopteryx*	20	
	Coenagrionidae	*Argia*	2	
	Gomphidae	*Gomphus* (Genus A) *consanguis*	1	
		Hagenius brevistylus	3	
		Stylurus scudderi	1	
PELECYPODA				1.0
	Corbiculidae	*Corbicula fluminea*	7	
PLECOPTERA				4.2
	Nemouridae	*Amphinemura nigritta/delosa*	2	
	Perlidae	*Perlesta*	27	
TRICHOPTERA				17.5
	Hydropsychidae	*Cheumatopsyche* larvae and pupa	33	
		Hydropsyche betteni/depravata	61	
	Limnephilidae	*Pycnopsyche guttifer/scabripennis* group	3	
	Philopotamidae	*Chimarra*	8	
	Uenoidae	*Neophylax consimilis*	3	
		Neophylax etnieri	12	
		Total	**685**	

TAXA RICHNESS = 45
EPT TAXA RICHNESS = 19
BIOCLASSIFICATION = 4.0 (GOOD)

Discussion

Mud Creek is typical of many streams in east Tennessee. Impacts from urbanization and agricultural practices ultimately have a degrading effect on many streams in the region. Although impacted to some degree, it was apparent that the fish and benthic community in this stream were somewhat healthier than many in the area. Given the amount of agricultural activity in the watershed it is likely that this stream could become degraded in the future.

Management Recommendations

1. Periodically monitor this stream to determine relative health changes.

New River

Introduction

The New River drainage has had a long history of ecological abuse. The most prominent influence on overall watershed and water quality has been the continued development of the coal mining industry in the region since the turn of the century. With the shift to surface mining in recent history the influence on water quality has shifted from acidic pulses from deep mines (prevalent in the early 1900's) to siltation from surface mining operations. The most recent investigations in the watershed were by Evans (1998), who completed extensive surveys within the watershed and developed specific assessment criteria for fish assemblages. It was summarized from these investigations that some recovery has taken place in the watershed and many streams support fairly diverse communities of fish. The Agency has conducted surveys within the watershed in a limited number of streams (Bivens and Williams 1990; Carter et al. 2003). With the resurgence of coal mining in the last few years, the watershed stands to receive another inoculation of degraded water quality if activities are not stringently monitored. Our efforts in the New River during 2004 were limited, and primarily focused on assessing the health of the river and gathering information on the sport species.

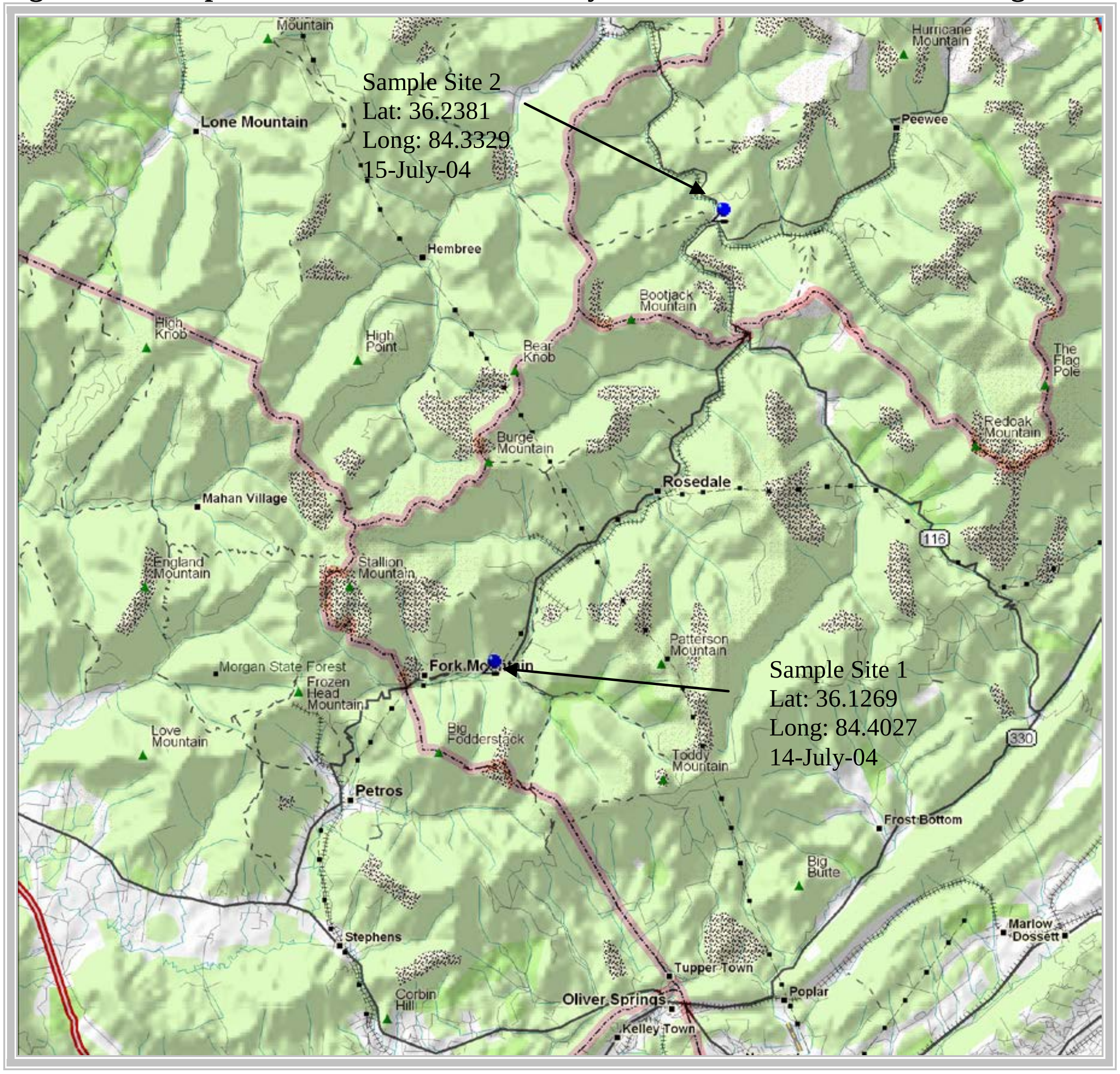
Study Area and Methods

The New River encompasses a drainage area of 989 km^2 and courses some 55 miles through Scott, Campbell, and Anderson counties before joining the Clear Fork River (Evans 1998). The convergence of the New River and Clear Fork form the headwaters of the Big South Fork of the Cumberland River. Access to the river is mostly through private holdings, however, the Big South Fork National Recreation Area bounds the lower reach of the river. Our survey of the New River was accomplished at two localities. Our lower survey was located near the confluence with Beech Fork while our upper station was located at Coon Pool Branch along Hwy. 116 (Figure 37).

Our evaluation of the fish community was accomplished through an Index of Biotic Integrity (IBI) survey. We incorporated the use of one backpack electrofisher and a 5 meter seine to collect fish in shallower habitat at both sites. Analysis of the IBI data followed those criteria described by Evans (1998). Benthic organisms were collected with kick nets during a timed survey. Analysis of the benthic samples followed procedures developed by Lenat (1993).

At our lower sampling station we used both boat and backpack electrofishing units to effectively sample shallow and deep habitats within the area. Fish were collected by boat electrofishing in accordance with the standard large river sampling protocols (TWRA 1998). Fixed-boom electrodes were used to transfer 4-5 amps DC at all sites. This current setting was determined effective in narcotizing all target species. Catch-per-unit-effort (CPUE) values were calculated for each target sport species at each site. Length categorization indices were calculated for target sport species following Gabelhouse (1984).

Figure 37. Sample site locations for the surveys conducted in New River during 2004.



At our sample locations gravel and rubble were the dominant substrate components, although sand was fairly common in the pool habitat. Coal fines were prevalent at both sites, which was not unexpected. Pools accounted for about 60% of the habitat in our survey reaches while riffles comprised about 40%. The riparian zones at both stations were intact and well vegetated. There were a few isolated areas that were eroded at our upper site which were associated with tight turns in the stream channel. Basic water quality measurements at site 1 revealed the following information, temperature 27 C, conductivity 430 µs/cm, and a pH of 7.0. At site 2, temperature was 21.5, conductivity 305 µs/cm, and pH was 6.5

Results

We collected a total of 292 fish comprising 11 species at our sample site 1 (420041301, Table 21). There were four game species collected at this site, which included the rock bass, bluegill, largemouth bass, and smallmouth bass. At site 2 we collected 415 representing 22 species (420041302, Table 21). Four species of game fish were collected at this site. These included smallmouth bass, longear sunfish, walleye, and rock bass. At site 1 the fish community was dominated by central stoneroller and rainbow darter, which comprised 62% of the total fish collected. At site 2, rosyface shiner and bluebreast darter represented 59% of the fish collected.

Table 21. Fish species occurrence for New River 2004.

Site Code	Species	Tads Code	Total Number
422041301	Bluegill	351	1
422041301	Central stoneroller	45	111
422041301	Creek chub	188	20
422041301	Largemouth bass	364	2
422041301	Northern hog sucker	207	25
422041301	Rainbow darter	401	69
422041301	Rock bass	342	7
422041301	Sand shiner	137	3
422041301	Smallmouth bass	362	1
422041301	Striped shiner	89	51
422041301	Western blacknose dace	184	2
		Total	**292**
420041302	Black redhorse	224	8
420041302	Blackside darter	470	1
420041302	Bloodfin darter	434	3
420041302	Bluebreast darter	402	52
420041302	Central stoneroller	45	27
420041302	Channel catfish	240	1
420041302	Golden redhorse	225	13
420041302	Greenside darter	398	2
420041302	Logperch	464	3
420041302	Longear sunfish	353	28
420041302	Mimic shiner	140	3
420041302	Nothern hog sucker	207	14
420041302	Rainbow darter	401	4
420041302	River redhorse	223	1
420041302	Rock bass	342	19
420041302	Rosefin shiner	93	3
420041302	Rosyface shiner	131	193
420041302	Sand shiner	137	1
420041302	Smallmouth bass	362	7
420041302	Smallmouth redhorse	226	5
420041302	Walleye	492	1
420041302	Whitetail shiner	54	26
		Total	**415**

Overall, the IBI analysis for the New River at site 1 indicated the river was in "poor" condition (IBI score = 30) (Table 22). There were several metrics that decreased the overall score. However, the most notable were the low number of native, darter and intolerant species. This reach of the New River is under the influence of siltation, primarily from tributary streams that drain areas of current or historical mining activities. Evans (1998) rated this same reach of the New River "poor" (IBI score 26) in 1996. Our visually based habitat assessment at this site indicated that the quality of the available habitat was "poor" based on an average rating of 38.

Table 22. New River (Site 1) Index of Biotic Integrity analysis.

Metric Description	**Scoring Criteria** **1 3 5**	**Observed**	**Score**
Number of Native Species	≤14 15-17 ≥18	8	1
Number of Darter Species	≤4 5-6 ≥7	1	1
Number of Intolerant Species	≤1 2 ≥3	0	1
Percent Benthic Invertivores	≤20.7 between ≥36.6	32.1	3
Percent Generalist Feeders	≥33.5 between ≤18.5	25.7	3
Percent Suckers	≤3.1 between ≥8.2	8.5	5
Percent Smallmouth Bass and Rock Bass	≤1.2 between ≥3.3	2.7	3
Percent Pioneering Species	≥17.6 between ≤5.1	17.4	3
Percent Simple Spawners	≤13.5 between ≥23.3	27.0	5
Catch Rate	≤10.2 between ≥22.1	103	5
		Total	**30 (Poor)**

Our initial conception of the benthic community at this site was that it would not be good. However, macroinvertebrates collected in our sample comprised 29 families representing 36 identified genera (Table 23). This was quite unexpected based on our findings in the fish community. The most abundant group in our collection was the mayflies comprising 37.5% of the total sample. Dipterans were the second dominant group contributing 29.4% to the sample. Overall, a total of 44 taxa were identified from the sample of which 22 were EPT. Based on the EPT taxa richness and overall biotic index of all species collected, the relative health of the benthic community was classified as "good" (4.2).

Table 23. Taxa list and associated biotic statistics for benthic macroinvertebrates collected from New River (Site 1).

ORDER	FAMILY	SPECIES	NUMBER	PERCENT
COLEOPTERA				2.4
	Dryopidae	*Helichus* adults	3	
	Elmidae	*Dubiraphia vittata* adult	1	
		Macronychus glabratus adult	1	
		Optioservus ovalis adults	2	
	Hydrophilidae	*Cymbiodyta* adult	1	
		Tropisternus blatchleyi blatchleyi adult	1	
	Psephenidae	*Psephenus herricki* larvae and adult	4	
DIPTERA				29.4
	Athericidae	*Atherix lantha*	117	
	Chironomidae		25	
	Empididae		3	
	Simuliidae		6	
	Tipulidae	*Antocha*	1	
		Tipula	3	
EPHEMEROPTERA				37.5
	Baetidae	*Acentrella*	9	
		Baetis	13	
	Ephemerellidae	*Eurylophella*	1	
	Ephemeridae	*Ephemera*	1	
	Heptageniidae	*Epeorus rubidus/subpallidus*	1	
		Stenonema early instars	17	
		Stenonema mediopunctatum	1	
		S. vicarium	56	
	Isonychiidae	*Isonychia*	99	
HETEROPTERA				5.5
	Gerridae	*Aquarius remigis* males and female	3	
	Veliidae	*Rhagovelia obesa* adults and nymph	26	
MEGALOPTERA				2.8
	Corydalidae	*Corydalus cornutus*	13	
		Nigronia serricornis	2	
ODONATA				2.4
	Aeshnidae	*Boyeria grafiana*	1	
		B. vinosa	9	
	Calopterygidae	*Calopteryx*	1	
	Gomphidae	*Gomphus lividus*	1	
		Stylogomphus albistylus	1	
PLECOPTERA				3.4
	Leuctridae	*Leuctra*	8	
	Perlidae	*Acroneuria abnormis*	6	
		A. carolinensis	3	
	Peltoperlidae	*Peltoperla*	1	
TRICHOPTERA				16.8
	Glossosomatidae	*Glossosoma* larva and pupa	2	
	Hydropsychidae	*Ceratopsyche sparna*	59	
		Ceratopsyche sp. cf. *C. slossonae*	3	
		Cheumatopsyche	5	
		Hydropsyche betteni/depravata	4	
	Leptoceridae	*Triaenodes ignitus*	3	
	Limnephilidae	*Pycnopsyche gittifer/scabripennis* group	5	
		Pycnopsyche luculenta group	1	
	Philopotamidae	*Dolophilodes distinctus*	3	
	Polycentropodidae	*Polycentropus*	1	
		Total	**527**	

TAXA RICHNESS = 44
EPT TAXA RICHNESS = 22
BIOCLASSIFICATION = 4.2 (GOOD)

The IBI analysis for the New River at our most downstream station (site 2) indicated the river was in “good” condition (IBI score = 42) (Table 24). There were several metrics that decreased the overall score. However, the most notable were the low number of darter species, low percentage of benthic invertivores, low percentage of rock bass and smallmouth bass, and the low catch rate. This reach showed some improvement over the survey conducted in 1996 by Evans (1998) (1996 IBI score 30), which was conducted just upstream from our sample site. Our visually based habitat assessment at this site indicated that the quality of the available habitat was “poor” based on an average rating of 35.7.

Table 24. New River (Site 2) Index of Biotic Integrity analysis.

Metric Description	**Scoring Criteria** **1 3 5**	**Observed**	**Score**
Number of Native Species	≤14 15-17 ≥18	22	5
Number of Darter Species	≤4 5-6 ≥7	5	3
Number of Intolerant Species	≤1 2 ≥3	3	5
Percent Benthic Invertivores	≤20.7 between ≥36.6	23.9	3
Percent Generalist Feeders	≥33.5 between ≤18.5	0.2	5
Percent Suckers	≤3.1 between ≥8.2	9.9	5
Percent Smallmouth Bass and Rock Bass	≤1.2 between ≥3.3	6.0	5
Percent Pioneering Species	≥17.6 between ≤5.1	0	5
Percent Simple Spawners	≤13.5 between ≥23.3	57.2	5
Catch Rate	≤10.2 between ≥22.1	9.0	1
		Total	**42 (Good)**

Conditions were much improved at our most downstream site and we expected to increase our benthic taxa richness. However, our collection resulted ten fewer taxa than were collected at site 1. A total of 34 taxa were collected here. Fourteen of these represented EPT taxa. Twenty-four families representing 28 identified genera (Table 25). The most abundant group in our collection was the caddisflies comprising 31.2% of the total sample. Mayflies were the second dominant group contributing 30.6% to the sample. Based on the EPT taxa richness and overall biotic index of all species collected, the relative health of the benthic community was classified as “fair/good” (3.5).

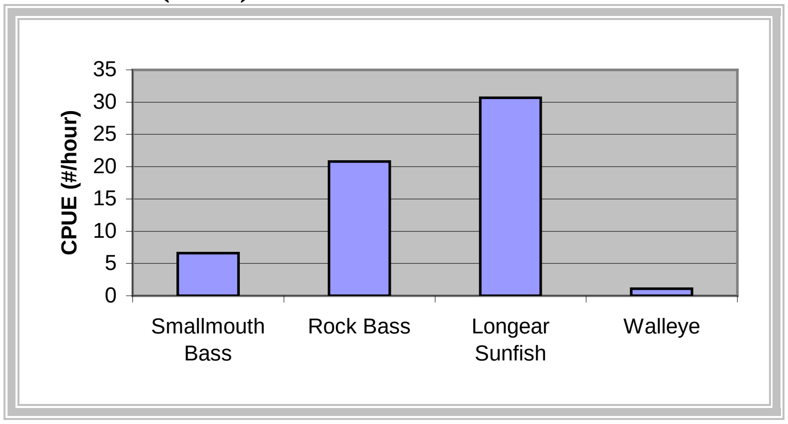
Table 25. Taxa list and associated biotic statistics for benthic macroinvertebrates collected from New River (Site 2).

ORDER	FAMILY	SPECIES	NUMBER	PERCENT
ANNELIDA				1.3
	Oligochaeta		5	
COLEOPTERA				5.5
	Dryopidae	*Helichus* adults	3	
	Elmidae	*Dubiraphia vitta* adult	1	
		Macronychus glabratus adults	3	
		Stenelmis adult	1	
	Gyrinidae	*Dineutus discolor* adults	8	
	Haliplidae	*Peltodytes duodecimpunctatus*	1	
	Hydrophilidae	*Berosus*	3	
	Psephenidae	*Psephenus herricki* adult	1	
DIPTERA				21.2
	Athericidae	*Atherix lantha*	61	
	Chironomidae		13	
	Simuliidae		6	
	Tanyderidae	*Protoplasa fitchii*	1	
EPHEMEROPTERA				30.6
	Heptageniidae	*Stenacron interpunctatum*	3	
		Stenonema early instars	16	
		Stenonema mediopunctatum	26	
		S. vicarium	3	
	Isonychiidae	*Isonychia*	69	
HETEROPTERA				2.9
	Gerridae	*Metrobates hesperius*	2	
	Veliidae	*Rhagovelia obesa* adults and nymphs	9	
MEGALOPTERA				5.0
	Corydalidae	*Corydalus cornutus*	19	
ODONATA				2.1
	Aeshnidae	*Boyeria vinosa*	2	
	Coenagrionidae	*Argia*	4	
		Enallagma exsulans	1	
	Macomiidae	*Macromia*	1	
PLECOPTERA				0.2
	Leuctridae	*Leuctra*	1	
TRICHOPTERA				31.2
	Hydropsychidae	*Ceratopsyche sparna*	31	
		Ceratopsyche sp. cf. *C. slossonae*	9	
		Cheumatopsyche	13	
		Hydropsyche dicantha	45	
	Leptoceridae	*Ceraclea transversa*	2	
	Philopotamidae	*Chimarra*	11	
	Polycentropodidae	*Neureclipsis crepuscularis*	1	
		Polycentropus larvae and pupa	3	
TURBELLARIA (Flat Worms)			4	
		Total	**382**	

TAXA RICHNESS = 34
EPT TAXA RICHNESS = 14
BIOCLASSIFICATION = 3.5 (FAIR/GOOD)

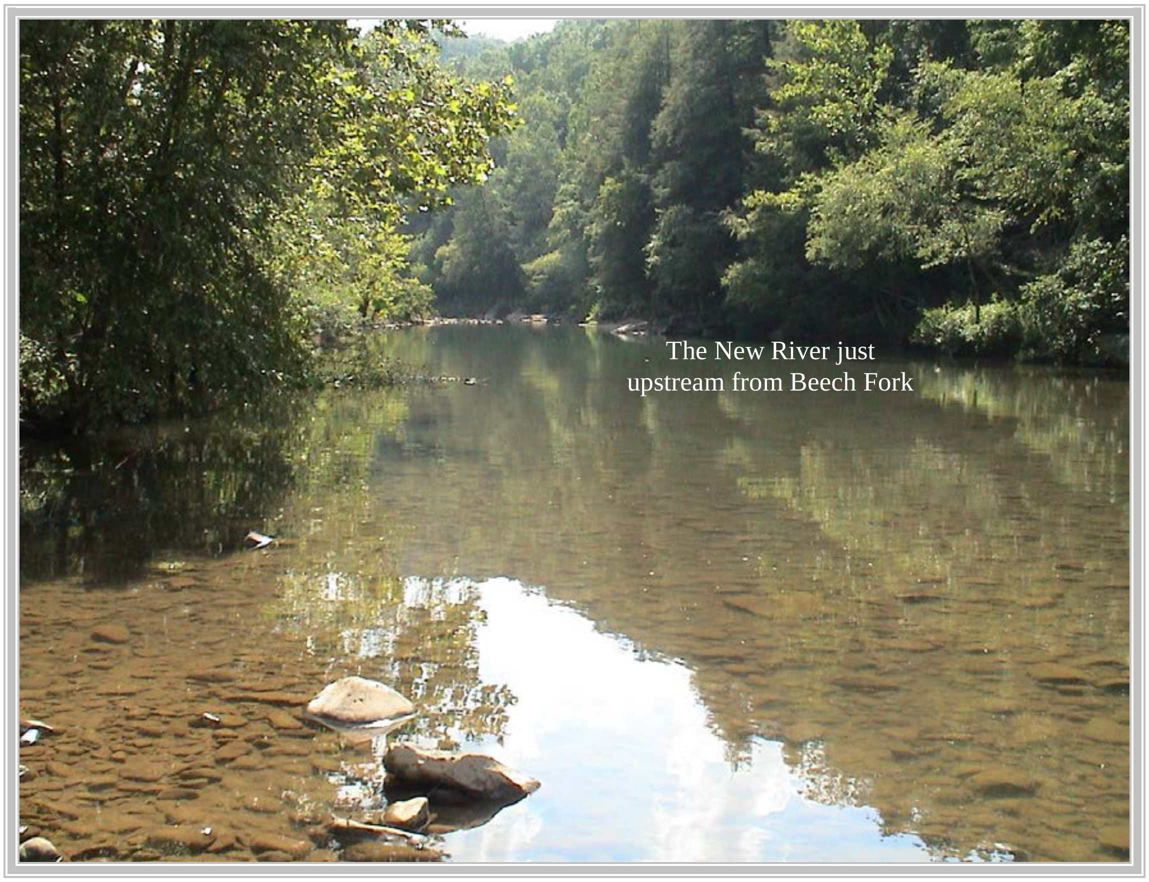
Of the game species collected at both sites, only those collected at Site 2 were in suitable densities to be considered fishable populations. Of the sport species encountered, only the rock bass, longear sunfish, and smallmouth bass were at levels that would provide any worthwhile recreational angling opportunities. We collected one walleye in our sample, which measured 583 mm (23 inches). Twenty-eight longear sunfish ranging from 68-152 mm were collected from the combined backpack and boat sampling. Seven smallmouth bass ranging in length from 36-164 mm were also collected. Nineteen rockbass were collected, which ranged in length from 109 to 194 mm. Mean catch rate for each of the four sport species can be found below in Figure 38.

Figure 38. Mean CPUE for sport species collected from New River (site 2).



Discussion

The New River watershed has been subjected to an array of natural resource extraction activities dating back to the early 1900's. Most of these activities have had some deleterious effect on watershed quality and ultimately led to the near sterilization of many tributary streams within the watershed. With the passing of legislation regarding water quality protection, the New River has gradually improved through the years and managers are now observing water quality conditions that have not been seen in this watershed in the past 80 to 100 years. The Agency has made efforts to enhance some sport species in the New River, particularly smallmouth bass and musky. Even though the river has recovered somewhat, there is much needed improvement to be accomplished within the watershed. Old mining sites still negatively influence water quality, and with resurgence in the coal mining industry the watershed could once again be under the influence of this activity if close monitoring is not undertaken. The Cumberland Mountain region offers many natural features and settings that can be found nowhere else in the state, and the New River that drains a large portion of the region is one of these.



Management Recommendations

1. Periodically monitor the river to determine relative health changes.

2. Ensure that future coal extraction is carefully monitored.

3. Consider another stocking of smallmouth bass since water quality appears to be much improved since the introduction in 1993.

4. Consider winter rainbow trout stocking.

Indian Fork

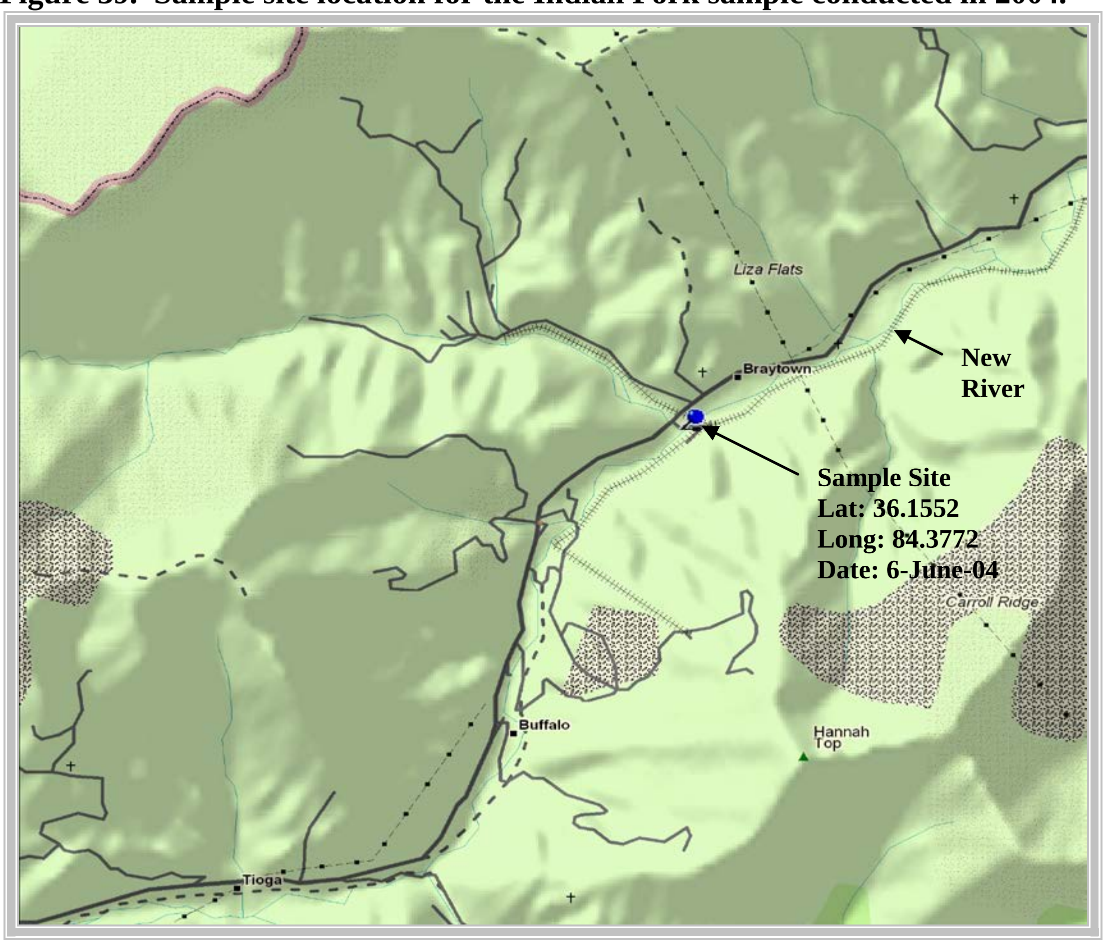
Introduction

Indian Fork originates northwest of Braytown and flows in a in a southeasterly direction before joining the New River. The Agency qualitatively surveyed this stream in 1989 (Bivens and Williams 1990). Winger et al. (1977) surveyed the stream as part of a comprehensive evaluation of the New River watershed. We were primarily interested in characterizing the fish community and assessing the relative health of the stream and comparing our findings to the historical surveys. Much of Indian Fork's watershed has been subjected to coal mining.

Study Area and Methods

Our survey of Indian Fork (Figure 39) was conducted at the bridge crossing on Hwy. 116. The stream at this point is fairly narrow averaging about 5 m in width. Coal mining activity in upstream area of the watershed had left a noticeable impact in the reach we surveyed. Substrate color and water chemistry indicated that mine drainage into the stream was still occurring.

Figure 39. Sample site location for the Indian Fork sample conducted in 2004.



Our evaluation of the fish community was accomplished through an Index of Biotic Integrity (IBI) survey. Benthic organisms were collected with kick nets during a timed survey. Analysis of the fish and benthic samples followed procedures developed by Evans (1998) and Lenat (1993). At our sample location sand, cobble and boulders were the dominant substrate components in pools comprising about 70% of the substrate. In the riffle areas gravel and cobble were dominant accounting for 60% of the available substrate. Riffles dominated the habitat features contributing about 70% of the available habitat. The riparian zones in our survey reach were well vegetated and appeared to be stable. Mine impacts were apparent by the color of the sediment. The bed load in this stream seemed to be unstable and there was evidence of significant movement of substrate components during high flows. Basic water quality measurements at this site revealed the following information, temperature 24 C, conductivity 550 µs/cm, and a pH of 6.5.


Indian Fork within our sample area

Results

We collected a total of 180 fish comprising 12 species at our sample site (Table 26). There were two game species collected at this site, which included the rock bass and longear sunfish. The two most dominant species collected in our sample were the rainbow darter and striped shiner. Together, these two species comprised 57% of the total number of fish in our sample. Two darter species were collected from the stream, bluebreast darter and rainbow darter. The surveys conducted between 1977 and 1989 accounted for 11 species, with most being common to our survey in 2004. The most notable difference in our survey was the collection of rock bass, smallmouth bass, bluebreast darter, whitetail shiner, and western blacknose dace. Species common to the 1977-1989 sample that were not collected in our survey included rosefin shiner, sand shiner, rosyface shiner, spotted bass, and yellow bullhead. It is uncertain why the species composition has changed this much since the last sample was taken in 1989. It is likely however, that the influence or lack of residual mine drainage is almost certain a factor in this faunal shift.

Table 26. Fish species occurrence for Indian Fork 2004.

Site Code	Species	Tads Code	Total Number
420041201	Bluebreast darter	402	5
420041201	Creek chub	188	6
420041201	Central stoneroller	45	33
420041201	Longear sunfish	353	3
420041201	Northern hog sucker	207	15
420041201	Western blacknose dace	184	4
420041201	Rainbow darter	401	48
420041201	Rock bass	342	7
420041201	Smallmouth bass	362	3
420041201	Striped shiner	89	54
420041201	White sucker	195	1
420041201	Whitetail shiner	54	1
		Total	**180**

Overall, the IBI analysis indicated Indian Fork was in good condition (IBI score = 41) (Table 27). This was a drastic improvement over the score calculated (IBI = 23, very poor) for the survey conducted in 1977 at the same locality. The major improvements we observed were the increase in sucker abundance, the decrease in creek chub abundance, the increase in occurrence of rock bass and smallmouth, and the increase in the number of darter and intolerant species. All of these scored a 1 in 1977 (Evans 1998) but were elevated to at least a value of 3 in 2004 or in most cases a 5. The percentage of pioneering species increased dramatically from the 1977 survey, which would indicate a recent disturbance has made conditions suitable for this species (striped shiner) to abundantly colonize the stream. The influences from historical mining practices upstream more than likely alter the fish assemblage in this stream periodically. The conductivity of the stream alone would indicate that there is a persistant influx from the mines within the watershed. Our visual assessment of the habitat resulted in a score of "poor" 36. This was primarily based on the observed instability of the streambed, lack of pools, and atypical water chemistry.

Table 27. Indian Fork Index of Biotic Integrity analysis.

Metric Description	**Scoring Criteria**			**Observed**	**Score**
	1	**3**	**5**		
Number of Native Species	≤8	9-12	≥13	11	3
Number of Darter Species	≤1	2-3	≥4	2	3
Number of Intolerant Species	0	1	≥2	1	3
Percent Benthic Invertivores	≤8.5	between	≥21.8	40.5	5
Percent Generalist Feeders	≥61.7	between	≤26.4	35.0	3
Percent Suckers	≤2.4	between	≥4.4	8.8	5
Percent Creek Chubs	≥30.5	between	≤9.3	3.3	5
Percent Smallmouth Bass and Rock Bass	≤0.8	between	≥4.1	5.5	5
Percent Pioneering Species	≥17.6	between	≤5.1	30	1
Percent Simple Spawners	≤3.8	between	≥14.2	8.3	3
Catch Rate	≤8.8	between	≥39.3	71.1	5
				Total	**41 (Good)**

Benthic macroinvertebrates collected in our sample comprised 30 families representing 30 identified genera (Table 28). The most abundant group in our collection was the caddisflies comprising 47.2% of the total sample. Overall, a total of 38 taxa were identified from the sample of which 18 were EPT. Based on the EPT taxa richness and overall biotic index of all species collected, the relative health of the benthic community was classified as "fair/good-good" (3.8).

Table 28. Taxa list and associated biotic statistics for benthic macroinvertebrates collected from Indian Fork.

ORDER	FAMILY	SPECIES	NUMBER	PERCENT
ANNELIDA				1.3
	Oligochaeta		3	
COLEOPTERA				8.7
	Dryopidae	*Helichus* adults	8	
	Elmidae	*Macronychus glabratus* adults	4	
	Psephenidae	*Psephenus herricki*	8	
DIPTERA				12.2
	Athericidae	*Atherix lantha*	6	
	Chironomidae		13	
	Simuliidae		2	
	Tabanidae	*Chrysops*	1	
	Tipulidae	*Tipula*	6	
EPHEMEROPTERA				10.5
	Baetidae	*Baetis*	5	
	Baetidae	early instars	12	
	Baetidae	undetermined, non-*Baetis*	2	
	Heptageniidae	1st instars	2	
	Leptophlebiidae	*Habrophlebiodes*	3	
HETEROPTERA				1.7
	Veliidae	*Rhagovelia obesa* males and females	4	
MEGALOPTERA				5.2
	Corydalidae	*Corydalus cornutus*	3	
		Nigronia serricornis	6	
	Sialidae	*Sialis*	3	
NEMATOMORPHA			2	0.9
ODONATA				9.6
	Aeshnidae	*Boyeria* early instar	1	
	Calopterygidae	*Calopteryx*	6	
	Coenagrionidae	*Enallagma*	1	
	Gomphidae	*Gomphus lividus*	4	
		Lanthus	4	
	Macomiidae	*Macromia*	6	
PLECOPTERA				2.6
	Leuctridae	*Leuctra*	3	
	Nemouridae	1st instar	1	
	Perlidae	*Acroneuria carolinensis*	1	
	Perlodidae	*Yugus bulbosus* (probably-early instar)	1	
TRICHOPTERA				47.2
	Glossosomatidae	*Glossosoma*	1	
	Hydropsychidae	*Ceratopsyche sparna*	56	
		Ceratopsyche undetermined	9	
		Cheumatopsyche	13	
		Diplectrona modesta	1	
		Hydropsyche betteni/depravata	3	
	Leptoceridae	*Triaenodes perna* larvae, 1 pupa	13	
	Limnephilidae	*Pycnopsyche gittifer/scabripennis* group	5	
		Pycnopsyche luculenta group	5	
	Polycentropodidae	*Polycentropus* pupa	1	
	Uenoidae	*Neophylax* without bulbous ventral gills	1	
		Total	**229**	

TAXA RICHNESS = 38
EPT TAXA RICHNESS = 18
BIOCLASSIFICATION = 3.8 (FAIR/GOOD-GOOD)

Discussion

Indian Fork has been subjected to years of coal mining within its watershed. Winger et al. (1977) noted that there were extensive deposits of yellow-boy on the substrate and that the water itself was yellowish-red in color. They also noted large amount of coal in the substrate. We did observe an off color to the substrate during our survey, however, it did not appear to be on the magnitude described in the 1977 survey of the stream. Likewise, the water clarity was good under normal flow conditions. It appears that the Indian Fork fish fauna has improved substantially in terms of biotic integrity since the 1977 survey. However, it is unlikely that this stream will ever see its full potential while under the influence of historical mine drainage within the watershed.

Management Recommendations

1. Periodically monitor this stream to determine relative health changes.

Summary

We surveyed four rivers and 11 streams, collecting 39 fish samples and nine benthic samples. In the four large rivers sampled during 2004, mean CPUE values for smallmouth bass ranged from a high of 67.4/hour in the North Fork Holston River to a low 22.9/hour in the French Broad River. We observed CPUE values for smallmouth bass in the North Fork that over twice the recorded value in 2001. In the Pigeon River we continued to observe an increase in the mean catch of smallmouth bass and an overall increase in the number of preferred (TL => 350mm) and memorable (TL => 430mm) size smallmouth bass when compared to the 2003 sample.

Of the six IBI surveys conducted in 2004, Mud Creek in Greene County scored the highest with (46) followed by New River (site 2) in Campbell County at 42 and Indian Fork in Anderson County at 41. The lower scoring streams included New River (site1) in Anderson County at 30 and Kendrick and Sinking creeks in Sullivan County at 34 and 32, respectively. Benthic scores for these six samples all fell between "fair/good and good" with three being rated as "fair/good-good" and two as "good". Tennessee dace were documented in two new localities in 2004, Spurling Branch in Monroe County, and Sheehan Branch in Polk County.

All of the streams we surveyed were suffering some type of impairment resulting from industrial, residential or agricultural activities within the watersheds. Because of their locations to large cities or mineral resources most of the streams we surveyed realistically do not have much chance of recovering unless drastic changes in land use practices are implemented.

Over the past 11 years the stream survey unit has been conducting Index of Biotic Integrity surveys in various watersheds within the region. These have been done in response to requests made by TWRA personnel, cooperative effort requests, and general interest in determining the state of certain streams. Our compilation of these surveys has given us a reference database for many streams in the region that can be used for comparison purposes should we return for a routine survey or responding to a water quality issue. Table 29 lists our results for various streams surveyed during this time period.

Table 29. Index of Biotic Integrity and Benthic Biotic Index scores for samples conducted between 1994 and 2004.

Water	Watershed	Year Surveyed	County	IBI Score	Benthic BI Score
Capuchin Creek	Cumberland River	1994	Campbell	44 (Fair)	3 (Fair/Good)
Trammel Branch	Cumberland River	1994	Campbell	36 (Poor/Fair)	3 (Fair/Good)
Hatfield Creek	Cumberland River	1994	Campbell	42 (Fair)	3 (Fair/Good)
Baird Creek	Cumberland River	1994	Campbell	38 (Poor/Fair)	3 (Fair/Good)
Clear Fork (Site 1)	Cumberland River	1994	Campbell	52 (Good)	3 (Fair/Good)
Clear Fork (Site 2)	Cumberland River	1994	Claiborne	40 (Fair)	N/A
Clear Fork (Site 3)	Cumberland River	1994	Claiborne	24 (Very Poor/Poor)	1 (Poor)
Elk Fork Creek	Clear Fork	1994	Campbell	40 (Fair)	2 (Fair)
Fall Branch	Clear Fork	1994	Campbell	28 (Poor)	1 (Poor)
Crooked Creek	Clear Fork	1994	Campbell	38 (Poor/Fair)	2 (Fair)

Table 29. Continued.

Water	Watershed	Year Surveyed	County	IBI Score	Benthic BI Score
Burnt Pone Creek	Clear Fork	1994	Campbell	38 (Poor/Fair)	2 (Fair)
Whistle Creek	Clear Fork	1994	Campbell	38 (Poor/Fair)	2 (Fair)
Little Elk Creek	Clear Fork	1994	Campbell	40 (Fair)	2 (Fair)
Lick Fork	Clear Fork	1994	Campbell	38 (Poor/Fair)	2 (Fair)
Terry Creek	Clear Fork	1994	Campbell	48 (Good)	2 (Fair)
Crouches Creek	Clear Fork	1994	Campbell	28 (Poor)	1 (Poor)
Hickory Creek (Site 1)	Clear Fork	1994	Campbell	46 (Fair/Good)	3 (Fair/Good)
Hickory Creek (Site 2)	Clear Fork	1994	Campbell	48 (Good)	2 (Fair)
White Oak Creek	Clear Fork	1994	Campbell	30 (Poor)	2 (Fair)
No Business Branch	Clear Fork	1994	Campbell	30 (Poor)	3 (Fair/Good)
Laurel Fork	Clear Fork	1994	Campbell	52 (Good)	3 (Fair/Good)
Lick Creek	Clear Fork	1994	Campbell	44 (Fair)	3 (Fair/Good)
Davis Creek	Clear Fork	1994	Campbell	38 (Poor/Fair)	2 (Fair)
Rock Creek	Clear Fork	1994	Campbell	54 (Good/Excellent)	3 (Fair/Good)
Little Tackett Creek	Clear Fork	1994	Claiborne	28 (Poor)	3 (Fair/Good)
Unnamed tributary to Little Tackett Creek	Clear Fork	1994	Claiborne	0 (No Fish)	3 (Fair/Good)
Rose Creek	Clear Fork	1994	Campbell	36 (Poor/Fair)	2 (Fair)
Rock Creek	Clear Fork	1994	Claiborne	28 (Poor)	2 (Fair)
Tracy Branch	Clear Fork	1994	Claiborne	34 (Poor)	2 (Fair)
Little Yellow Creek (Site 1)	Cumberland River	1994	Claiborne	38 (Poor/Fair)	N/A
Little Yellow Creek (Site 2)	Cumberland River	1994	Claiborne	38 (Poor/Fair)	N/A
Little Yellow Creek (Site 3)	Cumberland River	1994	Claiborne	36 (Poor/Fair)	N/A
Hickory Creek	Clinch River	1995	Knox	46 (Fair/Good)	3 (Fair/Good)
White Creek	Clinch River	1995	Union	34 (Poor) (SC)	4 (Good)
Little Sycamore Creek	Clinch River	1995	Claiborne	40 (Fair)	4.5 (Good/Excel).
Big War Creek	Clinch River	1995	Hancock	50 (Good)	4 (Good)
North Fork Clinch River	Clinch River	1995	Hancock	46 (Fair/Good)	4 (Good)
Old Town Creek (Site 1)	Powell River	1995	Claiborne	40 (Fair)	4 (Good)
Old Town Creek (Site 2)	Powell River	1995	Claiborne	42 (Fair)	4 (Good)
Indian Creek	Powell River	1995	Claiborne	N/A	4 (Good)
Sweetwater Creek	Tennessee River	1995	Loudon	30 (Poor)	3 (Fair/Good)
Burnett Creek	French Broad River	1995	Knox	46 (Fair/Good)	3 (Fair/Good)
Jockey Creek	Nolichucky River	1995	Greene	34 (Poor)	3 (Fair/Good)
South Indian Creek (Sandy Bottoms)	Nolichucky River	1995	Unicoi	38 (Poor/Fair)	4 (Good)
South Indian Creek (Ernestville)	Nolichucky River	1995	Unicoi	44 (Fair)	4 (Good)
Spivey Creek	Nolichucky River	1995	Unicoi	54 (Good/Excellent)	4 (Good)
Little Flat Creek	Holston River	1995	Knox	42 (Fair)	3 (Fair/Good)
Beech Creek	Holston River	1995	Hawkins	48 (Good)	4 (Good)
Big Creek	Holston River	1995	Hawkins	46 (Fair/Good)	4 (Good)
Alexander Creek	Holston River	1995	Hawkins	34 (Poor)	4 (Good)
Thomas Creek	South Fork Holston River	1995	Sullivan	54 (Good/Excellent)	4 (Good)
Hinds Creek	Clinch River	1996	Anderson	36 (Poor/Fair)	3 (Fair/Good)
Cove Creek	Clinch River	1996	Campbell	28 (Poor)	3 (Fair/Good)
Titus Creek	Clinch River	1996	Campbell	42 (Fair)	3 (Fair/Good)
Cloyd Creek	Tennessee River	1996	Loudon	36 (Poor/Fair)	4 (Good)
Sinking Creek	Little Tennessee River	1996	Loudon	34 (Poor)	4 (Good)
Baker Creek	Little Tennessee River	1996	Loudon	26 (Very Poor/Poor)	3 (Fair/Good)
Little Baker Creek	Little Tennessee River	1996	Blount	38 (Poor/Fair)	4 (Good)
Ninemile Creek	Little Tennessee River	1996	Blount	24 (Very Poor/Poor)	4 (Good)
East Fork Little Pigeon River	French Broad River	1996	Sevier	36 (Poor/Fair)	3 (Fair/Good)
Dunn Creek	French Broad River	1996	Sevier	32 (Poor)	4 (Good)
Wilhite Creek	French Broad River	1996	Sevier	44 (Fair)	4 (Good)
Watauga River (above Watauga Res.)	Holston River	1996	Johnson	42 (Fair)	4 (Good)
Stony Fork	Big South Fork	1996	Campbell	38 (Poor/Fair)	4 (Good)
Bullett Creek	Hiwassee River	1997	Monroe	50 (Good)	4.5 (Good/Excel.)
Canoe Branch	Powell River	1997	Claiborne	26 (V Poor/Poor) (SC)	4.7 (Excellent)
Town Creek	Tennessee River	1997	Loudon	34 (Poor)	2 (Fair)
Bat Creek	Little Tennessee River	1997	Monroe	30 (Poor)	1.5 (Poor/Fair)
Island Creek	Little Tennessee River	1997	Monroe	40 (Fair)	4 (Good)
Little Pigeon River	French Broad River	1997	Sevier	40 (Fair)	2 (Fair)
West Prong Little Pigeon River	French Broad River	1997	Sevier	46 (Fair/Good)	2 (Fair)
Flat Creek	French Broad River	1997	Sevier	30 (Poor)	3.8 (Good)
Clear Creek	French Broad River	1997	Jefferson	34 (Poor)	2.2 (Fair)
Richland Creek	Nolichucky River	1997	Greene	30 (Poor)	2.3 (Fair)
Middle Creek	Nolichucky River	1997	Greene	34 (Poor)	4 (Good)
Sinking Creek	Pigeon River	1997	Cocke	30 (Poor)	3.8 (Good)
Chestuee Creek	Hiwassee River	1998	Monroe	28 (Poor)	2.5 (Fair/Fair -Good)
Fourmile Creek	Powell River	1998	Hancock	36 (Poor/Fair)	4.5 (Good/Excel.)

Table 29. Continued.

Water	Watershed	Year Surveyed	County	IBI Score	Benthic BI Score
Martin Creek	Powell River	1998	Hancock	50 (Good)	4 (Good)
Big Creek	Tellico River	1998	Monroe	46 (Fair/Good)	4 (Good)
Oven Creek	Nolichucky River	1998	Cocke	40 (Fair)	2.9 (Fair/Good)
Cherokee Creek	Nolichucky River	1998	Washington	36 (Poor/Fair)	2.8 (Fair/Good)
Bennetts Fork	Cumblerland River	2000	Claiborne	30 (Poor)	3.5 (Fair/Good)
Gulf Fork Big Creek	French Broad River	2001	Cocke	42 (Fair)	4.0 (Good)
Nolichucky River	French Broad River	2001	Unicoi	56 (Good/Excellent)	4.0 (Good)
North Fork Holston River	Holston River	2001	Hawkins	50 (Good)	4.5 (Good)
Stinking Creek	Cumberland River	2002	Campbell	42 (Fair)	4.5 (Good)
Straight Fork	Cumberland River	2002	Campbell	18 (Very Poor)	3.0 (Fair/Good)
Montgomery Fork	Cumberland River	2002	Campbell	48 (Good)	3.5 (Fair/Good)
Turkey Creek	Holston River	2003	Hamblen	34 (Poor)	1.5 (Poor)
Spring Creek	Holston River	2003	Hamblen	34 (Poor)	2.2 (Fair)
Cedar Creek	Holston River	2003	Hamblen	30 (Poor)	3.5 (Fair/Good)
Fall Creek	Holston River	2003	Hamblen	32 (Poor)	2.3 (Fair)
Holley Creek	Nolichucky River	2003	Greene	30 (Poor)	2.4 (Fair)
College Creek	Nolichucky River	2003	Greene	36 (Poor/Fair)	2.2 (Fair)
Kendrick Creek	South Fork Holston River	2004	Sullivan	34 (Poor)	3.8 (Fair/Good-Good)
Sinking Creek	South Fork Holston River	2004	Sullivan	32 (Poor)	3.8 (Fair/Good-Good)
Mud Creek	Nolichucky River	2004	Greene	46 (Fair/Good)	4.0 (Good)
New River (Site 1)	Big South Fork Cumberland River	2004	Anderson	30 (Poor)	4.2 (Good)
New River (Site 2)	Big South Fork Cumberland River	2004	Campbell	42 (Good)	3.5 (Fair/Good)
Indian Fork	Big South Fork Cumberland River	2004	Anderson	41 (Good)	3.8 (Fair/Good-Good)

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APPENDIX A

Common and scientific names of fishes used in this report (Nelson et al. 2004)

Family	Common Name	Scientific Name
Acipenseridae	Lake sturgeon	*Acipenser fulvescens*
Catostomidae	Black buffalo	*Ictiobus niger*
	Black redhorse	*Moxostoma duquesnei*
	Blue sucker	*Cycleptus elongatus*
	Golden redhorse	*Moxostoma erythrurum*
	Northern hogsucker	*Hypentelium nigricans*
	River carpsucker	*Carpiodes carpio*
	River redhorse	*Moxostoma carinatum*
	Silver redhorse	*Moxostoma anisurum*
	Smallmouth redhorse	*Moxostoma breviceps*
	Smallmouth buffalo	*Ictiobus bubalus*
	White sucker	*Catostomus commersoni*
Centrarchidae	Bluegill	*Lepomis macrochirus*
	Green sunfish	*Lepomis cyanellus*
	Largemouth bass	*Micropterus salmoides*
	Longear sunfish	*Lepomis megalotis*
	Redbreast sunfish	*Lepomis auritus*
	Rock bass	*Ambloplites rupestris*
	Smallmouth bass	*Micropterus dolomieu*
	Spotted bass	*Micropterus punctulatus*
	White crappie	*Pomoxis annularis*
Clupeidae	Gizzard shad	*Dorosoma cepedianum*
Cottidae	Banded sculpin	*Cottus carolinae*
Cyprinidae	Bigeye chub	*Hybopsis amblops*
	Western Blacknose dace	*Rhinichthys obtusus*
	Bluntnose minnow	*Pimephales notatus*
	Carp	*Cyprinus carpio*
	Central stoneroller	*Campostoma anomalum*
	Creek chub	*Semotilus atromaculatus*
	Fathead minnow	*Pimephales promelas*
	Goldfish	*Carassius auratus*
	Largescale stoneroller	*Campostoma oligolepis*
	Longnose dace	*Rhinichthys cataractae*
	Mimic shiner	*Notropis vollucelus*
	River chub	*Nocomis micropogon*
	Rosefin shiner	*Lythrurus fasciolaris*
	Rosyface shiner	*Notropis rubellus*
	Sand shiner	*Notropis stramineus*
	Silver shiner	*Notropis photogenis*
	Spotfin shiner	*Cyprinella spiloptera*
	Striped shiner	*Luxilus chrysocephalus*
	Telescope shiner	*Notropis telescopus*

Cyprinidae	Tennessee dace	*Phoxinus tennesseensis*
	Tennessee shiner	*Notropis leuciodus*
	Warpaint shiner	*Luxilus coccogenis*
	Whitetail shiner	*Cyprinella galactura*
Esocidae	Musky	*Esox masquinongy*
Ictaluridae	Channel catfish	*Ictalurus punctatus*
	Chucky madtom	*Noturus sp.4*
	Flathead catfish	*Pylodictus olivaris*
	Yellow bullhead	*Ameiurus natalis*
Moronidae	White Bass	*Morone chrysops*
Percidae	Banded darter	*Etheostoma zonale*
	Blackside darter	*Percina maculata*
	Bloodfin darter	*Etheostoma sanguifluum*
	Bluebreast darter	*Etheostoma camurum*
	Gilt darter	*Percina evides*
	Greenside darter	*Etheostoma blenniodes*
	Logperch	*Percina caprodes*
	Rainbow darter	*Etheostoma caeruleum*
	Redline darter	*Etheostoma ruflineatum*
	Sauger	*Sander canadense*
	Snubnose darter	*Etheostoma simoterum*
	Swannanoa darter	*Etheostoma swannanoa*
	Tangerine darter	*Percina tanasi*
	Walleye	*Sander vitreum*
Petromyzontidae	Ohio lamprey	*Ichthyomyzon bdellium*
Poeciliidae	Western mosquitofish	*Gambusia affinis*
Salmonidae	Brown trout	*Salmo trutta*
	Rainbow trout	*Oncorhynchus mykiss*
Sciaenidae	Drum	*Aplodinotus grunniens*