# FISHERIES REPORT
# REPORT NO. 04-03
# WARMWATER STREAM FISHERIES REPORT
# REGION IV
# 2003


Prepared by

Bart D. Carter
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and
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TENNESSEE WILDLIFE RESOURCES AGENCY

April 2004

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**Cover:** Rick Bivens displays a nice smallmouth bass collected from the Powell River in 2003.

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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 seventeenth 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. 03-4. A total of 10 streams were sampled and are included in this report. Stream surveys were conducted from March to August 2003. Thirty-five (IBI or CPUE) fish samples and six 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 (Holston River, French Broad River, Powell River, and Pigeon 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 on 7.5 minute topographical maps 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). 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 2003. 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 2003 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 Robins et al. (1991) 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 2003 as collections were made from these rivers between 1997 and 2000.

## *BENTHIC COLLECTIONS*

Qualitative benthic samples were collected from each IBI fish sample site (6 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% isopropanol 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.

## *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 follow those described by Karr et al. (1986) and are as follows:

| **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. |

Catch-per-unit-effort analysis was performed on the four large rivers sampled during 2003. 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 during 2003.

Benthic data collected for the 2003 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.

# Powell River

## *Introduction*

The remoteness of the Powell River makes it one of the premier warmwater rivers in east Tennessee. It offers the opportunity to take float trips without seeing another individual during the course of a day. The surroundings are appealing which makes a trip to the Powell well worth the drive. It is an important recreational resource for the state both in consumptive and non-consumptive uses. It provides critical habitat for threatened and endangered species and species of special concern. The river supports a diverse fish community and has been documented to host some 37 species of mussels (Ahlstedt 1986). It is one of only two rivers in the region having reaches designated as mussel sanctuaries. Additionally, it supports one of east Tennessee's better warmwater sport fisheries. The Powell River has been the focus of numerous surveys and investigations conducted by other state and federal agencies with the major purpose of assessing and monitoring the fish and benthic communities. The Agency has made surveys of the river that focused primarily on collecting basic fish, benthic, and water quality data (Bivens 1988, Carter et al. 2000, 2003). Our survey of the Powell River in 2003 focused on re-evaluating the sport fish population sampled during the summer of 2002 and developing comparisons between the summer sample of that year and the spring sample conducted in March of 2003. Our findings from previous samples of the same river (i.e. Pigeon River) has indicated that a fall or spring sample may better represent the overall population structure of black bass and rock bass when compared to a summer sample (see Carter et al. 2003). Our goal for the Powell River in 2003 was to sample a subset of the sites surveyed in the summer of 2002 and make a comparison of catch rates and population size structure for black bass and rock bass. The major advantage in conducting a spring sample in free flowing rivers such as the Powell is that it allows us to navigate a large majority of the river with a jet boat making the collection of the survey data less physically demanding and time consuming when compared to a summer sample at low flow. It has also become apparent that the bass, especially larger smallmouth bass ultilize habitat (i.e. pools) in the spring and fall that is more accessible to boat electrofishing equipment than habitat ultilized during the summer (i.e. riffles). Our 2003 assessment was comprised of a sub-sample of the sites surveyed in the summer of 2002. Four sites from river mile 91 to 115 were sampled. Survey methods and durations were duplicated in order to make a valid comparison between the summer and spring samples.

## *Study Area and Methods*

The Powell River originates in Virginia and flows in a southwesterly direction before emptying into Norris Reservoir near river mile 54. The river has a drainage area of approximately 1,774 kilometers$^2$. In Tennessee, all of the Powell River flows through the Ridge and Valley province of east Tennessee coursing by the town of Harrogate before emptying into Norris Reservoir near the community of Authur. Public access 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 one developed launching area managed by the Tennessee Wildlife Resources Agency (Mulberry Creek).

On March 20, 2003, we conducted four fish surveys between the Virginia state line and river mile 91 (Figure 1). In our survey sites, the riparian habitat consisted primarily of wooded shorelines with interspersed agricultural fields. Submerged woody debri and underwater cover such as boulders and bedrock shelves were 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 approximately 30 meters to 40 meters, while site lengths fell between 290 meters and 577 meters (Table 1). Water clarity was excellent as indicted by a secchi disk reading of 2.0+ meters. No other water quality data was collected during the samples. River flow measured at the USGS gauging station at Arthur, TN was 800 cfs on the day of the survey.

**Figure 1. Site locations for samples conducted in the Powell River during 2003.**

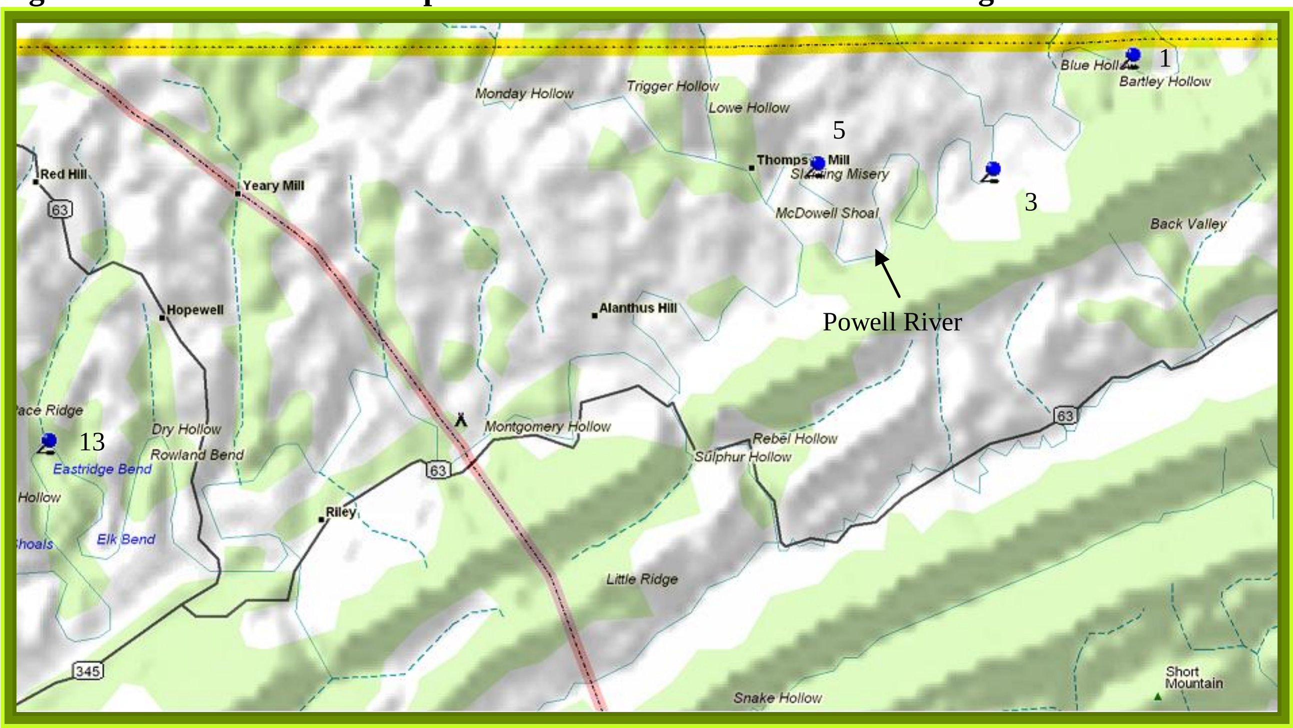



**Table 1. Physiochemical and site location data for samples conducted in the Powell River during 2003.**

| Site Code | Site | Quad | River Mile | Latitude | Longitude | Mean Width (m) | Length (m) | Temp. C | Cond. | Secchi (m) |
|---|---|---|---|---|---|---|---|---|---|---|
| 420030501 | 1 | Back Valley | 115 | 363541 | 831852 | 29.5 | 290 | - | - | 2.0+ |
| 420030503 | 3 | Back Valley | 112.1 | 363452 | 832005 | 30 | 577 | - | - | 2.0+ |
| 420030505 | 5 | Back Valley | 107.6 | 363455 | 832143 | 33.5 | 480 | - | - | 2.0+ |
| 420030513 | 13 | Coleman Gap | 91 | 363257 | 832827 | 38.5 | 537 | - | - | 2.0+ |

Fish were collected by boat electrofishing in accordance with the standard large river sampling protocols (TWRA 1998). Fixed-boom electrodes were used to transfer 4-5 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 901 to 1006 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 at the four sampling sites averaged 15.2/hour (SD 8.9) in 2002, while the mean smallmouth bass CPUE in 2003 was 60.4. This represents a significant increase (297%) in the catch of smallmouth bass between the two time periods. The rock bass estimate in 2002 was 106.3/hour (SD 84.6) which slightly decreased to 100.4/hour in the 2003 survey (Table 2). There were no spotted bass or largemouth bass collected at any of the four survey sites. Our data from the 1999 summer survey of the Powell River at the same sites adds support to our findings in 2003 as the mean CPUE for smallmouth bass and rock bass during this survey was 52.7/hour and 84.7/hour respectively. All data collected to date indicate that a spring sample (March or April) of the Powell River can produce higher catch rates and better size distribution data than samples collected between June and August.

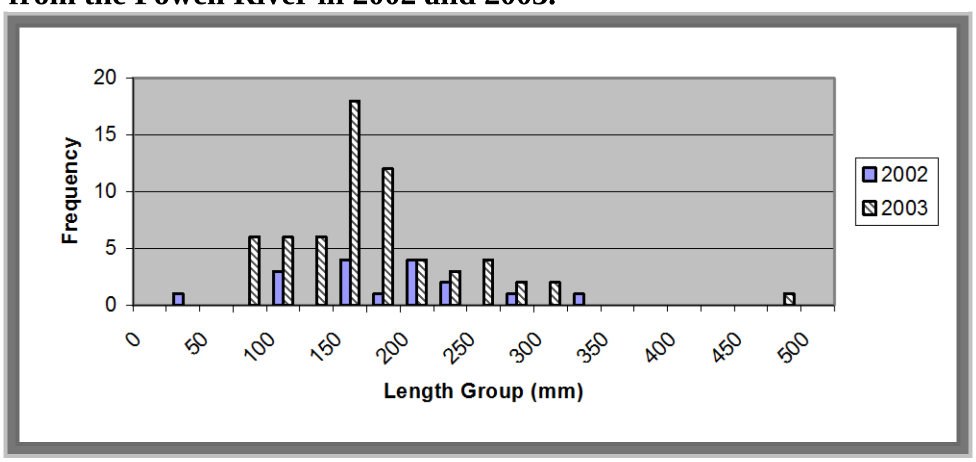
**Table 2. Catch per unit effort and length categorization indices of target species collected at four sites in the Powell River between 2002 and 2003.**

| Site Code | Smallmouth Bass **CPUE 2002** | Smallmouth Bass **CPUE 2003** | Rock Bass **CPUE 2002** | Rock Bass **CPUE 2003** |
|---|---|---|---|---|
| 420030501 | 10.2 | 70.5 | 84.7 | 48.2 |
| 420030503 | 7.6 | 71.5 | 26.6 | 85.8 |
| 420030505 | 15.2 | 47.9 | 88.0 | 103.8 |
| 420030513 | 27.7 | 52 | 226.0 | 164 |
| MEAN | 15.2 | 60.4 | 106.3 | 100.4 |
| STD. DEV. | 8.9 | 12.3 | 84.6 | 48.2 |
| | Length-Categorization Analysis | Length-Categorization Analysis | Length-Categorization Analysis | Length-Categorization Analysis |
| | **PSD = 25** | **PSD = 20.8** | **PSD = 14** | **PSD = 21.2** |
| | **RSD-PREFERRED = 0** | **RSD-PREFERRED = 4.2** | **RSD-PREFERRED = 0** | **RSD-PREFERRED = 0** |
| | **RSD-MEMORABLE = 0** | **RSD-MEMORABLE = 4.2** | **RSD-MEMORABLE = 0** | **RSD-MEMORABLE = 0** |
| | **RSD- TROPHY = 0** | **RSD- TROPHY = 0** | **RSD- TROPHY = 0** | **RSD- TROPHY = 0** |

The size distribution of smallmouth bass between 2002 and 2003 changed considerably between the two sampling periods (Figure 2). Representation of bass in the 75 mm to 175 mm size range was substantially higher when compared to the 2002 data. There was a higher occurrence of bass 200 mm and over in the 2003 sample and one bass

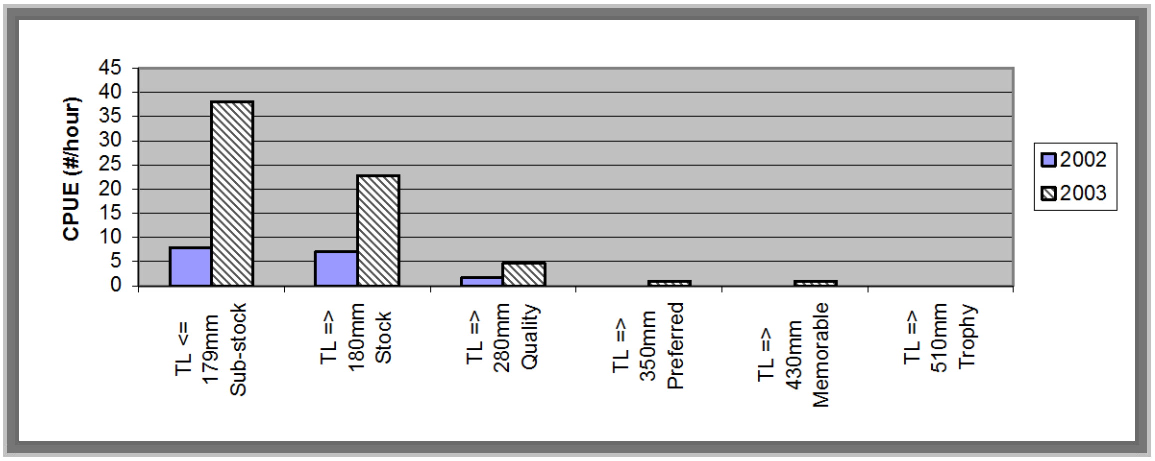

496 mm (19.5 in) was collected. It appears that the early spring sample also gave us a better indication of reproduction from the previous year as bass had moved into size classes that were more susceptible to the gear. Overall, the size distribution for the 2003 sample was much more indicative of the true population size and frequency structure simply from the standpoint that we increased our sample size by about 275% between the two samples.

**Figure 2. Length frequency distributions for smallmouth bass collected from the Powell River in 2002 and 2003.**




Length categorization analysis indicated the relative stock density (RSD) of preferred smallmouth bass (TL $\geq$ 350 mm) was 4.2 (Table 2). RSD for memorable (TL $\geq$ 430 mm) and trophy (TL $\geq$ 510 mm) size bass were 4.2 and 0, respectively. The PSD of smallmouth bass (ratio of quality size bass to stock size bass) was 20.8. In comparison, the values for 2002 was lower for bass in the preferred and memorable (0). No trophy size bass (TL $\geq$ 510 mm) were collected in either year. Catch-per-unit-effort estimates by RSD category between 2002 and 2003 indicated a substantial increase in the catch of all smallmouth bass (Figure 3). The most dramatic increases were in the two smaller categories (sub-stock and stock) where the values increased 388% and 225%, respectively.

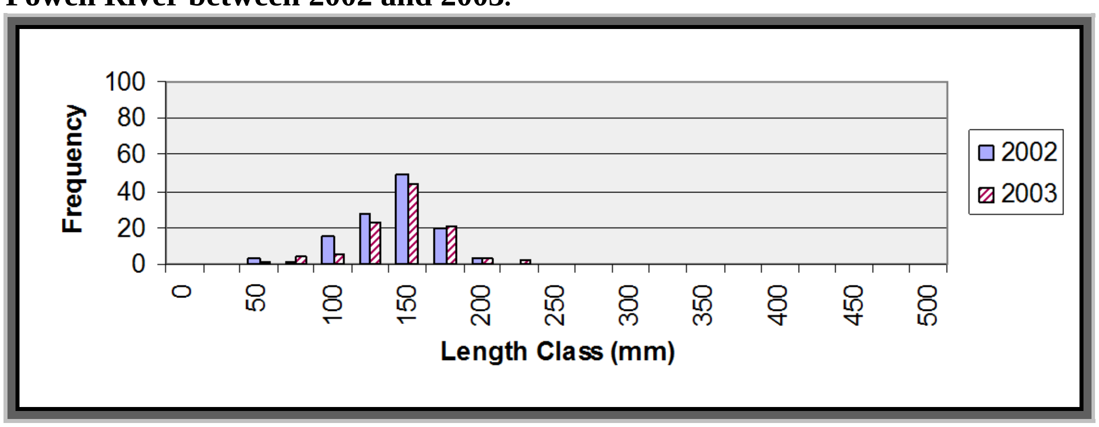
**Figure 3. Relative stock density (RSD) catch per unit effort for smallmouth bass collected from the Powell River between 2002 and 2003.**




Age and growth characteristics for the smallmouth bass population in the Powell River were characterized in 1999 (Carter et al. 2000). For the most part, the Powell River has had growth rates somewhat slower than other large river populations with the same age structure. We did not collect otoliths from smallmouth bass in 2002 or 2003, assuming that the values generated from the 1999 survey typify the general growth characteristics of this population. In general, it takes a smallmouth bass in the Powell River about 5.2 years to reach 305 mm (12 inches), and about 9.5 years to attain a length of 406 mm (16 inches).

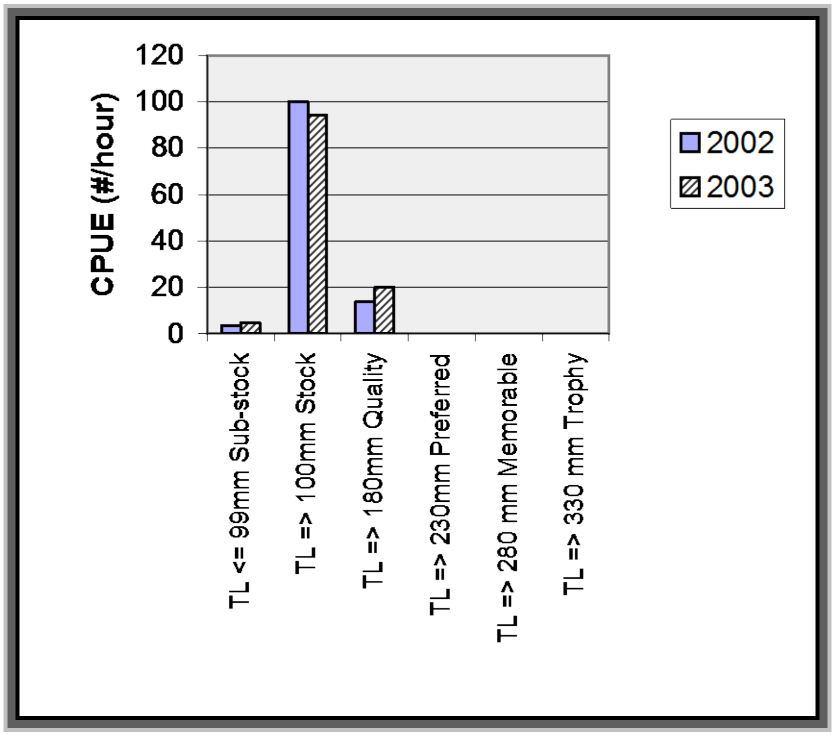
Individuals in the 100 to 200 mm range represented the majority of rock bass in our samples between 2002 and 2003 (Figure 4). Overall, there was very little change in the length frequency distribution between the two samples. Length categorization

**Figure 4. Length frequency distributions for rock bass collected from the Powell River between 2002 and 2003.**




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 21.2 (Table 2). Catch per unit effort estimates by RSD category followed similar trends to the length frequency data with relatively little change between the two sampling periods. The most notable change was the 43% increase in the catch of quality size rock bass in 2003 (Figure 5).

**Figure 5. Relative stock density (RSD) catch per unit effort for rock bass collected from the Powell River between 2002 and 2003.**




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 2003. Age and growth and mortality of rock bass in the Powell River are assumed to be similar to those reported from our 1999 assessment (Carter et al. 2000).

## *Discussion*

The Powell River provides anglers with the opportunity to catch all species of black bass along with rock bass. Because of the low numbers of spotted and largemouth bass in the Powell River, it should not be considered to contain a sport fishery for these species.

Overall, our comparisons between summer and spring samples on the Powell River confirmed our observations that we have made in the Pigeon River in Cocke County. It appears that smallmouth bass are more susceptible to our electrofishing gear during the fall or spring when they are utilizing pool habitat in these rivers rather than the riffles and runs that they typically inhabit during the summer. The size distribution difference is undoubtedly respresented in our samples as the larger fish move into winter holding areas (pools) during the fall and are still present in these habitats in the spring before the water temperature increases. We are fairly convinced that what we have seen on the Powell and in the Pigeon River (see Carter et al. 2003) a seasonal shift in habitat usage which in our case, allows us to be more effective in characterizing the bass populations in these rivers.

The trend for rock bass remained relatively unchanged which indicates that a summer sample would be as effective as a fall or spring sample. This trend was also observed in the Pigeon River during 2002.

The Powell River represents one of east Tennessee's premier warmwater resources. It provides anglers with the opportunity to catch good numbers of smallmouth bass and rock bass and has the potential of producing memorable catches (both in number and size). The surrounding landscape is as eye appealing as the wildlife that lives in and around the river. It provides an excellent escape for recreationists (consumptive and non-consumptive) who are looking for a river that offers relatively undisturbed surroundings and a diverse community of wildlife.

Surveys on the Powell River will be conducted on a three-year rotation in order to assess any changes in the fishery. Our return trip in 2005 will in all likelihood involve conducting a spring sample that will allow us to collect the most representative information for this river.

### *Management Recommendations*

1. Initiate an angler use and harvest survey.

2. Develop a fishery management plan for the river.

3. Implement a more efficient sampling strategy (spring samples).

# Holston River

## *Introduction*

The Holston River represents a valuable recreational resource to the state as it provides water based recreation to several communities, towns, and cities along its course. It is also an important source of drinking water for many populations between Kingsport and Knoxville. Historically, the Holston River has been subjected to many man-induced alterations including channelization, damming, and pollution. Two dams regulate most of the flow outside of tributaries that enter the river above and below these dams. Fort Patrick Henry Dam located on the South Fork Holston River near Kingsport controls the river between Boone Reservoir and Cherokee Reservoir. Releases from Fort Patrick Henry coincide with lake level management activities and the need for water at Eastman in Kingsport and the TVA John Sevier steam plant near Rogersville. With the completion of Cherokee Dam in 1941, much of the free flowing characteristics of the river basin within Tennessee were eliminated. Although a "controlled" river, the Holston still boasts a fairly diverse fish assemblage and is home to at least two threatened species (spotfin chub *Cyrpinella monacha* and snail darter *Percina tanasi*) and thirteen species of freshwater mussels (Ahlstedt 1986).

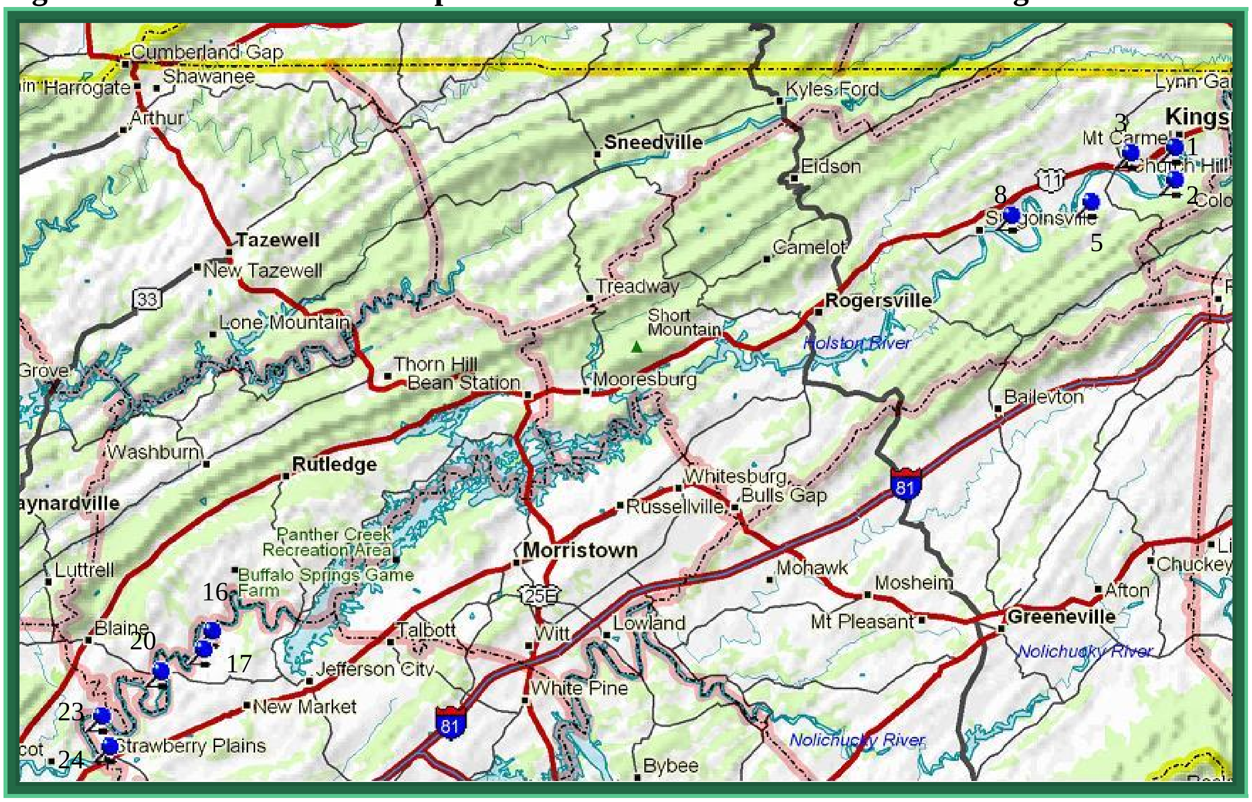
Our 2003 surveys focused on re-evaluating the black bass and rock bass populations in the river above and below Cherokee Dam. We conducted the first intensive survey of the these sport fish species in 2000 (Carter et al. 2001) characterizing black bass and rock bass population structure and developing a fish species list for TADS. Historical surveys have been conducted on the river by various agencies, with the majority of these focusing on community assessment.

## *Study Area and Methods*

The Holston River originates near Kingsport with the confluence of the North Fork Holston and South Fork Holston rivers. These rivers along with the Middle Fork all originate in Virginia. The Holston flows in a southwesterly direction before combining with the French Broad River to form the headwaters of the Tennessee River. The river has a drainage area of approximately 9,780 $km^2$ at its confluence with the French Broad River. In Tennessee, approximately 184 kilometers of the Holston River flows through the Ridge and Valley ecological province before joining the French Broad River near Knoxville. Public access along the river is primarily private, however, there are some "pull-outs" along public roads paralleling the river. The TWRA manages three public access areas along the river, which include boat ramps near Hunt Creek, the community of Surgoinsville, and Nance Ferry downstream of Cherokee Dam. TVA maintains access below John Sevier Steam Plant and immediately below Cherokee Dam. The cities of Church Hill and Kingsport both have public ramps at their city parks.

Between March 27 and April 3, 2003, we conducted 10 fish surveys between Kingsport and Mascot (Figure 6). Because this river is a tailwater, habitat availability fluctuates with water releases. However, in our survey sites, the habitat consisted

**Figure 6. Site locations for samples conducted on the Holston River during 2003.**




primarily of wooded shorelines with interspersed rock outcroppings. Submerged woody debri was scarce in most of our sample areas. The river substrate was predominately bedrock and boulder with some cobble in the riffle areas. Measured channel widths ranged from 68 to 145 m, while site lengths fell between 125 and 1108 m (Table 3). Water temperatures ranged from 16 to 18.5 C upstream of Cherokee Reservoir and 11 to 17.5 C downstream of Cherokee Reservoir. Conductivity varied from 195 to 330 µs/cm (Table 3). Conductivity was generally lower downstream of Cherokee Reservoir. Because we were able to conduct the samples earlier in the year we were not hindered by the water star-grass in that portion of the river above Cherokee Reservoir. This made navigating the river much easier and probably increased our sampling efficiency to some degree. Historically, the river channel becomes choked with this aquatic vegetation making navigation difficult during the summer months.

**Table 3. Physiochemical and site location data for samples conducted on the Holston River during 2003.**

| Site Code | Site | County | Quad | River Mile | Latitude | Longitude | Mean Width (m) | Length (m) | Temp. | Cond. | Secchi (m) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 420030601 | 1 | Hawkins | Church Hill 188SW | 136.3 | 363126 | 824054 | 127 | 1108 | - | - | 2.0 |
| 420030602 | 2 | Hawkins | Lovelace 189NW | 134.1 | 362955 | 824053 | 123 | 596 | - | - | 2.0 |
| 420030603 | 3 | Hawkins | Church Hill 188SW | 131.5 | 363110 | 824323 | 111 | 375 | 16 | 310 | 2.0 |
| 420030605 | 5 | Hawkins | Stony Point 180NE | 127.5 | 362854 | 824545 | 145 | 576 | 18.5 | 330 | 2.0 |
| 420030608 | 8 | Hawkins | Stony Point 180NE | 118.8 | 362818 | 825018 | 139 | 419 | 18.5 | 315 | 2.0 |
| 420030616 | 16 | Grainger/Jefferson | Joppa 155NE | 38.8 | 360859 | 833606 | 134.5 | 468 | 11 | 195 | 1.8 |
| 420030617 | 17 | Grainger/Jefferson | Joppa 155NE | 37.5 | 360809 | 833637 | 68 | 125 | 11 | 195 | 1.8 |
| 420030620 | 20 | Grainger/Jefferson | Mascot 155SW | 28 | 360707 | 833905 | 137.5 | 654 | 14.5 | 220 | 1.8 |
| 420030623 | 23 | Jefferson/Knox | Mascot 155SW | 19.7 | 360503 | 834226 | 144 | 554 | 17.5 | 230 | 1.8 |
| 420030624 | 24 | Knox | Mascot 155SW | 17 | 360325 | 834200 | 107.5 | 443 | 16.5 | 240 | 1.8 |

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 900 to 1449 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***

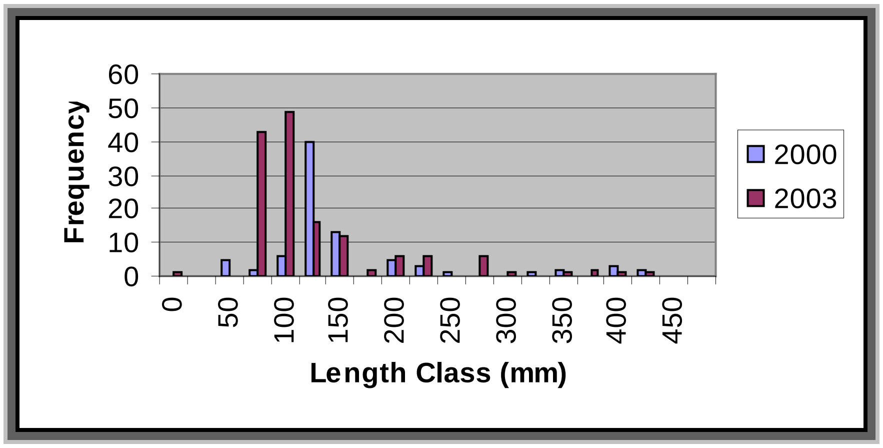
CPUE estimates for smallmouth bass above Cherokee Reservoir averaged 108.5/hour (SD 82.2), while the spotted bass and largemouth bass estimates were 0/hour and 1.3/hour (SD 1.8), respectively (Table 4). Comparatively, mean CPUE estimates at the same sites in 2000 were 52.8/hour for smallmouth bass and 3.2/hour for largemouth bass. No spotted bass were collected at these sites during the 2000 samples. Rock bass CPUE was 43.8/hour (SD 49.5) upstream of the reservoir in 2003. In 2000, at the same sampling stations the average was considerably lower at 17.5/hour. In the samples conducted below Cherokee Reservoir in 2003, smallmouth bass catches averaged 45.4/hour (SD 55.3). Spotted bass and largemouth bass catch rates were not surprisingly lower at 1.6/hour (SD 3.5) and 2.4/hour (SD 5.4), respectively. In comparison, the CPUE value for smallmouth bass in 2000 was much higher at 107/hour. Spotted bass and largemouth bass values were 12.6/hour and 2.4/hour. Overall, we saw a dramatic decline in the number of black bass between the two sampling periods, particularly the number of smallmouth bass (decrease of 57.5%). Whether this is a true decline in the population or simply a function of the time (which is probably the case) the sample was conducted and/or differing flow regimes from Cherokee Dam is unclear at this point. We have documented unusual age and growth characteristics in this portion of the river as summarized in Carter et al. 2001. This could potentially contribute to population instability. Rock bass catches in this part of the river averaged 61.2/hour (SD 45.2) Table 4. This was slightly higher than the value recorded for the 2000 samples (57.5/hour).

**Table 4. Catch per unit effort and length-categorization indices of target species collected at ten sites on the Holston River during 2003 (Sites 1-8 above Cherokee Reservoir, sites 16-24 below Cherokee Reservoir).**

| Site Code | Smallmouth Bass CPUE | Spotted Bass CPUE | Largemouth Bass CPUE | Rock Bass CPUE |
|---|---|---|---|---|
| 420030601 | 24.8 | - | 2.5 | - |
| 420030602 | 110.7 | - | - | 57.1 |
| 420030603 | 235.4 | - | - | 123.7 |
| 420030605 | 47.8 | - | 3.9 | 27.9 |
| 420030608 | 123.7 | - | - | 10.6 |
| MEAN | 108.5 | - | 1.3 | 43.8 |
| STD DEV. | 82.2 | - | 1.8 | 49.5 |
| **Sites 1-8** | Length-Categorization Analysis | Length-Categorization Analysis | Length-Categorization Analysis | Length-Categorization Analysis |
| | PSD = 44 | PSD = 0 | PSD = 100 | PSD = 25.5 |
| | RSD-Preferred = 20 | RSD-Preferred = 0 | RSD-Preferred = 50 | RSD-Preferred = 0 |
| | RSD-Memorable = 4 | RSD-Memorable = 0 | RSD-Memorable = 0 | RSD-Memorable = 0 |
| | RSD-Trophy = 0 | RSD-Trophy = 0 | RSD-Trophy = 0 | RSD-Trophy = 0 |
| 420030616 | 3.9 | - | - | 23.9 |
| 420030617 | 23.9 | - | - | 51.9 |
| 420030620 | 12 | 8 | 12 | 16 |
| 420030623 | 140 | - | - | 92 |
| 420030624 | 47.3 | - | - | 122.2 |
| MEAN | 45.4 | 1.6 | 2.4 | 61.2 |
| STD DEV. | 55.3 | 3.5 | 5.4 | 45.2 |
| **Sites 16-24** | Length-Categorization Analysis | Length-Categorization Analysis | Length-Categorization Analysis | Length-Categorization Analysis |
| | PSD = 18.4 | PSD = 0 | PSD = 33.3 | PSD = 21 |
| | RSD-Preferred = 7.9 | RSD-Preferred = 0 | RSD-Preferred = 0 | RSD-Preferred = 0 |
| | RSD-Memorable = 2.6 | RSD-Memorable = 0 | RSD-Memorable = 0 | RSD-Memorable = 0 |
| | RSD-Trophy = 0 | RSD-Trophy = 0 | RSD-Trophy = 0 | RSD-Trophy = 0 |

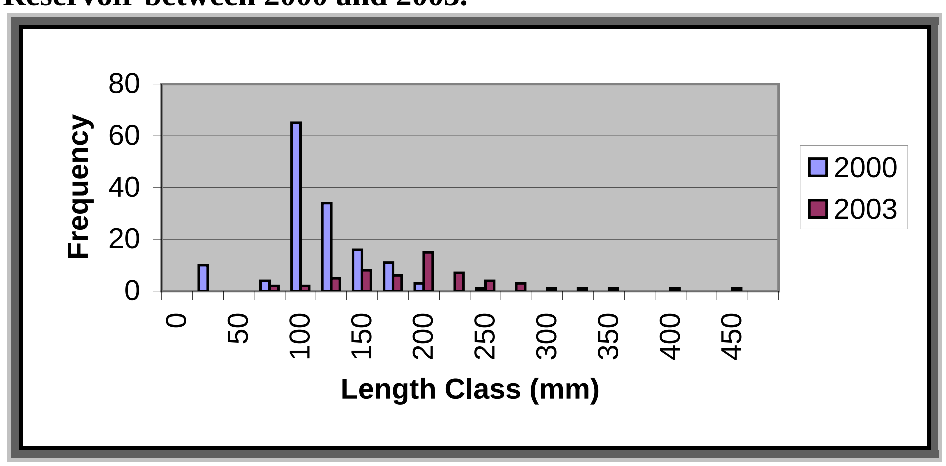
The majority of the smallmouth bass collected from the Holston River between 2000 and 2003 fell within the 75 mm to 275 mm length range both above and below Cherokee Reservoir (Figures 7 and 8). There was a higher representation of smaller bass in the sample taken above Cherokee in 2003 as was the general case for bass over 200 mm (Figure 7).

**Figure 7. Length frequency distributions for smallmouth bass collected from the Holston River above Cherokee Reservoir between 2000 and 2003.**




Below the reservoir the trend was somewhat opposite from the upstream samples. Here the smaller size classes of bass were better represented in the 2000 sample. In contrast the 2003 sample had a higher occurrence and better representation of bass 200 mm and over (Figure 8).

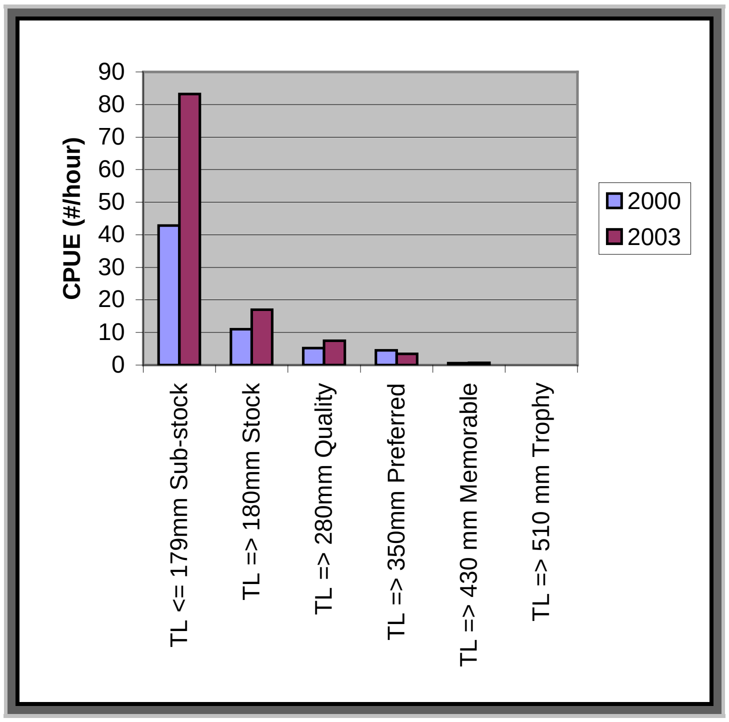
**Figure 8. Length frequency distributions for smallmouth bass collected from the Holston River below Cherokee Reservoir between 2000 and 2003.**




The 2003 Relative Stock Density (RSD) for preferred smallmouth bass (TL $\geq$ 350 mm) above and below the reservoir was 20 and 7.9, respectively. The observed values for this same category in 2000 were 41.1 above the reservoir and 0 below. RSD for memorable (TL $\geq$ 430 mm) and trophy (TL $\geq$ 510 mm) size bass during 2003 were 4 and 0 above the reservoir and 2.6 and 0 below the reservoir. The observed value in 2003 for preferred bass were slightly lower than the value observed in the 2000 sample (5.8). We actually observed an increase in the RSD of preferred bass below the reservoir between 2000 and 2003 (0 to 2.6). In both years, the RSD for trophy size bass remained at 0.

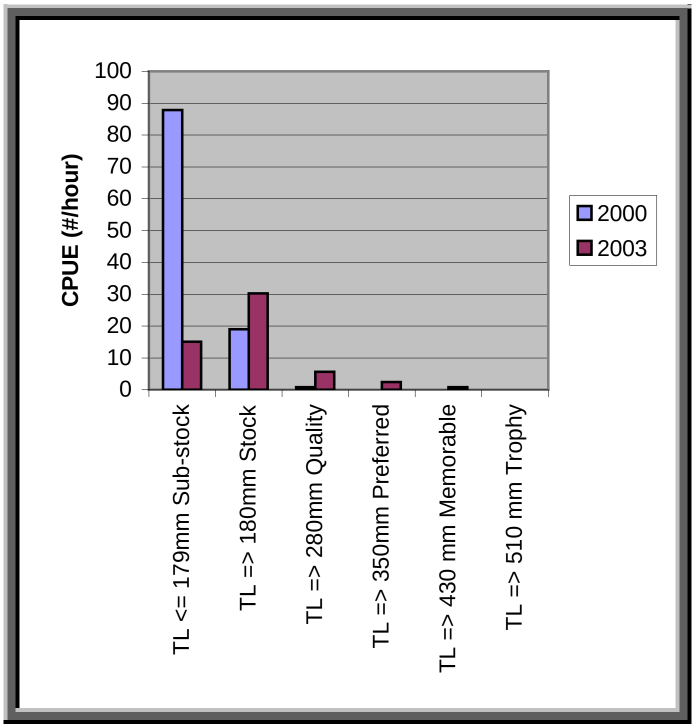
The PSD of smallmouth bass (ratio of quality size bass to stock size bass) was 44 above the reservoir and 18.4 below the reservoir during 2003. Catch per unit effort estimates by RSD category were apparently different between the 2000 and 2003 samples collected above the reservoir. There was a considerable increase in the number of sub-stock bass collected above the reservoir when compared to our 2000 sample. Likewise, all the other RSD categories with the exception of the preferred category exhibited increases. The catch of sub-stock smallmouth was high during 2003 indicating good recruitment (Figure 9). Although we did not collect any trophy size bass during the 2003 sample we have taken smallmouth in excess of 510 mm (20 in) in previous surveys.

**Figure 9. Relative stock density (RSD) catch per unit effort for smallmouth bass collected in the Holston River above Cherokee Reservoir between 2000 and 2003.**




Trends in catch per unit effort by RSD category below Cherokee Reservoir were similar to those above the reservoir with the exception of the sub-stock category. Within this category we observed almost the exact opposite of what we had seen above the reservoir (Figure 10). There was very little recruitment into the sub-stock category during 2003, while the others categories all demonstrated increases. This would suggest that we could see a decline in recruitment to the larger size classes if this population is being regulated by density independent factors. We did collect a memorable size bass during the 2003 survey which was not seen during 2000. Although we did not collect any trophy size bass during the 2003 sample we have taken smallmouth in excess of 510 mm (20 in) in previous surveys.

**Figure 10. Relative stock density (RSD) catch per unit effort for smallmouth bass collected in the Holston River below Cherokee Reservoir between 2000 and 2003.**

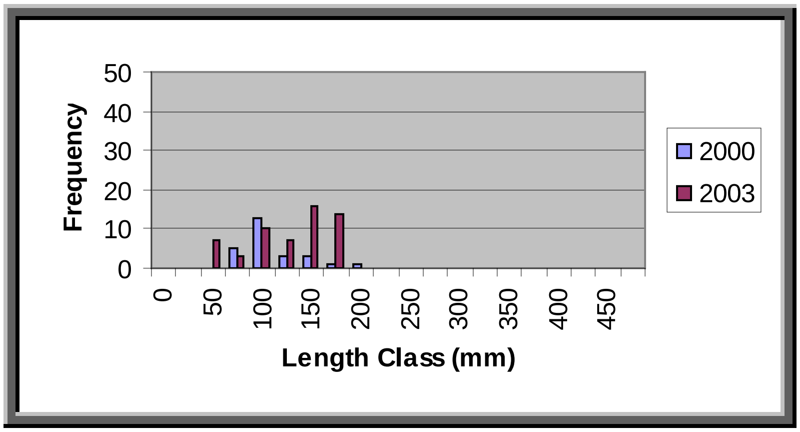



There were no spotted bass collected above Cherokee Reservoir during 2000 or 2003. Riverine occurrence of spotted bass in most the east Tennessee rivers is sporadic at best with the exception of the Nolichucky River where there is a viable fishery for this species. Only two spotted bass were collected below the reservoir which did not allow for any meaningful analysis regarding these populations.

Because so few largemouth bass were collected in the samples above and below the reservoir during both years it is difficult to make any conclusion regarding these populations. Like spotted bass, largemouth bass tend to occur sporadically and unpredictably in larger rivers of east Tennessee. Where found, they tend to inhabit the more sluggish and lower reaches of rivers usually associated with some type of woody cover.

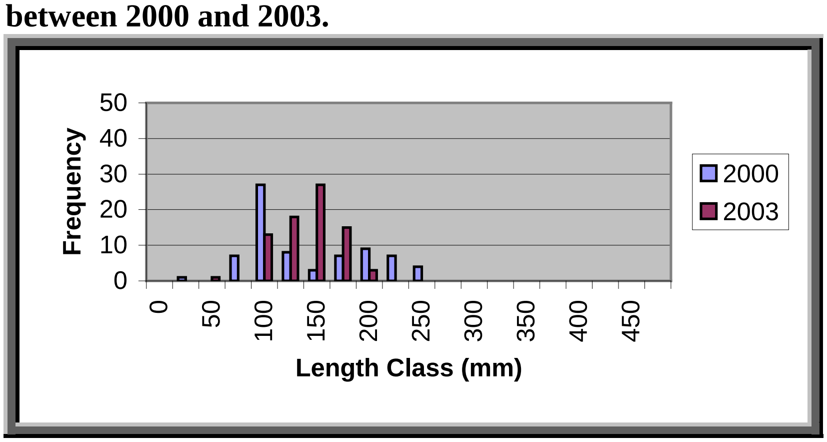
Individuals in the 100 to 175 mm range represented the majority of rock bass in our sample (Figure 11). There was a considerable increase in the number of rock bass collected during 2003, particularly in the 150 to 200 mm length range. This increase is most likely associated with the timing of the samples between the two years. The 2000 sample was conducted during the summer months while the 2003 sample took place during the spring. The abundance of aquatic vegetation in this portion of the river during the summer hampers electrofishing efficiency. During the spring this vegetation has not grown to the point that it impedes navigation in the river channel. Therefore, we feel that this factor alone had the most influence in the disparity of our catches between the two samples.

**Figure 11. Length frequency distributions for rock bass collected from the Holston River above Cherokee Reservoir between 2000 and 2003.**



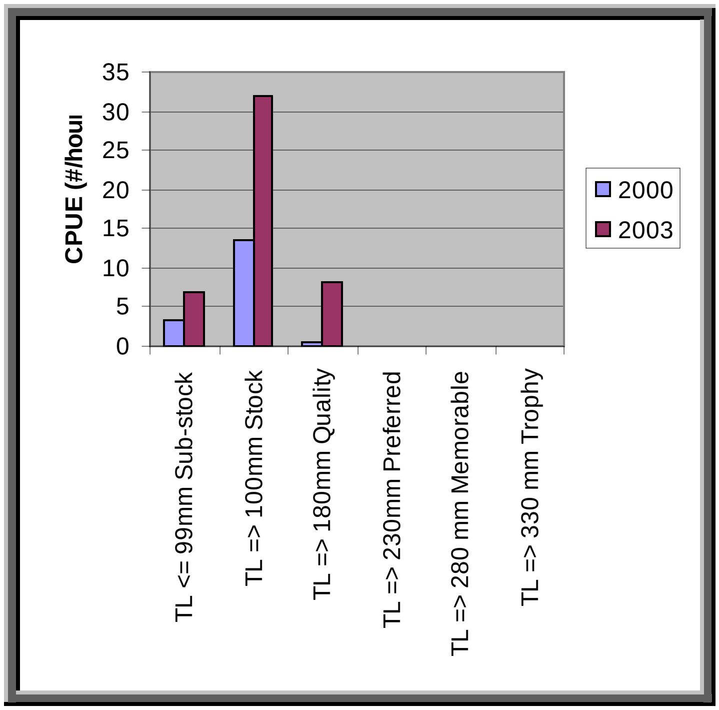

Below Cherokee Reservoir the size distributions for rock bass during both years was primarily composed of fish in the 100 to 250 mm size group (Figure 12). The most notable difference in the distributions above and below the reservoir was simply the number of fish collected. There seemed to be more suitable habitat downstream of the reservoir than above in the form of boulder/rubble banks and rocky outcroppings, which were the most likely factors contributing to the difference.

**Figure 12. Length frequency distributions for rock bass collected from the Holston River below Cherokee Reservoir between 2000 and 2003.**




The RSD of preferred (TL $\geq$ 230 mm) rock bass was 0 in 2003 both above and below the reservoir (Table 4). RSD for memorable (TL $\geq$ 280 mm) and trophy (TL $\geq$ 330 mm) size rock bass was also 0 in 2003. The 2003 PSD of rock bass was 25.5 above the reservoir and 21 below the reservoir. Catch per unit effort estimates by RSD category above Cherokee Reservoir indicated the majority of our catch was stock size fish during both years (Figure 13). We did observe substantial increases in the catch rate of rock bass above the reservoir in the RSD- sub-stock, stock, and quality size categories between 2000 and 2003.

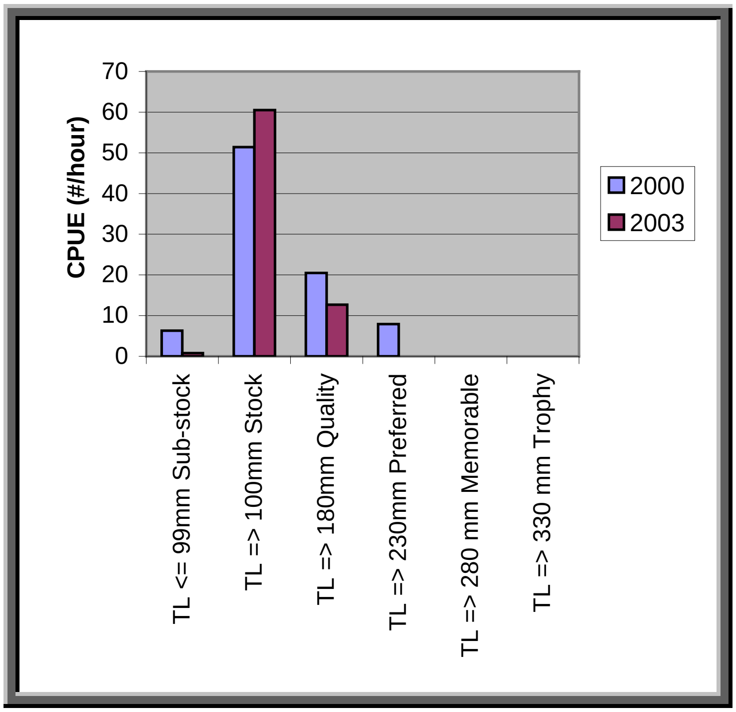
**Figure 13. Relative stock density (RSD) catch per unit effort for rock bass collected from the Holston River above Cherokee Reservoir between 2000 and 2003.**




The increases most likely are attributed to our increased sampling efficiency due to the lack of vegetation in the river channel. We were able to access more areas of the river within our survey sites that had preferred rock bass habitat during 2003. Prolific aquatic vegetation during the 2000 sample prevented us from effectively sampling much of the suitable habitat within these same survey sites. In our samples collected below the reservoir the RSD catch rate was highest during 2000 in all categories except in the RSD-stock category where the 2003 value surpassed the 2000 value by about 18% (Figure 14). During 2003 we observed fewer quality size rock bass and no preferred size. With increase in stock size rock bass during 2003 we should see better recruitment into the quality and preferred categories over the next couple of years as these fish move into the larger size classes. The low catch rate of sub-stock rock bass is probably not a function of our inability to effectively sample this size group. Although low in number we did see a considerable decline in this size category between 2000 and 2003. This finding could indicate a poor year class during 2003, which may be related to high discharges from Cherokee Dam during the late spring and early summer.

Since our primary focus of the samples during 2003 was to characterize the sport fish population we did not record a total species list for each sample site. However, a comprehensive list from the 2000 survey provides the most recent account of other fish species collected in the Holston River (Carter et al. 2001).

**Figure 14. Relative stock density (RSD) catch per unit effort for rock bass collected from the Holston River below Cherokee Reservoir between 2000 and 2003.**




### *Discussion*

The Holston River has had a long history of degradation and misuse. Because of the hydropower facilities established on the river much of its free flowing characteristics have been lost, altering the aquatic community and its inhabitants. Mitigation efforts have been conducted in order to establish or re-establish certain suitable species in portions of the river, particularly downstream of Cherokee Reservoir. Between 1997 and 1999, 11,816, 30 to 75 mm smallmouth bass were stocked into the tailwater downstream of Cherokee Dam, in an attempt to bolster the existing population. A put-and-take rainbow trout (*Oncorhynchus mykiss*) fishery was established in the Cherokee tailwater and has become quite popular with local anglers. One threatened species, the snail darter, has been successfully re-introduced into the tailwater near Knoxville and there has been discussion of re-introducing selected mussel species into the river. Lake sturgeon was recently introduced into the river below the reservoir.

Efforts made by the Tennessee Valley Authority to improve water quality downstream of Cherokee Dam have for the most part been responsible for the observed improvements below the dam. Dissolved oxygen management in the forbay of Cherokee Reservoir has drastically improved the D.O. levels in the tailwater resulting in restoration projects that would have historically not been considered.

For the most part we were able to improve our sampling efficiency above the reservoir. This was due to the lack of aquatic vegetation during our sample. The proliferation of aquatic vegetation during the summer months makes sampling the river above the reservoir difficult. Because of this we will most likely shift our sampling strategy to the spring months both above and below the reservoir. Our next scheduled sample of the Holston River will be in 2006.

### *Management Recommendations*

1. Continue the rainbow trout put-and-take program.

2. All fingerling smallmouth bass stocked into the tailwater should be marked with oxytetracycline (OTC) to enable cohort evaluation.

3. Begin a comparison study of smallmouth bass population dynamics in various tailwaters that would include the Holston River.

4. Initiate an angler use and harvest survey.

5. Develop a fishery management plan for the river.

6. Continue to cooperate with lake sturgeon re-introduction efforts.

# Turkey Creek

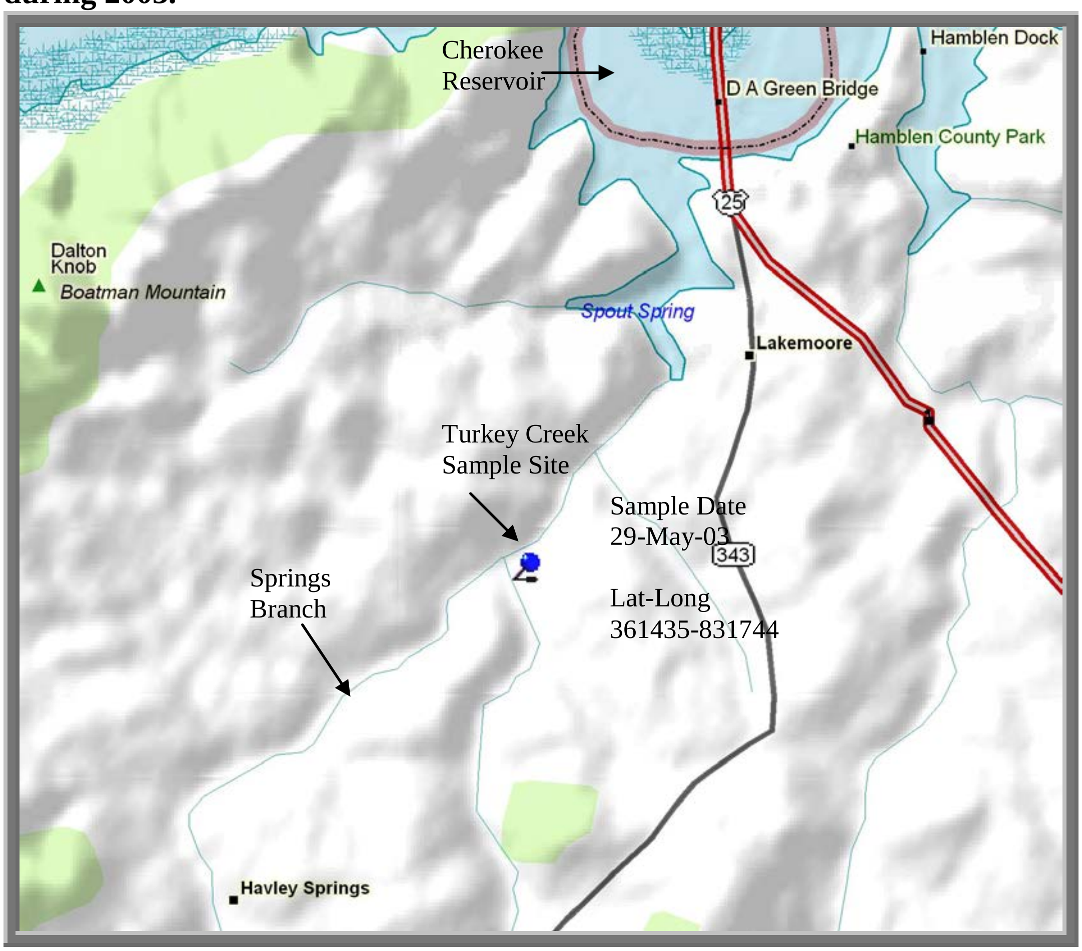
## *Introduction*

Turkey Creek has the reputation for being one of the more polluted streams in Hamblen County simply because the majority of its watershed courses through the city of Morristown. 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 1995 (TVA 1998).

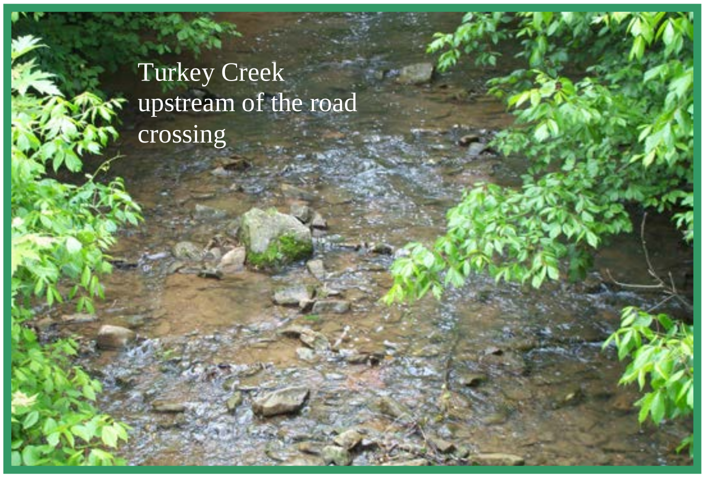
## *Study Area and Methods*

Our survey of Turkey Creek (Figure 15) was conducted at the bridge crossing on Fairview Road. Our survey was slightly upstream from the area surveyed by the TVA.

**Figure 15. Sample site location for the survey conducted in Turkey Creek during 2003.**



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 boulder and cobble were the dominant substrate components comprising about 50% 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 a well established riparian zone upstream of the bridge crossing. The portion of the sample area below the bridge had been converted into a pasture field and most of the larger trees had been removed from the stream banks. This allowed some "raw" areas to form along the stream margins in this lower reach of our survey area. Basic water quality measurements at this site revealed the following information, temperature 16.5 C, conductivity 400 µs/cm, 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.





### *Results*

We collected a total of 349 fish comprising eight species at our sample site (Table 5). There were two game species collected at this site which included the bluegill and green sunfish. The two most dominant species collected in our sample were the largescale stoneroller and orangeside dace. Together, these two species comprised 93% of the total number of fish in our sample. There were no darter species collected at this site although it was expected that snubnose darter would occur. 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, the lack of darters, and the abscense of intolerant species, trophic specialists, and piscivores.

**Table 5. Fish species occurrence for Turkey Creek 2003.**

| Site Code | Species | Tads Code | Total Number |
|---|---|---|---|
| 420030701 | Orangeside Dace | 184 | 304 |
| 420030701 | Bluegill | 351 | 1 |
| 420030701 | Carp | 62 | 1 |
| 420030701 | Creek Chub | 188 | 4 |
| 420030701 | Green Sunfish | 347 | 3 |
| 420030701 | Largescale Stoneroller | 45 | 21 |
| 420030701 | Northern Hogsucker | 207 | 1 |
| 420030701 | White Sucker | 195 | 14 |
| | | **Total** | **349** |

Overall, the IBI analysis indicated Turkey Creek was in poor condition (IBI score = 34) (Table 6). This was somewhat of an improvement based on the 1995 IBI data collected by the TVA. The major differences observed between the two samples were

**Table 6. Turkey Creek Index of Biotic Integrity analysis.**

| **Metric Description** | **Scoring Criteria**<br>**1 3 5** | **Observed** | **Score** |
|---|---|---|---|
| Number of Native Species | <8 8-15 >15 | 7 | 1 |
| Number of Darter Species | <2 2 >2 | 0 | 1 |
| Number of Sunfish Species less *Micropterus* | <2 2 >2 | 2 | 3 |
| Number of Sucker Species | <2 2 >2 | 2 | 3 |
| Number of Intolerant Species | <2 2 >2 | 0 | 1 |
| Percent of Individuals as Tolerant | >59 59-30 <30 | 6.0 | 5 |
| Percent of Individuals as Omnivores | >45 45-22 <22 | 10.1 | 5 |
| Percent of Individuals as Specialists | <16 16-32 >32 | 0 | 1 |
| Percent of Individuals as Piscivores | <1 1-5 >5 | 0 | 1 |
| Catch Rate | <16 16-32 >32 | 48.3 | 5 |
| Percent of Individuals as Hybrids | >1 1-TR 0 | 0 | 5 |
| Percent of Individuals with Anomalies | >5 5-2 <2 | 2.3 | 3 |
| | | **Total** | **34 (Poor)** |

the increase in the overall catch rate, the decrease in the percentage of omnivores, and the increase in the number of sucker species collected in the sample. These three metrics had the most influence in elevating the overall IBI score between the 1995 sample and the 2003 sample. The 1995 assessment by the TVA resulted in an overall IBI score of 26 (very poor/poor) (TVA 1998).

Benthic macroinvertebrates collected in our sample comprised 15 families representing 13 identified genera (Table 7). The most abundant group in our collection was the caddisflies comprising 41.5% of the total sample. Overall, a total of 17 taxa were identified from the sample of which 4 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 "poor" (1.5).

**Table 7. Taxa list and associated biotic statistics for benthic macroinvertebrates collected from Turkey Creek.**

| ORDER | FAMILY | SPECIES | NUMBER | PERCENT |
|---|---|---|---|---|
| **ANNELIDA** | | | | 3.3 |
| | Oligochaeta | | 9 | |
| **COLEOPTERA** | | | | 0.4 |
| | Chrysomelidae | *Hydrothassa* | 1 | |
| **DIPTERA** | | | | 26.1 |
| | Chironomidae | | 32 | |
| | Empididae | | 1 | |
| | Simuliidae | | 22 | |
| | Tabanidae | *Tabanus* pupa | 1 | |
| | Tipulidae | *Antocha* | 5 | |
| | | *Tipula* | 10 | |
| **EPHEMEROPTERA** | | | | 15.8 |
| | Baetidae | *Baetis* | 42 | |
| | Heptageniidae | *Stenacron interpunctatum* | 1 | |
| **GASTROPODA** | | | | 1.8 |
| | Ancylidae | *Ferrissia* | 1 | |
| | Physidae | | 4 | |
| **HEMIPTERA** | | | | 1.8 |
| | Gerridae | *Gerris remigis* 3♂ and I♀ | 4 | |
| | | *Gerris* nymph | 1 | |
| **ODONATA** | | | | 9.2 |
| | Calopterygidae | *Calopteryx* | 11 | |
| | Coenagrionidae | *Argia* | 14 | |
| **TRICHOPTERA** | | | | 41.5 |
| | Hydropsychidae | *Cheumatopsyche* | 42 | |
| | | *Hydropsyche betteni/depravata* | 71 | |
| | | **Total** | **272** | |

**TAXA RICHNESS = 17**
**EPT TAXA RICHNESS = 4**
**BIOCLASSIFICATION = 1.5 (POOR)**

### *Discussion*

Turkey 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 Turkey 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 1995 by the TVA.

### *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.

# Spring Creek

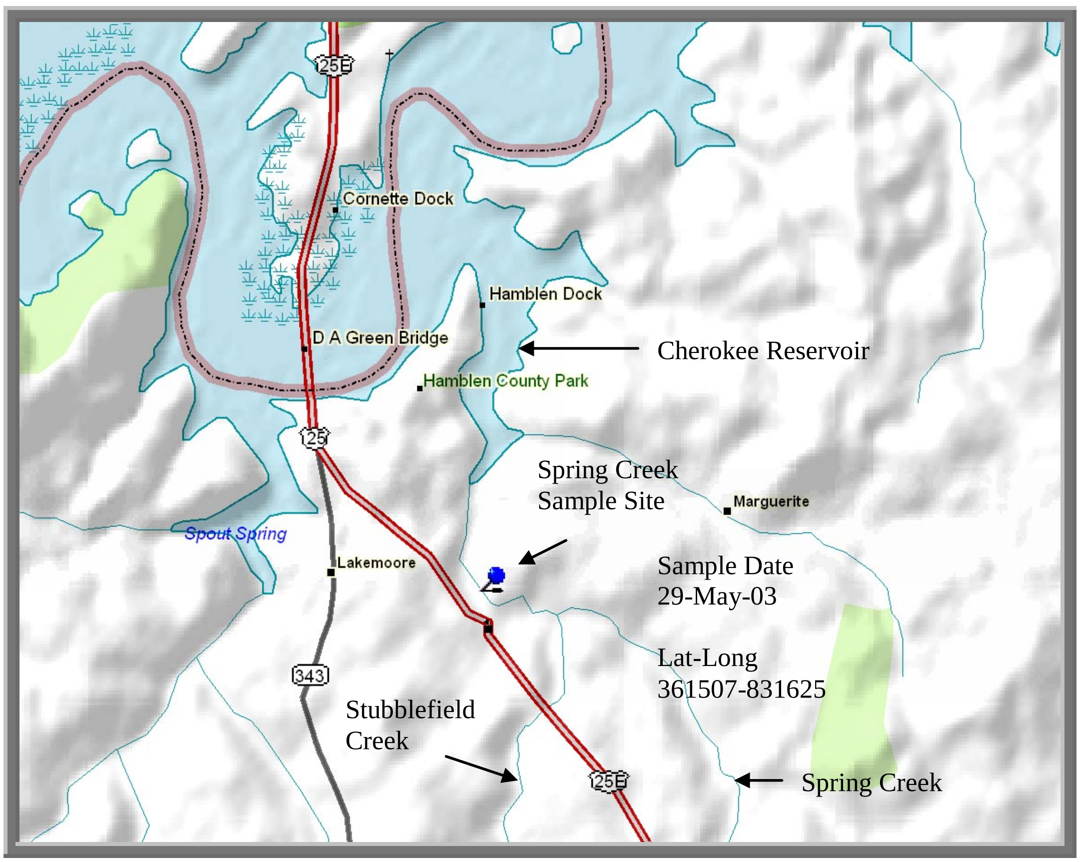
## *Introduction*

Similar to Turkey Creek, Spring Creek has the reputation for being one of the more polluted streams in Hamblen County. There is a major sewage trunk line that follows the creek and occasionally is in or crosses the stream channel. Most of the watershed flows through residential development or along Hwy. 25E. 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 we have collected very little information about Hamblen County streams, we were interested in evaluating the current health of this stream and making comparisons to a survey conducted by the TVA in 1993 (TVA 1998).

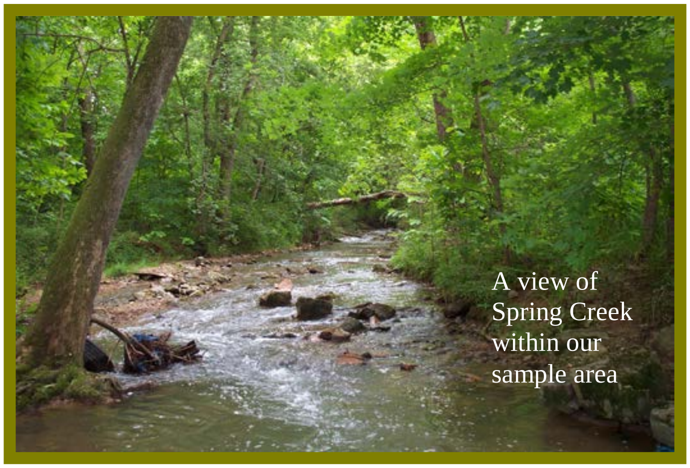
## *Study Area and Methods*

Our survey of Spring Creek (Figure 16) was conducted at the bridge crossing on Brights Pike. Our survey during 2003 was in close proximity to the area surveyed by the TVA during 1993.

**Figure 16. Sample site location for the survey conducted in Spring Creek during 2003.**



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 was the prevelant substrate component comprising about 30% of the substrate in the pools and about 35% in the riffles. Riffles dominated the habitat features contributing about 60% of the available habitat. Our sample site had well-established riparian zones upstream and downstream of the bridge crossing. 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 15.5 C, conductivity 380 µs/cm, and a pH of 7.0. Like many others streams in the area enrichment due to residential and municipal run-off was evident.


A view of Spring Creek within our sample area

## *Results*

We collected a total of 301 fish comprising six species at our sample site (Table 8). Bluegill was the only game species collected at this site. The two most dominant species collected in our sample were the largescale stoneroller and orangeside dace. Together, these two species comprised 83% of the total number of fish in our sample. There were no darter species collected at this site although it was expected that snubnose darter would occur. The only sucker species collected at this site was the white sucker. There were several of the 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, and the absence of piscivores.

**Table 8. Fish species occurrence for Spring Creek 2003.**

| Site Code | Species | Tads Code | Total Number |
|---|---|---|---|
| 420030801 | Banded Sculpin | 322 | 29 |
| 420030801 | Orangeside Dace | 184 | 40 |
| 420030801 | Bluegill | 351 | 1 |
| 420030801 | Creek Chub | 188 | 5 |
| 420030801 | Largescale Stoneroller | 45 | 220 |
| 420030801 | White Sucker | 195 | 6 |
| | | **Total** | **301** |

Overall, the IBI analysis indicated Spring Creek was in poor to fair condition (IBI score = 34) (Table 9). There were no apparent improvements in the health of the fish community based on comparisons with the 1993 IBI data collected by the TVA (IBI score = 34). The major differences observed between the two samples were the

**Table 9. Spring Creek Index of Biotic Integrity analysis.**

| Metric Description | Scoring Criteria<br>1 3 5 | Observed | Score |
|---|---|---|---|
| Number of Native Species | <5 5-9 >9 | 6 | 3 |
| Number of Darter Species | 0 1 >1 | 0 | 1 |
| Number of Sunfish Species less *Micropterus* | 0 1 >1 | 1 | 3 |
| Number of Sucker Species | 0 1 >1 | 1 | 3 |
| 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 | 75.1 | 1 |
| Percent of Individuals as Specialists | <16 16-32 >32 | 0 | 1 |
| Percent of Individuals as Piscivores | <1 1-5 >5 | 0 | 1 |
| Catch Rate | <16 16-32 >32 | 33.4 | 5 |
| Percent of Individuals as Hybrids | >1 1-TR 0 | 0 | 5 |
| Percent of Individuals with Anomalies | >5 5-2 <2 | 0 | 5 |
| | | **Total** | **34 (Poor)** |

prescense of a sunfish species, the dramatic increase in the percentage of omnivores in 2003, and the substantial decline in the percentage of tolerant species in 2003. Overall, the TVA sample did collect more species of fish including one darter, the logperch. Bluntnose minnow and spotfin shiner were also collected during this survey. These two species most likely were transients from the reservoir. 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.

Benthic macroinvertebrates collected in our sample comprised 16 families representing 17 identified genera (Table 10). The most abundant group in our collection was the caddisflies comprising 36.8% of the total sample. Overall, a total of 21 taxa were identified from the sample of which 7 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" (2.2).

**Table 10. Taxa list and associated biotic statistics for benthic macroinvertebrates collected from Spring Creek.**

| ORDER | FAMILY | SPECIES | NUMBER | PERCENT |
|---|---|---|---|---|
| **AMPHIPODA** | | | | 1.1 |
| | Gammaridae | *Gammarus* | 4 | |
| **ANNELIDA** | | | | 2.7 |
| | Oligochaeta | | 10 | |
| **COLEOPTERA** | | | | 1.6 |
| | Elmidae | *Macronychus glabratus* | 2 | |
| | | *Microcylloepus pusillus pusillus* | 1 | |
| | | *Stenelmis* adult and larvae | 3 | |
| **DIPTERA** | | | | 9.3 |
| | Chironomidae | | 27 | |
| | Simuliidae | | 6 | |
| | Tipulidae | *Antocha* | 1 | |
| **EPHEMEROPTERA** | | | | 14.7 |
| | Baetidae | *Baetis* | 9 | |
| | Heptageniidae | *Stenacron interpunctatum* | 30 | |
| | | *Stenonema* | 1 | |
| | Isonychiidae | *Isonychia* | 14 | |
| **GASTROPODA** | | | | 13.9 |
| | Pleuroceridae | *Elimia* | 51 | |
| **HEMIPTERA** | | | | 1.9 |
| | Gerridae | *Gerris remigis* 2♂ and 4♀ | 6 | |
| | | *Gerris* nymph | 1 | |
| **ODONATA** | | | | 7.4 |
| | Calopterygidae | *Calopteryx* | 21 | |
| | Coenagrionidae | *Argia* | 5 | |
| | Corduliidae | *Somatochlora* (early instar) | 1 | |
| **ISOPODA** | | | | 10.6 |
| | Asellidae | *Lirceus* | 39 | |
| **TRICHOPTERA** | | | | 36.8 |
| | Hydropsychidae | *Cheumatopsyche* | 56 | |
| | | **Total** | **367** | |

**TAXA RICHNESS = 21**
**EPT TAXA RICHNESS = 7**
**BIOCLASSIFICATION = 2.2 (FAIR)**

## *Discussion*

Spring Creek is in a situation similar to that of Turkey Creek although it does not course directly through Morristown. However, this stream still receives more than its share of undesirable run-off within the watershed. Like Turkey Creek, there is little opportunity for this stream to ever fully recover given amount of development within the watershed.  Involvement by landowners and a development of a sense of ownership in this creek 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.

# Cedar Creek

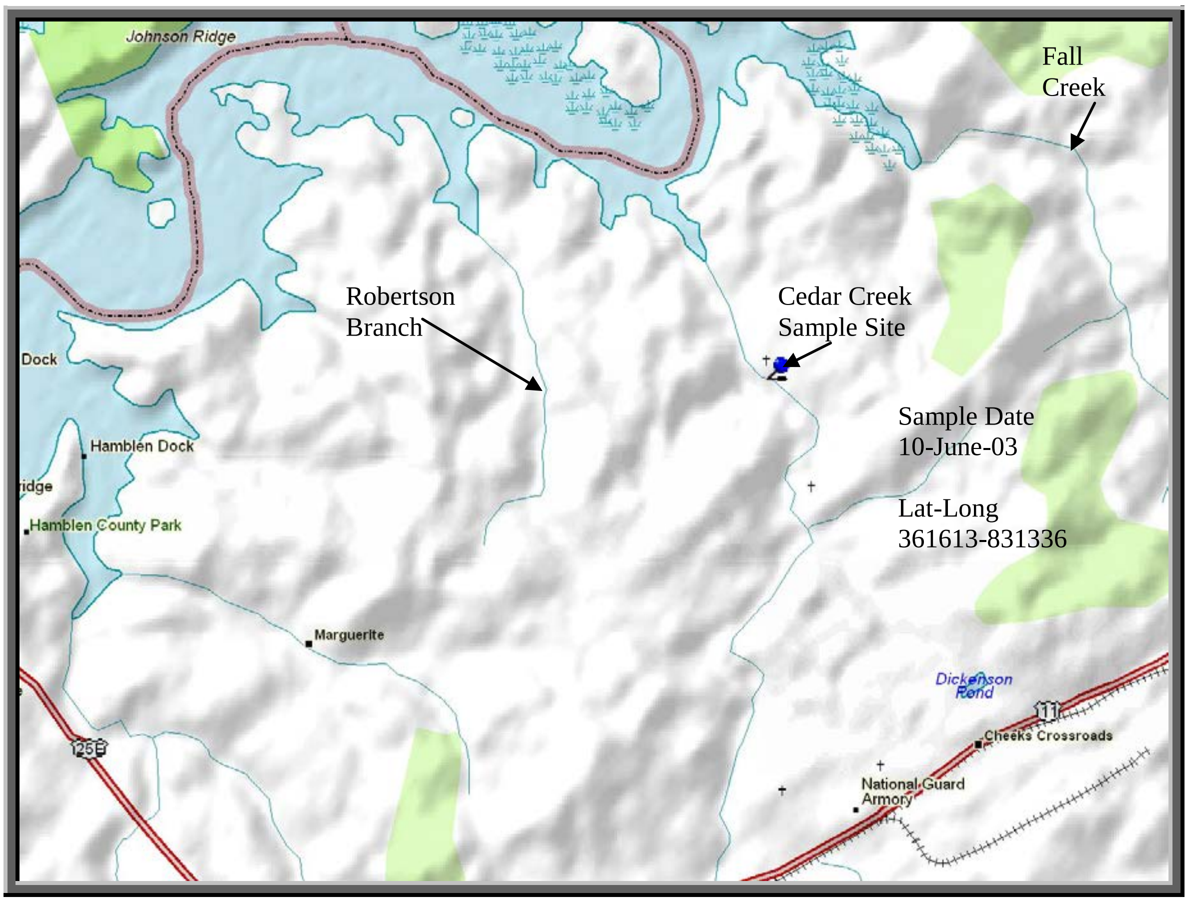
## *Introduction*

Cedar Creek is located in the northeastern portion of Hamblen County. It flows in a northerly direction and is a direct tributary to Cherokee Reservoir. 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 and macroinvertebrate list for TADS and determining the relative health of the stream based on the aquatic communities present.

## *Study Area and Methods*

Our survey of Cedar Creek (Figure 17) was conducted at the bridge crossing on Stuffel Road. 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 17. Sample site location for the survey conducted in Cedar Creek during 2003.**



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 cobble were the predominant substrate components comprising about 45% of the substrate in the pools and about 55% in the riffles. Riffles dominated the habitat features contributing about 75% 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. Many of the trees had been removed from the bank, which contributed to bank instability in portions of our survey area (see photo). A good portion of the stream courses through pastures and cattle have access to the stream at many locations along its length. Water turbidity was above normal and was most likely associated with sediment input from these areas. Basic water quality measurements at this site revealed the following information, temperature 18 C, conductivity 400 µs/cm, and a pH of 7.0. Enrichment of the stream from agricultural practices was evident and is partially responsible for the elevated conductivity. Likewise, the underlying geology of the area (karst) probably has a significant influence on the fertility of this system.


A view of Cedar Creek within our sample area. Note bank instability on right descending bank.

## *Results*

We collected a total of 250 fish comprising five species at our sample site (Table 11). There were no game species collected at this site. The two most dominant species collected in our sample were the largescale stoneroller and orangeside dace. Together, these two species comprised 69% of the total number of fish in our sample. There were no darter species collected at this site although it was expected that snubnose darter would occur. The only sucker species collected at this site was the white sucker. The IBI metrics that had the most negative influence on the overall score were the lack of species diversity, the absence of darter, sunfish and intolerant species, the low percentage of trophic specialists, the absence of piscivores. Realistically 10 to 12 species of fish could be expected from a stream of this size.

**Table 11. Fish species occurrence for Cedar Creek 2003.**

| Site Code | Species | Tads Code | Total Number |
|---|---|---|---|
| 420030901 | Banded Sculpin | 322 | 6 |
| 420030901 | Orangeside Dace | 184 | 115 |
| 420030901 | Creek Chub | 188 | 5 |
| 420030901 | Largescale Stoneroller | 45 | 57 |
| 420030901 | White Sucker | 195 | 6 |
| | | **Total** | **250** |

Overall, the IBI analysis indicated Cedar Creek was in poor condition based on the score of 30 (Table 12). The stream was depauperate of species, which ultimately had the greatest bearing on the score. The potential for the influence of groundwater to regulate the species diversity is possible since most spring systems are generally low in species richness. This combined with the input of sediment and the low quality of habitat are the most likely reasons for the condition of this stream.

**Table 12. Cedar Creek Index of Biotic Integrity analysis.**

| **Metric Description** | **Scoring Criteria**<br>**1 3 5** | **Observed** | **Score** |
|---|---|---|---|
| Number of Native Species | <8 8-15 >15 | 5 | 1 |
| Number of Darter Species | <2 2 >2 | 0 | 1 |
| Number of Sunfish Species less *Micropterus* | <2 2 >2 | 0 | 1 |
| Number of Sucker Species | <2 2 >2 | 1 | 1 |
| Number of Intolerant Species | <2 2 >2 | 0 | 1 |
| Percent of Individuals as Tolerant | >59 59-30 <30 | 24.8 | 5 |
| Percent of Individuals as Omnivores | >45 45-22 <22 | 25.2 | 3 |
| Percent of Individuals as Specialists | <16 16-32 >32 | 0 | 1 |
| Percent of Individuals as Piscivores | <1 1-5 >5 | 0 | 1 |
| Catch Rate | <16 16-32 >32 | 57.7 | 5 |
| Percent of Individuals as Hybrids | >1 1-TR 0 | 0 | 5 |
| Percent of Individuals with Anomalies | >5 5-2 <2 | 0.4 | 5 |
| | | **Total** | **30 (Poor)** |

Benthic macroinvertebrates collected in our sample comprised 22 families representing 22 identified genera (Table 13). The most abundant group in our collection was the caddisflies comprising 43.5% of the total sample. Overall, a total of 26 taxa were identified from the sample of which 10 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 to good" (3.5).

**Table 13. Taxa list and associated biotic statistics for benthic macroinvertebrates collected from Cedar Creek.**

| ORDER | FAMILY | SPECIES | NUMBER | PERCENT |
|---|---|---|---|---|
| **ANELLIDA** | | | | 0.5 |
| | Hirudinea | | 1 | |
| | Oligochaeta | | 2 | |
| **COLEOPTERA** | | | | 2.9 |
| | Elmidae | *Optioservus ovalis* larvae and adult | 3 | |
| | | *Stenelmis* larvae and adults | 14 | |
| **DIPTERA** | | | | 3.1 |
| | Chironomidae | | 9 | |
| | Dixidae | *Dixa* | 4 | |
| | Simuliidae | | 2 | |
| | Tabanidae | *Tabanus* | 2 | |
| | Tipulidae | *Hexatoma* | 1 | |
| **EPHEMEROPTERA** | | | | 14.6 |
| | Baetidae | *Baetis* | 7 | |
| | | *Centroptilum* (most probable determination) | 1 | |
| | Ephemerellidae | *Serratella deficiens* | 18 | |
| | Heptageniidae | *Stenacron interpunctatum* | 22 | |
| | Isonychidae | *Isonychia* | 37 | |
| **GASTROPODA** | | | | 11.7 |
| | Pleuroceridae | *Elimia* | 68 | |
| **HETEROPTERA** | | | | 0.3 |
| | Veliidae | *Rhagovelia obesa* 1♂, 1♀ | 2 | |
| **ISOPODA** | | | | 7.4 |
| | Asellidae | *Caecidotea* | 1 | |
| | | *Lirceus* | 42 | |
| **ODONATA** | | | | 2.7 |
| | Aeshnidae | *Boyeria vinosa* | 5 | |
| | Calopterygidae | *Calopteryx sp.* | 11 | |
| **PELECYPODA** | | | | 1.7 |
| | Corbiculidae | *Corbicula fluminea* | 10 | |
| **PLECOPTERA** | | | | 11.5 |
| | Perlidae | *Perlesta* | 67 | |
| **TRICHOPTERA** | | | | 43.5 |
| | Hydropsychidae | *Cheumatopsyche* | 57 | |
| | | *Hydropsyche betteni/depravata* | 173 | |
| | Philopotamidae | *Chimara* | 10 | |
| | Uenoidae | *Neophylax etnieri* | 13 | |
| | | **Total** | **582** | |

**TAXA RICHNESS = 26**
**EPT TAXA RICHNESS = 10**
**BIOCLASSIFICATION = 3.5 (FAIR/GOOD)**

## *Discussion*

The size and condition of Cedar Creek results in little or no recreational opportunity. The importance of this stream is the contribution it makes to the overall system and the influence it has on the water quality in Cherokee Reservoir.

### *Management Recommendations*

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

# Fall Creek

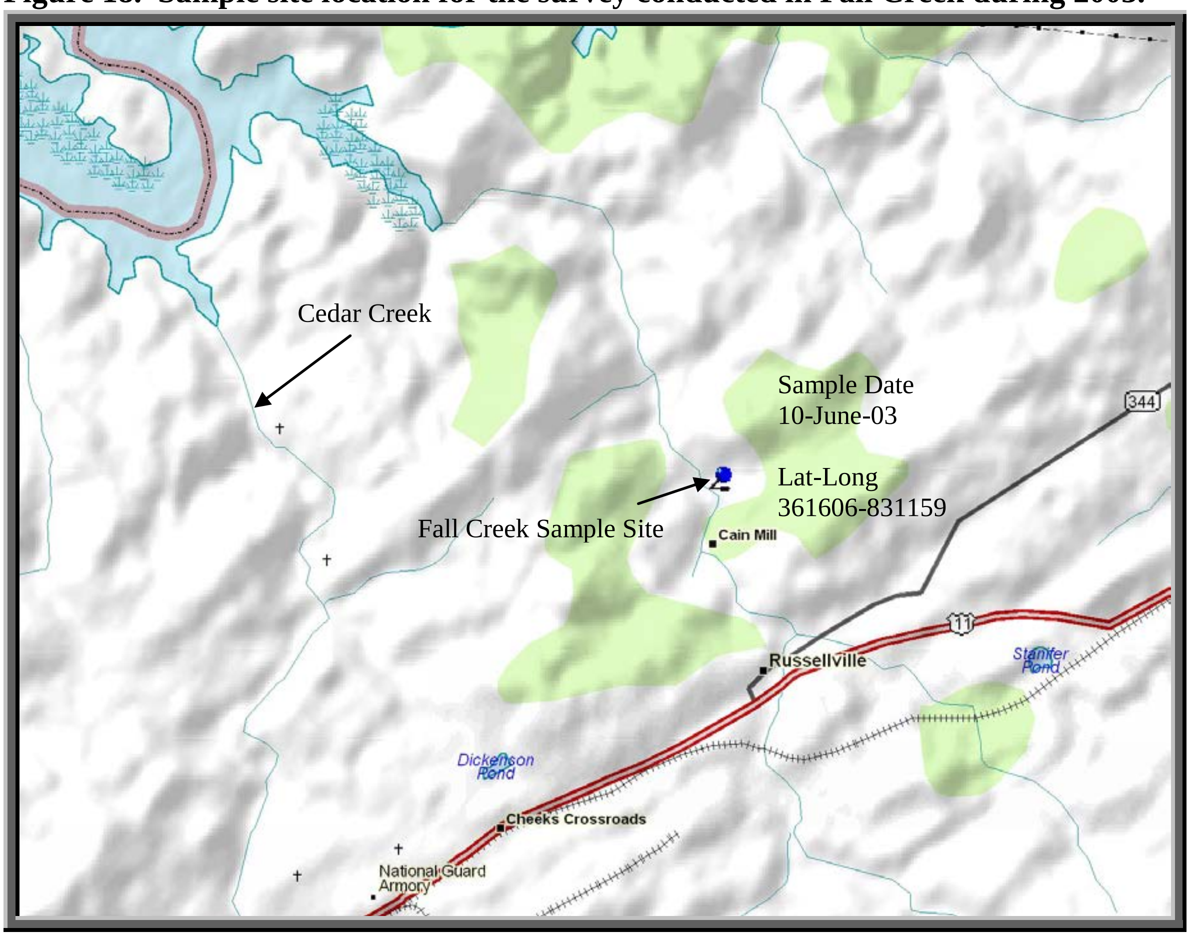
## *Introduction*

Fall Creek is located in the northeastern portion of Hamblen County and flows parallel to Cedar Creek entering the Holston River (Cherokee Reservoir) at river mile 80.7. The Agency did conduct two qualitative samples in this stream in June 1993 (Bivens and Williams 1994). We re-sampled the lower 1993 survey site in an attempt to document any changes in the fish/benthic community and to apply the IBI method to this portion of the stream.

## *Study Area and Methods*

The survey of Fall Creek (Figure 18) was conducted along Fall Creek Road upstream of the junction with Three Springs Road. The stream at this location was of low grade and had substrate primarily composed of boulder and bedrock. Silt was prevalent in the pool areas of the stream, which was also observed during the 1993 survey. This stream receives considerable influence from groundwater that was noted within our survey reach.

**Figure 18. Sample site location for the survey conducted in Fall Creek during 2003.**



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). Riffles dominated the habitat features contributing about 60% of the available habitat. Instream cover was lacking and was probably one of the major factors contributing to low number of fish species observed in our survey. Both stream margins were well vegetated and bank stability within our survey reach was excellent. Agricultural and residential run-off into the stream was apparent as water turbidity was high. Much of the stream courses through pasture fields and cattle have access to the stream at many locations along its length. Basic water quality measurements at this site revealed the following information, temperature 19 C, conductivity 410 µs/cm, and a pH of 7.0. In a stream this size, expected fish species richness should be around 12 to 15 however, this stream is limited by the quality of habitat and the external influences within the watershed (non-point source). Like Cedar Creek, limestone geology and groundwater influence has a strong influence on the productivity of this stream.


A view of Fall Creek within our sample area (note water turbidity).

## *Results*

One hundred thirty fish comprising six species were collected at our sample site (Table 14). Bluegill was the only game species collected from the survey site. The two most dominant species collected in our sample were the banded sculpin and orangeside dace. These two species comprised 68% of the total number of fish in our sample. As with other streams sampled in this area no darter species were collected. The only sucker species collected at this site was the pollution tolerant white sucker.

**Table 14. Fish species occurrence for Fall Creek 2003.**

| Site Code | Species | Tads Code | Total Number |
|---|---|---|---|
| 420031001 | Banded Sculpin | 322 | 45 |
| 420031001 | Orangeside Dace | 184 | 44 |
| 420031001 | Bluegill | 351 | 1 |
| 420031001 | Creek Chub | 188 | 22 |
| 420031001 | Largescale Stoneroller | 45 | 12 |
| 420031001 | White Sucker | 195 | 6 |
| | | **Total** | **130** |

Overall, the IBI analysis indicated Fall Creek was in poor condition based on the score of 32 (Table 15). The IBI metrics that had the most negative influence on the overall score were the lack of species diversity, the absence of darters, sunfish and intolerant species, the low percentage of trophic specialists, and the absence of piscivores. The input of non-point source sedimentation combined with poor habitat quality are the main factors regulating this stream.

**Table 15. Fall Creek Index of Biotic Integrity analysis.**

| **Metric Description** | **Scoring Criteria**<br>**1 3 5** | **Observed** | **Score** |
|---|---|---|---|
| Number of Native Species | <8 8-15 >15 | 6 | 1 |
| Number of Darter Species | <2 2 >2 | 0 | 1 |
| Number of Sunfish Species less *Micropterus* | <2 2 >2 | 1 | 1 |
| Number of Sucker Species | 0 1 >1 | 1 | 3 |
| Number of Intolerant Species | <2 2 >2 | 0 | 1 |
| Percent of Individuals as Tolerant | >59 59-30 <30 | 21.5 | 5 |
| Percent of Individuals as Omnivores | >45 45-22 <22 | 13.8 | 5 |
| Percent of Individuals as Specialists | <16 16-32 >32 | 0 | 1 |
| Percent of Individuals as Piscivores | <1 1-5 >5 | 0 | 1 |
| Catch Rate | <16 16-32 >32 | 22.0 | 3 |
| Percent of Individuals as Hybrids | >1 1-TR 0 | 0 | 5 |
| Percent of Individuals with Anomalies | >5 5-2 <2 | 0.7 | 5 |
| | | **Total** | **32 (Poor)** |

Benthic macroinvertebrates collected in our sample comprised 18 families representing 18 identified genera (Table 16). The most abundant group in our collection was the caddisflies comprising 44.8% of the total sample. Overall, a total of 24 taxa were identified from the sample of which 8 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” (2.3).

**Table 16. Taxa list and associated biotic statistics for benthic macroinvertebrates collected from Fall Creek.**

| ORDER | FAMILY | SPECIES | NUMBER | PERCENT |
|---|---|---|---|---|
| **AMPHIPODA** | | | | 2.6 |
| | Gammaridae | *Gammarus minus* | 10 | |
| **ANNELIDA** | | | | 0.3 |
| | Oligochaeta | | 1 | |
| **COLEOPTERA** | | | | 1.6 |
| | Elmidae | *Dubiraphia* adult | 1 | |
| | | *Stenelmis* adults | 5 | |
| **DIPTERA** | | | | 10.4 |
| | Chironomidae | | 30 | |
| | Simuliidae | | 8 | |
| | Tipulidae | *Tipula* | 2 | |
| **EPHEMEROPTERA** | | | | 16.9 |
| | Baetidae | *Baetis* | 3 | |
| | Heptageniidae | *Stenacron interpunctatum* | 28 | |
| | | *Stenonema* early instars | 6 | |
| | | *Stenonema mediopunctatum* | 2 | |
| | Isonychiidae | *Isonychia* | 26 | |
| **GASTROPODA** | | | | 5.2 |
| | Pleuroceridae | | 20 | |
| **HETEROPTERA** | | | | 2.6 |
| | Gerridae | *Gerris remigis* 1♂ and 1♀ | 2 | |
| | Veliidae | *Rhagovelia obesa* 4♂, 3♀, 1 nymph | 8 | |
| **ISOPODA** | | | | 7.6 |
| | Asellidae | *Lirceus* | 29 | |
| **MEGALOPTERA** | | | | 0.5 |
| | Sialidae | *Sialis* | 2 | |
| **ODONATA** | | | | 7.6 |
| | Aeshnidae | *Boyeria vinosa* | 2 | |
| | Calopterygidae | *Calopteryx* | 19 | |
| | Gomphidae | *Gomphus* Genus A *rogersi* | 2 | |
| | | *Gomphus lividus* | 6 | |
| **TRICHOPTERA** | | | | 44.8 |
| | Hydropsychidae | *Cheumatopsyche* | 51 | |
| | | *Hydropsyche betteni/depravata* | 98 | |
| | | *Hydropsyche rotosa* | 8 | |
| | Uenoidae | *Neophylax etnieri* | 15 | |
| | | **Total** | **384** | |

**TAXA RICHNESS = 24**
**EPT TAXA RICHNESS = 8**
**BIOCLASSIFICATION = 2.3 (FAIR)**

## *Discussion*

Fall Creek provides no valuable recreational angling opportunities. The availability of preferred habit for sunfish species typically inhabiting streams of this size is virtually non-existent. This combined with the sedimentation almost eliminates any establishment of a sport fishery or the recolanization of the stream by intolerant species. Bivens and Williams (1994) came to similar conclusions for this stream stating non-point source pollution and poor habitat were the limiting factors in this stream.

## *Management Recommendations*

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

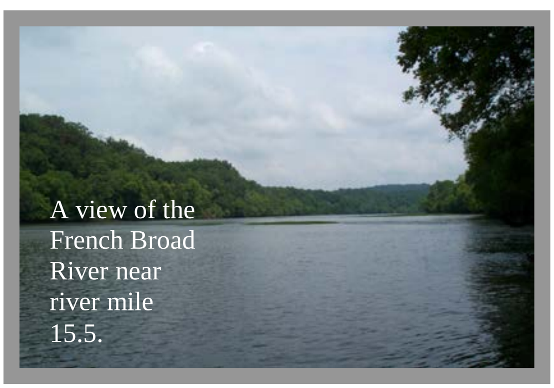
# French Broad River

## *Introduction*

Like many of the larger rivers in east Tennessee, the French Broad has a long history of pollution related problems stemming from 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 mainstem 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. We were primarily interested in reassessing the sport fish populations and developing a sampling strategy that was more effective than our previous efforts in 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 19).


A view of the French Broad River near river mile 15.5.

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 (TVA) 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.

Between June 19 and 20, 2003 we sampled nine sites below Douglas Dam (Figure 20). Because of our relative ineffectiveness in this reach of the river (due to high discharge) during 2000, we decided to re-establish new sampling sites and sample them under minimum flow conditions. We felt this would give us the best opportunity to representatively assess the sport fish population in the river. Because of an extremely wet summer we were never able to encounter suitable conditions for sampling the French Broad above Douglas Reservoir.

**Figure 19. Longitudinal profile of elevation along the French Broad River from Knoxville to the TN/NC state line.**

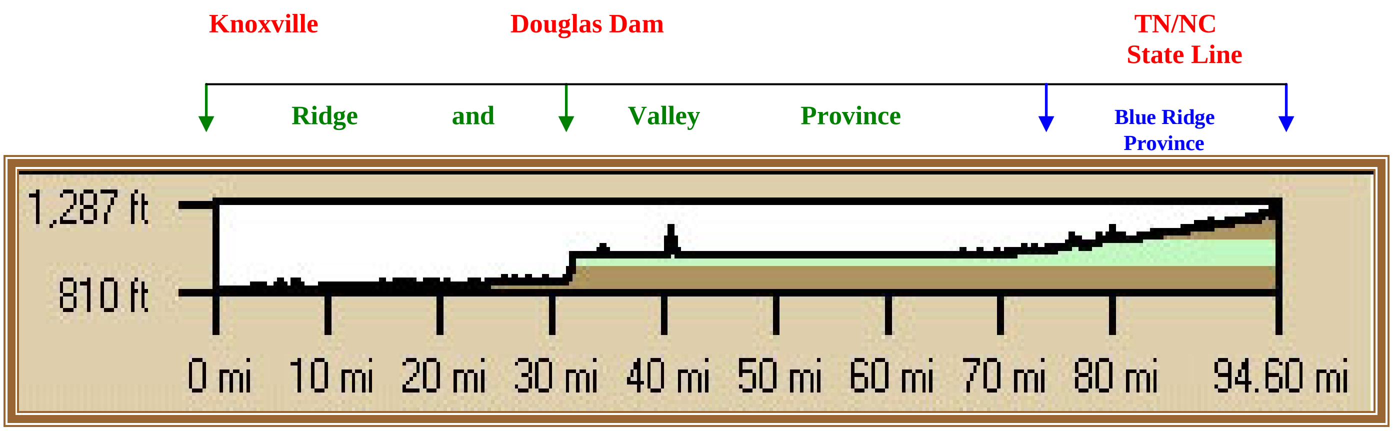
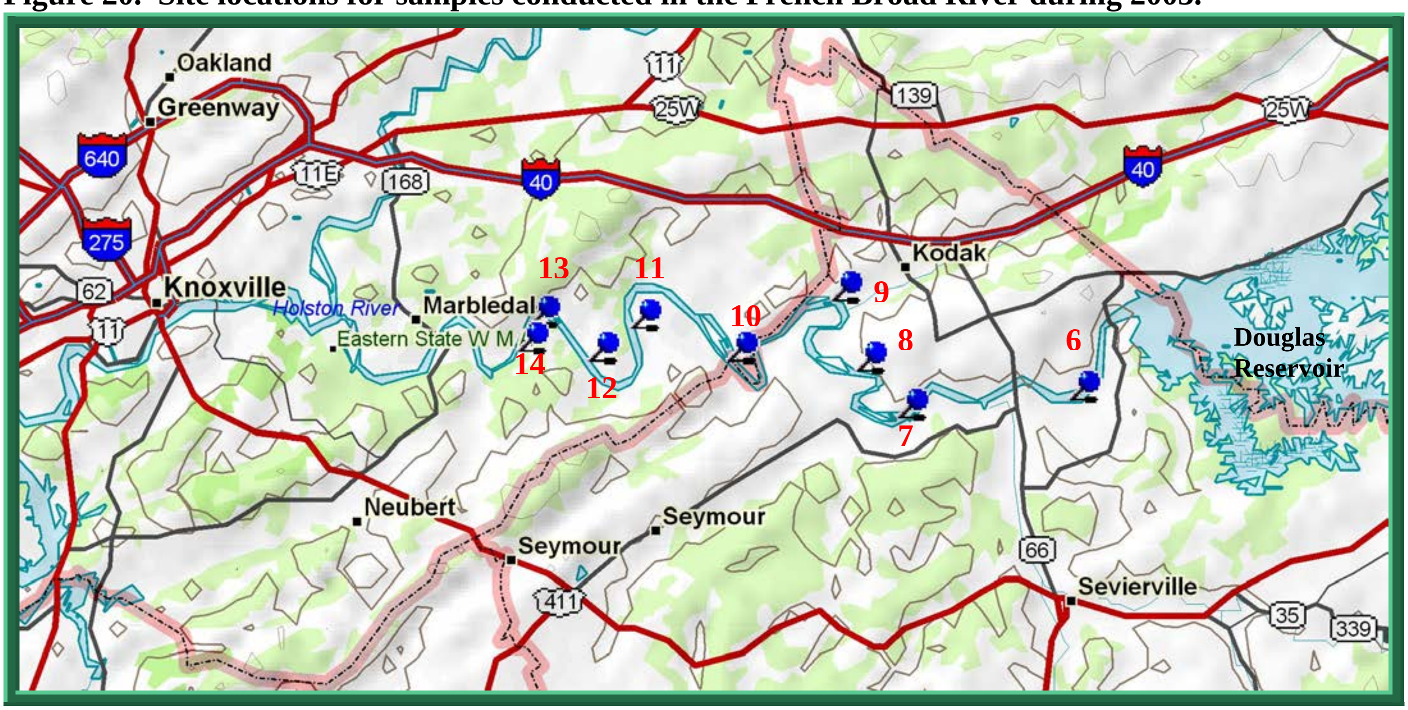



**Figure 20. Site locations for samples conducted in the French Broad River during 2003.**



In the reach of river we sampled, the native riparian vegetation was for the most part intact. There seemed to be more agricultural development in the tailwater reach of the river due to more suitable topography. Submerged woody debris was scarce in most of our sample areas. The river substrate was predominately bedrock and boulder with some cobble in the riffle areas. Measured channel widths ranged from 91.5 to 304 m, while site lengths fell between 277 and 1246 m (Table 17). Water temperatures ranged from 22 to 23 C. Conductivity varied from 110 to 120 µs/cm (Table 17).

**Table 17. Physiochemical and site location data for samples conducted on the French Broad River during 2003.**

| Site Code | Site | County | Quad | River Mile | Latitude | Longitude | Mean Width (m) | Length (m) | Temp. | Cond. | Secchi (m) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 420031406 | 6 | Sevier | Douglas Dam 156NE | 29.5 | 355557 | 833347 | 146.6 | 1246 | 20 | 110 | - |
| 420031407 | 7 | Sevier | Douglas Dam 156NE | 25.1 | 355536 | 833749 | 221 | 551 | - | - | - |
| 420031408 | 8 | Sevier | Boyds Creek 156NW | 22.4 | 355632 | 833849 | 91.5 | 845 | 22 | 110 | 1.3 |
| 420031409 | 9 | Sevier | Boyds Creek 156NW | 19.5 | 355752 | 833922 | 167 | 1027 | - | - | - |
| 420031410 | 10 | Knox | Boyds Creek 156NW | 15.5 | 355642 | 834150 | 304 | 818 | 21 | 110 | 2.0+ |
| 420031411 | 11 | Knox | Boyds Creek 156NW | 11.8 | 355719 | 834405 | 175 | 759 | 22 | 115 | - |
| 420031412 | 12 | Knox | Boyds Creek 156NW | 9.3 | 355641 | 834504 | 183 | 927 | - | - | - |
| 420031413 | 13 | Knox | Shooks Gap 147NE | 7.3 | 355723 | 834629 | 127 | 277 | - | - | - |
| 420031414 | 14 | Knox | Shooks Gap 147NE | 6.6 | 355653 | 834641 | 123 | 921 | 23 | 120 | - |

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 522 to 2216 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*

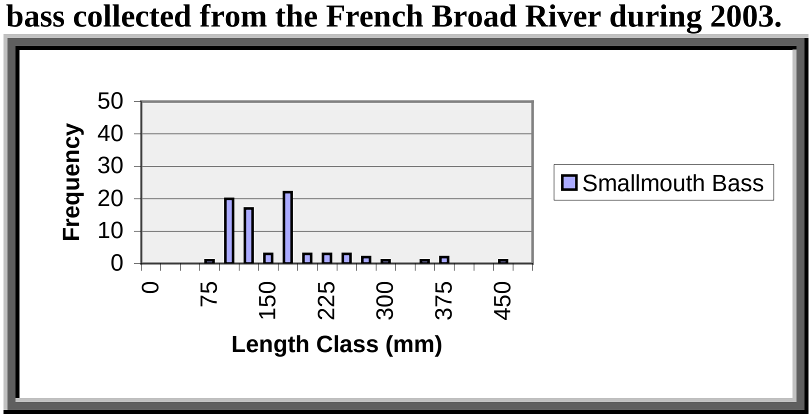
CPUE estimates for smallmouth bass averaged 2.8/hour (SD 1.8), while the mean spotted bass estimate was 1.4/hour (SD 0.7). Largemouth and rock bass estimates were 0.2/hour (SD 0.4) and 3.4/hour (SD 2.9), respectively (Table 18).

**Table 18. Catch per unit effort and length categorization indices of target species collected at nine sites on the French Broad River during 2003.**

| Site Code | Smallmouth Bass CPUE | Spotted Bass CPUE | Largemouth Bass CPUE | Rock Bass CPUE |
|---|---|---|---|---|
| 420031406 | 1.0 | 1.3 | 1.3 | 0.6 |
| 420031407 | 6.6 | - | - | 10.0 |
| 420031408 | 3.6 | 1.6 | - | 3.6 |
| 420031409 | 3 | 2.3 | 0.3 | 6.3 |
| 420031410 | 4.6 | 1.3 | - | 3.6 |
| 420031411 | 2.3 | 1.0 | - | 2.0 |
| 420031412 | 2.3 | 0.3 | - | 1.3 |
| 420031413 | 1 | 1.3 | - | 1.3 |
| 420031414 | 1.6 | 2.3 | - | 2.3 |
| **MEAN** | 2.8 | 1.4 | 0.2 | 3.4 |
| **STD. DEV.** | 1.8 | 0.7 | 0.4 | 2.9 |
| | Length-Categorization Analysis | Length-Categorization Analysis | Length-Categorization Analysis | Length-Categorization Analysis |
| | PSD = 18.7 | PSD = 31.2 | PSD = 80 | PSD = 52.2 |
| | RSD-Preferred = 12.5 | RSD-Preferred = 9.3 | RSD-Preferred = 0 | RSD-Preferred = 8.6 |
| | RSD-Memorable = 3.1 | RSD-Memorable = 0 | RSD-Memorable = 0 | RSD-Memorable = 0 |
| | RSD-Trophy = 0 | RSD-Trophy = 0 | RSD-Trophy = 0 | RSD-Trophy = 0 |

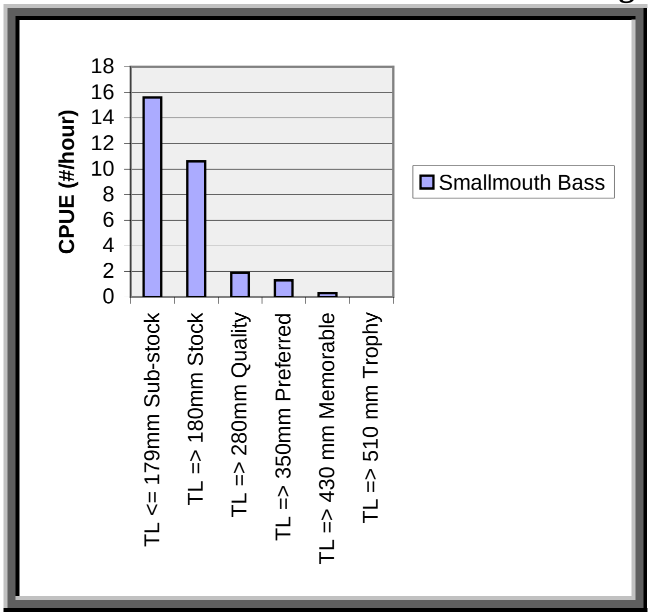
The length distribution of smallmouth bass was predominantly comprised of individuals in the 100 to 200 mm size range. Three bass 375 mm and over (15 in) were collected (Figure 21.)

**Figure 21. Length frequency distribution for smallmouth bass collected from the French Broad River during 2003.**



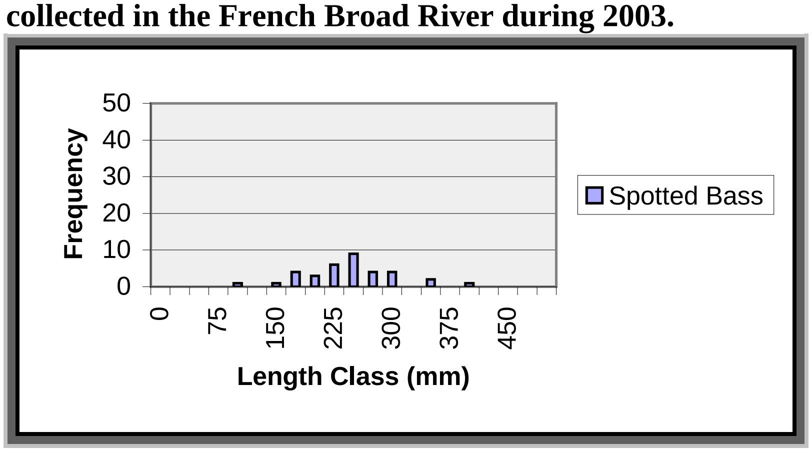

Length categorization analysis indicated the Relative Stock Density (RSD) for preferred smallmouth bass (TL $\geq$ 350 mm) was 12.5. RSD for memorable (TL $\geq$ 430 mm) and trophy (TL $\geq$ 510 mm) size bass were 3.1 and 0, respectively. The PSD of smallmouth bass (ratio of quality size bass to stock size bass) was 18.7. The catch of sub-stock smallmouth was relatively high, comprising 52% of our catch (Figure 22).

**Figure 22. Relative stock density (RSD) catch per unit effort by category for smallmouth bass collected from the French Broad River during 2003.**



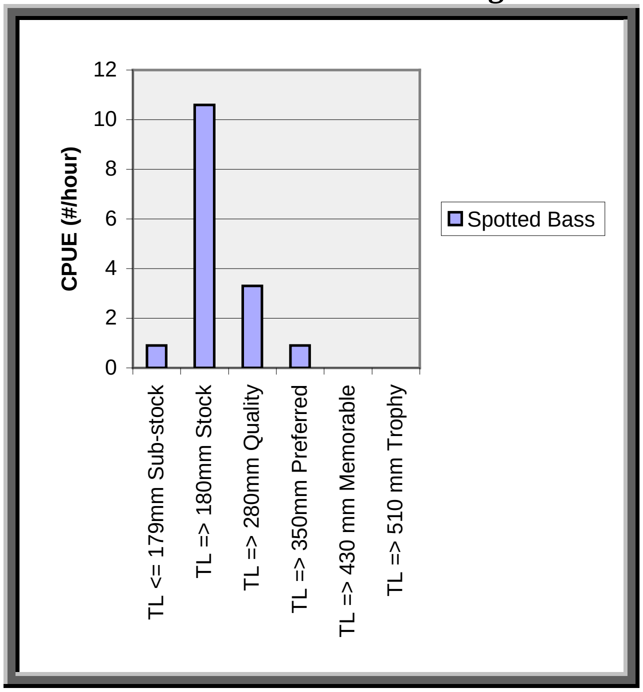

The majority of spotted bass collected from the French Broad River during 2003 fell within the 175 mm to 275 mm length range (Figure 23). Our data indicated that fish less than 100 mm, were for the most part, not effectively sampled. Length categorization analysis indicated the RSD for preferred spotted bass (TL $\geq$ 350 mm) was 9.3.

**Figure 23. Length frequency distribution for spotted bass collected in the French Broad River during 2003.**



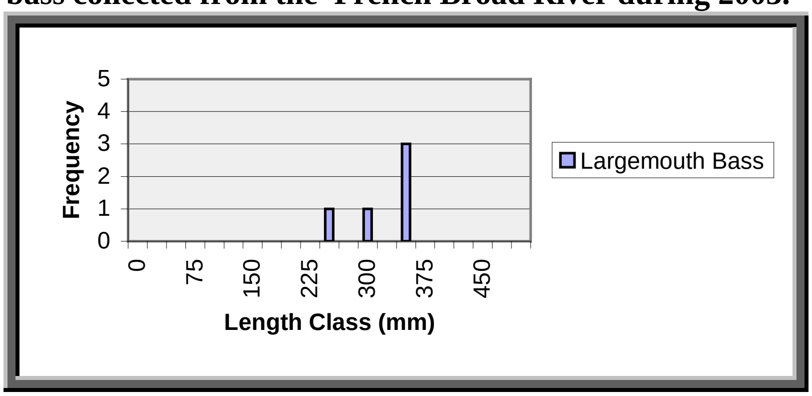

RSD for memorable (TL $\geq$ 430 mm) and trophy (TL $\geq$ 510 mm) size bass was 0. The PSD of spotted bass was 31.2. Catch per unit effort estimates by RSD category revealed favorable numbers of spotted bass above the RSD-S category. Twenty-seven percent of the spotted bass collected in our sample were quality size or larger (Figure 24). We also observed good recruitment into the stock category indicating a good 2001year class.

**Figure 24. Relative stock density (RSD) catch per unit effort by category for spotted bass collected from the French Broad River during 2003.**



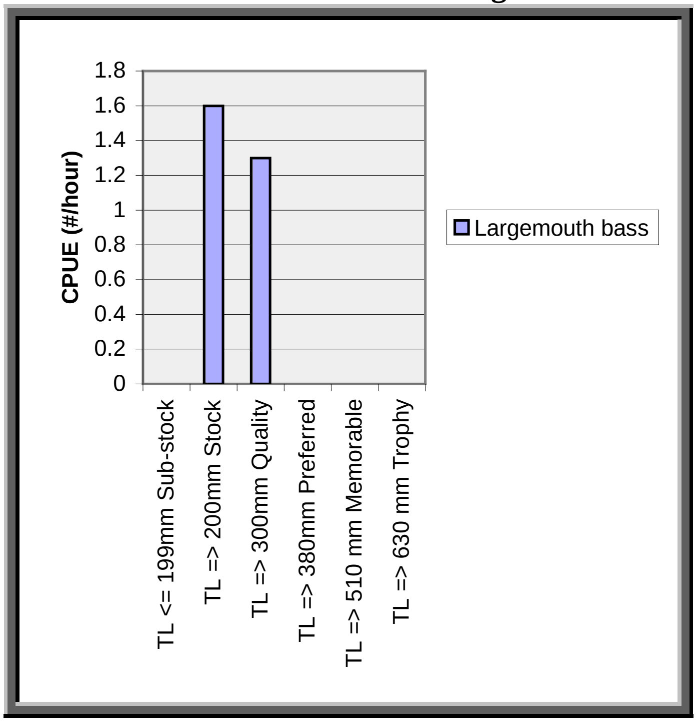

Very few largemouth bass were collected in the French Broad during 2003. Of those collected, all fell within the 250 mm to 375 mm length range (Figure 25).

**Figure 25. Length frequency distribution for largemouth bass collected from the French Broad River during 2003.**



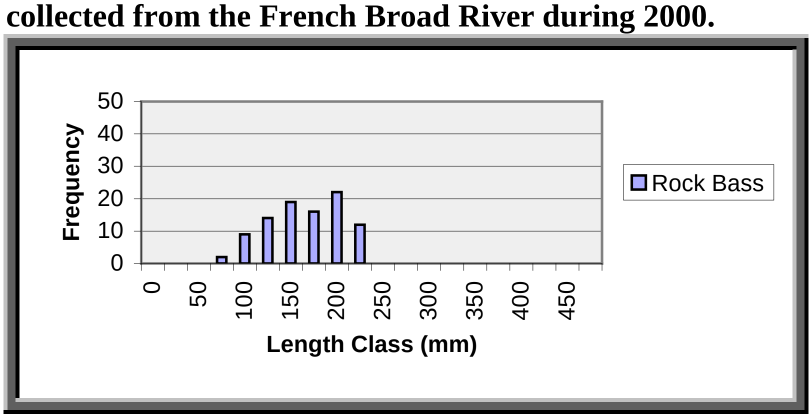

Length categorization analysis indicated the RSD for preferred largemouth bass (TL ≥ 380 mm) was 0. RSD for memorable (TL ≥ 510 mm) and trophy (TL ≥ 630 mm) size largemouth bass was 0 as well. The PSD of largemouth bass was 80. The highest catch rate by RSD category was for stock size largemouth bass. Although numbers were extremely low, recruitment into the quality category was good (Figure 26).

**Figure 26. Relative stock density (RSD) catch per unit effort by category for largemouth bass collected from the French Broad River during 2003.**



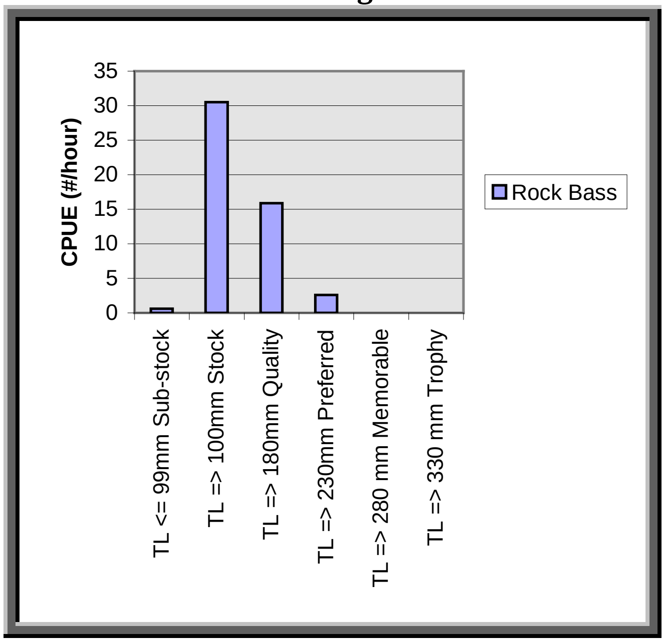

A total of 94 rock bass were collected in our survey of the French Broad River. The size distribution was fairly typical of other riverine populations with the bulk of the fish falling in the 75 to 175mm length range (Figure 27).

**Figure 27. Length frequency distribution for rock bass collected from the French Broad River during 2000.**




PSD for this population was 52.2. The value for preferred rock bass (TL $\geq$ 230 mm) was 8.6. The value for memorable (TL $\geq$ 280 mm) and trophy (TL $\geq$ 330 mm) rock bass was 0. Sub-stock catch of rock bass was low (Figure 28), however, this does not necessarily indicate the lack of reproduction. The vulnerability of these smaller fish to the electrofishing gear is considerably lower than larger size groups. Recruitment of rock bass into the stock and quality size was good with about 51% of the catch comprised of quality (TL > 180 mm) size fish or larger (Figure 28).

**Figure 28. Relative stock density (RSD) catch per unit effort by category for rock bass collected in the French Broad River during 2003.**




### *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 have encountered that would be sought by anglers is the channel catfish . 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. Approximately 7,500 lake sturgeon were stocked into the tailwater in 2003 in hopes of


Lake Sturgeon collected at Cain Island, French Broad River

recovering this species to some of its former range. We collected one sturgeon at Cain Island near river mile 19.5. This specimen was 567 mm (22") in length and had a left pectoral clip. Mussel reintroductions by the TWRA, U.S. Geological Survey, and Tennessee Tech University are 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.). 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), Highway 66 Bridge (TWRA) near Sevierville, and at Seven Islands. There are a few primitive ramps and pull-outs along some of the roads paralleling the river above and below Douglas Reservoir. We are scheduled to return to the French Broad in 2006 to sample sites above and below Douglas Reservoir. Because we were unable to sample the upper reaches of the French Broad during 2003, we are planning to survey this portion of the river during 2004.

### *Management Recommendations*

1. Develop a fishery management plan for the river.

2. Initiate an angler use survey on the river.

3. Continue the cooperative annual sturgeon monitoring.

4. Develop additional public access in that portion above Douglas Reservoir.

# Pigeon River

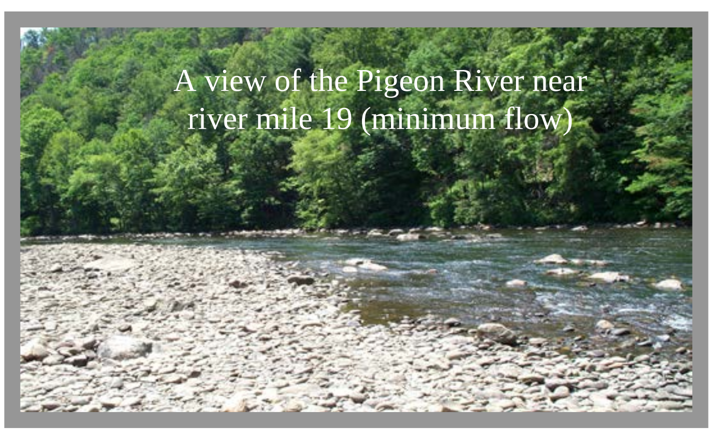
## *Introduction*

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 2002 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 2003 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.

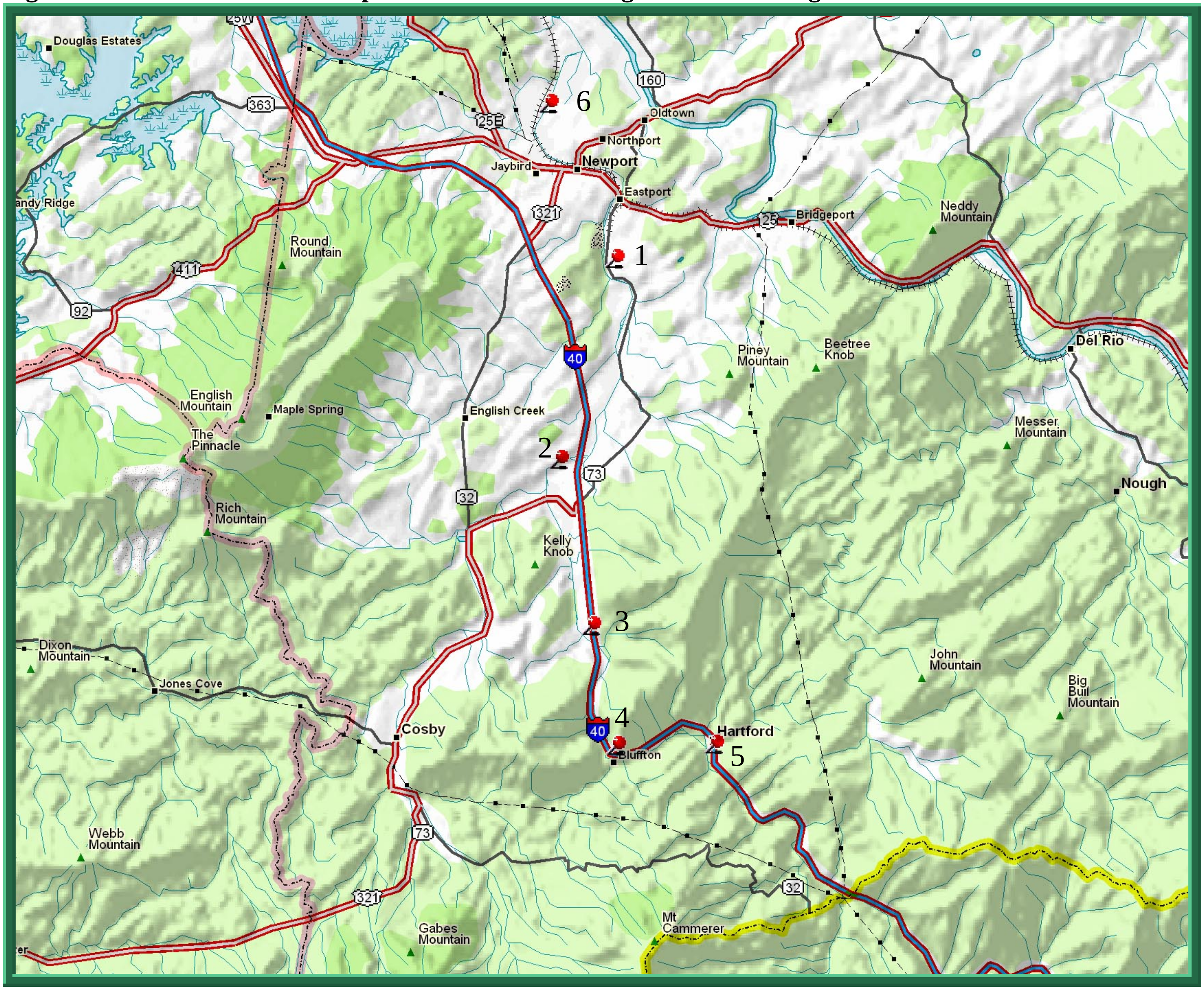
## *Study Area and Methods*

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 June 17 and July 17, 2002, we conducted six fish surveys at six sites between Newport and the



A view of the Pigeon River near river mile 19 (minimum flow) community of Hartford (Figure 29). 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 29. Site locations for samples conducted in the Pigeon River during 2003.**




35.3 to 64.3 m, while site lengths fell between 80 and 869 m (Table 19). Water temperatures ranged from 17.5 to 22 C and conductivity varied from 48 to 120 μs/cm (Table 19).

**Table 19. Physiochemical and site location data for samples conducted in the Pigeon River during 2003.**

| Site Code | Site | County | Quad | River Mile | Latitude | Longitude | Mean Width (m) | Length (m) | Temp. | Cond. | Secchi (m) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 420031301 | 1 | Cocke | Newport 173NW | 8.1 | 355633N | 831043W | 53.6 | 392 | - | - | - |
| 420031302 | 2 | Cocke | Newport 173NW | 13 | 355322N | 831147W | 64.3 | 869 | 22 | 80 | 2+ |
| 420031303 | 3 | Cocke | Hartford 173SW | 16.6 | 355039N | 831104W | - | 414 | - | - | - |
| 420031304 | 4 | Cocke | Hartford 173SW | 19 | 354847N | 831041W | 35.3 | 80 | 17.5 | 48 | 2+ |
| 420031305 | 5 | Cocke | Hartford 173SW | 20.5 | 354849N | 830945W | 47.3 | 839 | 17.5 | 48 | 2+ |
| 420031306 | 6 | Cocke | Newport 173NW | 4.0 | 355857N | 831156W | 54 | 193 | 21 | 120 | 2+ |

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 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 1006 to 4800 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*

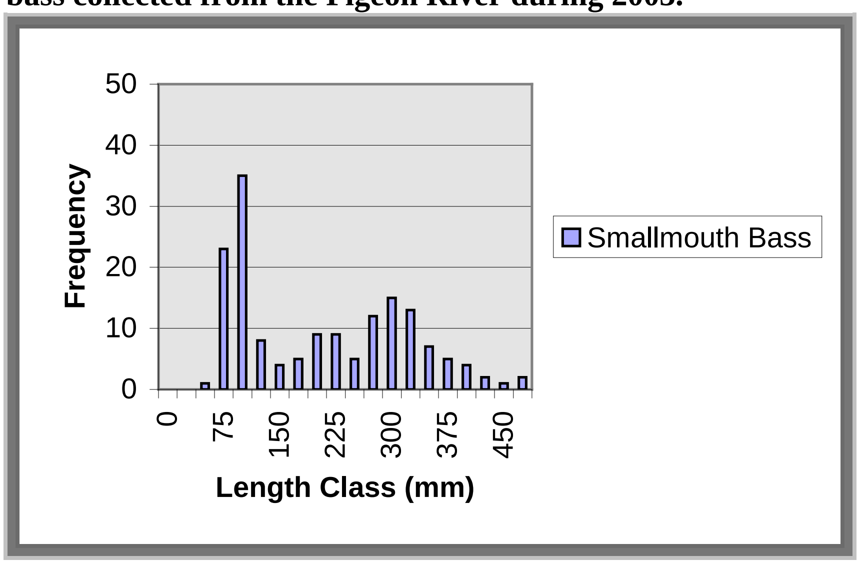
During our surveys, smallmouth bass and rock bass were collected from all sample sites. The collection of spotted bass and largemouth bass was more sporadic. Smallmouth bass was the most abundant black bass species at any of the survey sites. CPUE estimates for this species averaged 29.5/hour (SD 23.4), while the spotted bass and largemouth bass estimates were 0.9/hour (SD 1.2) and 1.7/hour (SD 1.9), respectively (Table 20). There was a general trend of increasing catch rate for smallmouth bass in the intermediate reaches (sites 3-5) of the river (Table 20). This was also the case in the 2002 sample where catch rates were highest in these areas. Rock bass CPUE was highest in sites 2,3, and 5, averaging 20.7/hour (SD 14.6). The highest catch rate for this species was recorded at site 3 (36.7/hour), which also had the highest value in 2002. Overall, we observed increases in the catch rate of smallmouth bass and rockbass between the 2002 sample and the 2003 sample. Spotted bass number remained relatively constant and largemouth bass numbers declined (82%) sharply between the two samples. 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 20. Catch per unit effort and length categorization indices of target species collected at six sites on the Pigeon River during 2003.**

| Site Code | Smallmouth Bass CPUE | Spotted Bass CPUE | Largemouth Bass CPUE | Rock Bass CPUE |
|---|---|---|---|---|
| 420031301 | 8.6 | 1.7 | 4.2 | 10.3 |
| 420031302 | 10.5 | - | 3.8 | 34.3 |
| 420031303 | 51.7 | 3.0 | - | 36.7 |
| 420031304 | 42.9 | - | - | 10.7 |
| 420031305 | 56.8 | 1.0 | - | 30.0 |
| 420031306 | 6.5 | - | 2.2 | 2.2 |
| MEAN | 29.5 | 0.9 | 1.7 | 20.7 |
| STD. DEV. | 23.4 | 1.2 | 1.9 | 14.6 |
| | **Smallmouth Bass Length-Categorization Analysis** | **Spotted Bass Length-Categorization Analysis** | **Largemouth Bass Length-Categorization Analysis** | **Rock Bass Length-Categorization Analysis** |
| | PSD = 67.0 | PSD = 33.3 | PSD = 66.6 | PSD = 48.2 |
| | RSD-Preferred = 23.8 | RSD-Preferred = 16.6 | RSD-Preferred = 50.0 | RSD-Preferred = 0.8 |
| | RSD-Memorable = 5.6 | RSD-Memorable = 0 | RSD-Memorable = 0 | RSD-Memorable = 0 |
| | RSD-Trophy = 0 | RSD-Trophy = 0 | RSD-Trophy = 0 | RSD-Trophy = 0 |

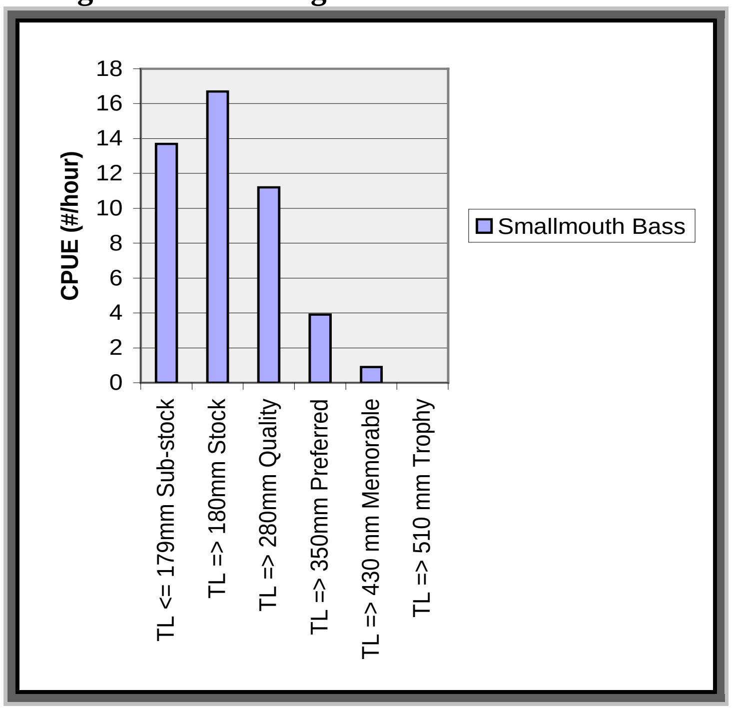
The majority of the smallmouth bass collected from the Pigeon River during 2003 fell within the 75 to 350 mm length range (Figure 30). Our data indicated that bass less than 75 mm were not completely vulnerable to the sampling gear. Length categorization analysis indicated the Relative Stock Density (RSD) for preferred smallmouth

**Figure 30. Length frequency distribution for smallmouth bass collected from the Pigeon River during 2003.**



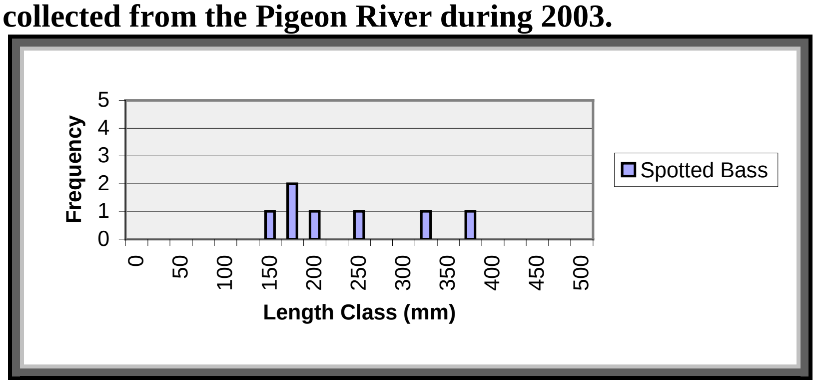

bass (TL $\geq$ 350 mm) was 23.8, which was up 22.6% (18.4) from the previous year. RSD for memorable (TL $\geq$ 430 mm) and trophy (TL $\geq$ 510 mm) size bass were 5.6 and 0, respectively. The PSD of smallmouth bass (ratio of quality size bass to stock size bass) was 67.0. Catch per unit effort estimates by RSD category indicated smallmouth bass had the highest catch rates of any of the black bass species collected for the category RSD-Q and above (Figure 31). Both sub-stock and stock categories were strong during 2003 indicating good reproduction and recruitment from previous year classes. We also observed increases in the preferred and memorable size categories.

**Figure 31. Relative stock density (RSD) catch per unit effort for smallmouth bass collected from the Pigeon River during 2003.**



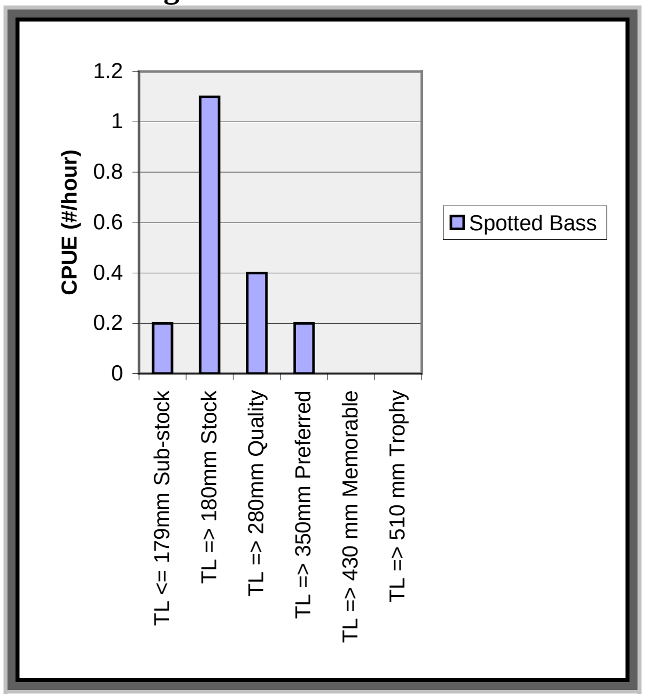

There were very few spotted bass collected from the Pigeon River in 2003. A total of seven (8 in 2002) spotted bass were collected in all of our samples. Because there were so few spotted bass collected in the sample, no one size range dominated the length distribution although the majority of the bass collected were between 150 mm and 250 mm (Figure 32).

**Figure 32. Length frequency distribution for spotted bass collected from the Pigeon River during 2003.**



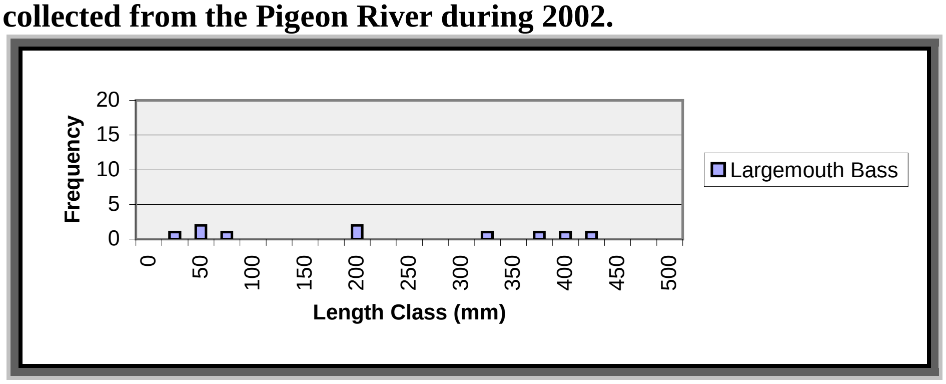
Length categorization analysis indicated the RSD for preferred spotted bass (TL ≥ 350 mm) was 16.6. RSD for memorable (TL ≥ 430 mm) and trophy (TL ≥ 510 mm) size bass was 0. The PSD of spotted bass was 33.3. Catch per unit effort estimates by RSD category revealed very few spotted bass above the RSD-Q category, indicating a relative lack of larger fish available to anglers (Figure 33). Although the catch of larger spotted bass was low, it was higher than the sample collected in 2002. Although the reproduction of this species is low in the Pigeon River, they do persist, and depending on the strength of any given year class can contribute to the fishery.

**Figure 33. Relative stock density (RSD) catch per unit effort for spotted bass collected from the Pigeon River during 2003.**



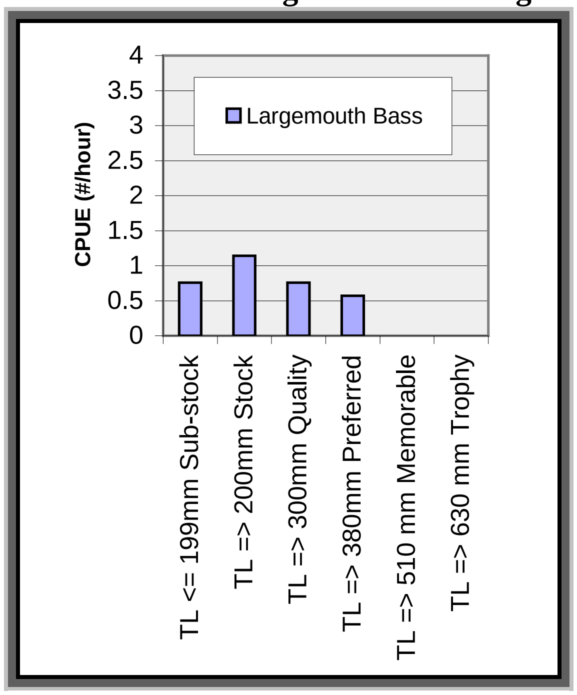

Most of the largemouth bass collected during 2003 fell within the 325 to 375 mm length range (Figure 34). Length categorization analysis indicated the RSD for preferred

**Figure 34. Length frequency distribution for largemouth bass collected from the Pigeon River during 2002.**



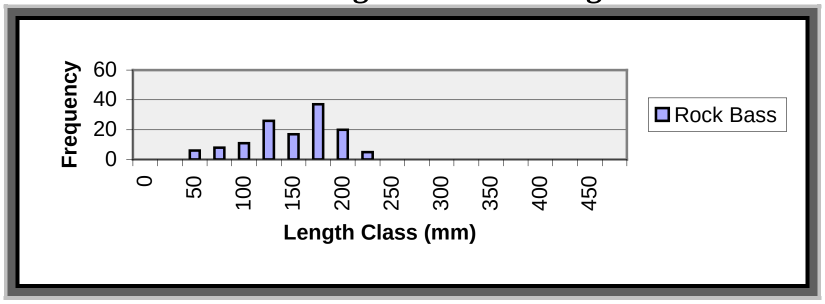
largemouth bass (TL ≥ 380 mm) was 50.0. RSD for memorable (TL ≥ 510 mm) and trophy (TL ≥ 630 mm) size largemouth bass was 0. The PSD of largemouth bass was 66.6. A very few largemouth bass above the RSD-Q category were collected in 2003, this was a substantial decrease from the 2002 survey (Figure 35). Recruitment into the sub-stock category in 2003 was less than half of the value in 2002. All RSD categories for largemouth bass in the Pigeon River declined with the exception of the memorable and trophy categories, which remained at 0.

**Figure 35. Relative stock density (RSD) catch per unit effort by category for largemouth bass collected from the Pigeon River during 2003.**



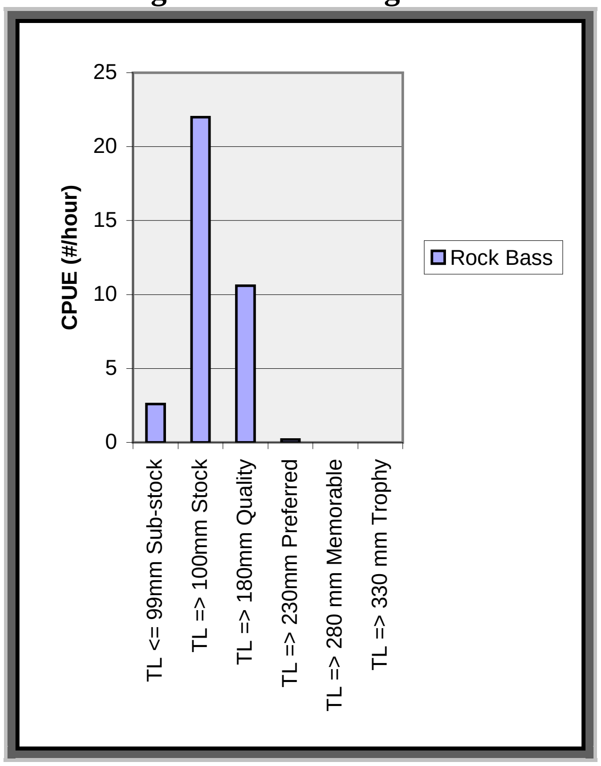

Individuals in the 100 to 200 mm range represented the majority of rock bass in our sample (Figure 36). Length categorization analysis indicated the RSD for preferred rock bass (TL ≥ 230 mm) was 0.8, which was a 62% decline from the previous year sample. RSD for memorable (TL ≥ 280 mm) and trophy (TL ≥ 330 mm) size rock bass was 0.

**Figure 36. Length frequency distribution for rock bass collected from the Pigeon River during 2003.**



The PSD of rock bass was 48.2. Catch per unit effort estimates by RSD category indicated the majority of our catch was stock size fish (Figure 37) with about 30.5% of the catch representing quality size and larger 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.

**Figure 37. Relative stock density (RSD) catch per unit effort by category for rock bass collected from the Pigeon River during 2003.**




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 2003 data. No age and growth data was collected from this population in 2003; 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 (42) during our cooperative IBI surveys at Tannery Island and Denton. None of the fish collected in the 2003 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 21.

**Table 21. Distribution of fish species collected in the Pigeon River during 2002.**  **= presence**

| Pigeon River Mile | 8.1 | 16.6 |
|---|---|---|
| **Site Code** | 4<br>2<br>0<br>0<br>3<br>1<br>3<br>0<br>1 | 4<br>2<br>0<br>0<br>3<br>1<br>3<br>0<br>3 |
| **Species** | | |
| **Catostomidae** | | |
| Black Buffalo |  | |
| Black Redhorse |  |  |
| Golden Redhorse |  | |
| Northern Hogsucker |  |  |
| River Carpsucker |  | |
| River Redhorse |  |  |
| Silver Redhorse |  |  |
| Smallmouth Buffalo |  |  |
| **Centrarchidae** | | |
| Bluegill |  |  |
| Green Sunfish |  | |
| Largemouth Bass |  | |
| Redbreast Sunfish |  |  |
| Rock Bass |  |  |
| Smallmouth Bass |  |  |
| Spotted Bass |  |  |
| White Crappie |  |  |
| | | |

**Table 21. Continued.**

| Pigeon River Mile | 8.1 | 16.6 |
|---|---|---|
| **Site Code** | 420031301 | 420031303 |
| **Species** | | |
| **Clupeidae** | | |
| Gizzard Shad |  |  |
| **Cottidae** | | |
| Banded Sculpin |  |  |
| **Cyprinidae** | | |
| Bigeye Chub |  |  |
| Carp |  |  |
| Central Stoneroller | |  |
| Longnose Dace | |  |
| Fathead Minnow |  | |
| Rosyface Shiner |  |  |
| Silver Shiner |  |  |
| Spotfin Shiner |  |  |
| Largescale Stoneroller |  | |
| Telescope Shiner |  |  |
| Whitetail Shiner |  |  |
| **Ictaluridae** | | |
| Channel Catfish |  |  |
| Flathead Catfish |  | |
| Yellow Bullhead | |  |
| **Percidae** | | |
| Banded Darter |  | |
| Gilt Darter |  | |
| Greenside Darter |  |  |
| Logperch |  |  |

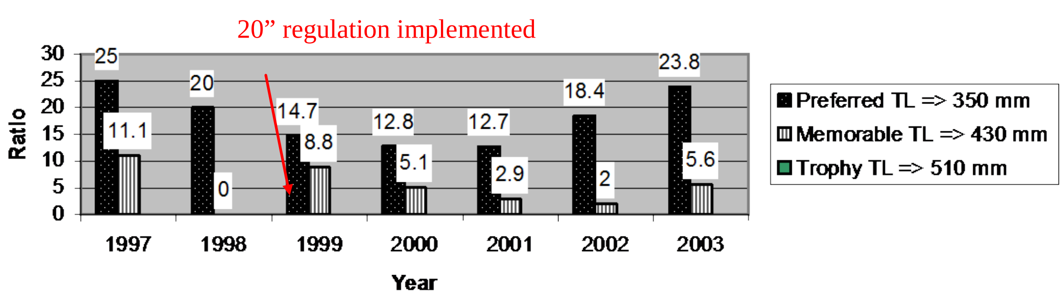
**Table 21. Continued.**

| Pigeon River Mile | 8.1 | 16.6 |
|---|---|---|
| **Site Code** | 420031301 | 420031303 |
| **Species** | | |
| Redline Darter |  |  |
| Sauger | |  |
| Snubnose Darter |  |  |
| Walleye |  |  |
| **Petromyzontidae** | | |
| Chestnut 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 18% between 1997-2003) 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 38).

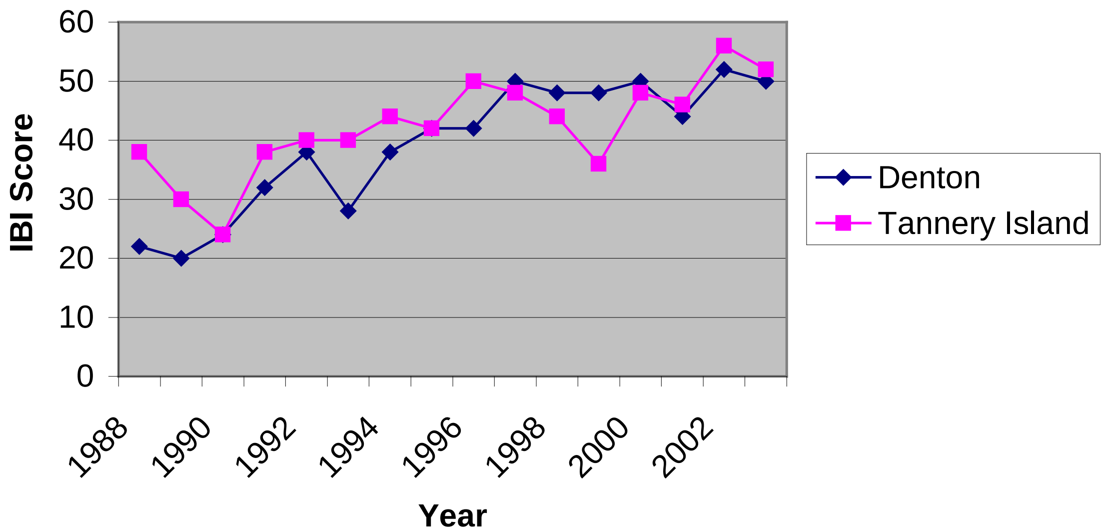
**Figure 38. Trends in the ratio of preferred, memorable, and trophy smallmouth bass collected from the Pigeon River 1997-2003.**



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 16 years the IBI scores (TWRA and TVA data) at two stations on the Pigeon River have been steadily increasing (Figure 39). 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 39. Trends in Index of Biotic Integrity (IBI) at two stations on the Pigeon River (1988-2003).**




Based on our findings from our 2002 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. Beginning in 2004, 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 these sport fish species.

### *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.

# Holley Creek

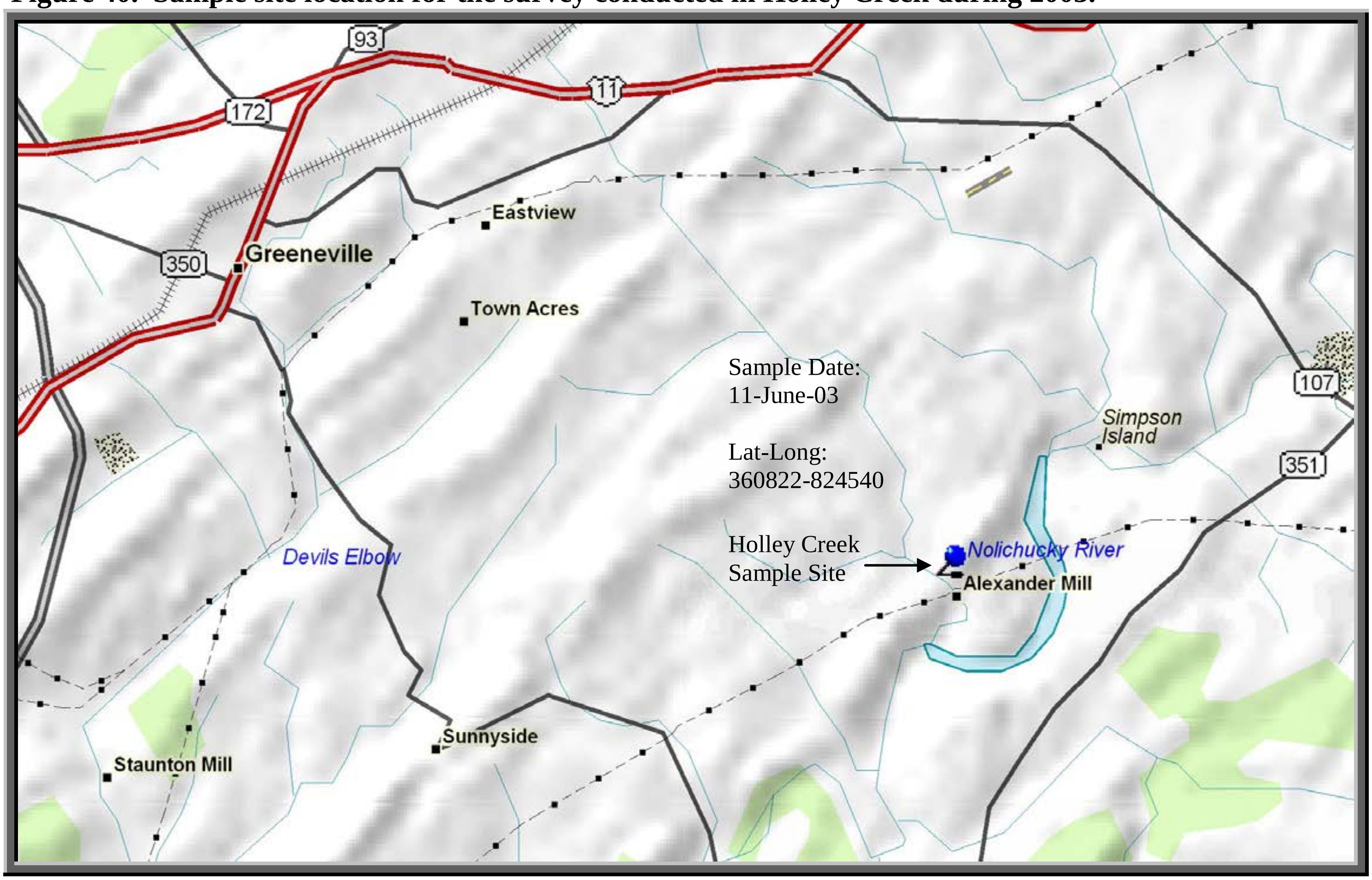
### *Introduction*

Holley Creek originates just northeast of Greeneville and flow in a southeasterly direction before joining the Nolichucky River downstream of Simpson Island. Because of its close proximity to the city of Greeneville and Tusculum we were interested in evaluating the relative health of the stream. This stream also courses through dairy operations near Tusculum. There is a milldam located on the stream that serves as a barrier to upstream movement of fishes.

### *Study Area and Methods*

Our survey of Holley Creek (Figure 40) was conducted at the bridge crossing on Buckingham Road just upstream of Alexander Mill. The stream at this location was fairly wide below the bridge crossing but narrowed considerably upstream. Residential development in the area had increased as a new subdivision development was underway.

**Figure 40. Sample site location for the survey conducted in Holley Creek during 2003.**



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 silt were the dominant substrate components comprising about 60% of the substrate in the pools and about 45% in the riffles. Riffles dominated the habitat features contributing about 60% of the available habitat. The riparian zones both upstream and downstream of the bridge crossing had been altered. In both cases residential lawns had been established in portions of our sample area. However, there was no indication that this had caused erosion problems as the stream margins in these areas were stable. Basic water quality measurements at this site revealed the following information, temperature 20.5 C, conductivity 395 µs/cm, and a pH of 6.8. Enrichment of this stream was evident by the elevated conductivity and the amount of periphyton present in the stream.



## *Results*

We collected a total of 776 fish comprising 10 species at our sample site (Table 22). 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 bluntnose minnow and orangeside dace. Together, these two species comprised 56% of the total number of fish in our sample. Snubnose darter was the only darter species collected at this site. 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 darter species, the lack of intolerant species, the high percentage of omnivores, the low percentage of trophic specialists, and the high occurrence of anomalies on the fish.

**Table 22. Fish species occurrence for Holley Creek 2003.**

| Site Code | Species | Tads Code | Total Number |
|---|---|---|---|
| 420031101 | Banded Sculpin | 322 | 29 |
| 420031101 | Orangeside Dace | 184 | 163 |
| 420031101 | Bluegill | 351 | 3 |
| 420031101 | Bluntnose Minnow | 176 | 267 |
| 420031101 | Creek Chub | 188 | 4 |
| 420031101 | Fathead Minnow | 177 | 3 |
| 420031101 | Redbreast Sunfish | 346 | 4 |
| 420031101 | Largescale Stoneroller | 45 | 156 |
| 420031101 | Snubnose Darter | 435 | 104 |
| 420031101 | White Sucker | 195 | 43 |
| | | **Total** | **776** |

Overall, the IBI analysis indicated Holley Creek was in poor condition (IBI score = 30) (Table 23). As mentioned above there were several metrics that lowered the overall score. The influences from the agricultural practices upstream were prevalent in this stream as indicated by the amount of siltation and visible indicators of enrichment.

**Table 23. Holley Creek Index of Biotic Integrity analysis.**

| **Metric Description** | **Scoring Criteria**<br>**1 3 5** | **Observed** | **Score** |
|---|---|---|---|
| Number of Native Species | <7 7-13 >13 | 8 | 3 |
| Number of Darter Species | <2 2-3 >3 | 1 | 1 |
| Number of Sunfish Species less *Micropterus* | 0 1 >1 | 1 | 3 |
| Number of Sucker Species | 0 1 >1 | 1 | 3 |
| Number of Intolerant Species | <2 2 >2 | 0 | 1 |
| Percent of Individuals as Tolerant | >38 38-20 <20 | 6.1 | 5 |
| Percent of Individuals as Omnivores | >47 47-24 <24 | 60.5 | 1 |
| Percent of Individuals as Specialists | <14 14-27 >27 | 13.5 | 1 |
| 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 | 124.2 | 5 |
| Percent of Individuals as Hybrids | >1 Tr-1 0 | 0 | 5 |
| Percent of Individuals with Anomalies | >5 5-2 <2 | 17.5 | 1 |
| | | **Total** | **30 (Poor)** |

Benthic macroinvertebrates collected in our sample comprised 25 families representing 27 identified genera (Table 24). The most abundant group in our collection was the caddisflies comprising 42.1% of the total sample. Overall, a total of 34 taxa were identified from the sample of which 7 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" (2.4).

**Table 24. Taxa list and associated biotic statistics for benthic macroinvertebrates collected from Holley Creek.**

| ORDER | FAMILY | SPECIES | NUMBER | PERCENT |
|---|---|---|---|---|
| **ANNELIDA** | | | | 0.6 |
| | Hirudinea | | 1 | |
| | Oligochaeta | | 2 | |
| **COLEOPTERA** | | | | 10.1 |
| | Elmidae | *Dubiraphia* adults | 5 | |
| | | *Optioservus* larva | 1 | |
| | | *Stenelmis* larvae and adults | 43 | |
| | Eubridae | *Ectopria* adult | 1 | |
| **DIPTERA** | | | | 24.2 |
| | Chironomidae | | 100 | |
| | Simuliidae | | 11 | |
| | Tipulidae | *Antocha* | 1 | |
| | | *Hexatoma* | 8 | |
| **EPHEMEROPTERA** | | | | 7.3 |
| | Baetidae | *Baetis* | 17 | |
| | Ephemeridae | *Ephemera* | 1 | |
| | Heptageniidae | *Stenacron interpunctatum* | 17 | |
| | Isonychiidae | *Isonychia* | 1 | |
| **GASTROPODA** | | | | 3.6 |
| | Ancylidae | *Ferrissia* | 8 | |
| | Physidae | | 3 | |
| | Pleuroceridae | *Pleurocera* sp. | 7 | |
| **HETEROPTERA** | | | | 1 |
| | Corixidae | | 1 | |
| | Gerridae | *Gerris remigis* 1 ♂, 1 ♀ | 2 | |
| | Veliidae | *Rhagovelia obesa* 1 ♂, 1 ♀ | 2 | |
| **ISOPODA** | | | | 3.8 |
| | Asellidae | *Asellus* | 2 | |
| | | *Lirceus* | 17 | |
| **LEPIDOPTERA** | | | | 0.4 |
| | Pyralidae | | 2 | |
| **MEGALOPTERA** | | | | 2.2 |
| | Corydalidae | *Corydalus cornutus* | 1 | |
| | | *Nigronia serricornis* | 3 | |
| | Sialidae | *Sialis* | 7 | |
| **ODONATA** | | | | 2.2 |
| | Aeshnidae | *Boyeria vinosa* | 3 | |
| | Calopterygidae | *Calopteryx* | 5 | |
| | Coenagrionidae | *Argia* | 3 | |
| **PELECYPODA** | | | | 2.4 |
| | Corbiculidae | *Corbicula fluminea* | 10 | |
| | Sphaeriidae | *Sphaerium* | 2 | |
| **TRICHOPTERA** | | | | 42.1 |
| | Hydropsychidae | *Cheumatopsyche* | 78 | |
| | | *Hydropsyche betteni/depravata* | 124 | |
| | | *Hydropsyche rotosa* | 7 | |
| | | *Nigronia serricornis* | 3 | |
| | | **Total** | **496** | |

**TAXA RICHNESS = 34**
**EPT TAXA RICHNESS = 7**
**BIOCLASSIFICATION = 2.4 (FAIR)**

### *Discussion*

Holley 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.  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.

### *Management Recommendations*

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

# College Creek

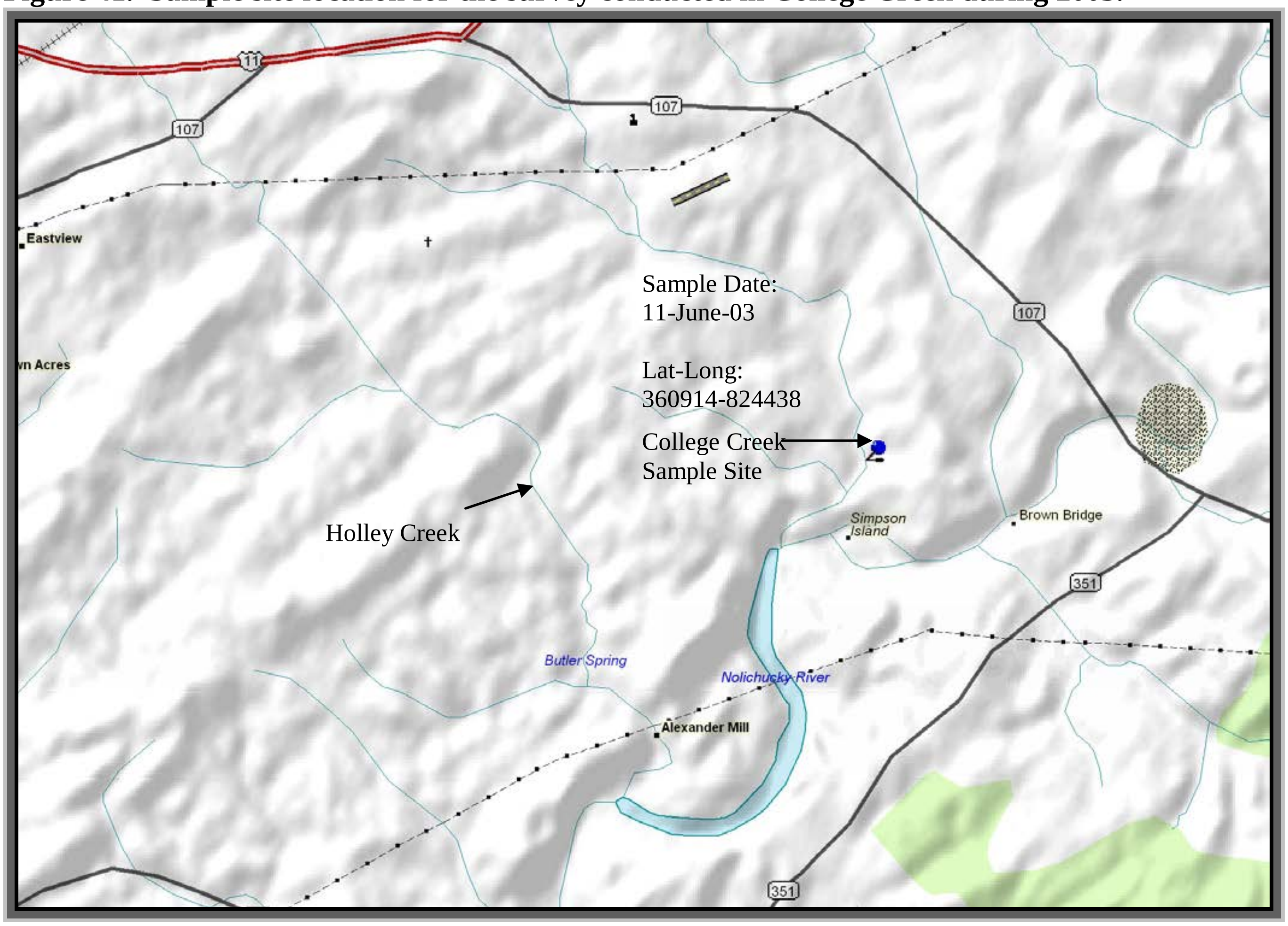
### Introduction

College Creek originates just northeast of Greeneville and flows in a southeasterly direction before joining the Nolichucky River downstream of Simpson Island. Because of its close proximity to the city of Greeneville and Tusculum we were interested in evaluating the relative health of the stream. This stream also courses through dairy operations near Tusculum.

### Study Area and Methods

Our survey of College Creek was conducted at the bridge crossing on Browns Bridge Road (Figure 41). At this location the stream channel was fairly narrow and was bounded by pasture fields on both sides of a small woodlot.

**Figure 41. Sample site location for the survey conducted in College Creek during 2003.**



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 silt were the dominant substrate in the pools comprising about 50% of the substrate. In the riffles, gravel and cobble were the predominant substrate types contributing about 45% to the substrate composition.


Pools dominated the habitat features contributing about 60% of the available habitat. The riparian zone downstream of the bridge crossing had been altered. Here the left descending bank had been converted to pasture field although it had been fallow for some time. There were a few “raw” areas in this portion of the stream as indicated in the photo. Basic water quality measurements at this site revealed the following information, temperature 22 C, conductivity 418 µs/cm, and a pH of 7.5. Enrichment of this stream was evident by the elevated conductivity and the amount of periphyton present in the stream.


## *Results*

We collected a total of 343 fish comprising 14 species at our sample site (Table 25). There were three game species collected at this site, which included the rock bass, bluegill and green sunfish. The two most dominant species collected in our sample were the snubnose darter and largescale stoneroller. Together, these two species comprised 72% of the total number of fish in our sample. Snubnose darter was the only darter species collected at this site. 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 darter species, the lack of intolerant species, the high percentage of omnivores, the low percentage of piscivores, and the high occurrence of anomalies on the fish.

**Table 25. Fish species occurrence for College Creek 2003.**

| Site Code | Species | Tads Code | Total Number |
|---|---|---|---|
| 420031201 | BANDED SCULPIN | 322 | 1 |
| 420031201 | BLACK REDHORSE | 224 | 2 |
| 420031201 | ORANGESIDE DACE | 184 | 28 |
| 420031201 | BLUEGILL | 351 | 2 |
| 420031201 | CREEK CHUB | 188 | 20 |
| 420031201 | GREEN SUNFISH | 347 | 2 |
| 420031201 | HYBRID SUNFISH | 345 | 1 |
| 420031201 | LARGESCALE STONEROLLER | 45 | 149 |
| 420031201 | NORTHERN HOGSUCKER | 207 | 4 |
| 420031201 | RIVER CHUB | 110 | 1 |
| 420031201 | ROCK BASS | 342 | 1 |
| 420031201 | SNUBNOSE DARTER | 435 | 99 |
| 420031201 | SPOTFIN SHINER | 57 | 4 |
| 420031201 | STRIPED SHINER | 89 | 3 |
| 420031201 | WHITE SUCKER | 195 | 26 |
| | | **Total** | **343** |

Overall, the IBI analysis indicated Holley Creek was in poor to fair condition (IBI score = 38) (Table 26). As mentioned above there were several metrics that lowered the overall score. The influences from the agricultural practices upstream were prevelant in this stream as indicated by the amount of siltation and visible indicators of enrichment.

**Table 26. College Creek Index of Biotic Integrity analysis.**

| Metric Description | Scoring Criteria<br>1 3 5 | Observed | Score |
|---|---|---|---|
| Number of Native Species | <7 7-13 >13 | 14 | 5 |
| Number of Darter Species | <2 2-3 >3 | 1 | 1 |
| 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 | 0 | 1 |
| Percent of Individuals as Tolerant | >38 38-20 <20 | 16.1 | 5 |
| Percent of Individuals as Omnivores | >47 47-24 <24 | 52.0 | 1 |
| Percent of Individuals as Specialists | <14 14-27 >27 | 28.9 | 5 |
| Percent of Individuals as Piscivores | <1.9 1.9-3.6 >3.6 | 0.3 | 1 |
| Catch Rate | <29.2 29.2-58.2 > 58.2 | 71.1 | 5 |
| Percent of Individuals as Hybrids | >1 Tr-1 0 | 0.3 | 3 |
| Percent of Individuals with Anomalies | >5 5-2 <2 | 7.6 | 1 |
| | | **Total** | **38 (Poor/Fair)** |

Benthic macroinvertebrates collected in our sample comprised 20 families representing 19 identified genera (Table 27). The most abundant group in our collection was the caddisflies comprising 42.1% of the total sample. Overall, a total of 26 taxa were identified from the sample of which 7 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" (2.2).

**Table 27. Taxa list and associated biotic statistics for benthic macroinvertebrates collected from College Creek.**

| ORDER | FAMILY | SPECIES | NUMBER | PERCENT |
|---|---|---|---|---|
| **ANNELIDA** | | | | 0.7 |
| | Oligochaeta | | 3 | |
| **COLEOPTERA** | | | | 8.6 |
| | Dytiscidae | *Laccophilus maculosus maculosus* | 1 | |
| | Elmidae | *Dubiraphia vittata* | 8 | |
| | | *Stenelmis* adults and larvae | 27 | |
| **DIPTERA** | | | | 11.9 |
| | Chironomidae | | 43 | |
| | Simuliidae | | 5 | |
| | Tipulidae | *Antocha* | 2 | |
| **EPHEMEROPTERA** | | | | 15.2 |
| | Baetidae | *Baetis* | 39 | |
| | Ephemeridae | *Ephemera* | 1 | |
| | Heptageniidae | *Stenacron interpunctatum* | 19 | |
| | Isonychiidae | *Isonychia* | 5 | |
| **GASTROPODA** | | | | 1.4 |
| | Physidae | | 6 | |
| **HEMIPTERA** | | | | 2.6 |
| | Corixidae | *Sigara* | 2 | |
| | Gerridae | *Gerris remigis* 5♂ and 3♀ | 8 | |
| | | *Gerris* nymph | 1 | |
| **ISOPODA** | | | | 13.5 |
| | Asellidae | *Caecidotea* | 5 | |
| | | *Lirceus* | 52 | |
| **MEGALOPTERA** | | | | 0.2 |
| | Sialidae | *Sialis* | 1 | |
| **ODONATA** | | | | 5.2 |
| | Aeshnidae | *Boyeria vinosa* | 4 | |
| | Calopterygidae | *Calopteryx* | 13 | |
| | Coenagrionidae | *Argia* | 5 | |
| **PELECYPODA** | | | | 2.1 |
| | Corbiculidae | *Corbicula fluminea* | 4 | |
| | Sphaeriidae | | 5 | |
| **TRICHOPTERA** | | | | 38.2 |
| | Hydropsychidae | *Cheumatopsyche* | 52 | |
| | | *Hydropsyche betteni/depravata* | 103 | |
| | | *H. rotosa* | 6 | |
| **TURBELLARIA** | | | 1 | 0.2 |
| | | **Total** | **421** | |

**TAXA RICHNESS = 26**
**EPT TAXA RICHNESS = 7**
**BIOCLASSIFICATION = 2.2 (FAIR)**

### *Discussion*

College 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. 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. Although degraded, the habitat quality was somewhat better than the neighboring Holley Creek.

### *Management Recommendations*

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

2. Encourage community involvement in watershed protection.

## Summary

We surveyed four rivers and six streams, collecting 35 fish samples and six benthic samples. In the four large rivers sampled during 2003, mean CPUE values for smallmouth bass ranged from a high of 76.9/hour in the Holston River to a low 2.8/hour in the French Broad River. The only rivers that we could make any kind of comparisons on were the Holston River, Powell River and Pigeon River. Our investigation in the Powell River proved to be worthwhile in gathering more information regarding the validity of spring sampling for smallmouth bass in larger rivers. We observed a doubling of the smallmouth bass catch rate between 2000 and 2003 in the Holston River above Cherokee Reservoir. Likewise we observed a 150% increase in the average catch of rock bass in this reach of the river. We observed a 57.5% decline in the average catch of smallmouth bass in the Holston River below Cherokee Reservoir between 2000 and 2003. In the Pigeon River we observed a 72.5% 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 2002 sample.

The smallmouth bass declines we observed in the comparisons made in 2002 are not unlike the previous year (Carter et al. 2002). We had documented declines in the abundance and size structure of this species in most of our riverine populations. A four-year drought cycle in east Tennessee is believed to be the most influential factor in the observed trends. The situations we have observed in east Tennessee are apparently influencing other populations in the Southeast. Similar trends have been observed in Virginia smallmouth populations according Larry Mohn of the Virginia Department of Game and Inland Fisheries. In a recent sport fishing periodical he indicated that they have observed smallmouth bass mortality rates as high as 80% under similar drought conditions (Hart 2002). With greater rainfall in 2003 we are expecting many habitat that were previously dewatered to return to suitable habitat for black bass species and rock bass.

Of the six IBI surveys conducted in 2003, College Creek in Greene County scored the highest with (38) followed by Turkey and Spring Creeks (34) in Hamblen County, Fall Creek (32) and Holley and Cedar creeks (30). Benthic scores for these six samples all fell between “poor and fair/good” with four of the six being rated as “fair”.

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 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 10 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 28 lists our results for various streams surveyed during this time period.

**Table 28. Index of Biotic Integrity and Benthic Biotic Index scores for samples conducted between 1994 and 2002.**

| 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) |
| 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) |

## Table 28. Continued.

| Water | Watershed | Year Surveyed | County | IBI Score | Benthic BI Score |
|---|---|---|---|---|---|
| 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.) |
| 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) |

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# APPENDIX A

**Common and scientific names of fishes used in this report**

| Family | Common Name | Scientific Name |
|---|---|---|
| **Catostomidae** | Black buffalo | *Ictiobus niger* |
| | Black redhorse | *Moxostoma duquesnei* |
| | Golden redhorse | *Moxostoma erythrurum* |
| | Northern hogsucker | *Hypentelium nigricans* |
| | River carpsucker | *Carpiodes carpio* |
| | River redhorse | *Moxostoma carinatum* |
| | Silver redhorse | *Moxostoma anisurum* |
| | Smallmouth buffalo | *Ictiobus bubalus* |
| | White sucker | *Catostomus commersoni* |
| **Centrarchidae** | Bluegill | *Lepomis macrochirus* |
| | Green sunfish | *Lepomis cyanellus* |
| | Largemouth bass | *Micropterus salmoides* |
| | 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* |
| | Orangeside dace | *Rhinichthys obtusus* |
| | Bluntnose minnow | *Pimephales notatus* |
| | Carp | *Cyprinus carpio* |
| | Central stoneroller | *Campostoma anomalum* |
| | Creek chub | *Semotilus atromaulatus* |
| | Fathead minnow | *Pimephales promelas* |
| | Largescale stoneroller | *Campostoma oligolepis* |
| | Longnose dace | *Rhinichthys cataractae* |
| | River chub | *Nocomis micropogon* |
| | Rosyface shiner | *Notropis rubellus* |
| | Silver shiner | *Notropis photogenis* |
| | Spotfin shiner | *Cyprinella spiloptera* |
| | Striped shiner | *Luxilus chrysocephalus* |
| | Telescope shiner | *Notropis telescopus* |
| | Whitetail shiner | *Cyprinella galactura* |
| **Ictaluridae** | Channel catfish | *Ictalurus punctatus* |
| | Flathead catfish | *Pylodictus olivaris* |
| | Yellow bullhead | *Ameiurus natalis* |
| **Percidae** | Banded darter | *Etheostoma zonale* |
| | Gilt darter | *Percina evides* |

| Family | Common Name | Scientific Name |
| --- | --- | --- |
| **Percidae** | Greenside darter | *Etheostoma blenniodes* |
| | Logperch | *Percina caprodes* |
| | Redline darter | *Etheostoma ruflineatum* |
| | Sauger | *Sander canadense* |
| | Snubnose darter | *Etheostoma simoterum* |
| | Walleye | *Sander vitreum* |
| | | |
| **Petromyzontidae** | Chestnut lamprey | *Ichthyomyzon castaneus* |
| | | |
| **Sciaenidae** | Drum | *Aplodinotus grunniens* |