FISHERIES REPORT
REPORT NO. 06-02
WARMWATER STREAM FISHERIES REPORT
REGION IV
2005

Prepared by

Bart D. Carter
Carl E. Williams
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TENNESSEE WILDLIFE RESOURCES AGENCY

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Cover: Tangerine darter (*Percina aurantiaca*) collected from the Clinch River during 2005. The Tangerine darter is deemed in need of management.

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

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

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

METHODS

The streams to be sampled and the methods required are outlined in TWRA field request No. 04-05. A total of 11 rivers/streams were sampled and are included in this report. Stream surveys were conducted from April to November 2005. Fifty-one (IBI, CPUE, or Qualitative) fish samples and 12 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 (Clinch River, Powell River, Little 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 utilizing hand held Geographical Positioning Units (GPS) and then digitally re-created using a commercially available software package.

WATERSHED ANALYSIS

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

FISH COLLECTIONS

Fish data were collected by employing an Index of Biological Integrity (Karr et al. 1986). 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 2005. 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 2005 samples will be catalogued into our reference collection or deposited in the University of Tennessee Research Collection of Fishes. Common and scientific names of fishes used in this report are after Nelson et al. (2004) and Etnier and Starnes (1993).

AGE and GROWTH

In order to address management questions pertaining to the age and growth characteristics of stream dwelling smallmouth bass, spotted bass, largemouth bass, and rock bass populations, statewide collection of otolith samples was initiated in 1995 by regional stream crews. No otoltihs were collected from black bass or rock bass in 2005 as collections were made from these rivers between 1997 and 2000.

BENTHIC COLLECTIONS

Qualitative benthic samples were collected from each IBI fish sample site (12 total). These were taken with aquatic insect nets, by rock turning, and by selected pickings from as many types of habitat as possible within the sample area. Taxa richness and relative abundance are the primary considerations of this type of sampling. Taxa richness reflects the health of the benthic community and biological impairment is reflected in the absence of pollution sensitive taxa such as Ephemeroptera, Plecoptera, and Trichoptera (EPT).

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

WATER QUALITY MEASUREMENTS

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

HABITAT QUALITY ANALYSIS

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

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

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

Experimental Stream Habitat Assessment Form

STREAM QUALITY ASSESSMENT FORM FORM:SQA-09-2004

Tennessee Wildlife Resources Agency Stream Survey Unit

STREAM:____________________ DATE:____________________

INVESTIGATOR:____________________ SITE CODE:____________________

LAT/LONG:____________________ ELEVATION:____________________

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

SCORE

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

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

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

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

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

6 BANK STABILITY ☐
(signs of bank erosion)

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

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

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

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

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

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

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

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

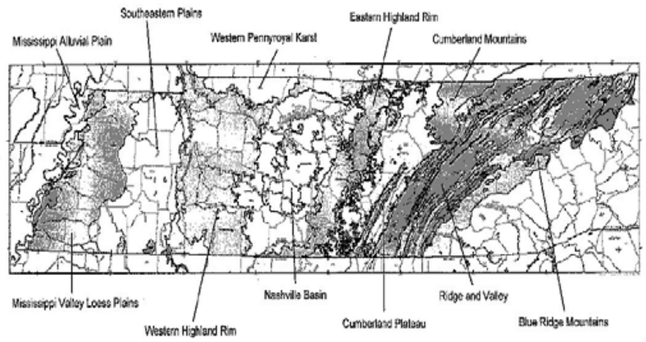
TOTAL ☐

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

STREAM ASSESSMENT VALUE = TOTAL + BIA ——→ ☐

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

INDICATE (CIRCLE) ECOREGION:



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

CHECK IF STREAM IS:

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

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

DATA ANALYSIS

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

Karr et al. (1986) criteria

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

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

Catch-per-unit-effort analysis was performed on the four large rivers sampled during 2005. Total time spent electrofishing at each site was used to calculate the CPUE estimates for each species collected. Length categorization analysis (Gabelhouse 1984) was used to calculate Proportional Stock Density (PSD) and Relative Stock Density (RSD) for black bass and rock bass populations sampled.

Benthic data collected for the 2005 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.

Turkey Creek and Hurricane Creek

As part of the State Wildlife Grant (SWG) funding being given to state wildlife management agencies by the USFWS, many states including Tennessee have implemented wildlife diversity monitoring programs to gather information regarding nongame species within their political boundaries. In Tennessee, regional programs have been developed as a result of this SWG initiative. We were invited to attend a “bioblitz” event organized by TWRA’s Region II within the newly acquired Bear Hollow Mountain WMA. Our participation in the event concentrated on evaluating the fish and benthic communities within two streams on the WMA (Turkey Creek and Hurricane Creek). Both survey locations were in Franklin County in close proximity to the TN/AL state line (Figure 1). A listing of the fish and benthic invertebrates collected from these streams can be found in Tables 1-3. We did collect one Neophylax species from Turkey Creek that may represent and undescribed species. Further collection and rearing will be conducted in order to assess the taxonomic uncertainty of this caddisfly.

Figure 1. Sample site locations for Turkey Creek and Hurricane Creek 2005.

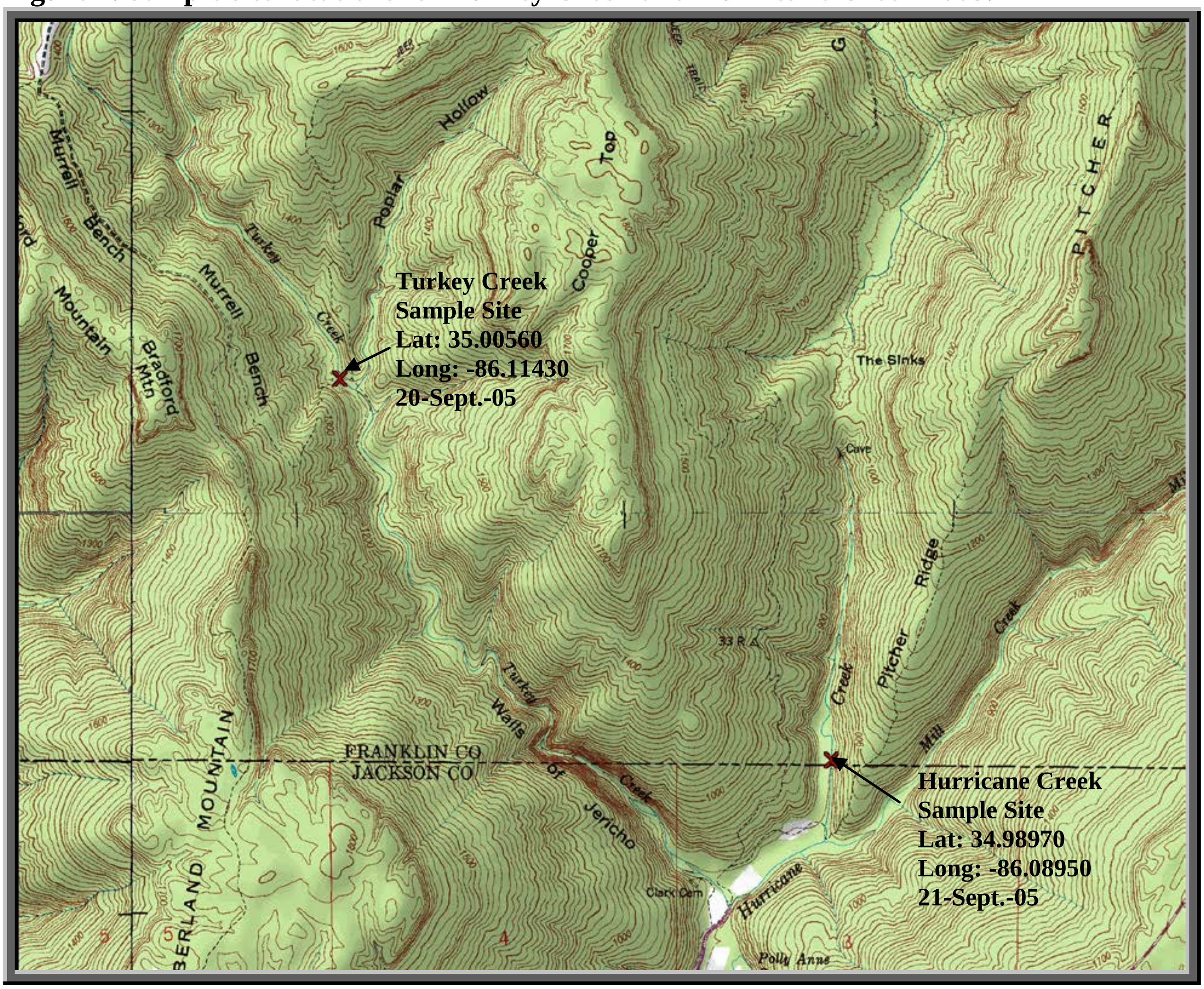


Table 1. Fish species collected in Turkey Creek and Hurricane Creek 2005.

Turkey Creek (420051401)	Hurricane Creek (420051501)
Species	**Species**
Rhinichthys obtusus	*Ambloplites rupestris*
	Campostoma oligolepis
	Catostomus commersoni
	Clinostomus funduloides
	Cottus carolinae
	Etheostoma blenniodes
	Etheostoma caeruleum
	Etheostoma duryi
	Etheostoma flabellare
	Etheostoma jessiae
	Etheostoma kennicotti
	Etheostoma nigrum
	Etheostoma tennesseense
	Fundulus olivaceous
	Hybopsis amblops
	Hypentelium nigricans
	Icthyomyzon sp.
	Lepomis auritus
	Lepomis macrochirus
	Luxilus chrysocephalus
	Lythrurus faciolaris
	Notropis telescopus
	Pimephales notatus
	Rhinichthys obtusus
	Semotilus atromaculatus

Table 2. Taxa list and associated biotic statistics for benthic macroinvertebrates collected from Turkey Creek.

	FAMILY	SPECIES	NUMBER	PERCENT
ANNELIDA				0.7
Oligochaeta			2	
COLEOPTERA				8.4
	Dryopidae	*Helichus*	2	
	Elmidae	*Optioservus* larvae	3	
		Optioservus ovalis	2	
	Psephenidae	*Ectopria*	4	
		Psephenus herricki	14	
DIPTERA				16.4
	Athericidae	*Atherix lantha*	16	
	Chironomidae		31	
	Empididae		1	
	Tipulidae	*Limonia*	1	
EPHEMEROPTERA				13.7
	Caenidae	*Caenis*	4	
	Ephemerellidae	*Eurylophella*	1	
	Ephemeridae	*Ephemera*	6	
	Heptageniidae	*Stenonema femoratum*	4	
	Isonychiidae	*Isonychia*	26	
HETEROPTERA				2.3
	Gerridae	*Aquarius remigis 1*♂ and 2♀	3	
	Veliidae	*Rhagovelia obesa 2*♂, 1♀, 1 nymph	4	
MEGALOPTERA				6.7
	Corydalidae	*Corydalus cornutus*	3	
		Nigronia serricornis	17	
ODONATA				6.7
	Aeshnidae	*Boyeria grafiana*	14	
	Cordulegasteridae	*Cordulegaster macultata*	3	
	Corduliidae	*Helocordulia uhleri*	1	
	Gomphidae	*Gomphus descriptus*	1	
		Stylogomphus albistylus	1	
PLECOPTERA				13.7
	Perlidae	*Acroneuria abnormis*	36	
	Leuctridae	*Leuctra*	5	
TRICHOPTERA				31.4
	Glossosomatidae	*Glossosoma* larvae and pupae	14	
	Hydropsychidae	*Cheumatopsyche*	32	
		Hydropsyche betteni/depravata	38	
	Limnephilidae	*Pycnopsyche* pupae	3	
	Philopotamidae	*Chimarra*	6	
	Uenoidae	*Neophylax* pupa	1	
		Total	**299**	

TAXA RICHNESS = 31
EPT TAXA RICHNESS = 13
BIOCLASSIFICATION = 3.5 (FAIR-GOOD)

Table 3. Taxa list and associated biotic statistics for benthic macroinvertebrates collected from Hurricane Creek.

	FAMILY	SPECIES	NUMBER	PERCENT
AMPHIPODA				3.7
	Gammaridae	*Gammarus minus*	13	
ANNELIDA				0.6
Oligochaeta			2	
COLEOPTERA				30.7
	Dryopidae	*Helichus*	35	
	Dytiscidae	*Hydroporus blanchardi*	1	
	Elmidae	*Macronychus glabratus*	1	
		Optioservus larva	5	
		Optioservus ovalis	54	
	Psephenidae	*Psephenus herricki*	11	
DIPTERA				12.9
	Athericidae	*Atherix lantha*	9	
	Chironomidae	larvae and pupae	22	
	Simuliidae	larvae and pupa	4	
	Tipulidae	*Hexatoma*	2	
		Limonia	1	
		Tipula	7	
EPHEMEROPTERA				9.5
	Baetidae	*Baetis*	5	
	Heptageniidae	*Leucrocuta*	1	
		Maccaffertium	8	
		Maccaffertium pulchellum	2	
		Stenacron interpunctatum	3	
	Isonychiidae	*Isonychia*	13	
	Leptophlebiidae	*Paraleptophlebia*	1	
GASTROPODA				10.9
	Pleuroceridae	*Elimia laqueata*	30	
		Pleurocera sp. cf. *P. acuta*	8	
HETEROPTERA				3.7
	Corixidae		1	
	Gerridae	*Aquarius remigis 3*♂, 1♀, 1 nymph	5	
	Veliidae	*Rhagovelia obesa 3*♂, 3♀, 1 nymph	7	
LEPIDOPTERA				0.3
	Noctuidae	*Bellura*	1	
MEGALOPTERA				2.6
	Corydalidae	*Nigronia serricornis*	5	
	Sialidae	*Sialis*	4	
NEMATOMORPHA			1	0.3
ODONATA				2.3
	Aeshnidae	*Boyeria vinosa*	4	
	Cordulegasteridae	*Cordulegaster macultata*	2	
	Gomphidae	*Gomphus descriptus*	1	
		Stylogomphus albistylus	1	
PLECOPTERA				8.0
	Perlidae	*Acroneuria* early instars	2	
		Acroneuria abnormis	26	
TRICHOPTERA				14.7
	Glossosomatidae	*Glossosoma* pupa	1	
	Goeridae	*Goera calcarata*	4	
	Helicopsychidae	*Helicopsyche borealis*	1	
	Hydropsychidae	*Cheumatopsyche*	19	
		Ceratopsyche morosa	2	
		Ceratopsyche slossonae	8	
		Hydropsyche betteni/depravata	5	
	Leptoceridae	*Triaenodes* pupae	3	
	Limnephilidae	*Pycnopsyche* pupa	1	
	Polycentropodidae	*Nyctiophylax*	1	
		Polycentropus	2	
	Uenoidae	*Neophylax* pupae sp. 1	1	
		Neophylax acutus pupa	1	
		Neophylax sp. cf. *N concinnus*	1	
		Total	**348**	

TAXA RICHNESS = 46
EPT TAXA RICHNESS = 21
BIOCLASSIFICATION = 4.0 (GOOD)

Unnamed Tributary to Taylor Branch

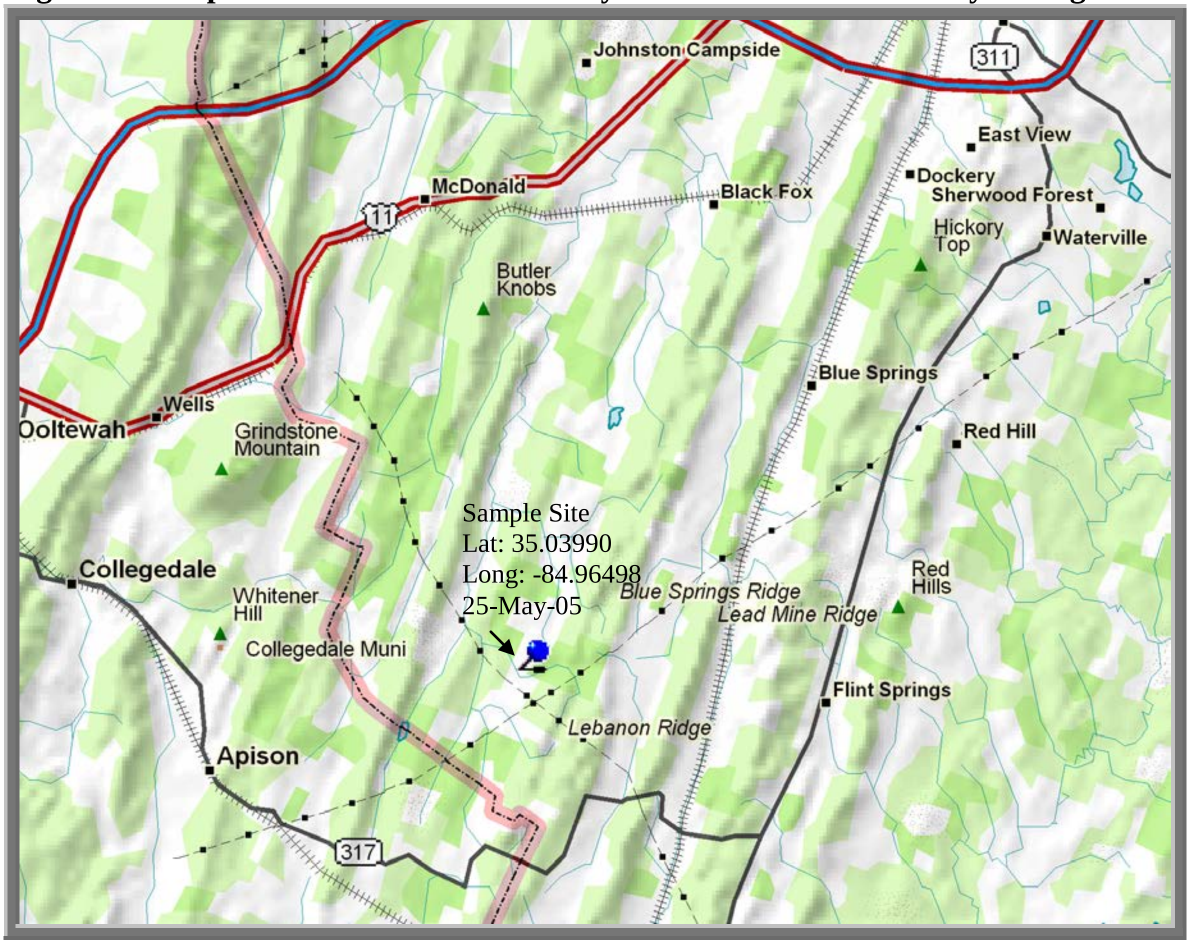
Introduction

This tributary stream to Taylor Branch is located in Bradley County near the city of Ooltewah. Most of the land use in the surrounding watershed is residential or agricultural. We were primarily interested in evaluating the health of the stream and investigating the occurrence of Tennessee dace. No prior agency collections had been made in this stream.

Study Area and Methods

Our survey of this tributary was conducted near Tunnel Hill Road southeast of Ooltewah (Figure 2). The stream at this location was low grade, narrow, and severely entrenched in some locations. Remnants of a pond dam indicated that this portion of the stream had been impounded historically.

Figure 2. Sample site location for the survey conducted in the tributary during 2005.




A view of the tributary within our sample area. Note bank instability due to cattle access.

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 silt and cobble were dominant substrate components in pools comprising about 50% of the substrate. In riffles, bedrock and cobble were dominant substrates contributing 70% to the substrate composition. Riffles were most prevalent, comprising about 70% of the available habitat. Riparian zones within our survey site were severely impacted by tree removal and cattle grazing. Basic water quality measurements at this site revealed the following information: temperature 16.5 C, conductivity 170 µs/cm, flow 1.2 cfs and a pH of 6.3.

Results

We collected a total of 722 fish comprising eight species at our sample site (Table 4). No game species were collected at this site. The two most dominant species collected in our sample were the largescale stoneroller and creek chub. Together, these two species comprised 69% of the total number of fish in our sample. Only one darter species was collected here, the black darter. The only sucker species present was the white sucker. The most interesting collection made at this location, was Tennessee dace, which is deemed in need of management by the Agency. We did collect a hybrid which was apparently a cross between a Tennessee dace and creek chub. We have observed this in a few other locales where *Phoxinus* sp. and other minnows co-exist. There were two IBI metrics that had a substantial effect on lowering the overall score for this stream. These included the low percentage of trophic specialists and the absence of piscivores. All other metrics scored average or better resulting in an IBI score of 48 (good) (Table 5). We did not observe any anomalies on the fish we collected even though the potential for this occurence seemed good given the state of enrichment in the stream. The abundance of Tennessee dace was relatively high, although the number of juvenile fish was low. Much of the streams flow is contributed by groundwater which probably elevates the water quality despite the disturbances in the watershed. Our overall assessment of the habitat quality resulted in a score of 33 “poor”.

Table 4. Fish species occurrence for the unnamed tributary 2005.

Site Code	Species	Tads Code	Total Number
420051301	*Campostoma oligolepis*	45	61
420051301	*Catostomus commersoni*	195	4
420051301	*Cottus carolinae*	322	85
420051301	*Etheostoma tennesseense*	435	18
420051301	Lamprey sp.	7	1
420051301	*Phoxinus tenneseensis*	169	54
420051301	*Rhynichthys obtusus*	184	337
420051301	*Semotilus atromaculatus*	188	160
420051301	*Semotilus x Phoxinus* hybrid		2
		Total	**722**

Table 5. Unnamed tributary Index of Biotic Integrity analysis.

Metric Description	Scoring Criteria 1 3 5	Observed	Score
Number of Native Species	1 1-2 >2	8	5
Number of Riffle Species	<2 2 >2	2	3
Number of Pool Species	Absent Present	Present	5
% Two most Dominant Species	>90 90-80 <80	69	5
Number of Headwater Intolerant Species	<0 1 >1	2	5
Percent of Individuals as Tolerant	>40 40-20 <20	22.7	3
Percent of Individuals as Omnivores	>50 50-25 <25	9.0	5
Percent of Individuals as Specialists	<5 5-10 >10	2.5	1
Percent of Individuals as Piscivores	Absent Present	Absent	1
Catch Rate	<50 50-100 >100	273.4	5
Percent of Individuals as Lithophilic Spawners	<25 25-50 >50	57.3	5
Percent of Individuals with Anomalies	>5 5-2 <2	0	5
		Total	**48 (Good)**

Benthic macroinvertebrates collected in our sample comprised 34 families representing 35 identified genera (Table 6). The most abundant group in our collection was the caddisflies comprising 38.5% of the total sample. Overall, a total of 42 taxa were identified from the sample of which 19 were EPT. Based on the EPT taxa richness and overall biotic index of all species collected, the relative health of the benthic community was classified as “good” (4.0). We did collect one dragonfly species *Gomphus* (Genus A) *consanguis* (Cherokee clubtail dragonfly) which is listed S1 (rare statewide). This species is currently distributed in six southeastern states (Tennessee, Alabama, Georgia, South Carolina, North Carolina, and Virginia) where it is listed as S1 (critically imperiled) in all but two (South Carolina and Virginia; imperiled (S2)).

Table 6. Taxa list and associated biotic statistics for benthic macroinvertebrates collected from the unnamed tributary.

ORDER	FAMILY	SPECIES	NUMBER	PERCENT
AMPHIPODA				0.9
	Crangonyctidae	*Crangonyx*	4	
ANNELIDA				0.2
Oligochaeta			1	
COLEOPTERA				0.7
	Dryopidae	*Helichus* adult	1	
	Elmidae	*Optioservus* larvae	2	
DIPTERA				18.4
	Chironomidae		61	
	Dixidae	*Dixa*	1	
	Simuliidae		9	
	Tabanidae	*Tabanus*	2	
	Tipulidae	*Antocha* larvae and pupa	4	
		Tipula	2	
EPHEMEROPTERA				1.9
	Baetidae	*Baetis*	5	
	Heptageniidae	*Stenacron* interpunctatum	2	
	Isonychiidae	*Isonychia*	1	
GASTROPODA				8.2
	Physidae		11	
	Pleuroceridae		24	
HETEROPTERA				1.2
	Belostomatidae	*Belostoma testaceum*	1	
	Gerridae	*Aquarius remigis* male and female	2	
	Notonectidae	*Notonecta*	1	
	Veliidae	*Rhagovelia obesa* nymph	1	
ISOPODA				13.3
	Asellidae	*Caecidotea*	1	
		Lirceus	56	
MEGALOPTERA				0.2
	Corydalidae	*Nigronia serricornis*	1	
ODONATA				1.4
	Aeshnidae	*Boyeria vinosa*	1	
	Calopterygidae	*Calopteryx*	3	
	Gomphidae	*Gomphus* (Genus A) *consanguis*	1	
		Stylogomphus albistylus	1	
PLECOPTERA				15.2
	Nemouridae	*Amphinemura delosa/nigritta*	1	
	Perlidae	*Eccoptura xanthenes*	4	
		Perlesta	60	
TRICHOPTERA				38.5
	Glossosomatidae	*Agapetus pupa*	1	
		Glossosoma larvae and pupae	51	
	Hydropsychidae	*Cheumatopsyche*	36	
		Hydropsyche betteni/depravata	32	
	Lepidostomatidae	*Lepidostoma* pupa	1	
	Leptoceridae	*Triaenodes* pupae	3	
	Limnephilidae	*Pycnopsyche luculenta* group	8	
	Odontoceridae	*Psilotreta labida* pupae	7	
	Philopotamidae	*Chimara*	2	
	Rhyacophilidae	*Rhyacophila carolina*	10	
	Uenoidae	*Neophylax concinnus*	3	
		Neophylax consimilis	1	
		Neophylax etnieri	10	
		Total	**429**	

TAXA RICHNESS = 42
EPT TAXA RICHNESS = 19
BIOCLASSIFICATION = 4.0 (GOOD)

Discussion

The occurrence of Tennessee dace in this stream merits protection of the stream and the surrounding watershed. However, given the state of development and current land use practices this is unlikely to occur. With the amount of spring influence in this stream, the water quality may remain good enough to continue to support this species. Restricting cattle access to the stream would have the most pronounced impact on retaining the species diversity and improving the water quality.

Management Recommendations

1. Watershed protection.

2. Restrict cattle access to the stream.

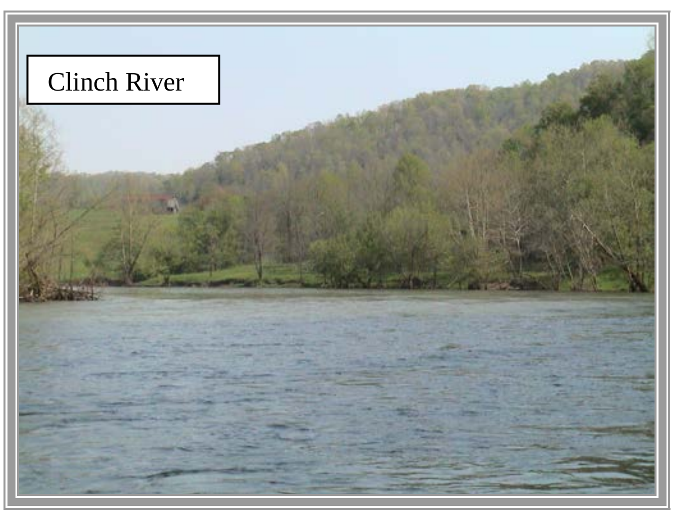
Clinch River

Introduction

The Clinch River represents 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 43 species of mussels (Ahlstedt 1986). Additionally, it supports one of east Tennessee's better warmwater sport fisheries. The Clinch River has been the focus of numerous surveys and investigations conducted by both state and federal agencies with the major purpose of assessing and monitoring the fish and benthic communities. The Agency has made limited 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 Clinch River focused on re-evaluating the sport fish population originally sampled in 1999. Our 2005 assessment was derived from nine sample sites located between river mile 202 and river mile 152. After our initial evaluation in 1999, the Clinch River was put into a 3-year rotational schedule with eight other rivers in the region. Sport fish sampling sites were reduced to those that would best characterize these populations.

Study Area and Methods

The Clinch River originates in Virginia and flows in a southwesterly direction before emptying into Norris Reservoir near river mile 152. The river has a drainage area of approximately 3,838 $kilometers^2$ (upstream of the reservoir). In Tennessee, all of the Clinch River flows through the Ridge and Valley province of east Tennessee coursing by the town of Sneedville before emptying into Norris Reservoir just northwest of Thorn Hill. 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 three developed launching areas managed by the Tennessee Wildlife Resources Agency (Kyles Ford, Sneedeville, Hwy. 25E Bridge).



Between April 19 and 20, 2005, we conducted nine fish surveys between the Virginia state line and Norris Reservoir (Figure 3). In our survey sites, the riparian habitat consisted primarily of wooded shorelines with interspersed agricultural fields. Submerged woody debri was fairly common in most of our sample areas. The river substrate was predominately boulder/cobble in riffle areas and bedrock with interspersed boulders/cobble in the pool habitat. Measured mean channel widths ranged from 41.6 meters to 71.5 meters, while site lengths fell between 190 meters and 890 meters (Table 7). Water temperatures ranged from 14.8 C to 19.5 C and conductivity varied from 225 to 270μs/cm (Table 7).

Figure 3. Site locations for samples conducted in the Clinch River during 2005.

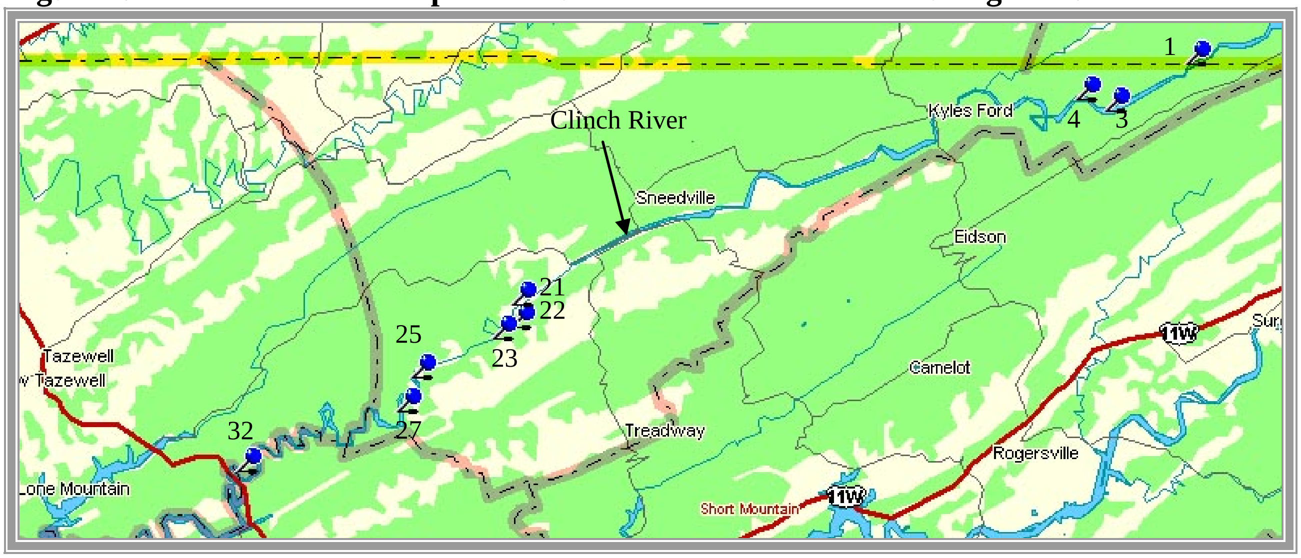


Table 7. Physiochemical and site location data for samples conducted in the Clinch River during 2005.

Site Code	Site	Quad	River Mile	Latitude	Longitude	Mean Width (m)	Length (m)	Temp. C	Cond.	Secchi (m)
420050601	1	Looney Gap	202	36.59361	-82.88944	44.6	376	15.5	240	1.4
420050603	3	Looney Gap	199	36.57667	-82.94139	41.6	381	16	250	1.4
420050604	4	Looney Gap	197.8	36.58139	-82.95444	50.6	190	17	250	1.4
420050621	21	Swan Island	172.5	36.47722	-83.28917	53	718	17	230	0.9
420050622	22	Swan Island	170.7	36.47528	-83.30306	71.5	480	17	230	0.9
420050623	23	Swan Island	169.6	36.46500	-83.30083	50	217	16	225	0.9
420050625	25	Swan Island	166.6	36.44583	-83.34917	63	890	15	225	0.9
420050627	27	Swan Island	164.5	36.42917	-83.35778	68.5	520	14.8	230	0.9
420050632	32	Howard Quarter	152.2	36.40139	-83.45250	71.5	413	19.5	270	1.4

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 926 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).

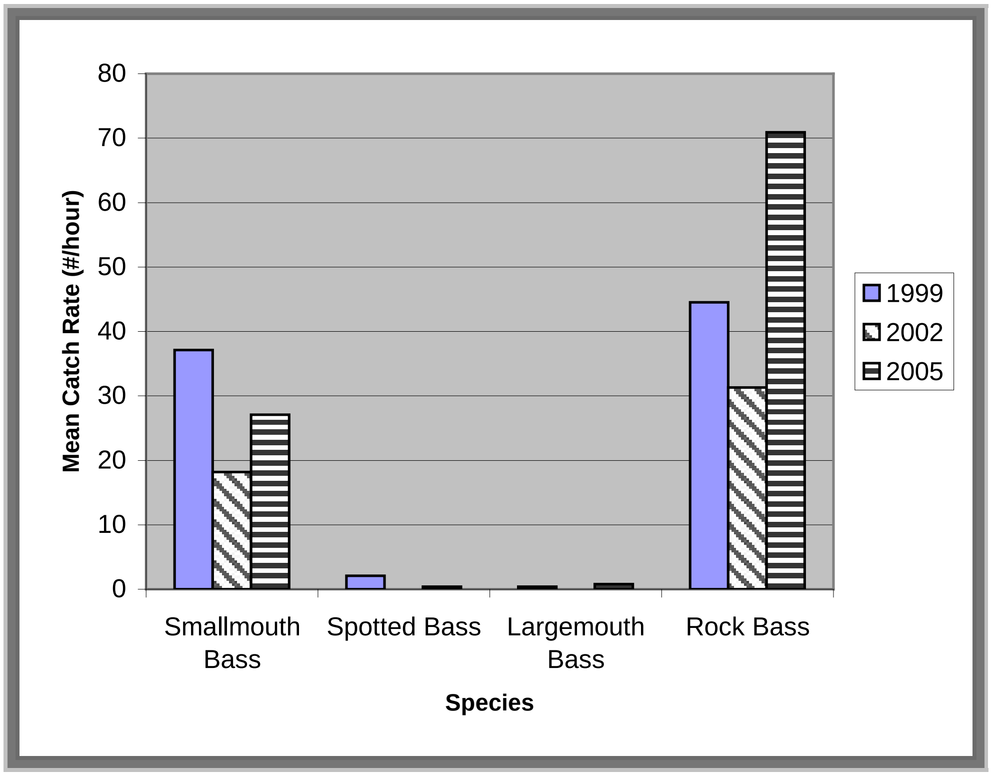
Results

CPUE estimates for smallmouth bass averaged 27.1/hour (SD 15.2), while the mean rock bass estimate was 70.9/hour (SD 23.9) (Table 8). Unlike our 2002 survey, spotted bass and largemouth bass did return to our sample sites. The CPUE estimates for spotted bass and largemouth bass were 0.4 (SD 1.3) and 0.8 (SD 1.7). Comparatively, there was an overall increase in the mean catch rate of black bass species (49% for smallmouth bass) from our survey in 2005 (Figure 4). However, the 2005 catch did not surpass the value recorded in 1999, remaining 27% below that value. Likewise, the mean catch rate for rock bass increased 126.5% from our sample taken in 2002 and surpassed the 1999 value by 59%. Our catch most likely increased over the summer 2002 sample due to the timing of our sample. Spring and fall samples have been shown to more accurately reflect true population density and size structure when compared to summer month samples (June-August). Almost all of the sample sites showed increases in CPUE for both smallmouth bass and rock bass when compared to the 2002 survey.

Table 8. Catch per unit effort and length categorization indices of target species collected at nine sites on the Clinch River during 2005.

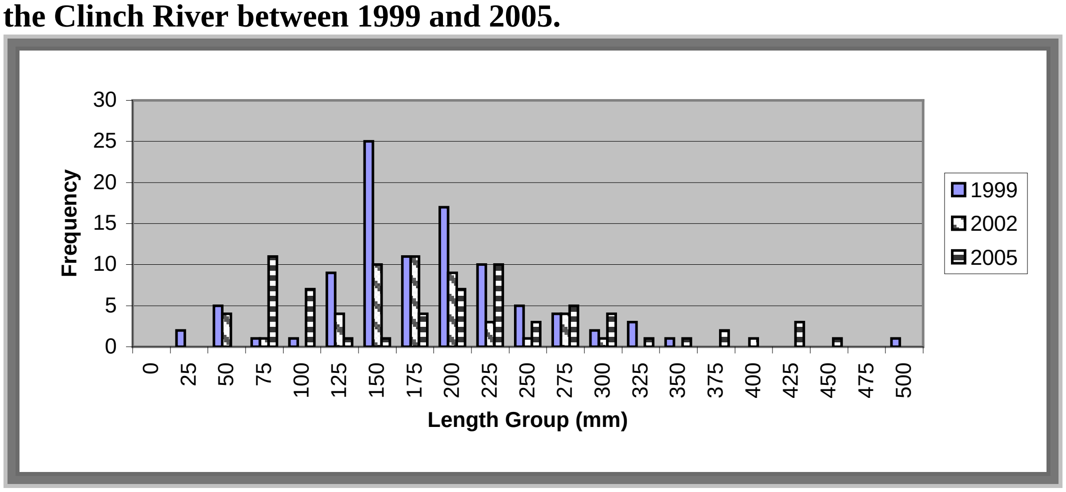
Site Code	Smallmouth Bass CPUE	Spotted Bass CPUE	Largemouth Bass CPUE	Rock Bass CPUE
420050601	12	-	-	96
420050603	4	-	-	68
420050604	40	-	4.0	68
420050621	20	-	-	60
420050622	15.6	-	4.0	42.8
420050623	24	-	-	120
420050625	44	-	-	56
420050627	40	4.0	-	52
420050632	44	-	-	76
MEAN	27.1	0.4	0.8	70.9
STD. DEV.	15.2	1.3	1.7	23.9
	Length-Categorization Analysis	**Length-Categorization Analysis**	**Length-Categorization Analysis**	**Length-Categorization Analysis**
	PSD = 40	PSD = 0	PSD = 50	PSD = 35.8
	RSD-PREFERRED = 17.5	RSD-PREFERRED = 0	RSD-PREFERRED = 50	RSD-PREFERRED = 1.9
	RSD-MEMORABLE = 10	RSD-MEMORABLE = 0	RSD-MEMORABLE =0	RSD-MEMORABLE = 0
	RSD- TROPHY = 0	RSD- TROPHY = 0	RSD- TROPHY = 0	RSD- TROPHY = 0

Figure 4. Trends in mean catch rate of black bass and rock bass collected between 1999 and 2005 from the Clinch River.



The size distribution of smallmouth bass between 1999 and 2005 changed somewhat among our nine sampling stations (Figure 5). Good recruitment for bass 125 mm and less indicated a good year class in 2004. The occurrence of quality size bass 250 mm and larger was higher in 2005 than previous samples. There was a higher frequency of larger fish as well, particularly in the 400 to 475 mm range. Although somewhat staggered when compared to the 1999 survey, the size distribution in 2005 did give a good representation of the population structure and revealed recruitment impacts to the fishery from the flooding encountered in 2003.

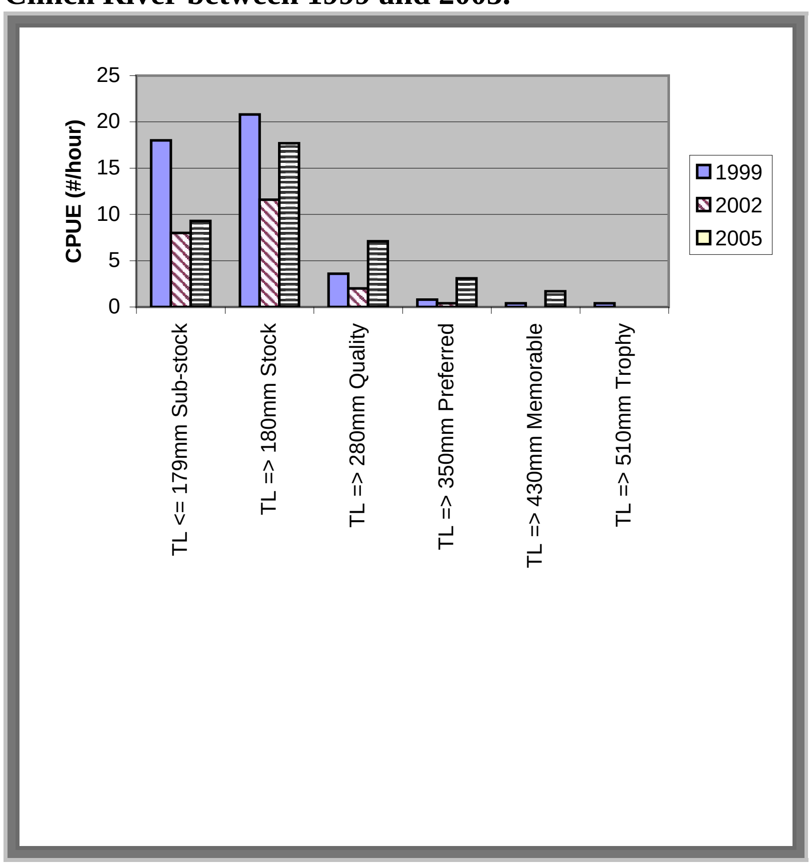
Figure 5. Length frequency distributions for smallmouth bass collected from the Clinch River between 1999 and 2005.



The number of bass over 14 inches increased about 130 % over the two previous samples. We feel this is primarily due to the sample timing (spring) which has consistently resulted in higher catches of larger fish. Only one bass in the 20 inch class has been observed in our samples to date. It was collected in 1999 at site 1.

Length categorization analysis indicated the relative stock density (RSD) of preferred smallmouth bass (TL ≥ 350 mm) was 17.5 (Table 8). RSD for memorable (TL ≥ 430 mm) and trophy (TL ≥ 510 mm) size bass were 10 and 0, respectively. The PSD of smallmouth bass (ratio of quality size bass to stock size bass) was 40. In comparison, the value for 2002 was substantially lower for bass in the preferred category (0.4). The value for memorable fish (1.7) was higher in 2005, while the value for trophy size bass remained at 0. Catch per unit effort estimates by RSD category in 1999 and 2002 indicated a substantial decline in the catch of sub-stock smallmouth bass (Figure 6). This value rebounded somewhat in 2005, slightly surpassing the value recorded in 2002. Overall, with the exception of the trophy category, the values recorded for quality smallmouth bass and larger substantially exceeded those reported from previous samples.

Figure 6. Relative stock density (RSD) catch per unit effort for smallmouth bass collected from the Clinch River between 1999 and 2005.

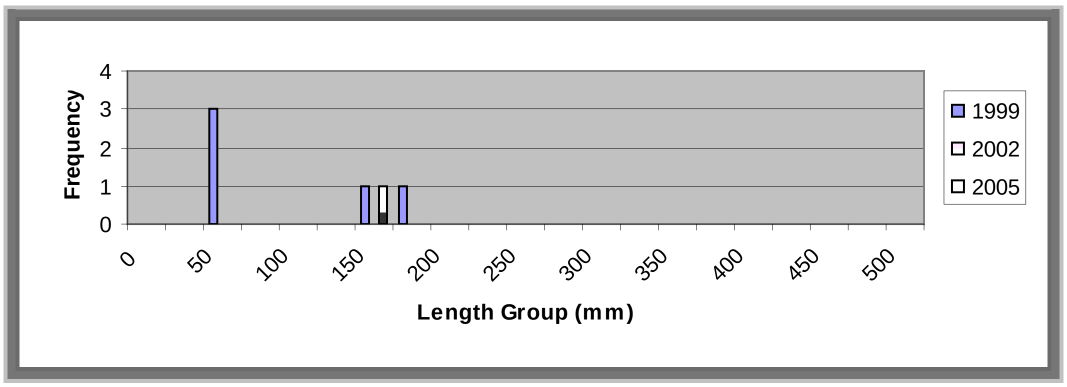


Age and growth characteristics for the smallmouth bass population in the Clinch River were characterized in 1999 (Carter et al. 2000). For the most part, the Clinch River has had growth rates similar to other large river populations with the same age structure.

We did not collect otoliths from smallmouth bass in 2005, 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 Clinch River about 4.7 years to reach 305 mm (12 inches), and about 7.8 years to attain a length of 406 mm (16 inches).

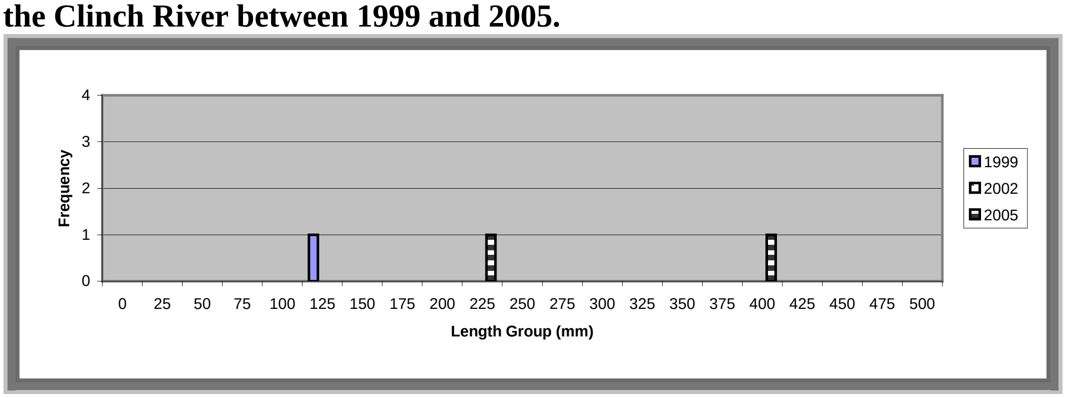
There was only one spotted bass collected from the Clinch River in 2005. This fish was 151 mm in length and was collected in the lower reach of the river at site 27. Given the scarcity of spotted bass in the Clinch, no real inferences about their contribution to the fishery can be made. However, they do persist in the river and may offer some opportunity to anglers. Figure 7 portrays the distribution of lengths for spotted bass collected from the Clinch River between 1999 and 2005. Catch rate for spotted bass averaged 0.4/hour (SD 1.3).

Figure 7. Length frequency distributions for spotted bass collected from the Clinch River between 1999 and 2005.



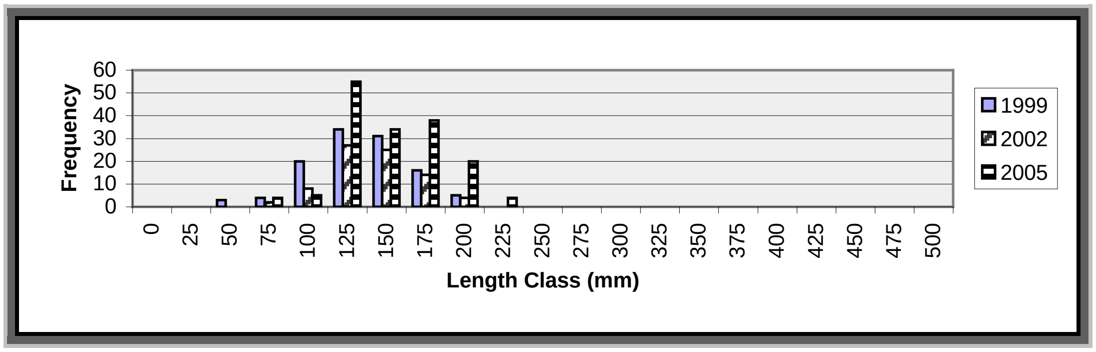
Only two largemouth bass were collected during the 2005 survey (Figure 8). One at site 4 and one at site 22. These fish ranged from 247 mm to 408 mm. Due to the low abundance of largemouth bass in the Clinch, little can be said about population density and size structure. The catch rate for largemouth bass averaged 0.8/hour (SD 1.7).

Figure 8. Length frequency distributions for largemouth bass collected from the Clinch River between 1999 and 2005.



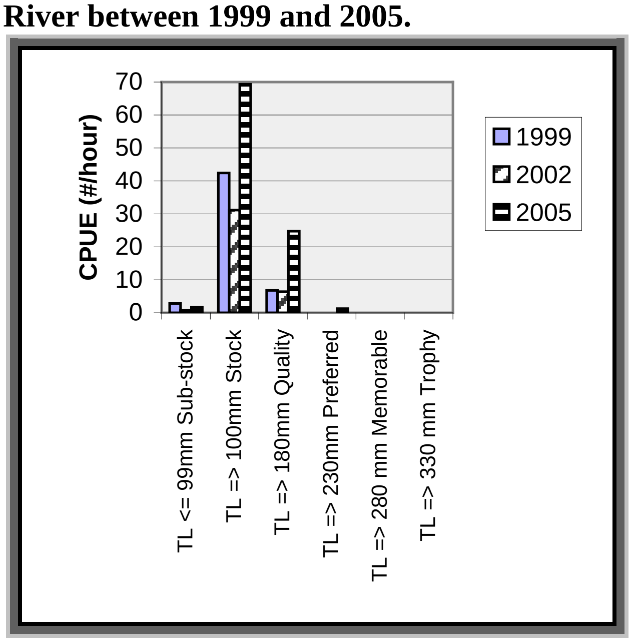
Individuals in the 100 to 200 mm range represented the majority of rock bass in our samples between 1999 and 2005 (Figure 9). The representation of rock bass in size classes above 100 mm increased substantially over our survey in 2002. Generally, our 2005 survey proved to be our best sample of rock bass since monitoring was initiated in 1999. We believe that our spring sample in 2005 allowed us to more effectively sample this species and aid us in more accurately depicting the population size structure.

Figure 9. Length frequency distributions for rock bass collected from the Clinch River between 1999 and 2005.



Relative stock density (RSD) analysis indicated the RSD for preferred rock bass (TL ≥ 230 mm) was 1.9 (0 in 2002). RSD for both memorable (TL ≥ 280 mm) and trophy (TL ≥ 330 mm) size rock bass was 0. The PSD of rock bass increased over our 2002 survey (20.5) to 35.8. Our catch values by RSD category increased substantially over the previous surveys (Figure 10). For the first time since we began monitoring we recorded rock bass in the preferred size category. Stock and quality size categories saw the largest increases when compared to the 1999 and 2002 values.

Figure 10. Relative stock density (RSD) catch per unit effort for rock bass collected from the Clinch River between 1999 and 2005.



As with smallmouth bass, we feel our timing of the sample is responsible for the observed increases. We are confident that by surveying these large river populations in the spring we are able to better characterize the true population size structure and density.

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 2002. Therefore, no mortality or potential population growth statistics could be calculated. Age and growth and mortality of rock bass in the Clinch River are assumed to be similar to those reported from our 1999 assessment (Carter et al. 2000).

Discussion

The Clinch 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 the Clinch River, it should not be considered to contain a sport fishery for these species.

The popularity of this riverine fishery has grown over the last few years and now hosts a good percentage of anglers from Kentucky. Currently we have no angler use/harvest data on the river to aid in evaluating the effects that angler use may or may not have on the sport fishery. It is imperative that we obtain this data in order to answer fisheries management questions, public inquiries, and aid in the development of regulations.

The occurrence of musky in the river warrants continued investigations. The consistent stockings made by the VAGF upstream of the state line could lead to the development of a fishery in the Tennessee portion of the Clinch River. According to Tom Hampton (VAGF) their stockings have been quite successful and have resulted in the establishment of a sport fishery. Recent Index of Biotic Integrity surveys by TVA have indicated that the Clinch River is in "good" condition based on data from two long-term monitoring stations.

Surveys on the Clinch River will be conducted on a three-year rotation in order to assess any changes in the fishery. Our return trip in 2008 will in all likelihood focus on the sample sites surveyed in 2005, providing no new or more efficient sampling scheme is developed.

Management Recommendations

1. Initiate an angler use and harvest survey.

2. Develop a fishery management plan for the river.

Williams Creek

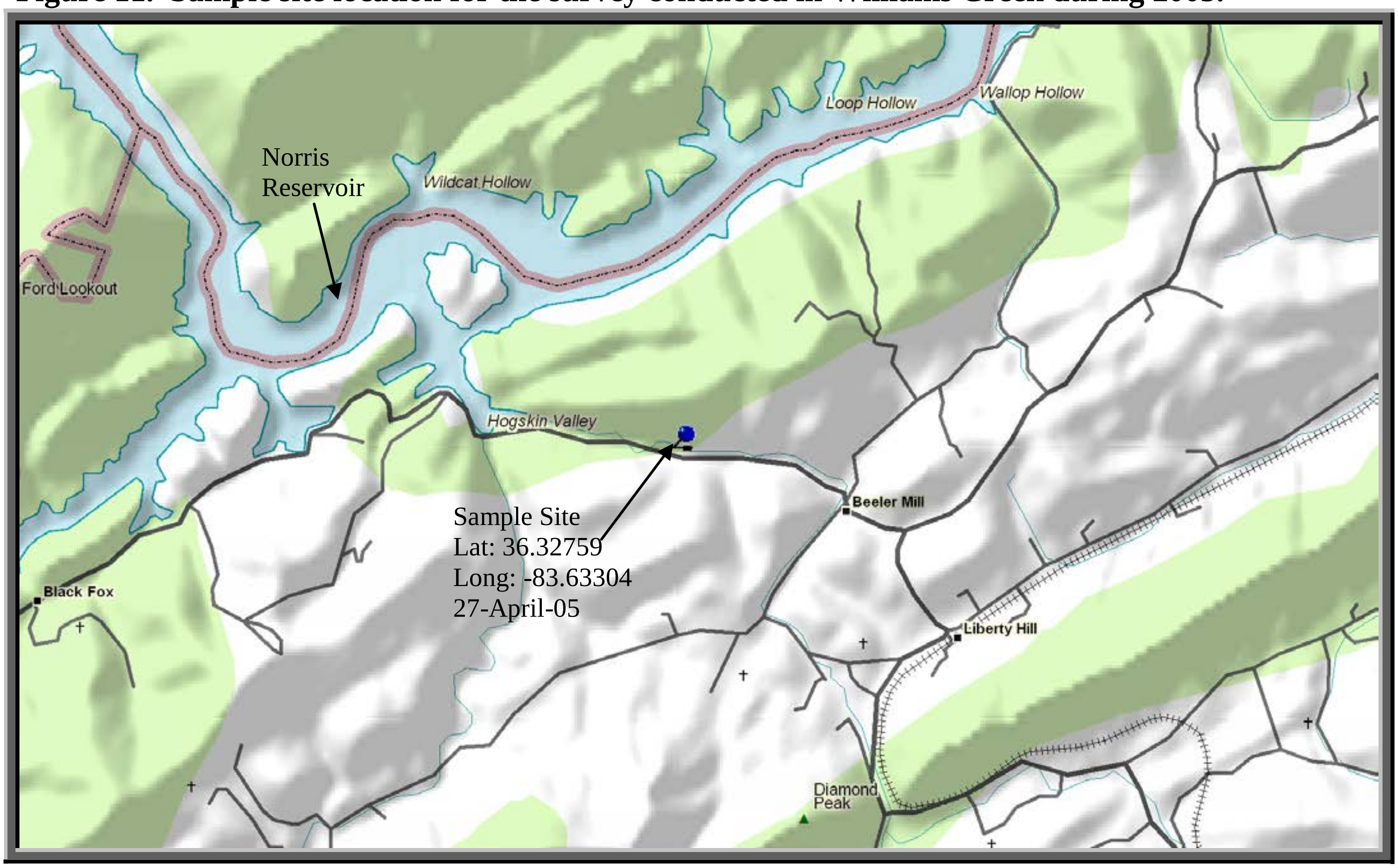
Introduction

Williams Creek is located in Grainger County near the community of Washburn. The stream flows in a northwesterly direction before joining the Clinch River near mile 129. Agricultural runoff into the stream is the most prominent pollution influence in this stream. We were primarily interested in evaluating the relative health of the stream and developing a species list for TADS. No prior agency collections had been made in this stream.

Study Area and Methods

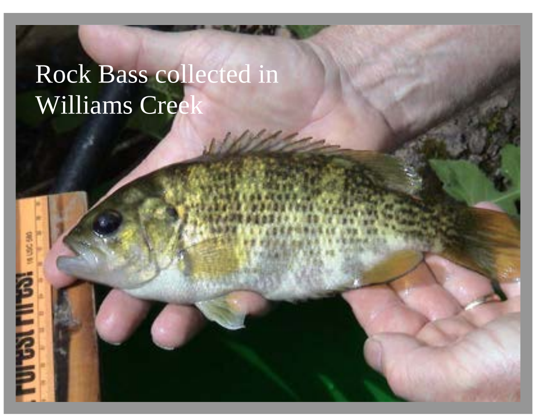
Our survey of Williams Creek (Figure 11) was conducted along Black Fox Road about 0.75 mi. upstream of Norris Reservoir. The stream at this location was moderately graded and was apparently influenced by a substantial volume of groundwater.

Figure 11. Sample site location for the survey conducted in Williams Creek during 2005.



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 50% in the riffles. Riffles dominated the habitat features contributing about 85% of the available habitat. Our sample site had a well-established riparian zone. Basic water quality measurements at this site revealed the following information: temperature 12.2 C, conductivity 238 µs/cm, flow 16.9 cfs and a pH of 6.5. There appeared to be some agricultural enrichment based on our observations within the watershed. Spring influence was also apparent based on stream vegetation and water volume.

Results



We collected a total of 91 fish comprising 17 species at our sample site (Table 9). There were four game species collected at this site, which included green sunfish, bluegill, rock bass, and smallmouth bass. The two most dominant species collected in our sample were the largescale stoneroller and striped shiner. Together, these two species comprised 54% of the total number of fish in our sample. Four species of darters were collected, greenside darter, rainbow darter, logperch and snubnose darter. Both the northern hog sucker and black redhorse were collected at this site although the northern hog sucker was the predominant species. There were three IBI metrics that had a substantial effect on lowering the overall score for this stream. These included the high percentage of omnivores in the population, the low percentage of trophic specialists, and the low catch rate. All other metrics scored fair or better and there was a low occurrence of anomalies on the fish collected. The high species richness encountered in this stream had the most dramatic positive influence on the overall rating. Overall, the IBI analysis indicated Williams Creek was in fair condition (IBI score = 42) (Table 10). The influence of spring inflow on this stream may be having a positive influence on the water quality and allowing the stream to continue to support the diverse fish assemblage even though there are apparent development disturbances and well established agriculture within the watershed. Our overall assessment of the habitat quality resulted in a score of 30.3 "fair".

Table 9. Fish species occurrence for Williams Creek 2005.

Site Code	Species	Tads Code	Total Number
420050801	*Ambloplites rupestris*	342	1
420050801	*Campostoma oligolepis*	45	39
420050801	*Cottus carolinae*	322	6
420050801	*Cyprinella spiloptera*	57	2
420050801	*Etheostoma blennioides*	398	1
420050801	*Etheostoma caeruleum*	401	2
420050801	*Etheostoma tennesseense*	435	3
420050801	*Hypentelium nigricans*	207	9
420050801	*Lepomis cyanellus*	347	3
420050801	*Lepomis macrochirus*	351	4
420050801	*Luxilus chrysocephalus*	89	10
420050801	*Micropterus dolomieu*	362	1
420050801	*Moxostoma duquesnei*	224	1
420050801	*Percina caprodes*	464	1
420050801	*Pimephales notatus*	176	1
420050801	*Rhinichthys obtusus*	184	4
420050801	*Semotilus atromacualtus*	188	3
		Total	**91**

Table 10. Williams Creek Index of Biotic Integrity analysis.

Metric Description	Scoring Criteria 1 3 5	Observed	Score
Number of Native Species	<7 7-14 >14	17	5
Number of Darter Species	<1 1 >1	4	5
Number of Sunfish Species less Micropterus	<1 1 >1	3	5
Number of Sucker Species	<1 1 >1	2	5
Number of Intolerant Species	<1 1 >1	1	3
Percent of Individuals as Tolerant	>34 34-19 <19	20	3
Percent of Individuals as Omnivores	>45 45-24 <24	55	1
Percent of Individuals as Specialists	<14 14-24 >24	8	1
Percent of Individuals as Piscivores	<2 2-3.5 >3.5	2	3
Catch Rate	<29 29-53 >53	8.8	1
Percent of Individuals as Hybrids	>1 1-TR 0	0	5
Percent of Individuals with Anomalies	>5 5-2 <2	1	5
		Total	**42 (Fair)**

Benthic macroinvertebrates collected in our sample comprised 29 families representing 40 identified genera (Table 11). The most abundant group in our collection was the mayflies comprising 55.7% of the total sample. Overall, a total of 43 taxa were identified from the sample of which 24 were EPT. Based on the EPT taxa richness and overall biotic index of all species collected, the relative health of the benthic community was classified as “good” (4.3).

Table 11. Taxa list and associated biotic statistics for benthic macroinvertebrates collected from Williams Creek.

ORDER	FAMILY	SPECIES	NUMBER	PERCENT
ANNELIDA				0.3
Oligochaeta			2	
COLEOPTERA				3.9
	Elmidae	*Macronychus glabratus* adult	1	
		Stenelmis larvae and adult	3	
	Psephenidae	*Ectopria*	2	
		Psephenus herricki	20	
DIPTERA				7.7
	Blephariceridae	*Blepharicera* pupae	14	
	Chironomidae		24	
	Simuliidae		11	
	Tipulidae	*Tipula*	2	
EPHEMEROPTERA				55.7
	Baetidae	*Baetis*	109	
	Ephemerellidae	*Ephemerella*	61	
		Eurylophella	10	
		Timpanago	1	
	Heptageniidae	*Epeorus rubidus/subpallidus*	24	
		Leucrocuta	11	
		Maccaffertium early instars	13	
		Maccaffertium modestum	10	
		Stenacron interpunctatum	4	
	Isonychiidae	*Isonychia*	124	
	Leptophlebiidae	*Habrophlebiodes*	1	
GASTROPODA				3.2
	Pleuroceridae	*Elimia*	21	
HETEROPTERA				0.2
	Gerridae	*Aquarius remigis* adult	1	
ISOPODA				9.5
	Asellidae	*Lirceus*	63	
MEGALOPTERA				0.6
	Corydalidae	*Corydalus cornutus*	1	
		Nigronia serricornis	3	
ODONATA				2.3
	Aeshnidae	*Boyeria vinosa*	2	
	Calopterygidae	*Calopteryx*	7	
	Gomphidae	*Gomphus* early instar	1	
		Gomphus (Genus A) rogersi	3	
		Stylogomphus albistylus	2	
PELECYPODA				1.5
	Sphaeriidae	*Sphaerium*	10	
PLECOPTERA				3.8
	Nemouridae	*Amphinemura delosa/nigritta*	4	
	Peltoperlidae	*Tallaperla*	2	
	Perlidae	*Acroneuria evoluta*	1	
		Neoperla	2	
		Perlesta early instars	8	
	Perlodidae	*Isoperla*	8	
TRICHOPTERA				11.3
	Glossosomatidae	*Glossosoma*	1	
	Helicopsychidae	*Helicopsyche borealis*	5	
		Ceratopsyche sparna	3	
		Cheumatopsyche	4	
		Hydropsyche rotosa	44	
	Limnephilidae	*Pycnopsyche* probably *guttifer*	1	
	Polycentropodidae	*Polycentropus* larvae and pupa	6	
	Uenoidae	*Neophylax etnieri*	9	
		Neophylax pupae	2	
		Total	**661**	

TAXA RICHNESS = 43
EPT TAXA RICHNESS = 24
BIOCLASSIFICATION = 4.3 (GOOD)

Discussion

Williams Creek is typical of many rural streams flowing within agricultural landscapes. With the inflow of groundwater into this system, Williams Creek is at a slight advantage over other tributaries in this watershed. The ability to support the diversity observed can be attributed to the influx of relatively clean water and the maintenance of flows which maximizes the amount of available habitat throughout the year. The potential for this stream to receive limited stocking of trout could be feasible as access along the stream is good.

Management Recommendations

1. Consider an experimental stocking of trout to evaluate angler use and feasibility.

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

3. Encourage BMP's within the watershed.

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 limited surveys of the river that focused primarily on collecting basic fish, benthic, and water quality data (Bivens 1988, Carter et al. 2000, 2003, 2004). Our survey of the Powell River focused on re-evaluating the sport fish population originally sampled in 1999. Our 2005 assessment was derived from ten sample sites located between river mile 115 and river mile 59. After our initial evaluation in 1999, the Powell River was put into a 3-year rotational schedule with eight other rivers in the region. Sport fish sampling sites were reduced to those that would best characterize these populations.

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).

A view of the Powell River near river mile 79

Between April 11 and 13, 2005, we conducted ten fish surveys between the Virginia state line and Norris Reservoir (Figure 12). In our survey sites, the riparian habitat consisted primarily of wooded shorelines with interspersed agricultural fields. Submerged woody debri and water willow 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 29.5 meters to 52.0 meters, while site lengths fell between 290 meters and 649 meters (Table 12). Water temperatures ranged from 15 C to 19.5 C and conductivity varied from 280 to 310µs/cm (Table 12).

Figure 12. Site locations for samples conducted in the Powell River during 2005.

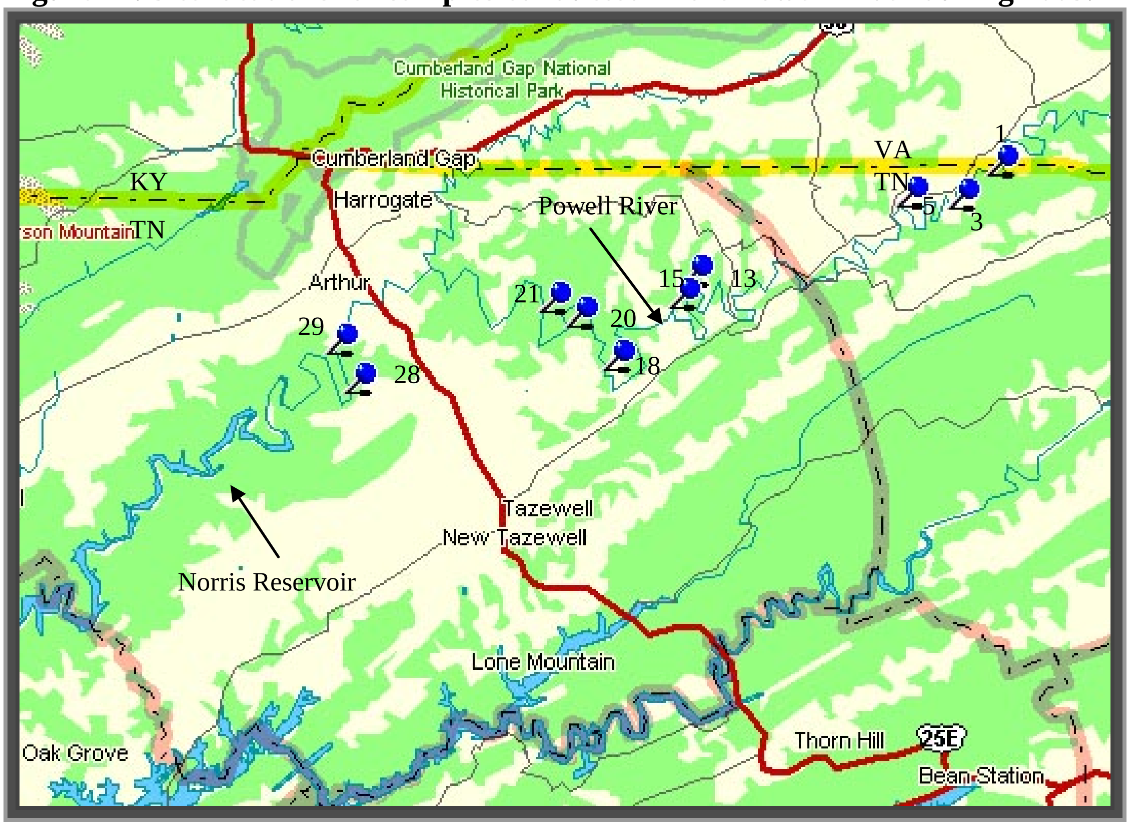


Table 12. Physiochemical and site location data for samples conducted in the Powell River during 2005.

Site Code	Site	Quad	River Mile	Latitude	Longitude	Mean Width (m)	Length (m)	Temp. C	Cond.	Secchi (m)
420050501	1	Back Valley	115	36.59472	-83.31444	29.5	290	15	310	1.5
420050503	3	Back Valley	112.1	36.58111	-83.33472	30	577	15	310	1.5
420050505	5	Back Valley	107.6	36.58194	-83.36194	33.5	480	15	310	1.5
420050513	13	Coleman Gap	91	36.54917	-83.47417	38.5	537	18	300	1.3
420050515	15	Coleman Gap	87.1	36.53972	-83.48028	39	649	19	300	1.3
420050518	18	Wheeler	81	36.51500	-83.51444	40	383	18	308	1.3
420050520	20	Wheeler	77.3	36.53139	-83.53389	38	570	18	300	1.2
420050521	21	Wheeler	75	36.53833	-83.54750	38.5	467	19.5	305	1.2
420050528	28	Middlesboro South	61	36.50528	-83.64861	52	452	16.5	280	1.3
420050529	29	Middlesboro South	59	36.52194	-83.65750	41.5	479	16.5	280	1.3

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 940 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).

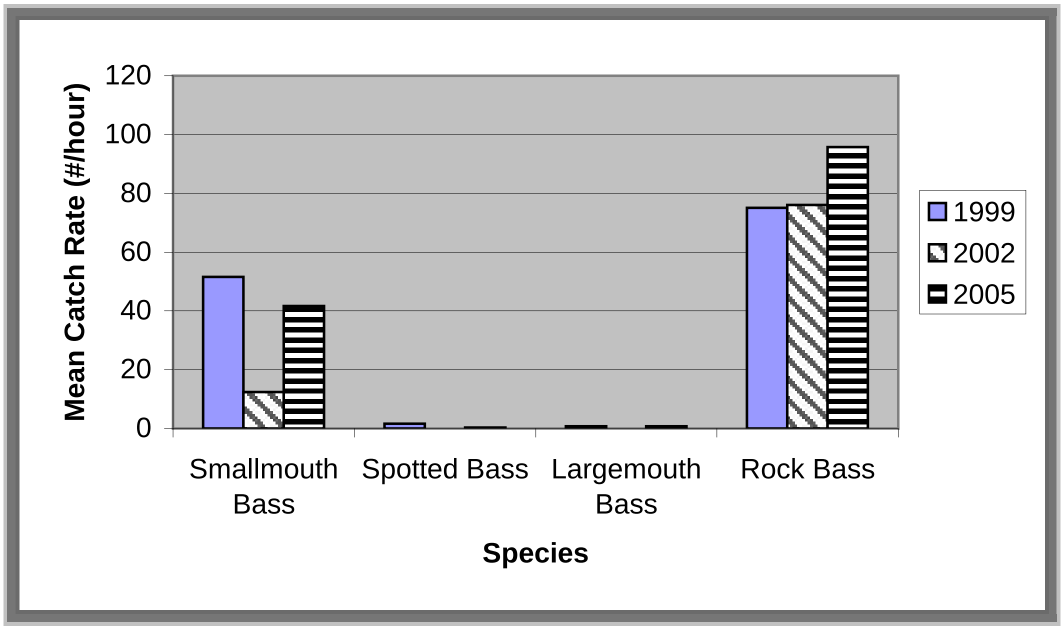
Results

CPUE estimates for smallmouth bass averaged 41.7/hour (SD 24.2), while the mean rock bass estimate was 95.7/hour (SD 71.6) (Table 13). Unlike the previous survey in 2002, spotted bass (0.38/hour) and largemouth bass (0.79/hour) were collected from a few of the ten survey sites in 2005. Although present, the numbers were extremely low making any comparisons to previous surveys difficult. Comparatively, there was a significant increase (236%) in the catch of smallmouth bass and likewise rock bass exhibited a 26% increase over the value recorded in 2002 (Figure 13). However, the 2005 value for smallmouth bass did fall short of that recorded in 1999. Given that our survey was conducted in the spring, our dramatic increases were not unexpected.

Table 13. Catch per unit effort and length categorization indices of target species collected at ten sites in the Powell River during 2005.

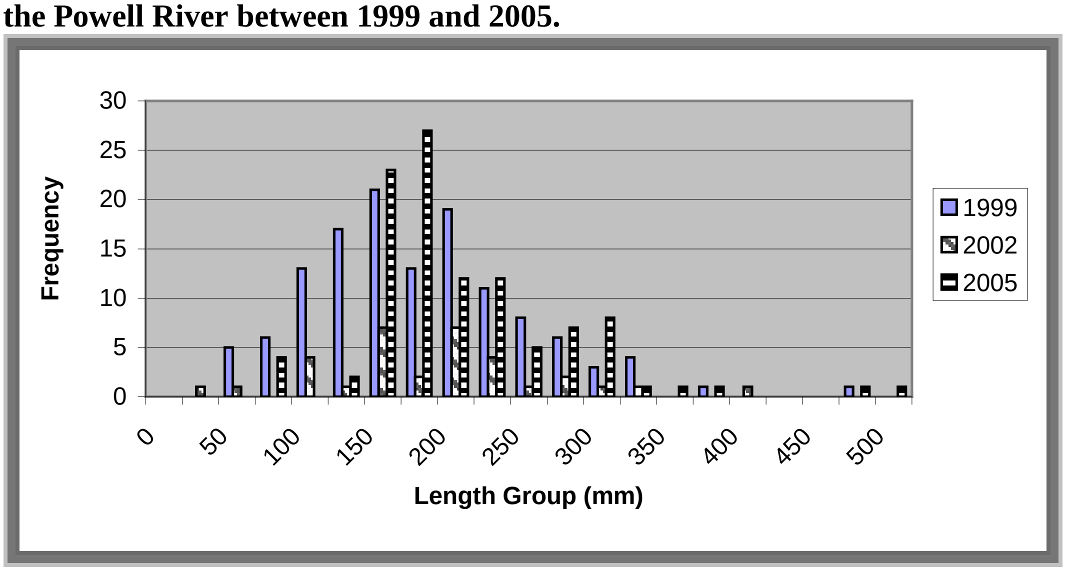
Site Code	Smallmouth Bass CPUE	Spotted Bass CPUE	Largemouth Bass CPUE	Rock Bass CPUE
420050501	51.8	-	-	31.9
420050503	36	-	-	16
420050505	16	-	-	124
420050513	99.1	-	-	233.9
420050515	55.8	-	3.9	191.5
420050518	47.9	-	-	55.9
420050520	36	-	4	116
420050521	20	-	-	56
420050528	23.9	-	-	39.9
420050529	30.6	3.8	-	91.9
MEAN	41.7	0.38	0.79	95.7
STD. DEV.	24.2	1.2	1.6	71.6
	Length-Categorization Analysis	**Length-Categorization Analysis**	**Length-Categorization Analysis**	**Length-Categorization Analysis**
	PSD = 25.3	PSD = 0	PSD = 0	PSD = 30
	RSD-PREFERRED = 5.6	RSD-PREFERRED = 0	RSD-PREFERRED = 0	RSD-PREFERRED = 0.83
	RSD-MEMORABLE = 2.8	RSD-MEMORABLE = 0	RSD-MEMORABLE = 0	RSD-MEMORABLE = 0
	RSD- TROPHY = 1.4	RSD- TROPHY = 0	RSD- TROPHY = 0	RSD- TROPHY = 0

Figure 13. Trends in mean catch rate of black bass and rock bass collected between 1999 and 2005 from the Powell River.



The size distribution of smallmouth bass between 1999 and 2005 changed somewhat among our ten sampling stations (Figure 14). We did observe an increase in the number of bass 150 mm and greater, although our catch of bass less than this value was somewhat less than 2002. Generally, we observed good recruitment into size classes above 6 inches and were able to collect one bass that fell into the trophy category (20 inches). Overall we felt the size structure in 2005 was well represented although the 1999 distribution seemed to be somewhat "richer" particularly with regards to smaller size classes.

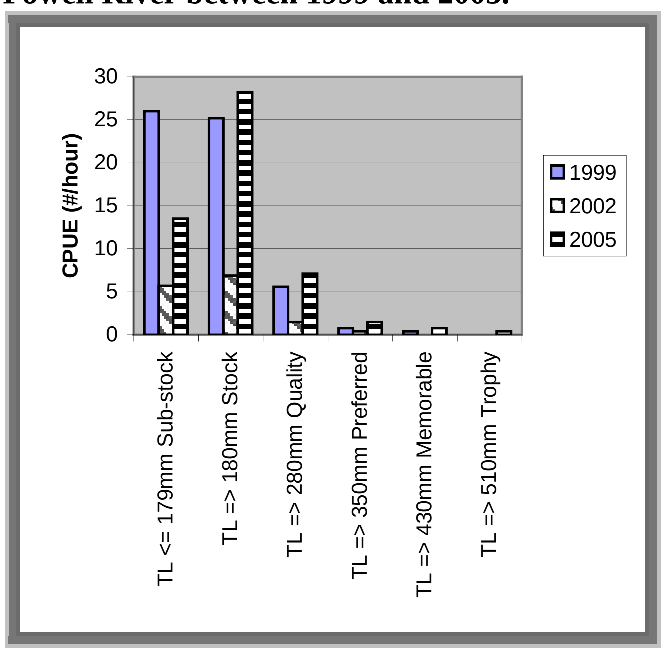
Figure 14. Length frequency distributions for smallmouth bass collected from the Powell River between 1999 and 2005.



The number of bass over 14 inches increased between the two sampling periods. Four bass 14 inches or greater were collected in 2005 compared to one bass in the 2002 sample. One bass in the 20-inch class was collected and represents the first to be recorded in this size class.

Length categorization analysis indicated the relative stock density (RSD) of preferred smallmouth bass (TL $\geq$ 350 mm) was 5.6 (Table 13). RSD for memorable (TL $\geq$ 430 mm) and trophy (TL $\geq$ 510 mm) size bass were 2.8 and 1.4, respectively. The PSD of smallmouth bass (ratio of quality size bass to stock size bass) was 25.3. In comparison, the value for 2005 was slightly higher for bass in the preferred category when compared to 2002 and the collection of memorable and trophy size bass had not been accomplished in previous surveys. Catch-per-unit-effort estimates by RSD category in 2005 indicated an increase in every RSD category when compared to 2002. This was most likely related to the timing of our sample which decreased the probability of catching smaller size classes. The 2005 figures were well above those observed in 2002 and for the most part those seen 1999. The exception was in the sub-stock category where the 1999 value was about double that observed in 2005 (Figure 15).

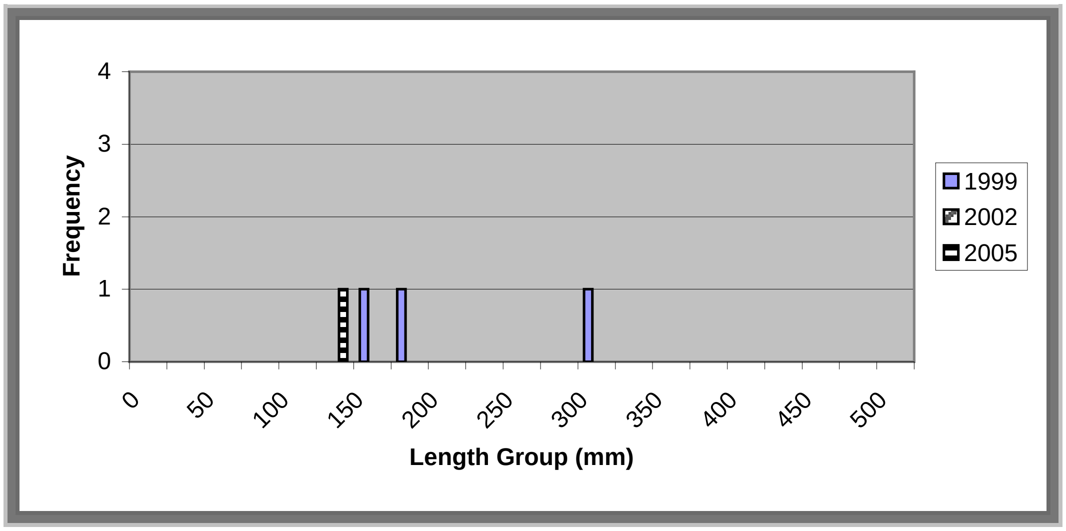
Figure 15. Relative stock density (RSD) catch per unit effort for smallmouth bass collected from the Powell River between 1999 and 2005.



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 2005, 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).

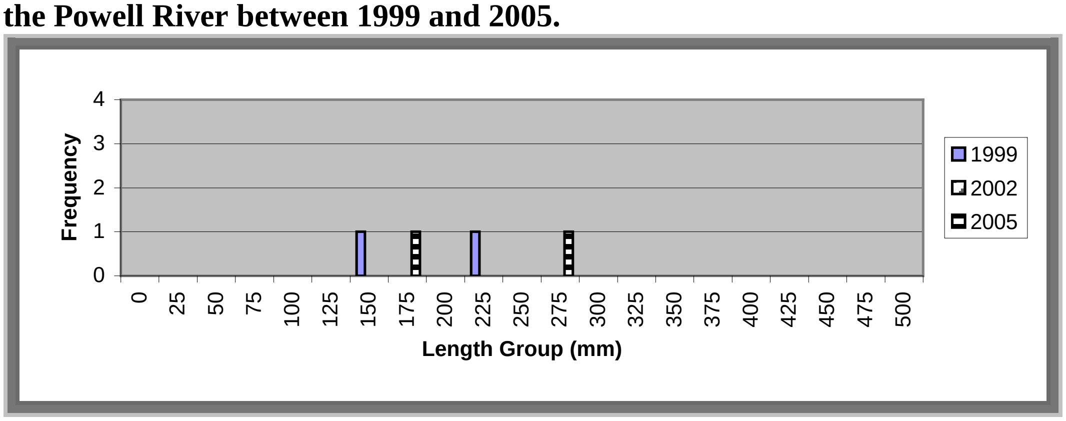
There was only one spotted bass collected from the Powell River in 2005. This fish was 142 mm in length and was collected in the lower reach of the river at site 29. Given the scarcity of spotted bass in the Powell, no real inferences about their contribution to the fishery can be made. However, they do persist in the river and may offer some opportunity to anglers. Figure 16 portrays the distribution of lengths for spotted bass collected from the Powell River between 1999 and 2005. Catch rate for spotted bass averaged 0.38/hour (SD 1.2).

Figure 16. Length frequency distributions for spotted bass collected from the Powell River between 1999 and 2005.



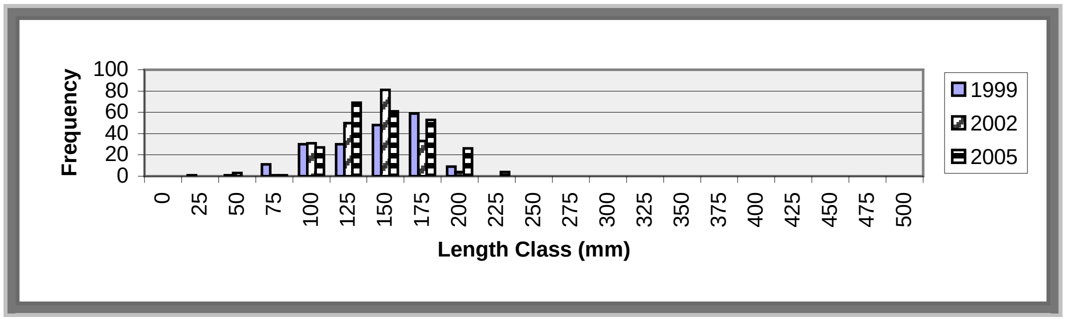
Two largemouth bass were collected from the Powell River during the 2005 survey (Figure 17). One at site 15 and one at site 20. These fish ranged from 180 mm to 277 mm. Due to the low abundance of largemouth bass in the Powell, little can be said about population density and size structure. The catch rate for largemouth bass averaged 0.79/hour (SD 1.6).

Figure 17. Length frequency distributions for largemouth bass collected from the Powell River between 1999 and 2005.



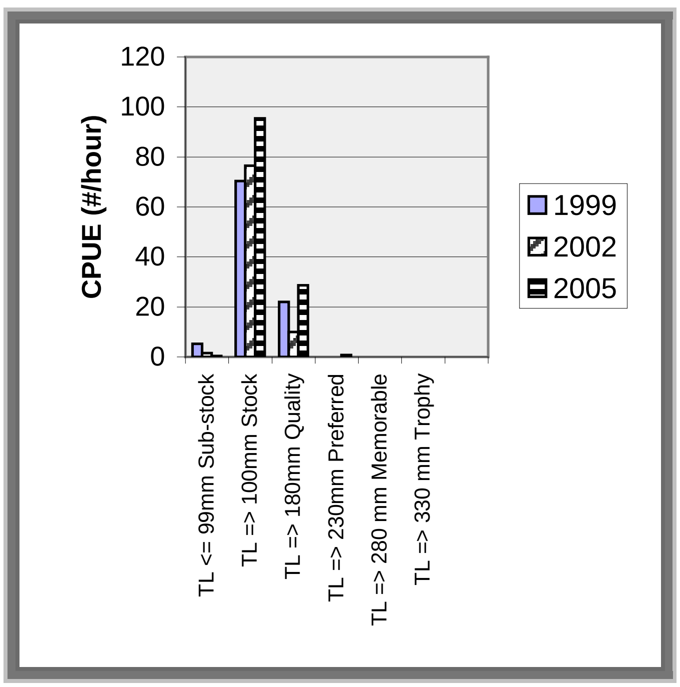
Individuals in the 100 to 200 mm range represented the majority of rock bass in our samples between 1999 and 2005 (Figure 18). For the most part, the distributions among years were fairly similar. We did observe noticeable increases in the number of rock bass in the 175 mm size class and above during 2005. Length categorization analysis indicated the RSD

Figure 18. Length frequency distributions for rock bass collected from the Powell River between 1999 and 2005.



for preferred rock bass (TL ≥ 230 mm) was 0.83. RSD for both memorable (TL ≥ 280 mm) and trophy (TL ≥ 330 mm) size rock bass was 0. The PSD of rock bass was 30 which was a substantial increase over the value observed in 2002 (13.1) (Table 13). Catch per unit effort estimates by RSD category indicated the majority of our catch was stock size fish with fewer quality size rock bass represented in the sample (Figure 19). However, the value recorded in 2005 for quality size rock bass was considerably higher than the value observed in 2002 (186%). We did collect rock bass in the RSD-P category, which was a first for the samples conducted to date.

Figure 19. Relative stock density (RSD) catch per unit effort for rock bass collected from the Powell River between 1999 and 2005.



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 2005. Therefore, no mortality or potential population growth statistics could be calculated. 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.

The popularity of this riverine fishery is continuing to grow as more anglers shift from reservoir habitats to rivers. This trend will undoubtedly continue as the use on reservoirs increases. This type of potential for exploitation of riverine fisheries requires angler use/harvest data collection in order to effectively manage the resource. It is imperative that we obtain this data in order to answer fish management questions, public inquiries, and aid in the development of regulations. Recent Index of Biotic Integrity surveys by TVA have indicated that the Powell River is in "good to excellent" condition based on data from one long-term monitoring station.

Overall the Powell River represents one of east Tennessee's premier warmwater river 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 2008 will in all likelihood repeat those samples conducted in 2005.

Management Recommendations

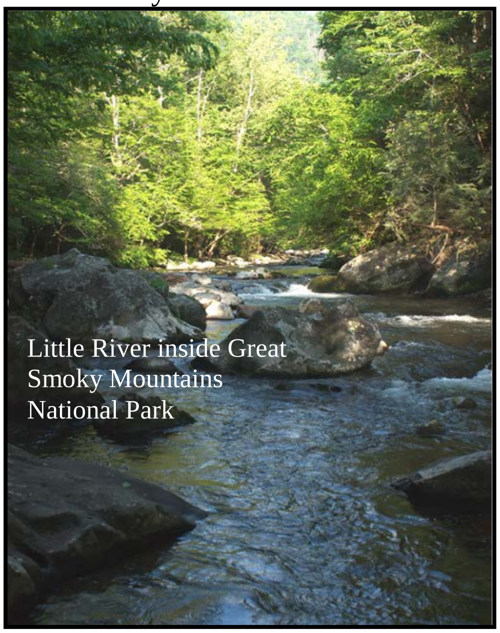
1. Initiate an angler use and harvest survey.

2. Develop a fishery management plan for the river.

Little River

Introduction

Little River originates in Sevier County on the north slope of Clingmans Dome, in the Great Smoky Mountains National Park. It flows in a northwesterly direction for about 95 kilometers, past Elkmont in the National Park, and Townsend, Walland, and Maryville in Blount County, and joins the Tennessee River near river mile 635.6. Fort Loudoun Reservoir, impounds the lower 6.8 miles of Little River with another 1.5 miles being impounded by the low head dam at Rockford (located at the backwaters of Fort Loudoun). In all, a little over eight lower river miles are impounded. Another 0.75 mile or so is impounded by Perrys Milldam downstream of Walland, near river mile 22. A third low head dam is located in Townsend near river mile 33.6. The river has a drainage area of approximately 982 km^2 at its confluence with the Tennessee River. The upper reach of the river (upstream of Walland) is located in the Blue Ridge physiographic province, and then transitions into the Ridge and Valley province from Walland to Fort Loudoun Reservoir. Little River is a very scenic stream in the Great Smoky Mountains National Park. There, it drains an area containing some of the most spectacular scenery in the southeastern United States. The Little River fishery within the National Park boundary is primarily wild rainbow and brown trout with smallmouth bass in the lower reaches. An excellent trout fishery exists, and is managed by the National Park Service. Little River's gradient becomes moderate as it leaves the National Park and flows through the Tuckaleechee Valley from Townsend to Walland. Excellent populations of smallmouth bass and rock bass exist there, and rainbow trout are stocked in spring and fall as water temperatures allow. This portion of the river has many developed campgrounds and is a popular recreation destination for tourists. While not as developed as Pigeon Forge, the Townsend area has grown significantly over the past two decades. Downstream of Walland, Little River leaves the mountains and no longer displays the extreme clarity and attractive rocky bottom of its upper reaches. Here it enters the Ridge and Valley province and resembles the more typical large river habitat with lower gradient and large deep pools interspersed with shallow shoal areas. Downstream of Perrys Milldam, the fishery, while still primarily smallmouth bass and rock bass, declines in quality relative to the upstream reach. This is probably related to limited availability of preferred smallmouth bass habitat. Near the small community of Rockford, Little River flows into a surprisingly large (given the size of the stream) embayment of Fort Loudon Lake. The Little River forms the boundary between Blount County and Knox County for the last few miles of its course.



Little River inside Great Smoky Mountains National Park

Little River represents an important recreational resource for the state both in consumptive and non-consumptive uses. It supports an active tubing/rafting industry and is an important recreational resource for local residents and tourists alike. It is also the municipal water source of the cities of Alcoa and Maryville. It provides critical habitat for species of special concern and is home to over 50 species of fish (four listed as federally). Additionally, its upper reach supports one of east Tennessee's better warmwater sport fisheries. It provides anglers with the opportunity to catch all species of black bass, rock bass, and even stocked rainbow trout when water temperatures allow. Our survey of Little River was primarily concerned with characterizing the sport fish populations and developing a sampling protocol for the river. This was our first intensive survey of the river which required varying techniques and equipment at different locations in the river.

Study Area and Methods

Little River near Walland

Our survey of Little River was confined between river mile 10 and 32 and consisted of 15 sites. All of our sample sites with the exception of 12-15 were located in the Ridge and Valley ecoregion. Sites 12-15 were in the transitional zone between the Blue Ridge and the Ridge and Valley.

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 access area managed by the Agency (Perrys Mill). Between April 3 and 24, 2005, we conducted sport fish surveys between Townsend and Rockford (Figure 20). In our survey sites, the riparian habitat consisted primarily of wooded shorelines with interspersed agricultural fields. Submerged woody debri was fairly common in most of our sample areas along with large boulder in the upper reaches. The river substrate was predominately boulder/cobble in riffle areas and bedrock with interspersed boulders/cobble in the pool habitat. The prevalence of boulders decreased somewhat as we proceeded downstream and the abundance of gravel and coble increased. Water temperatures ranged from 11 C to 17 C and conductivity varied from 30 to 87 µs/cm (Table 14).

Figure 20. Site locations for samples conducted in Little River during 2005.

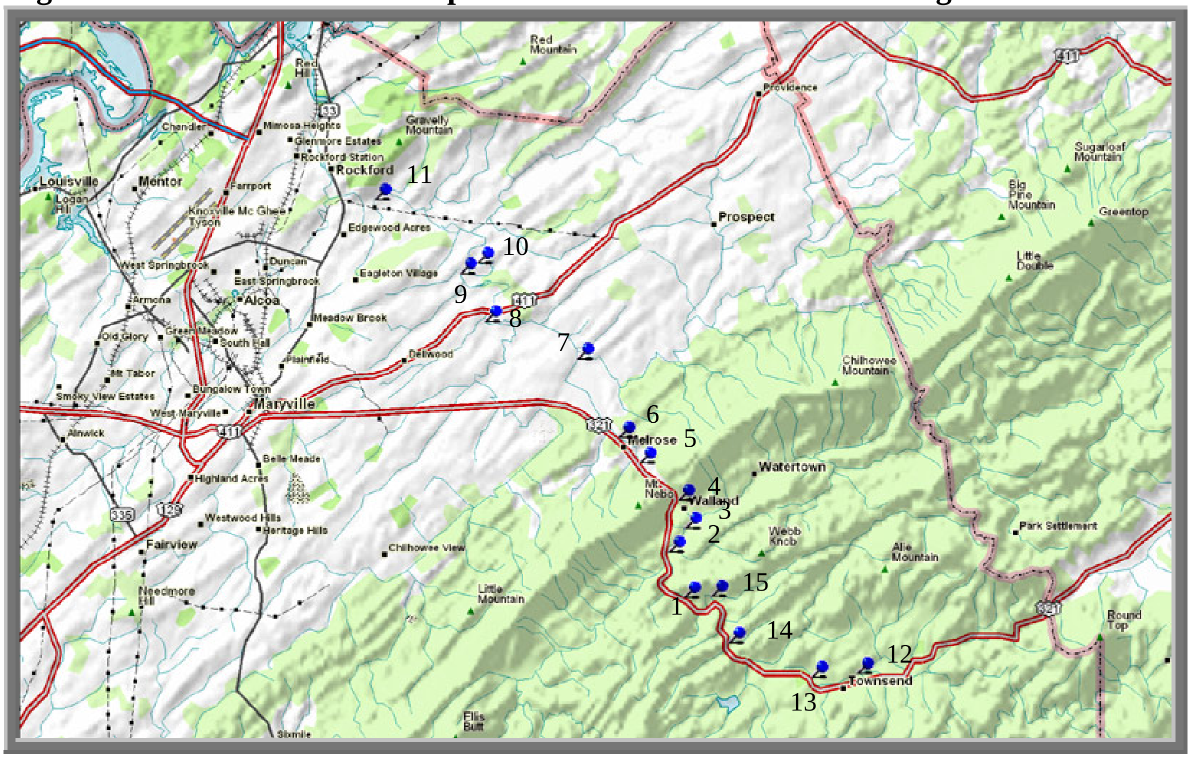


Table 14. Physiochemical and site location data for samples conducted in Little River during 2005.

Site Code	Site	Quad	River Mile	Latitude	Longitude	Mean Width (m)	Length (m)	Temp. C	Cond.	Secchi (m)
420050901	1	Kinzel Springs	26.6	35.70190	-83.81320	-	-	11	31	1.7
420050902	2	Kinzel Springs	25.1	35.71550	-83.81870	-	-	12	31	1.7
420050903	3	Kinzel Springs	24.6	35.72240	-83.81280	-	-	13	40	1.7
420050904	4	Kinzel Springs	23.8	35.73050	-83.81550	-	-	14.5	38	2.7
420050905	5	Kinzel Springs	22.6	35.74160	-83.82940	-	-	14	40	2.7
420050906	6	Kinzel Springs	21.9	35.74920	-83.83700	-	-	11.5	38	1.7
420050907	7	Wildwood	19.7	35.77180	-83.85190	-	-	12.8	50	1.7
420050908	8	Maryville	17.6	35.78320	-83.88510	-	-	13.5	70	1.7
420050909	9	Maryville	15.3	35.79710	-83.89400	-	-	15	70	1.5
420050910	10	Maryville	14.1	35.80020	-83.88840	-	-	16	75	1.7
420050911	11	Maryville	10.6	35.81880	-83.92520	-	-	15	87	1.7
420050912	12	Kinzel Springs	32.1	35.67960	-83.75060	-	-	16.5	32	2
420050913	13	Kinzel Springs	30.9	35.67880	-83.76700	-	-	17	31	2
420050914	14	Kinzel Springs	28.8	35.68850	-83.79720	-	-	17	30	2
420050915	15	Kinzel Springs	27.5	35.70250	-83.80380	-	-	17	50	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 2-3 amps DC at all sites. This current setting was determined effective in narcotizing all target species (black bass and rock bass). Additionally, efforts were made to identify non-target species subsequently encountered and compile a list for each survey site. All sites were sampled during daylight hours and had survey durations ranging from 522 to 1401 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).

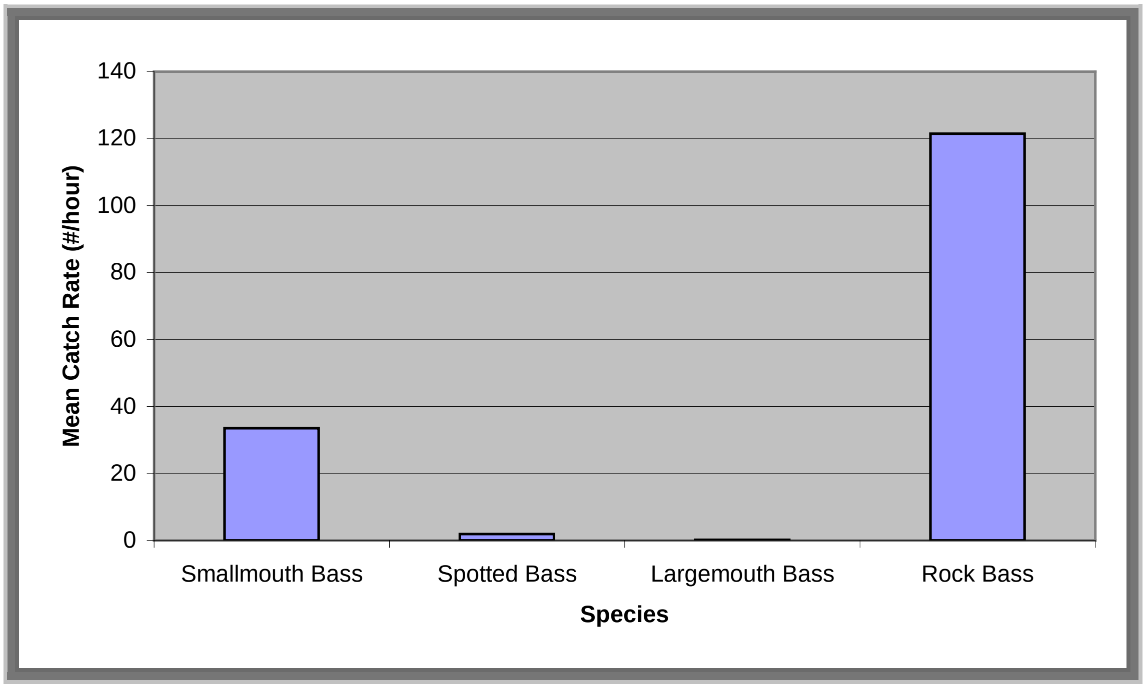
Results

CPUE estimates for smallmouth bass averaged 33.5/hour (SD 25.9), while the mean rock bass estimate was 121.5/hour (SD 70.5) (Table 15). The CPUE estimates for spotted bass and largemouth bass were 1.9 (SD 4.3) and 0.2 (SD 0.9).

Table 15. Catch per unit effort and length categorization indices of target species collected at nine sites on Little River during 2005.

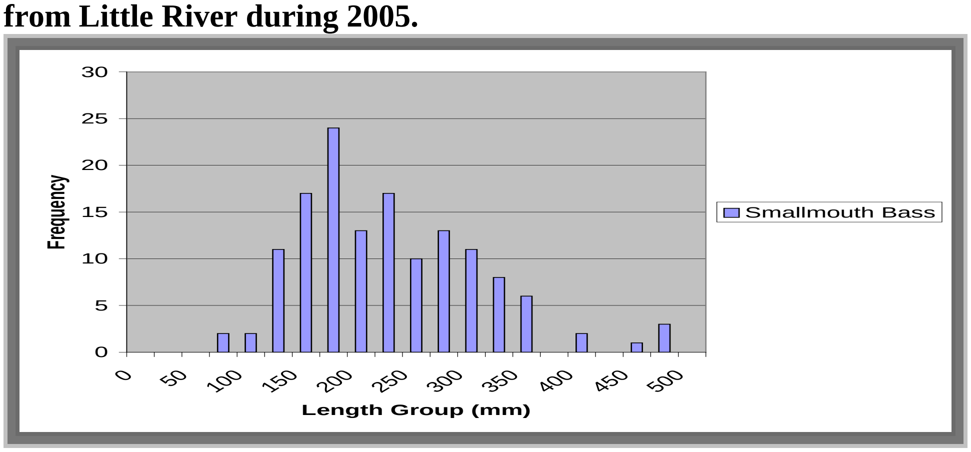
Site Code	Smallmouth Bass CPUE	Spotted Bass CPUE	Largemouth Bass CPUE	Rock Bass CPUE
420050901	96.9	-	-	124.6
420050902	54.5	-	-	217.9
420050903	37.9	-	-	238.5
420050904	30.8	-	-	143.9
420050905	25.6	-	3.7	43.9
420050906	-	-	-	41.4
420050907	23.4	3.7	-	88.0
420050908	6.4	-	-	70.2
420050909	11.9	12.8	-	44.7
420050910	27.9	-	-	95.4
420050911	58.6	11.4	-	239.6
420050912	64.0	-	-	75.8
420050913	35.3	-	-	200.0
420050914	23.4	-	-	108.0
420050915	6.4	-	-	90.2
MEAN	33.5	1.9	0.2	121.5
STD. DEV.	25.9	4.3	0.9	70.5
	Length-Categorization Analysis	**Length-Categorization Analysis**	**Length-Categorization Analysis**	**Length-Categorization Analysis**
	PSD = 42	PSD = 0	PSD = 0	PSD = 26.7
	RSD-PREFERRED = 12	RSD-PREFERRED = 0	RSD-PREFERRED = 0	RSD-PREFERRED = 3.8
	RSD-MEMORABLE = 4	RSD-MEMORABLE = 0	RSD-MEMORABLE = 0	RSD-MEMORABLE = 0.6
	RSD- TROPHY = 0	RSD- TROPHY = 0	RSD- TROPHY = 0	RSD- TROPHY = 0

Figure 21. Trends in mean catch rate of black bass and rock bass collected from Little River in 2005.



Our observation of mean catch for sport species was not untypical for east Tennessee rivers. Our highest catches were associated with two species, smallmouth bass and rock bass (Figure 21). Spotted bass and largemouth bass followed suit with much lower densities and typical ranking (spotted bass usually higher than largemouth bass). The size distribution of smallmouth bass in Little River was fairly typical although the number of quality size bass appeared to be somewhat higher than other rivers in the region (Figure 22). Although our catch of juvenile bass was low, we did observe enough bass in these size categories to indicate reproduction and progressive recruitment into larger size classes.

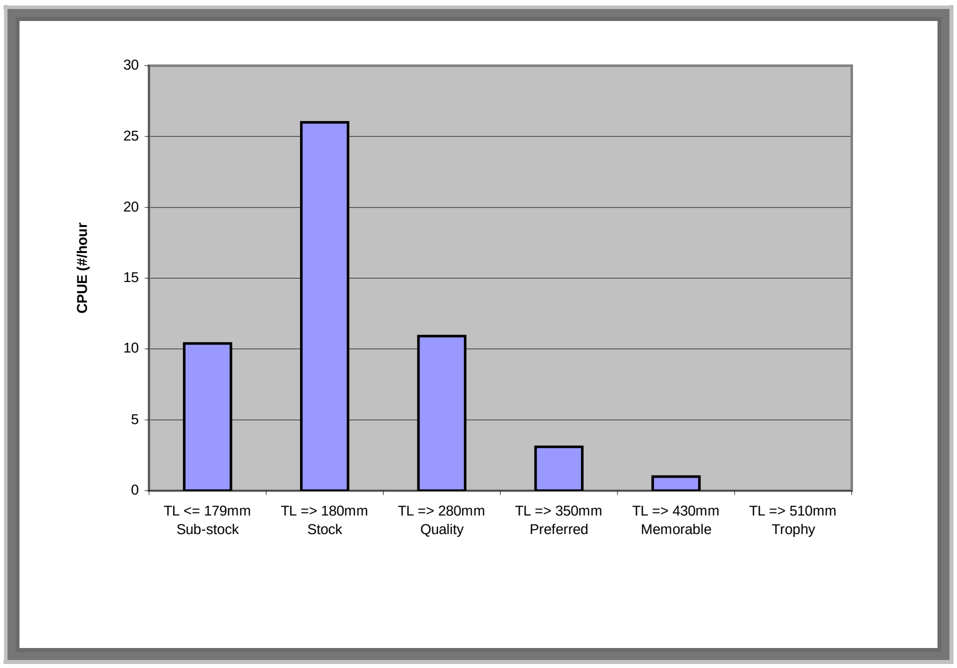
Figure 22. Length frequency distribution for smallmouth bass collected from Little River during 2005.



The largest smallmouth bass we collected were in the 475 mm class (18 inches). Three fish in this size category were collected.

Length categorization analysis indicated the relative stock density (RSD) of preferred smallmouth bass (TL ≥ 350 mm) was 12 (Table 15). RSD for memorable (TL ≥ 430 mm) and trophy (TL ≥ 510 mm) size bass were 4 and 0, respectively. The PSD of smallmouth bass (ratio of quality size bass to stock size bass) was 42. Our highest catch for the reported RSD categories was for bass of stock size (length ≥ 180mm). We did observe a high number of bass in the sub-stock category which is relatively indicative of good reproduction. Overall, the catch for each respective category was fairly similar to other rivers in the region displaying a normal distribution among size categories (Figure 23).

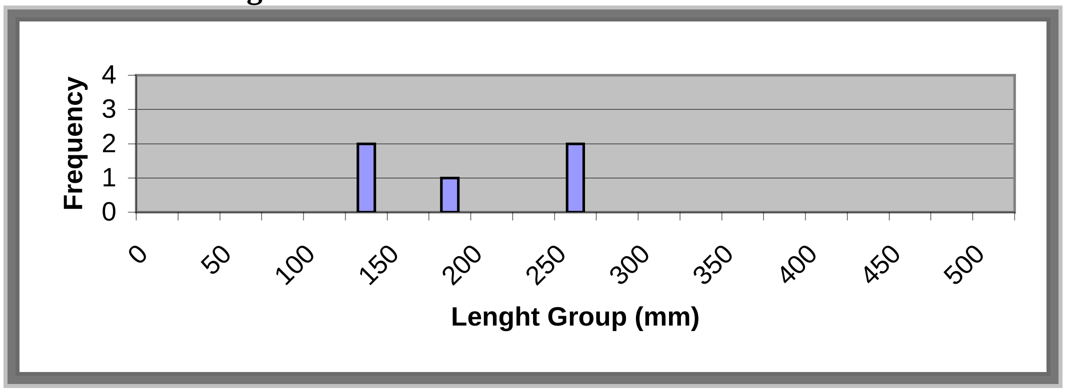
Figure 23. Relative stock density (RSD) catch per unit effort for smallmouth bass collected from Little River in 2005.



We did not sample otoliths from smallmouth bass collected in Little River. Since we have no information pertaining to the age and growth of this population, subsequent samples need to include a sub-sample of fish for age and growth analysis.

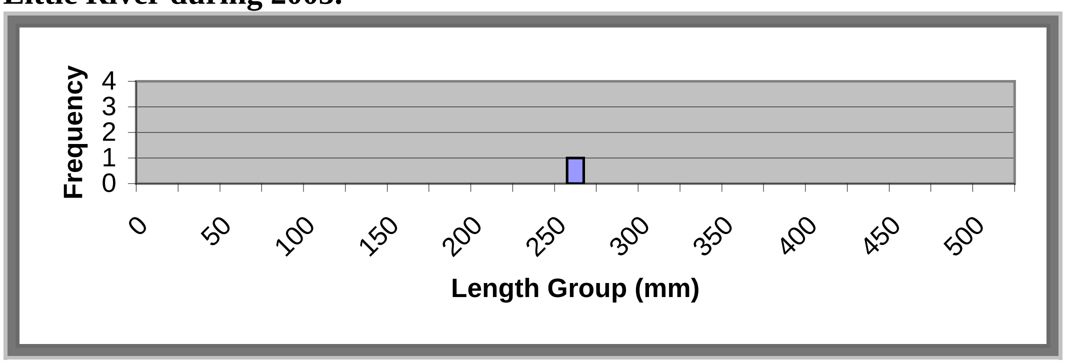
There were only five spotted bass collected from the Little River in 2005. These fish ranged in length from 142 to 254 mm in length and were collected in the lower reaches of the river. Given the scarcity of spotted bass in Little River, no real inferences about their contribution to the fishery can be made. However, they do persist in the river and may offer some opportunity to anglers. Figure 24 portrays the distribution of lengths for spotted bass collected from Little River during 2005. Catch rate for spotted bass averaged 1.9/hour (SD 4.3).

Figure 24. Length frequency distribution for spotted bass collected from Little River during 2005.



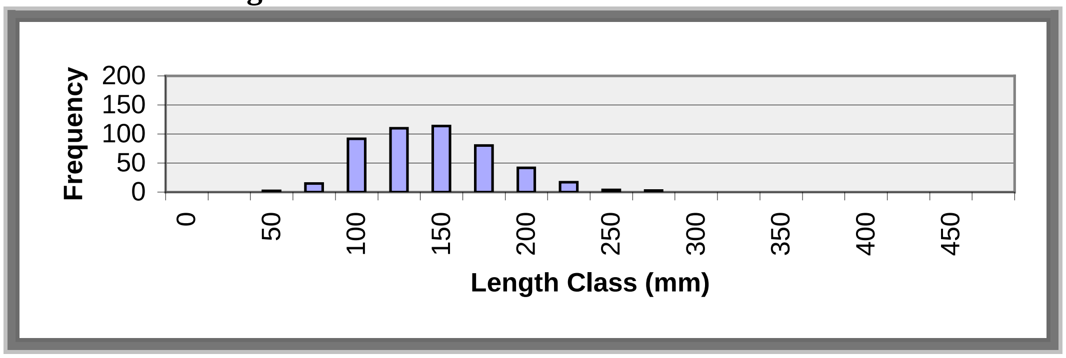
Only one largemouth bass was collected during the 2005 survey (Figure 25). This fish was 254 mm in length. Due to the low abundance of largemouth bass in this river, little can be said about population density and size structure. The catch rate for largemouth bass averaged 0.2/hour (SD 0.9).

Figure 25. Length frequency distribution for largemouth bass collected from Little River during 2005.



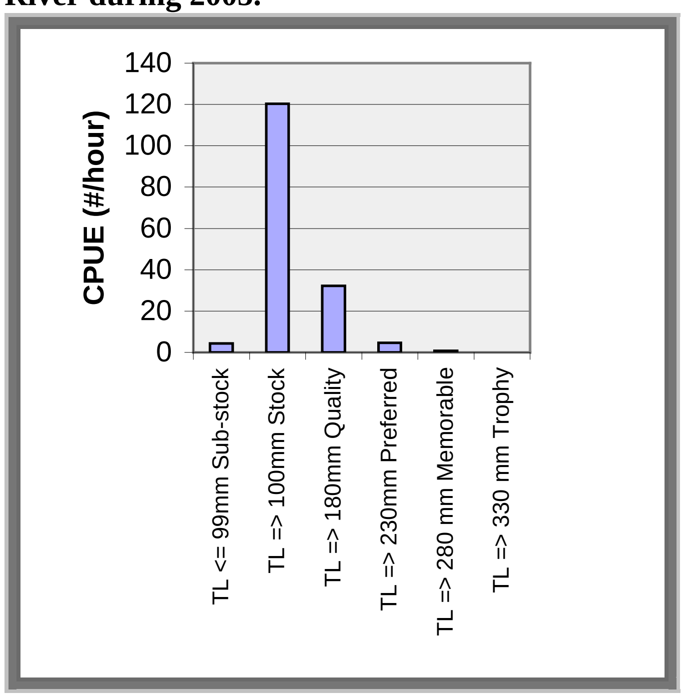
Individuals in the 100 to 200 mm range represented the majority of rock bass in our Little River sample during 2005 (Figure 26). The collection of rock bass from Little River represents our highest catch (for the number of sites sampled) for this species in any of the rivers surveyed to date. We collected 479 rock bass from 15 sample sites with about 26% of these fish being quality size (7 inches) or larger. For the first time since large river sampling was initiated (1998) we were able to collect one rock bass considered to be of trophy size 297 mm (11.6 inches). This fish was very well conditioned and had a weight of 312 grams (0.69 pounds). Although low in number, we did collect juvenile rock bass in the 70 mm class.

Figure 26. Length frequency distribution for rock bass collected from the Little River during 2005.



Relative stock density (RSD) analysis indicated the RSD for preferred rock bass (TL ≥ 230 mm) was 3.8. RSD for both memorable (TL ≥ 280 mm) and trophy (TL ≥ 330 mm) size rock bass was 0.6 and 0, respectively. The PSD (ratio of quality size to stock size) of rock bass was 26.7. Catch by RSD category illustrated most of the fish we collected were in the stock category (Figure 27). We did observe a good representation by quality size fish and did record a low percentage of rock bass above 280 mm (11 inches).

Figure 27. Relative stock density (RSD) catch per unit effort for rock bass collected from Little River during 2005.



Like smallmouth bass, we did not take any otoliths from rock bass collected in Little River. Future surveys of this river should include a sub-sample of otoliths from this species in order to evaluate the age and growth characteristics of the population.

Collaborative community assessments of Little River have been ongoing since the 1980's. These surveys have primarily focused on evaluating relative health changes in the fish community. Two Index of Biotic Integrity surveys were conducted in July 2005 at Coulter's Bridge (river mile 20) and Townsend (river mile 29.8). A total of 47 fish species were collected at the Coulters Bridge site while 26 were observed at Townsend. Overall, The IBI analysis indicated the fish community was in good to excellent condition at Coulters Bridge (IBI score 54). The condition of the fish community decreased somewhat at the upper most station, Townsend, although the rating of this reach of stream was still classified as good (IBI score 48). Several rare or endangered species of fish inhabit Little River, and thus, the protection of the watershed is a high priority of managing agencies and local conservation groups. Table 16 lists the species and number of fish collected at the two IBI stations.


Blotchside logperch collected from Little River

Table 16. Fish species collected at two Little River IBI station during 2005.

Site	Species	Number Collected
420050916 (Coulter's Bridge)	*Ambloplites rupestris*	31
420050916 (Coulter's Bridge)	*Aplodinotus grunniens*	4
420050916 (Coulter's Bridge)	*Campostoma oligolepis*	53
420050916 (Coulter's Bridge)	*Cottus carolinae*	33
420050916 (Coulter's Bridge)	*Cyprinella galactura*	27
420050916 (Coulter's Bridge)	*Cyprinella spiloptera*	10
420050916 (Coulter's Bridge)	*Cyprinus carpio*	9
420050916 (Coulter's Bridge)	*Dorosoma cepedianum*	12
420050916 (Coulter's Bridge)	*Erimystax insignis*	4
420050916 (Coulter's Bridge)	*Etheostoma blennioides*	11
420050916 (Coulter's Bridge)	*Etheostoma camurum*	3
420050916 (Coulter's Bridge)	*Etheostoma jessiae*	5
420050916 (Coulter's Bridge)	*Etheostoma rufilineatum*	316
420050916 (Coulter's Bridge)	*Etheostoma tennessense*	1
420050916 (Coulter's Bridge)	*Etheostoma zonale*	9
420050916 (Coulter's Bridge)	*Fundulus catenatus*	1
420050916 (Coulter's Bridge)	*Hybopsis amblops*	159
420050916 (Coulter's Bridge)	*Hypentelium nigricans*	27
420050916 (Coulter's Bridge)	*Ichthyomyzon sp.*	2
420050916 (Coulter's Bridge)	*Lepisosteus osseus*	2
420050916 (Coulter's Bridge)	*Lepomis auritus*	77
420050916 (Coulter's Bridge)	*Lepomis cyanellus*	19
420050916 (Coulter's Bridge)	*Lepomis macrochirus*	45
420050916 (Coulter's Bridge)	*Luxilus chrysocephalus*	1

Table 16. Continued.

Site	Species	Number Collected
420050916 (Coulter's Bridge)	*Luxilus coccogenis*	21
420050916 (Coulter's Bridge)	*Lythrurus lirus*	5
420050916 (Coulter's Bridge)	*Micropterus dolomieu*	5
420050916 (Coulter's Bridge)	*Micropterus punctulatus*	2
420050916 (Coulter's Bridge)	*Micropterus salmoides*	4
420050916 (Coulter's Bridge)	*Minytrema melanops*	1
420050916 (Coulter's Bridge)	*Moxostoma anisurum*	4
420050916 (Coulter's Bridge)	*Moxostoma carinatum*	3
420050916 (Coulter's Bridge)	*Moxostoma duquesnei*	57
420050916 (Coulter's Bridge)	*Moxostoma erythrurum*	19
420050916 (Coulter's Bridge)	*Nocomis micropogon*	9
420050916 (Coulter's Bridge)	*Notropis leuciodus*	133
420050916 (Coulter's Bridge)	*Notropis photogenis*	9
420050916 (Coulter's Bridge)	*Notropis rubellus*	47
420050916 (Coulter's Bridge)	*Notropis telescopus*	71
420050916 (Coulter's Bridge)	*Notropis volucellus*	18
420050916 (Coulter's Bridge)	*Noturus eleutherus*	1
420050916 (Coulter's Bridge)	*Percina aurantiaca*	1
420050916 (Coulter's Bridge)	*Percina burtoni*	1
420050916 (Coulter's Bridge)	*Percina caprodes*	4
420050916 (Coulter's Bridge)	*Percina evides*	11
420050916 (Coulter's Bridge)	*Percina macrocephala*	1
420050916 (Coulter's Bridge)	*Phenacobius uranops*	3
	Total	**1291**
420050917 (Townsend)	*Ambloplites rupestris*	39
420050917 (Townsend)	*Campostoma oligolepis*	38
420050917 (Townsend)	*Cottus carolinae*	87
420050917 (Townsend)	*Cyprinella galactura*	27
420050917 (Townsend)	*Etheostoma blennioides*	5
420050917 (Townsend)	*Etheostoma rufilineatum*	156
420050917 (Townsend)	*Etheostoma tennessense*	10
420050917 (Townsend)	*Etheostoma zonale*	1
420050917 (Townsend)	*Fundulus catenatus*	2
420050917 (Townsend)	*Hybopsis amblops*	29
420050917 (Townsend)	*Hypentelium nigricans*	23
420050917 (Townsend)	*Ichthyomyzon greeleyi*	4
420050917 (Townsend)	*Lampetra appendix*	10
420050917 (Townsend)	*Lepomis auritus*	5
420050917 (Townsend)	*Lepomis macrochirus*	3
420050917 (Townsend)	*Luxilus chrysocephalus*	3
420050917 (Townsend)	*Luxilus coccogenis*	39
420050917 (Townsend)	*Micropterus dolomieu*	7
420050917 (Townsend)	*Moxostoma duquesnei*	8
420050917 (Townsend)	*Moxostoma erythrurum*	1
420050917 (Townsend)	*Nocomis micropogon*	11
420050917 (Townsend)	*Notropis leuciodus*	300
420050917 (Townsend)	*Notropis photogenis*	6
420050917 (Townsend)	*Notropis telescopus*	191
420050917 (Townsend)	*Oncorhynchus mykiss*	3
420050917 (Townsend)	*Percina evides*	4
	Total	**1012**

Benthic macroinvertebrates collected in our sample at Townsend comprised 35 families representing 47 identified genera (Table 17). The most abundant group in our collection was the mayflies comprising 35.2% of the total sample. Overall, a total of 51 taxa were identified from the sample of which 23 were EPT. Based on the EPT taxa richness and overall biotic index of all species collected, the relative health of the benthic community was classified as "good" (4.2).

Table 17. Taxa list and associated biotic statistics for benthic macroinvertebrates collected from Little River at Townsend.

ORDER	FAMILY	SPECIES	NUMBER	PERCENT
ANNELIDA				0.9
Oligochaeta			2	
COLEOPTERA				13.7
	Dryopidae	*Helichus* adult	1	
	Elmidae	*Dubiraphia vittata* adults	3	
		Macronychus glabratus adults	3	
		Optioservus trivittatus adult	1	
		Optioservus larva	1	
		Promoresia elegans larva & adults	4	
		Stenelmis larvae & adult	5	
	Gyrinidae	*Dineutus* larvae	5	
	Psephenidae	*Psephenus herricki* larvae & adults	7	
DIPTERA				8.2
	Chironomidae		15	
	Simuliidae		2	
	Tabanidae	*Tabanus*	1	
EPHEMEROPTERA				35.2
	Baetidae	*Acentrella*	6	
		Baetis	12	
	Caenidae	*Caenis*	4	
	Ephemerellidae	*Serratella*	2	
	Heptageniidae	*Epeorus rubidus/subpallidus*	11	
		Leucrocuta	3	
		Maccaffertium early instars	4	
		Maccaffertum ithaca	23	
	Isonychiidae	*Isonychia*	4	
	Leptohyphidae	*Tricorythodes*	3	
	Leptophlebiidae	*Paraleptophlebia*	2	
	Neoephemeridae	*Neoephemera purpurea*	3	
GASTROPODA				1.8
	Planorbidae		1	
	Pleuroceridae	*Pleurocera*	3	
HETEROPTERA				4.6
	Veliidae	*Rhagovelia obesa* adults	10	
HYDRACARINA				0.5
		Hydracarina sp.	1	
ISOPODA				0.5
	Asellidae	*Caecidotea*	1	
MEGALOPTERA				1.8
	Corydalidae	*Corydalus cornutus*	2	
		Nigronia serricornis	2	
ODONATA				11.9
	Aeshnidae	*Boyeria vinosa*	15	
	Calopterygidae	*Calopteryx augustipennis*	1	
		Hetaerina americana	2	
	Coenagrionidae	*Argia*	1	
	Gomphidae	*Gomphus* sp. (early instar)	1	
		Hagenius brevistylus	1	
		Stylogomphus albistylus	2	
	Macromiidae	*Macromia*	3	
PELECYPODA				0.9
	Corbiculidae	*Corbicula fluminea*	2	
PLECOPTERA				13.7
	Leuctridae	*Leuctra*	10	
	Peltoperlidae	*Peltoperla*	4	
	Perlidae	*Acroneuria abnormis*	6	
		Perlesta	9	
	Pteronarcyidae	*Pteronarcys dorsata*	1	
TRICHOPTERA				6.2
	Brachycentridae	*Brachycentrus lateralis*	7	
		Micrasema bennetti	1	
	Hydropsychidae	*Ceratopsyche sparna*	1	
		Cheumatopsyche	1	
	Lepidostmatidae	*Lepidostoma*	1	
	Leptoceridae	*Oecetis avara*	1	
		Triaenodes ignitus	2	
		Total	**219**	

TAXA RICHNESS = 51
EPT TAXA RICHNESS = 23
BIOCLASSIFICATION = 4.2 (GOOD)

Benthic macroinvertebrates collected in our sample at Coulter's Bridge comprised 33 families representing 49 identified genera (Table 18). The most abundant group in our collection was the mayflies comprising 41.8% of the total sample. Overall, a total of 57 taxa were identified from the sample of which 27 were EPT. Based on the EPT taxa richness and overall biotic index of all species collected, the relative health of the benthic community was classified as "good" (4.5).

Table 18. Taxa list and associated biotic statistics for benthic macroinvertebrates collected from Little River at Coulter's Bridge.

ORDER	FAMILY	SPECIES	NUMBER	PERCENT
ANNELIDA				2.9
Oligochaeta			7	
COLEOPTERA				14.2
	Dryopidae	*Helichus* adult	1	
	Elmidae	*Dubiraphia* adult	1	
		Maconychus glabratus adults	3	
		Optioservus larva	1	
		Optioservus ovalis adult	1	
		Optioservus trivittatus adults	6	
		Promoresia elegans adults	7	
		Stenelmis adult	1	
	Gyrinidae	*Dineutus discolor* adults	2	
		Dineutus larva	1	
	Psephenidae	*Psephenus herricki*	10	
DIPTERA				8.4
	Athericidae	*Atherix lantha*	1	
	Chironomidae		10	
	Simuliidae		7	
	Stratiomyidae	*Allognosta*	1	
	Tipulidae	*Antocha*	1	
EPHEMEROPTERA				41.8
	Baetidae	*Acentrella*	2	
		Baetis	13	
		Procloeon	1	
		undetermined	2	
	Caenidae	*Caenis*	1	
	Ephemerellidae	*Drunella*	1	
		Eurylophella	2	
		Serratella	2	
	Heptageniidae	*Epeorus rubidus/subpallidus*	6	
		Macaffertium early instars	9	
		Macaffertium ithaca	4	
		Macaffertium mediopunctatum	22	
		Macaffertium probably *modestum*	1	
		Stenacron pallidum	2	
	Isonychiidae	*Isonychia*	27	
	Leptohyphidae	*Tricorythodes*	4	
	Leptophlebiidae	*Paraleptophlebia*	1	
GASTROPODA				6.7
	Ancylidae	*Ferrissia*	1	
	Pleuroceridae	*Leptoxis*	13	
		Pleurocera	2	
HETEROPTERA				1.3
	Gerridae	*Aquarius remigis* male	1	
	Veliidae	*Rhagovelia obesa* male and female	2	
MEGALOPTERA				2.9
	Corydalidae	*Corydalus cornutus*	4	
		Nigronia serricornis	3	
ODONATA				3.8
	Aeshnidae	*Boyeria vinosa*	2	
	Coenagrionidae	*Argia*	1	
	Gomphidae	*Gomphurus lineatifrons*	1	
		Gomphus lividus	1	
		Hylogomphus viridifrons	1	
		Stylogomphus albistylus	2	
	Macromiidae	*Macromia*	1	
PELECYPODA	Corbiculidae	*Corbicula fluminea*	2	0.8

Table 18. Continued.

PLECOPTERA				3.3
	Leuctridae	*Leuctra*	2	
	Peltoperlidae	*Peltoperla*	1	
	Perlidae	*Acroneuria* early instar	1	
		Perlesta	4	
TRICHOPTERA				13.8
	Brachycentridae	*Brachycentrus lateralis*	5	
		Micrasema wataga	1	
	Hydropsychidae	*Ceratopsyche morosa*	1	
		Ceratopsyche sparna	2	
		Cheumatopsyche	15	
		Hydropsyche betteni/depravata	1	
		Hydropsyche venularis	7	
	Leptoceridae	*Oecetis*	1	
		Total	**239**	

TAXA RICHNESS = 57
EPT TAXA RICHNESS = 27
BIOCLASSIFICATION = 4.5 (GOOD)

Discussion

Little 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 Little River, it should not be considered to contain a viable sport fishery for these species.

The river represents an outstanding resource in the quality of the water and the species that inhabit it. With the growing development in the watershed it will be imperative to monitor activities such that mitigation measures can be taken to ensure that the river maintains its outstanding water quality and aesthetic value. Continued efforts by the watershed group will continue to play an important role in the management of the watershed and serve as a "watchdog" for unregulated activities.

Trout stocking during suitable months is very popular for residents and non-residents visiting the area. This program should continue at the current level unless use dictates the need for program expansion.

TWRA should continue to be involved with the cooperative community assessment surveys each year. These are important indicators of the health of one of the regions best streams and serves as a benchmark in evaluating other streams of similar size and character. Sport fishery surveys on Little River will be conducted on a three-year rotation in order to assess any changes in the fishery. Our return trip in 2008 will in all likelihood focus on the sample sites surveyed in 2005, providing no new or more efficient sampling scheme is developed.

Management Recommendations

1. Initiate an angler use and harvest survey.

2. Develop a fishery management plan for the river.

3. Cooperate with the local watershed organization to protect and enhance the river and its tributaries.

Beaver Creek

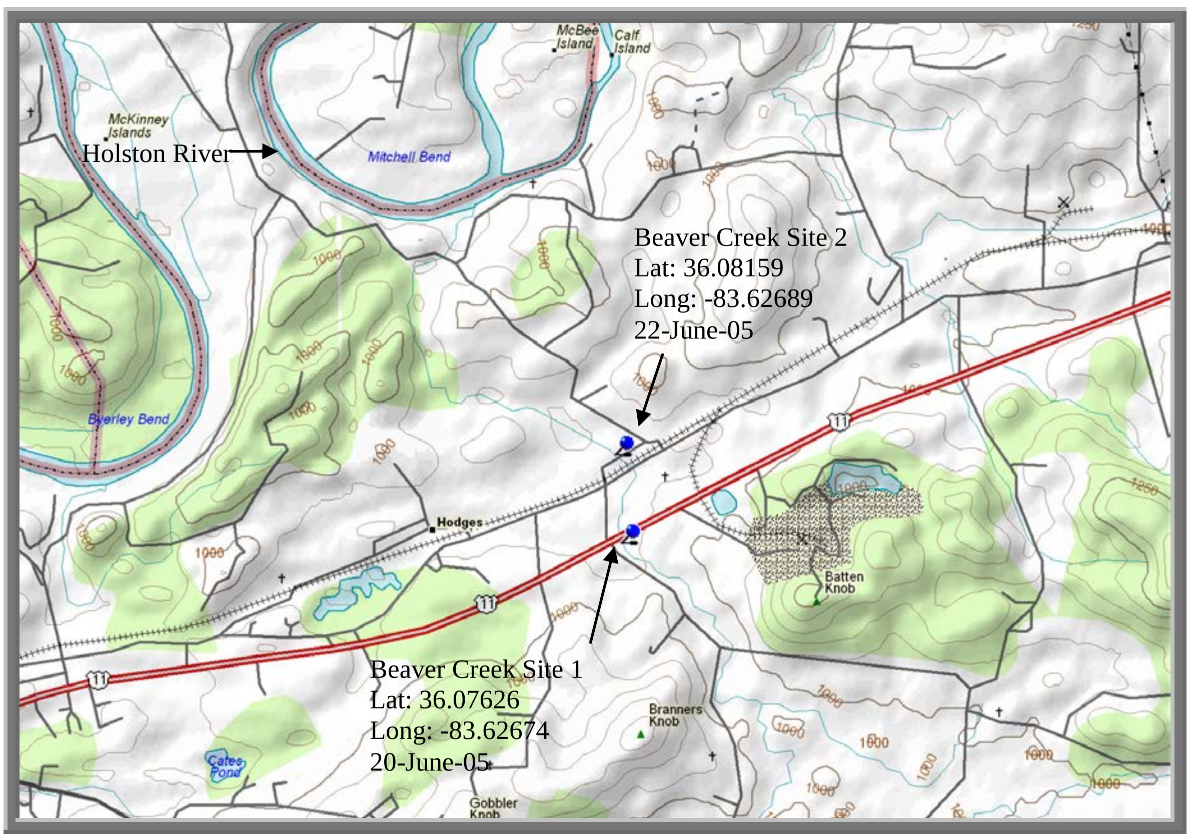
Introduction

Beaver Creek located just west of Jefferson City was surveyed in 2005 at the request of TWRA's Enviromental Services Division. The stream flows in a northwesterly direction before entering the Holston River near Mitchell Bend. The geology underlying Beaver Creek is karst with rich deposits of zinc. Mining for zinc and to a lesser extent limestone has been an active industry historically, but in recent years has declined due to lower demand for products produced from these mines. We were primarily interested in evaluating outfall from these mining operations and assessing impacts to the stream. The Tennessee Valley Authority conducted one survey of this stream in 2003, near our downstream site. One historical Agency collection was made in Beaver Creek in 1975.

Study Area and Methods

Our surveys of Beaver Creek (Figure 28) were conducted at the bridge crossing on Hwy. 11E (Site 1) and just below the bridge crossing on Beaver Creek Road (Site 2). Our survey at Beaver Creek Road was in close proximity to the area surveyed by the TVA in 2003.

Figure 28. Sample site locations for the surveys conducted in Beaver Creek during 2005.



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 upstream sample location (site 1) silt/sand and gravel were the dominate substrate components in the pools, comprising about 70% of the substrate. In the riffle habitat, substrate was primarily gravel and cobble (60%). At our downstream location (site 2) silt and sand contributed about 50% to the overall substrate composition in the pools, while gravel and cobble were most notable in the riffles (55%). At both locations, pools were the dominant habitat feature contributing 60% of the available habitat at site 1 and about 80% at site 2. The riparian zones at both sites had been altered. However, our upstream location was almost entirely devoid of woody vegetation in about half of the survey reach. At the downstream location the impact to the riparian zone was not as dramatic although the corridor of natural vegetation along the stream had been significantly reduced on both sides of the stream. Water turbidity was high at both locations and was most likely related to agricultural disturbances in the watershed and mine seepage from surrounding groundwater upwellings. Basic water quality measurements at site 1 revealed the following information: temperature 21 C, conductivity 440 µs/cm, flow 10.8 cfs, and a pH of 6.2. Water quality conditions at site 2 were similar. Here the temperature was 20 C, conductivity 462 µs/cm, flow 14.0 cfs, and a pH of 6.5. Like many other streams in the area enrichment due to agricultural run-off was evident. As we investigated further upstream we noticed several areas where cattle had access to the stream.

Results

We collected a total of 363 fish comprising 14 species at site 1 and 161 fish representing 12 species at sample site 2 (Table 19). The two most common species collected at both of our sample sites were the largescale stoneroller and green sunfish. Together, these two species comprised 45% of the total number of fish collected at site 1 and 39% at site 2. Two darter species were collected at site 1, snubnose darter and greenside darter. At site 2 the greenside darter was the only darter species encountered. Suckers collected from the survey sites included northern hog sucker, golden redhorse, and white sucker. The preponderance of hybrid sunfish was somewhat unusual as we observed at least three intergrades between green sunfish, redbreast sunfish, and bluegill. Rock bass was the only other sunfish species observed in our survey sites. There were several IBI metrics that had a substantial effect on lowering the overall score for this stream. At site 1, the low number of intolerant species and the high percentage of hybrids had the greatest influence on lowering the score. At site 2, the high percentage of tolerant species, low number of intolerant species, low percentage of piscivores and trophic specialists had the most influence in decreasing the overall IBI score.

Table 19. Fish species occurrence for Beaver Creek 2005.

Site Code	Species	Tads Code	Total Number
420051001	*Ambloplites rupestris*	342	11
420051001	*Campostoma oligolepis*	45	109
420051001	*Catostomus commersoni*	195	1
420051001	*Cottus carolinae*	322	42
420051001	*Cyprinus carpio*	62	1
420051001	*Etheostoma blenniodes*	398	36
420051001	*Etheostoma tenneseense*	435	31
420051001	*Hypentelium nigricans*	207	13
420051001	*Lepomis auritus*	346	18
420051001	*Lepomis cyanellus*	347	54
420051001	*Lepomis* hybrid (bluegill x green)	345	2
420051001	*Lepomis* hybrid (bluegill x redbreast)	345	1
420051001	*Lepomis* hybrid (redbreast x green)	345	3
420051001	*Lepomis macrochirus*	351	8
420051001	*Luxilus chrysocephalus*	89	30
420051001	*Luxilus coccogenis*	90	1
420051001	*Moxostoma erythrurum*	225	2
		Total	**363**
420051002	*Ambloplites rupestris*	342	2
420051002	*Campostoma oligolepis*	45	26
420051002	*Cottus carolinae*	322	16
420051002	*Etheostoma blenniodes*	398	6
420051002	*Etheostoma tenneseense*	435	9
420051002	*Gambusia affinis*	309	12
420051002	*Hypentelium nigricans*	207	10
420051002	*Lepomis auritus*	346	5
420051002	*Lepomis cyanellus*	347	37
420051002	*Lepomis* hybrid (bluegill x green)	345	4
420051002	*Lepomis* hybrid (bluegill x redbreast)	345	4
420051002	*Lepomis* hybrid (green x redbreast)	345	2
420051002	*Lepomis macrochirus*	351	6
420051002	*Luxilus chrysocephalus*	89	21
420051002	*Moxostoma erythrurum*	225	1
		Total	**161**

Table 20. Beaver Creek Index of Biotic Integrity analysis (Site 1).

Metric Description	Scoring Criteria			Observed	Score
	1	3	5		
Number of Native Species	<10	10-19	>19	12	3
Number of Darter Species	<2	2	>2	2	3
Number of Sunfish Species less Micropterus	<2	2	>2	3	5
Number of Sucker Species	<2	2	>2	3	5
Number of Intolerant Species	<2	2	>2	1	1
Percent of Individuals as Tolerant	>33	33-17	<17	23.4	3
Percent of Individuals as Omnivores	>40	40-21	<21	38.2	3
Percent of Individuals as Specialists	<18	18-35	>35	18.7	3
Percent of Individuals as Piscivores	<2	2-4	>4	3.0	3
Catch Rate	<22.6	22.6-45.1	>45.1	42.1	3
Percent of Individuals as Hybrids	>1	1-TR	0	1.6	1
Percent of Individuals with Anomalies	>5	5-2	<2	1.9	5
				Total	**38 (Poor-Fair)**

Table 21. Beaver Creek Index of Biotic Integrity analysis (Site 2).

Metric Description	Scoring Criteria			Observed	Score
	1	3	5		
Number of Native Species	<10	10-19	>19	10	3
Number of Darter Species	<2	2	>2	2	3
Number of Sunfish Species less Micropterus	<2	2	>2	3	5
Number of Sucker Species	<2	2	>2	2	3
Number of Intolerant Species	<2	2	>2	1	1
Percent of Individuals as Tolerant	>33	33-17	<17	36.0	1
Percent of Individuals as Omnivores	>40	40-21	<21	29.1	3
Percent of Individuals as Specialists	<18	18-35	>35	9.3	1
Percent of Individuals as Piscivores	<2	2-4	>4	1.2	1
Catch Rate	<22.6	22.6-45.1	>45.1	29.0	3
Percent of Individuals as Hybrids	>1	1-TR	0	6.2	1
Percent of Individuals with Anomalies	>5	5-2	<2	0	5
				Total	**30 (Poor)**

Overall, the IBI analysis indicated Beaver Creek was in poor to fair condition (IBI score = 38) at site 1 (Table 20). Conditions did not improve at our downstream station as the IBI scored dropped eight points to 30 (Table 21). This resulted in the classification of the stream being downgraded to “poor”. Based on the evaluation reported by TVA in 2003 the stream at site 2 has degraded quite substantially over the two year period. In 2003, TVA recorded 15 native species and had an overall IBI score of 40 (fair), which was 10 points higher than our value in 2005. They did collect one additional darter species that we did not see (redline darter) as well as spotted bass and black redhorse which all contributed to increasing the overall score. Based on our visual observations we were very disappointed with the quality of the habitat at site 2 and for the most part at site 1 although there was some improvement above the 11E crossing. Our visually based habitat assessment rated site 1 a “poor” with a score of 40.2, whereas, site 2 received a score of 45.4, resulting in a classification of “very poor”.

Benthic macroinvertebrates collected in our sample at site 1 comprised 26 families representing 27 identified genera (Table 22). The most abundant group in our collection was the caddisflies comprising 36.3% of the total sample. Overall, a total of 34 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/fair-good" (2.8).

Table 22. Taxa list and associated biotic statistics for benthic macroinvertebrates collected from Beaver Creek Site 1.

ORDER	FAMILY	SPECIES	NUMBER	PERCENT
AMPHIPODA				0.3
			1	
ANNELIDA				1.3
Oligochaeta			4	
COLEOPTERA				7
	Elmidae	*Dubiraphia* larva and adults	7	
		Stenelmis larvae and adults	15	
DIPTERA				2.5
	Chironomidae		7	
	Tipulidae	*Hexatoma*	1	
EPHEMEROPTERA				15.6
	Baetidae	*Baetis*	7	
	Ephemeridae	*Hexagenia*	4	
		Maccaffertium	14	
	Heptageniidae	*Stenacron interpunctatum*	13	
	Isonychiidae	*Isonychia*	11	
GASTROPODA				10.5
	Physidae		4	
	Planorbidae		1	
	Pleuroceridae	*Elimia*	24	
		Pleurocera	4	
HETEROPTERA				1.3
	Corixidae		1	
	Gerridae	*Aquarius remigis* adult female	1	
	Veliidae	*Rhagovelia obesa* adult male and female	2	
ISOPODA				7
	Asellidae	*Lirceus*	22	
MEGALOPTERA				3.8
	Corydalidae	*Nigronia serricornis*	10	
	Sialidae	*Sialis*	2	
ODONATA				9.9
	Aeshnidae	*Boyeria vinosa*	9	
	Calopterygidae	*Calopteryx*	5	
	Coenagrionidae	*Argia*	2	
	Gomphidae	*Gomphus* (Genus A) *consanguis*	12	
		Gomphus lividus	1	
		Hagenius brevistylus	2	
PELECYPODA				4.5
	Corbiculidae	*Corbicula fluminea*	1	
	Sphaeriidae	*Pisidium*	2	
		Sphaerium	10	
	Unionidae	*Villosa iris*	1	
TRICHOPTERA				36.3
	Hydropsychidae	*Cheumatopsyche*	39	
		Hydropsyche betteni/depravata	70	
	Uenoidae	*Neophylax etnieri*	5	
		Total	**314**	

TAXA RICHNESS = 34
EPT TAXA RICHNESS = 8
BIOCLASSIFICATION = 2.8 (FAIR/FAIR-GOOD)

Benthic macroinvertebrates collected at site 2 comprised 22 families representing 31 identified genera (Table 23). The most abundant group in our collection was the caddisflies comprising 32.3% of the total sample. Overall, a total of 34 taxa were identified from the sample of which 11 were EPT. Based on the EPT taxa richness and overall biotic index of all species collected, the relative health of the benthic community was classified as "fair/good" (3.2).

Table 23. Taxa list and associated biotic statistics for benthic macroinvertebrates collected from Beaver Creek Site 2.

ORDER	FAMILY	SPECIES	NUMBER	PERCENT
ANNELIDA				0.5
Oligochaeta			1	
Tubificidae		*Branchiura sowerbyi*	1	
COLEOPTERA				13.6
	Elmidae	*Dubiraphia adults*	11	
		Macronychus glabratus adults	3	
		Stenelmis larvae and adults	36	
DIPTERA				5.2
	Chironomidae		11	
	Tipulidae	*Antocha*	1	
		Hexatoma	7	
EPHEMEROPTERA				18.2
	Baetidae	*Baetis*	10	
	Ephemeridae	*Ephemera*	4	
		Hexagenia	13	
	Heptageniidae	*Maccaffertium* early instars	5	
		Maccaffertium sp.	7	
		Stenacron interpunctatum	14	
	Isonychiidae	*Isonychia*	14	
GASTROPODA				7.6
	Pleuroceridae	*Elimia*	25	
		Pleurocera	3	
HETEROPTERA				0.3
	Veliidae	*Rhagovelia obesa* adult	1	
ISOPODA				10.6
	Asellidae	*Caecidotea*	1	
		Lirceus	38	
MEGALOPTERA				2.2
	Corydalidae	*Corydalus cornutus*	2	
		Nigronia serricornis	2	
	Sialidae	*Sialis*	4	
ODONATA				8.2
	Aeshnidae	*Boyeria vinosa*	11	
	Calopterygidae	*Calopteryx*	9	
	Gomphidae	*Dromogomphus spinosus*	2	
		Gomphus (Genus A) *consanguis*	5	
		Gomphus lividus	2	
		Hagenius brevistylus	1	
PELECYPODA				1.4
	Corbiculidae	*Corbicula fluminea*	5	
TRICHOPTERA				32.3
	Hydropsychidae	*Cheumatopsyche*	84	
		Hydropsyche betteni/depravata	22	
	Leptoceridae	*Triaenodes ignitus* larvae and pupa	7	
	Limnephilidae	*Pycnopsyche*	1	
	Philopotamidae	*Chimara*	5	
		Total	**368**	

TAXA RICHNESS = 34
EPT TAXA RICHNESS = 11
BIOCLASSIFICATION = 3.2 (FAIR/GOOD)

The Cherokee Clubtail dragonfly *(Gomphus* (Genus A) *consanguis)* listed as S1 (critically imperiled) was collected at both survey sites. This species was only collected in one other stream during 2005.

Discussion

Beaver Creek is in a situation where pollutants are entering the stream on two fronts. The agricultural use within the watershed is a constant influence that has increased the turbidity of the stream and introduced significant amounts of sediment as well. Secondly, the influence that historical and present mining activity has had and is having on the stream was apparent. In the 1975 survey of the stream, TWRA personnel did illustrate a higher abundance of sport species (rock bass and redbreast sunfish) in a section of stream upstream of the zinc mine. Similarly there was a documented decline in the number and species composition of sport fish below the mine area. Groundwater upwelling from mine impacted aquifers as well as surface runoff from the mine sites continues to influence this stream. Although undocumented, we expect there is some improvement in the condition of the habitat further upstream in the watershed.

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.

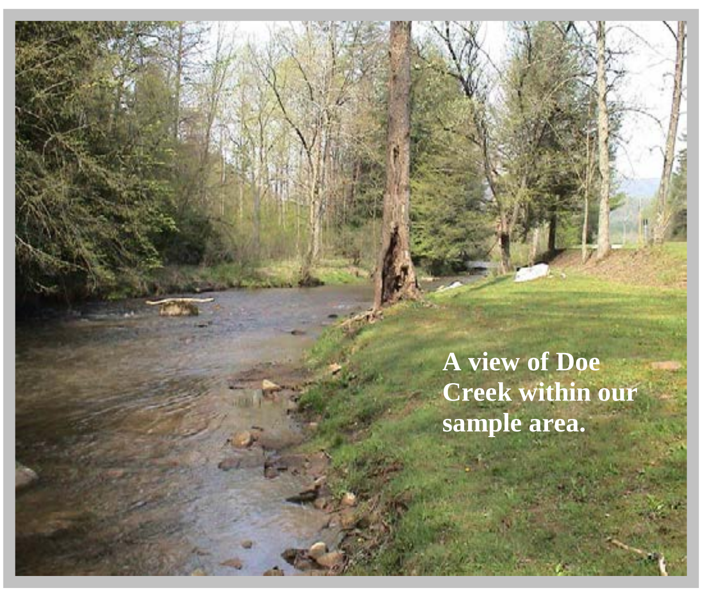
Doe Creek

Introduction

Doe Creek originates just west of Mountain City and flows southwesterly through Doe Valley before entering the Watauga Reservoir near the community of Doeville. Doe Creek is one of east Tennessee's premier wild trout streams and numerous surveys have been conducted in the stream over the last decade (Habera et al. 2006). Historically there was a run of wild rainbow trout from Watauga Reservoir that for a short period of time was a popular sport fishery for residents and non-residents alike. Doe Creek is unique among wild trout stream in that its productivity is somewhat higher than most other trout streams in the region (geologically influenced) and a substantial portion of its flow is contributed by groundwater. Recently, there has been controversy over the use of the stream by the city of Mountain City. Water withdrawal from Lowe Spring (major contributor to Doe Creek's flow) by Mountain City was permitted by the state and has been ongoing since 2002. Recent requests from the city have indicated additional water needs, which if allowed, could negatively influence the fish community downstream of the spring. Our survey of Doe Creek was targeted at assessing the fish community downstream of Doeville at the request of a local resident. Recently, there have been plans to construct an Asphalt plant in close proximity to the stream and concerns over the impact this may have to stream were brought to the attention of the Agency. TVA surveyed Doe Creek in 1994 just downstream of our survey site in 2005. Our primary goal in surveying Doe Creek was to gather some baseline information prior to the construction of the plant and compare our finding with those reported by TVA in 1994 (TVA 1998).

Study Area and Methods

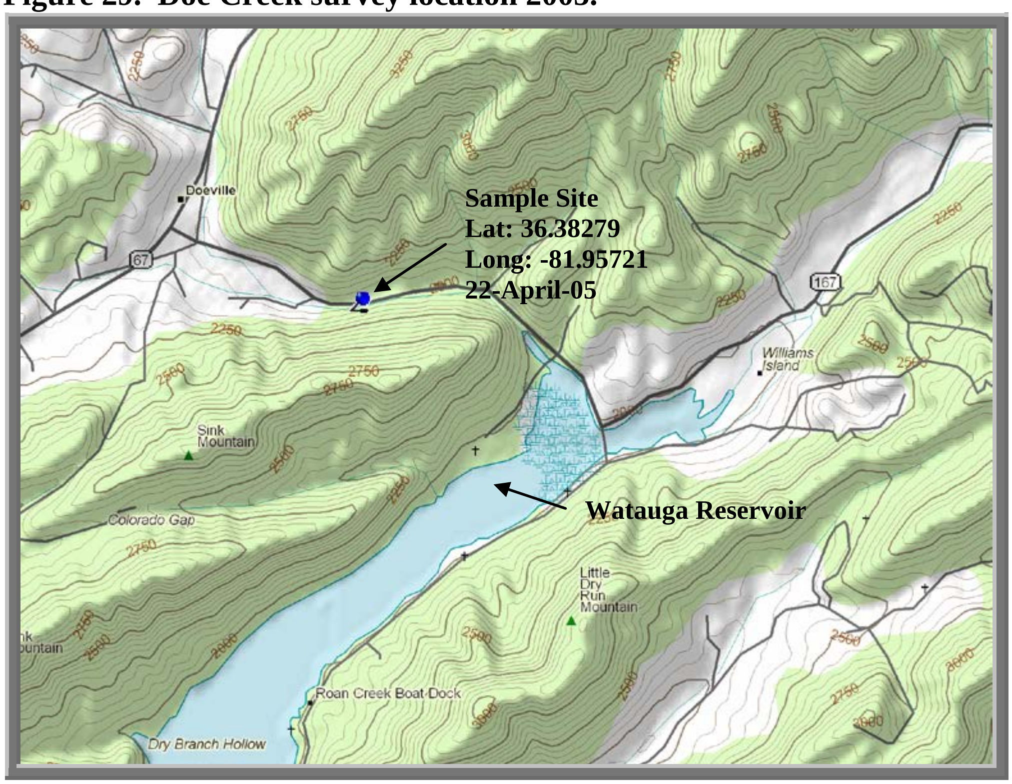
Our survey of Doe Creek (Figure 29) was conducted along Hwy 167 at the TWRA roadside fishing access. Agricultural operations within the watershed are prevalent, although not extensive. For the most part, cattle are fairly restricted from the stream, although a substantial portion of the riparian zone has been altered on one or both sides of the stream along its entirety**.** 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).



A view of Doe Creek within our sample area.

At our sample location gravel and cobble were the dominant substrate components in pools comprising about 60% of the substrate. In the riffle areas cobble and bedrock were dominant accounting for 70% of the available substrate. Pools dominated the habitat features contributing about 60% of the available habitat. We did notice an unusual amount of bedload movement within our survey site. There were numerous depositonal areas of gravel as illustrated in the photo. There was some alteration of the riparian zones especially on the left descending bank, mainly by activities associated with residential development. Stream bank erosion was minimal, although there were a few "raw" areas within our survey reach. Basic water quality measurements at this site revealed the following information: temperature 16 C, conductivity 97 µs/cm, and a pH of 6.2. The discharge for the stream was calculated to be 75 cfs.

Figure 29. Doe Creek survey location 2005.



Results

We collected a total of 264 fish representing ten species at our sample site (Table 23). There were two game species collected at this site, which included the bluegill and rainbow trout. The two most dominant species collected in our sample were the mottled sculpin and western blacknose dace. Together, these two species comprised 65% of the total number of fish in our sample. Two darter species were collected from the stream, snubnose darter and fantail darter. Two of the IBI metrics had a substantial effect on lowering the overall score for this stream. These included the low percentage of trophic specialists and the low percentage of piscivores.

Table 23. Fish species occurrence for Doe Creek 2005.

Site Code	Species	Tads Code	Total Number
420050701	*Campostoma anomalum*	45	28
420050701	*Catostomus commersoni*	195	1
420050701	*Cottus bairdi*	321	114
420050701	*Etheostoma flabellare*	411	42
420050701	*Etheostoma simoterum*	435	2
420050701	*Hypentelium nigricans*	207	2
420050701	*Lepomis macrochirus*	351	1
420050701	*Oncorhynchus mykiss*	279	14
420050701	*Rhynichthys obtusus*	184	57
420050701	*Semotilus atromaculatus*	188	3
		Total	**264**

Table 24. Doe Creek Index of Biotic Integrity analysis.

Metric Description	Scoring Criteria 1 3 5	Observed	Score
Number of Native Species	<8 8-15 >15	9	3
Number of Darter Species	<1 1 >1	2	5
Number of Sunfish Species less Micropterus	<1 1 >1	1	3
Number of Sucker Species	<1 1 >1	1	3
Number of Intolerant Species	<1 1 >1	2	5
Percent of Individuals as Tolerant	>30 30-15 <15	1.6	5
Percent of Individuals as Omnivores	>25 25-12 <12	11.2	5
Percent of Individuals as Specialists	<25 25-50 >50	17.6	1
Percent of Individuals as Piscivores	<2 2-4 >4	0	1
Catch Rate	<8 8-15 >15	40.0	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	**46 (Fair-Good)**

Overall, the IBI analysis indicated Doe Creek was in fair to good condition (IBI score = 46) (Table 24). Although not very diverse, Doe Creek had several metrics that scored well. In comparison the 1994 TVA evaluation resulted in a score of 42 (fair). Between the two samples scoring criteria changed somewhat due to developments in techniques and increased data from Blue Ridge streams. When the 1994 data was subjected to the revised criteria used in the 2005 analysis, Doe Creek scored 46. Based on this comparison, the health of Doe Creek has remained relatively unchanged since the initial survey in 1994. Our visual assessment of the habitat resulted in a score of “fair” 27. This was primarily based on the state of the riparian zones and the amount of bed load movement we observed at our sample site.

Benthic macroinvertebrates collected in our sample comprised 37 families representing 45 identified genera (Table 25). The most abundant group in our collection was the mayflies

Table 25. Taxa list and associated biotic statistics for benthic macroinvertebrates collected from Doe Creek.

ORDER	FAMILY	SPECIES	NUMBER	PERCENT
ANNELIDA				0.4
Oligochaeta			2	
COLEOPTERA				0.8
	Elmidae	*Dubiraphia* larva	1	
		Stenelmis adult	1	
	Psephenidae	*Psephenus herricki*	1	
	Ptilodactylidae	*Anchytarsus bicolor* larva	1	
DIPTERA				12.4
	Blephariceridae	*Blepharicera* larvae and pupae	20	
	Chironomidae		32	
	Simuliidae		1	
	Tipulidae	*Antocha*	4	
		Hexatoma	3	
		Pseudolimnephila	1	
		Tipula	3	
EPHEMEROPTERA				42.9
	Baetidae	*Acentrella*	4	
		Baetis	15	
	Baetiscidae	*Baetisca berneri*	1	
	Ephemerellidae	*Drunella cornuta/cornutella*	4	
		Ephemerella	105	
		Eurylophella	12	
	Ephemeridae	*Ephemera*	4	
	Heptageniidae	*Epeorus rubidus/subpallidus*	9	
		Maccaffertium early instars	19	
		Maccaffertium ithaca	14	
		Stenacron interpunctatum	19	
	Isonychiidae	*Isonychia*	5	
	Leptophlebiidae	*Paraleptophlebia*	10	
GASTROPODA				4.7
	Physidae		5	
	Pleuroceridae		19	
HETEROPTERA				0.2
	Gerridae	*Aquarius remigis* female	1	
MEGALOPTERA				0.4
	Corydalidae	*Nigronia serricornis*	1	
	Sialidae	*Sialis*	1	
ODONATA				2.7
	Aeshnidae	*Boyeria vinosa*	3	
	Calopterygidae	*Calopteryx*	7	
	Gomphidae	*Gomphus* early instar	1	
		Lanthus vernalis	2	
		Stylurus early instar	1	
PELECYPODA				0.6
	Sphaeriidae		3	
PLECOPTERA				7.2
	Chloroperlidae	*Alloperla*	2	
	Nemouridae	*Amphinemura delosa/nigritta*	3	
	Perlidae	*Acroneuria carolinensis*	2	
		Paragnetina immarginata	11	
	Perlodidae	*Isoperla dicala*	1	
	Pteronarcyidae	*Pteronarcys (Allonarcys) biloba* group	18	
TRICHOPTERA				27.8
	Glossosomatidae	*Agapetus*	3	
	Hydropsychidae	*Ceratopsyche bronta*	18	
		Ceratopsyche sparna	6	
		Cheumatopsyche	74	
		Hydropsyche carolina	4	
	Limnephilidae	*Platycentropus radiatus*	1	
		Pycnopsyche scabripenis group	1	
	Philopotamidae	*Dolophilodes distinctus*	2	
	Phryganeidae	pupa	1	
	Polycentropodidae	*Polycentropus*	1	
	Rhyacophilidae	*Rhyacophila carolina*	1	
		Rhyacophila fuscula larvae and pupae	28	
	Uenoidae	*Neophylax*	3	
		Total	**515**	

TAXA RICHNESS = 54 EPT TAXA RICHNESS = 31 BIOCLASSIFICATION = 4.0 (GOOD)

comprising 42.9% of the total sample. Caddisflies (27.8%) and dipterans (12.4%) rounded out the top three groups in terms of abundance. Stoneflies only accounted for 7.2% of the sample. Overall, a total of 54 taxa were identified from the sample of which 31 were EPT. Based on the EPT taxa richness and overall biotic index of all species collected, the relative health of the benthic community was classified as "good" (4.0). Probably the most notable occurrence resulting from our benthic survey was the collection of *Hydropsyche carolina* which represented a new occurrence record for the state. Likewise, we collected a species of *Neophylax* that may represent an undescribed species. Further collection and rearing will be conducted in order to assess the taxonomic uncertainty of this caddisfly.

Discussion

Doe Creek represents an outstanding and unique resource in east Tennessee. The protection of the watershed and water supply to the creek should be a management priority of the Agency. With the request to withdraw more water from Lowe Spring and remove the restrictions on when the water can be withdrawn, the ability of Doe Creek to maintain the quality fishery it now supports will be in question. The potential development of an asphalt plant also poses another threat to the stream in the lower reaches. This needs to be monitored closely so any degradation to Doe Creek can be quickly addressed.

Management Recommendations

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

2. Continue to oppose the increased withdrawal of water from Lowe Spring.

Gap Creek

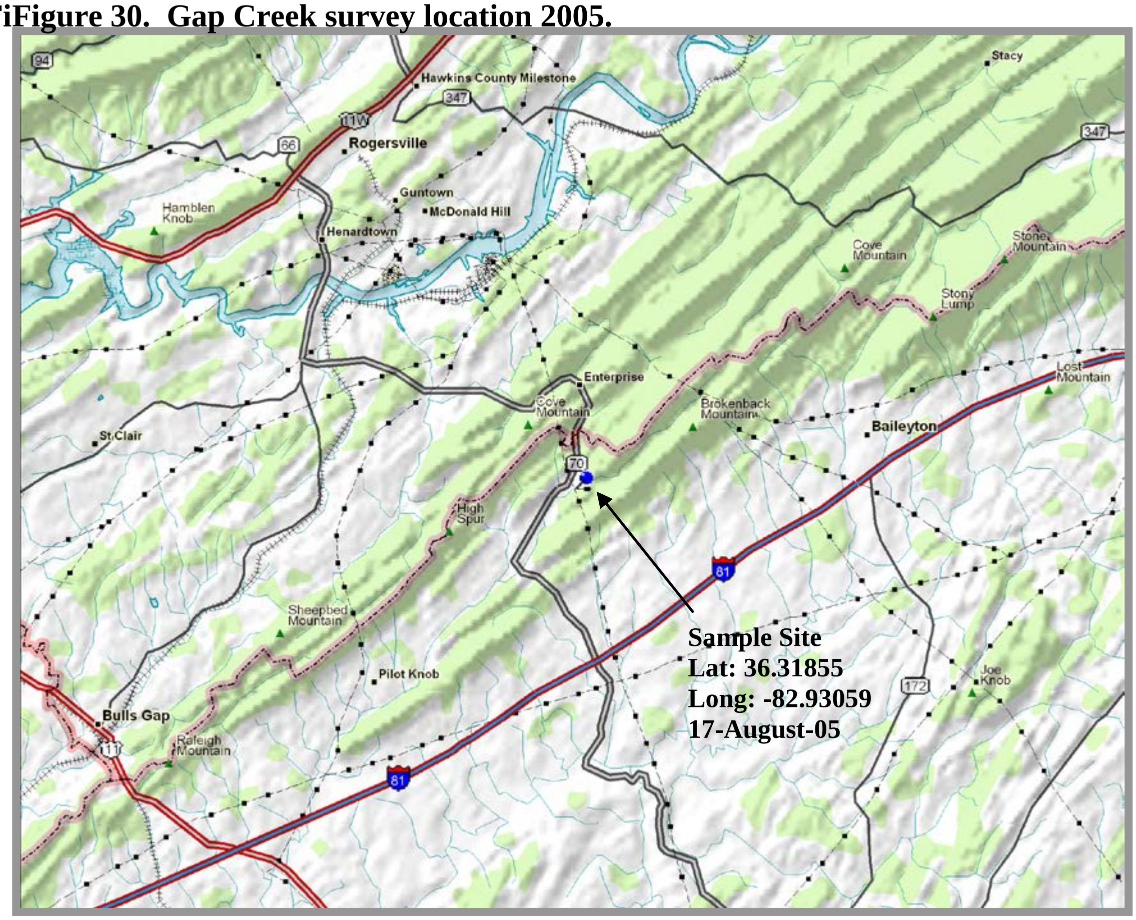
Introduction

We were asked to evaluate Gap Creek as a result of stream protection work that had been accomplished by the landowner through the Natural Resources Conservation Service (NRCS) stream protection programs. The agency has not collected any information on the species inhabiting this reach of the stream. Agricultural is the primary activity in the watershed, and many reaches of this streams riparian zone had been cleared as a result of these activities.

Study Area and Methods

Our survey of Gap Creek (Figure 30) was conducted along Hwy 70 just south of the community of Enterprise. Agricultural operations within the watershed are prevalent, some, being quite extensive. Our evaluation of the fish community was accomplished

Figure 30. Gap Creek survey location 2005.



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 silt/sand and bedrock were the dominant substrate components in pools comprising about 60% of the substrate. In the riffle areas cobble and bedrock were dominant accounting for 50% of the available substrate.

Riffles dominated the habitat features contributing about 70% of the available habitat. There was some alteration of the riparian zones especially on the right descending bank, although this had been recently mitigated by the landowner. Basic water quality measurements at this site revealed the following information: temperature 25 C, conductivity 330 µs/cm, and a pH of 6.5. The discharge for the stream was estimated to be 0.2 cfs.

Results

We collected a total of 336 fish representing 11 species at our sample site (Table 26). The only game species collected at this site was redbreast sunfish. The two most dominant species collected in our sample were the striped shiner and the largescale stoneroller. Together, these two species comprised 59% of the total number of fish in our sample. Two darter species were collected from the stream, snubnose darter and stripetail darter. There were four IBI metrics that had the most negative influence on the overall score. These included the high percentage of tolerant species, high percentage of trophic generalists, low percentage of specialized insectivores, and the absence of piscivores.

Table 26. Fish species occurrence for Gap Creek 2005.

Site Code	Species	Tads Code	Total Number
420051101	*Ambloplites rupestris*	342	5
420051101	*Campostoma oligolepis*	45	80
420051101	*Catostomus commersoni*	195	4
420051101	*Etheostoma kennicotti*	418	20
420051101	*Etheostoma tennesseense*	435	5
420051101	*Hypentelium nigricans*	207	9
420051101	*Lepomis auritus*	346	2
420051101	*Luxilus chrysocephalus*	89	117
420051101	*Pimephales notatus*	176	1
420051101	*Rhynichthys obtusus*	184	53
420051101	*Semotilus atromacualtus*	188	40
		Total	**336**

Overall, the IBI analysis indicated this reach of Gap Creek was in poor to fair condition (IBI score = 36) (Table 27). The most noticeable physical factors influencing this low rating were the poor habitat and the influence of sedimentation. The preponderance of bedrock in the site provided very little habitat for fish and probably was the single most influential factor in regulating the diversity in this reach. The improvements to the stream crossings as well as the riparian zone management and exclusion of cattle from the stream will ultimately benefit this reach of the stream. Overall our visual assessment of the habitat resulted in a rating of “poor” based on an average score of 35. Although the stream did have factors that were depressing the fish community, we did collect species considered less tolerant to pollutants. Both rock bass and northern hog sucker were present as well as the two darter species mentioned previously.

Table 27. Gap Creek Index of Biotic Integrity analysis.

Metric Description	Scoring Criteria 1 3 5	Observed	Score
Number of Native Species	<7 7-14 >15	10	3
Number of Darter Species	0 1 >1	2	5
Number of Sunfish Species less Micropterus	0 1 >1	1	3
Number of Sucker Species	0 1 >1	2	5
Number of Intolerant Species	0 1-2 >2	1	3
Percent of Individuals as Tolerant	>37 37-18 <18	48.2	1
Percent of Individuals as Omnivores	>46 46-23 <23	60	1
Percent of Individuals as Specialists	<13 13-26 >26	7.5	1
Percent of Individuals as Piscivores	<1.3 1.3-3.5 >3.5	0	1
Catch Rate	<15 15-53 >53	51.7	3
Percent of Individuals as Hybrids	>1 1-Tr 0	0	5
Percent of Individuals with Anomalies	>5 5-2 <2	0	5
		Total	**36 (Poor-Fair)**

Table 28. Taxa list and associated biotic statistics for benthic macroinvertebrates collected from Gap Creek.

ORDER	FAMILY	SPECIES	NUMBER	PERCENT
COLEOPTERA				13.7
	Dryopidae	*Helichus* adult	1	
	Elmidae	*Ancyronx variegatus* larva	1	
		Dubiraphia adults	2	
		Optioservus larvae and adults	12	
		Stenelmis adults	13	
	Psephenidae	*Psephenus herricki* larvae and adults	19	
DIPTERA				5.1
	Chironomidae		15	
	Simuliidae		2	
	Tabanidae	*Tabanus*	1	
EPHEMEROPTERA				38.9
	Baetidae	*Baetis*	4	
	Heptageniidae	*Leucrocuta* early instar	1	
		Maccaffertium early instars	45	
		Maccaffertium ithaca	11	
		Stenacron interpunctatum	3	
	Isonychiidae	*Isonychia*	72	
HETEROPTERA				0.9
	Gerridae	*Aquarius remigis* male and female	2	
	Veliidae	*Rhagovelia obesa* adult male	1	
MEGALOPTERA				10.3
	Corydalidae	*Corydalus cornutus*	8	
		Nigronia serricornis	27	
	Sialidae	*Sialis*	1	
NEMATOMORPHA			1	0.3
ODONATA				8.6
	Aeshnidae	*Basiaeshna janata*	1	
		Boyeria vinosa	4	
	Calopterygidae	*Calopteryx*	2	
	Coenagrionidae	*Argia*	2	
	Gomphidae	*Gomphus* (Genus A) *rogersi*	1	
		Gomphus early instars	5	
		Gomphus lividus	4	
		Stylogomphus albistylus	9	
	Macromiidae	*Macromia*	2	
PLECOPTERA				5.4
	Leuctridae	*Leuctra*	11	
	Peltoperlidae	*Peltoperla*	4	
	Perlidae	*Acroneuria evoluta*	4	
TRICHOPTERA				16.9
	Hydropsychidae	*Cheumatopsyche*	22	
		Hydropsyche betteni/depravata	2	
	Limnephilidae	*Pycnopsyche luculenta* group	2	
	Philopotamidae	*Chimara*	32	
	Psychomyiidae	*Lype diversa*	1	
		Total	**350**	

TAXA RICHNESS = 36 EPT TAXA RICHNESS = 13 BIOCLASSIFICATION = 3.5 (FAIR/GOOD)

Benthic macroinvertebrates collected in our sample comprised 25 families representing 32 identified genera (Table 28). The most abundant group in our collection was the mayflies representing 38.9% of the total sample. Overall, a total of 36 taxa were identified from the sample of which 13 were EPT. Based on the EPT taxa richness and overall biotic index of all species collected, the relative health of the benthic community was classified as “fair/good” (3.5).

Discussion

Gap Creek is typical of many streams in the Ridge and Valley province of east Tennessee. Agricultural impacts are the dominating influence impairing many of the streams in the region. Efforts such as those demonstrated on this reach of Gap Creek ultimately benefit the landowner and landowners downstream.

Management Recommendations

1. Periodically monitor this stream to determine relative health changes and evaluate improvements resulting from land management practices.

Pigeon River

Introduction

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

Our 2005 surveys focused on continuing our collection of catch effort data for black bass and rock bass and assisting with evaluating the fish community at two long-term IBI stations. 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 five to six sites between river mile 4.0 and 20.5 (Carter et al. 2000, 2001, 2002, 2003, 2004). During 1998, a 508 mm minimum (20-inch) length limit on smallmouth bass with a one fish possession limit was passed by the Tennessee Wildlife Resources Commission (TWRC). This regulation was implemented on March 1, 1999.

Study Area and Methods

The Pigeon River originates in North Carolina and flows in a northwesterly direction before emptying into the French Broad River near river mile 73.8. The river has a drainage area of approximately 1,784 km^2 at its confluence with the French Broad River. In Tennessee, approximately 35 kilometers of the Pigeon River flows through mountainous terrain with interspersed communities and small farms before joining the French Broad River near Newport. Public access along the river is primarily limited to bridge crossings and small "pull-outs" along roads paralleling the river. There are a few primitive launching areas for canoes or small boats. Between July and October, 2005, we conducted seven fish surveys at six sites between Newport and the community of Hartford (Figure 31). We were unable to complete one of our CPUE survey sites (site 2) due to flood damage at this location. Our historical access to the river had all but been obliterated from a flood that hit the watershed in late summer 2004. Because this portion of the river is a tailwater, habitat availability fluctuates with water releases. However, in our survey sites during low flow, the habitat consisted primarily of wooded shorelines with interspersed rock outcroppings. Submerged woody debris was fairly common in most of our sample areas. The river substrate was predominately boulder/cobble in riffle areas and bedrock with interspersed boulder/cobble in the pool areas. Measured channel widths ranged from 35.3 to 64.3 m, while site lengths fell between 80 and 839 m (Table 25). Water temperatures ranged from 15.5 to 19.5 C and conductivity varied from 185 to 230 μs/cm (Table 29).

Figure 31. Site locations for samples conducted in the Pigeon River during 2005.

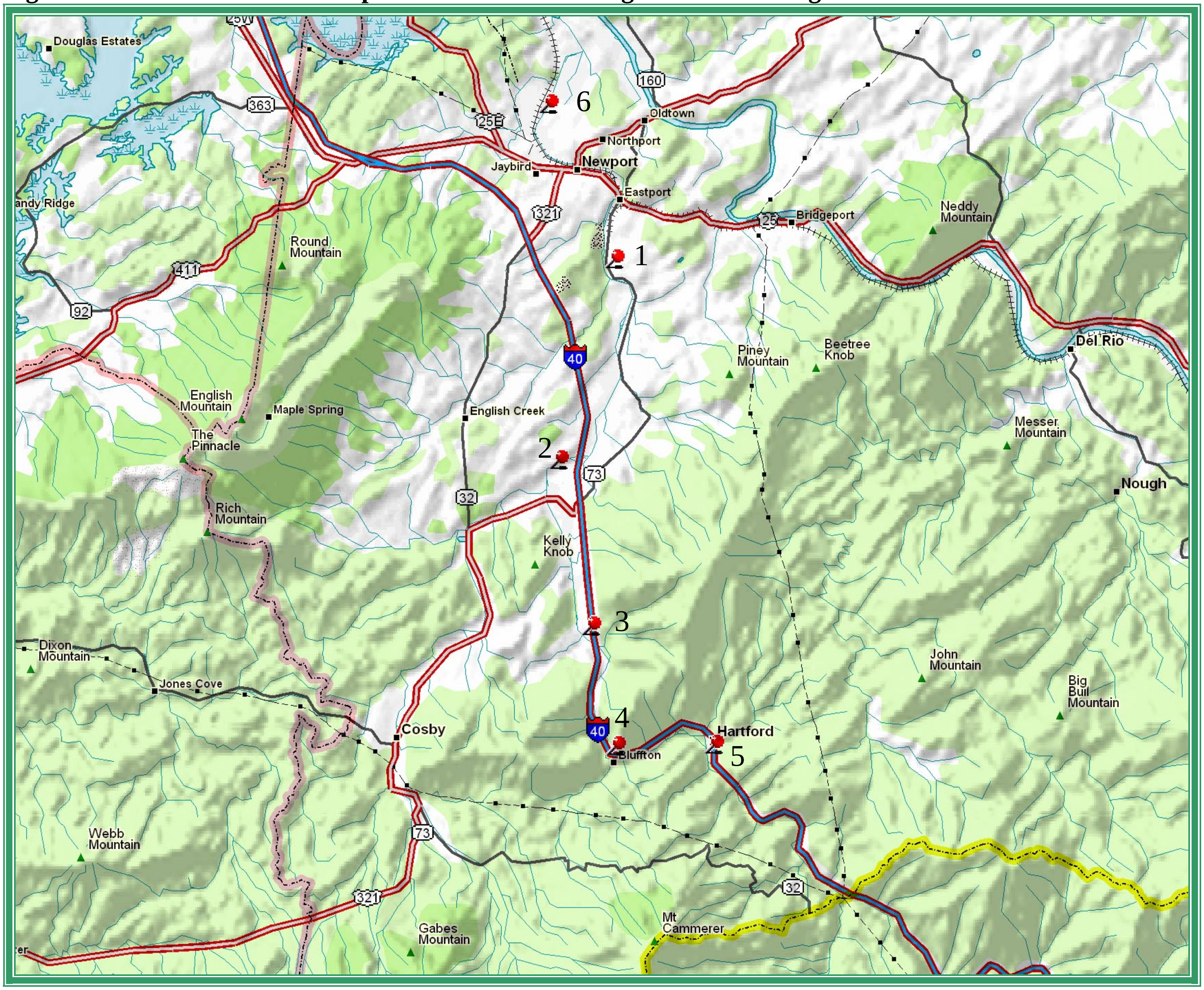


Table 29. Physiochemical and site location data for CPUE samples conducted in the Pigeon River during 2005.

Site Code	Site	County	Quad	River Mile	Latitude	Longitude	Mean Width (m)	Length (m)	Temp. C	Cond.	Secchi (m)
420051201	1	Cocke	Newport 173NW	8.1	35.94250	-83.17860	53.6	392	-	-	-
420051202	No Sample										
420051203	3	Cocke	Hartford 173SW	16.6	35.84410	-83.18440	-	414	-	-	-
420051204	4	Cocke	Hartford 173SW	19	35.81300	-83.17800	35.3	80	15.5	185	-
420051205	5	Cocke	Hartford 173SW	20.5	35.81360	-83.16250	47.3	839	16	202	-
420051206	6	Cocke	Newport 173NW	4.0	35.98250	-83.19880	54	193	19.5	230	-

Catch-per-unit-effort fish samples were collected by boat electrofishing in accordance with the standard large river sampling protocols (TWRA 1998). Fixed-boom electrodes were used to transfer 4-5 amps DC at all sites. This current setting was determined effective in narcotizing all target species (black bass and rock bass). All fish collected were returned to the river. Additionally, efforts were made to identify non-target species encountered at each survey site. All sites were sampled during daylight hours and had survey durations ranging from 901 to 3,057 seconds. Catch-per-unit-effort values were calculated for each target species at each site. Length categorization indices were calculated for target species following Gabelhouse (1984). Index of Biotic Integrity samples were collected using both backpack and boat electrofishing in accordance with standardized protocols.

Results

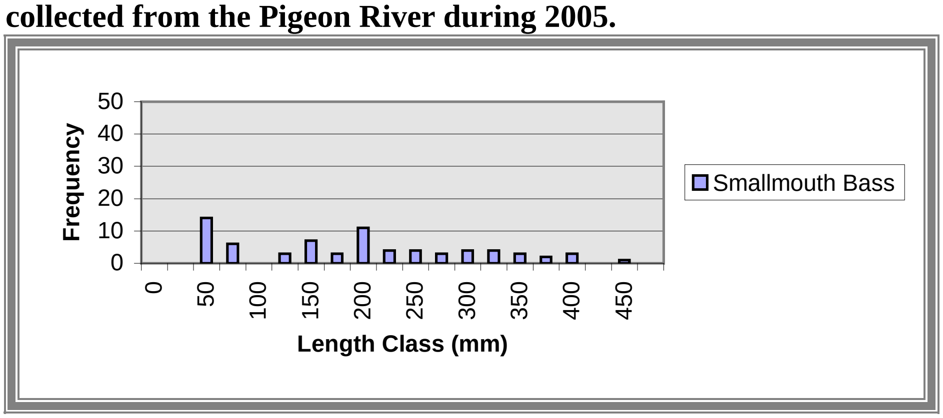
During our surveys, smallmouth bass and rock bass were collected from all sample sites. Spotted bass were not collected at any of the sampling stations. Largemouth bass was present only at site 5. Smallmouth bass was the most abundant black bass species at any of the survey sites. CPUE estimates for this species averaged 26.4/hour (SD 12.8) (Table 30). Our highest observed catches of smallmouth bass were recorded at site 3 (Denton) and site 5 (Hartford). Rock bass CPUE was highest in sites 3 and 5, averaging 23.6/hour (SD 15.0). The highest catch rate for this species was recorded at site 3 (45.8/hour), which also had the highest value in 2004. Overall, we observed a 57% decrease in the mean catch rate of smallmouth bass between the 2004 and 2005 samples. Although our 2005 sample was consistently timed with the sampled taken in 2004 (mid-October) we feel the water temperature had not decreased sufficiently to move the majority of the bass into their winter habitat (pools). Therefore, our catches were probably depressed from expected values. Fluctuation in the number of spotted bass and largemouth bass 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 30. Catch per unit effort and length categorization indices of target species collected at five sites on the Pigeon River during 2005.

Site Code	Smallmouth Bass CPUE	Spotted Bass CPUE	Largemouth Bass CPUE	Rock Bass CPUE
420051201	6.0	-	-	4.0
420051202	No sample	No sample	No sample	No sample
420051203	30.6	-	-	45.8
420051204	26.0	-	-	18.5
420051205	41.4	-	4.3	25.7
420051206	28.0	-	-	24.0
MEAN	26.4	0	0.86	23.6
STD. DEV.	12.8	0	1.92	15.0
	Smallmouth Bass Length-Categorization Analysis	**Spotted Bass Length-Categorization Analysis**	**Largemouth Bass Length-Categorization Analysis**	**Rock Bass Length-Categorization Analysis**
	PSD =45.2	PSD = 0	PSD =50	PSD =23.8
	RSD-Preferred =21.4	RSD-Preferred = 0	RSD-Preferred =0	RSD-Preferred =2.9
	RSD-Memorable =2.3	RSD-Memorable = 0	RSD-Memorable =0	RSD-Memorable =0
	RSD-Trophy =0	RSD-Trophy = 0	RSD-Trophy =0	RSD-Trophy =0

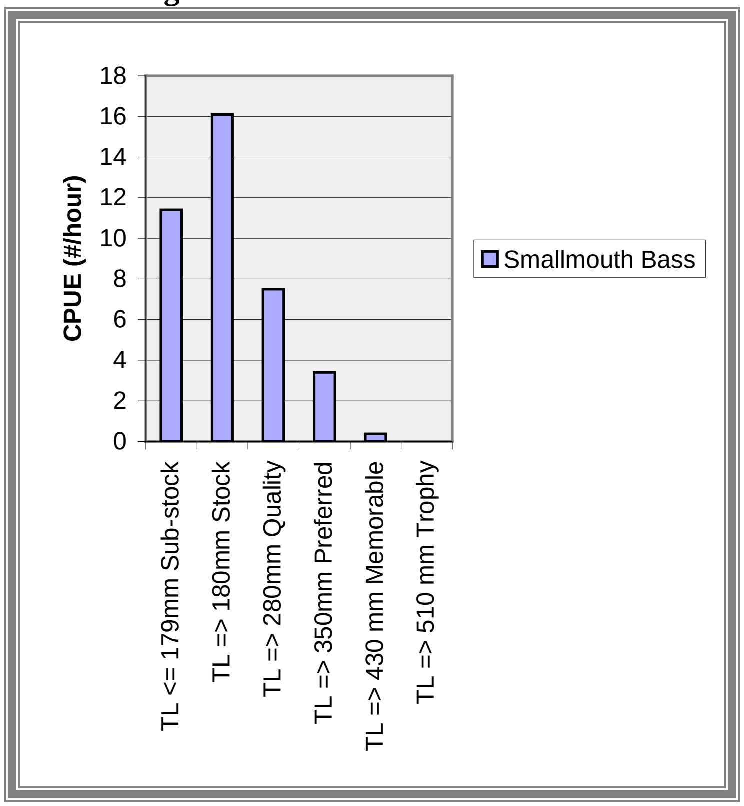
The majority of the smallmouth bass collected from the Pigeon River during 2005 fell within the 125 to 250 mm length range (Figure 32). Our data indicated that bass less than 100 mm were not completely vulnerable to the sampling gear, although the catch of juvenile fish was somewhat higher when compared to 2004. Length categorization analysis indicated the Relative Stock Density (RSD) for preferred smallmouth bass (TL $\geq$ 350 mm) was 21.4,

Figure 32. Length frequency distribution for smallmouth bass collected from the Pigeon River during 2005.



which was down 33% from the previous year. RSD for memorable (TL $\geq$ 430 mm) and trophy (TL $\geq$ 510 mm) size bass were 2.3 and 0, respectively. The PSD of smallmouth bass (ratio of quality size bass to stock size bass) was 45.2. Catch per unit effort estimates by RSD category indicated smallmouth bass had the highest catch rates of any of the black bass species collected for the category RSD-S and above (Figure 33). Both sub-stock and stock categories declined proportionally between 2004 and 2005 and most noticeably in the RSD-Stock category. We observed proportional decreases in the other RSD categories as well, resulting from our 57% decrease in catch rate.

Figure 33. Relative stock density (RSD) catch per unit effort for smallmouth bass collected from the Pigeon River during 2005.

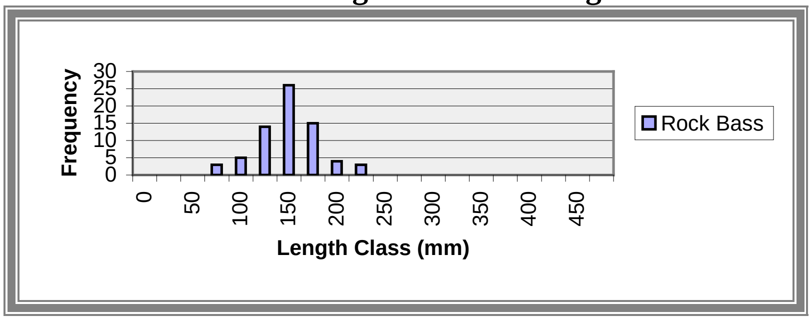


There were no spotted bass collected from the Pigeon River in 2005 (2 collected in 2004. Because no spotted bass collected in the sample, no useful information could be derived regarding the size structure of this species.

Only three largemouth bass were collected from all of our sites surveyed in 2005. Largemouth bass have always been a rarity at all of our sample stations and it is not unexpected to survey all sample stations without observing this species. The largemouth collected in 2005 ranged in length from 236 to 342 mm.

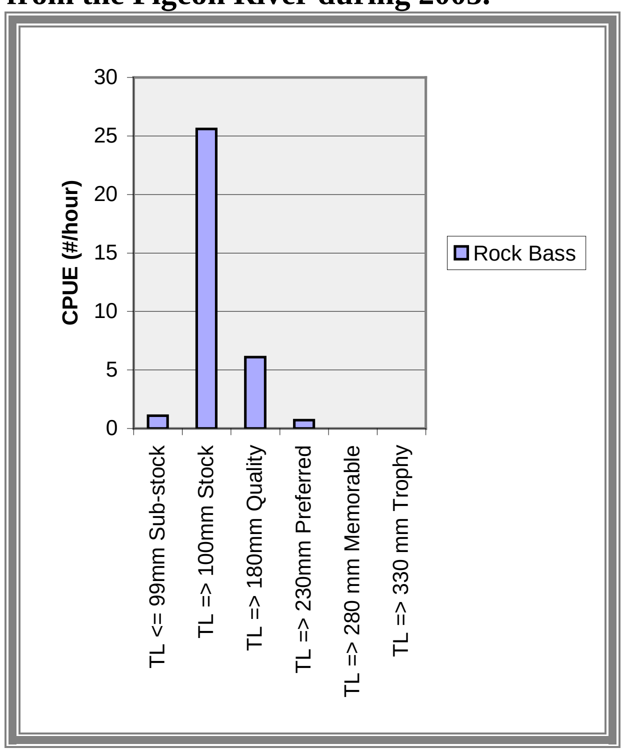
Individuals in the 125 to 175 mm range represented the majority of rock bass in our sample (Figure 34). Length categorization analysis indicated the RSD for preferred rock bass (TL $\geq$ 230 mm) was 2.9, which was an increase from the previous year sample (0). RSD for memorable (TL $\geq$ 280 mm) and trophy (TL $\geq$ 330 mm) size rock bass was 0. The PSD of rock bass was 23.8, which was down 19% from the sample taken in 2004. Catch per unit effort estimates by RSD category indicated the majority of our catch was stock size fish (Figure 35) with about 22.7% of the catch representing quality size fish.

Figure 34. Length frequency distribution for rock bass collected from the Pigeon River during 2005.



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. Overall, we observed increases in all RSD categories represented in 2005 when compared to the 2004 values.

Figure 35. Relative stock density (RSD) catch per unit effort by category for rock bass collected from the Pigeon River during 2005.



Linear and curvilinear length-weight regression analysis has been calculated for previous data (Carter et al. 1999, 2000), and is assumed to be similar for the 2005 data. No age and growth data was collected from this population in 2005; 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 (40) during our cooperative IBI surveys at Tannery Island and Denton. None of the fish collected in the 2005 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 31.

Table 31. Distribution of fish species collected in the Pigeon River during 2005.

Pigeon River Mile	8.1	16.6
	420051201	420051203
Species	*Ambloplites rupestris*	*Ambloplites rupestris*
	Aplodinotus grunniens	*Campostoma oligolepis*
	Campostoma oligolepis	*Cottus carolinae*
	Catostomus commersoni	*Cyprinella galactura*
	Cottus carolinae	*Dorosoma cepedianum*
	Cyprinella galactura	*Etheostoma blennioides*
	Cyprinella spiloptera	*Etheostoma rufilineatum*
	Cyprinus carpio	*Etheostoma tennessense*
	Dorosoma cepedianum	*Hypentelium nigricans*
	Etheostoma blennioides	*Ictalurus punctatus*
	Etheostoma kennicotti	*Ictiobus bubalus*
	Etheostoma rufilineatum	*Lepomis auritus*
	Etheostoma tennessense	*Lepomis macrochirus*
	Hybopsis amblops	*Micropterus dolomieu*
	Hybrid Lepomis spp.	*Micropterus punctulatus*
	Hypentelium nigricans	*Moxostoma anisurum*
	Ichthyomyzon bdellium	*Moxostoma carinatum*
	Ictalurus punctatus	*Moxostoma duquesnei*
	Ictiobus bubalus	*Moxostoma erythrurum*
	Ictiobus niger	*Moxostoma breviceps*
	Lepomis auritus	*Notropis amblops*
	Lepomis cyanellus	*Notropis leuciodus*
	Lepomis macrochirus	*Notropis photogenis*
	Micropterus dolomieu	*Notropis rubellus*
	Micropterus punctulatus	*Notropis telescopus*
	Micropterus salmoides	*Percina caprodes*
	Morone chrysops	*Sander canadense*
	Moxostoma anisurum	*Sander vitreum*
	Moxostoma breviceps	
	Moxostoma carinatum	
	Moxostoma duquesnei	
	Moxostoma erythrurum	
	Notropis photogenis	
	Notropis rubellus	
	Notropis telescopus	
	Percina caprodes	
	Percina evides	
	Pomoxis nigromaculatus	
	Sander canadense	
	Sander vitreum	

Benthic macroinvertebrates collected at the Tannery Island site comprised 20 families representing 21 identified genera (Table 32). The most abundant group in our collection was the dipterans comprising 24.2% of the total sample. Overall, a total of 29 taxa were identified from the sample of which 9 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/fair-good" (2.8).

Table 32. Taxa list and associated biotic statistics for benthic macroinvertebrates collected from the Pigeon River at Tannery Island (river mile 8.1).

	FAMILY	SPECIES	NUMBER	PERCENT
ANNELIDA				7.6
Hirudinea			1	
Oligochaeta			11	
COLEOPTERA				1.9
	Elmidae	*Ancyronyx variegatus* adults	2	
		Promoresia elegans adult	1	
DIPTERA				24.2
	Chironomidae	larvae and pupae	18	
	Simuliidae		18	
	Tipulidae	*Tipula*	2	
EPHEMEROPTERA				7.0
	Baetidae	*Acentrella*	5	
		Heterocloeon	5	
	Ephemerellidae	*Eurylophella verisimilis*	1	
GASTROPODA				14.0
	Physidae		7	
	Pleuroceridae	*Pleurocera*	15	
ISOPODA				2.5
	Asellidae	*Caecidotea*	4	
MEGALOPTERA				6.4
	Corydalidae	*Corydalus cornutus*	8	
		Nigronia serricornis	2	
ODONATA				8.3
	Calopterygidae	*Hetaerina americana*	8	
	Coenagrionidae	*Argia bipunctulata*	1	
		Argia fumipennis	1	
		Enallagma divagans	1	
		Enallagma weewa	1	
	Gomphidae	*Hagenius brevistylus*	1	
PELECYPODA				3.8
	Corbiculidae	*Corbicula fluminea*	3	
	Sphaeriidae	*Pisidium*	3	
PLECOPTERA				1.3
	Perlidae	*Perlesta* (freckled form)	2	
TRICHOPTERA				22.9
	Brachycentridae	*Brachycentrus lateralis*	1	
		Brachycentrus numerosus	2	
	Hydropsychidae	*Ceratopsyche morosa*	29	
		Cheumatopsyche	3	
		Hydropsyche franclemonti	1	
		Total	**157**	

TAXA RICHNESS = 29
EPT TAXA RICHNESS = 9
BIOCLASSIFICATION = 2.8 (FAIR/FAIR-GOOD)

Benthic macroinvertebrates collected at the Denton site comprised 31 families representing 33 identified genera (Table 33). The most abundant group in our collection was the mayflies comprising 32.7% of the total sample. Overall, a total of 42 taxa were identified from the sample of which 17 were EPT. Based on the EPT taxa richness and overall biotic index of all species collected, the relative health of the benthic community was classified as "fair-good/good" (3.8).

Table 33. Taxa list and associated biotic statistics for benthic macroinvertebrates collected from the Pigeon River at Denton (river mile 16.6).

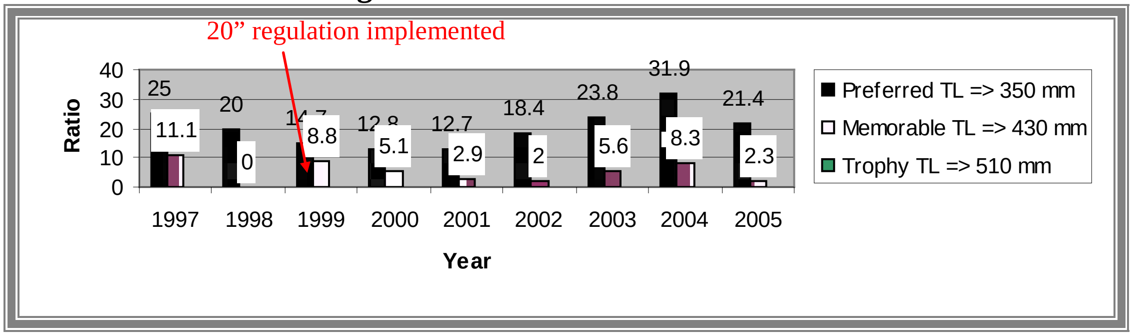
	FAMILY	SPECIES	NUMBER	PERCENT
ANNELIDA				1.8
Oligochaeta			10	
COLEOPTERA				6.0
	Dryopidae	*Helichus* adults	5	
	Elmidae	*Ancyronyx variegatus*	2	
		Macronychus glabratus	3	
		Optioservus ovalis	2	
		Promoresia elegans larva and adults	22	
COLLEMBOLA				0.4
	Isotomidae	*Isotomurus palustris*	2	
DIPTERA				
	Chironomidae	larvae and pupae	32	12.4
	Empididae		1	
	Simuliidae	larvae and pupae	22	
	Tabanidae	*Tabanus*	1	
	Tipulidae	*Antocha*	13	
		Tipula	1	
EPHEMEROPTERA				32.7
	Baetidae	*Acentrella*	62	
		Heterocloeon	28	
		Procloeon	22	
	Caenidae	*Caenis*	1	
	Ephemerellidae	*Serratella*	11	
	Heptageniidae	*Maccaffertium* sp.	48	
		Maccaffertium mediopunctatum	2	
	Isonychiidae	*Isonychia*	11	
GASTROPODA				1.8
	Physidae		9	
	Planorbidae		1	
HETEROPTERA				13.6
	Veliidae	*Rhagovelia obesa* nymphs and adults	77	
ISOPODA				2.7
	Asellidae	*Caecidotea*	15	
MEGALOPTERA				2.7
	Corydalidae	*Corydalus cornutus*	13	
		Nigronia serricornis	2	
ODONATA				4.1
	Aeshnidae	*Boyeria vinosa*	7	
	Calopterygidae	*Hetaerina americana*	12	
	Corduliidae	early instars	3	
	Gomphidae	*Lanthus vernalis*	1	
PELECYPODA				1.9
	Corbiculidae	*Corbicula fluminea*	9	
	Sphaeriidae	*Psidium*	3	
TRICHOPTERA				19.8
	Brachycentridae	*Brachycentrus lateralis*	4	
	Hydropsychidae	*Ceratopsyche morosa*	27	
		Ceratopsyche sparna	46	
		Hydropsyche venularis	18	
	Lepidostomatidae	*Lepidostoma*	2	
	Leptoceridae	*Mystacides sepulchralis*	1	
		Oecetis avara	2	
	Polycentropodidae	*Polycentropus*	11	
	Psyschomyiidae	*Lype diversa*	1	
		Total	**565**	

TAXA RICHNESS = 42
EPT TAXA RICHNESS = 17
BIOCLASSIFICATION = 3.8 (FAIR-GOOD/GOOD)

Discussion

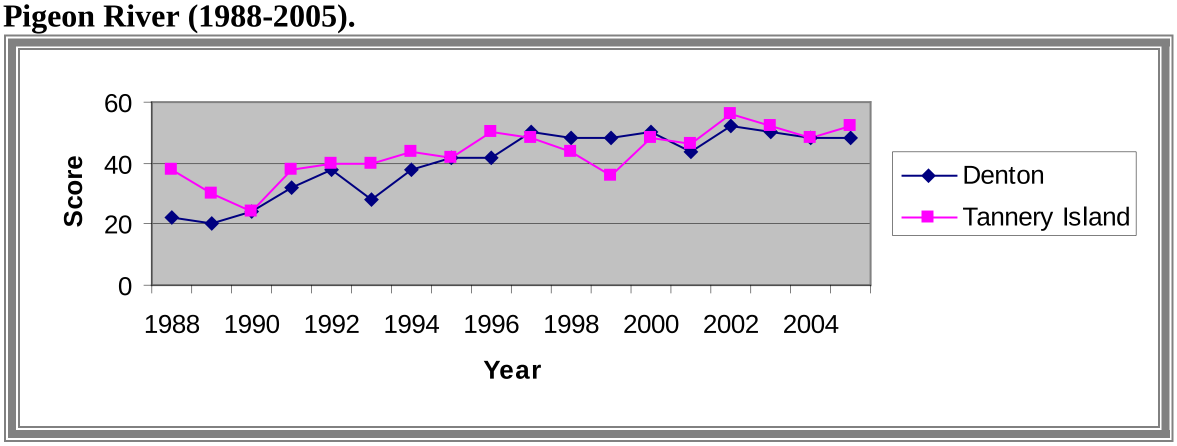
The Pigeon River provides anglers with the opportunity to catch all species of black bass as well as rock bass. Perhaps the greatest potential for elevating this river's "trophy" status lies in the smallmouth bass population. Given that a fair percentage of smallmouth bass are reaching the preferred category (average 20% between 1997-2005) 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 36).

Figure 36. Trends in the ratio of preferred, memorable, and trophy smallmouth bass collected from the Pigeon River 1997-2005.



Over the last 18 years the IBI scores (TWRA and TVA data) at two stations on the Pigeon River have been steadily increasing (Figure 37). Results from the 2005 surveys indicated the Pigeon River was in "good" condition at river mile 8.1 (IBI score 52) and 16.5 (IBI score 48). This has primarily been the result of improved wastewater treatment at the Blue Ridge 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 and the implementation of a fish and mollusk recovery effort. 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.

Figure 37. Trends in Index of Biotic Integrity (IBI) at two stations on the Pigeon River (1988-2005).



Based on our findings from our 2002 and 2004 fall surveys, we have become convinced that sampling the river at this time of year gives us a better indication of the actual smallmouth bass population composition and size structure. We will monitor black bass and rock bass populations in the Pigeon River during late September or October in order to increase our efficiency in characterizing the smallmouth bass populations in the river. An angler use survey will be conducted for the Pigeon River in 2006.

Management Recommendations

1. Implement an angler-use and harvest survey in 2006.

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.

Summary

We surveyed four rivers and 11 streams, collecting 51 fish samples and 12 benthic samples. In the four large rivers sampled during 2005, mean CPUE values for smallmouth bass ranged from a high of 41.7/hour in the Powell River to a low 26.4/hour in the Pigeon River. In the Pigeon River we observed a decrease in the mean catch of smallmouth bass and an overall decrease in the number of preferred (TL => 350mm) and memorable (TL => 430mm) size smallmouth bass when compared to the 2004. Although our sample timing was consistent with previous samples (mid-October) in the Pigeon River, the water temperature had not decreased enough to initiate the movement of bass into their winter habitat.

Of the five small stream IBI surveys conducted in 2005, Doe Creek in Johnson County and the unnamed tributary to Taylor Branch in Bradley County scored the highest with (46) followed by Williams Creek in Grainger County at 42. The lower scoring streams included Gap Creek in Greene County at 36 and Beaver Creek in Jefferson County at 30 and 38, respectively. Benthic scores for these five samples all fell between "good" and "fair/fair-good" with three being rated as "good". One new state record of caddisfly was recorded from Doe Creek in Johnson County as well as the collection of two undetermined species of *Neophylax* from Doe Creek and Hurricane Creek (Franklin County). Tennessee dace were documented in three new localities in 2005 (unnamed tributary to Taylor Branch, Bradley County and to tributaries to Beech Creek in Hawkins County).

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

Over the past 11 years the stream survey unit has been conducting Index of Biotic Integrity surveys in various watersheds within the region. These have been done in response to requests made by TWRA personnel, cooperative effort requests, and general interest in determining the state of certain streams. Our compilation of these surveys has given us a reference database for many streams in the region that can be used for comparison purposes should we return for a routine survey or responding to a water quality issue. Table 34 lists our results for various streams surveyed during this time period.

Table 34. Index of Biotic Integrity and Benthic Biotic Index scores for samples conducted between 1994 and 2005.

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

Table 34. Continued.

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

Table 34. Continued.

Water	Watershed	Year Surveyed	County	IBI Score	Benthic BI Score
Martin Creek	Powell River	1998	Hancock	50 (Good)	4 (Good)
Big Creek	Tellico River	1998	Monroe	46 (Fair/Good)	4 (Good)
Oven Creek	Nolichucky River	1998	Cocke	40 (Fair)	2.9 (Fair/Good)
Cherokee Creek	Nolichucky River	1998	Washington	36 (Poor/Fair)	2.8 (Fair/Good)
Bennetts Fork	Cumblerland River	2000	Claiborne	30 (Poor)	3.5 (Fair/Good)
Gulf Fork Big Creek	French Broad River	2001	Cocke	42 (Fair)	4.0 (Good)
Nolichucky River	French Broad River	2001	Unicoi	56 (Good/Excellent)	4.0 (Good)
North Fork Holston River	Holston River	2001	Hawkins	50 (Good)	4.5 (Good)
Stinking Creek	Cumberland River	2002	Campbell	42 (Fair)	4.5 (Good)
Straight Fork	Cumberland River	2002	Campbell	18 (Very Poor)	3.0 (Fair/Good)
Montgomery Fork	Cumberland River	2002	Campbell	48 (Good)	3.5 (Fair/Good)
Turkey Creek	Holston River	2003	Hamblen	34 (Poor)	1.5 (Poor)
Spring Creek	Holston River	2003	Hamblen	34 (Poor)	2.2 (Fair)
Cedar Creek	Holston River	2003	Hamblen	30 (Poor)	3.5 (Fair/Good)
Fall Creek	Holston River	2003	Hamblen	32 (Poor)	2.3 (Fair)
Holley Creek	Nolichucky River	2003	Greene	30 (Poor)	2.4 (Fair)
College Creek	Nolichucky River	2003	Greene	36 (Poor/Fair)	2.2 (Fair)
Kendrick Creek	South Fork Holston River	2004	Sullivan	34 (Poor)	3.8 (Fair/Good-Good)
Sinking Creek	South Fork Holston River	2004	Sullivan	32 (Poor)	3.8 (Fair/Good-Good)
Mud Creek	Nolichucky River	2004	Greene	46 (Fair/Good)	4.0 (Good)
New River (Site 1)	Big South Fork Cumberland River	2004	Anderson	30 (Poor)	4.2 (Good)
New River (Site 2)	Big South Fork Cumberland River	2004	Campbell	42 (Fair)	3.5 (Fair/Good)
Indian Fork	Big South Fork Cumberland River	2004	Anderson	41 (Fair)	3.8 (Fair/Good-Good)
Unnamed Tributary to Taylor Branch	Hiwassee River	2005	Bradley	48 (Good)	4.0 (Good)
Little River (Coulters Bridge)	Tennessee River	2005	Blount	54 (Good/Excellent)	
Little River (Townsend)	Tennessee River	2005	Blount	48 (Good)	
Williams Creek	Clinch River	2005	Grainger	42 (Fair)	4.3 (Good)
Beaver Creek (Site 1)	Holston River	2005	Jefferson	38 (Poor/Fair)	2.8 (Fair/Fair-Good)
Beaver Creek (Site 2)	Holston River	2005	Jefferson	30 (Poor)	3.2 (Fair/Good)
Doe Creek	Holston River	2005	Johnson	46 (Fair/Good)	4.0 (Good)
Gap Creek	Nolichucky River	2005	Greene	36 (Poor/Fair)	3.5 (Fair/Good)
Pigeon River (Tannery Island)	French Broad River	2005	Cocke	52 (Good)	2.8 (Fair/Fair-Good)
Pigeon River (Denton)	French Broad River	2005	Cocke	48 (Good)	3.8 (Fair-Good/Good)

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APPENDIX A

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

Family	Common Name	Scientific Name
Catostomidae	Black buffalo	*Ictiobus niger*
	Black redhorse	*Moxostoma duquesnei*
	Golden redhorse	*Moxostoma erythrurum*
	Spotted sucker	*Minytreram melanops*
	Northern hogsucker	*Hypentelium nigricans*
	River redhorse	*Moxostoma carinatum*
	Silver redhorse	*Moxostoma anisurum*
	Smallmouth redhorse	*Moxostoma breviceps*
	Smallmouth buffalo	*Ictiobus bubalus*
	White sucker	*Catostomus commersoni*
Centrarchidae	Bluegill	*Lepomis macrochirus*
	Green sunfish	*Lepomis cyanellus*
	Largemouth bass	*Micropterus salmoides*
	Redbreast sunfish	*Lepomis auritus*
	Rock bass	*Ambloplites rupestris*
	Smallmouth bass	*Micropterus dolomieu*
	Spotted bass	*Micropterus punctulatus*
	Black crappie	*Pomoxis nigromacualtus*
Clupeidae	Gizzard shad	*Dorosoma cepedianum*
Cottidae	Banded sculpin	*Cottus carolinae*
	Mottled sculpin	*Cottus bairdi*
Cyprinidae	Bigeye chub	*Hybopsis amblops*
	Western Blacknose dace	*Rhinichthys obtusus*
	Bluntnose minnow	*Pimephales notatus*
	Carp	*Cyprinus carpio*
	Central stoneroller	*Campostoma anomalum*
	Creek chub	*Semotilus atromaculatus*
	Blotched chub	*Erimystax insignis*
	Largescale stoneroller	*Campostoma oligolepis*
	Mimic shiner	*Notropis vollucelus*
	Mountain shiner	*Lythrurus lirus*
	River chub	*Nocomis micropogon*
	Rosefin shiner	*Lythrurus fasciolaris*
	Rosyface shiner	*Notropis rubellus*
	Rosyside dace	*Clinostomus funduloides*
	Silver shiner	*Notropis photogenis*
	Spotfin shiner	*Cyprinella spiloptera*
	Striped shiner	*Luxilus chrysocephalus*
	Telescope shiner	*Notropis telescopus*
	Tennessee dace	*Phoxinus tennesseensis*
	Tennessee shiner	*Notropis leuciodus*
	Stargazing minnow	*Phenocobius uranops*
	Warpaint shiner	*Luxilus coccogenis*

Cyprinidae	Whitetail shiner	*Cyprinella galactura*
Fundulidae	Northern studfish	*Fundulus catenatus*
	Blackspotted topminnow	*Fundulus olivaceous*
Ictaluridae	Channel catfish	*Ictalurus punctatus*
	Mountain madtom	*Noturus eleutherus*
Lepisosteidae	Longnose gar	*Lepisosteus osseus*
Moronidae	White Bass	*Morone chrysops*
Percidae	Banded darter	*Etheostoma zonale*
	Black darter	*Etheostoma duryi*
	Blotchside logperch	*Percina burtoni*
	Bluebreast darter	*Etheostoma camurum*
	Blueside darter	*Etheostoma jessiae*
	Fantail darter	*Etheostoma flabellare*
	Gilt darter	*Percina evides*
	Greenside darter	*Etheostoma blenniodes*
		Etheostoma tennessense
	Johnny darter	*Etheostoma nigurm*
	Logperch	*Percina caprodes*
	Longhead darter	*Percina macrocephala*
	Rainbow darter	*Etheostoma caeruleum*
	Redline darter	*Etheostoma ruflineatum*
	Sauger	*Sander canadense*
	Snubnose darter	*Etheostoma simoterum*
	Stripetail darter	*Etheostoma kennocotti*
	Tangerine darter	*Percina tanasi*
	Walleye	*Sander vitreum*
Petromyzontidae	American brook lamprey	*Lampetra appendix*
	Least brook lamprey	*Lampetra aepyptera*
	Mountain brook lamprey	*Icthyomyzon greeleyi*
	Ohio lamprey	*Icthyomyzon bdellium*
Poeciliidae	Western mosquitofish	*Gambusia affinis*
Salmonidae	Rainbow trout	*Oncorhynchus mykiss*
Sciaenidae	Drum	*Aplodinotus grunniens*