FISHERIES REPORT

Warmwater Streams and Rivers

Tennessee Wildlife Resources Agency--Region IV

Report 14-05

2013

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REPORT NO. 14-05
WARMWATER STREAM FISHERIES REPORT
REGION IV
2013

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TENNESSEE WILDLIFE RESOURCES AGENCY

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Cover: Cumberland arrow darter (*Etheostoma sagitta),* Lick Fork, Campbell Co.

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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). Streams in Region IV, except for a few in Anderson, Campbell, Claiborne, and Scott 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, Holston, and Big South Fork Cumberland River.

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 2014) as a primary goal.

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. 04-13. Four rivers and 6 streams were sampled and are included in this report. Surveys were conducted from April to November 2013. A total of 21 (IBI, CPUE) fish and four benthic macroinvertebrate 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 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

A percentage of the fish data collected in this report was accomplished 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 meters x 5 meters) 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. 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. In larger rivers, a boat was used in conjunction with the backpack samples to effectively sample deep pool habitat. Timed (10-min duration) runs were used until all habitat types had been depleted.

Streams sampled for the Cumberland Habitat Conservation Plan (HCP) utilized two techniques for collecting fish data. Catch-per-unit-effort samples (CPUE) were calculated for all target species covered under the HCP. Site lengths for these streams were typically 200 meters and were sampled by a one pass electrofishing run utilizing one backpack electrofishing unit.

Catch-per-unit-effort samples were conducted in three rivers during 2013. 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 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 2013 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), Powers and Mayden (2007) and Etnier and Starnes (1993).

BENTHIC COLLECTIONS

Qualitative benthic samples were collected from each IBI fish sample site and at four other locations for a total of eight samples. 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 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 (Smith et al. 2002). The major advantages of this evaluation procedure include more concise metrics and categories that identify the stream or river based on size, gradient, temperature, ecoregion 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 us to develop a more accurate biotic index for benthic macroinvertebrates for the Ridge and Valley and Blue Ridge Ecoregions of east Tennessee. The illustrations on the following page 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 us 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 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.)

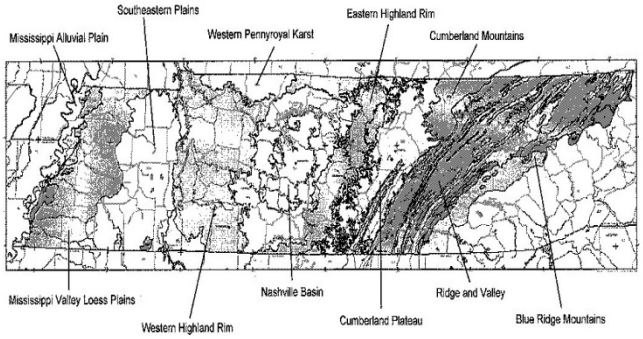
TOTAL ☐

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 <0.01	GRADIENT MOD 0.01-0.05	GRADIENT HIGH >0.05	TEMPERATURE COLD <20°C	TEMPERATURE COOL <25°C	TEMPERATURE WARM >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 mid-western United States, many state and federal agencies have modified the original twelve metrics to accommodate regional differences. Such modifications have been developed for Tennessee primarily through the efforts of TWRA (Bivens et al. 1995), TVA, and Tennessee Tech University. In developing our scoring criteria for the twelve metrics we reviewed pertinent literature [North American Atlas of Fishes (Lee et al. 1980), The Fishes of Tennessee (Etnier and Starnes 1993), various TWRA Annual Reports and unpublished data] to establish historical and more recent accounts of fishes expected to occur in the drainages we sampled. Scoring criteria for the twelve metrics were modified according to watershed size. Watersheds draining less than 13 kilometer^2 were assigned different scoring criteria than those draining greater areas. This was done to accommodate the inherent problems associated with small stream samples (e.g., lower catch rates and species richness). Young-of-the-year fish and non-native species were excluded from the IBI calculations. After calculating a final score, an integrity class was assigned to the stream reach based on that score. The classes used follow those described by Karr et al. (1986).

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 for three large rivers sampled during 2013. 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. Catch per unit effort samples were also calculated for streams being monitored for the HCP.

Benthic data collected for the 2013 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 (2006) with minor modifications for taxa, which did not have assigned tolerance values.

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 river miles are impounded. Another 0.75 mile or so is impounded by Perrys Mill dam 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

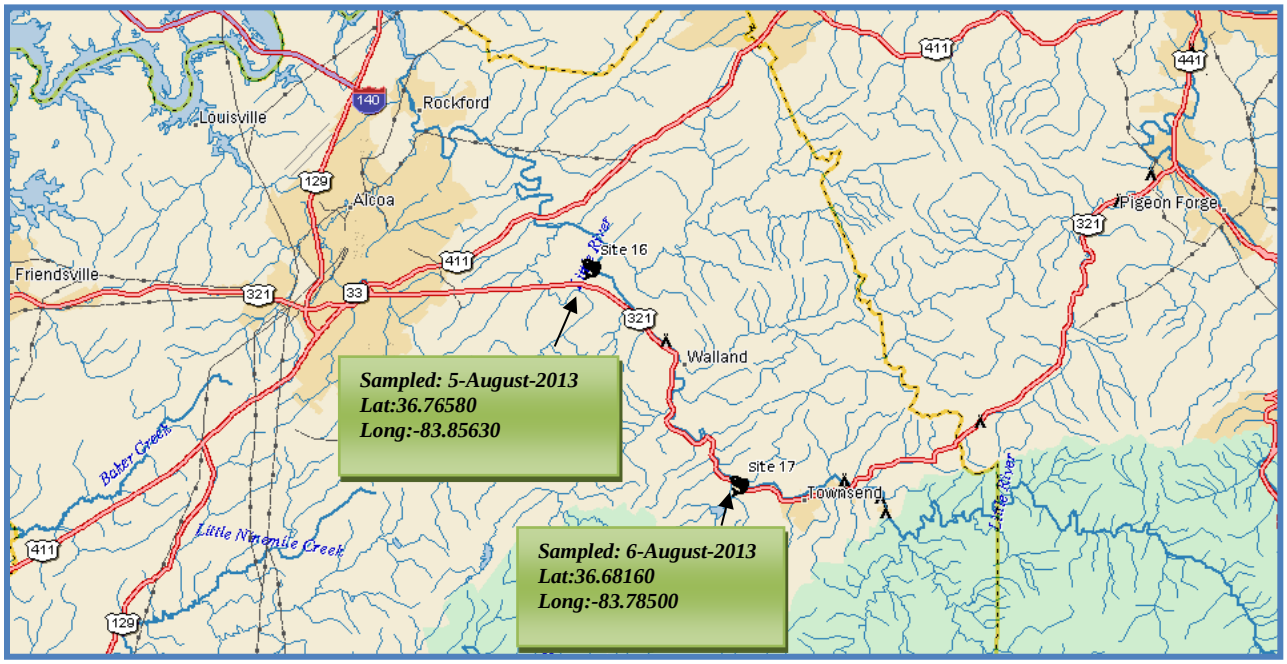
the boundary between Blount County and Knox County for the last few miles of its course.

Little River 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 federally). Additionally, its upper reach supports one of east Tennessee's better warm water 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.

Study Area and Methods

Our 2013 survey of Little River consisted of two IBI sites (Coulters Bridge and Townsend). We cooperated with several agencies in conducting the two IBI samples on August 5 and 6. The Coulters Bridge site (16) is located in the Ridge and Valley Province of Blount County while the Townsend site (17) lies in the transitional zone between the Blue Ridge and the Ridge and Valley Provinces (Figure1).

Figure 1. Little River sample site locations 2013.



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).

Results

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 August 2013, one at Coulters Bridge (river mile 20) and one at Townsend (river mile 29.8). A total of 50 fish species were collected at the Coulters Bridge site while 32 were observed at Townsend. Overall, the IBI analysis indicated the fish community was in excellent condition at Coulters Bridge (IBI score 58). The analysis for the fish community at Townsend decreased four points to 54 when compared to the 2012 score (Figure 2). 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 1 lists the species and number of fish collected at the two IBI stations.

Figure 2. Trends in the Index of Biotic Integrity (IBI) at two stations in Little River (1987-2013).

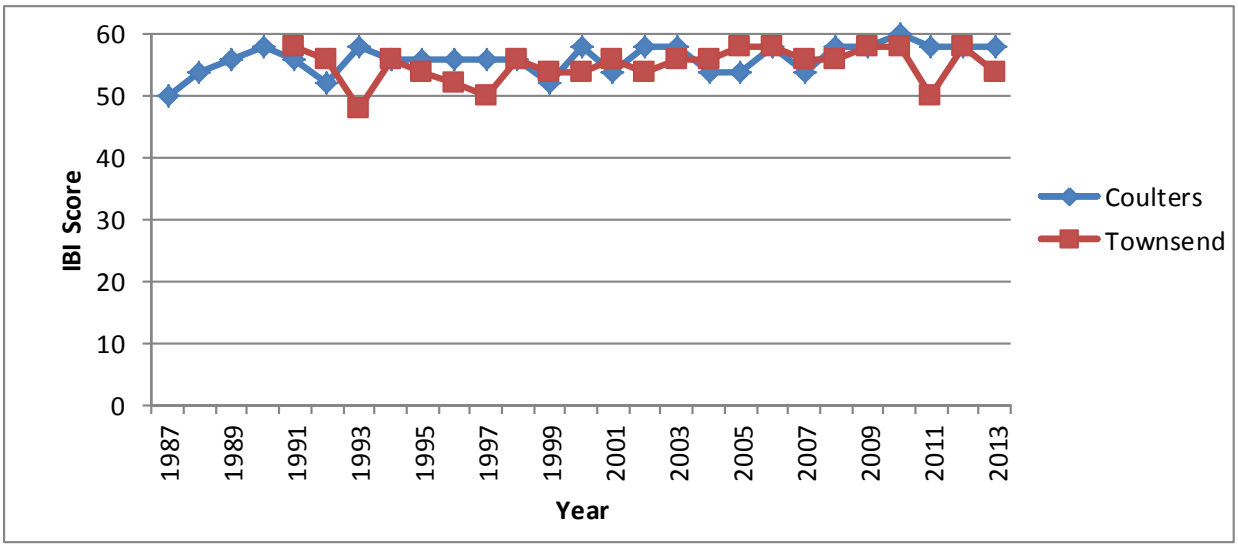


Table 1. Fish species collected at two Little River IBI stations 2013.

Site	Species	Number Collected
420131416	*Ambloplites rupestris*	59
420131416	*Aplodinotus grunniens*	3
420131416	*Campostoma oligolepis*	45
420131416	*Carpiodes cyprinus*	3
420131416	*Cottus carolinae*	19
420131416	*Cyprinella galactura*	53
420131416	*Cyprinella spiloptera*	2
420131416	*Cyprinus carpio*	1
420131416	*Dorosoma cepedianum*	3
420131416	*Erimystax insignis*	1
420131416	*Etheostoma blennioides*	13
420131416	*Etheostoma camurum*	14
420131416	*Etheostoma jessiae*	21
420131416	*Etheostoma rufilineatum*	468
420131416	*Etheostoma tennesseense*	28
420131416	*Etheostoma vulneratum*	1
420131416	*Etheostoma zonale*	6
420131416	*Fundulus catenatus*	1
420131416	*Hybopsis amblops*	36
420131416	*Hypentelium nigricans*	24
420131416	*Ichthyomyzon greeleyi*	1
420131416	*Ictalurus punctatus*	2
420131416	*Lampetra appendix*	3
420131416	*Lepisosteus osseus*	2
420131416	*Lepomis auritus*	46
420131416	*Lepomis cyanellus*	1
420131416	*Lepomis macrochirus*	13
420131416	*Luxilus chrysocephalus*	5
420131416	*Luxilus coccogenis*	12
420131416	*Lythrurus lirus*	59
420131416	*Micropterus dolomieu*	9
420131416	*Micropterus punctulatus*	1
420131416	*Micropterus salmoides*	1
420131416	*Minytrema melanops*	2
420131416	*Moxostoma anisurum*	1
420131416	*Moxostoma carinatum*	10
420131416	*Moxostoma duquesnei*	54
420131416	*Moxostoma erythrurum*	22
420131416	*Nocomis micropogon*	22
420131416	*Notropis leuciodus*	16
420131416	*Notropis micropteryx*	121
420131416	*Notropis photogenis*	6
420131416	*Notropis telescopus*	18
420131416	*Notropis volucellus*	15
420131416	*Noturus eleutherus*	11
420131416	*Percina aurantiaca*	4
420131416	*Percina caprodes*	10
420131416	*Percina evides*	9
420131416	*Percina williamsi*	1
420131416	*Phenacobius uranops*	2
420131417	*Ambloplites rupestris*	36
420131417	*Campostoma anomalum*	7
420131417	*Catostomus commersonii*	1
420131417	*Cottus carolinae*	54
420131417	*Cyprinella galactura*	83
420131417	*Erimystax insignis*	8
420131417	*Etheostoma blennioides*	6

Table 1. Continued.

Site	Species	Number Collected
420131417	*Etheostoma rufilineatum*	143
420131417	*Etheostoma tennesseense*	19
420131417	*Etheostoma vulneratum*	1
420131417	*Etheostoma zonale*	4
420131417	*Fundulus catenatus*	9
420131417	*Hybopsis amblops*	27
420131417	*Hypentelium nigricans*	24
420131417	*Ichthyomyzon greeleyi*	3
420131417	*Lampetra appendix*	18
420131417	*Lepomis auritus*	16
420131417	*Lepomis cyanellus*	3
420131417	*Lepomis macrochirus*	9
420131417	*Lepomis sp. (hybrid)*	4
420131417	*Luxilus chrysocephalus*	7
420131417	*Luxilus coccogenis*	39
420131417	*Lythrurus lirus*	15
420131417	*Micropterus dolomieu*	9
420131417	*Moxostoma duquesnei*	23
420131417	*Moxostoma erythrurum*	1
420131417	*Nocomis micropogon*	19
420131417	*Notropis leuciodus*	110
420131417	*Notropis micropteryx*	11
420131417	*Notropis photogenis*	1
420131417	*Notropis telescopus*	124
420131417	*Notropis volucellus*	9
420131417	*Percina evides*	1

Benthic macroinvertebrates collected in our sample at Townsend comprised 40 families representing 54 identified genera (Table 2). The most abundant group in our collection was the mayflies comprising 29.9% of the total sample. Overall, a total of 70 taxa were identified from the sample of which 32 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 to Excellent" (4.6).

Table 2. Taxa list and associated biotic statistics for benthic macroinvertebrates collected from Little River at Townsend during 2013.

ORDER	FAMILY	SPECIES	NUMBER	PERCENT
AMPHIPODA				2.6
	Gammaridae		10	
ANELLIDA				1.6
	Oligochaeta		6	
COLEOPTERA				8.2
	Dryopidae	*Helichus* adults	3	
	Elmidae	*Dubiraphia vittata* adult	2	
		Macronychus glabratus adults	8	
		Optioservus larvae	2	
		Optioservus trivittatus adults	3	
		Promoresis elegans adults	6	
		Stenelmis adult	1	
	Psephenidae	*Psephenus herricki* larvae	5	
	Ptilodactylidae	*Anchytarsus bicolor*	1	
COLLEMBOLA				0.3
	Isotomidae	*Isotomurus palustris*	1	
DIPTERA				20.6
	Athericidae	*Atherix lantha*	6	
	Chironomidae	larvae and pupa	40	
	Simuliidae	larvae and pupa	22	
	Empididae		1	
	Tipulidae	*Antocha*	8	
		Tipula	1	
EPHEMEROPTERA				29.9

Table 2. Continued.

	Baetidae	*Acentrella*	6	
		Baetis	31	
		Procloeon	1	
	Ephemerellidae	*Serratella deficiens*	2	
		Serratella serratoides	3	
	Heptageniidae	*Epeorus rubidus/subpallidus*	1	
		Heptagenia	3	
		Leucrocuta	3	
		Maccaffertium ithaca	21	
		Maccaffertium mediopunctatum	3	
		Stenacron pallidum	1	
	Isonychiidae	*Isonychia*	19	
	Leptohyphidae	*Tricorythodes*	8	
	Leptophlebiidae	*Paraleptophlebia*	2	
	Neoephemeridae	*Neoephemera purpurea*	9	
GASTROPODA				4.2
	Pleuroceridae	*Leptoxis*	7	
		Pleurocera sp. with stripes	2	
		Pleurocera sp. yellow	7	
HEMIPTERA				1.3
	Nepidae	*Ranatra nigra*	1	
	Veliidae	*Rhagovelia obesa* nymphs	4	
HYDRACARINA			5	1.3
MEGALOPTERA				1.9
	Corydalidae	*Corydalus cornutus*	6	
		Nigronia serricornis	1	
ODONATA				9.3
	Aeshnidae	*Boyeria vinosa*	10	
	Calopterygidae	*Calopteryx*	5	
	Coenagrionidae	*Argia moesta/translata*	1	
	Corduliidae	*Neurocordulia obsoleta*	2	
	Gomphidae	*Gomphus lividus*	3	
		Gomphus rogersi	3	
		Hagenius brevistylus	2	
		Stylogomphus albistylus	3	
	Macromiidae	*Macromia*	5	
PELECYPODA				0.8
	Corbiculidae	*Corbicula fluminea*	3	
PLECOPTERA				4.8
	Leuctridae	*Leuctra*	7	
	Peltoperlidae	*Peltoperla*	1	
	Perlidae	*Acroneuria abnormis*	3	
		Perlesta	5	
	Pteronarcyidae	*Pteronarcys dorsata*	2	
TRICHOPTERA				13.0
	Brachycentridae	*Brachycentrus lateralis*	3	
		Micrasema rickeri	1	
		Micrasema wataga	10	
	Hydropsychidae	*Ceratopsyche morosa*	2	
		Ceratopsyche sparna	3	
		Cheumatopsyche	7	
		Hydropsyche venularis	5	
		Undetermined pupa	1	
	Lepidostomatidae	*Lepidostoma*	3	
	Leptoceridae	*Triaenodes ignitus*	4	
		Triaenodes injustus	1	
	Limnephilidae	*Pycnospyche luculenta* group	1	
	Polycentropodidae	*Polycentropus*	8	
TURBELLARIA			1	0.3
			378	

TAXA RICHNESS = 70 EPT TAXA RICHNESS = 32 BIOCLASSIFICATION = 4.6 (GOOD/EXCELLENT)

Benthic macroinvertebrates collected in our sample at Coulters Bridge comprised 40 families representing 59 identified genera (Table 3). The most abundant group in our collection was the mayflies comprising 33.3% of the total sample. Overall, a total of 66 taxa were identified from the sample of which 28 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 3. Taxa list and associated biotic statistics for benthic macroinvertebrates collected from Little River at Coulters Bridge during 2013.

ORDER	FAMILY	SPECIES	NUMBER	PERCENT
AMPHIPODA				0.4
	Crangonyctidae	*Synurella*	2	
ANELLIDA				1.5
	Oligochaeta		7	
COLEOPTERA				16.1
	Dryopidae	*Helichus* adults	9	
	Elmidae	*Dubiraphia vittata* adult	2	
		Macronychus glabratus adults	9	
		Optioservus larvae	3	
		Optioservus trivittatus adults	14	
		Promoresis elegans larvae and adults	14	
	Gyrinidae	*Dineutus discolor* adults	4	
		Dineutus larvae	2	
	Haliplidae	*Peltodytes lengi*	1	
	Hydrophilidae	*Enochrus pygmaeus*	1	
		Tropisternus lateralis nimbatus adult	1	
	Psephenidae	*Psephenus herricki* larvae and adults	13	
	Staphylinidae	*Stenus*	4	
DIPTERA				13.4
	Athericidae	*Atherix lantha*	6	
	Chironomidae	larvae	32	
	Simuliidae		22	
	Tipulidae	*Antocha*	2	
		Tipula	2	
EPHEMEROPTERA				33.3
	Baetidae	*Acentrella*	10	
		Baetis	32	
		Labiobaetis	2	
	Ephemerellidae	*Serratella deficiens*	18	
	Heptageniidae	*Epeorus rubidus/subpallidus*	10	
		Leucrocuta	1	
		Maccaffertium mediopunctatum	41	
		Maccaffertium modestum	6	
	Isonychiidae	*Isonychia*	33	
	Leptohyphidae	*Tricorythodes*	5	
	Neoephemeridae	*Neoephemera purpurea*	1	
GASTROPODA				4.6
	Ancylidae	*Ferrissia*	1	
	Pleuroceridae	*Leptoxis*	16	
		Pleurocera sp. with stripes	5	
HEMIPTERA				0.6
	Veliidae	*Rhagovelia obesa* nymphs	3	
HYDRACARINA			1	0.2
ISOPODA				0.2
	Asellidae	*Caecidotea*	1	
LEPIDOPTERA				0.2
	Noctuidae	*Lithacodia*	1	
MEGALOPTERA				0.4
	Corydalidae	*Corydalus cornutus*	1	
		Nigronia serricornis	1	
ODONATA				11.5
	Aeshnidae	*Boyeria vinosa*	9	
	Calopterygidae	*Calopteryx*	1	
		Hetaerina americana	21	
	Gomphidae	*Dromogomphus spinosus*	1	
		Gomphus lividus	4	
		Hagenius brevistylus	4	
		Hylopomphus viridifrons	2	
		Stylogomphus albistylus	5	
	Macromiidae	*Macromia*	8	
PELECYPODA				1.0
	Corbiculidae	*Corbicula fluminea*	5	
PLECOPTERA				3.8
	Leuctridae	*Leuctra*	1	
	Peltoperlidae	*Peltoplerla*	3	
	Perlidae	*Acroneuria abnormis*	2	
	Pteronarcyidae	*Pteronarcys dorsata*	12	
TRICHOPTERA				12.8
	Brachycentridae	*Brachycentrus lateralis*	2	
		Micrasema wataga	1	

Table 3. Continued.

Hydropsychidae	*Ceratopsyche morosa*	8
	Ceratopsyche sparna	6
	Cheumatopsyche	8
	Hydropsyche venularis	21
Lepidostomatidae	*Lepidostoma*	2
Leptoceridae	*Nectopsyche exquisita*	1
	Ocetis	2
	Triaenodes ignitus	5
Philopotamidae	*Dolophilodes* pupa	1
	Chimarra	2
Polycentropodidae	*Polycentropus*	2
		478

TAXA RICHNESS = 66 EPT TAXA RICHNESS = 28 BIOCLASSIFICATION = 4.5 (GOOD)

Smallmouth Bass and Rock Bass Age and Growth

Age and growth evaluation of smallmouth bass and rock bass in most major regional fisheries was completed in 2001. The exception to this was Little River which had been identified for this type of investigation. In 2013, a graduate study was initiated in conjunction with the University of Tennessee to evaluate these population characteristics. Fish were collected with standard boat electrofishing techniques during the spring (April-May) when boat access to the river was feasible. The maximum age for smallmouth bass and rock bass were 15 and 7 years, respectively (Wolbert 2014). Based on growth models it was estimated that smallmouth bass would take 2.5 years to reach 180 mm (7 inches), 5 years to attain 305 mm (12 inches), and 6.7 years before they reached the preferred size of 356 mm (14 inches) (Wolbert 2014). Rock bass growth is typically slow and as seen in other regional populations, the Little River rock bass exhibited slow growth. Rock bass took 2.4 year to reach 100 mm (4 inches), 5.2 years to reach 180 mm (7 inches), and 8.3 years to attain the preferred size of 230 mm (9 inches) (Wolbert 2014). Figures 3 and 4 illustrate the growth curve characterizing the length at age for smallmouth bass and rock bass in Little River.

Figure 3. von Bertalannfy growth curve for smallmouth bass from Little River 2013 (Wolbert 2014).

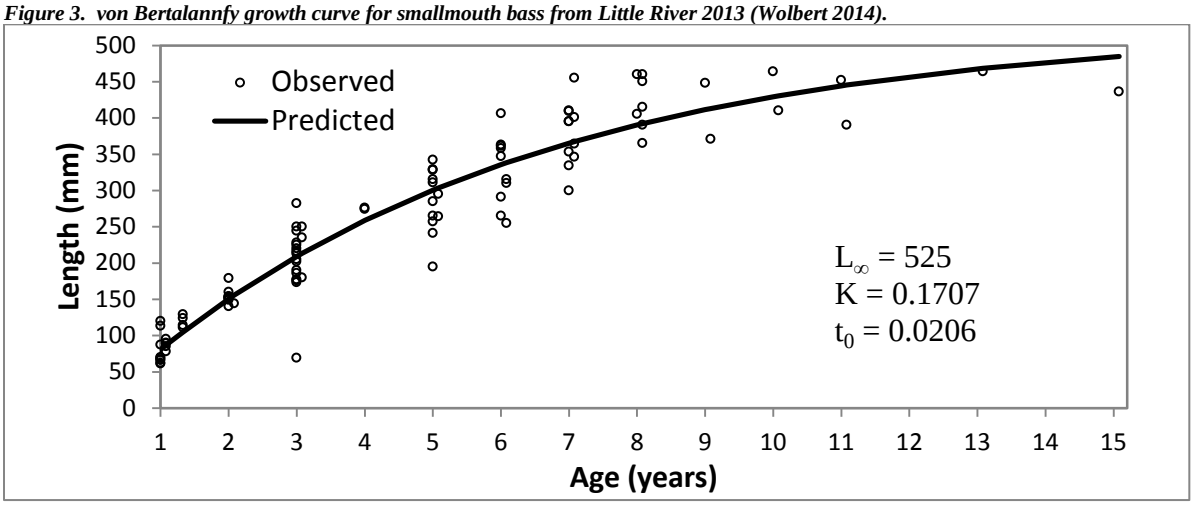
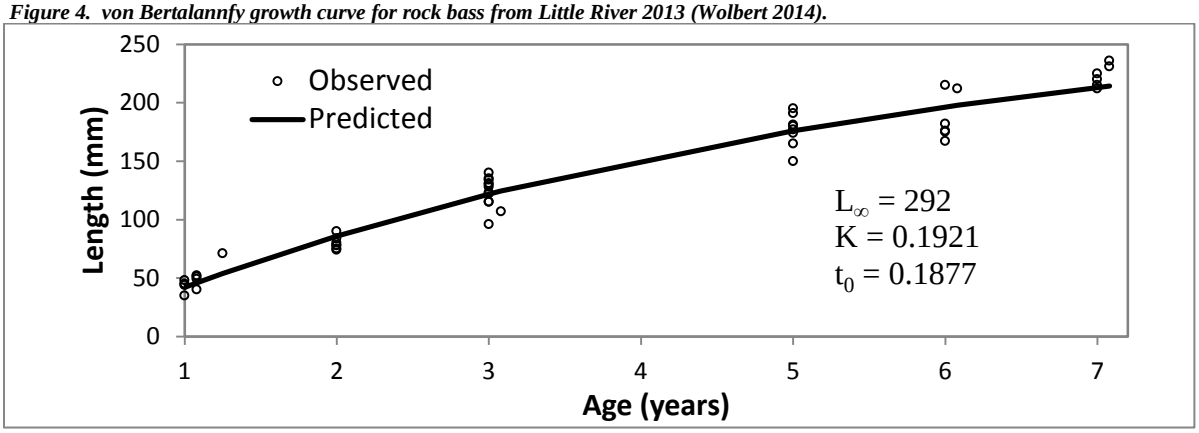


Figure 4. von Bertalannfy growth curve for rock bass from Little River 2013 (Wolbert 2014).



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 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 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 region’s best streams and serves as a benchmark in evaluating other streams of similar size and character. Effective March 1, 2009, smallmouth bass regulations in Little River from Rockford Dam upstream to the Great Smoky Mountains National Park boundary will protect bass 13 to 17 inches in length. One fish of the five fish daily creel limit can exceed 17 inches. 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 2014 to look at the sport fish will in all likelihood focus on the sample sites surveyed in 2011, providing no new or more efficient sampling scheme is developed. An angler use and harvest survey is scheduled for 2014.

Management Recommendations

1. Initiate an angler use and harvest survey in 2014.

2. Incorporate river into regional operational and implementation plan.

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

North Fork Holston River

Introduction

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

Study Area and Methods

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

During June 2013, six fish surveys (CPUE) were conducted on the North Fork between the TN/VA line and its confluence with the South Fork (Figure 5). The riparian habitat along this reach consists primarily of wooded shorelines with interspersed fields and residential lawns. Submerged woody debri was fairly common in most of our sample areas. The river substrate was predominately composed of bedrock and boulders. Perpendicular/parallel (to flow) bedrock shelves were more abundant in the pool habitat, while a combination of boulder and bedrock comprised the majority of the riffle habitat. There were a few riffles within the survey areas that had cobble size substrate as the primary component. Measured mean channel widths ranged from 45.2 m to 68.3 m, while site lengths fell between 250 meters and 1,325 meters (Table 4). Water temperatures ranged from 23 C to 25 C and conductivity varied from 370 to 400 µs/cm (Table 4).

Figure 5. Site locations for the samples conducted in the North Fork Holston River 2013.

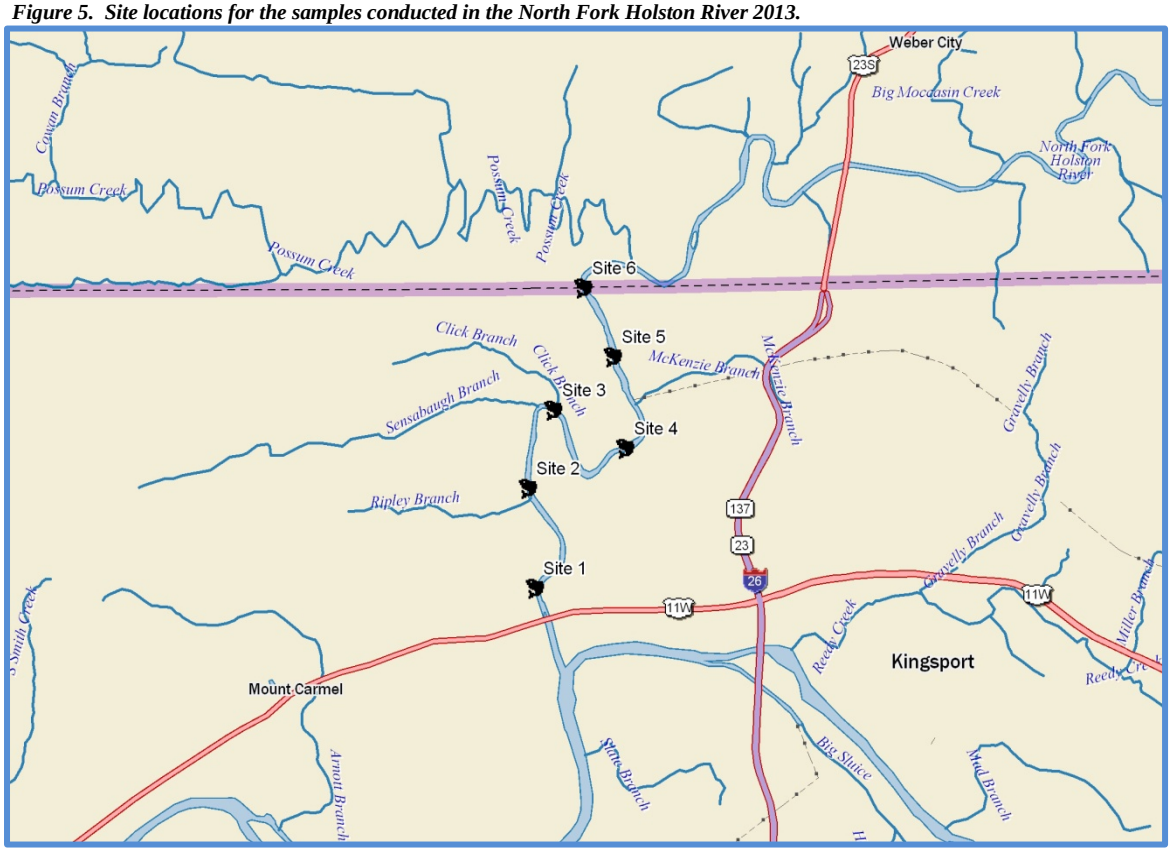


Table 4. Physiochemical and site location data for samples conducted on the North Fork Holston River during 2013.

Site Code	Site	County	Quad	River Mile	Latitude	Longitude	Mean Width (m)	Length (m)	Temp.	Cond.	Secchi (m)
420100601	1	Hawkins/Sullivan	Kingsport 188SE	0.8	36.55799	-82.61641	68.3	293	25	400	1
420100602	2	Hawkins/Sullivan	Kingsport 188SE	2.0	36.57000	-82.61750	54.4	1158	25	370	1
420100603	3	Hawkins/Sullivan	Kingsport 188SE	2.7	36.57943	-82.61376	48.3	518	24	370	1
420100604	4	Hawkins/Sullivan	Kingsport 188SE	4.0	36.57472	-82.60250	45.2	1325	24	370	1
420100605	5	Hawkins/Sullivan	Kingsport 188SE	4.4	36.58583	-82.60444	52.0	953	23	370	1
420100606	6	Hawkins/Sullivan	Kingsport 188SE	5.0	36.59416	-82.60888	58.0	250	23	375	1

Fish were collected by boat electrofishing in accordance with the standard large river sampling protocols (TWRA 1998). Fixed-boom electrodes were used to transfer 4 amps DC at all sites. This current setting was determined effective in narcotizing smallmouth bass and rock bass. All sites were sampled during daylight hours and had survey durations ranging from 600 to 1800 seconds. CPUE values were calculated for each target species at each site. Length categorization indices were calculated for target species following Gabelhouse (1984).

Results

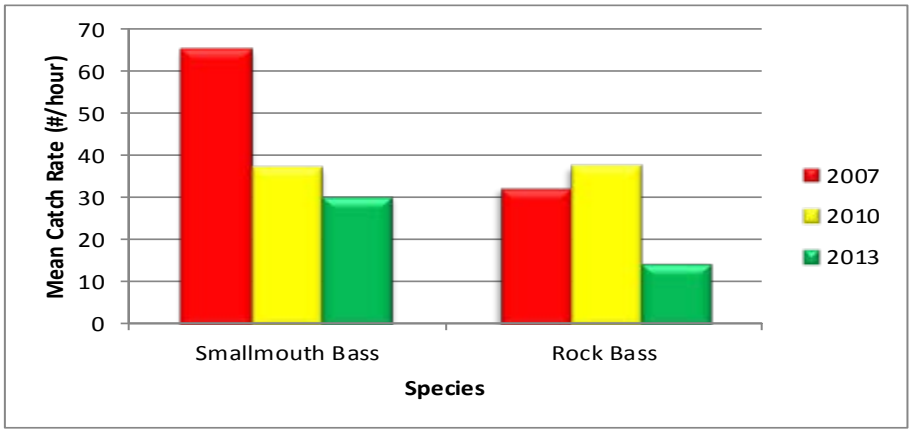
Smallmouth bass and rock bass were collected from all sites, with the exception of site 5 where no rock bass were collected. Smallmouth bass was the only black bass collected during our surveys. CPUE estimates for this species averaged 30.1/hour (Table 5). This was a decrease of 18% from our 2010 value. The overall decrease is associated with the substantial decline in the number of bass collected at site 1 and 4 when compared to the 2010 sample. It is not uncommon for large smallmouth to migrate from the larger Holston River to the smaller tributaries such as the North Fork to spawn. This may have played a role in our observations in 2013, as the survey was conducted later in the year (June) than our normal survey (April).

Table 5. Catch per unit effort and length categorization indices of target species collected at six sites on the North Fork Holston River during 2013.

Site Code	Smallmouth Bass CPUE	Rock Bass CPUE
420130601	31.3	6.3
420130602	20.0	16.0
420130603	13.1	21.0
420130604	34.2	15.7
420130605	31.5	0.0
420130606	44.0	28.0
MEAN	30.1	14.5
STD. DEV.	10.9	10.1
	Smallmouth Bass Length-Categorization Analysis	**Rock Bass Length-Categorization Analysis**
	PSD = 60.7	PSD = 7.1
	RSD-Preferred = 27.4	RSD-Preferred = 0
	RSD-Memorable = 7.8	RSD-Memorable = 0
	RSD-Trophy = 0	RSD-Trophy = 0

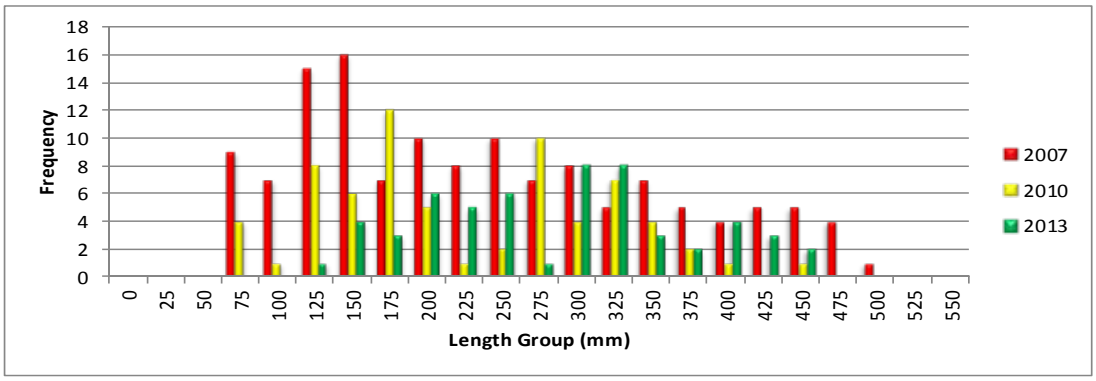
In 2013, our highest catches were observed at sites 4 and 6 for smallmouth bass. This was consistent with previous years as these sites seem to be consistent producers. Rock bass were generally less abundant than smallmouth bass encountered in our survey areas and had an average CPUE of 14.5 which was down 61% from 2010 (Table 5). The sites where the catch rates were highest usually had at least one shoreline that had good boulder cover. Our 2013 catch was the lowest encountered when compared to our most recent surveys in 2007 and 2010 (Figure 6). Although no trophy category smallmouth bass were collected in 2010, we are confident that 20 + inch smallmouth bass reside in the river. It is possible that high flows in 2013 could have suppressed the rock bass population and was reflected in our survey results. We sustained a long delay in our sampling efforts due to unfavorable water conditions during our normal time frame for sampling the river. The delay may have had some influence on our catch as well.

Figure 6. Trends in mean catch rate of black bass and rock bass collected between 2007 and 2013 from the North Fork Holston River.



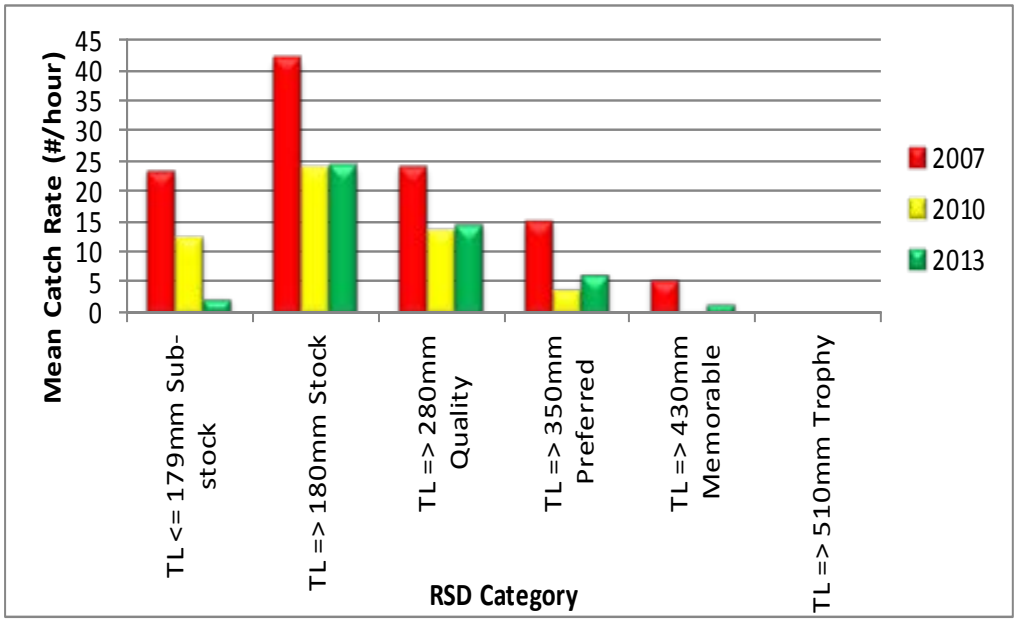
The majority of the smallmouth bass collected in the North Fork Holston River during 2013 fell within the 200 mm to 350 mm length range (Figure 7). The size distribution in 2013 showed fair representation in all size classes but abundance was considerably less in most respective classes when compared to 2007 and 2010. Probably the most notable difference was the relative lack of fish less than 150 mm which was represented well in 2007 and to a lesser extent in 2010. There was only one fish in this category in the 2013 sample.

Figure 7. Length frequency distributions for smallmouth bass collected from the North Fork Holston River between 2007 and 2013.



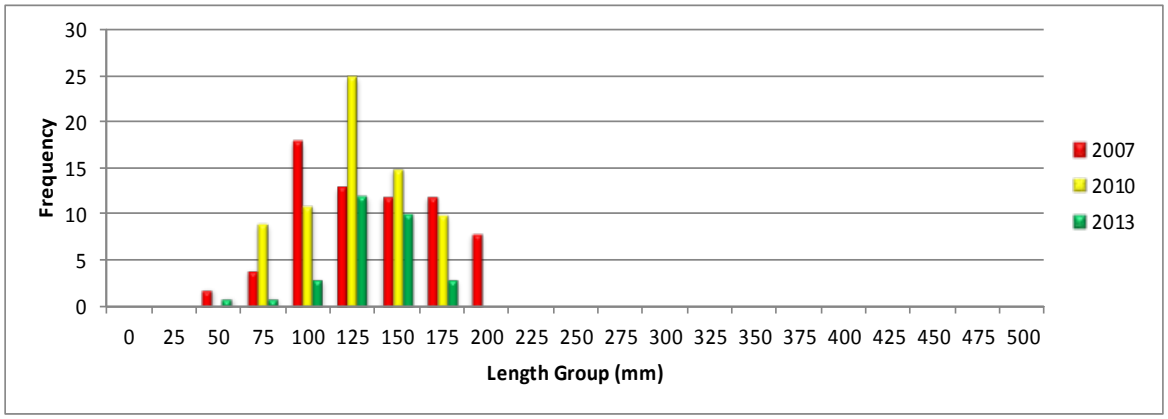
Length categorization analysis indicated the Relative Stock Density (RSD) for preferred smallmouth bass (TL $\geq$ 350 mm) was 27.4, an increase of 57% from the 2010 value. RSD for memorable (TL $\geq$ 430 mm) and trophy (TL $\geq$ 510 mm) size bass was 7.8 and 0, respectively. All RSD categories decreased considerably between the 2007 sample and the 2010 due to the absence of the larger transient fish in the sample. The ratio of quality (TL $\geq$ 280 mm) smallmouth bass to stock size bass (TL $\geq$ 180 mm) increased slightly in 2013 to 60.7 when compared to the 2010 value (58.6). Catch per unit effort estimates by RSD category indicated the majority of the catch was in the RSD-S category, following the trends observed in 2007 and 2010 (Figure 8). Overall, the proportional distribution of CPUE was close to the same or higher in most of the categories when compared to the 2010. The one exception was the sub-stock category where the catch was considerably lower.

Figure 8. Relative stock density (RSD) catch per unit effort for smallmouth bass collected from the North Fork Holston River between 2007 and 2013.



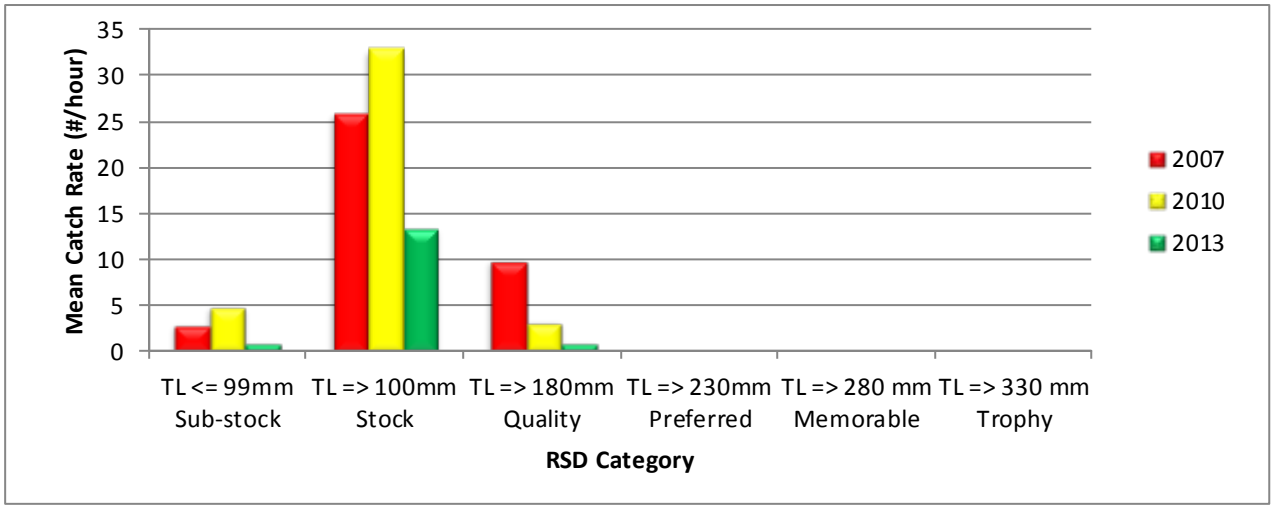
Individuals in the 125 mm to 175 mm range represented the majority of rock bass in our sample (Figure 9). Length categorization analysis indicated the RSD for preferred rock bass (TL ≥ 230 mm) was 0. This was the same as the value observed in 2007 and 2013.

Figure 9. Length frequency distributions for rock bass collected from the North Fork Holston River between 2007 and 2013.



RSD for memorable (TL ≥ 280 mm) and trophy (TL ≥ 330 mm) size rock bass was 0. The ratio of quality (TL ≥ 180 mm) rock bass to stock size rock bass (TL ≥ 100 mm) was 7.1 which was down slightly from the 2010 value. All catch data for RSD categories revealed substantial declines in all classes when compared to the previous samples (Figure 10). High flows during 2013 may have been a contributor to this result.

Figure 10. Relative stock density (RSD) catch per unit effort by category for rock bass collected from the North Fork Holston River between 2007 and 2013.



Discussion

The North Fork Holston River can provide anglers with the opportunity to catch substantial numbers of quality size smallmouth bass and rock bass. Catches of smallmouth bass in 2013 both in number and size were somewhat lower than observed in 2010. High flows during 2013, were problematic for our sampling efforts and most likely had an influence on the number of fish we observed. In 2001, a roving creel survey was conducted on the North Fork indicating relatively high angling pressure and moderate harvest (Bettoli 2002, Carter et al. 2003). All information from our survey data indicates that the smallmouth bass population, although fluctuating under extreme hydrologic conditions, has continued to produce good numbers of quality fish.

Surveys on the North Fork Holston River will be conducted on a three-year rotation in order to assess any changes in the fishery. The North Fork has been under consideration for some time regarding smallmouth bass regulations. In March 2008, a 13-17 inch protected length range with a five bass creel limit, of which only one can exceed 17 inches was place on the North Fork between the state line and the confluence with the South Fork.

Management Recommendations

1. Incorporate river into regional operational and implementation plan.

Pigeon River

Introduction

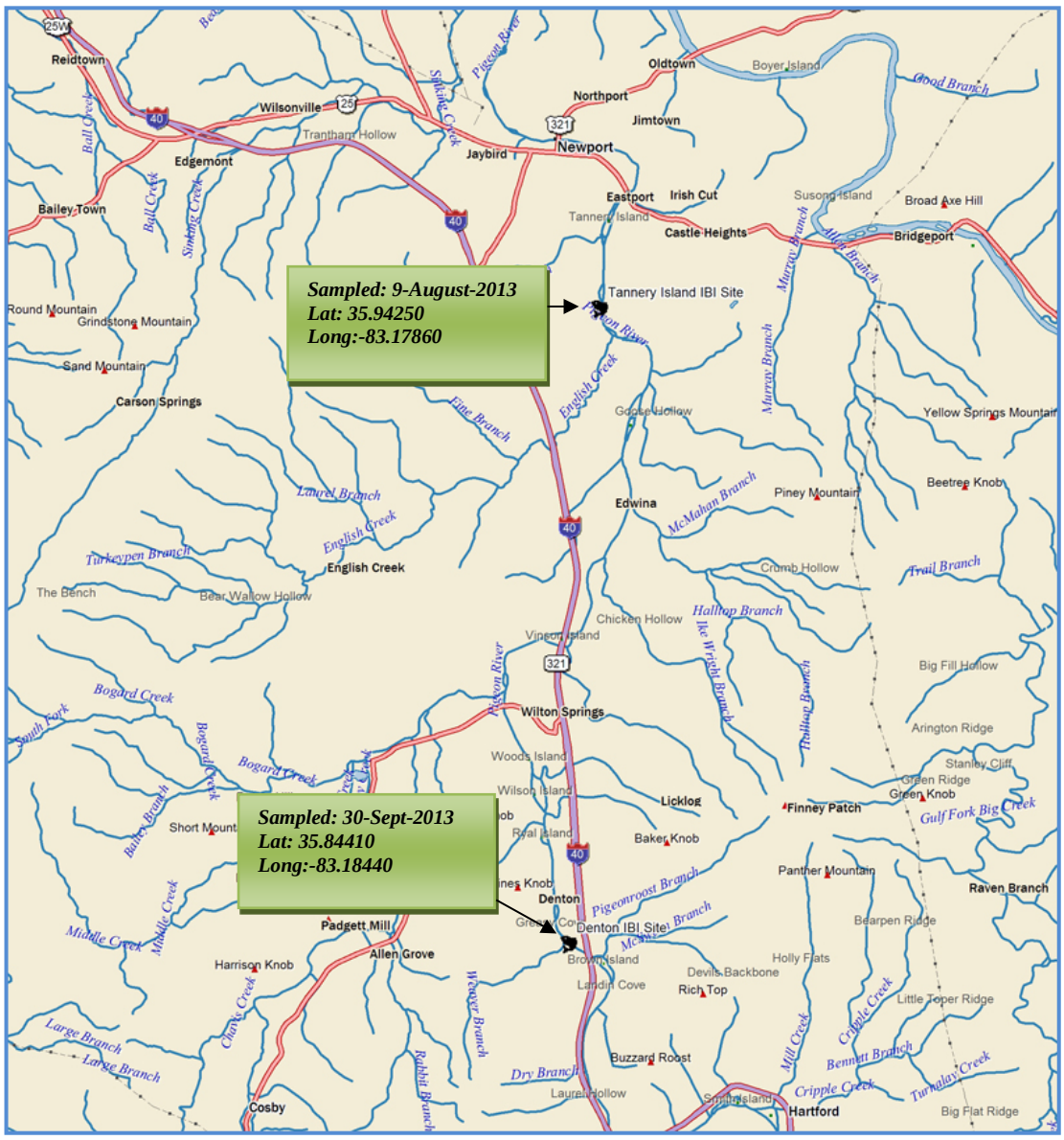
The Pigeon River has had a long history of pollution problems, stemming primarily from the discharge of wastewater from the Blue Ridge Paper Products Mill (formerly Champion Paper Mill) in Canton, North Carolina. This discharge has undoubtedly had a profound effect on the recreational use of the river 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, one near river mile 8.2 (Tannery Island) and one at river mile 16.6 (Denton).

Our 2013 surveys focused on continuing the evaluation of 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 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. 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,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 and one moderately developed launch at Denton. On September 30 and July 9, 2013, we conducted IBI fish surveys at Tannery Island (PRM 8.2) and Denton (PRM 16.6) (Figure 11).

Figure 11. Site locations for the IBI samples conducted in the Pigeon River during 2013.



Fish were collected according to the IBI criteria described in the methods section of this report. Both backpack and boat electrofishing were used to collect samples from both stations. Qualitative benthic macroinvertebrates were collected at both stations and analyzed to produce a biotic index score similar to those derived for the fish IBI.

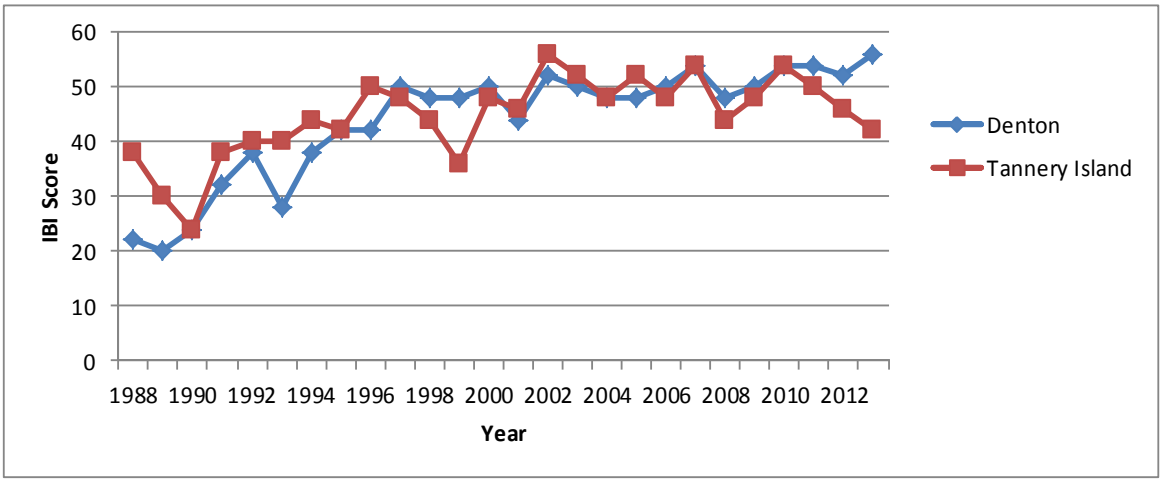
Results

Collaborative community assessments of Pigeon River have been ongoing since the late 1980's. These surveys have primarily focused on evaluating relative health changes in the fish community. A total of 35 fish species were collected at the Tannery Island and a total of 31 at the Denton site (Table 6). Overall, the IBI analysis indicated the fish community was in "fair" condition at Tannery Island (IBI score 42). This was a four point decrease from the 2012 score and marked the third straight year the score has declined. The condition of the fish community assessed "good/excellent" at the Denton site in 2013 (56) (Figure 12).

Table 6. Fish species collected at the two Pigeon River IBI stations during 2013.

Pigeon River Mile	8.2 (Tannery Island)	Number Collected	16.6 (Denton)	Number Collected
	420131501		420131503	
	Ambloplites rupestris	8	*Ambloplites rupestris*	35
	Aplodinotus grunniens	2	*Aplodinotus grunniens*	4
	Campostoma oligolepis	47	*Campostoma anomalum*	24
	Cottus carolinae	72	*Cottus carolinae*	159
	Cyprinella galactura	42	*Cyprinella galactura*	31
	Cyprinella spiloptera	8	*Dorosoma cepedianum*	47
	Cyprinus carpio	48	*Etheostoma blennioides*	20
	Dorosoma cepedianum	27	*Etheostoma rufilineatum*	249
	Etheostoma blennioides	37	*Etheostoma tennesseense*	52
	Etheostoma kennicotti	6	*Hybopsis amblops*	5
	Etheostoma rufilineatum	264	*Hypentelium nigricans*	18
	Etheostoma tennesseense	22	*Ichthyomyzon bdellium*	1
	Etheostoma zonale	2	*Ichthyomyzon greeleyi*	3
	Hypentelium nigricans	17	*Ictalurus punctatus*	4
	Ichthyomyzon castaneus	1	*Ictiobus bubalus*	2
	Ictalurus punctatus	2	*Ictiobus niger*	2
	Ictiobus bubalus	12	*Labidesthes sicculus*	1
	Ictiobus niger	1	*Lepomis auritus*	17
	Labidesthes sicculus	7	*Lepomis macrochirus*	8
	Lepomis auritus	9	*Micropterus dolomieu*	58
	Lepomis cyanellus	1	*Moxostoma anisurum*	1
	Lepomis macrochirus	7	*Moxostoma breviceps*	3
	Micropterus dolomieu	10	*Moxostoma carinatum*	3
	Moxostoma anisurum	1	*Moxostoma duquesnei*	29
	Moxostoma breviceps	9	*Moxostoma erythrurum*	3
	Moxostoma carinatum	4	*Notropis micropteryx*	1
	Moxostoma duquesnei	31	*Notropis photogenis*	1
	Moxostoma erythrurum	14	*Notropis telescopus*	114
	Notropis micropteryx	16	*Percina caprodes*	4
	Notropis telescopus	14	*Pomoxis annularis*	24
	Noturus eleutherus	2	*Pomoxis nigromaculatus*	1
	Percina caprodes	4		
	Pomoxis annularis	6		
	Pomoxis nigromaculatus	2		
	Sander vitreum	2		

Figure 12. Trends in Index of Biotic Integrity (IBI) at two stations on the Pigeon River (1988-2013).



Benthic macroinvertebrates collected at the Tannery Island site comprised 32 families representing 36 identified genera (Table 7). The most abundant group in our collection was the caddisflies comprising 15.5% of the total sample. Overall, a total of 47 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” (3.0).

Table 7. Taxa list and associated biotic statistics for benthic macroinvertebrates collected from the Pigeon River at Tannery Island (river mile 8.2) 2013.

ORDER	FAMILY	SPECIES	NUMBER	PERCENT
AMPHIPODA				0.3
	Crangonyctidae	*Crangonyx*	1	
ANELLIDA				7.9
	Hirudinea		8	
	Oligochaeta		16	
COLEOPTERA				4.6
	Dytiscidae	*Laccophilus maculosus* female	1	
	Elmidae	*Ancyronyx variegatus* adult	1	
		Dubiraphia adults	2	
		Macronychus glabratus adults	11	
		Promoresis elegans adult	1	
	Psephenidae	*Psephenus herricki* larva	1	
DIPTERA				32.8
	Athericidae	*Atherix lantha*	2	
	Chironomidae	larvae and pupae	42	
	Simuliidae	larvae and pupae	54	
	Tipulidae	*Dicranota*	1	
		Tipula	1	
EPHEMEROPTERA				9.5
	Baetidae	*Acentrella*	17	
		Baetis	5	
	Heptageniidae	*Maccaffertium* early instar	1	
	Isonychiidae	*Isonychia*	6	
GASTROPODA				9.2
	Ancylidae	*Ferrissia*	7	
	Physidae		11	
	Planorbidae		2	
	Pleuroceridae	*Leptoxis*	8	
		Pleurocera	13	
HEMIPTERA				2.6
	Veliidae	*Rhagovelia obesa* male, females, & nymphs	8	
HYDRACARINA			9	3.0
ISOPODA				1.0
	Asellidae	*Caecidotea*	3	
MEGALOPTERA				3.3
	Corydalidae	*Corydalus cornutus*	10	
ODONATA				7.5
	Aeshnidae	*Boyeria vinosa*	3	
	Calopterygidae	*Hetaerina americana*	12	
	Coenagrionidae	*Argia bipunctulata*	2	
		Argia moesta/translata	1	
		Enallagma	1	
	Corduliidae	*Neurocordulia obsoleta*	1	
	Gomphidae	*Dromogomphus spinosus*	1	
		Hagenius brevistylus	1	
	Macromiidae	*Macromia*	1	
PELECYPODA				2.0
	Corbiculidae	*Corbicula fluminea*	6	
TRICHOPTERA				15.5
	Brachycentridae	*Brachycentrus lateralis*	1	
	Hydropsychidae	*Ceratopsyche morosa*	1	
		Ceratopsyche sparna	2	
		Cheumatopsyche	7	
	Hydroptilidae	*Hydroptila*	3	
	Leptoceridae	*Triaenodes ignitus*	7	
		Triaenodes sp.	1	
		Ocetis	2	
	Polycentropodidae	*Neureclipsis*	1	
TURBELLARIA			9	0.6
		Total	**305**	

TAXA RICHNESS = 47 EPT TAXA RICHNESS = 13 BIOCLASSIFICATION = (3.0 FAIR/GOOD)

Benthic macroinvertebrates collected at the Denton site comprised 28 families representing 37 identified genera (Table 8). The most abundant groups in our collection were the mayflies comprising about 32% of the total sample.

Overall, a total of 43 taxa were identified from the sample of which 18 were EPT. Based on the EPT taxa richness and overall biotic index of all species collected, the relative health of the benthic community was classified as “Good” (4.0).

Table 8. Taxa list and associated biotic statistics for benthic macroinvertebrates collected from the Pigeon River at Denton (river mile 17.1) 2013.

ORDER	FAMILY	SPECIES	NUMBER	PERCENT
AMPHIPODA				0.9
	Crangonyctidae	*Crangonyx*	5	
ANELLIDA				1.7
	Oligochaeta		9	
COLEOPTERA				7.4
	Gyrinidae	*Dineutus discolor* adult males & females	10	
	Elmidae	*Ancyronyx variegatus* adults	6	
		Macronychus glabratus larva & adults	14	
		Optioservus ovalis adult	1	
		Promoresis elegans larva & adult	2	
	Psephenidae	*Psephenus herricki* larvae	6	
DIPTERA				22.8
	Athericidae	*Atherix lantha*	12	
	Chironomidae	larvae	74	
	Simuliidae	larvae and pupae	18	
	Tipulidae	*Antocha*	15	
		Tipula	2	
EPHEMEROPTERA				32.1
	Baetidae	*Acentrella*	23	
		Baetis	23	
	Caenidae	*Caenis*	1	
	Ephemerellidae	*Serratella deficiens*	24	
	Heptageniidae	*Maccaffertium ithaca*	47	
		Maccaffertium mediopunctatum	23	
		Stenacron interpunctatum	1	
		Stenonema femoratum	1	
	Isonychiidae	*Isonychia*	27	
GASTROPODA				1.5
	Ancylidae	*Ferrissia*	1	
	Pleuroceridae	*Leptoxis*	4	
		Pleurocera	3	
HEMIPTERA				3.4
	Gerridae	*Rheumatobates* female	1	
	Veliidae	*Rhagovelia obesa* males & nymphs	18	
HYDRACARINA			3	0.6
ISOPODA				0.6
	Asellidae	*Caecidotea*	3	
MEGALOPTERA				5.5
	Corydalidae	*Corydalus cornutus*	20	
		Nigronia serricornis	9	
ODONATA				0.8
	Aeshnidae	*Boyeria vinosa*	3	
	Corduliidae	*Neurocordulia obsoleta*	1	
PELECYPODA				1.3
	Corbiculidae	*Corbicula fluminea*	7	
PLECOPTERA				0.2
	Pteronarcyidae	*Pteronarcys (Allonarcys)* proteus type	1	
TRICHOPTERA				21.1
	Hydropsychidae	*Ceratopsyche morosa*	37	
		Ceratopsyche sparna	8	
		Cheumatopsyche	36	
		Hydropsyche venularis	8	
		Hydropsyche undetermined pupae	8	
	Lepidostomatidae	*Lepidostoma*	1	
	Polycentropodidae	*Polycentropus*	12	
	Psychomyiidae	*Lype diversa*	1	
	Ueonidae	*Neophylax* pupa	1	
		Total	**530**	

TAXA RICHNESS = 43 EPT TAXA RICHNESS = 18 BIOCLASSIFICATION = 4.0 (GOOD)

In 2006, the Pigeon River was put into a 3-year rotational sampling scheme (black bass and rock bass) after being annually sampled since 1998. On November 21, 2013 we conducted sport fish surveys at four sites between Newport and Walters Powerhouse (Figure 13). We were unable to complete one of our CPUE survey sites (site 2) due to flood damage at this location. 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 9). Water temperatures ranged from 8 to 10.5 C and conductivity varied from 225 to 270 µs/cm (Table 9).

Figure 13. Site locations for CPUE samples conducted in the Pigeon River during 2013.

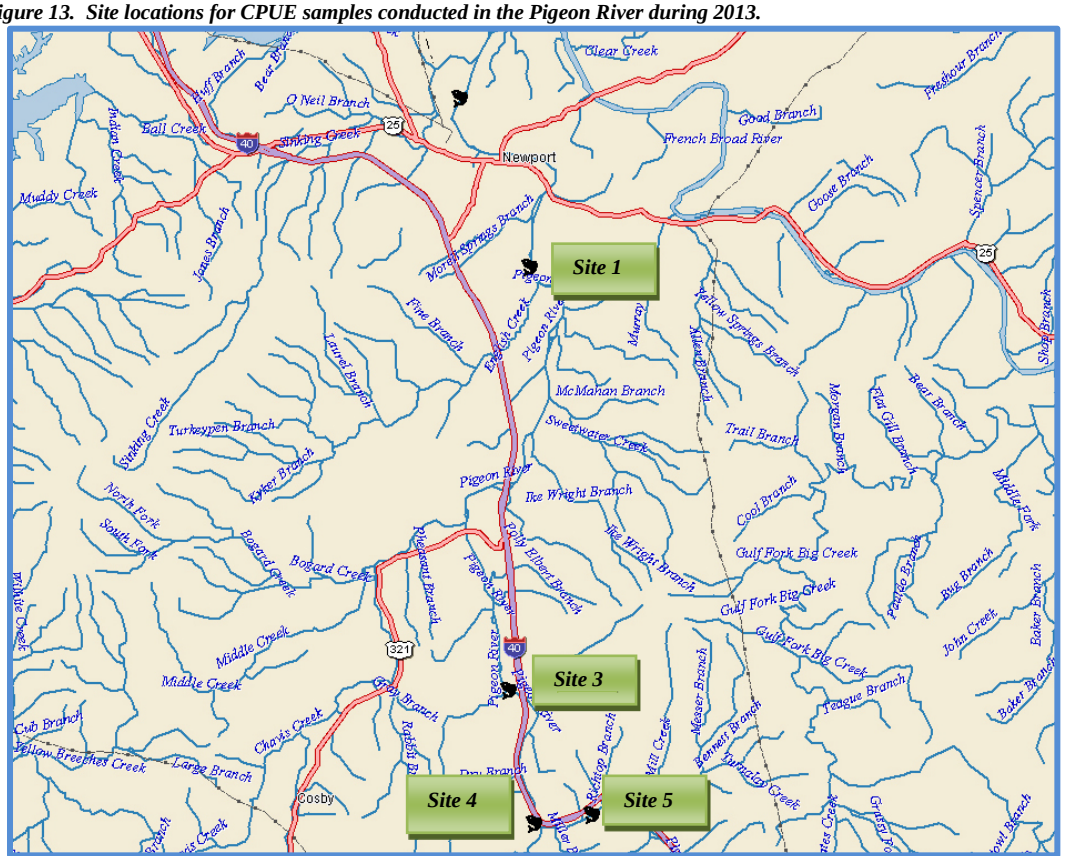


Table 9. Physiochemical and site location data for CPUE samples conducted in the Pigeon River during 2013.

Site Code	Site	County	Quad	River Mile	Latitude	Longitude	Mean Width (m)	Length (m)	Temp. C	Cond.	Secchi (m)
420131501	1	Cocke	Newport 173NW	8.1	35.94236	-83.17906	53.6	392	8	225	2.9
420131503	3	Cocke	Hartford 173SW	16.6	35.84343	-83.18493	-	414	10	225	2.9
420131504	4	Cocke	Hartford 173SW	19	35.81298	-83.17837	35.3	80	10	270	2.9
420131505	5	Cocke	Hartford 173SW	20.5	35.81380	-83.16261	47.3	839	10.5	265	2.9

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 900 to 2,801 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.

During our surveys, smallmouth bass and rock bass were collected from all sample sites with the exception of site 1. Spotted bass were not collected at any of the sampling stations. Largemouth bass were present at site 1 only. Smallmouth bass was the most abundant black bass species at any of the survey sites. CPUE estimates for this species averaged 35.2/hour (Table 15). Our highest observed catches of smallmouth bass were recorded at site 5 (Hartford) and site 3 (Denton). Rock bass CPUE was highest at sites 3 and 4, averaging 15.0/hour for all sites. The highest catch rate for this species was recorded at site 3 (28.0/hour). Overall, we observed a 25% decrease in the mean catch rate of smallmouth bass between the 2010 and 2013 samples. In 2010 we were able to collect our first smallmouth bass in what is considered the trophy class (>20 inches) from sample site 1. We did not encounter any smallmouth in the category during 2013. Angler accounts have verified that this size fish is occasionally caught in the river but up until 2010, bass of this size have eluded our electrofishing equipment. Our change in sampling strategy has increased our odds of collecting bass in this size range as the cooler water temperatures cause a shift in habitat usage that allows us to more effectively sample larger fish.

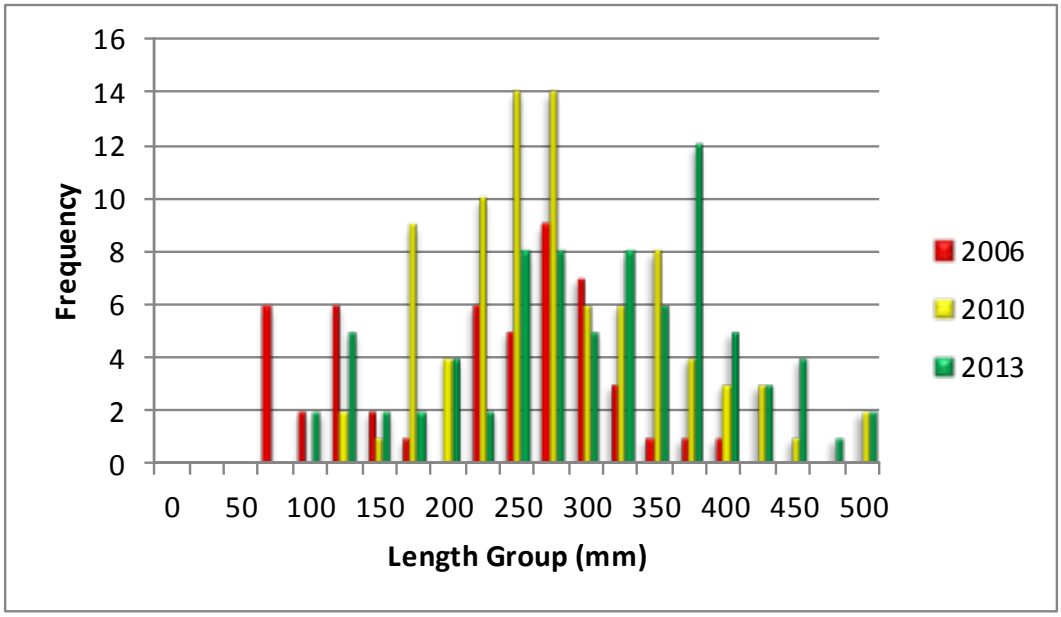
Table 15. Catch per unit effort and length categorization indices of target species collected at five sites on the Pigeon River during 2013.

Site Code	Smallmouth Bass CPUE	Spotted Bass CPUE	Largemouth Bass CPUE	Rock Bass CPUE
420100701	9.0	0	4.0	0
420100703	41.0	0	0	28.0
420100704	28.0	0	0	24.0
420100705	63.0	0	0	8.0
MEAN	35.2	0	1.0	15.0
STD. DEV.	22.7	0	2.0	13.2
	Smallmouth Bass Length-Categorization Analysis	**Spotted Bass Length-Categorization Analysis**	**Largemouth Bass Length-Categorization Analysis**	**Rock Bass Length-Categorization Analysis**
	PSD = 75.7 RSD-Preferred = 47.1 RSD-Memorable = 12.8 RSD-Trophy = 0	PSD = 0 RSD-Preferred = 0 RSD-Memorable = 0 RSD-Trophy = 0	PSD =100 RSD-Preferred = 50 RSD-Memorable = 0 RSD-Trophy = 0	PSD = 68.1 RSD-Preferred = 13.6 RSD-Memorable = 0 RSD-Trophy = 0

The majority of the smallmouth bass collected from the Pigeon River during 2013 fell within the 250 to 400 mm length range (Figure 14). Bass less than 125 mm were scarce in the 2013 sample. Length categorization analysis

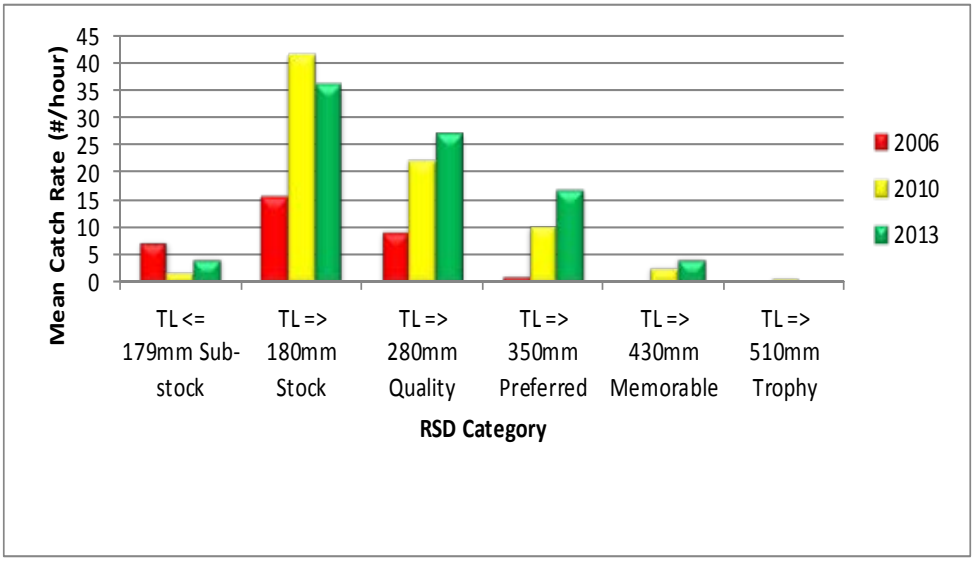
indicated the Relative Stock Density (RSD) for preferred smallmouth bass (TL ≥ 350 mm) was 47.1, which was up 86% from the sample taken in 2010.

Figure 14. Length frequency distribution for smallmouth bass collected from the Pigeon River between 2006 and 2013.



RSD for memorable (TL ≥ 430 mm) and trophy (TL ≥ 510 mm) size bass were 12.8 and 0, respectively. The PSD of smallmouth bass (ratio of quality size bass to stock size bass) was 75.7. Catch per unit effort estimates by RSD category indicated smallmouth bass exceeded 2010 catches in all RSD categories except sub-stock and trophy (Figure 15).

Figure 15. Relative stock density (RSD) catch per unit effort for smallmouth bass collected from the Pigeon River between 2006 and 2013.



Only two largemouth bass were collected from all of our sites surveyed in 2010. 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 ranged in length from 360 to 451 mm.

Individuals in the 150 to 225 mm range represented the majority of rock bass in our sample (Figure 16). Length categorization analysis indicated the RSD for preferred rock bass (TL ≥ 230 mm) was 13.6 which was an increase from the value of 6.2 in 2010. RSD for memorable (TL ≥ 280 mm) and trophy (TL ≥ 330 mm) size rock bass was 0. The PSD of rock bass was 68.1. Catch per unit effort estimates by RSD category indicated the majority of our catch was stock size fish (Figure 17) with about 37% of the catch representing quality size fish.

Figure 16. Length frequency distribution for rock bass collected from the Pigeon River between 2006 and 2013.

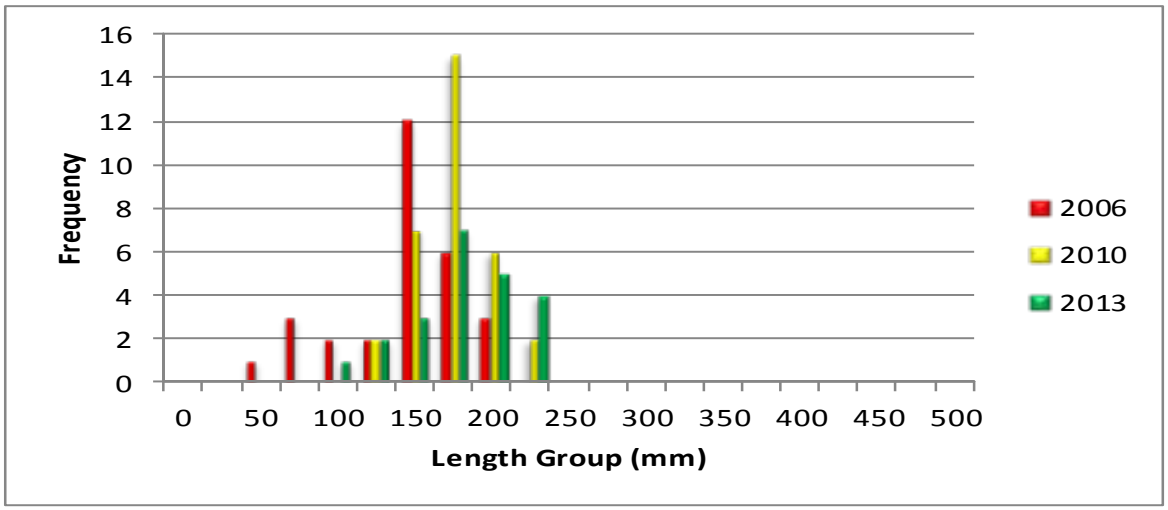
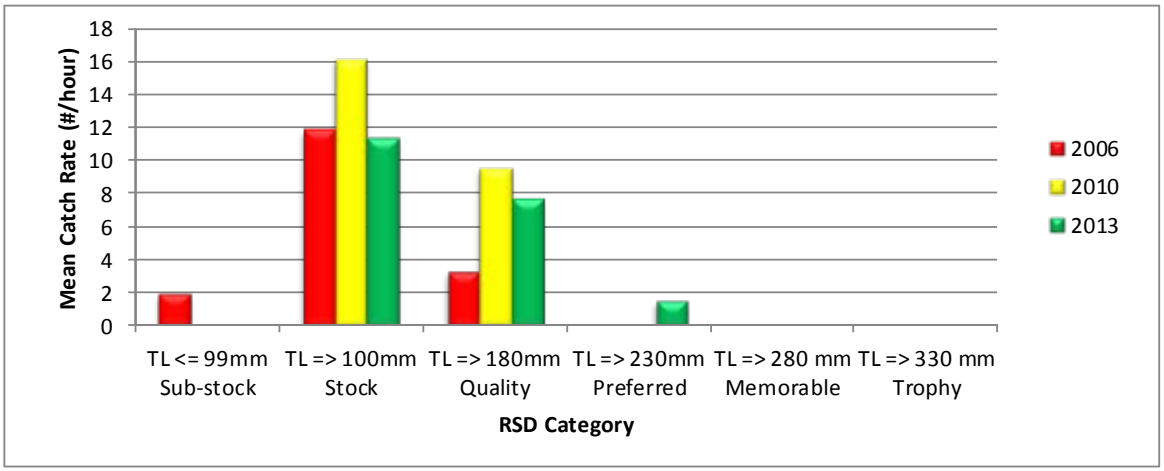


Figure 17. Relative stock density (RSD) catch per unit effort by category for rock bass collected from the Pigeon River between 2006 and 2013.

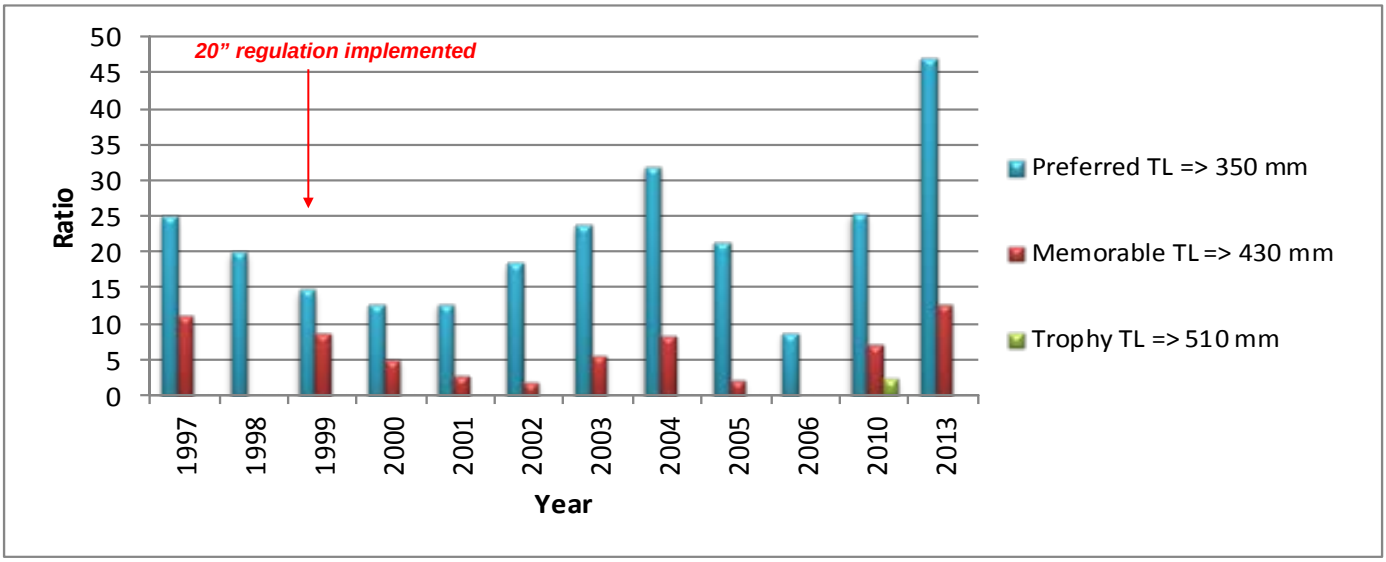


Discussion

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. The last annual black bass and rock bass survey of the Pigeon was in 2006. The river was put into a rotational survey scheme after 2006 and was scheduled to be sampled in 2009. Unfortunately, excessive generation from the Waterville Powerhouse precluded us from sampling during September or October. We reattempted in 2010 and were able to conduct a fall sample of the river. During 2006, we recorded the lowest percentage of preferred smallmouth bass to date (Figure 18). This figure rebounded nicely in 2010, and in our last sample, had

reached the highest value recorded since sampling was initiated in 1997. The percentage of memorable size fish was also the highest observed during the 14 year period.

Figure 18. Trends in the ratio of preferred, memorable, and trophy smallmouth bass collected from the Pigeon River 1997-2013.



Water quality improvement over the last 20 years has primarily been the result of more advanced wastewater treatment at the Blue Ridge Paper Mill in Canton, North Carolina. The improved water quality has undoubtedly had an effect 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. During 2006, there were at least two instances of pesticides entering the river. During these events, both benthic invertebrates and fish were killed. Investigations by TWRA and TDEC resulted in identifying the areas of agricultural runoff into the river. A remediation plan to control the runoff of agricultural pesticides is being developed by TDEC and TWRA.

We will monitor black bass and rock bass populations in the Pigeon River during late September or October in order to maintain our efficiency in characterizing the smallmouth bass populations in the river. Index of Biotic Integrity samples will continue on an annual basis.

Management Recommendations

1. Continue monitoring the sport fish population every three years.

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

3. Incorporate river into regional operational and implementation plan.

4. Continue cooperative efforts to reintroduce common species.

New River

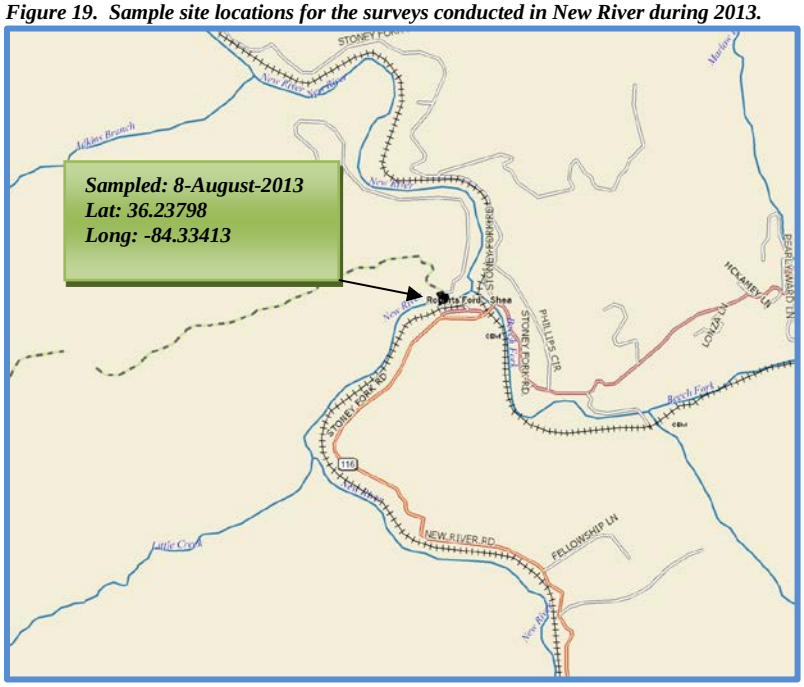
Introduction

The New River drainage has had a long history of ecological abuse. The most prominent influence on overall watershed and water quality has been the continued development of the coal mining industry in the region since the turn of the century. With the shift to surface mining in recent history the influence on water quality has shifted from acidic pulses from deep mines (prevalent in the early 1900's) to siltation from surface mining operations. The most recent investigations in the watershed were by Evans (1998), who completed extensive surveys within the watershed and developed specific assessment criteria for fish assemblages. It was summarized from these investigations that some recovery has taken place in the watershed and many streams support fairly diverse communities of fish. The Agency has conducted surveys within the watershed in a limited number of streams (Bivens and Williams 1990; Carter et al. 2003; Carter et al. 2005). With the resurgence of coal mining in the last few years, the watershed stands to receive another inoculation of degraded water quality if activities are not stringently monitored. Our efforts in the New River during 2013 were limited, and primarily focused on gathering information on the sport fishery.

Study Area and Methods

The New River encompasses a drainage area of 989 km^2 and courses some 55 miles through Scott, Campbell, and Anderson counties before joining the Clear Fork (Evans 1998). The convergence of the New River and Clear Fork form the headwaters of the Big South Fork of the Cumberland River. Access to the river is mostly through private holdings, however, the Big South Fork National Recreation Area bounds the lower reach of the river. Our survey of the New River was follow-up monitoring of the sport species at our sample site established in 2004. The sample site is located at Robert Ford near the confluence with Beech Fork (Figure 19). At our sampling station we used boat electrofishing to effectively sample shallow and deep habitats within the area. Fish were collected in accordance with the standard large river sampling protocols (TWRA 1998). Fixed-boom electrodes were used to transfer 4-5 amps DC. This current setting was determined effective in narcotizing all target species. Catch-per-unit-effort (CPUE) values were calculated for each target species. Length categorization indices were calculated for target sport species following Gabelhouse (1984).

Figure 19. Sample site locations for the surveys conducted in New River during 2013.

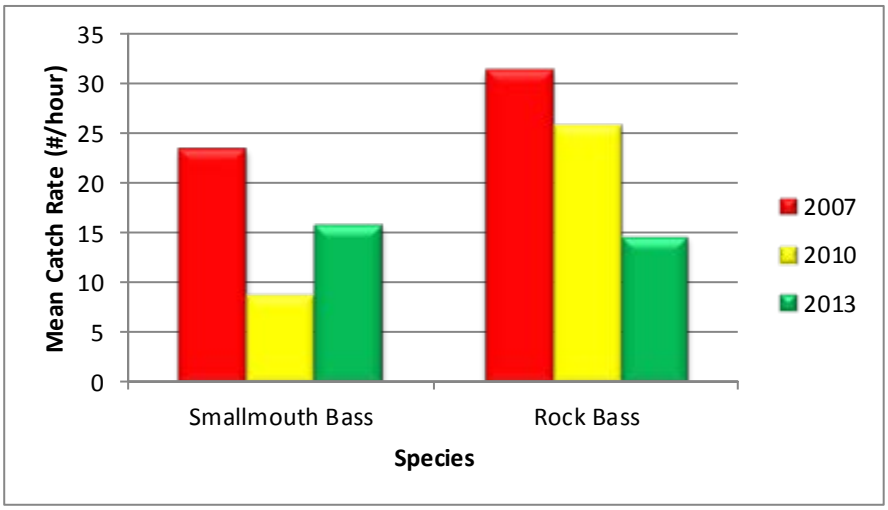


At our sample location gravel and rubble were the dominant substrate components, although bedrock was fairly common in the pool habitat. Coal fines were prevalent at the site. Temperature at the site was 22.4 C and the water clarity was below average due to higher than normal flow.

Results

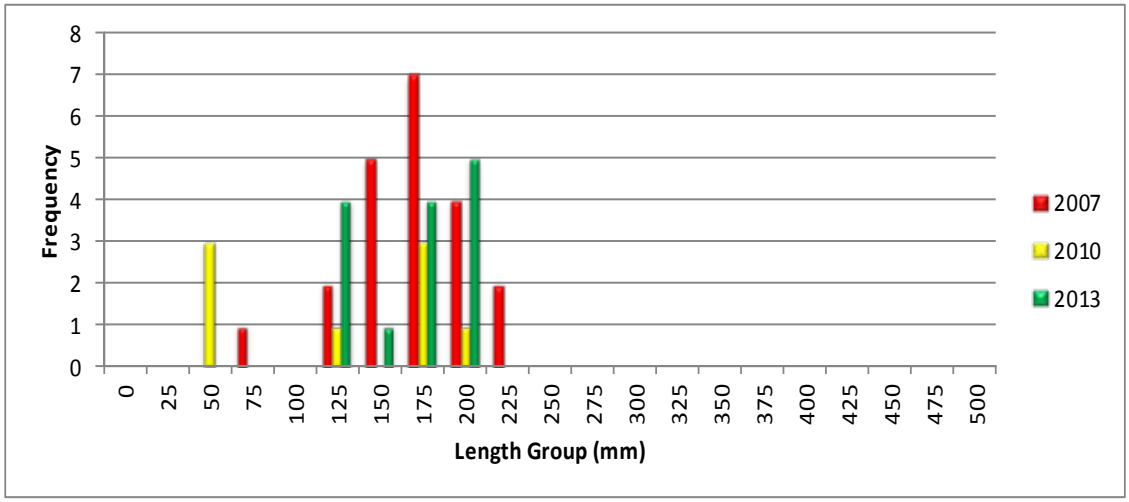
Of the game species collected, rock bass and smallmouth bass were the dominant species. We also collected longear sunfish and have collected walleye in the past although none were observed during this sample. A total of 13 (23 in 2010) rock bass and 14 (8 in 2010) smallmouth bass were collected from the survey site. The observed number of rock bass was down compared to 2010, however, the catch of smallmouth bass increased considerably. from the 21 observed in 2007. The catch rate for smallmouth bass and rock bass was 15.7 and 14.6, respectively (Figure 20).

Figure 20. CPUE for smallmouth bass and rock bass collected from New River between 2007 and 2013.



The majority of smallmouth bass collected during 2013 fell within the 125 mm to 200 mm length range (Figure 21). Limited visibility during the sample may have reduced our catch although it was considerably higher than in 2010 when extremely low water conditions were encountered.

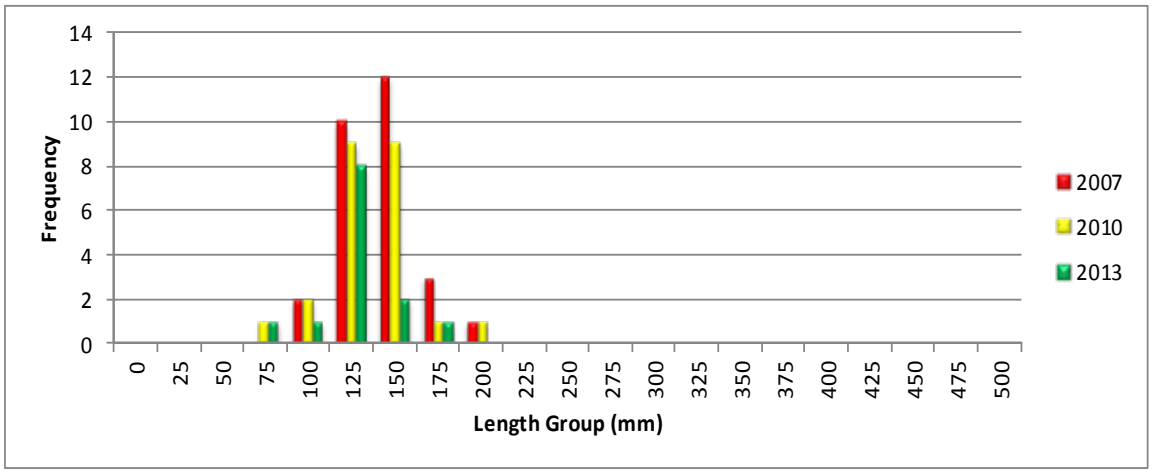
Figure 21. Length frequency distribution for smallmouth bass collected in the New River between 2007 and 2013.



Length categorization analysis indicated the relative stock density (RSD) for smallmouth bass was 0 in all categories. PSD could not be calculated because there were no quality size (≥ 280 mm) bass collected in the sample. This was the same situation observed in the 2010 sample. The catch rates for sub-stock and stock size bass were both 5.6/hour and 10.1/hour, respectively.

Rock bass collected from the New River in 2013 fell within the 75 mm to 175 mm length groups (Figure 22). As with smallmouth bass we had a limited amount of visibility during the sample, so we feel that the number we collected was good, given our sampling situation.

Figure 22. Length frequency distribution for rock bass collected in the New River between 2007 and 2013.



Length categorization analysis indicated the relative stock density (RSD) for rock bass was 0 in all categories. PSD for rock bass was 8.3. Although the catch was almost half of what was observed in 2010, the persistence of the rock bass in the river is encouraging given the ongoing issues within the watershed. The less than optimal sampling conditions almost certainly influenced our observations for rock bass during this sample.

Management Recommendations

1. Periodically monitor the river to determine relative health changes and sport fish abundance.

2. Ensure that future coal extraction is carefully monitored.

3. Consider winter rainbow trout stocking.

Straight Fork

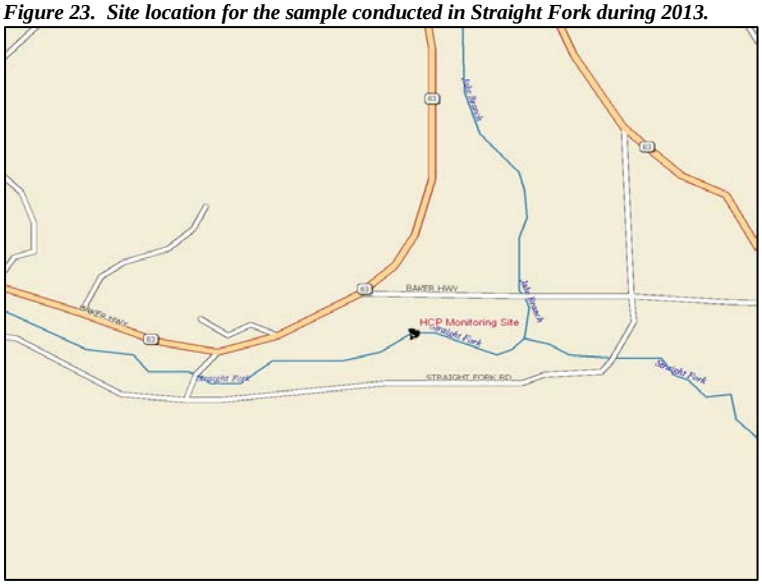
Introduction

Straight Fork was chosen for monitoring due to TWRA's planned forestry activity within the watershed and the occurrence of blackside dace in the stream. The blackside dace (federally listed) is the species of concern in this system and was identified as one of the key species for monitoring under the Habitat Conservation Plan (HCP).

Study Area and Methods

The area we surveyed was located near the confluence with Jake Branch (Figure 23). We conducted the survey on August 14, 2013. Our survey was actually on private land but was at the upper extent of the blackside dace distribution. There is a substantial reach of the stream above our survey site that flows through private land that depending on use, could have impacts on the population we are monitoring. We surveyed approximately 208 meters of stream, recording our total electrofishing time so that subsequent samples could be repeated with same amount of effort. We used one backpack electrofishing unit operating at 200 volts DC to stun fish which were collected by the backpack operator or the netter assisting with the survey. Population estimates have been derived for this species using a one pass electrofishing model developed by Black and Mattingly (2007). However, recent surveys have captured very few individuals and were below the recommended minimal sample size for using the estimator. Subsequent samples and those conducted previously using the one pass estimate will be reassessed with CPUE estimates to alleviate the uncertainty of the estimate when low numbers of dace are encountered. Basic water quality collected at the site indicated a conductivity of 216 µs/cm, a pH of 6.0, and water temperature of 19.6 C. Overall, the physical habitat and condition of the stream scored 100 (marginal). The most influential metrics on the overall score were the amount of sediment deposition, instability of the stream banks and substrate embeddedness.

Figure 23. Site location for the sample conducted in Straight Fork during 2013.



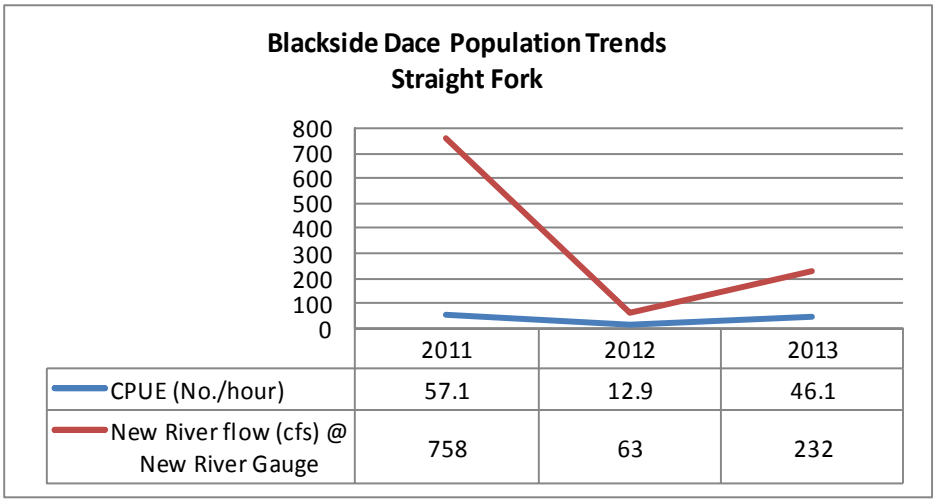
Results

We collected five fish species during our 2013 survey of Straight Fork. The most abundant species were creek chub and green sunfish. Eighteen (4 in 2012) blackside dace were collected within our sample area (Table 16). Based on the one pass electrofishing catch, our CPUE estimate within our sample area was 46.1 (Figure 24). This was up from 12.9 recorded in the 2012 survey. Blackside dace abundance is highly variable from year to year depending on flow conditions. Straight Fork flow was very low during 2012 and Jake Branch (tributary) almost went dry according to a resident on the stream. Other factors potentially affecting the dace population in the stream could be the fluctuation in abundance of predators such as green sunfish. These values will be used to develop trends over a five year period and serve as a benchmark for comparison should forestry practices take place within the watershed.

Table 16. Fish species collected from Straight Fork 2013.

Species	Abundance
Chrosomus cumberlandensis	18 (CPUE = 46.1)
Lepomis cyanellus	Abundant
Lepomis macrochirus	Common
Micropterus salmoides	Rare
Semotilus atromaculatus	Abundant

Figure 24. Blackside dace population trends in Straight Fork 2011-13.



Discussion

Straight Fork is still under the influence of acid mine drainage and if not for the buffering effect of Jake Branch, recovery of stream would not be realized for some distance downstream of our sample location. In previous surveys of the stream, we have documented pH as low as 2.3 in tributaries to Straight Fork. We will return to repeat the sample in 2014 to add to the HCP database.

Management Recommendations

1. Continue to monitor blackside dace annually.

Jake Branch

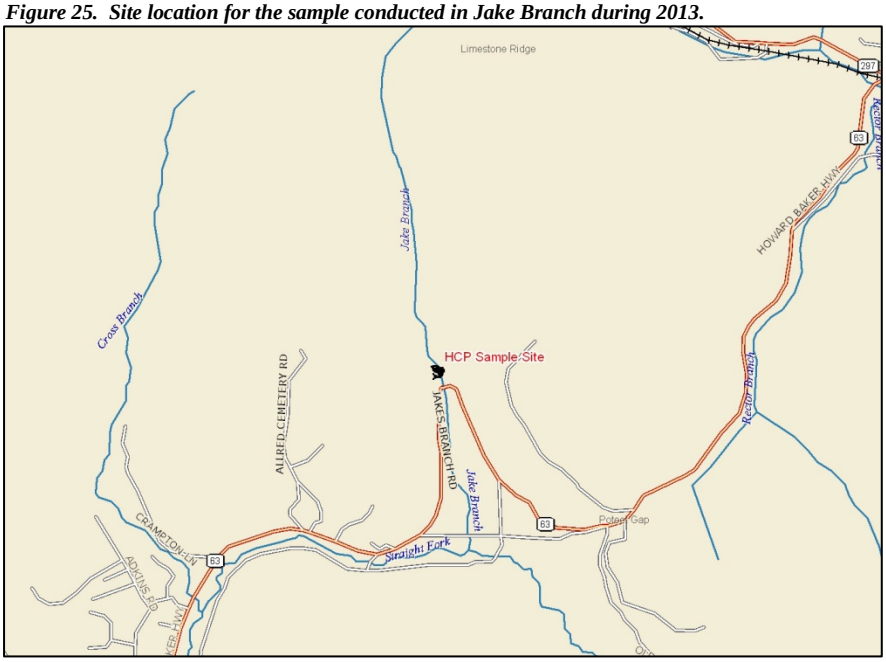
Introduction

Jake Branch was chosen for monitoring due to TWRA's planned forestry activity within the watershed and the occurrence of blackside dace in the stream. The blackside dace (federally listed) is the species of concern in this system and was identified as one of the key species for monitoring under the HCP.

Study Area and Methods

The area we surveyed was located approximately 0.6 miles upstream from the confluence with Straight Fork on the Bridge's property (Figure 25). We conducted the survey on August 14, 2013. We were confined to the reach of stream located at the downstream boundary of the private property and the first farm road crossing upstream from the landowner residence. We surveyed approximately 178 meters of stream, recording our total electrofishing time so that subsequent samples could be repeated with same amount of effort. We used one backpack electrofishing unit operating at 200 volts DC to stun fish which were collected by the backpack operator or the netter assisting with the survey. Population estimates have been derived for this species using a one pass electrofishing model developed by Black and Mattingly (2007). However, recent surveys have captured very few individuals and were below the recommended minimal sample size for using the model. Subsequent samples and those conducted previously using the one pass estimate will be reassessed with CPUE estimates to alleviate the uncertainty of the estimate when low numbers of dace are encountered. Basic water quality collected at the site indicated a conductivity of 232 µs/cm, a pH of 6.0, and water temperature of 18.9 C. Overall, the physical habitat and condition of the stream scored 110 (sub-optimal). The most influential metrics on the overall score were the bank vegetative protection and the width of the riparian zone.

Figure 25. Site location for the sample conducted in Jake Branch during 2013.



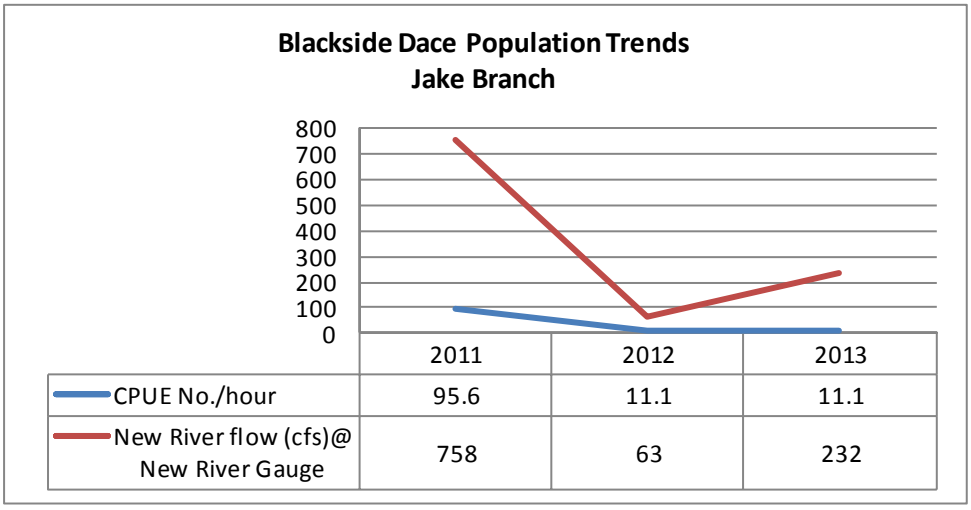
Results

We collected three fish species during our survey of Jake Branch. Both the green sunfish and creek chub were abundant in our sample area. Four blackside dace (3 in 2012) were collected within our sample area (Table 17). Based on the one pass electrofishing catch, our CPUE within our sample area was 11.1 (Figure 26). This was equivalent to our 2012 estimate and significantly lower than our 2011 value (95.6). Blackside dace abundance is highly variable from year to year depending on flow conditions. There were high water events during 2013 according to the land owner and our observations over the last two sampling events have indicated an increase in the green sunfish abundance in this section of the stream. These values will be used to develop trends over a five year period and serve as a benchmark for comparison should forestry practices take place within the watershed.

Table 17. Fish species collected from Jake Branch 2013.

Species	Abundance
Chrosomus cumberlandensis	4 (CPUE = 11.1)
Lepomis cyanellus	Abundant
Semotilus atromaculatus	Abundant

Figure 26. Blackside dace population trends in Jake Branch 2011-13.



Discussion

There is the potential to manage the Jake Branch watershed for early successional forest type as identified in the HCP plan. Therefore, we will monitor the blackside dace in this stream in order to document trends in relation to TWRA's activities. We will return to repeat the sample in 2014 to add to the HCP database.

Management Recommendations

1. Continue to monitor blackside dace annually.

Hudson Branch

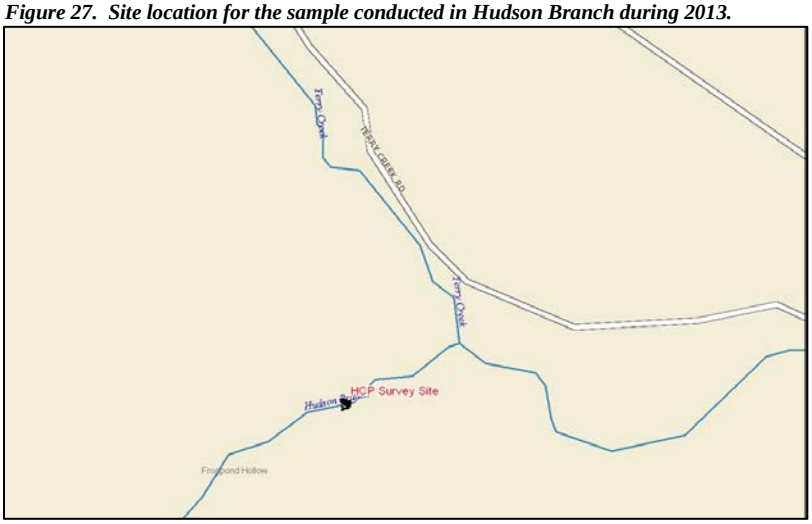
Introduction

Hudson Branch was chosen for monitoring due to TWRA's potential forestry activity within the watershed and the occurrence of blackside dace and Cumberland arrow darter in the stream. The blackside dace (federally listed) and Cumberland arrow darter (state listed) are species of concern in this system and were identified as key species for monitoring under the HCP.

Study Area and Methods

The area we surveyed was located approximately 0.1 miles upstream from the confluence with Terry Creek on private property (Figure 27). We conducted the survey on August 14, 2013. We surveyed approximately 234 meters of stream, recording our total electrofishing time so that subsequent samples could be repeated with same amount of effort. We used one backpack electrofishing unit operating at 250 volts DC to stun fish which were collected by the backpack operator or the netter assisting with the survey. Population estimates have been derived for this species using a one pass electrofishing model developed by Black and Mattingly (2007). However, recent surveys have captured very few individuals and were below the recommended minimal sample size for using the estimator. Subsequent samples and those conducted previously using the one pass estimate will be reassessed with CPUE estimates to alleviate the uncertainty of the estimate when low numbers of dace are encountered. Catch per unit effort (fish/hour) was calculated for Cumberland arrow darter and blackside dace. Basic water quality collected at the site indicated a conductivity of 80 µs/cm, a pH of 6.0, and water temperature of 21.1 C. Overall, the physical habitat and condition of the stream scored 113 (suboptimal). The most influential metrics on the overall score were sedimentation and the bank instability. During the spring of 2012 a flash flood hit this watershed causing extreme alteration to the stream channel resulting in the lower habitat quality score. To compound the issue with the high water event, the stream had very low flow at the time of the survey.

Figure 27. Site location for the sample conducted in Hudson Branch during 2013.



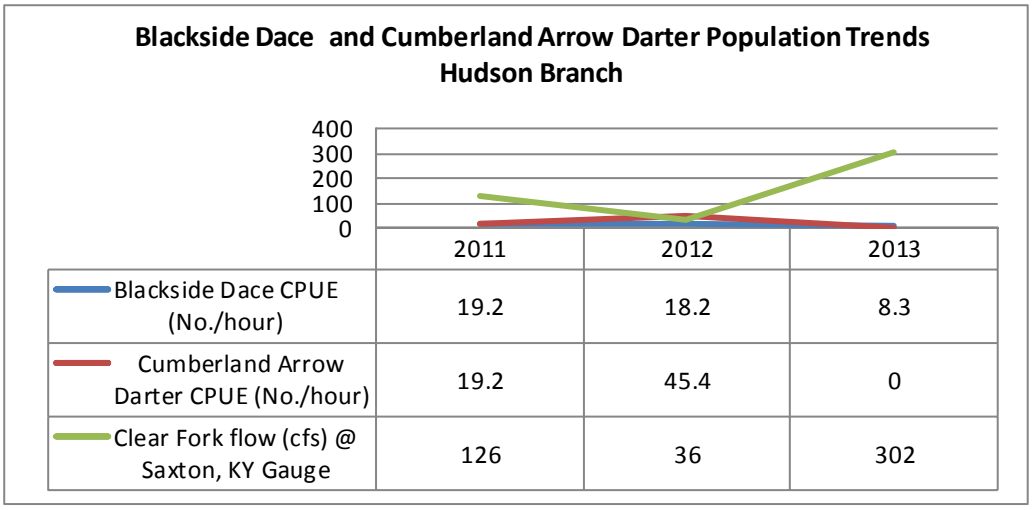
Results

We collected seven fish species during our survey of Hudson Branch. The most common species collected in our survey was creek chub and stripetail darter. Three blackside dace (2 in 2012) were collected within our sample area (Table 18). Based on the one pass electrofishing catch, our CPUE estimate of blackside dace within our sample area was 8.3 (Figure 28). This was down from 18.2 recorded in the 2012 survey. There were no Cumberland arrow darters collected during our survey (5 in 2012). These values will be used to develop trends over a five year period and serve as a benchmark for comparison within the watershed.

Table 18. Fish species collected from Hudson Branch 2013.

Species	Abundance
Campostoma anomalum	Common
Chrosomus cumberlandensis	3 (CPUE = 8.3)
Etheostoma caeruleum	Rare
Etheostoma kennicotti	Abundant
Lepomis cyanellus	Scarce
Rhinichthys atratulus	Rare
Semotilus atromaculatus	Common

Figure 28. Blackside dace and Cumberland arrow darter population trends in Hudson Branch 2011-13.



Discussion

There are no plans by TWRA forestry to conduct activity within this watershed currently. However, given the occurrence of blackside dace and Cumberland arrow darter we wanted to begin building background data as a control. We will return to repeat the sample in 2014 to add to the HCP database.

Management Recommendations

1. Continue to monitor blackside dace and Cumberland arrow darter annually.

Terry Creek

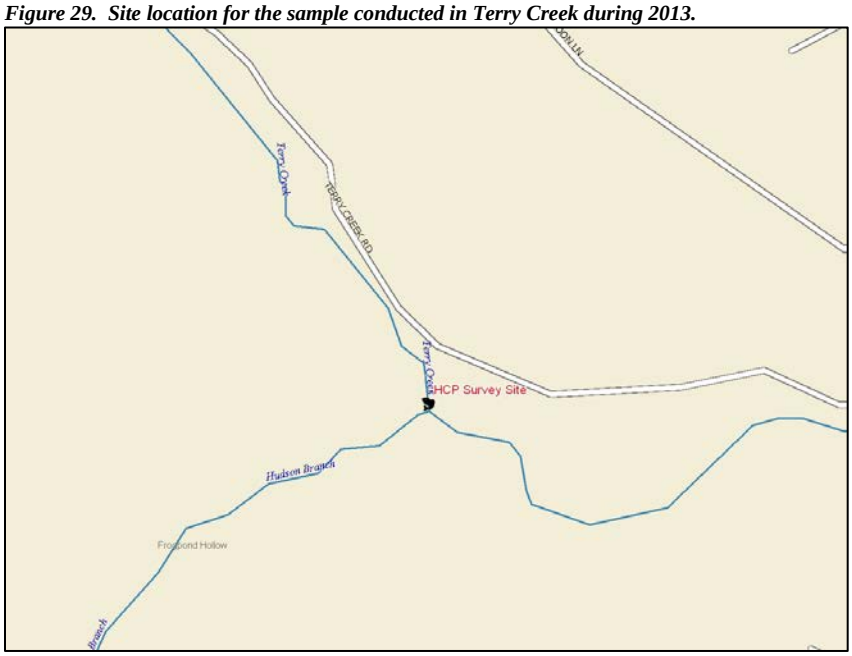
Introduction

Terry Creek was chosen for monitoring due to TWRA's potential forestry activity within the watershed and the occurrence of blackside dace and Cumberland arrow darter in the stream. The blackside dace (federally listed) and Cumberland arrow darter (state listed) are species of concern in this system and were identified as key species for monitoring under the HCP.

Study Area and Methods

The area we surveyed was located just upstream from the confluence with Hudson Branch on private property (Figure 29). We conducted the survey on August 14, 2013. We surveyed approximately 113 meters of stream, recording our total electrofishing time so that subsequent samples could be repeated with same amount of effort. We used one backpack electrofishing unit operating at 250 volts DC to stun fish which were collected by the backpack operator or the netter assisting with the survey. Population estimates have been derived for this species using a one pass electrofishing model developed by Black and Mattingly (2007). However, recent surveys have captured very few individuals and were below the recommended minimal sample size for using the estimator. Subsequent samples and those conducted previously using the one pass estimate will be reassessed with CPUE estimates to alleviate the uncertainty of the estimate when low numbers of dace are encountered. Catch per unit effort (fish/hour) was calculated for Cumberland arrow darter and blackside dace. Basic water quality collected at the site indicated a conductivity of 122 µs/cm, a pH of 6.0, and water temperature of 20.2 C. Overall, the physical habitat and condition of the stream scored 110 (sub-optimal). The most influential metrics on the overall score were the bank vegetative protection, riparian zone width, and bank instability.

Figure 29. Site location for the sample conducted in Terry Creek during 2013.



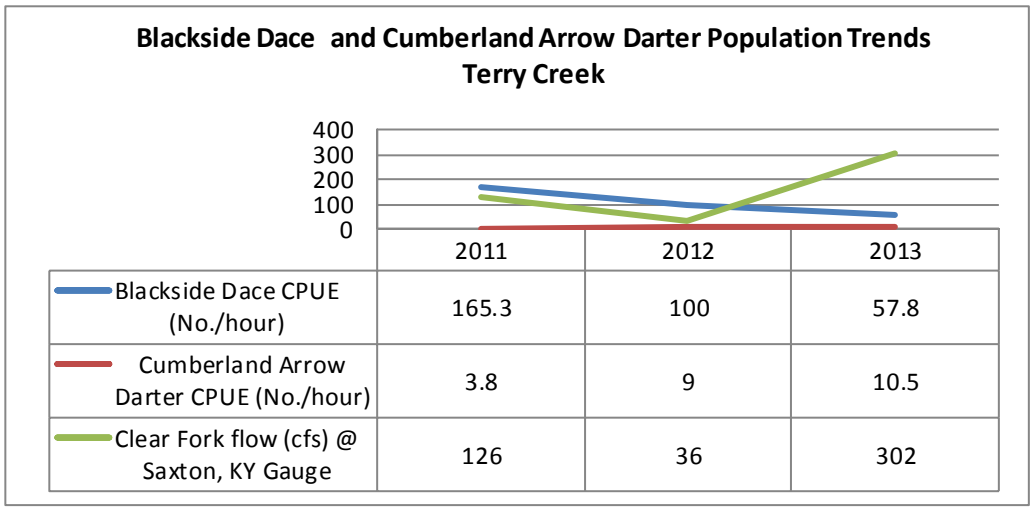
Results

We collected eight fish species during our survey of Terry Creek. The most common species were creek chub, stoneroller, and stripetail darter. Due to flooding in 2012, the abundance of many species collected in 2013 was still depressed. Eleven blackside dace were collected within our sample area (Table 19). This was the same number as collected in 2012. Based on the one pass electrofishing catch, our CPUE estimate of blackside dace within our sample area was 57.8 (Figure 30). This was down from 100 in 2012. Two Cumberland arrow darter was collected during our survey. Based on our catch and the amount of electrofishing effort expended at the site we calculated a CPUE of 10.5 for this species (9 in 2012). These values will be used to develop trends over a five year period and serve as a benchmark for comparison purposes within the watershed.

Table 19. Fish species collected from Terry Creek 2013.

Species	Abundance
Campostoma anomalum	Common
Catostomus commersonii	Rare
Chrosomus cumberlandensis	11 (CPUE= 57.8)
Etheostoma caeruleum	Scarce
Etheostoma kennicotti	Common
Etheostoma sagitta sagitta	2 (CPUE = 10.5)
Lepomis cyanellus	Scarce
Semotilus atromaculatus	Abundant

Figure 30. Blackside dace and Cumberland arrow darter population trends in Terry Creek 2011-13.



Discussion

There are no plans by TWRA forestry to conduct activity within this watershed currently. However, given the occurrence of blackside dace and Cumberland arrow darter we wanted to begin building background data as a control. We will return to repeat the sample in 2014 to add to the HCP database.

Management Recommendations

1. Continue to monitor blackside dace and Cumberland arrow darter annually.

Stinking Creek

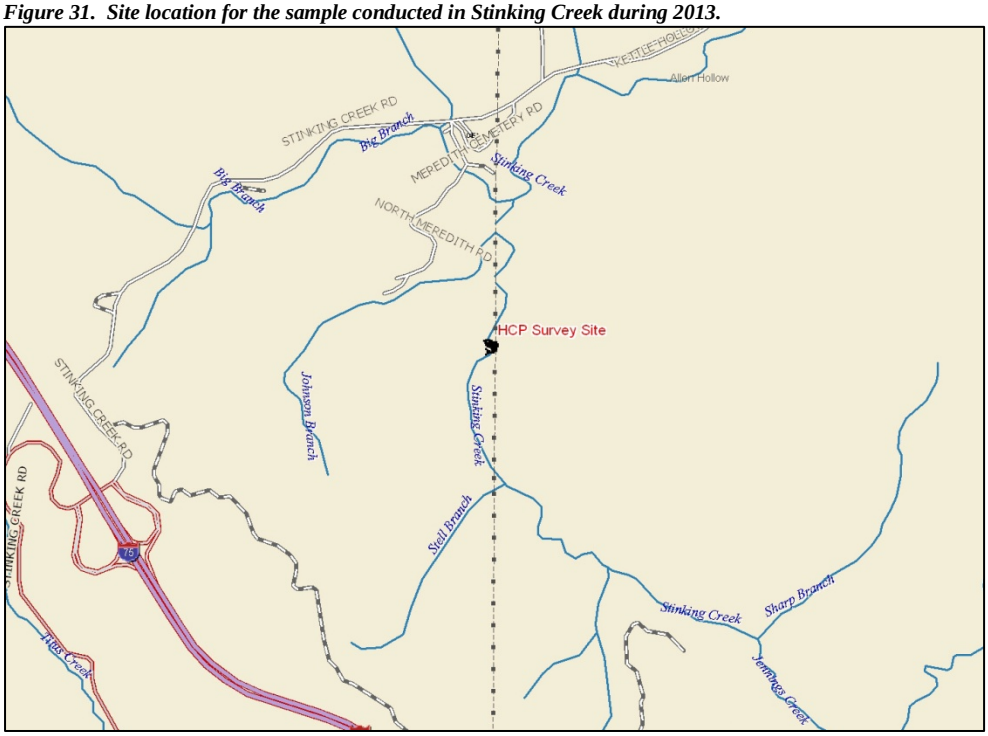
Introduction

Stinking Creek was chosen for monitoring due to TWRA's potential forestry activity within the watershed and the occurrence of Cumberland arrow darter in the stream. The Cumberland arrow darter (state listed) is a species of concern in this system and was identified as key species for monitoring under the HCP.

Study Area and Methods

The area we surveyed was located about 200 m upstream from the first road crossing after entering North Cumberland WMA (Figure 31). We conducted the survey on August 15, 2013. We surveyed approximately 200 meters of stream, recording our total electrofishing time so that subsequent samples could be repeated with same amount of effort. We used one backpack electrofishing unit operating at 250 volts AC to stun fish which were collected by the backpack operator or the netter assisting with the survey. Catch per unit effort (fish/hour) was calculated for Cumberland arrow darter. Basic water quality collected at the site indicated a conductivity of 93.2 µs/cm, a pH of 6.0, and water temperature of 19.4 C. Overall, the physical habitat and condition of the stream scored 126 (sub-optimal). The most influential metrics on the overall score were the amount of embeddedness, sediment deposition, and bank vegetative cover.

Figure 31. Site location for the sample conducted in Stinking Creek during 2013.



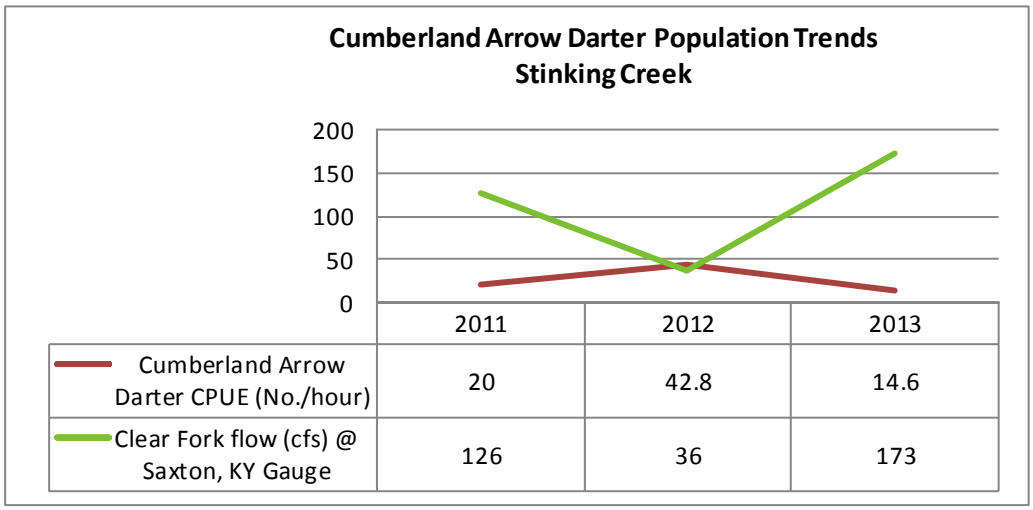
Results

We collected 13 fish species during our survey of Stinking Creek. There were several species in the survey that were common (Table 20). Six Cumberland arrow darters were collected during our survey. This was down substantially from the 21 collected in the 2012 survey. Based on our catch and the amount of electrofishing effort expended at the site we calculated a CPUE of 14.6 (42.8 in 2012) for this species (Figure 32). This value will be used to develop trends over the next three years and serve as a benchmark for comparison should forestry practices take place within the watershed.

Table 20. Fish species collected from Stinking Creek 2013.

Species	Abundance
Ambloplites rupestris	Rare
Campostoma anomalum	Scarce
Etheostoma sagitta sagitta	6 (CPUE = 14.6)
Etheostoma caeruleum	Common
Etheostoma kennicotti	Common
Hypentelium nigricans	Common
Lepomis auritus	Scarce
Lepomis macrochirus	Rare
Micropterus dolomieu	Rare
Notropis rubellus	Abundant
Percina maculata	Rare
Pimephales notatus	Common
Semotilus atromaculatus	Abundant

Figure 32. Cumberland arrow darter population trends in Stinking Creek 2011-13.



Discussion

There are plans by TWRA forestry to conduct forest management activities within this watershed in the future. We are monitoring Cumberland arrow darter to begin building background data for activities that will take place here and evaluate any influence these activities may have on this species. We will return to repeat the sample in 2014 to add to the HCP database.

Management Recommendations

1. Continue to monitor Cumberland arrow darter annually.

Louse Creek

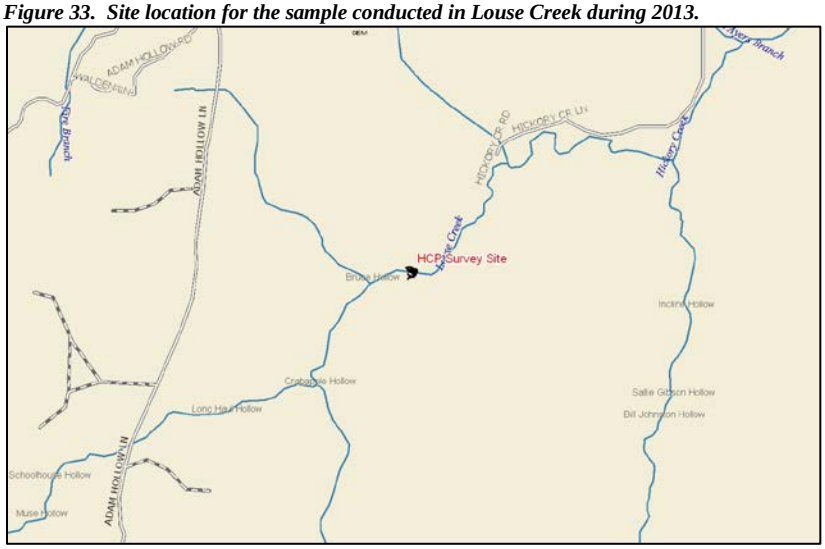
Introduction

Louse Creek was chosen for monitoring due to TWRA's potential forestry activity within the watershed and the occurrence of blackside dace and Cumberland arrow darter in the stream. The blackside dace (federally listed) and Cumberland arrow darter (state listed) are species of concern in this system and were identified as key species for monitoring under the HCP.

Study Area and Methods

The area we surveyed was located just upstream from the logging access road (Figure 33). We conducted the survey on August 15, 2013. We surveyed approximately 190 meters of stream, recording our total electrofishing time so that subsequent samples could be repeated with same amount of effort. We used one backpack electrofishing unit operating at 250 volts DC to stun fish which were collected by the backpack operator or the netter assisting with the survey. Population estimates have been derived for this species using a one pass electrofishing model developed by Black and Mattingly (2007). However, recent surveys have captured very few individuals and were below the recommended minimal sample size for using the estimator. Subsequent samples and those conducted previously using the one pass estimate will be reassessed with CPUE estimates to alleviate the uncertainty of the estimate when low numbers of dace are encountered. Catch per unit effort (fish/hour) was calculated for Cumberland arrow darter and blackside dace. Basic water quality collected at the site indicated a conductivity of 141 µs/cm, a pH of 6.0, and water temperature of 17.3 C. Overall, the physical habitat and condition of the stream scored 127 (sub-optimal) which was similar to the previous year's score 121. The most influential metric on the overall score was bank instability.

Figure 33. Site location for the sample conducted in Louse Creek during 2013.



Results

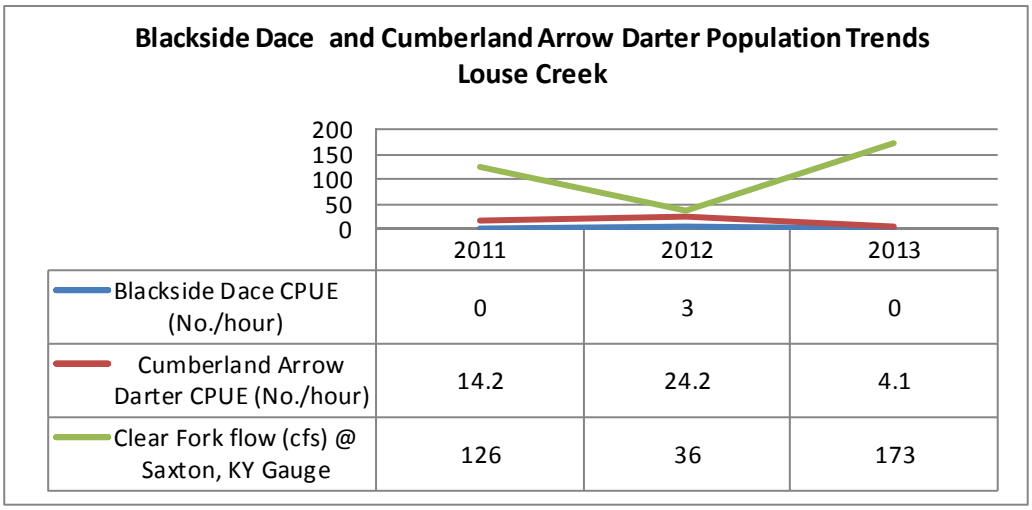
We collected 11 fish species during our survey of Louse Creek. The most common species were creek chub, stripetail darter, and rainbow darter (Table

21). We did not collect any blackside dace in 2013 (1 in 2012). Two Cumberland arrow darters were collected during our survey. Based on our catch and the amount of electrofishing effort expended at the site we calculated a CPUE of 4.1 which was down considerably from the previous sample (Figure 34). These values will be used to develop trends over the next three years and serve as a benchmark for comparison should forestry practices take place within the watershed.

Table 21. Fish species collected from Louse Creek 2013.

Species	Abundance
Ambloplites rupestris	Rare
Campostoma anamolum	Scarce
Etheostoma caeruleum	Common
Etheostoma kennicotti	Common
Etheostoma sagitta sagitta	2 (CPUE = 4.1)
Hypentelium nigricans	Common
Lepomis cyanellus	Scarce
Lepomis macrochirus	Rare
Micropterus salmoides	Rare
Rhinichthys atratulus	Scarce
Semotilus atromaculatus	Abundant

Figure 34. Blackside dace and Cumberland arrow darter population trends in Louse Creek 2011-13.



Discussion

There are no plans by TWRA forestry to conduct activity within this watershed currently. However, given the occurrence of blackside dace and Cumberland arrow darter we wanted to begin building background data for activities that may take place in the future. We will return to repeat the sample in 2014 to add to the HCP database.

Management Recommendations

1. Continue to monitor blackside dace and Cumberland arrow darter annually.

Summary

During 2013, we collected 21 fish and four benthic macroinvertebrate samples. These included samples from Little River, North Fork Holston River, New River, and Pigeon River. Additionally, six streams were surveyed for North Cumberland HCP monitoring program.

Overall, CPUE estimates for black bass and rock bass were down in the North Fork Holston River and the New River during 2013. We had poor sampling conditions (low visibility) in the New River and our sample in the North Fork Holston was delayed beyond our normal spring survey time frame which could have influenced our sample results although the smallmouth bass catch in the New River was higher than the sample in 2010. In the Pigeon River, however, we recorded the highest catch of preferred and memorable smallmouth bass since we began sampling the river 14 years ago. Smallmouth bass and rock bass age and growth from the TWRA/UT Little River project indicated smallmouth bass were persisting in the population to 15 years and the oldest rock bass was recorded at 7 years. Maximum growth potential for smallmouth bass and rock bass were estimated to be 525 mm (20 inches) and 292 mm (11 inches), respectively.

The IBI surveys for Little River and the Pigeon River changes slightly when compared to the 2012 values. In Little River, the Townsend site decreased four points from the 2012 value whereas the Coulters Bridge retained the same score as the previous year. The Pigeon River exhibited a decline at the Tannery Island site for the third consecutive year, while the Denton site improved four points over the 2012 value.

Streams monitored for the HCP were completed and the third year of monitoring data for species covered under the plan was generated. We will continue to monitor these select streams over the next three years to establish benchmarks to relate to TWRA's forestry activities in these watersheds.

Over the past several 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 22 lists our results for various streams surveyed during this time period.

Table 22. Index of Biotic Integrity and Benthic Biotic Index scores for samples conducted between 1994 and 2013.

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 Cumberland River	1994	Campbell	38 (Poor/Fair)	2 (Fair)
Burnt Pone Creek	Clear Fork Cumberland River	1994	Campbell	38 (Poor/Fair)	2 (Fair)
Whistle Creek	Clear Fork Cumberland River	1994	Campbell	38 (Poor/Fair)	2 (Fair)
Little Elk Creek	Clear Fork Cumberland River	1994	Campbell	40 (Fair)	2 (Fair)
Lick Fork	Clear Fork Cumberland River	1994	Campbell	38 (Poor/Fair)	2 (Fair)
Terry Creek	Clear Fork Cumberland River	1994	Campbell	48 (Good)	2 (Fair)

Table 22. Continued.

Water	Watershed	Year Surveyed	County	IBI Score	Benthic BI Score
Crouches Creek	Clear Fork Cumberland River	1994	Campbell	28 (Poor)	1 (Poor)
Hickory Creek (Site 1)	Clear Fork Cumberland River	1994	Campbell	46 (Fair/Good)	3 (Fair/Good)
Hickory Creek (Site 2)	Clear Fork Cumberland River	1994	Campbell	48 (Good)	2 (Fair)
White Oak Creek	Clear Fork Cumberland River	1994	Campbell	30 (Poor)	2 (Fair)
No Business Branch	Clear Fork Cumberland River	1994	Campbell	30 (Poor)	3 (Fair/Good)
Laurel Fork	Clear Fork Cumberland River	1994	Campbell	52 (Good)	3 (Fair/Good)
Lick Creek	Clear Fork Cumberland River	1994	Campbell	44 (Fair)	3 (Fair/Good)
Davis Creek	Clear Fork Cumberland River	1994	Campbell	38 (Poor/Fair)	2 (Fair)
Rock Creek	Clear Fork Cumberland River	1994	Campbell	54 (Good/Excellent)	3 (Fair/Good)
Little Tackett Creek	Clear Fork Cumberland River	1994	Claiborne	28 (Poor)	3 (Fair/Good)
Unnamed tributary to Little Tackett Creek	Clear Fork Cumberland River	1994	Claiborne	0 (No Fish)	3 (Fair/Good)
Rose Creek	Clear Fork Cumberland River	1994	Campbell	36 (Poor/Fair)	2 (Fair)
Rock Creek	Clear Fork Cumberland River	1994	Claiborne	28 (Poor)	2 (Fair)
Tracy Branch	Clear Fork Cumberland River	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.)
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)

Table 22. Continued.

Water	Watershed	Year Surveyed	County	IBI Score	Benthic BI Score
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)
Little River (Coulters Bridge)	Tennessee River	2006	Blount	58 (Excellent)	4.2 (Good)
Little River (Townsend)	Tennessee River	2006	Blount	58 (Excellent)	4.7 (Good-Excellent)
Pigeon River (Tannery Island)	French Broad River	2006	Cocke	48 (Good)	3.5 (Fair-Good)
Pigeon River (Denton)	French Broad River	2006	Cocke	50 (Good)	3.8 (Fair-Good/Good)
Pigeon River (Hwy. 73 Bridge)	French Broad River	2006	Cocke	-	3.8 (Fair-Good/Good)
Little River (Coulters Bridge)	Tennessee River	2007	Blount	54 (Good)	3.8 (Fair-Good/Good)
Little River (Townsend)	Tennessee River	2007	Blount	56 (Good/Excellent)	4.0 (Good)
Pigeon River (Tannery Island)	French Broad River	2007	Cocke	54 (Good)	3.7 (Fair-Good/Good)
Pigeon River (Denton)	French Broad River	2007	Cocke	54 (Good)	3.5 (Fair/Good)
Little River (Coulters Bridge)	Tennessee River	2008	Blount	58 (Excellent)	3.8 (Fair-Good/Good)
Little River (Townsend)	Tennessee River	2008	Blount	56 (Good/Excellent)	3.0 (Fair/Good)
Pigeon River (Tannery Island)	French Broad River	2008	Cocke	44 (Fair)	2.0 (Fair)
Pigeon River (Denton)	French Broad River	2008	Cocke	48 (Good)	3.0 (Fair/Good)
Little River (Coulters Bridge)	Tennessee River	2009	Blount	58 (Excellent)	4.3 (Good)
Little River (Townsend)	Tennessee River	2009	Blount	58 (Excellent)	4.5 (Good)
Pigeon River (Tannery Island)	French Broad River	2009	Cocke	48 (Good)	3.0 (Fair/Good) July
Pigeon River (Denton)	French Broad River	2009	Cocke	50 (Good)	3.0 (Fair/Good) July
Pigeon River (Waterville)	French Broad River	2009	Cocke	-	4.5 (Good) March
Pigeon River (Denton)	French Broad River	2009	Cocke	-	4.3 (Good) March
Pigeon River (Tannery Island)	French Broad River	2009	Cocke	-	4.0 (Good) March
Poplar Creek	Clinch River	2009	Anderson	30 (Poor)	3.7 (Fair/Good-Good)
Titus Creek	Clinch River	2009	Campbell	-	4.5 (Good)
Pigeon River (Tannery Island)	French Broad River	2010	Cocke	54 (Good)	4.0 (Good)
Pigeon River (Denton)	French Broad River	2010	Cocke	54 (Good)	3.3 (Fair/Good)
Little River (Coulters Bridge)	Tennessee River	2010	Blount	60 (Excellent)	4.3 (Good)
Little River (Townsend)	Tennessee River	2010	Blount	58 (Excellent)	4.5 (Good/Excellent)
Smoky Creek	New River	2010	Scott	37 (Fair)	3.5 (Fair/Good)
Beech Fork	New River	2010	Campbell	47 (Good)	-
Pigeon River (Tannery Island)	French Broad River	2011	Cocke	50 (Good	2.5 (Fair)
Pigeon River (Denton)	French Broad River	2011	Cocke	54 (Good)	3.3 (Fair/Good)
Little River (Coulters Bridge)	Tennessee River	2011	Blount	58 (Excellent)	4.3 (Good)
Little River (Townsend)	Tennessee River	2011	Blount	50 (Good)	4.3 (Good)
Little River (Coulters Bridge)	Tennessee River	2012	Blount	58 (Excellent)	4.5 (Good)
Little River (Townsend)	Tennessee River	2012	Blount	58 (Excellent)	4.2 (Good)
Cove Creek	Clinch river	2012	Campbell	32 (Poor)	-
Pigeon River (Tannery Island)	French Broad River	2012	Cocke	46 (Good	3.0 (Fair/Good)
Pigeon River (Denton)	French Broad River	2012	Cocke	52 (Good)	4.0 (Good)
Capuchin Creek	Clear Fork Cumberland River	2012	Campbell	38 (Poor/Fair)	-
Little Elk Creek	Clear Fork Cumberland River	2012	Campbell	42 (Fair)	-
Little River (Coulters Bridge)	Tennessee River	2013	Blount	58 (Excellent)	4.5 (Good)
Little River (Townsend)	Tennessee River	2013	Blount	54 (Excellent)	4.6 (Good/Excellent)
Pigeon River (Tannery Island)	French Broad River	2013	Cocke	42 (Good)	3.0 (Fair/Good)
Pigeon River (Denton)	French Broad River	2013	Cocke	56 (Good/Excellent)	4.0 (Good)

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