FISHERIES REPORT:
Warmwater Streams and Rivers

2016

Tennessee Wildlife Resources Agency
Region IV

FISHERIES REPORT
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WARMWATER STREAM FISHERIES REPORT
REGION IV

2016

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Cover: Blackside Dace is one of the covered species monitored as part of the developing habitat conservation plan for North Cumberlands WMA.

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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 Fisheries Operational Plan. Four rivers and 50 streams were sampled and are included in this report. Surveys were conducted from April to November 2016. A total of 69 (IBI, CPUE, Qualitative) 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 catch-per-unit-effort samples (CPUE) 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 2016. 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 2016 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 Page et al. (2013), Powers and Mayden (2007) and Etnier and Starnes (1993).

BENTHIC COLLECTIONS

Qualitative benthic samples were collected from each IBI fish sample site. 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.

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).

Catch-per-unit-effort analysis was performed for three large rivers sampled during 2016. 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 and those surveyed for Tennessee Dace.

Benthic data collected for the 2016 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 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.

Index of Biotic Integrity Surveys

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 2016 surveys focused on continuing the evaluation of the fish community at two long-term IBI stations. Catch effort data for rock bass and black bass have been collected routinely since 1997 at five 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 in March, 1999.

Study Area and Methods


Pigeon River

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 July 6 and 7, 2016, we conducted IBI fish surveys at Tannery Island (PRM 8.2) and Denton (PRM 16.6) (Figure 1).

Figure 1. Site locations for the IBI samples conducted in the Pigeon River during 2016.

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 the Pigeon River have been ongoing since the late 1980's. These surveys have primarily focused on evaluating relative health changes in the fish community in relation to improvements of discharges from the Blue Ridge paper mill in Canton, NC. A total of 39 fish species were collected at the Tannery Island site and a total of 24 at the Denton site (Table 1). Overall, the IBI analysis indicated the fish community was in "fair" condition at Tannery Island (IBI score 44) (Figure 2). This was a four point decrease from the score in 2015. The condition of the fish community assessed "good" at the Denton site in 2016 (52), with a two point increase in the overall score from the previous sample in 2015 (Figure 2).

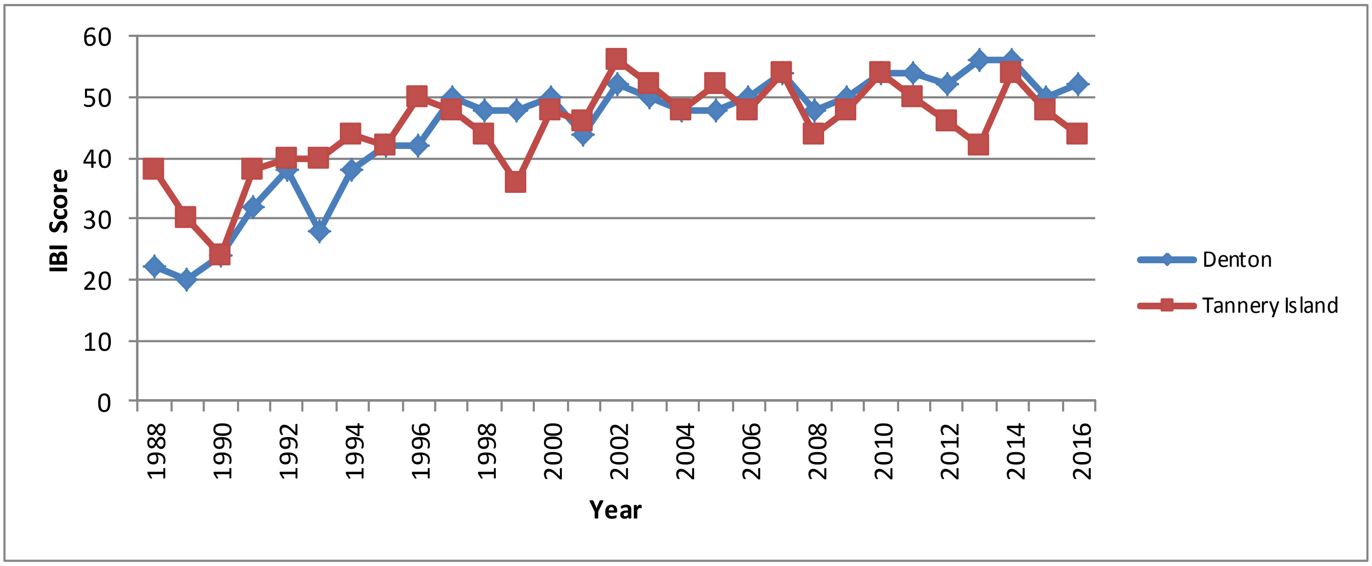
Table 1. Fish species collected from the Pigeon River at Tannery Island and Denton 2016.

Site	Common Name	Species	Number
Denton	Banded Sculpin	*Cottus carolinae*	41
Denton	Black Buffalo	*Ictiobus niger*	4
Denton	Black Redhorse	*Moxostoma duquesnei*	34
Denton	Central Stoneroller	*Campostoma anomalum*	76
Denton	Channel Catfish	*Ictalurus punctatus*	4
Denton	Gizzard Shad	*Dorosoma cepedianum*	71
Denton	Golden Redhorse	*Moxostoma erythrurum*	3
Denton	Greenside Darter	*Etheostoma blennioides*	27
Denton	Highland Shiner	*Notropis micropteryx*	18
Denton	Logperch	*Percina caprodes*	6
Denton	Northern Hog Sucker	*Hypentelium nigricans*	22
Denton	Ohio Lamprey	*Ichthyomyzon bdellium*	1
Denton	Redbreast Sunfish	*Lepomis auritus*	33
Denton	Redline Darter	*Etheostoma rufilineatum*	224
Denton	River Redhorse	*Moxostoma carinatum*	1
Denton	Rock Bass	*Ambloplites rupestris*	40

Site	Common Name	Species	Number
Denton	Smallmouth Bass	*Micropterus dolomieu*	66
Denton	Smallmouth Buffalo	*Ictiobus bubalus*	3
Denton	Smallmouth Redhorse	*Moxostoma breviceps*	2
Denton	Telescope Shiner	*Notropis telescopus*	92
Denton	Tennessee Darter	*Etheostoma tennesseense*	29
Denton	Whitetail Shiner	*Cyprinella galactura*	345
Denton	Yellow Bullhead	*Ameiurus natalis*	2
Denton	Walleye	*Sander vitreum*	1
Tannery Island	Banded Darter	*Etheostoma zonale*	10
Tannery Island	Banded Sculpin	*Cottus carolinae*	78
Tannery Island	Bigeye Chub	*Hybopsis amblops*	6
Tannery Island	Black Buffalo	*Ictiobus niger*	2
Tannery Island	Black Redhorse	*Moxostoma duquesnei*	24
Tannery Island	Bluegill	*Lepomis macrochirus*	4
Tannery Island	Brook Silverside	*Labidesthes sicculus*	18
Tannery Island	Central Stoneroller	*Campostoma anomalum*	217
Tannery Island	Channel Catfish	*Ictalurus punctatus*	11
Tannery Island	Creek Chub	*Semotilus atromaculatus*	11
Tannery Island	Freshwater Drum	*Aplodinotus grunniens*	2
Tannery Island	Gilt Darter	*Percina evides*	1
Tannery Island	Gizzard Shad	*Dorosoma cepedianum*	75
Tannery Island	Golden Redhorse	*Moxostoma erythrurum*	8
Tannery Island	Golden Shiner	*Notemigonus crysoleucas*	2
Tannery Island	Green Sunfish	*Lepomis cyanellus*	3
Tannery Island	Greenside Darter	*Etheostoma blennioides*	63
Tannery Island	Highland Shiner	*Notropis micropteryx*	17

Site	Common Name	Species	Number
Tannery Island	Largemouth Bass	*Micropterus salmoides*	3
Tannery Island	Logperch	*Percina caprodes*	38
Tannery Island	Longnose Dace	*Rhinichthys cataractae*	2
Tannery Island	Northern Hog Sucker	*Hypentelium nigricans*	17
Tannery Island	Redbreast Sunfish	*Lepomis auritus*	21
Tannery Island	Redline Darter	*Etheostoma rufilineatum*	325
Tannery Island	River Carpsucker	*Carpiodes carpio*	1
Tannery Island	River Chub	*Nocomis micropogon*	1
Tannery Island	River Redhorse	*Moxostoma carinatum*	5
Tannery Island	Rock Bass	*Ambloplites rupestris*	15
Tannery Island	Silver Redhorse	*Moxostoma anisurum*	4
Tannery Island	Silver Shiner	*Notropis photogenis*	28
Tannery Island	Smallmouth Bass	*Micropterus dolomieu*	11
Tannery Island	Smallmouth Buffalo	*Ictiobus bubalus*	7
Tannery Island	Smallmouth Redhorse	*Moxostoma breviceps*	6
Tannery Island	Spotfin Shiner	*Cyprinella spiloptera*	19
Tannery Island	Striped Shiner	*Luxilus chrysocephalus*	2
Tannery Island	Stripetail Darter	*Etheostoma kennicotti*	1
Tannery Island	Telescope Shiner	*Notropis telescopus*	63
Tannery Island	Tennessee Darter	*Etheostoma tennesseense*	52
Tannery Island	Whitetail Shiner	*Cyprinella galactura*	54

Figure 2. Trends in Index of Biotic Integrity (IBI) at two stations on the Pigeon River (1988-2016).



Benthic macroinvertebrates collected at the Tannery Island site comprised 28 families representing 32 identified genera (Table 3). The most abundant group in our collection was the caddisflies comprising 33.7% of the total sample. Overall, a total of 40 taxa were identified from the sample of which 13 were EPT. Based on the EPT taxa richness and overall biotic index of all species collected, the relative health of the benthic community was classified as “Fair-Good” (3.5).

Table 3. Taxa list and associated biotic statistics for benthic macroinvertebrates collected from the Pigeon River at Tannery Island.

ORDER/GROUP	FAMILY	SPECIES	NUMBER	PERCENT
ANNELIDA				0.4
	Oligochaeta		1	
COLEOPTERA				17.1
	Elmidae	*Ancyronyx variegatus* adult	1	
		Dubiraphia adult	1	
		Macronychus glabratus adults	4	
		Microcylloepus pusillus adults	3	
		Promoresia elegans larvae and adults	33	
	Hydrophylidae	*Tropisternus natator* adult	1	

ORDER/GROUP	FAMILY	SPECIES	NUMBER	PERCENT
	Psephenidae	*Psephenus herricki*	1	
DIPTERA				9.3
	Athericidae	*Atherix lantha*	1	
	Chironomidae		14	
	Empididae		5	
	Simuliidae		4	
EPHEMEROPTERA				11.6
	Baetidae	*Acentrella*	2	
		Baetis	1	
		Heterocloeon	1	
	Ephemerellidae	*Serratella deficiens*	8	
	Heptageniidae	*Maccaffertium mediopunctatum*	15	
	Isonychiidae	*Isonychia*	2	
	Leptohyphidae	*Tricorythodes*	1	
GASTROPODA				6.2
	Ancylidae	*Ferrissia*	2	
	Pleuroceridae	*Leptoxis*	**8**	
		Pleurocera form concolorous	4	
		Pleurocera with contrasting stripes	2	
HETEROPTERA				0.4
	Corixidae		1	
HYDRACARINA			4	1.6
MEGALOPTERA				4.3
	Corydalidae	*Corydalus cornutus*	11	
ODONATA				12.0
	Aeshnidae	*Baesiaeschna janata*	2	

ORDER/GROUP	FAMILY	SPECIES	NUMBER	PERCENT
		Boyeria vinosa	13	
	Calopterygidae	*Hetaerina americana*	9	
	Coenagrionidae	*Argia*	1	
	Gomphidae	*Hagenius brevistylus*	4	
		Stylogomphus albistylus	1	
	Macromiidae	*Macromia*	1	
PELECYPODA				1.2
	Corbiclidae	*Corbicula fluminea*	3	
TRICHOPTERA				33.7
	Brachycentridae	*Brachycentrus lateralis*	19	
	Hydropsychidae	*Ceratopsyche morosa* larvae and pupae	17	
		Cheumatopsyche	36	
	Hydroptilidae	*Hydroptila* larvae and pupae	13	
	Lepidostomatidae	*Lepidostoma*	1	
	Leptoceridae	*Oecetis*	1	
TURBELLARIA			6	2.3
		Total	258	

TAXA RICHNESS = 40
EPT RICHNESS = 13
BIOCLASSIFICATION = 3.5 (FAIR-GOOD)

Benthic macroinvertebrates collected at the Denton site comprised 34 families representing 45 identified genera (Table 4). The most abundant groups in our collection were the caddisflies comprising about 31.6% of the total sample. Overall, a total of 54 taxa were identified from the sample of which 24 were EPT. Based on the EPT taxa richness and overall biotic index of all species collected, the relative health of the benthic community was classified as “Fair-Good” (3.5).

Table 4. Taxa list and associated biotic statistics for benthic macroinvertebrates collected from the Pigeon River at Denton.

ORDER/GROUP	FAMILY	SPECIES	NUMBER	PERCENT
AMPHIPODA			1	0.2
ANNILIDA				1.7
	Hirudinea		1	
	Oligochaeta		6	
COLEOPTERA				9.6
	Dryopidae	*Helichus* adults	4	
	Elmidae	*Ancyronyx varigatus* larva	1	
		Macronychus glabratus larvae and adults	16	
		Optioservus ovalis adult	1	
		Promoresia elegans larva and adult	2	
	Gyrinidae	*Dineutus disclor* male and female	2	
		Dineutus larvae	8	
	Psephenidae	*Psephenus herricki* larvae	6	
DIPTERA				13.0
	Athericidae	*Atherix lantha*	4	
	Chironomidae		49	
	Simuliidae		1	
EPHEMEROPTERA				25.8
	Baetidae	*Acentrella*	11	
		Baetis	15	
		Callibaetis	1	
	Caenidae	*Caenis*	6	
	Ephemerellidae	*Eurylophella*	1	
		Serratella	10	
	Heptageniidae	*Epeorus* early instars	2	

ORDER/GROUP	FAMILY	SPECIES	NUMBER	PERCENT
		Maccaffertium early instars	24	
		Maccaffertium ithaca	4	
		Maccaffertium mediopunctatum	6	
		Stenacron interpunctatum	4	
	Isonychiidae	*Isonychia*	22	
	Leptohyphidae	*Tricorythodes*	1	
GASTROPODA				2.9
	Ancylidae	*Ferrissia*	3	
	Pleuroceridae	*Leptoxis*	4	
		Pleurocera	3	
	Viviparidae	*Campeloma*	2	
HYDRACARINA			3	0.7
ISOPODA				3.6
	Asellidae	*Caecidotea*	15	
MEGALOPTERA				3.4
	Corydalidae	*Corydalus cornutus*	12	
		Nigronia serricornis	2	
ODONATA				5.5
	Aeshnidae	*Boyeria vinosa*	8	
	Calopterygidae	*Hetaerina americana*	1	
	Coenagrionidae	*Argia*	6	
	Cordulidae	*Neurocordulia obsoleta*	1	
		Neurocordulia yamaskanensis	2	
	Gomphidae	*Hylogomphus abbreviatus*	1	
		Lanthus vernalis	1	
	Macromiidae	*Macromia*	3	

ORDER/GROUP	FAMILY	SPECIES	NUMBER	PERCENT
PELECYPODA				1.7
	Corbiculidae	*Corbicula fluminea*	7	
PLECOPTERA				0.2
	Leuctridae	*Leuctra*	1	
TRICHOPTERA				31.6
	Brachycentridae	*Brachycentrus lateralis*	7	
	Glossosomatidae	*Glossosoma*	1	
	Hydropsychidae	*Ceratopsyche morosa*	45	
		Ceratopsyche sparna	1	
		Cheumatopsyche	59	
		Hydropsyche franclemonti	5	
		Hydropsyche venularis	3	
	Lepidostomatidae	*Lepidostoma* early instar	1	
	Polycentropodidae	*Polycentropus*	6	
	Psychomiidae	*Lype diversa*	2	
		Psychomyia flavida	1	
		Total	415	

TAXA RICHNESS = 54
EPT RICHNESS = 24
BIOCLASSIFICATION = 3.5 (FAIR-GOOD)

Discussion

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 some 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. Reintroduction of select fish species occurs annually through efforts by the University of Tennessee, Tennessee Department of Environment and Conservation, and North Carolina Wildlife Resources Commission. These efforts have resulted in the establishment of viable populations of Gilt Darter, Stripetail Darter, and Mountain Brook Lamprey.

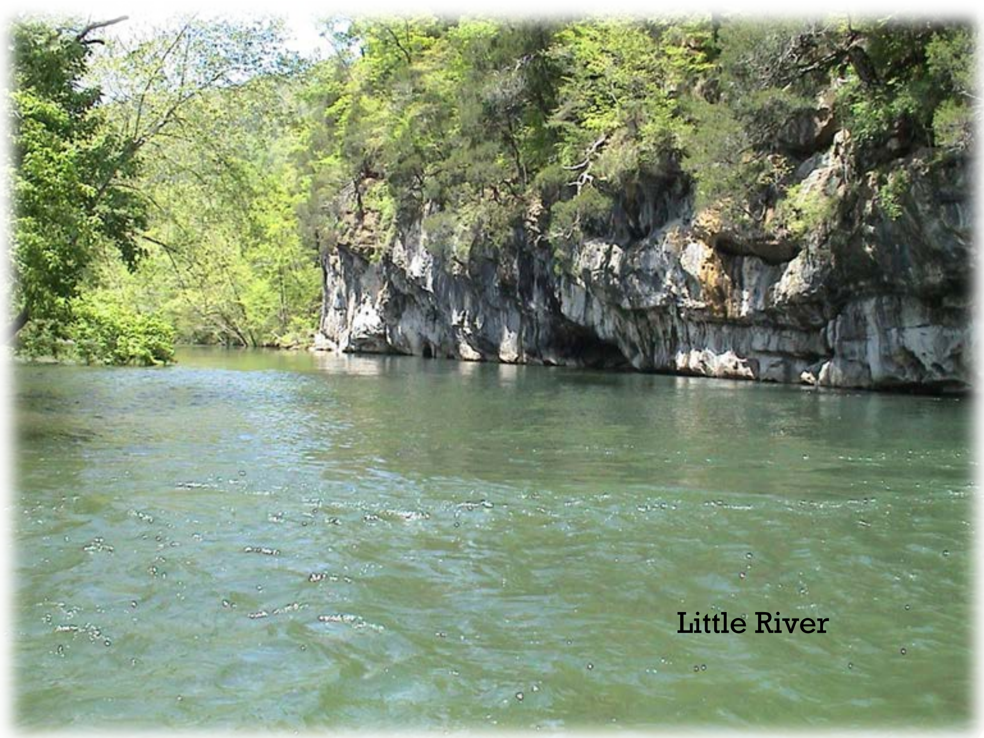
Management Recommendations

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. Continue cooperative efforts to reintroduce common species.
4. Continue stocking that section of the river between the powerhouse and Bluffton with Rainbow Trout when available.

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 Milldam downstream of Walland, near river mile 22. A third low head dam is located in Townsend near river mile 33.6. The river has a drainage area of approximately 982 km^2 at its confluence with the Tennessee River. The upper reach of the river (upstream of Walland) is located in the Blue Ridge physiographic province, and then transitions into the Ridge and Valley province from Walland to Fort Loudoun Reservoir. Little River is a very scenic stream in the Great Smoky Mountains National Park. There, it drains an area containing some of the most spectacular scenery in the southeastern United States. The Little River fishery within the National Park boundary is primarily wild Rainbow, Brook 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.


Stoneroller

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 (two 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.

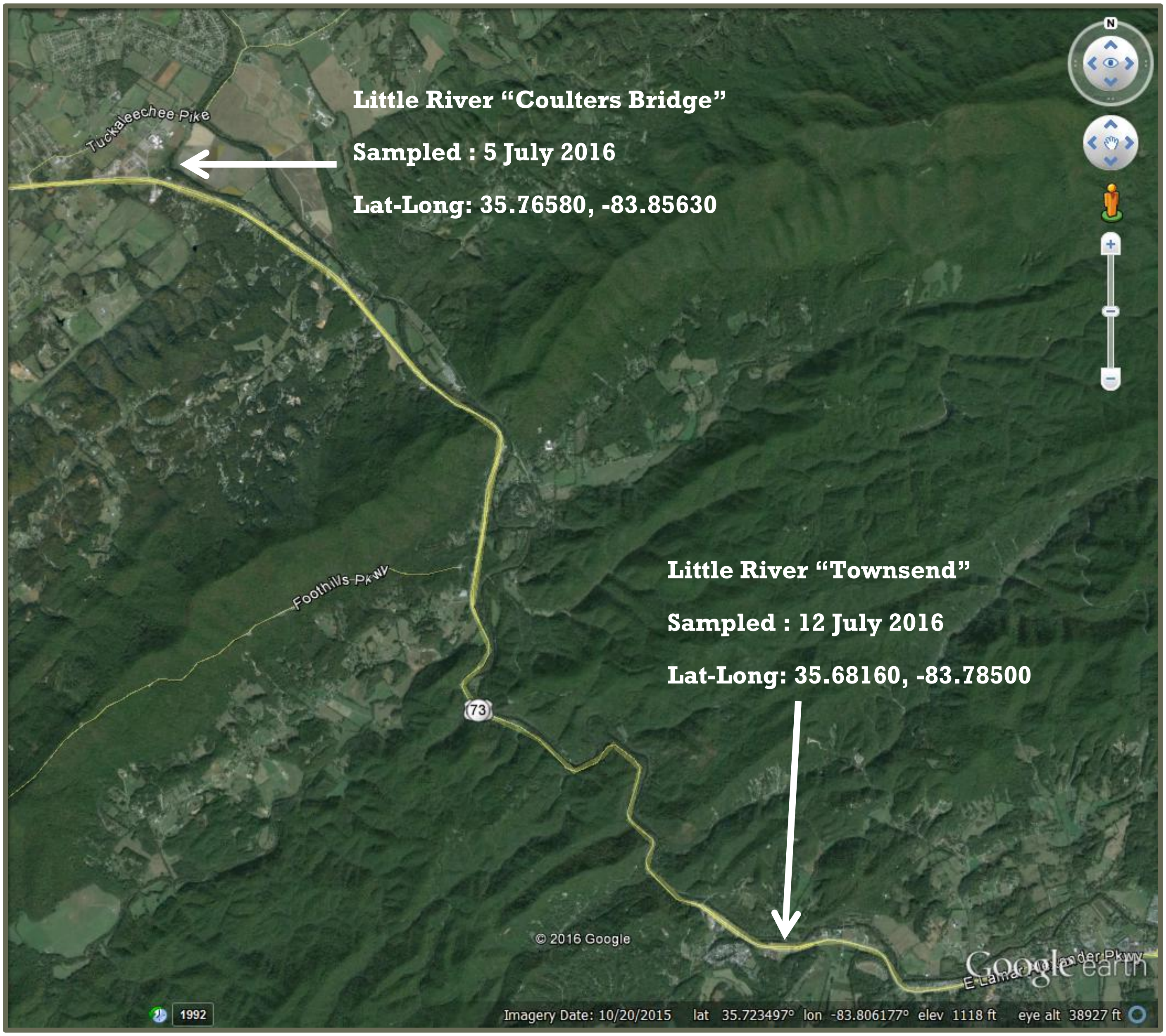
Study Area and Methods

Our 2016 survey of Little River consisted of two IBI sites (Coulters Bridge and Townsend). We cooperated with several agencies in conducting the two IBI samples between July 5 and 12. The Coulters Bridge site is located in the Ridge and Valley Province of Blount

County while the Townsend site lies in the transitional zone between the Blue Ridge and the Ridge and Valley Provinces (Figure 3).

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).

Figure 3. Site locations for samples conducted in Little River during 2016.



Both backpack and boat electrofishing were used to collect samples at both stations. Qualitative benthic macroinvertebrates samples were collected at both stations and analyzed to produce a biotic index score similar to those derived for the fish IBI.

In our survey sites, the riparian habitat consisted primarily of wooded shorelines with interspersed agricultural fields. Submerged woody debri was fairly common in most of our sample areas along with large boulder in the upper reaches. The river substrate was predominately boulder/cobble in riffle areas and bedrock with interspersed boulder/cobble in the pool habitat.

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 July 2016, one at Coulters Bridge (river mile 20) and one at Townsend (river mile 29.8). A total of 52 fish species were collected at the Coulters Bridge site and 33 were observed at Townsend. Overall, the IBI analysis indicated the fish community was in excellent condition at Coulters Bridge (IBI score 60). The condition of the fish community increased slightly from the value observed in 2015 (58). At the upper most station, Townsend, the stream rated excellent as well receiving a score of 58. This was an increase of four points from the previous sample (Figure 4). Several rare or endangered species of fish inhabit Little River, and thus, the protection of the watershed is a high priority for managing agencies and local conservation groups. Table 5 lists fish species collected at the Coulters Bridge and Townsend sites.

Sickle Darter

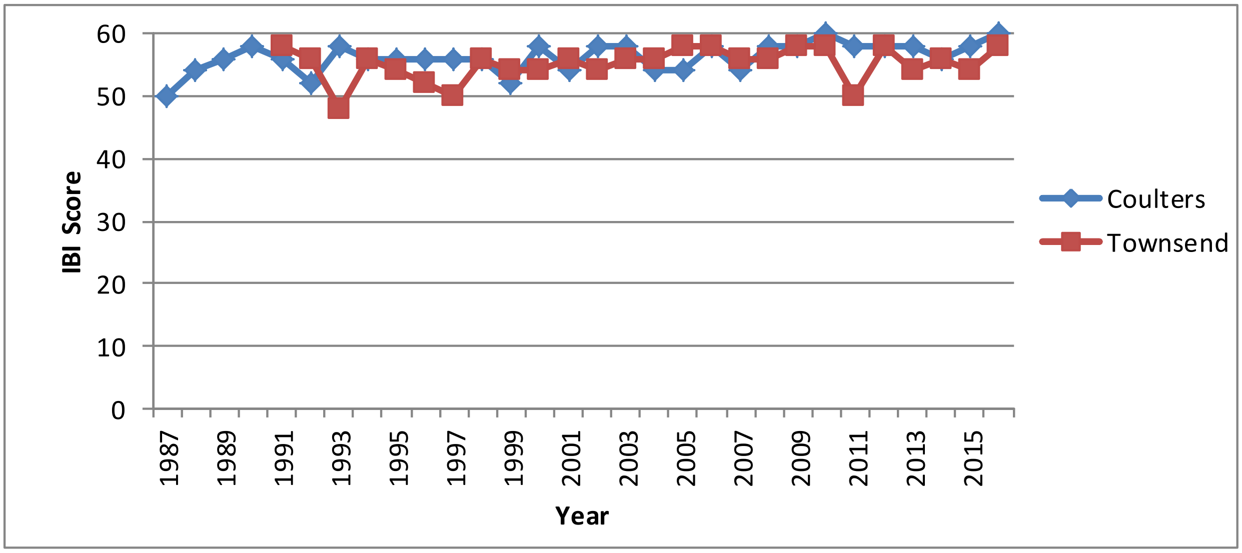
Table 5. Fish species collected from Little River at Coulter Bridge and Townsend 2016.

Site	Common Name	Species	Number
Coulters Bridge	Ashy Darter	*Etheostoma cinereum*	1
Coulters Bridge	Banded Darter	*Etheostoma zonale*	20
Coulters Bridge	Banded Sculpin	*Cottus carolinae*	18
Coulters Bridge	Bigeye Chub	*Hybopsis amblops*	114
Coulters Bridge	Black Bullhead	*Ameiurus melas*	1
Coulters Bridge	Black Redhorse	*Moxostoma duquesnei*	94
Coulters Bridge	Blotchside Logperch	*Percina burtoni*	1
Coulters Bridge	Bluebreast Darter	*Etheostoma camurum*	3
Coulters Bridge	Bluegill	*Lepomis macrochirus*	15
Coulters Bridge	Blueside Darter	*Etheostoma jessiae*	22
Coulters Bridge	Brook Silverside	*Labidesthes sicculus*	1
Coulters Bridge	Channel catfish	*Ictalurus punctatus*	1
Coulters Bridge	Common Carp	*Cyprinus carpio*	2
Coulters Bridge	Flathead Catfish	*Pylodictis olivaris*	1
Coulters Bridge	Gilt Darter	*Percina evides*	4
Coulters Bridge	Gizzard Shad	*Dorosoma cepedianum*	2
Coulters Bridge	Golden Redhorse	*Moxostoma erythrurum*	29
Coulters Bridge	Green Sunfish	*Lepomis cyanellus*	5
Coulters Bridge	Greenside Darter	*Etheostoma blennioides*	12
Coulters Bridge	Highland Shiner	*Notropis micropteryx*	147
Coulters Bridge	Largemouth Bass	*Micropterus salmoides*	5
Coulters Bridge	Largescale Stoneroller	*Campostoma oligolepis*	55
Coulters Bridge	Logperch	*Percina caprodes*	3
Coulters Bridge	Longnose Gar	*Lepisosteus osseus*	7
Coulters Bridge	Mimic Shiner	*Notropis volucellus*	74
Coulters Bridge	Mountain Madtom	*Noturus eleutherus*	18
Coulters Bridge	Mountain Shiner	*Lythrurus lirus*	43
Coulters Bridge	Northern Hog Sucker	*Hypentelium nigricans*	21

Site	Common Name	Species	Number
Coulters Bridge	Northern Studfish	*Fundulus catenatus*	10
Coulters Bridge	Ohio Lamprey	*Ichthyomyzon bdellium*	1
Coulters Bridge	Quillback	*Carpiodes cyprinus*	2
Coulters Bridge	Redbreast Sunfish	*Lepomis auritus*	30
Coulters Bridge	Redear Sunfish	*Lepomis microlophus*	1
Coulters Bridge	Redline Darter	*Etheostoma rufilineatum*	319
Coulters Bridge	River Chub	*Nocomis micropogon*	36
Coulters Bridge	River Redhorse	*Moxostoma carinatum*	14
Coulters Bridge	Rock Bass	*Ambloplites rupestris*	44
Coulters Bridge	Sickle Darter	*Percina williamsi*	5
Coulters Bridge	Silver Redhorse	*Moxostoma anisurum*	4
Coulters Bridge	Silver Shiner	*Notropis photogenis*	8
Coulters Bridge	Smallmouth Bass	*Micropterus dolomieu*	14
Coulters Bridge	Spotfin Shiner	*Cyprinella spiloptera*	11
Coulters Bridge	Spotted Bass	*Micropterus punctulatus*	1
Coulters Bridge	Spotted Sucker	*Minytrema melanops*	1
Coulters Bridge	Stargazing Minnow	*Phenacobius uranops*	5
Coulters Bridge	Striped Shiner	*Luxilus chrysocephalus*	25
Coulters Bridge	Tangerine Darter	*Percina aurantiaca*	3
Coulters Bridge	Telescope Shiner	*Notropis telescopus*	46
Coulters Bridge	Tennessee Darter	*Etheostoma tennesseense*	29
Coulters Bridge	Tennessee Shiner	*Notropis leuciodus*	84
Coulters Bridge	Warpaint Shiner	*Luxilus coccogenis*	23
Coulters Bridge	Western Mosquitofish	*Gambusia affinis*	1
Coulters Bridge	Whitetail Shiner	*Cyprinella galactura*	19
Townsend	American Brook Lamprey	*Lethenteron appendix*	8
Townsend	Banded Darter	*Etheostoma zonale*	12
Townsend	Banded Sculpin	*Cottus carolinae*	61

Site	Common Name	Species	Number
Townsend	Bigeye Chub	*Hybopsis amblops*	10
Townsend	Black Redhorse	*Moxostoma duquesnei*	28
Townsend	Blotched Chub	*Erimystax insignis*	9
Townsend	Bluegill	*Lepomis macrochirus*	14
Townsend	Central Stoneroller	*Campostoma anomalum*	41
Townsend	Gilt Darter	*Percina evides*	1
Townsend	Golden Redhorse	*Moxostoma erythrurum*	1
Townsend	Green Sunfish	*Lepomis cyanellus*	4
Townsend	Greenside Darter	*Etheostoma blennioides*	8
Townsend	Highland Shiner	*Notropis micropteryx*	18
Townsend	Mimic Shiner	*Notropis volucellus*	13
Townsend	Mountain Brook Lamprey	*Ichthyomyzon greeleyi*	1
Townsend	Mountain Shiner	*Lythrurus lirus*	3
Townsend	Northern Hog Sucker	*Hypentelium nigricans*	16
Townsend	Northern Studfish	*Fundulus catenatus*	25
Townsend	Rainbow Trout	*Oncorhynchus mykiss*	1
Townsend	Redbreast Sunfish	*Lepomis auritus*	2
Townsend	Redline Darter	*Etheostoma rufilineatum*	197
Townsend	River Chub	*Nocomis micropogon*	26
Townsend	Rock Bass	*Ambloplites rupestris*	42
Townsend	Silver Shiner	*Notropis photogenis*	30
Townsend	Smallmouth Bass	*Micropterus dolomieu*	9
Townsend	Stargazing Minnow	*Phenacobius uranops*	1
Townsend	Telescope Shiner	*Notropis telescopus*	125
Townsend	Tennessee Darter	*Etheostoma tennesseense*	20
Townsend	Tennessee Shiner	*Notropis leuciodus*	118
Townsend	Warpaint Shiner	*Luxilus coccogenis*	58
Townsend	Whitetail Shiner	*Cyprinella galactura*	70

Figure 4. Trends in the Index of Biotic Integrity (IBI) at two stations in Little River (1987-2016).



Benthic macroinvertebrates collected in our sample at Coulters Bridge comprised 38 families representing 50 identified genera (Table 6). The most abundant group in our collection was the mayflies comprising 27.7% of the total sample. Overall, a total of 62 taxa were identified from the sample of which 23 were EPT. Based on the EPT taxa richness and overall biotic index of all species collected, the relative health of the benthic community was classified as “Good” (4.2).

Table 6. Taxa list and associated biotic statistics for benthic macroinvertebrates collected from the Little River at Coulters Bridge.

ORDER/GROUP	FAMILY	SPECIES	NUMBER	PERCENT
AMPHIPODA			4	1.2
ANNELIDA				0.9
	Hirudinea		1	
	Oligochaeta		2	
COLEOPTERA				16.8
	Dryopidae	*Helichus* adults	8	
	Elmidae	*Ancyronyx variegatus*	2	
		Dubiraphia adults	10	

ORDER/GROUP	FAMILY	SPECIES	NUMBER	PERCENT
		Macronychus glabratus adults	4	
		Optioservus larva	1	
		Optioservus trivitatus adults	8	
		Promoresia elegans adults and larvae	13	
		Stenelmis adult	1	
	Gyrinidae	*Dineutus discolor* adult	2	
		Dineutus larva	1	
	Hydrophilidae	*Berosus* adult	1	
	Psephenidae	*Psephenus herricki* larvae	3	
DIPTERA				8.4
	Athericidae	*Atherix lantha*	2	
	Ceratopognidae	*Palpomyia* complex	1	
	Chironomidae		19	
	Simuliidae		5	
EPHEMEROPTERA				27.7
	Baetidae	*Baetis*	30	
		Centroptilum	1	
	Caenidae	*Caenis*	1	
	Ephemerellidae	*Serratella*	8	
	Ephemeridae	*Hexagenia*	1	
	Heptageniidae	*Leucrocuta*	1	
		Maccaffertium early instars	7	
		Maccaffertium mediopunctatum	9	
		Maccaffertium modestum	1	
		Stenacron interpunctatum	5	
	Isonychiidae	*Isonychia*	22	
	Leptohyphidae	*Tricorythodes*	3	
GASTROPODA				6.5

ORDER/GROUP	FAMILY	SPECIES	NUMBER	PERCENT
	Ancylidae	*Ferrissia*	4	
	Physidae		4	
	Planorbidae		2	
	Pleuroceridae	*Leptoxis*	4	
		Pleurocera sp. with yellow stripes	7	
HETEROPTERA				1.9
	Nepidae	*Ranatra* nymphs	4	
	Veliidae	*Rhagovelia obesa* male and female	2	
HYDRACARINA			6	1.9
MEGALOPTERA				1.6
	Corydalidae	*Corydalus cornutus*	3	
		Nigronia serricornis	2	
ODONATA				12.5
	Aeshnidae	*Basiaeschna janata*	2	
		Boyeria vinosa	8	
	Calopterygidae	*Hetaerina americana*	12	
	Coenagrionidae	*Argia*	1	
	Gomphidae	*Dromogomphus spinosus*	7	
		Gomphus lividus	1	
		Gomphus quadricolor	1	
		Hagenius brevistylus	1	
		Stylogomphus albistylus	3	
	Macromiidae	*Macromia*	4	
PELECYPODA				0.6
	Corbiculidae	*Corbicula fluminea*	2	
PLECOPTERA				2.5

ORDER/GROUP	FAMILY	SPECIES	NUMBER	PERCENT
	Leuctridae	*Leuctra*	2	
	Pteronarcyidae	*Pteronarcys dorsata*	6	
TRICHOPTERA				15.0
	Brachycentridae	*Brachycentrus lateralis*	3	
		Micrasema wataga	4	
	Hydropshchidae	*Ceratopsyche morosa*	2	
		Cheumatopsyche	7	
		Hydropsyche early instars	4	
		Hydropsyche venularis	2	
	Leptoceridae	*Oecetis avara*	1	
		Trieanodes ignitus	9	
		Trieanodes perna	1	
		Trieanodes sp. undetermined	1	
	Philopotamidae	*Chimarra*	10	
	Polycentropodidae	*Polycentropus*	4	
TURBELLARIA			8	2.5
		Total	321	

TAXA RICHNESS = 62
EPT RICHNESS = 23
BIOCLASSIFICATION = 4.2 (GOOD)

Benthic macroinvertebrates collected in our sample at Townsend comprised 42 families representing 58 identified genera (Table 7). The most abundant group in our collection was the mayflies comprising 21.8% of the total sample. Overall, a total of 74 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 “Fair/Good-Good” (3.8).

Table 7. Taxa list and associated biotic statistics for benthic macroinvertebrates collected from the Little River at Townsend.

ORDER/GROUP	FAMILY	SPECIES	NUMBER	PERCENT
AMPHIPODA				2.1
	Crangonyctidae	*Synorella*	9	
ANNELIDA				0.9
	Oligochaeta		4	
COLEOPTERA				18.8
	Dryopidae	*Helichus* adults	13	
	Elmidae	*Dubiraphia* adults	3	
		Macronychus glabratus adults	13	
		Optioservus ovalis adult	1	
		Optioservus trivittatus adults	15	
		Oulimnius latiusculus adult	1	
		Promoresia elegans larvae and adults	18	
		Stenelmis larva and adult	2	
	Gyrinidae	*Gyrinus* larva	1	
	Psephenidae	*Psephenus herricki* larvae and adult	13	
DIPTERA				12.4
	Athericidae	*Atherix lantha*	6	
	Chironomidae		39	
	Simuliidae		5	
	Tabanidae larva		1	
	Tipulidae	*Tipula*	2	
EPHEMEROPTERA				21.8
	Baetidae	*Baetis*	11	
		Plauditus cestus	1	
		Labiobaetis	1	
		Procloeon	1	

ORDER/GROUP	FAMILY	SPECIES	NUMBER	PERCENT
	Caenidae	*Caenis*	4	
	Ephemerellidae	*Drunella* early instar	1	
		Serratella deficiens	4	
		Serratella sp. with small maxillary palp	4	
	Ephemeridae	*Hexagenia*	2	
	Heptageniidae	*Epeorus rubidus/subpallidus*	3	
		Leucrocuta	8	
		Maccaffertium early instars	6	
		Maccaffertium ithaca	2	
		Maccaffertium mediopunctatum	1	
		Rhithrogena	1	
		Stenacron	4	
	Isonychiidae	*Isonychia*	19	
	Leptohyphidae	*Tricorythodes*	14	
	Leptophlebiidae	*Paraleptophlebia*	2	
	Neoephemeridae	*Neoephemera purpurea*	4	
GASTROPODA				3.3
	Ancylidae	*Ferrissia*	3	
	Physidae		3	
	Pleuroceridae	*Leptoxis*	4	
		Pleurocera sp. w/contrasting sptripes	2	
		Pleurocera sp. yellow form	2	
HETEROPTERA				0.9
	Nepidae	*Ranatra nigra* adult	1	
		Ranatra nymph	1	
	Veliidae	*Rhagovelia obesa* male and female	2	
HYDRACARINA			4	0.9

ORDER/GROUP	FAMILY	SPECIES	NUMBER	PERCENT
MEGALOPTERA				2.1
	Corydalidae	*Corydalus cornutus*	7	
		Nigronia serricornis	2	
ODONATA				16.4
	Aeshnidae	*Boyeria vinosa*	19	
	Calopterygidae	*Calopteryx*	2	
	Coenagrionidae	*Argia*	2	
	Corduliidae	*Helocordulia uhleri*	1	
	Gomphidae	*Dromogomphus spinosus*	2	
		Gomphus lividus	4	
		Gomphus rogersi	4	
		Hagenius brevistylus	11	
		Hylogomphus adelphus	9	
		Stylogomphus albistylus	6	
	Macromiidae	*Macromia*	10	
PELECYPODA				2.1
	Corbiculidae	*Corbicula fluminea*	4	
	Sphaeriidae	*Pisidium*	4	
	Unionidae		1	
PLECOPTERA				2.6
	Leuctridae	*Luectra*	4	
	Perlidae	*Acroneuria abnormis*	1	
		Perlesta	5	
	Pteronarcyidae	*Pteronarcys dorsata*	1	
TRICHOPTERA				15.3
	Brachycentridae	*Micrasema wataga*	6	
	Hydropsychidae	*Ceratopsyche morosa*	19	

ORDER/GROUP	FAMILY	SPECIES	NUMBER	PERCENT
		Ceratopsyche sparna	2	
		Cheumatopsyche	13	
		Hydropsyche undetermined early instars	5	
		Hydropsyche franclemonti	2	
		Hydropsyche venularis	1	
	Leptoceridae	*Triaenodes ignitus*	11	
		Triaenodes perna	1	
		Triaenodes undetermined early instar	1	
	Polycentropodidae	*Polycentropus*	4	
TURBELLARIA			1	0.2
		Total	426	

TAXA RICHNESS = 74
EPT RICHNESS = 32
BIOCLASSIFICATION = 3.8 (FAIR/GOOD-GOOD)

Discussion

Little River provides anglers with the opportunity to catch all species of black bass along with rock bass. 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.

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

Management Recommendations

1. Continue cooperative IBI surveys.
2. Cooperate with the local watershed organization to protect and enhance the river and its tributaries.
3. Conduct an angler survey periodically.

North Cumberland Habitat Conservation Plan Monitoring

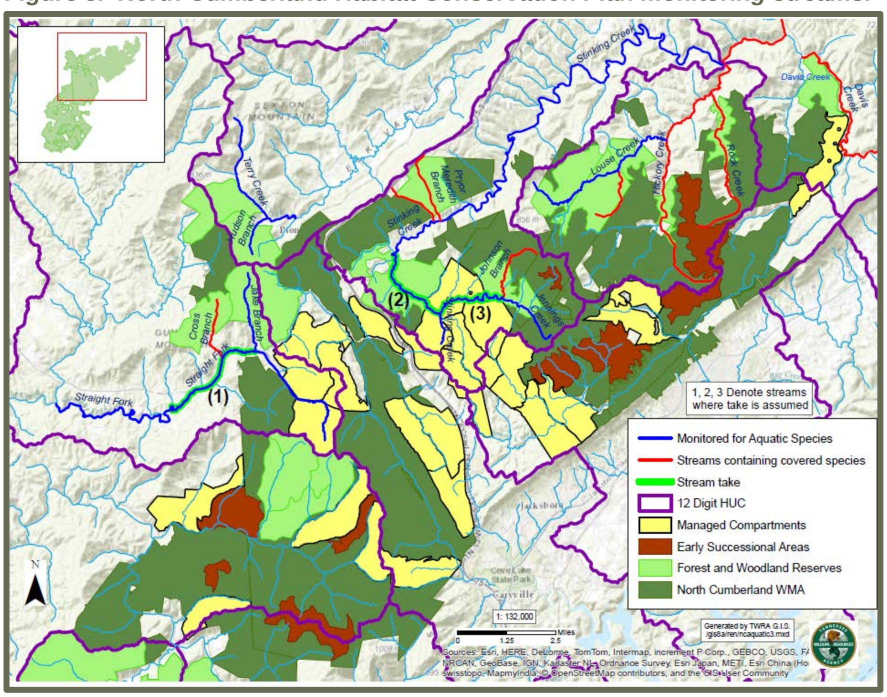
Introduction

The development of a comprehensive forest resource Habitat Conservation Plan (HCP) has been an ongoing effort for the Tennessee Wildlife Resources Agency. This collaboration between TWRA, USFWS and several other governmental and academic groups has focused on developing a plan to determine "take" of species listed in the plan in relation TWRA's forestry practices and formulate mitigation strategies should this occur. The goal of this plan is to allow the Agency to qualify for USFWS grant funding to purchase land within the project area and be covered under a blanket permit for activities covered in the plan.

Our involvement with the development of the plan was to address aquatic issues and strategies regarding TWRA's forest resource management and the means by which the Agency could evaluate "take" for covered fish species. The following stream accounts encompass monitoring efforts undertaken to evaluate TWRA's forestry activities in watersheds that have harvest compartments identified. This data will be used to establish bench marks for these populations and serve as the standard by which influences from land use practices can be determined.

The surveys conducted in 2016 marked the sixth year of baseline monitoring for the streams identified in the plan. Figure 5 illustrates the location of the monitoring streams in relation to the managed compartments and HCP reserves (no action).

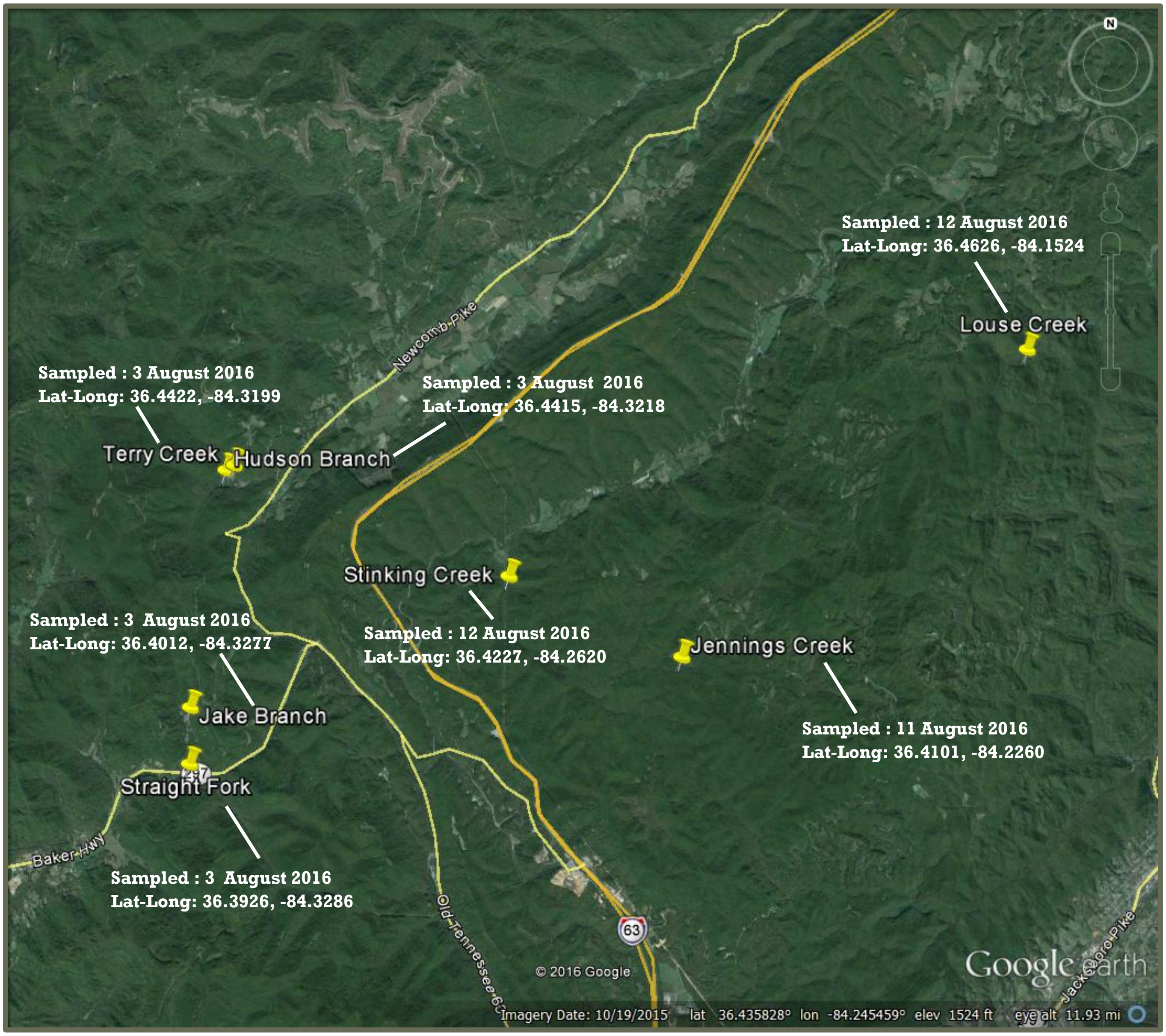
Figure 5. North Cumberland Habitat Conservation Plan monitoring streams.



Study Area and Methods

Seven streams were selected as part of the aquatic monitoring program for the HCP. These include Straight Fork and Jake Branch in the New River drainage and Terry Creek, Hudson Branch, Stinking Creek, Jennings Creek, and Louse Creek in the Clear Fork Cumberland drainage. Figure 6 depicts these survey sites and their geographical relationship to each other.

Figure 6 North Cumberland Habitat Conservation Plan monitoring site distribution.



We conducted surveys between August 3 and August 12. Our survey reaches ranged from 100 to 200 meters in length. We surveyed each site with one backpack electrofishing unit, recording our total electrofishing time so that subsequent samples could be repeated with similar amount of effort. Standard backpack electrofishing units operating at or between 150 and 300 volts were used to stun fish during 2016. Where blackside dace were present, DC current was used to capture fish. Catch per unit effort (CPUE) estimates for blackside dace and Cumberland arrow darter were calculated based on the total catch from a single electrofishing pass and amount of effort expended at the site. Basic water quality collected at each site included conductivity, pH and temperature. Physical habitat features were visually evaluated at each site.

Results

Basic water quality, habitat score, and electrofishing effort for each stream is listed in Table 8. Temperatures ranged from 23.3 to 27.3 degrees C while conductivities varied between 98.7 and 336.8 µs/cm (Table 8). Hudson Branch and Stinking Creek had the lowest conductivities of the seven streams. Potential hydrogen values were varied ranging from a low of 6 in Straight Fork to a high of 7.0 in Stinking, Louse and Jennings creeks. Stream habitat scores ranged from 90 to 119. Straight Fork, Jake Branch and Hudson Branch ranked “marginal” while the remainder of the streams were classified slightly higher as “sub-optimal”. Electrofishing effort ranged from 958 to 2360 seconds for the seven streams.

Table 8. Water quality, habitat score, and electrofishing effort for seven streams monitored as part of the North Cumberland Habitat Conservation Plan 2016.

Stream	Temperature (C)	Conductivity	pH	Habitat Score	Electrofishing Effort (Seconds)
Straight Fork	24.4	336.8	6.0	90	1528
Jake Branch	25.1	281.4	6.2	96	982
Hudson Branch	26.3	103.5	6.5	90	1015
Terry Creek	25.4	117.6	6.2	113	958
Stinking Creek	27.3	98.7	7.0	118	2201
Louse Creek	23.3	111.3	7.0	119	1824
Jennings Creek	23.5	162.5	7.0	108	2360

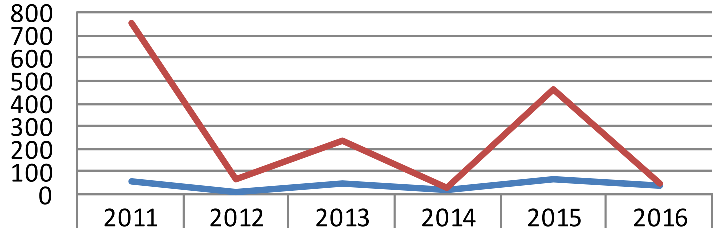
Stinking Creek had the highest fish diversity (15) of the seven streams samples followed by Terry Creek (9). Samples from all other streams resulted in the collection of eight or fewer species (Table 9). Of the seven streams, Straight Fork, Jake Branch, Hudson Branch, Terry Creek all had blackside dace present in the 2016 surveys. Although blackside dace do occur in Louse Creek, none were collected during the 2016 survey. Cumberland arrow darter was present in all the streams where they have historically been collected (Terry Creek, Hudson Branch, Stinking Creek, Louse Creek and Jennings Creek).

Table 9. Fish species occurrence and abundance for seven streams monitored as part of the North Cumberland Habitat Conservation Plan 2016.

Stream	Common Name	Species	Number
Straight Fork	Bluegill	*Lepomis macrochirus*	SCARCE
Straight Fork	Longear Sunfish	*Lepomis megalotis*	SCARCE
Straight Fork	Green Sunfish	*Lepomis cyanellus*	ABUNDANT
Straight Fork	Blackside Dace	*Chrosomus cumberlandensis*	17
Straight Fork	Southern Redbelly Dace	*Chrosomus erythrogaster*	18
Straight Fork	Creek Chub	*Semotilus atromaculatus*	COMMON
Straight Fork	Blacknose Dace	*Rhinicthys atratulus*	RARE
Straight Fork	Striped Shiner	*Luxilus chrysocephalus*	ABUNDANT
Jake Branch	Creek Chub	*Semotilus atromaculatus*	ABUNDANT
Jake Branch	Green Sunfish	*Lepomis cyanellus*	9
Jake Branch	Striped Shiner	*Luxilus chrysocephalus*	SCARCE
Jake Branch	Blacknose Dace	*Rhinicthys atratulus*	COMMON
Jake Branch	Blackside Dace	*Chrosomus cumberlandensis*	4
Jake Branch	Southern Redbelly Dace	*Chrosomus erythrogaster*	1
Hudson Branch	Green Sunfish	*Lepomis cyanellus*	1
Hudson Branch	Cumberland Arrow Darter	*Etheostoma sagitta*	1
Hudson Branch	Stripetail Darter	*Etheostoma kennicotti*	ABUNDANT
Hudson Branch	Blackside Dace	*Chrosomus cumberlandensis*	3
Hudson Branch	Blacknose Dace	*Rhinicthys atratulus*	COMMON
Hudson Branch	Creek Chub	*Semotilus atromacualtus*	COMMON
Hudson Branch	Rainbow Darter	*Etheostoma caeruleum*	RARE
Terry Creek	Creek Chub	*Semotilus atromaculatus*	ABUNDANT
Terry Creek	Stripetail Darter	*Etheostoma kennicotti*	COMMON
Terry Creek	Northern Hog Sucker	*Hypentelium nigricans*	SCARCE
Terry Creek	Rainbow Darter	*Etheostoma caeruleum*	COMMON
Terry Creek	Central Stoneroller	*Campostoma anomalum*	ABUNDANT
Terry Creek	Blacknose Dace	*Rhinicthys atratulus*	RARE
Terry Creek	Blackside Dace	*Chrosomus cumberlandensis*	25
Terry Creek	Southern Redbelly Dace	*Chrosomus erythrogaster*	2
Terry Creek	Cumberland Arrow Darter	*Etheostoma sagitta*	6
Stinking Creek	Rock Bass	*Ambloplites rupestris*	5
Stinking Creek	Striped Shiner	*Luxilus chrysocephalus*	RARE
Stinking Creek	Redbreast Sunfish	*Lepomis auritus*	2
Stinking Creek	Smallmouth Bass	*Micropterus dolomieu*	1
Stinking Creek	Central Stoneroller	*Campostoma anomalum*	COMMON
Stinking Creek	White Sucker	*Catostomus commersonii*	RARE
Stinking Creek	Creek Chub	*Semotilus atromaculatus*	COMMON
Stinking Creek	Rosyface Shiner	*Notropis rubellus*	COMMON
Stinking Creek	Bluntnose Minnow	*Pimephales notatus*	COMMON
Stinking Creek	Northern Hog Sucker	*Hypentelium nigricans*	SCARCE
Stinking Creek	Stripetail Darter	*Etheostoma kennicotti*	COMMON
Stinking Creek	Rainbow Darter	*Etheostoma caeruleum*	ABUNDANT
Stinking Creek	Cumberland Arrow Darter	*Etheostoma sagitta*	12
Slinking Creek	Greenside Darter	*Etheostoma blenniodes*	RARE
Stinking Creek	Blackside Darter	*Percina maculata*	RARE
Louse Creek	Largemouth Bass	*Micropterus salmoides*	2
Louse Creek	Stripetail Darter	*Etheostoma kennicotti*	COMMON
Louse Creek	White Sucker	*Catostomus commersonii*	COMMON
Louse Creek	Creek Chub	*Semotilus atromaculatus*	ABUNDANT
Louse Creek	Rainbow Darter	*Etheostoma caeruleum*	COMMON
Louse Creek	Blacknose Dace	*Rhinicthys atratulus*	COMMON
Louse Creek	Central Stoneroller	*Campostoma anomalum*	ABUNDANT
Louse Creek	Cumberland Arrow Darter	*Etheostoma sagitta*	13
Jennings Creek	Rock Bass	*Ambloplites rupestris*	5
Jennings Creek	Bluegill	*Lepomis macrochirus*	19
Jennings Creek	Creek Chub	*Semotilus atromaculatus*	COMMON
Jennings Creek	Stripetail Darter	*Etheostoma kennicotti*	COMMON
Jennings Creek	Cumberland Arrow Darter	*Etheostoma sagitta*	5

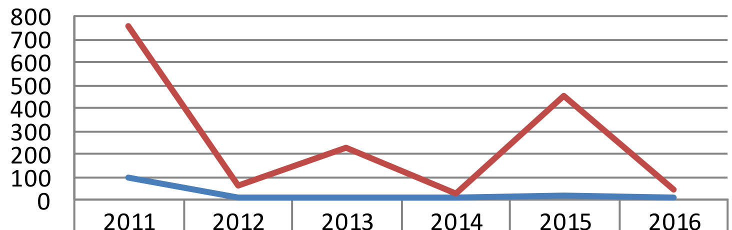
Covered species under the HCP, blackside dace and Cumberland arrow darter, exhibited varying trends in CPUE during the 2016 surveys. In the New River drainage streams, both Straight Fork and Jake Branch showed increases in CPUE for blackside dace, the only covered species occurring in this watershed. The survey in Straight Fork revealed a 38.5% decline in the CPUE when compared to 2015 and was only slightly below the six year average of 40.7. In Jake Branch the catch also decreased but not as substantially (17.3%). Overall, the 2016 catch in Straight Fork was similar to the value observed in 2013 (Figure 7). The 2016 catch in Jake Branch continued to be depressed and was far below the value observed in 2011(Figure 8).

Figure 7. Blackside Dace population trends in Straight Fork 2011-16.



	2011	2012	2013	2014	2015	2016
Blackside Dace CPUE (No./hour)	57.1	12.9	46.1	22.5	65.7	40.4
New River flow (cfs) @ New River Gauge	758	63	232	26	458	46

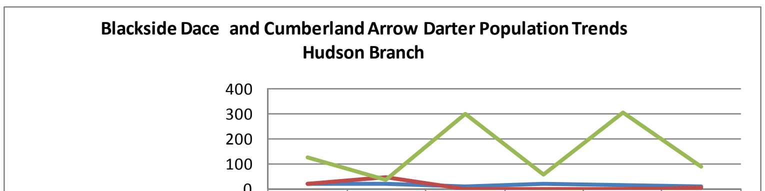
Figure 8. Blackside Dace population trends in Jake Branch 2011-16.



	2011	2012	2013	2014	2015	2016
Blackside Dace CPUE (No./hour)	95.6	11.1	11.1	7.7	17.9	14.8
New River flow (cfs) @ New River Gauge	758	63	232	26	458	46

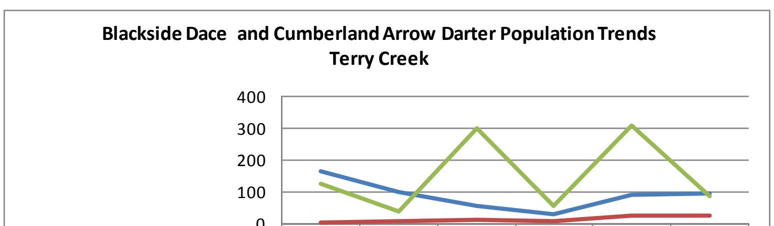
Habitat Conservation Plan monitoring streams in the Clear Fork Cumberland River drainage includes Terry Creek and Hudson Branch which are tributaries to Elk Fork Creek. Stinking Creek and Louse Creek are tributaries to Hickory Creek and Jennings Creek flows in to Stinking Creek on the North Cumberland WMA. Both blackside dace and Cumberland arrow darter are found in Terry Creek and Hudson Branch. Cumberland arrow darters have only been collected from Hudson Branch in 2011, 2012 and 2016. Our catch for this species in 2012 was highest of the two with a CPUE value of 45.4 (Figure 9). Blackside dace catches have remained relatively constant in Hudson Branch during the survey period with the exception of 2013 when the value decreased relative to other surveys (Figure 9). In Terry Creek, blackside dace catches have fluctuated considerably over the survey period. Catch rate values have varied from a high of 165 in 2011 to a low of 28 in 2014 (Figure 10). Generally, blackside dace population tend to ebb and flow based on hydrological conditions (and timing) during the year and can be influenced by abundance changes of predatory sunfish species such as green sunfish. Catches of Cumberland arrow darter in Terry Creek have remained fairly consistent over the period, with 2016 being only slightly lower than the recorded high observed in 2015 (Figure 10).

Figure 9. Blackside Dace and Cumberland Arrow Darter population trends in Hudson Branch 2011-16.



	2011	2012	2013	2014	2015	2016
Blackside Dace CPUE (No./hour)	19.2	18.2	8.3	16.6	15.1	10.7
Cumberland Arrow Darter CPUE (No./hour)	19.2	45.4	0	0	0	3.5
Clear Fork flow (cfs) @ Saxton, KY Gauge	126	36	302	54	307	88

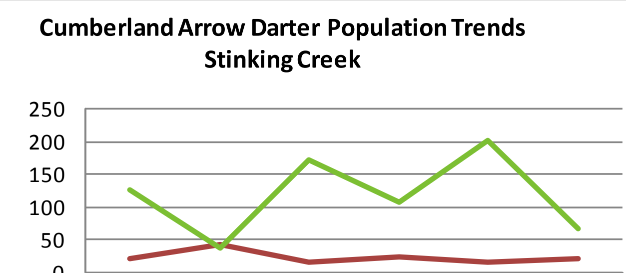
Figure 10. Blackside Dace and Cumberland Arrow Darter population trends in Terry Creek 2011-16.



	2011	2012	2013	2014	2015	2016
Blackside Dace CPUE (No./hour)	165.3	100	57.8	27.7	92.3	96.1
Cumberland Arrow Darter CPUE (No./hour)	3.8	9	10.5	5.5	26.9	23
Clear Fork flow (cfs) @ Saxton, KY Gauge	126	36	302	54	307	88

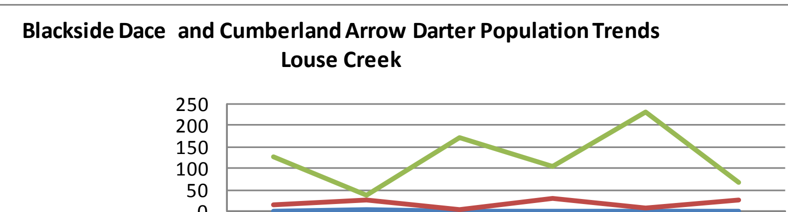
Stinking Creek consistently has high catches of Cumberland arrow darter and represents the most consistent stream of the five where it persists. Our catch in 2016 represented a slight increase over our 2015 value which was the lowest recorded for any of the surveys. Surveys conducted during higher flow usually result in a decreased capture efficiency for this species as illustrated in Figure 11. Stinking Creek has always been considered one of the better streams in the watershed and although suffering from non-point source sedimentation within the watershed, still harbors 13 to 15 species of fish within our survey area. Both HCP covered species are found in Louse Creek. Based on our survey experience with Louse Creek, blackside dace are encountered rarely and are usually represented by 1 or 2 individuals. The only year we encountered this species from our survey area was in 2012 (Figure 12). We have collected specimens of blackside dace farther upstream during surveys conducted in 2002. Cumberland arrow darter has been observed during all surveys and the 2016 sample resulted in the second highest catch for this species since the survey was initiated (Figure 12).

Figure 11. Cumberland Arrow Darter population trends in Stinking Creek 2011-16.



	2011	2012	2013	2014	2015	2016
Cumberland Arrow Darter CPUE (No./hour)	20	42.8	14.6	22	14	19.6
Clear Fork flow (cfs) @ Saxton, KY Gauge	126	36	173	106	202	66

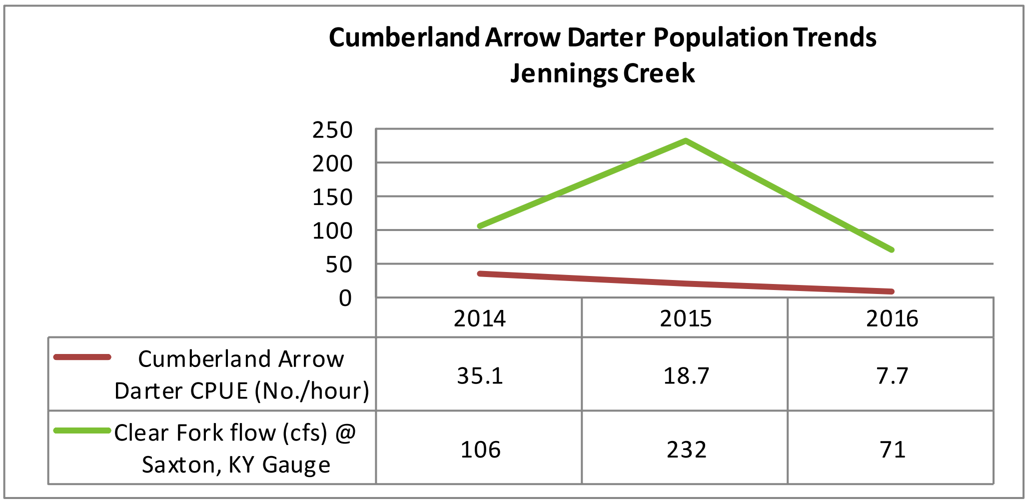
Figure 12. Blackside Dace and Cumberland Arrow Darter population trends in Louse Creek 2011-16.



	2011	2012	2013	2014	2015	2016
Blackside Dace CPUE (No./hour)	0	3	0	0	0	0
Cumberland Arrow Darter CPUE (No./hour)	14.2	24.2	4.1	31.2	8.1	26
Clear Fork flow (cfs) @ Saxton, KY Gauge	126	36	173	106	232	66

Jennings Creek was added to the suite of streams sampled under the HCP to monitor Cumberland arrow darter in a portion of the watershed that could be influenced by a managed forest compartment. Samples were initiated in this stream in 2014, and the catch of Cumberland arrow darter was one of the highest values recorded for streams surveyed that year. In 2016, the catch was the lowest recorded since the survey began despite low flow conditions (Figure 13). Jennings Creek does carry a fairly significant sediment load and many of the pools within our survey reach have significant amounts of silt/sand as a substrate component. There is an extensive OHV trail system in the watershed and many of the tributaries and main stem Jennings Creek have trail crossings that contribute sediment to the stream.

Figure 13. Cumberland arrow darter population trends in Jennings Creek 2014-16.



	2014	2015	2016
Cumberland Arrow Darter CPUE (No./hour)	35.1	18.7	7.7
Clear Fork flow (cfs) @ Saxton, KY Gauge	106	232	71

TWRA is committed to continuing monitoring efforts within the identified HCP streams and until the plan is finalized. The monitoring efforts conducted thus far will provide useful data to support the HCP plan as well as provide benchmark data for activities (e.g. coal mining) where these species may be impacted. I will also give insight into processes of hybridization between Southern Redbelly Dace and Blackside Dace. Collected data has been utilized by the USFWS to address permitting request for coal mining activities within the region.

Collection Efforts to Locate Tennessee Dace in Four east Tennessee Counties

Introduction

As a continuation of the project started in 2014 (Carter et al. 2015), the TWRA Region 4 Stream Unit conducted additional fish surveys in 2016 to determine the occurrence of Tennessee Dace (*Chrosomus tennesseensis*). The Tennessee Dace is a state listed species deemed "in need of management". It occurs primarily in first and second order streams in the upper Tennessee River watershed from Polk County north to Sullivan County in Tennessee (and also in SW VA). These streams typically have fairly low gradient, shallow, silt and gravel pools, or undercut banks in shady areas created by surrounding woody vegetation. Forty-three target streams were identified from historical documentation, primarily from the University of Tennessee Etnier Ichthyological Collection (UTEIC) records, and also from areas where habitat was considered similar to known and historical locations. The surveys were conducted from March to November of 2016.

Sample Methods

Fish were qualitatively collected with standard backpack electrofishing techniques (TWRA 2005). Collection from each stream was with a single backpack electrofishing unit operating at 125 to 250 VAC and usually a person assisting with a dipnet. However, some streams were sampled by only one collector. Sample lengths were approximated in most cases and most were around 200-300 m, but varied from about 100 to 1,360 m. Collections were made in all habitat types within the selected survey reach. They were made repeatedly for each habitat type and especially in pool areas until it was considered likely that no Tennessee Dace would occur with repeated efforts. All fish collected from each sample were enumerated by actual number or in terms of relative abundance (i.e. few, several, common, abundant, or very abundant). In general, most fish were identified in the field and released. However, selected voucher specimens from some streams were retained and were preserved in 10% formalin. Voucher specimens of all Tennessee Dace were retained. All voucher specimens were later identified in the lab and catalogued into the Agency reference collection. Specimens of Tennessee Dace representing new locality records were also sent to UT to be catalogued into the UTEIC as well. Common and scientific names of fishes used in this report are after Etnier and Starnes (1993) and Page et al. (2013).

Results and Discussion

Fish were collected from 47 electrofishing samples on 43 streams in Blount, Knox, Monroe, and Sullivan counties. Four of the 43 streams had multiple samples. Tennessee Dace were collected from 17 of the 43 streams sampled. Six were from historic locations and all the rest (11) represented new records. Twenty-nine other sample sites produced no Tennessee Dace.

Tennessee Dace were collected from 17 streams in Blount, Knox, and Monroe counties. The majority (9) came from streams in the Little Tennessee River and the Citico Creek watersheds in Monroe County. Seven were in Blount County, mostly in the Fourmile, Sixmile, and Ninemile Creek watersheds, and one was from Knox County. Tennessee Dace were collected from six historical locations; an unnamed tributary to Ninemile Creek and an unnamed tributary to Sixmile Creek in Blount County, McCall Branch in Knox County, and Duncan Branch, Caney Branch, and Little Fourmile Creek in Monroe County. McCall Branch in Knox County was sampled in two locations on different dates and each site produced a single Tennessee Dace. The first record of Tennessee Dace in McCall Branch was in 1988 and was based on a single specimen (UTEIC Cat. # 44.4432). One of our 2016 specimens came from the same location as the 1988 UTEIC record. While there does not seem to be a robust Tennessee dace population in McCall Branch, they at least appear to be surviving there based on the 28 year old record. McCall Branch is an impaired urban stream in the lower southeast corner of Knox County and is on the 2014 303(d) List for the State of Tennessee based on the loss of biological integrity due to siltation (TDEC 2016). We observed siltation to be very heavy in our sample areas in 2016 along with noticeable streambank erosion. McCall Branch is a tributary to Stock Creek which flows into the Little River embayment of Fort Loudoun Reservoir. Reed Creek, in the Little River watershed, is the type locality for Tennessee Dace (Starnes and Jenkins 1988).

All the sample sites had the electrofishing time recorded for each sample in 2016. On the 17 streams where Tennessee Dace were collected, the sample time (switch-on time) averaged 1,795 sec. and ranged from 451 to 3,613 sec. The sample length (approx.) averaged about 300 m and ranged from 100 to 760 m. Catch Per Unit Effort (CPUE) averaged 45.3 fish/hr. and ranged from 1 to 151.7 fish/hr. The average number of Tennessee Dace collected per sample from the 17 streams averaged 15.6 fish (range of 1 to 27 fish). The most collected in any one sample (27) came from Little Fourmile Creek in Monroe Co.

Sport Fish Surveys

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 comprehensive investigation of the watershed was by Evans (1998), who completed extensive surveys 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 2016 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 14). 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 2005). 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).

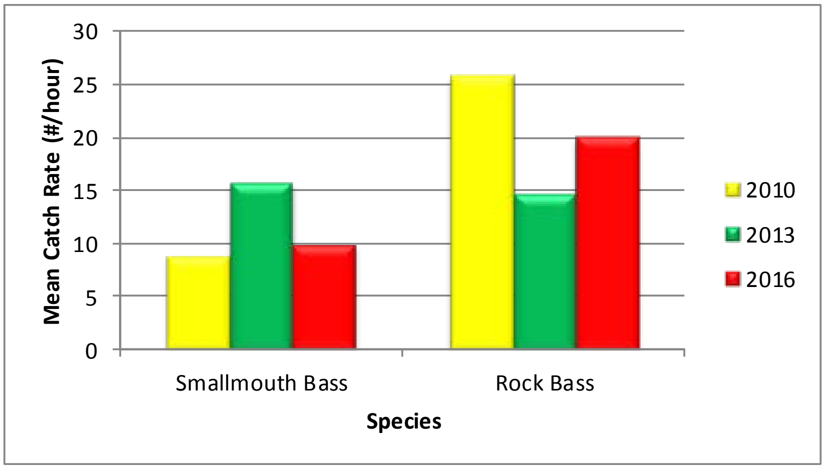
Figure 14. Locations of samples conducted in the New River during 2016.

At our sample location gravel and rubble were the dominant substrate components, although bedrock was fairly common in the pool habitat. Water clarity was above average due to lower than normal flow. Water quality measurements were not taken due to meter failure.

Results

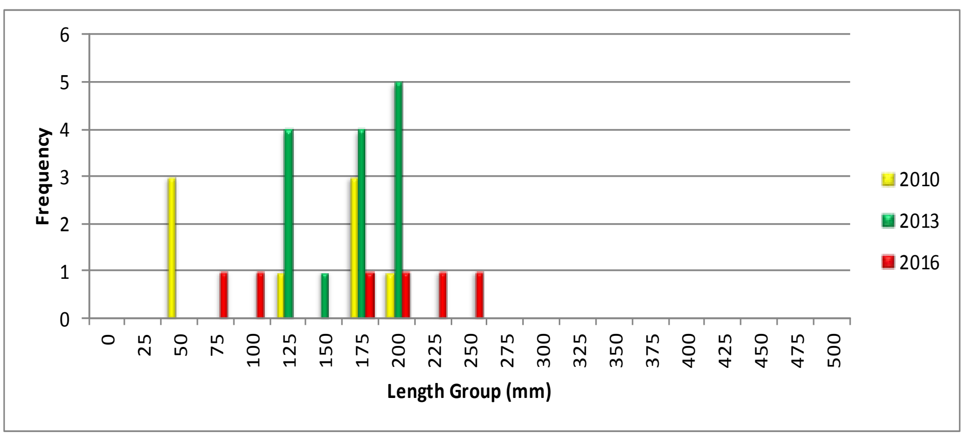
Of the game species collected, rock bass and smallmouth bass were the dominant species. A total of 12 (13 in 2013) rock bass and 6 (14 in 2013) smallmouth bass were collected from the survey site. The observed number of rock bas was similar to the 2013 collection although the number of smallmouth bass collected was about half the number observed in 2013. The catch rate for smallmouth bass and rock bass was 10 and 20, respectively (Figure 15).

Figure 15. CPUE for smallmouth bass and rock bass collected from New River between 2010 and 2016.



The majority of smallmouth bass collected during 2016 fell within the 200 mm to 275 mm length range (Figure 16). Because of the limited number of fish captured, inferences about the size structure characteristics for this population is limited.

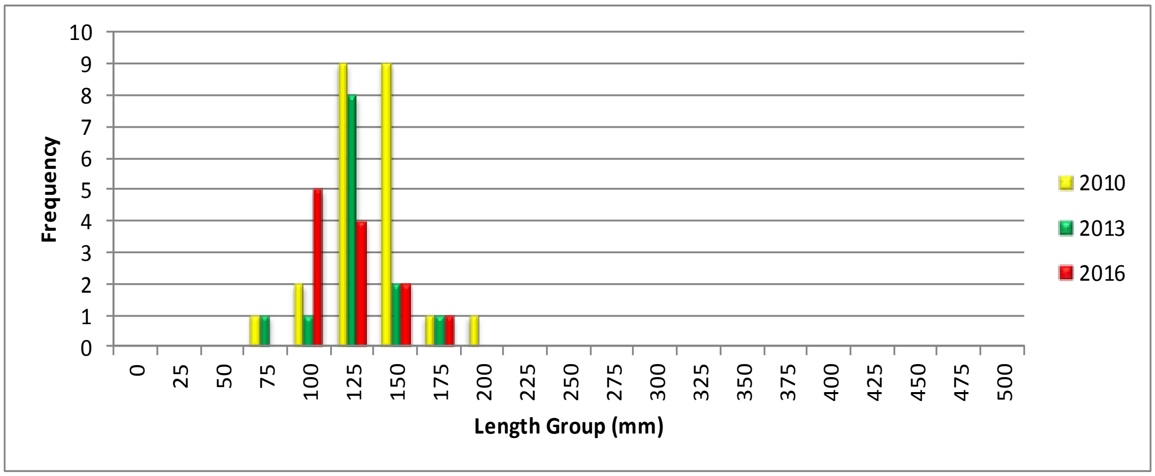
Figure 16. Length frequency distributions for smallmouth bass collected in the New River between 2010 and 2016.



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 ($\geq$ 280 mm) bass collected in the sample. This was the same situation observed in the 2013 sample. The catch rates for sub-stock and stock size bass were both 3.3/hour and 6.6/hour, respectively.

Rock bass collected from the New River in 2016 fell within the 100 mm to 150 mm length groups (Figure 16). Due to the low number of fish collected very little can be inferred regarding the size structure of this population.

Figure 16. Length frequency distribution for rock bass collected in the New River between 2010 and 2016.



Length categorization analysis indicated the relative stock density (RSD) for rock bass was 0 in all categories. PSD could not be calculated due to the absence of quality size fish. The CPUE was slightly higher to the value observed in 2013 but about 30 percent below the 2010 value. The persistence of the rock bass in the river is encouraging given the ongoing issues within the watershed. The less than optimal sampling conditions (low flow) eliminated much of the habitat where we have collected rock bass in past surveys.

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.

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 April 2016, six fish surveys (CPUE) were conducted on the North Fork between the TN/VA line and its confluence with the South Fork (Figure 16). 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 14.5 C to 16.7 C and conductivity varied from 297 to 364 µs/cm (Table 10).

Figure 16. Site locations for samples conducted on the North Fork Holston River during 2016.

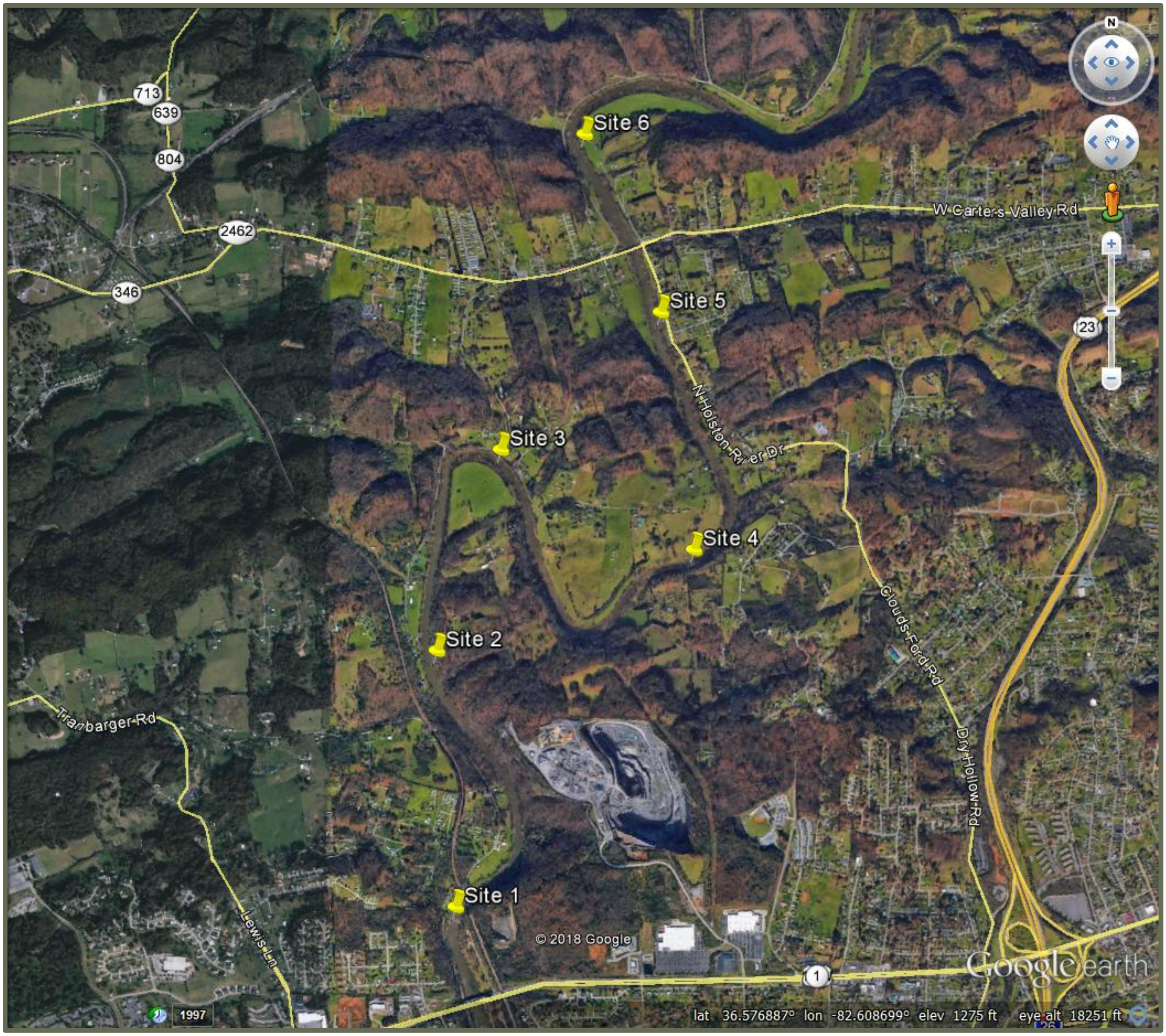


Table 10. Physiochemical and site location data for samples conducted on the North Fork Holston River during 2016.

Site Code	Site	County	Quad	River Mile	Latitude	Longitude	Mean Width (m)	Length (m)	Temp.	Cond.	Secchi (m)
420160601	1	Hawkins/Sullivan	Kingsport 188SE	0.8	36.55799	-82.61641	68.3	293	16.5	364	
420160602	2	Hawkins/Sullivan	Kingsport 188SE	2.0	36.57000	-82.61750	54.4	1158	16.7	307.2	
420160603	3	Hawkins/Sullivan	Kingsport 188SE	2.7	36.57943	-82.61376	48.3	518			
420160604	4	Hawkins/Sullivan	Kingsport 188SE	4.0	36.57472	-82.60250	45.2	1325	15.6	302.8	
420160605	5	Hawkins/Sullivan	Kingsport 188SE	4.4	36.58583	-82.60444	52.0	953	15.2	297	
420160606	6	Hawkins/Sullivan	Kingsport 188SE	5.0	36.59416	-82.60888	58.0	250	14.5	333.2	

Fish were collected by boat electrofishing in accordance with the standard large river sampling protocols (TWRA 2005). Fixed-boom electrodes were used to transfer 4-5 amps DC at all sites. This current setting was determined effective in narcotizing all target species (black bass and rock bass). All sites were sampled during daylight hours and had survey durations ranging from 605 to 2800 seconds. Catch-per-unit-effort (CPUE) values were calculated for each target species at each site. Length categorization indices were calculated for target species following Gabelhouse (1984).

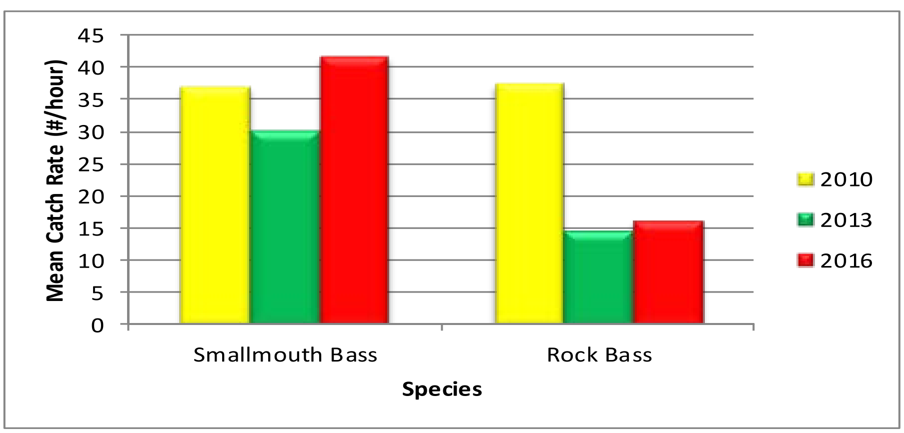
Results

Smallmouth bass were collected from all sites and rock bass were collected from sites 2-6. Smallmouth bass was the only black bass collected during our surveys. CPUE estimates for this species averaged 41.6/hour (Table 11). In 2016, our highest catches were observed at sites 2 and 4 for smallmouth bass. Rock bass were generally less abundant than smallmouth bass encountered in our survey areas and had an average CPUE of 16.2 which was relatively consistent with the 2013 value (Table 11). The sites where the catch rates were highest usually had at least one shoreline that had good boulder cover. Our 2016 catch was the highest recorded when compared to our most recent surveys in 2010 and 2013 for smallmouth bass (Figure 17). We did collect one trophy category smallmouth bass in 2016. Rock bass catch in 2016 was consistent with 2013 but still considerably lower than 2010 (Figure 17).

Table 11. Catch per unit effort and length categorization indices of target species collected at six sites on the North Fork Holston River during 2016.

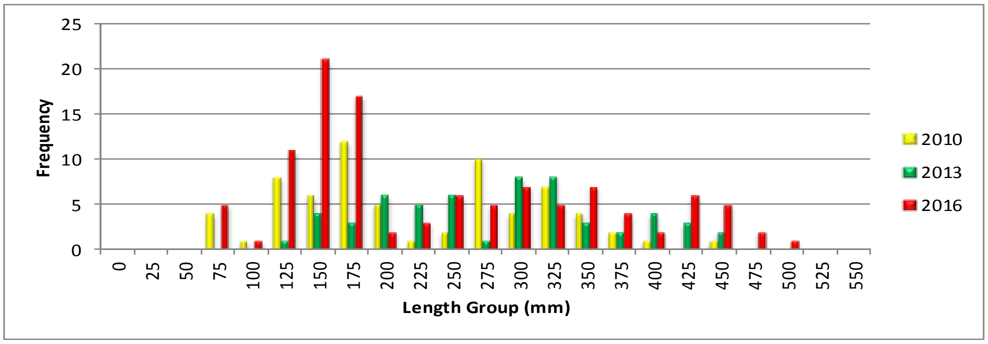
Site Code	Smallmouth Bass CPUE	Rock Bass CPUE
420160601	12.5	-
420160602	59.7	42.8
420160603	50	15.7
420160604	60.5	2.6
420160605	23.0	20.5
420160606	44.0	16.0
MEAN	41.6	16.2
STD. DEV.	19.7	15.3
	Smallmouth Bass Length-Categorization Analysis	**Rock Bass Length-Categorization Analysis**
	PSD = 64.1	PSD = 22.2
	RSD-Preferred = 40.2	RSD-Preferred = 0
	RSD-Memorable = 19.4	RSD-Memorable = 0
	RSD-Trophy = 1.4	RSD-Trophy = 0

Figure 17. Trends in mean catch rate of black bass and rock bass collected between 2010 and 2016 from the North Fork Holston River.



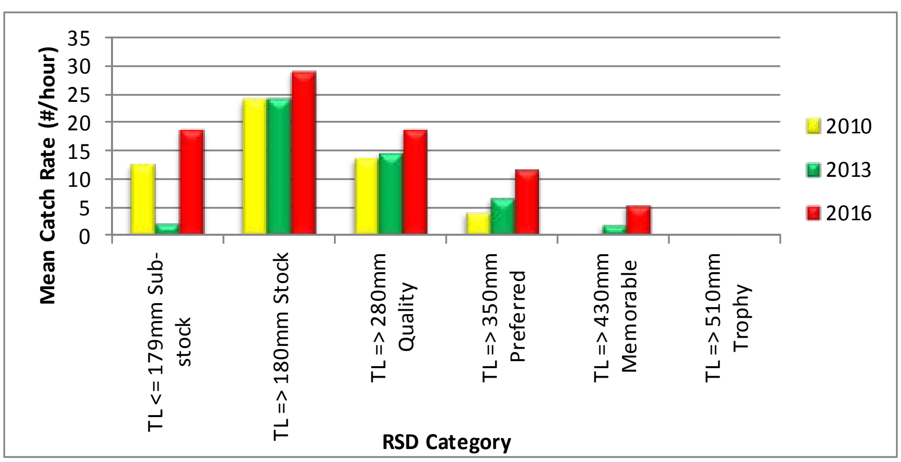
The majority of the smallmouth bass collected in the North Fork Holston River during 2016 fell within the 125 mm to 200 mm length range (Figure 18). The size distribution in 2016 was robust compared to previous samples with higher numbers of fish in larger size classes and good representation of one 1+ bass.

Figure 18. Length frequency distributions for smallmouth bass collected from the North Fork Holston River between 2010 and 2016.



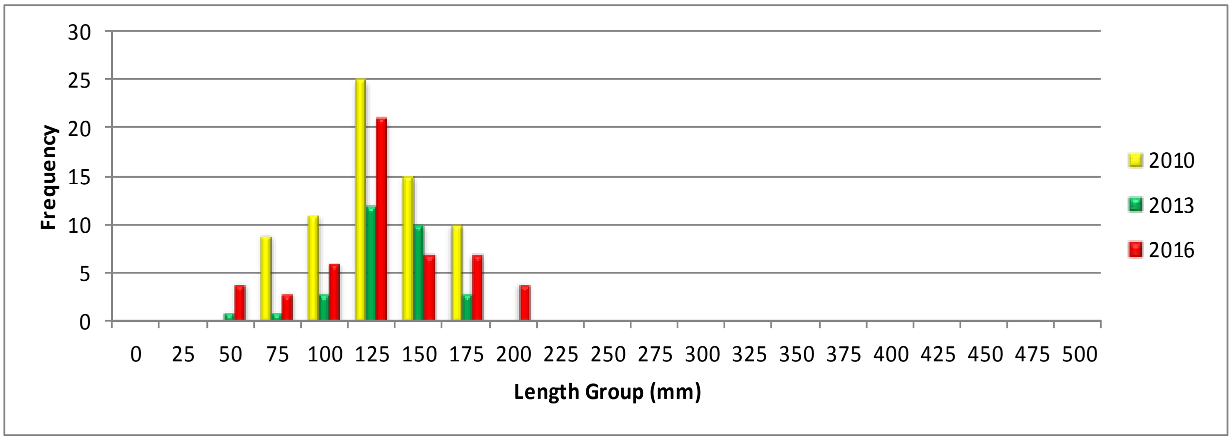
Length categorization analysis indicated the Relative Stock Density (RSD) for preferred smallmouth bass (TL ≥ 350 mm) was 40.2, an increase of 66% from the 2013 value. RSD for memorable (TL ≥ 430 mm) and trophy (TL ≥ 510 mm) size bass was 19.4 and 1.4, respectively. All RSD categories increased between the 2013 sample and the 2016. The ratio of quality (TL ≥ 280 mm) smallmouth bass to stock size bass (TL ≥ 180 mm) increased slightly in 2016 to 64.1. 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 2010 and 2013 (Figure 19). Overall, the proportional distribution of CPUE was higher in all of the categories when compared to the 2013 sample.

Figure 19. Relative stock density (RSD) catch per unit effort for smallmouth bass collected from the North Fork Holston River between 2010 and 2016.



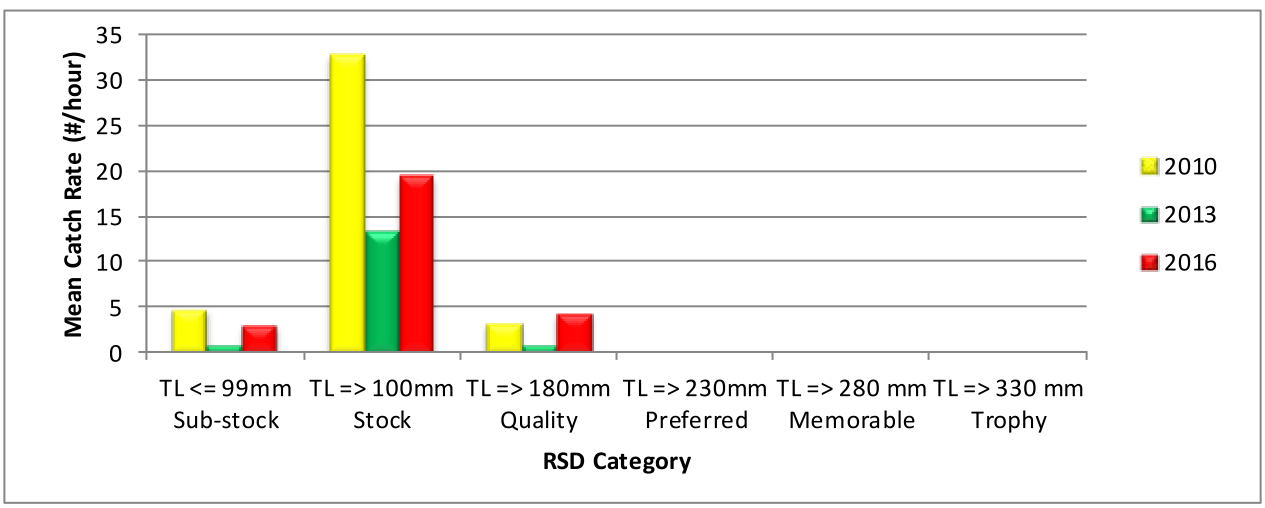
Individuals in the 125 mm to 175 mm range represented the majority of rock bass in our sample (Figure 20). Length categorization analysis indicated the RSD for preferred rock bass (TL ≥ 230 mm) was 0.

Figure 20. Length frequency distributions for rock bass collected from the North Fork Holston River between 2010 and 2016.



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 22.2. All catch data for RSD categories revealed increases in all categories when compared to the 2013 sample (Figure 21).

Figure 21. Relative stock density (RSD) catch per unit effort by category for rock bass collected from the North Fork Holston River between 2010 and 2016.



Discussion

The North Fork Holston River can provide anglers with the opportunity to catch substantial numbers of quality size smallmouth bass and rock bass. High flows during 2013, were problematic for our sampling efforts and most likely had an influence on the number of fish we observed. In 2017, a roving creel survey was conducted on the North Fork Holston. Survey results are pending and will be included in future reports for this river.

Surveys on the North Fork Holston River will be conducted on a three-year rotation in order to assess any changes in the fishery. 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 placed on the North Fork between the state line and the confluence with the South Fork.

Management Recommendations

1. Continue rotational sampling to monitor sport fish populations.

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 2016 surveys focused on continuing the evaluation of the fish community at two long-term IBI stations. Catch effort data for rock bass and black bass have been collected routinely since 1997 at five 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 in 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.

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 15, 2016 we conducted sport fish surveys at four sites between Newport and Walters Powerhouse (Figure 22). 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 12). Water temperatures ranged from 8 to 10.5 C and conductivity varied from 225 to 270 µs/cm (Table 12).

Figure 22. Site locations for CPUE samples conducted in the Pigeon River during 2016.

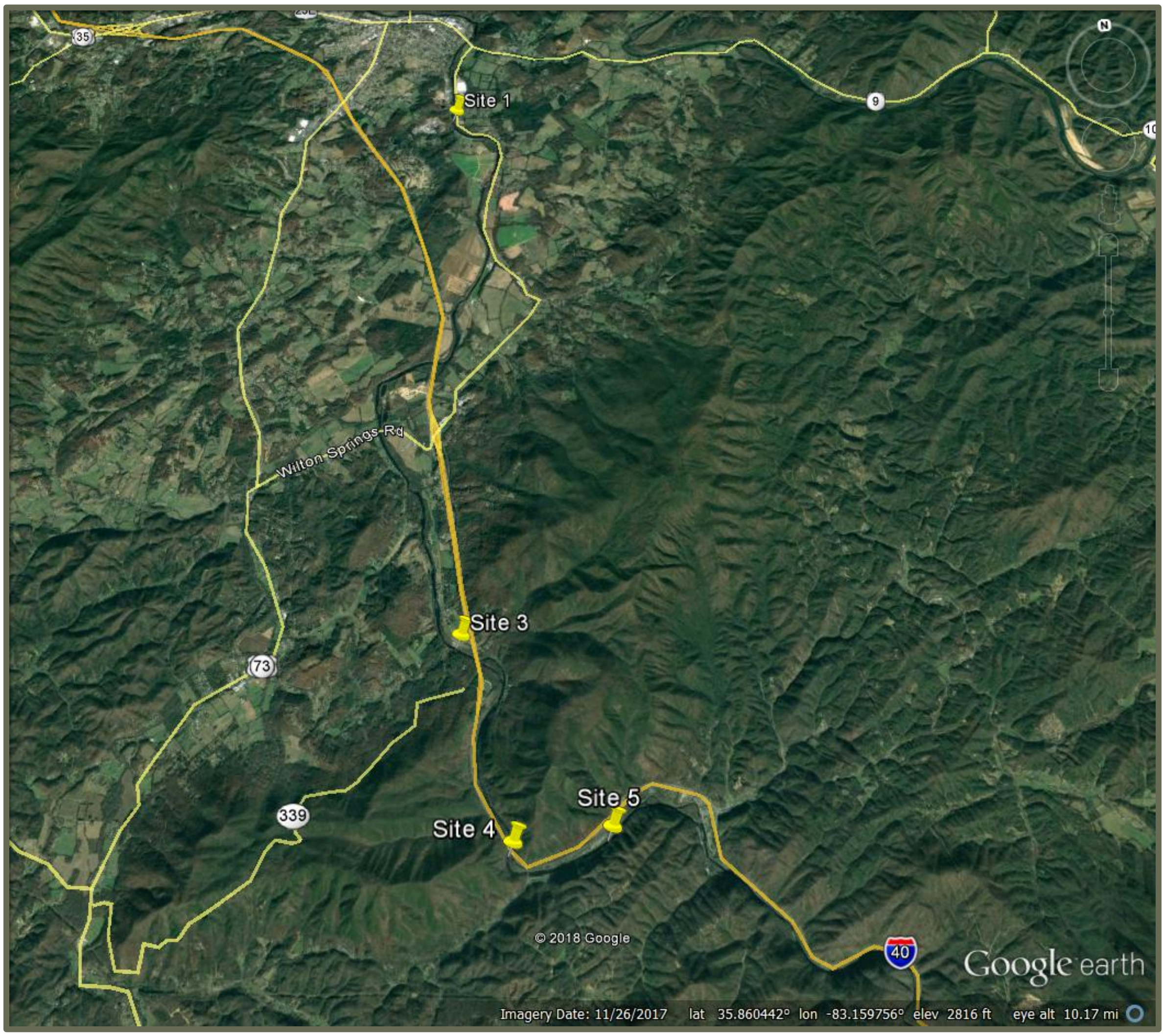


Table 12. Physiochemical and site location data for samples conducted on the Pigeon River during 2016.

Site Code	Site	County	Quad	River Mile	Latitude	Longitude	Mean Width (m)	Length (m)	Temp. C	Cond.	Secchi (m)
420160901	1	Cocke	Newport 173NW	8.1	35.94236	-83.17906	53.6	392	11.4	435.1	2.5
420160903	3	Cocke	Hartford 173SW	16.6	35.84343	-83.18493	-	414	11.9	492	2.5
420160904	4	Cocke	Hartford 173SW	19	35.81298	-83.17837	35.3	80	11.7	494	2.5
420160905	5	Cocke	Hartford 173SW	20.5	35.81380	-83.16261	47.3	839	10.7	485	2.5

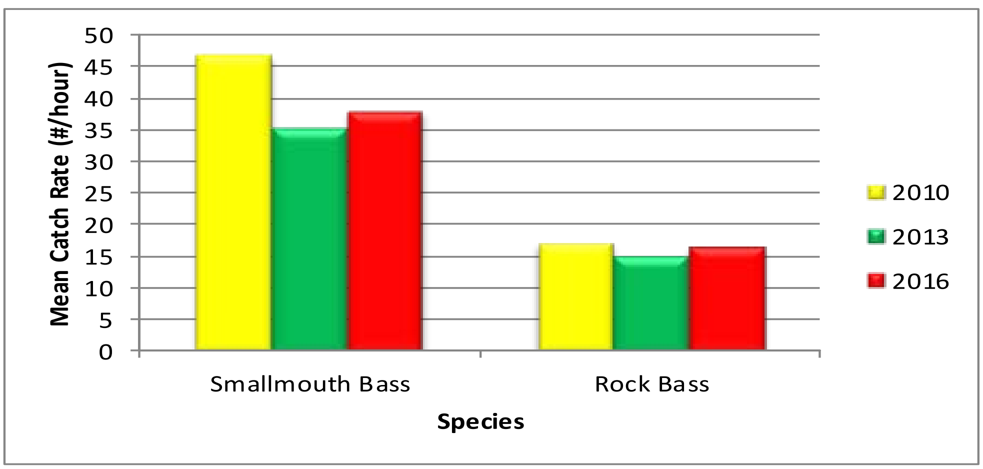
Catch-per-unit-effort fish samples were collected by boat electrofishing in accordance with the standard large river sampling protocols (TWRA 2005). Fixed-boom electrodes were used to transfer 4-5 amps DC at all sites. All fish collected were returned to the river. All sites were sampled during daylight hours and had survey durations ranging from 918 to 4,200 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. There were no spotted or largemouth bass collected at any of the survey sites. Smallmouth bass CPUE estimates averaged 37.9/hour (Table 13). Our highest observed catches of smallmouth bass were recorded at site 5 (Hartford) and site 1 (Tannery Island). The highest catch rate for this species was recorded at site 3 (42.0/hour). Overall, we observed a 25% decrease in the mean catch rate of smallmouth bass between the 2010 and 2013 samples but the value rebounded somewhat in 2017 rising by 8% (Figure 23). In 2016 we had one smallmouth that was in the memorable category at 18 inches. Rock bass CPUE was highest at sites 1 and 3, averaging 16.4/hour for all sites. Mean CPUE estimates for rock bass have hovered around the 15/hour mark for the last three samples with 2010 and 2016 being slightly above the value recorded in 2013 (Figure 23).

Table 13. Catch per unit effort and length categorization indices of target species collected at four sites on the Pigeon River during 2016.

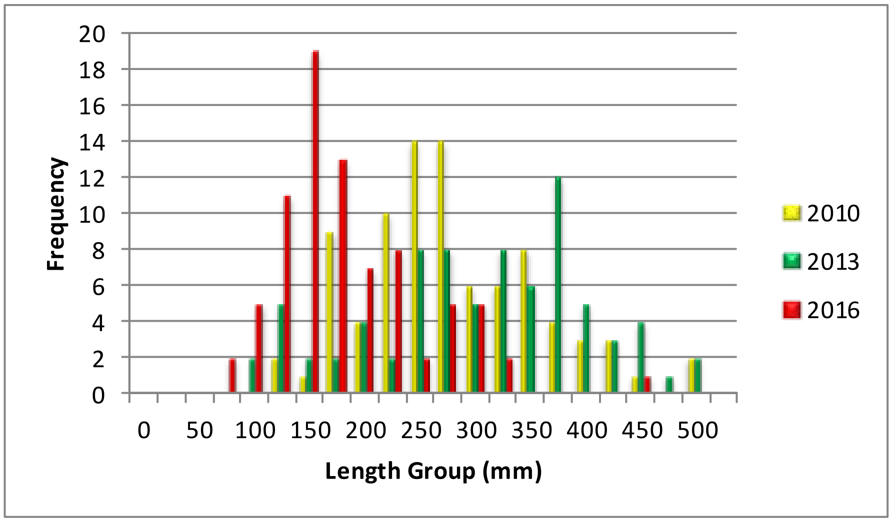
Site Code	Smallmouth Bass CPUE	Rock Bass CPUE
420160901	46.5	13.9
420160903	62	42
420160904	24	8
420160905	19.2	1.7
MEAN	37.9	16.4
STD. DEV.	19.9	17.7
	Smallmouth Bass Length-Categorization Analysis	**Rock Bass Length-Categorization Analysis**
	PSD = 26.8	PSD = 48.3
	RSD-Preferred = 2.4	RSD-Preferred = 3.4
	RSD-Memorable = 2.4	RSD-Memorable = 0
	RSD-Trophy = 0	RSD-Trophy = 0

Figure 23. Trends in mean catch rate of smallmouth bass and rock bass collected between 2010 and 2016 from the Pigeon River.



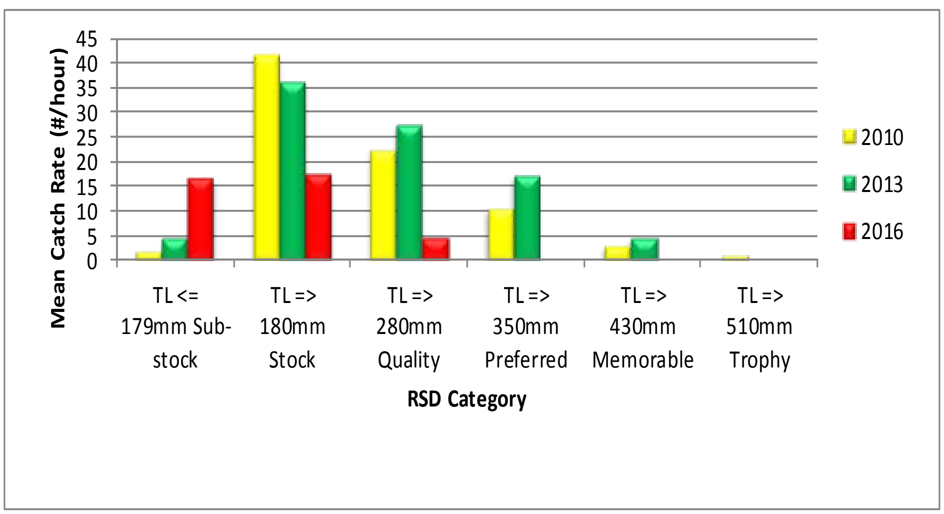
The majority of the smallmouth bass collected from the Pigeon River during 2016 fell within the 125 to 250 mm length range (Figure 24). Overall, we observed a dramatic shift in size classes when compared to the 2013 sample. The frequency of bass larger than 12 inches was considerably lower than the previous sample (Figure 24). Length categorization analysis indicated the Relative Stock Density (RSD) for preferred smallmouth bass (TL ≥ 350 mm) was 2.4, which was down 95% from the sample taken in 2013.

Figure 24. Length frequency distribution for smallmouth bass collected from the Pigeon River between 2010 and 2016.



RSD for memorable (TL ≥ 430 mm) and trophy (TL ≥ 510 mm) size bass were 2.4 and 0, respectively. The PSD of smallmouth bass (ratio of quality size bass to stock size bass) was 26.8 (75.7 in 2013). Catch per unit effort estimates by RSD category indicated smallmouth bass catches in all RSD categories were lower in the 2016 samples in all categories with the exception of sub-stock (Figure 25). Generally, we observed a dramatic reduction in the size structure of bass in the river which had a strong influence on the categorical analysis.

Figure 25. Relative stock density (RSD) catch per unit effort for smallmouth bass collected from the Pigeon River between 2010and 2016.



Individuals in the 125 to 225 mm range represented the majority of rock bass in our sample (Figure 26). Length categorization analysis indicated the RSD for preferred rock bass (TL > 230 mm) was 3.4 which was a substantial decrease from the value of 13.6 in 2013. RSD for memorable (TL > 280 mm) and trophy (TL > 330 mm) size rock bass was 0. The PSD of rock bass was 48.3. Catch per unit effort estimates by RSD category indicated the majority of our catch was stock size fish (Figure 27) with about 45% of the catch representing quality size fish.

Figure 26. Length frequency distribution for rock bass collected from the Pigeon River between 2010 and 2016.

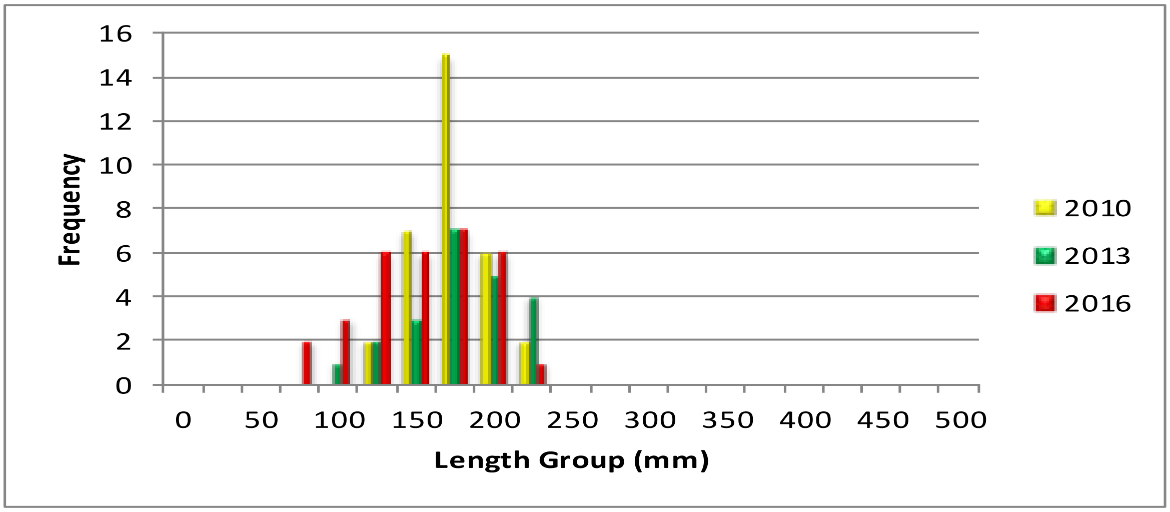
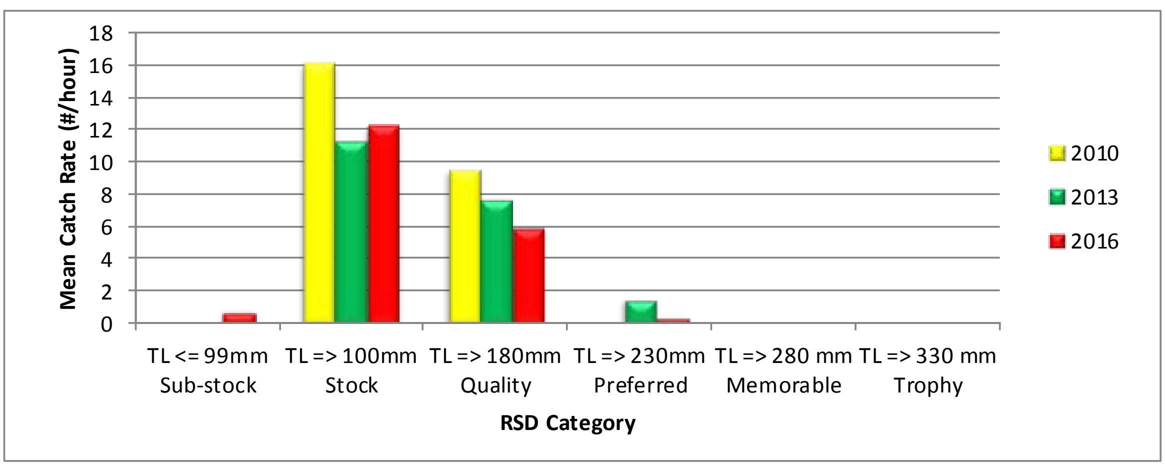


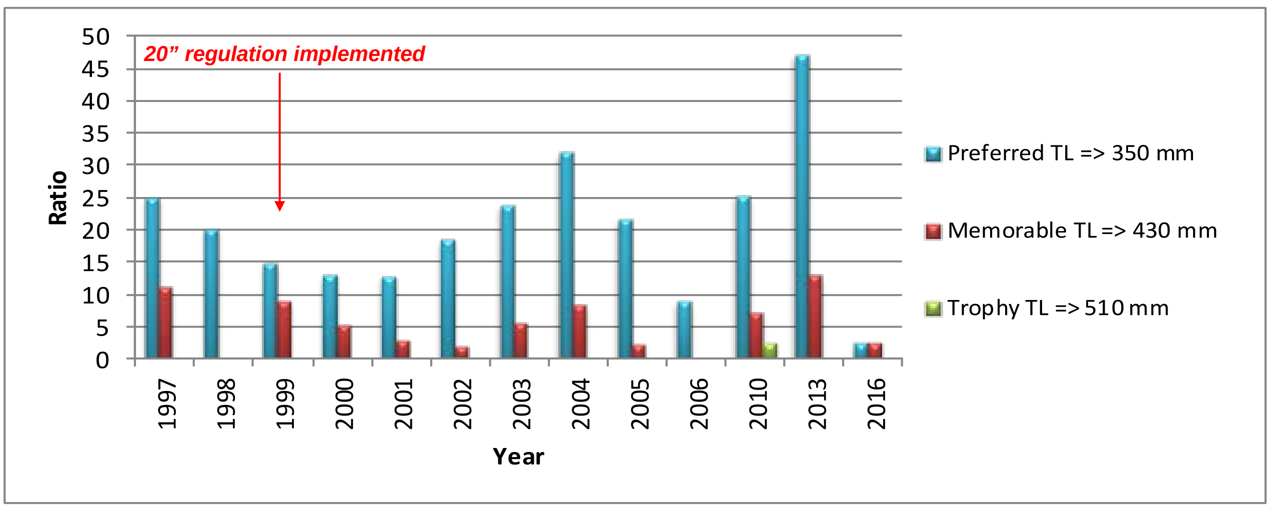
Figure 27. Relative stock density (RSD) catch per unit effort by category for rock bass collected from the Pigeon River between 2010 and 2016.



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 prior to the 2016 survey (Figure 28). This figure rebounded nicely in 2013, but reached an all-time low during 2016 for the preferred category. We believe this was a result of the drought conditions encountered during the summer of 2016. Dewatering of habitat and increases temperatures during drought has been documented to negatively impact riverine smallmouth bass populations, particularly larger fish.

Figure 28. Trends in the ratio of preferred, memorable, and trophy smallmouth bass collected from the Pigeon River 1997-2016.



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 in the fall (October-November) to maintain our efficiency in characterizing the smallmouth bass populations in the river. Index of Biotic Integrity samples will continue on an annual basis. A roving angler survey is scheduled for 2018 to gather use, harvest and demographic information for the fishery.

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.

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