FISHERIES REPORT:
Warmwater Streams and Rivers

2015

Tennessee Wildlife Resources Agency
Region IV
Report 16-11

FISHERIES REPORT
REPORT NO. 16-11
WARMWATER STREAM FISHERIES REPORT
REGION IV

2015

Prepared by

Bart D. Carter

Rick D. Bivens

Carl E. Williams

and

James W. Habera

TENNESSEE WILDLIFE RESOURCES AGENCY

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Cover: Lake Sturgeon find a new home in the French Broad River above Douglas Reservoir. Releases were made in the French Broad River in 2014 and 2015.

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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 55 streams were sampled and are included in this report. Surveys were conducted from April to December 2015. A total of 89 (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 two rivers during 2015. 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 2015 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 and at four other locations for a total of eight samples. These were taken with aquatic insect nets, by rock turning, and by selected pickings from as many types of habitat as possible within the sample area. Taxa richness and relative abundance are the primary considerations of this type of sampling. Taxa richness reflects the health of the benthic community and biological impairment is reflected in the absence of pollution sensitive taxa such as Ephemeroptera, Plecoptera, and Trichoptera (EPT).

Large particles and debris were picked from the samples and discarded in the field. The remaining sample was preserved in 70% ethanol and later sorted in the laboratory. Organisms were enumerated and attempts were made to identify specimens to species level when possible. Many were identified to genus, and most were at least identified to family. Dr. David A. Etnier (UTK) examined problematic specimens and either made the determination or

confirmed our identifications. Comparisons with identified specimens in our aquatic invertebrate collection were also useful in making determinations. For the most part, nomenclature of aquatic insects used in this report follows Brigham et al. (1982) and Louton (1982). Names of stoneflies (Plecoptera) are after Stewart and Stark (1988) and caddisflies are after Etnier et al. (1998). Benthic results are presented in tabular form with each stream account.

WATER QUALITY MEASUREMENTS

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

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 2015. 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 2015 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

South Indian Creek

Introduction

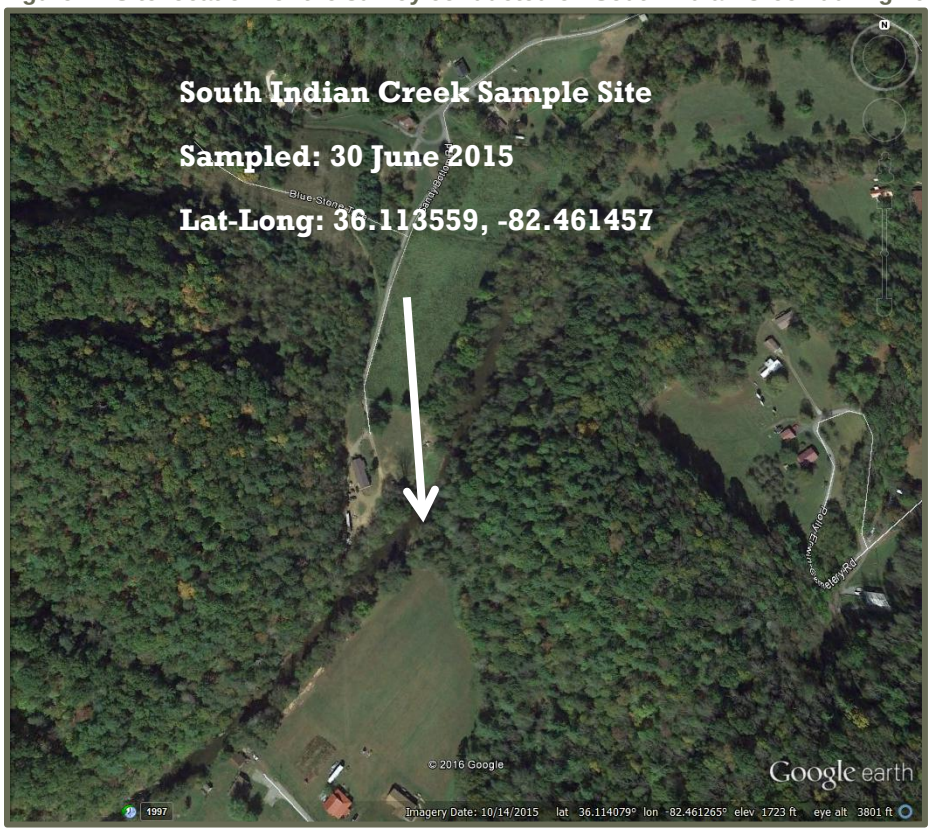
South Indian Creek is a tributary to the Nolichucky River in Unicoi County near the town of Erwin. It is located in the Blue Ridge ecological province of east Tennessee and flows generally in an easterly direction towards Erwin originating near the community of Flag Pond. Historically, the stream had frequent studies conducted for fish and benthic macroinvertebrates residing there resulting from the construction of the I-26 corridor between Erwin and Asheville, NC. These investigations span six years between 1991 and 1997 and primarily focused on assessing any impacts from the interstate construction. Two locations were historically sampled during the construction of the interstate, one known as Sandy Bottoms and the other as Ernestville. In 2015, we were contacted by TWRA Law Enforcement personnel regarding an inquiry about the decline of central stoneroller in the stream. This species of fish has long been revered by anglers, particularly, those in Unicoi, Carter and Johnson counties for table fare and have been traditionally sought during the spring by local anglers. The inquiry pertained to the perceived decline in stoneroller numbers and size. Because of the history associated with this stream, we decided to replicate one of the historical IBI surveys (Sandy Bottoms) in order to asses any fish community changes and address the inquiry regarding stonerollers.

Study Area and Methods


River Chub nests observed within the survey site

On June 30, 2015 we sampled the fish community at the Sandy Bottom site located at a private residence at the end of Sandy Bottom Road (Figure 1). Fish were sampled employing an Index of Biological Integrity (IBI) using standard electrofishing (backpack) and seining technique. A 1.5 m X 4.5 m seine was used in conjunction with a backpack electrofisher operating at 150 volts AC to sample riffle, run, and pool habitats. Linear sections of shoreline habitat were sampled using the backpack electrofisher and a dip net. Analysis of the fish sample followed procedures developed by Karr et al. (1986). Basic water quality data were taken: temperature 20.5 C, conductivity 116.7 µs/cm, and pH 6.5.

Figure 1. Site location for the survey conducted on South Indian Creek during 2015.



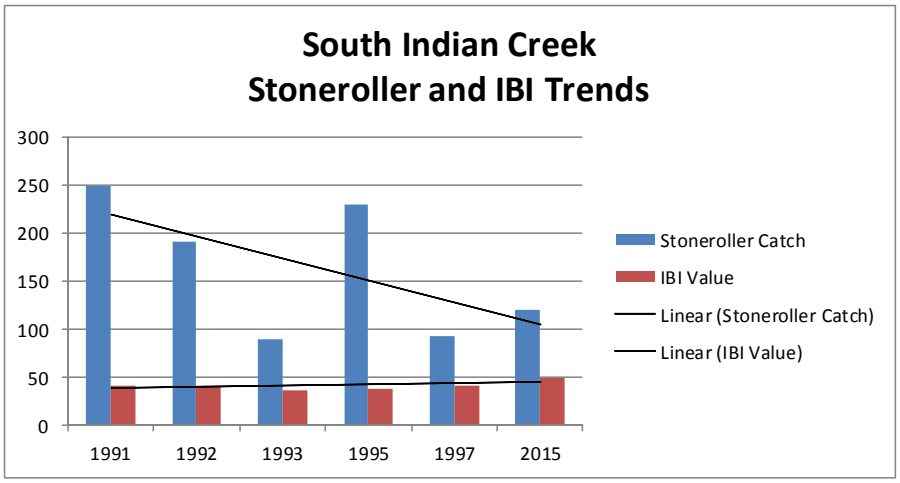
Results

Our survey produced a total of 912 fish comprising 26 species (Table 1). Four game fish species were present. These included rainbow trout, smallmouth bass. Green sunfish, and rock bass. The most abundant species collected were banded sculpin and central stoneroller. Together these two species comprised 33% of the total number of fish collected. Several darter and shiner species were collected along with numerous American brook lamprey. Several stonerollers were collected (13% of all fish collected) although the size of the fish captured was relatively small. Three sucker species were encountered, these included northern hog sucker, white sucker and black redhorse. Overall the species composition was similar to previous surveys in this same area and capture numbers appeared to be relatively comparable. Overall, there was a downward trend in stoneroller catch when all sample events are compared, although the 2015 value was not the lowest recorded during the sample period (Figure 2). Index of Biotic Integrity trends over the same time span show a slight increasing trend with the 2015 value being the highest recorded during any of the sampling events.

Table 1. Fish species occurrence for South Indian Creek 2015.

Species	Number
Ambloplites rupestris	28
Campostoma anomalum	120
Catostomus commersonii	8
Cottus carolinae	182
Cyprinella galactura	21
Ehteostoma chlorobranchium	10
Etheostoma blennioides	11
Etheostoma swannanoa	1
Etheostoma tenneseense	27
Hybopsis amblops	16
Hypentelium nigricans	50
Lampetra appendix	51
Lepomis cyanellus	3
Luxilus coccogenis	70
Lythrurus lirus	1
Micropterus dolomieu	4
Moxostoma duquesnei	13
Nocomis micropogon	101
Notropis leuciodus	88
Notropis micropteryx	3
Notropis rubricroceus	2
Notropis telescopus	63
Oncorhynchus mykiss	2
Percina evides	19
Rhinichthys atratulus	2
Rhinichthys cataractae	16
Total	**912**

Figure 2. Stoneroller and index of biotic integrity trends for South Indian Creek at Sandy Bottom.



Overall, the fish survey analysis indicated South Indian Creek was in "Good" condition at this site. The 2015 value was the highest for the recorded samples. None of the twelve metrics scored poorly although there was a fair number of mediocre scores. Over half of the metrics scores excellent and represented measures that are associated with better water quality (Table 2).

Table 2. South Indian Creek Index of Biotic Integrity analysis for the 2015 survey.

Metric Description	Scoring Criteria 1 3 5	Observed	Score
Number of Native Species	<13 13-25 >25	25	3
Number of Darter Species	<4 4-7 >7	5	3
Number of Sunfish Species	<2 2 >2	2	3
Number of Sucker Species	<2 2 >2	3	5
Number of Intolerant Species	<2 2 >2	3	5
Percent of Individuals as Tolerant	>20% 20-10 <10%	1.2	5
Percent of Individuals as Omnivores	>30% 30-15 <15%	11.9	5
Percent of Individuals as Specialist	<25% 25-50 >50%	33.9	3
Percent of Individuals as Piscivores	<2% 2-5 >5%	3.5	3
Catch Rate	<8 8-16 >16	42.9	5
Percent of Individuals as Hybrids	>1% 1-Tr 0	0	5
Percent of Individuals with Anomalies	>5% 5-2 <2%	1.5	5
		Total	50 (GOOD)

Discussion

Although there is a significant time gap between this survey and the last surveys conducted as part of the interstate construction, it would appear South Indian Creek at this site has maintained if not slightly improved in regards to the fish community. Stoneroller numbers were lower in 2015 than in some of the previous surveys but were not the lowest recorded. General improvements in regulation of water quality and land use practices over the time period may have decreased the fertility to some degree in this stream. The reliance of stonerollers on periphyton growth as a food source could have been diminished somewhat over this period and may have impacted the abundance and growth for this species. This general decline has been noticed by residents in the area and was a primary focal point for this evaluation.

Long Creek

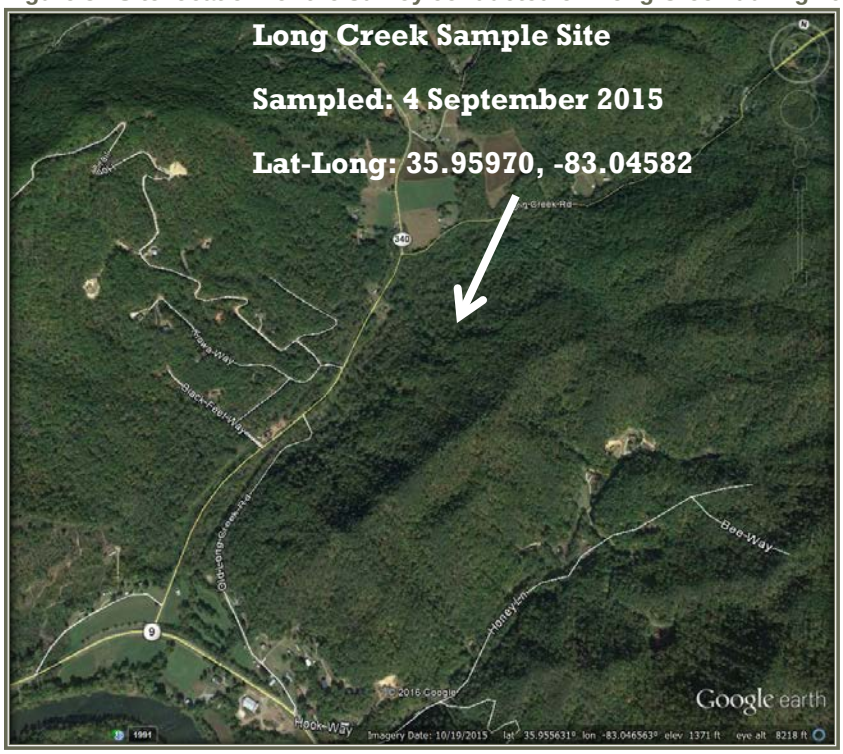
Introduction

We cooperated with Cherokee National Forest personnel in conducting an Index of Biotic Integrity Survey on the lower reach of the stream. Long Creek originates in a developed agricultural region of Cocke County. It flows along the base of Meadow Creek Mountain for a good portion of its length before emptying into the French Broad River at river mile 84.2. Because much of the stream flows through developed land, the impacts of non-point source were evident in the survey site.

Study Area and Methods

On September 4, 2015 we sampled the fish community near the mouth of the stream along Long Creek Road (Figure 3). Fish were sampled employing an Index of Biological Integrity (IBI) using standard electrofishing (backpack) and seining technique. A 1.5 m X 4.5 m seine was used in conjunction with a backpack electrofisher operating at 100 volts AC to sample riffle, run, and pool habitats. Linear sections of shoreline habitat were sampled using the backpack electrofisher and a dip net.

Figure 3. Site location for the survey conducted on Long Creek during 2015.



Results

Our survey produced a total of 270 fish comprising 16 species (Table 3). The only game fish collected were bluegill and green sunfish. The two most abundant species collected were striped shiner and telescope shiner. Together these two species comprised 42.5% of the total number of fish collected. Only one dater species, Tennessee darter, was collected during the survey. Three sucker species were encountered, these included norther hog sucker, white sucker and black redhorse. Overall the species composition was similar to our previous survey in 1997 (Bivens et al. 1998) where 18 species were collected. The obvious difference in the two samples was the absence of rock bass in the latter sample. We collected 12 rock bass in that sample which was slightly downstream of the area surveyed in 2015. Suitable habitat for rock bass was obviously lacking at the current survey site.

Table 3. Fish species occurrence for Long Creek 2015.

Species	Number
Campostoma oligolepis	9
Catostomus commersonii	4
Cottus carolinae	1
Cyprinella galactura	5
Dorosoma cepedianum	2
Etheostoma tennesseense	27
Hybopsis amblops	9
Hypentelium nigricans	20
Lepomis cyanellus	1
Lepomis macrochirus	9
Luxilus chrysocephalus	68
Luxilus coccogenis	5
Moxostoma dequesnei	3
Notropis telescopus	47
Rhinichthys atratulus	25
Semotilus atromaculatus	35
Total	**270**

Overall, the IBI analysis indicated Long Creek was in “Fair” condition at this site based on a score of 40. The most influential metrics on decreasing the overall score were the low

number of darter species, high percentage of tolerant species, and the low number of piscivores (Table 4).

Table 4. Long Creek Index of Biotic Integrity analysis for the 2015 survey.

Metric Description	Scoring Criteria 1 3 5	Observed	Score
Number of Native Species	<8 8-15 >15	16	5
Number of Darter Species	<2 2-3 >3	1	1
Number of Sunfish Species	<2 2 >2	2	3
Number of Sucker Species	<2 2 >2	3	5
Number of Intolerant Species	<2 2 >2	2	3
Percent of Individuals as Tolerant	>36.6% 36.6-18.3 <18.3%	40.7	1
Percent of Individuals as Omnivores	>44.9% 44.9-22.5 <22.5%	30.7	3
Percent of Individuals as Specialist	<15.2% 15.2-30.4 >30.4%	32.6	5
Percent of Individuals as Piscivores	<2% 2-4 >4%	0	1
Catch Rate	<26 26-53 >53	38	3
Percent of Individuals as Hybrids	>1% 1-Tr 0	0	5
Percent of Individuals with Anomalies	>5% 5-2 <2%	0.4	5
		Total	40 (FAIR)

Discussion

Long Creek at this location was fairly low gradient and therefore had substantial accumulation of sediment in the reach. Riffle habitat was lacking and instream cover was scarce. Any action that would address sedimentation within the watershed would be beneficial. Based on our 1997 survey, there was an apparent fishery for rock bass in the stream. Future surveys should focus on re-evaluating this and determining if this opportunity still persists.

Turkey Creek

Introduction

Located in the Ridge and Valley Province of eastern Tennessee, Turkey Creek originates on the south side of the City of Morristown and flows generally northward through the city proper where it courses through a largely urban environment, including industrial and municipal developments, as well as extensively developed residential communities before finally reaching the confluence with Cherokee Reservoir (Holston River). It is a small creek averaging three to five meters in width, has a significant spring (groundwater) influence, and exhibits relatively cool maximum summer temperatures. Our survey was initiated at the request of the City of Morristown for biological assessment of the fish and benthic communities. Two previous IBI fish surveys have been conducted on this stream: Tennessee Valley Authority in 1995 (TVA 1998), and Tennessee Wildlife Resources Agency (Carter et al. 2004). Both are herein used for comparison of analysis.

Study Area and Methods

On 27 April 2015, the Tennessee Wildlife Resources Agency (TWRA) Region IV Stream Survey Unit sampled the fish and benthic communities on a section of Turkey Creek beginning just upstream of the bridge crossing on Fairview Road and extending upstream approximately 535 meters (Figure 4).

Figure 4. Site location for the survey conducted on Turkey Creek during 2015.

Fish were sampled employing an Index of Biological Integrity (IBI) using standard electrofishing (backpack) and seining techniques. A 1.5 m X 4.5 m seine was used in conjunction with a backpack electrofisher operating at 125 volts AC to sample riffle, run, and pool habitats. Linear sections of shoreline habitat were sampled using the backpack electrofisher and a dip net. Benthic organisms were sampled qualitatively by conducting a three hour collection effort from all habitats types using aquatic insect nets and dissecting forceps. Analysis of the fish and benthic samples followed procedures developed by Karr et al. (1986) and Lenat (1993). Basic water quality data were taken: temperature 15.5 C, conductivity 495 µs/cm, and pH 7.5.

Results

Our survey produced a total of 678 fish comprising six species (Table 5). Only one game fish species, the green sunfish (*Lepomis cyanellus*), was encountered. The most abundant species collected were the largescale stoneroller (*Campostoma oligolepis*) and the blacknose dace (*Rhinichthys atratulus*). Together these two species comprised 97% of the total number of fish collected. No darter species were collected although given the stream size at least one darter species would be likely to occur. Two sucker species were encountered including nine white suckers (*Catostomus commersonii*), and a single specimen of the northern hog sucker (*Hypentelium nigricans*).

Table 5. Fish species occurrence for Turkey Creek 2015.

Species	Number
Rhinichthys atratulus	235
Semotilis atromaculatus	11
Campostoma oligolepis	419
Catostomus commersonii	9
Hypentelium nigricans	1
Lepomis cyanellus	3
Total	678

Overall, the fish survey analysis indicates Turkey Creek is in poor condition with an IBI score of 30 (Table 6). This is a small decrease compared to the 2003 survey score of 34 (poor), however, the score does remain higher than the TVA 1995 survey score of 26 (very poor/poor). Low numbers of native and intolerant species, high numbers of omnivores, the absence of darters, trophic specialist, and piscivores continue to ensure relatively low scores for this stream. Fluctuations in total numbers of the largescale stoneroller and blacknose dace account for slight variations in IBI scores among the three surveys.

Table 6. Turkey Creek Index of Biotic Integrity analysis for the 2015 survey.

Metric Description	Scoring Criteria 1 3 5	Observed	Score
Number of Native Species	<8 8-15 >15	6	1
Number of Darter Species	<2 2 >2	0	1
Number of Sunfish Species	<2 2 >2	1	1
Number of Sucker Species	<2 2 >2	2	3
Number of Intolerant Species	<2 2 >2	1	1
Percent of Individuals as Tolerant	>59 59-30 <30	3.4	5
Percent of Individuals as Omnivores	>45 45-22 <22	61.8	1
Percent of Individuals as Specialist	<16 11-32 >32	0	1
Percent of Individuals as Piscivores	<1 1-5 >5	0	1
Catch Rate	<16 16-32 >32	49.5	5
Percent of Individuals as Hybrids	>1 1-TR 0	0	5
Percent of Individuals with Anomalies	>5 5-2 <2	0.6	5
		Total	**30 (POOR)**

For the most part, the fish fauna within Turkey Creek has been fairly consistent for all three surveys spanning the past 20 years. The 2003 TWRA and the 1995 TVA surveys did produce seven species that weren't collected during this sample: Bluegill (*Lepomis macrochirus*), bluntnose minnow (*Pimephales notatus*), common carp (*Cyprinis carpio*), logperch (*Percina caprodes*), redbreast sunfish (*L. auritus*), striped shiner (*Luxilus chrysocephalus*), and warmouth (*L. gulosus*). However, this is likely due to the localities of the 1995 and 2003 survey sites which were located further downstream (closer to Cherokee Reservoir) and contained habitat associated with those species.

Benthic macroinvertebrates collected within the sample site comprised 8 families representing 8 identified genera (Table 7). The most abundant group in our collection was the caddisflies comprising 35.7% of the total sample. Overall, a total of 11 taxa were identified from the sample of which three belonged to the Ephemeroptera, Plecoptera, and Trichoptera (EPT) group, which represent important water quality indicators.

Based on the EPT taxa richness and overall biotic index of all species collected, the relative health of the benthic community was classified as “poor” (1.5), and scored identical to the TWRA 2003 benthic survey. The 2003 survey produced six additional taxa that were not collected during this sample including one member of Ephemeroptera, however, each of those species were represented in low numbers, usually one specimen, and could have easily been missed, or possibly occurred in the downstream reach below this sampling effort. The overall low diversity, absence of intolerant taxa, and high numbers of tolerant taxa indicate a depressed benthic fauna.

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

ORDER/GROUP	FAMILY	SPECIES	NUMBER	PERCENT
ANELLIDA/ Oligochaeta			11	4.3
DIPTERA				16.7
	Chironomidae		34	
	Simuliidae		7	
	Tipulidae	*Tipula*	1	
		Pedicia	1	
EPHEMEROPTERA				33.3
	Baetidae	*Baetis*	86	
GASTROPODA				0.4
	Physidae	relic	1	
HEMIPTERA				1.9
	Gerridae	*Gerris* (*Aquarius*) nymphs	5	
ODONATA				7.8
	Calopterygidae	*Calopteryx*	11	
	Coenagrionidae	*Argia bipunctulata*	9	
TRICHOPTERA				35.7
	Hydropsychidae	*Cheumatopsyche*	14	
		Hydropsyche betteni/depravata	69	
		Undetermined pupae	9	
		TOTAL	**258**	

DECAPODA/Cambaridae/*Cambarus bartonii cavatus* – present
C. sp. cf. *longirostris* – present

TAXA RICHNESS = 11
EPT RICHNESS = 3
BIOCLASSIFICATION = 1.5 (POOR)

Discussion

Turkey Creek is typical of many urban streams in east Tennessee. With the constant run-off and input of undesirable pollutants the fish and benthic fauna in this type of stream is under the constant barrage of urbanization. This allows little chance for recovery of streams such as Turkey Creek, keeping it constantly depressed. Given the amount of new and established development in the watershed it is unlikely that this stream has much chance of ever recovering to its full potential.

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 2015 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 August 5 and 6, 2015, we conducted IBI fish surveys at Tannery Island (PRM 8.2) and Denton (PRM 16.6) (Figure 5).

Figure 5. Site locations for the IBI samples conducted in the Pigeon River during 2015.

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. A total of 34 fish species were collected at the Tannery Island site and a total of 30 at the Denton site (Table 8). Overall, the IBI analysis indicated the fish community was in "good" condition at Tannery Island (IBI score 48) (Figure 6). This was a 6 point decrease from the score in 2014. The condition of the fish community assessed "good" at the Denton site in 2015 (50), this was also a 6 point decline from the previous sample in 2014 (Figure 6).

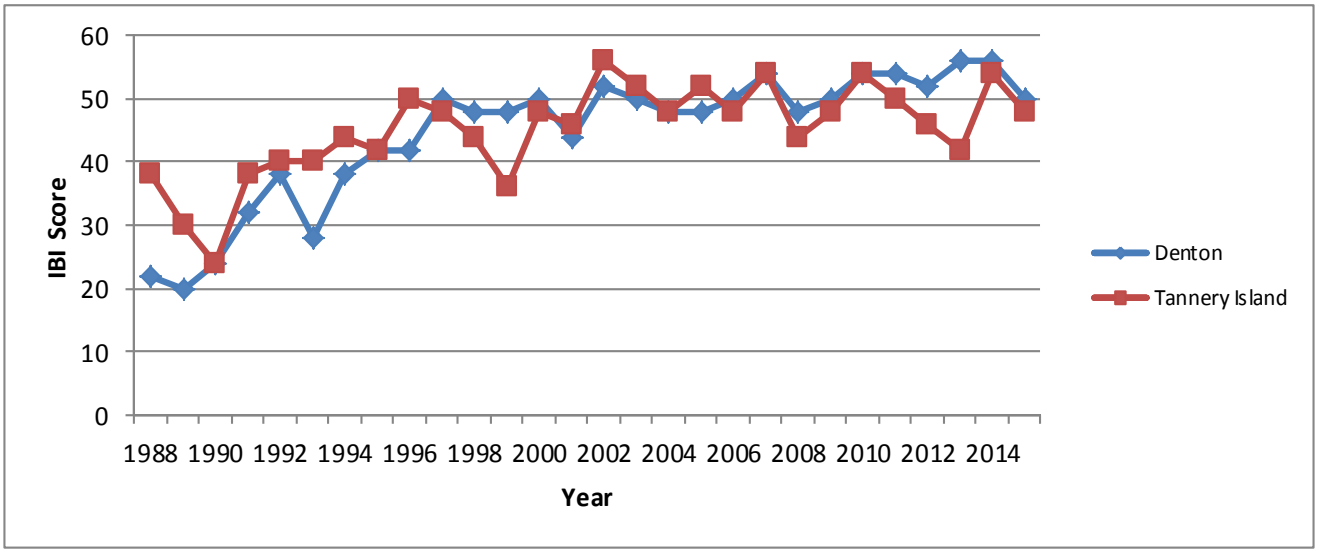
Table 8. Fish species collected from the Pigeon River at Tannery Island and Denton 2015.

Site	Common Name	Species	Number
Tannery Island	Banded darter	*Etheostoma zonale*	2
Tannery Island	Banded sculpin	*Cottus carolinae*	268
Tannery Island	Black buffalo	*Ictiobus niger*	3
Tannery Island	Black redhorse	*Moxostoma duquesnei*	25
Tannery Island	Bluegill	*Lepomis macrochirus*	3
Tannery Island	Brook silverside	*Labidesthes sicculus*	17
Tannery Island	Channel catfish	*Ictalurus punctatus*	7
Tannery Island	Flathead catfish	*Pylodictis olivaris*	1
Tannery Island	Freshwater drum	*Aplodinotus grunniens*	3
Tannery Island	Gilt darter	*Percina evides*	1
Tannery Island	Gizzard shad	*Dorosoma cepedianum*	38
Tannery Island	Golden redhorse	*Moxostoma erythrurum*	14
Tannery Island	Green sunfish	*Lepomis cyanellus*	1
Tannery Island	Greenside darter	*Etheostoma blennioides*	63
Tannery Island	Highland shiner	*Notropis micropteryx*	4
Tannery Island	Largemouth bass	*Micropterus salmoides*	1
Tannery Island	Largescale stoneroller	*Campostoma oligolepis*	79
Tannery Island	Logperch	*Percina caprodes*	27
Tannery Island	Northern hog sucker	*Hypentelium nigricans*	35
Tannery Island	Quillback	*Carpiodes cyprinus*	3
Tannery Island	Redbreast sunfish	*Lepomis auritus*	7
Tannery Island	Redline darter	*Etheostoma rufilineatum*	365
Tannery Island	Rock bass	*Ambloplites rupestris*	13
Tannery Island	Silver redhorse	*Moxostoma anisurum*	1
Tannery Island	Smallmouth bass	*Micropterus dolomieu*	23
Tannery Island	Smallmouth buffalo	*Ictiobus bubalus*	16
Tannery Island	Smallmouth redhorse	*Moxostoma breviceps*	6
Tannery Island	Spotfin shiner	*Cyprinella spiloptera*	3

Table 8. Continued.

Site	Common Name	Species	Number
Tannery Island	Stripetail darter	*Etheostoma kennicotti*	5
Tannery Island	Tennessee darter	*Etheostoma tennesseense*	105
Tannery Island	Walleye	*Sander vitreum*	2
Tannery Island	Western mosquitofish	*Gambusia affinis*	1
Tannery Island	Whitetail shiner	*Cyprinella galactura*	12
Tannery Island	Yellow bullhead	*Ameiurus natalis*	1
Denton	Banded sculpin	*Cottus carolinae*	142
Denton	Bigeye chub	*Hybopsis amblops*	8
Denton	Black buffalo	*Ictiobus niger*	4
Denton	Black redhorse	*Moxostoma duquesnei*	32
Denton	Bluegill	*Lepomis macrochirus*	9
Denton	Brook silverside	*Labidesthes sicculus*	2
Denton	Central stoneroller	*Campostoma anomalum*	53
Denton	Channel catfish	*Ictalurus punctatus*	4
Denton	Chestnut lamprey	*Ichthyomyzon castaneus*	1
Denton	Freshwater drum	*Aplodinotus grunniens*	1
Denton	Gizzard shad	*Dorosoma cepedianum*	19
Denton	Golden redhorse	*Moxostoma erythrurum*	3
Denton	Green sunfish	*Lepomis cyanellus*	1
Denton	Greenside darter	*Etheostoma blennioides*	38
Denton	Logperch	*Percina caprodes*	21
Denton	Northern hog sucker	*Hypentelium nigricans*	21
Denton	Redbreast sunfish	*Lepomis auritus*	27
Denton	Redline darter	*Etheostoma rufilineatum*	119
Denton	River redhorse	*Moxostoma carinatum*	2
Denton	Rock bass	*Ambloplites rupestris*	38
Denton	Silver redhorse	*Moxostoma anisurum*	1
Denton	Smallmouth bass	*Micropterus dolomieu*	48
Denton	Smallmouth buffalo	*Ictiobus bubalus*	7
Denton	Smallmouth redhorse	*Moxostoma breviceps*	5
Denton	Telescope shiner	*Notropis telescopus*	36
Denton	Tennessee darter	*Etheostoma tennesseense*	25
Denton	Walleye	*Sander vitreum*	1
Denton	White crappie	*Pomoxis annularis*	1
Denton	Whitetail shiner	*Cyprinella galactura*	69
Denton	Yellow bullhead	*Ameiurus natalis*	2

Figure 6. Trends in Index of Biotic Integrity (IBI) at two stations on the Pigeon River (1988-2015).



Benthic macroinvertebrates collected at the Tannery Island site comprised 30 families representing 37 identified genera (Table 9). The most abundant group in our collection was the mayflies comprising 30.5% of the total sample. Overall, a total of 46 taxa were identified from the sample of which 19 were EPT. Based on the EPT taxa richness and overall biotic index of all species collected, the relative health of the benthic community was classified as "Good" (4.0).

Table 9. Taxa list and associated biotic statistics for benthic macroinvertebrates collected from the Pigeon River at Tannery Island.

ORDER/GROUP	FAMILY	SPECIES	NUMBER	PERCENT
ANELLIDA				1.8
	Hirndinea		4	
	Oligochaeta		3	
COLEOPTERA				6.5
	Dytisicidae	*Liodessus affinis*	1	
	Elmidae	*Ancyronyx variegatus*	4	
		Macronychus glabratus adults	5	
		Promoresis elegans larva and adults	10	
	Gyrinidae	*Dineutus discolor* adults	4	
		Dineutus larva	1	

Table 9. Continued.

ORDER/GROUP	FAMILY	SPECIES	NUMBER	PERCENT
DIPTERA				7.6
	Chironomidae	larvae, pupa, and adults	21	
	Simuliidae	larvae	8	
EPHEMEROPTERA				30.5
	Baetidae	*Acentrella*	10	
		Baetis	1	
		Callibaetis	2	
		Hetercloeon	1	
	Caenidae	*Caenis*	2	
	Ephemerellidae	*Serratella* sp. 1	2	
		Serratella sp. 2	11	
	Heptageniidae	*Maccaffertium mediopunctatum*	53	
		Maccaffertium undetermined	6	
		Stenacron interpunctatum	1	
	Isonychiidae	*Isonychia*	24	
	Leptohyphidae	*Tricorythodes*	4	
GASTROPODA				5.2
	Ancylidae	*Ferrissia*	7	
	Physidae		1	
	Pleuroceridae	*Leptoxis*	2	
		Pleurocera sp. with stripes	5	
		Pleurocera sp. without stripes	5	
HEMIPTERA				1.3
	Gerridae	*Trepobates*	3	
	Veliidae	*Rhagovelia obesa* adults	2	
HYDRACARINA			1	0.3
MEGALOPTERA				2.6

Table 9. Continued.

ORDER/GROUP	FAMILY	SPECIES	NUMBER	PERCENT
	Corydalidae	*Corydalus cornutus*	10	
ODONATA				10.2
	Aeshnidae	*Boyeria vinosa*	3	
		Basiaeschna janata	1	
	Calopterygidae	*Calopteryx*	1	
		Hetaerina americana	9	
	Coenagrionidae	*Argia*	4	
		Enallagma	18	
	Corduliidae	*Neurocordulia yamaskanensis*	1	
	Gomphidae	early instar	1	
		Hagenius brevistylus	1	
PELECYPODA				0.8
	Corbiculidae	*Corbicula fluminea*	3	
TRICHOPTERA				30.0
	Brachycentridae	*Brachycentrus lateralis*	25	
	Hydroptilidae	*Hydroptila*	7	
	Hydropsychidae	*Ceratopsyche morosa*	29	
		Ceratopsyche sparna	1	
		Cheumatopsyche	46	
		Hydropshche venularis	2	
	Lepidostomatidae	*Lepidostoma* pupa and larvae	3	
	Leptoceridae	*Oecetis avara*	2	
TURBELLARIA			12	3.1
		Total	383	

TAXA RICHNESS = 46
EPT RICHNESS = 19
BIOCLASSIFICATION = 4.0 (GOOD)

Benthic macroinvertebrates collected at the Denton site comprised 29 families representing 36 identified genera (Table 10). The most abundant groups in our collection were

the caddisflies comprising about 33.3% of the total sample. Overall, a total of 45 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-Good” (3.5).

Table 10. Taxa list and associated biotic statistics for benthic macroinvertebrates collected from the Pigeon River at Denton.

ORDER/GROUP	FAMILY	SPECIES	NUMBER	PERCENT
ANELLIDA				0.2
	Oligochaeta		1	
COLEOPTERA				4.3
	Gyrinidae	*Dineutus discolor* adult male & females	4	
		Dineutus larvae	2	
	Elmidae	*Ancyronyx varigatus*	1	
		Macronychus glabratus larva & adults	6	
		Promoresia tardella larva & adults	7	
	Psephenidae	*Psephenus herricki* larvae	3	
DIPTERA				22.0
	Athericidae	*Atherix lantha*	1	
	Chironomidae	larvae and pupae	98	
	Simuliidae	larvae and pupa	20	
EPHEMEROPTERA				29.6
	Baetidae	*Acentrella*	8	
		Baetis	8	
		Heterocloeon	4	
	Caenidae	*Caenis*	8	
	Ephemerellidae	*Serratella* sp. 1	4	
		Serratella sp. 2	9	
	Heptageniidae	*Maccaffertium mediopunctatum*	68	
		Maccaffertium modestum	3	
		Maccaffertium early instars	4	

Table 10. Continued.

ORDER/GROUP	FAMILY	SPECIES	NUMBER	PERCENT
		Stenacron interpunctatum	11	
	Isonychiidae	*Isonychia*	33	
GASTROPODA				2.4
	Ancylidae	*Ferrissia*	9	
	Pleuroceridae	*Leptoxis*	4	
HEMIPTERA				0.4
	Veliidae	*Rhagovelia obesa* adults	2	
HYDRACARINA			10	1.9
ISOPODA				0.2
	Asellidae	*Caecidotea*	1	
MEGALOPTERA				2.2
	Corydalidae	*Corydalus cornutus*	11	
		Nigronia serricornis	1	
ODONATA				2.0
	Aeshnidae	*Boyeria vinosa*	7	
	Coenagrionidae	*Argia*	3	
	Gomphidae	*Hagenius brevistylus*	1	
PELECYPODA				1.3
	Corbiculidae	*Corbicula fluminea*	7	
TRICHOPTERA				33.3
	Brachycentridae	*Brachycentrus lateralis*	15	
		Micrasema watauga	6	
	Goeridae	*Goera* pupa	1	
	Hydropsychidae	*Ceratopsyche morosa*	27	
		Ceratopsyche sparna	8	
		Cheumatopsyche	18	

Table 10. Continued.

ORDER/GROUP	FAMILY	SPECIES	NUMBER	PERCENT
		Hydropsyche franclemonti	7	
		Hydropsyche venularis	37	
		Undetermined early instars	33	
	Hydroptilidae	*Hydroptila*	15	
		Leucotrichia pictipes	5	
		Undetermined pupa	1	
	Lepidostomatidae	*Lepidostoma*	4	
	Leptoceridae	*Oecetis*	1	
	Polycentropodidae	*Nyctiophylax*	1	
	Psychomyiidae	*Psychomyia flavida*	1	
TURBELLARIA			1	0.2
		Total	540	

TAXA RICHNESS = 45
EPT RICHNESS = 24
BIOCLASSIFICATION = 3.5 (FAIR/GOOD-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 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. 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.

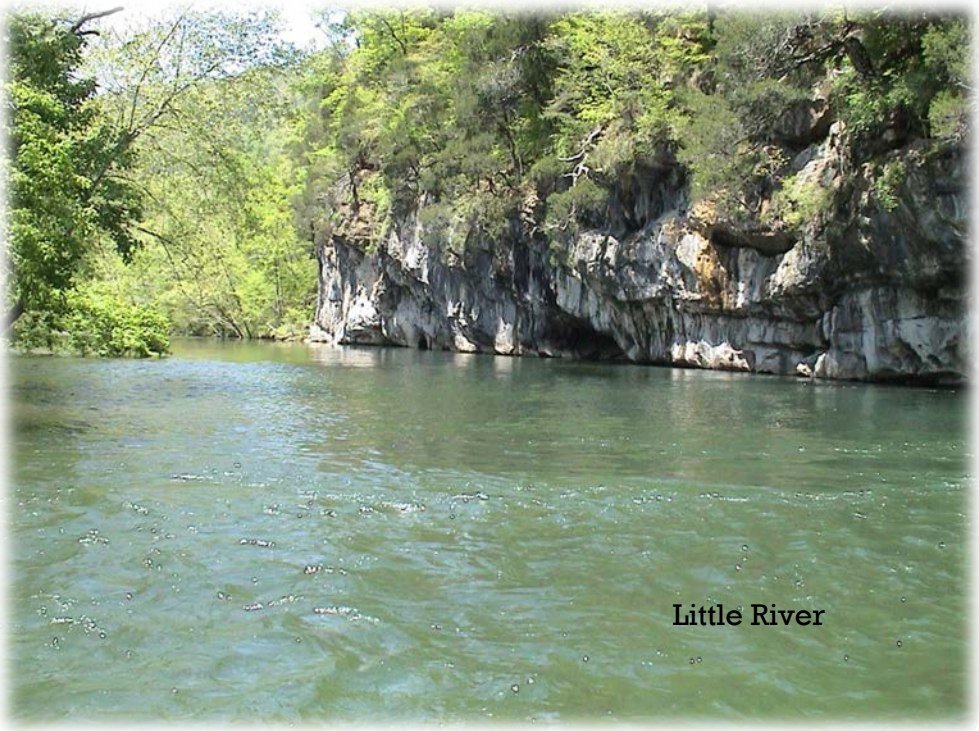
Management Recommendations

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 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



Little River

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 (four listed federally). Additionally, its upper reach supports one of east Tennessee's better warm water sport fisheries. It provides anglers with the opportunity to catch all species of black bass, rock bass, and even stocked rainbow trout when water temperatures allow.

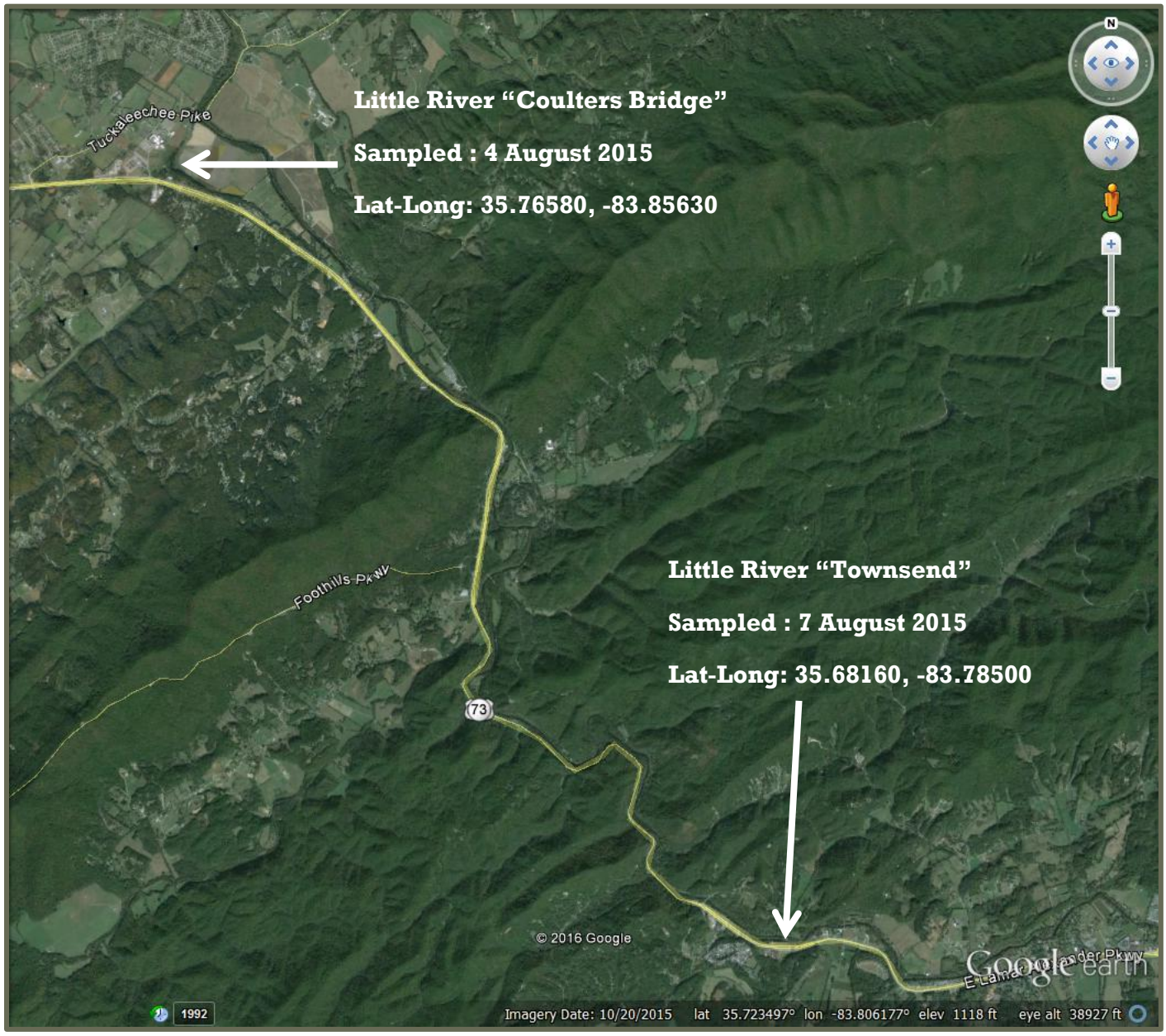
Study Area and Methods

Our 2015 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 August 4 and 7. 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 7).

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 7. Site locations for samples conducted in Little River during 2015.



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 August 2015, 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 58). The condition of the fish community increased slightly from the value observed in 2014 (56). At the upper most station, Townsend, the stream rated good to excellent receiving a score of 54. This was a slight decrease of two points from the previous sample (Figure 8). 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 11 lists fish species collected at the Coulters Bridge and Townsend sites.

Sickle Darter

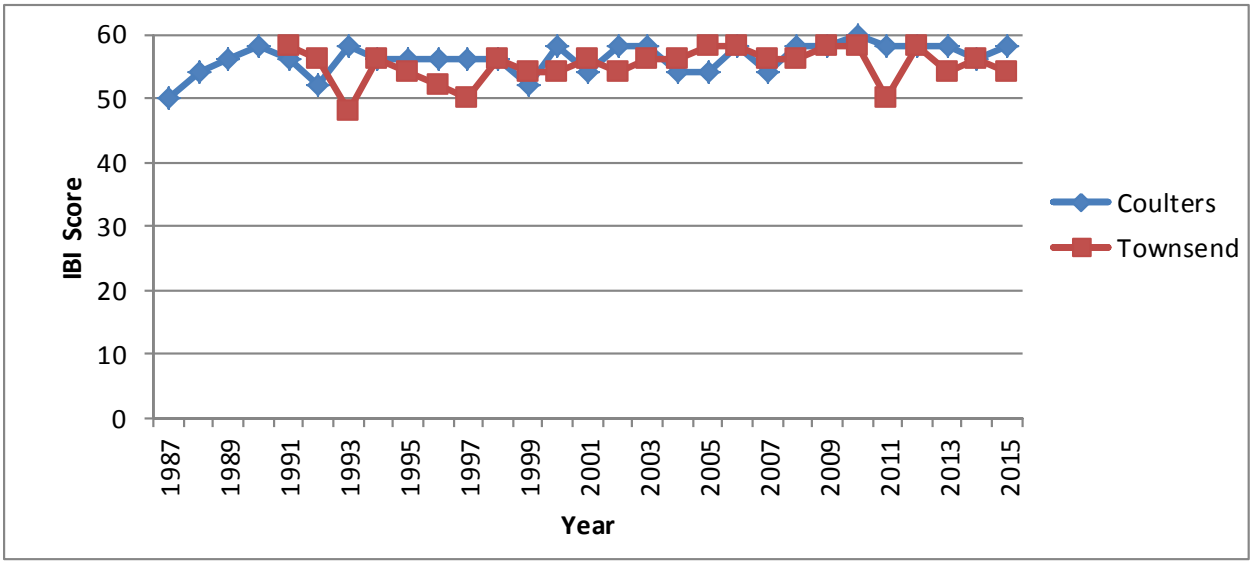
Table 11. Fish species collected from Little River at Coulter Bridge and Townsend 2015.

Site	Common Name	Species	Number
Coulters Bridge	Banded darter	*Etheostoma zonale*	47
Coulters Bridge	Banded sculpin	*Cottus carolinae*	32
Coulters Bridge	Bigeye chub	*Hybopsis amblops*	59
Coulters Bridge	Black redhorse	*Moxostoma duquesnei*	88
Coulters Bridge	Bluebreast darter	*Etheostoma camurum*	21
Coulters Bridge	Bluegill	*Lepomis macrochirus*	32
Coulters Bridge	Blueside darter	*Etheostoma jessiae*	10
Coulters Bridge	Largescale stoneroller	*Campostoma oligolepis*	42
Coulters Bridge	Channel catfish	*Ictalurus punctatus*	2
Coulters Bridge	Common carp	*Cyprinus carpio*	10
Coulters Bridge	Creek chub	*Semotilus atromaculatus*	1
Coulters Bridge	Flathead catfish	*Pylodictis olivaris*	4
Coulters Bridge	Freshwater drum	*Aplodinotus grunniens*	2
Coulters Bridge	Gilt darter	*Percina evides*	6
Coulters Bridge	Gizzard shad	*Dorosoma cepedianum*	5
Coulters Bridge	Golden redhorse	*Moxostoma erythrurum*	52
Coulters Bridge	Green sunfish	*Lepomis cyanellus*	6
Coulters Bridge	Greenside darter	*Etheostoma blennioides*	24
Coulters Bridge	Highland shiner	*Notropis micropteryx*	116
Coulters Bridge	Largemouth bass	*Micropterus salmoides*	1
Coulters Bridge	Logperch	*Percina caprodes*	14
Coulters Bridge	Longnose gar	*Lepisosteus osseus*	5
Coulters Bridge	Mimic shiner	*Notropis volucellus*	51
Coulters Bridge	Mountain madtom	*Noturus eleutherus*	25
Coulters Bridge	Mountain shiner	*Lythrurus lirus*	5
Coulters Bridge	Northern hog sucker	*Hypentelium nigricans*	25
Coulters Bridge	Northern studfish	*Fundulus catenatus*	3
Coulters Bridge	Ohio lamprey	*Ichthyomyzon bdellium*	1
Coulters Bridge	Quillback	*Carpiodes cyprinus*	2
Coulters Bridge	Rainbow trout	*Oncorhynchus mykiss*	1
Coulters Bridge	Redbreast sunfish	*Lepomis auritus*	42
Coulters Bridge	Redline darter	*Etheostoma rufilineatum*	428
Coulters Bridge	River chub	*Nocomis micropogon*	53
Coulters Bridge	River redhorse	*Moxostoma carinatum*	7
Coulters Bridge	Rock bass	*Ambloplites rupestris*	72
Coulters Bridge	Sickle darter	*Percina williamsi*	7
Coulters Bridge	Silver shiner	*Notropis photogenis*	22
Coulters Bridge	Smallmouth bass	*Micropterus dolomieu*	13
Coulters Bridge	Spotfin shiner	*Cyprinella spiloptera*	8
Coulters Bridge	Spotted bass	*Micropterus punctulatus*	6
Coulters Bridge	Spotted sucker	*Minytrema melanops*	4
Coulters Bridge	Stargazing minnow	*Phenacobius uranops*	2

Table 11. Continued.

Site	Common Name	Species	Number
Coulters Bridge	Striped shiner	*Luxilus chrysocephalus*	58
Coulters Bridge	Tangerine darter	*Percina aurantiaca*	9
Coulters Bridge	Telescope shiner	*Notropis telescopus*	60
Coulters Bridge	Tennessee darter	*Etheostoma tennesseense*	39
Coulters Bridge	Tennessee shiner	*Notropis leuciodus*	88
Coulters Bridge	Unidentified lamprey (I)	*Ichthyomyzon sp.*	2
Coulters Bridge	Unidentified lamprey (L)	*Lampetra sp.*	2
Coulters Bridge	Warpaint shiner	*Luxilus coccogenis*	127
Coulters Bridge	Whitetail shiner	*Cyprinella galactura*	161
Coulters Bridge	Yellow bullhead	*Ameiurus natalis*	1
Townsend	American brook lamprey	*Lethenteron appendix*	1
Townsend	Banded darter	*Etheostoma zonale*	29
Townsend	Banded sculpin	*Cottus carolinae*	82
Townsend	Bigeye chub	*Hybopsis amblops*	4
Townsend	Black redhorse	*Moxostoma duquesnei*	26
Townsend	Blotched chub	*Erimystax insignis*	32
Townsend	Blotchside logperch	*Percina burtoni*	1
Townsend	Bluegill	*Lepomis macrochirus*	22
Townsend	Gilt darter	*Percina evides*	2
Townsend	Green sunfish	*Lepomis cyanellus*	7
Townsend	Greenside darter	*Etheostoma blennioides*	28
Townsend	Highland shiner	*Notropis micropteryx*	7
Townsend	Hybrid sunfish	*Hybrid lepomis spp.*	1
Townsend	Largemouth bass	*Micropterus salmoides*	1
Townsend	Central stoneroller	*Campostoma anomalum*	25
Townsend	Mimic shiner	*Notropis volucellus*	5
Townsend	Mountain brook lamprey	*Ichthyomyzon greeleyi*	16
Townsend	Mountain shiner	*Lythrurus lirus*	5
Townsend	Northern hog sucker	*Hypentelium nigricans*	28
Townsend	Northern studfish	*Fundulus catenatus*	5
Townsend	Rainbow trout	*Oncorhynchus mykiss*	1
Townsend	Redbreast sunfish	*Lepomis auritus*	5
Townsend	Redline darter	*Etheostoma rufilineatum*	149
Townsend	River chub	*Nocomis micropogon*	43
Townsend	Rock bass	*Ambloplites rupestris*	41
Townsend	Silver shiner	*Notropis photogenis*	16
Townsend	Smallmouth bass	*Micropterus dolomieu*	6
Townsend	Striped shiner	*Luxilus chrysocephalus*	2
Townsend	Telescope shiner	*Notropis telescopus*	119
Townsend	Tennessee darter	*Etheostoma tennesseense*	26
Townsend	Tennessee shiner	*Notropis leuciodus*	245
Townsend	Warpaint shiner	*Luxilus coccogenis*	64
Townsend	Whitetail shiner	*Cyprinella galactura*	56

Figure 8. Trends in the Index of Biotic Integrity (IBI) at two stations in Little River (1987-2015).



Benthic macroinvertebrates collected in our sample at Coulters Bridge comprised 31 families representing 45 identified genera (Table 12). The most abundant group in our collection was the mayflies comprising 26.9% of the total sample. Overall, a total of 55 taxa were identified from the sample of which 24 were EPT. Based on the EPT taxa richness and overall biotic index of all species collected, the relative health of the benthic community was classified as "Good" (4.3).

Table 12. Taxa list and associated biotic statistics for benthic macroinvertebrates collected from the Little River at Coulters Bridge.

ORDER/GROUP	FAMILY	SPECIES	NUMBER	PERCENT
AMPHIPODA				1.7
	Crangonyctidae	*Synurella*	7	
ANELLIDA				2.2
	Oligochaeta		9	
COLEOPTERA				12.8
	Dryopidae	*Helichus* adults	7	
	Elmidae	*Ancyronyx variegatus*	2	
		Dubiraphia larva	1	
		Macronychus glabratus adults	5	

Table 12. Continued.

ORDER/GROUP	FAMILY	SPECIES	NUMBER	PERCENT
		Optioservus larvae	2	
		Optioservus trivittatus adult	8	
		Promoresis elegans adults	12	
	Gyrinidae	*Dineutus discolor* adults	10	
	Psephenidae	*Psephenus herricki* larvae and adults	5	
DIPTERA				14.8
	Athericidae	*Atherix lantha*	16	
	Ceratopogonidae	*Palpomyia* complex	1	
	Chironomidae	larvae	30	
	Simuliidae	larvae	13	
EPHEMEROPTERA				26.9
	Baetidae	*Baetis*	5	
	Ephemerellidae	*Serratella* sp. 1	8	
		Serratella sp. 2	4	
	Heptageniidae	*Maccaffertium* early instars	5	
		Maccaffertium exiguum	1	
		Maccaffertium mediopunctatum	27	
		Maccaffertium modestum	9	
		Rhithrogena	1	
		Stenacron interpunctatum	2	
	Isonychiidae	*Isonychia*	41	
	Leptohyphidae	*Tricorythodes*	6	
GASTROPODA				8.9
	Ancylidae	*Ferrissia*	5	
	Pleuroceridae	*Leptoxis*	20	
		Pleurocera sp. with stripes	9	
		Pleurocera sp. without stripes	2	
MEGALOPTERA				3.7

Table 12. Continued.

ORDER/GROUP	FAMILY	SPECIES	NUMBER	PERCENT
	Corydalidae	*Corydalus cornutus*	8	
		Nigronia serricornis	7	
ODONATA				14.1
	Aeshnidae	*Boyeria vinosa*	26	
	Calopterygidae	*Calopteryx*	6	
		Hetaerina americana	4	
	Corduliidae	*Helocordulia uhleri*	1	
	Gomphidae	*Gomphus lividus*	5	
		Gomphus rogersi	1	
		Hagenius brevistylus	3	
		Hylogomphus adelphus	2	
		Stylogomphus albistylus	4	
	Macromiidae	*Macromia*	5	
PELECYPODA				1.5
	Corbiculidae	*Corbicula fluminea*	6	
PLECOPTERA				2.5
	Perlidae	*Acroneuria abnormis*	3	
	Pteronarcyidae	*Pteronarcys dorsata*	7	
TRICHOPTERA				10.9
	Brachycentridae	*Brachycentrus lateralis*	4	
		Brachycentrus nigrosoma	1	
		Micrasema wataga	4	
	Hydropsychidae	*Ceratopsyche morosa*	4	
		Cheumatopsyche larave	10	
		Hydropsyche venularis	9	
	Leptoceridae	*Nectopsyche exquisita*	4	
		Nectopsyche pavida	1	
		Ocetis	1	

Table 12. Continued.

ORDER/GROUP	FAMILY	SPECIES	NUMBER	PERCENT
		Triaenodes perna	1	
	Philopotamidae	*Chimarra*	3	
	Polycentropodidae	*Polycentropus*	1	
		Total	404	

TAXA RICHNESS = 55
EPT RICHNESS = 24
BIOCLASSIFICATION = 4.3 (GOOD)

Benthic macroinvertebrates collected in our sample at Townsend comprised 33 families representing 47 identified genera (Table 13). The most abundant group in our collection was the mayflies comprising 32.6% of the total sample. Overall, a total of 49 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 13. Taxa list and associated biotic statistics for benthic macroinvertebrates collected from the Little River at Townsend.

ORDER/GROUP	FAMILY	SPECIES	NUMBER	PERCENT
AMPHIPODA				1.2
	Crangonyctidae	*Synurella*	4	
ANELLIDA				4.9
	Branchiobdellida		14	
	Oligochaeta		2	
COLEOPTERA				9.5
	Dryopidae	*Helichus* adults	3	
	Elmidae	*Ancyronyx variegatus*	2	
		Macronychus glabratus adults	4	
		Microcylloepus pusillus adult	1	
		Promoresis elegans larvae and adults	7	
		Stenelmis larvae	3	
	Psephenidae	*Psephenus herricki* larvae	11	
DIPTERA				11.3
	Athericidae	*Atherix lantha*	1	
	Chironomidae	larvae and pupa	26	
	Simuliidae	larvae	10	
EPHEMEROPTERA				32.6
	Baetidae	*Baetis*	9	
	Caenidae	*Caenis*	5	
	Ephemerellidae	*Serratella* sp.	4	
	Heptageniidae	*Heptagenia*	2	
		Leucrocuta	9	

Table 13. Continued.

ORDER/GROUP	FAMILY	SPECIES	NUMBER	PERCENT
		Maccaffertium mediopunctatum	38	
		Maccaffertium undetermined	5	
		Stenacron interpunctatum	6	
	Isonychiidae	*Isonychia*	17	
	Leptohyphidae	*Tricorythodes*	6	
	Leptophlebiidae	*Paraleptophlebia*	1	
	Neoephemeridae	*Neoephemera purpurea*	5	
GASTROPODA				4.6
	Ancylidae	*Ferrissia*	1	
	Pleuroceridae	*Leptoxis*	7	
		Pleurocera sp. with stripes	5	
		Pleurocera sp. without stripes	2	
HEMIPTERA				1.5
	Veliidae	*Rhagovelia obesa* adults	5	
MEGALOPTERA				1.2
	Corydalidae	*Corydalus cornutus*	2	
		Nigronia serricornis	2	
ODONATA				13.4
	Aeshnidae	*Boyeria vinosa*	10	
	Calopterygidae	*Calopteryx*	2	
		Hetaerina americana	3	
	Gomphidae	early instars	9	
		Hagenius brevistylus	6	
		Hylogomphus adelphus	2	
		Ophiogomphus mainensis	1	
		Stylogomphus albistylus	8	
	Macromiidae	*Macromia*	3	
PELECYPODA				0.6
	Corbiculidae	*Corbicula fluminea*	2	
PLECOPTERA				0.9
	Leuctridae	*Leuctra*	2	
	Pteronarcyidae	*Pteronarcys dorsata*	1	
TRICHOPTERA				18.0
	Brachycentridae	*Brachycentrus lateralis*	17	
		Micrasema wataga	8	
	Goeridae	*Goera calcarata*	1	
	Hydropsychidae	*Ceratopsyche morosa*	4	
		Ceratopsyche sparna	1	
		Cheumatopsyche	2	
		Undetermined sp.	1	
	Leptoceridae	*Nectopsyche exquisita*	9	
		Triaenodes ignitus	4	
		Triaenodes perna	1	
		Oecetis avara	3	
	Polycentropodidae	*Polycentropus*	8	

Table 13. Continued.

ORDER/GROUP	FAMILY	SPECIES	NUMBER	PERCENT
TURBELLARIA			1	0.3
		Total	328	

TAXA RICHNESS = 49
EPT RICHNESS = 24
BIOCLASSIFICATION = 3.5 (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

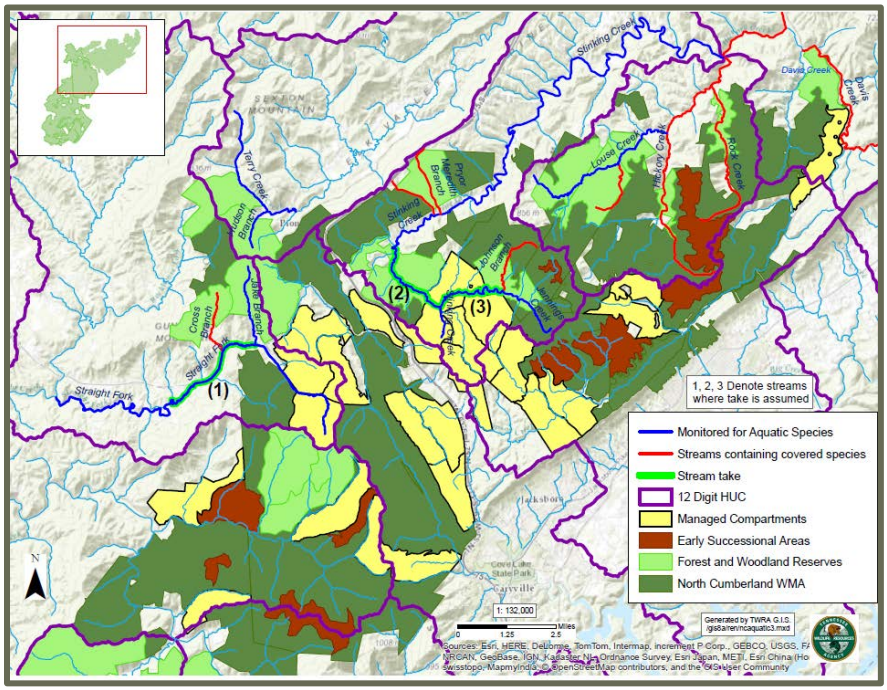
Introduction

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.

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 listed 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 2015 marked the fifth year of baseline monitoring for the streams identified in the plan. Figure 9 illustrates the location of the monitoring streams in relation to the managed compartments and HCP reserves (no action).

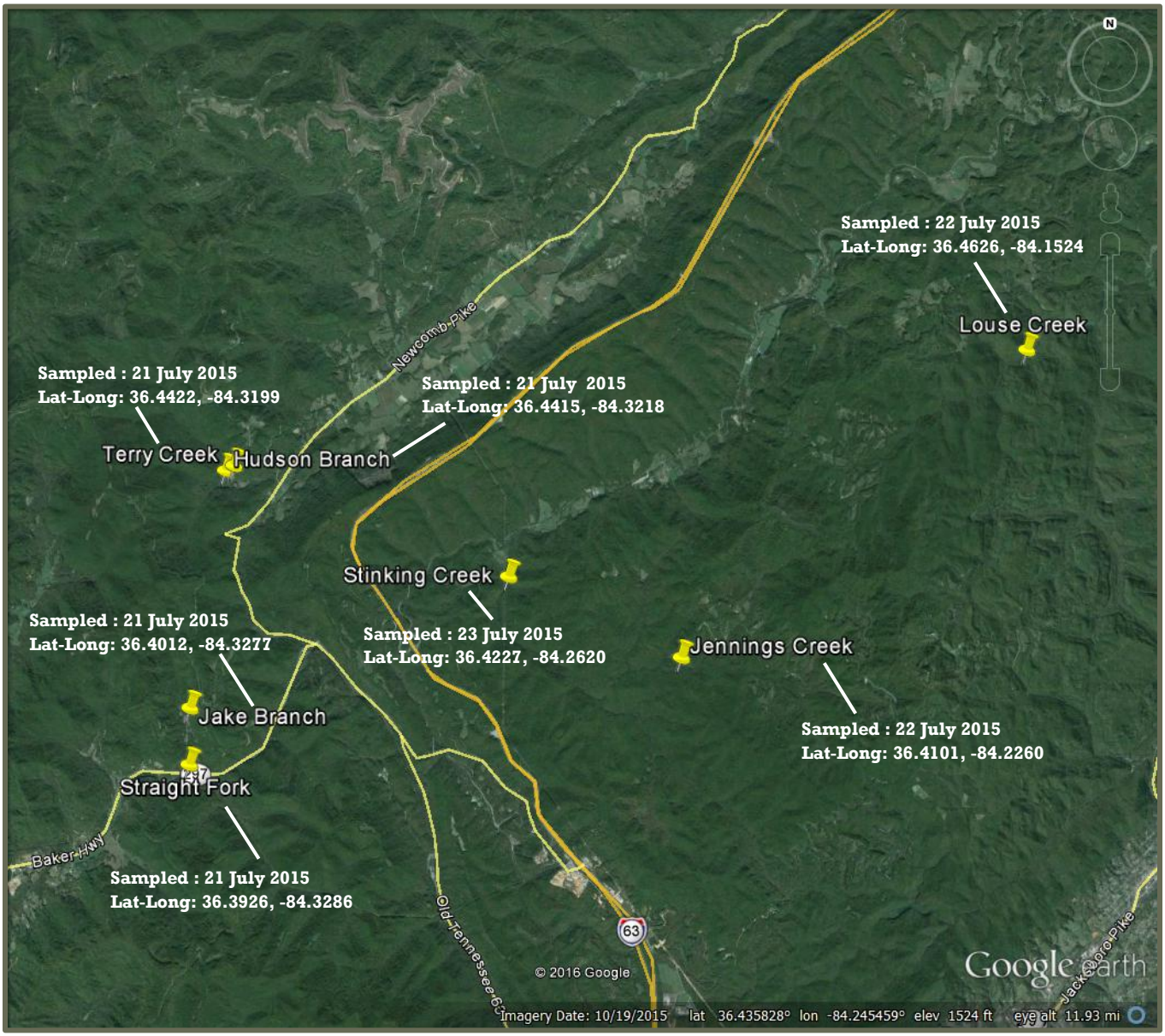
Figure 9. North Cumberland Habitat Conservation Plan monitoring streams.



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 10 depicts these survey sites and their geographical relationship to each other.

Figure 10. North Cumberland Habitat Conservation Plan monitoring site distribution.



We conducted surveys between July 21 and July 23. 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 2015. 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 14. Temperatures ranged from 21.6 to 23.7 degrees C while conductivities varied between 71 and 233.4 µs/cm (Table 14). Hudson Branch and Stinking Creek had the lowest conductivities of the seven streams. Potential hydrogen values were relatively consistent among streams, ranging from 6 to 6.2. Stream habitat scores ranged from 115 to 146 which were all in the "sub-optimal" range although Terry Creek did approach the "optimal" category at 146. Electrofishing effort ranged from 949 to 1884 seconds.

Table 14. Water quality, habitat score, and electrofishing effort for seven streams monitored as part of the North Cumberland Habitat Conservation Plan 2015.

Stream	Temperature (C)	Conductivity	pH	Habitat Score	Electrofishing Effort (Seconds)
Straight Fork	21.9	208.3	6.0	116	1288
Jake Branch	23.0	233.4	6.2	115	1404
Hudson Branch	23.7	86.5	6.0	121	1215
Terry Creek	23.7	112.6	6.2	146	949
Stinking Creek	21.8	71.0	6.2	121	1884
Louse Creek	22.3	114.9	6.2	140	1733
Jennings Creek	21.6	110.7	6.2	117	1350

Stinking Creek had the highest fish diversity (13) of the seven streams samples followed by Terry Creek (11). All other streams with exception of Louse Creek and Jennings Creek contained six species of fish during the 2015 survey (Table 15). Of the seven streams, Straight Fork, Jake Branch, Hudson Branch, Terry Creek all had blackside present in the 2015 surveys. Although blackside dace do occur in Louse Creek, none were collected during the 2015 survey. Cumberland arrow darter was present in Terry Creek, Stinking Creek, Louse Creek

and Jennings Creek. Cumberland arrow darter was not encountered in Hudson Branch during 2015, but has been present in low numbers in previous samples.

Table 15. Fish species occurrence and abundance for seven streams monitored as part of the North Cumberland Habitat Conservation Plan 2015.

Stream	Common Name	Species	Number
Straight Fork	Bluegill	*Lepomis macrochirus*	20
Straight Fork	Green Sunfish	*Lepomis cyanellus*	32
Straight Fork	Blackside Dace	*Chrosomus cumberlandensis*	23
Straight Fork	Southern Redbelly Dace	*Chrosomus erythrogaster*	4
Straight Fork	Creek Chub	*Semotilus atromacualtus*	ABUNDANT
Straight Fork	Blacknose Dace	*Rhinicthys atratulus*	RARE
Jake Branch	Creek Chub	*Semotilus atromaculatus*	ABUNDANT
Jake Branch	Green Sunfish	*Lepomis cyanellus*	14
Jake Branch	Central Stoneroller	*Campostoma anomalum*	SCARCE
Jake Branch	Blacknose Dace	*Rhinicthys atratulus*	RARE
Jake Branch	Blackside Dace	*Chrosomus cumberlandensis*	7
Jake Branch	Southern Redbelly Dace	*Chrosomus erythrogaster*	2
Hudson Branch	Green Sunfish	*Lepomis cyanellus*	3
Hudson Branch	Central Stoneroller	*Campostoma anomalum*	RARE
Hudson Branch	Rainbow Darter	*Etheostoma caeruleum*	RARE
Hudson Branch	Stripetail Darter	*Etheostoma kennicotti*	SCARCE
Hudson Branch	Striped Shiner	*Luxilus chrysocephalus*	RARE
Hudson Branch	Blackside Dace	*Chrosomus cumberlandensis*	5
Terry Creek	Redbreast Sunfish	*Lepomis auritus*	3
Terry Creek	Green Sunfish	*Lepomis cyanellus*	1
Terry Creek	Creek Chub	*Semotilus atromaculatus*	ABUNDANT
Terry Creek	Stripetail Darter	*Etheostoma kennicotti*	ABUNDANT
Terry Creek	Northern Hog Sucker	*Hypentelium nigricans*	COMMON
Terry Creek	Rainbow Darter	*Etheostoma caeruleum*	COMMON
Terry Creek	Central Stoneroller	*Campostoma anomalum*	COMMON
Terry Creek	Blacknose Dace	*Rhinicthys atratulus*	RARE
Terry Creek	Blackside Dace	*Chrosomus cumberlandensis*	24
Terry Creek	Southern Redbelly Dace	*Chrosomus erythrogaster*	2
Terry Creek	Hybrid	*S. atromaculatus x C. cumberlandensis*	1
Terry Creek	Cumberland Arrow Darter	*Etheostoma sagitta*	7
Stinking Creek	Rock Bass	*Ambloplites rupestris*	3
Stinking Creek	Bluegill	*Lepomis macrochirus*	1
Stinking Creek	Redbreast Sunfish	*Lepomis auritus*	3
Stinking Creek	Smallmouth Bass	*Micropterus dolomieu*	2
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*	SCARCE
Stinking Creek	Northern Hog Sucker	*Hypentelium nigricans*	RARE
Stinking Creek	Stripetail Darter	*Etheostoma kennicotti*	COMMON
Stinking Creek	Rainbow Darter	*Etheostoma caeruleum*	COMMON
Stinking Creek	Cumberland Arrow Darter	*Etheostoma sagitta*	8
Louse Creek	Green Sunfish	*Lepomis cyanellus*	1
Louse Creek	Northern Hog Sucker	*Hypentelium nigricans*	SCARCE
Louse Creek	Stripetail Darter	*Etheostoma kennicotti*	COMMON
Louse Creek	White Sucker	*Catostomus commersonii*	SCARCE
Louse Creek	Creek Chub	*Semotilus atromaculatus*	ABUNDANT
Louse Creek	Rainbow Darter	*Etheostoma caeruleum*	ABUNDANT
Louse Creek	Blacknose Dace	*Rhinicthys atratulus*	RARE
Louse Creek	Central Stoneroller	*Campostoma anomalum*	SCARCE
Louse Creek	Cumberland Arrow Darter	*Etheostoma sagitta*	3
Jennings Creek	Rock Bass	*Ambloplites rupestris*	9
Jennings Creek	Bluegill	*Lepomis macrochirus*	6
Jennings Creek	Creek Chub	*Semotilus atromaculatus*	COMMON
Jennings Creek	Stripetail Darter	*Etheostoma kennicotti*	COMMON
Jennings Creek	Cumberland Arrow Darter	*Etheostoma sagitta*	9

Covered species under the HCP, blackside dace and Cumberland arrow darter, exhibited varying trends in CPUE during the 2015 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. Straight Fork saw a 192% increase in catch while the Jake Branch catch increased 132% from the previous year. Overall, the 2015 catch in Straight Fork was the highest recorded since the survey was started in 2011 (Figure 11). The 2015 catch in Jake Branch was second highest for the same time period in this stream, but was far short of the 95.6 value recorded in 2011 (Figure 12).

Figure 11. Blackside dace population trends in Straight Fork 2011-15.

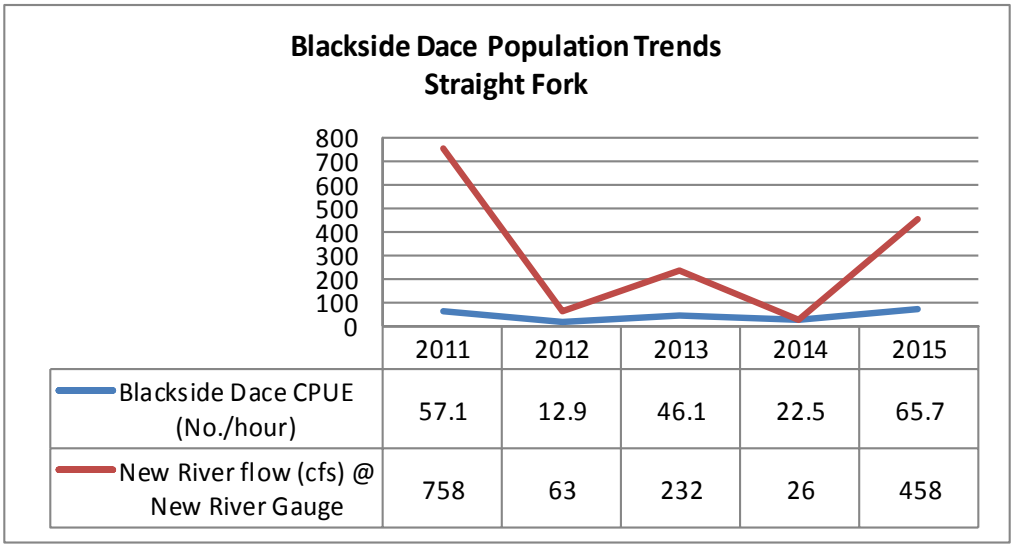
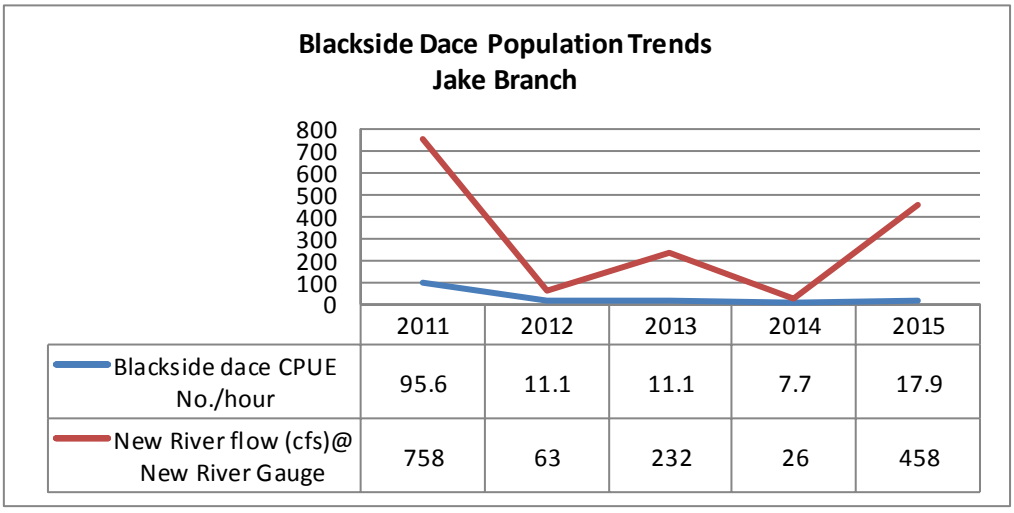
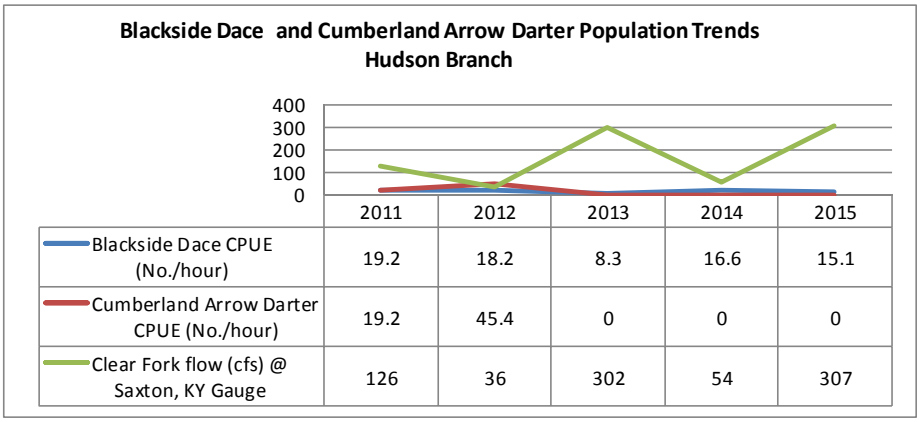


Figure 12. Blackside dace population trends in Jake Branch 2011-15.



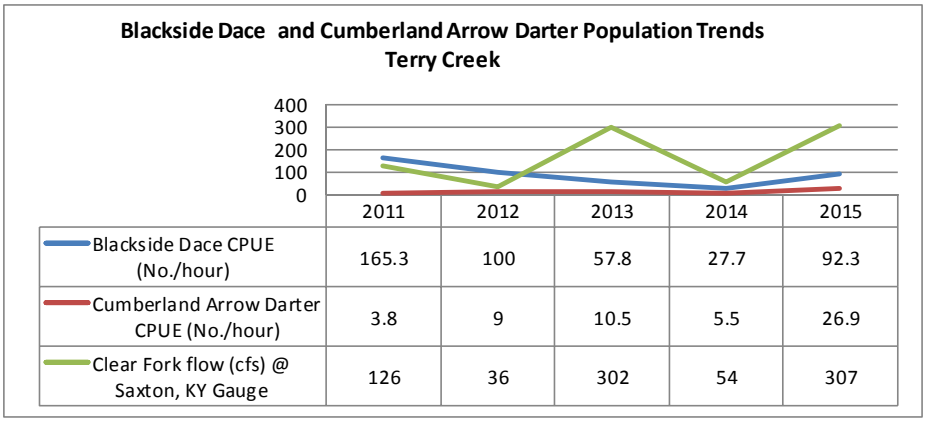
Habitat Conservation Plan monitoring streams in the Clear Fork Cumberland River drainage include Terry Creek and Husdon Branch which are tributaries to Elk Fork Creek, Stinking Creek and Louse Creek are tributaries to Hickory Creek and Jennings Creek flows in to Stinking Creek on the North Cumberland 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 and 2012. Our catch for this species in 2012 was highest of the two with a CPUE value of 45.4 (Figure 13). Blackside dace catches have remained relatively constant in Hudson Branch during the survey period with the exception of 2013 when the value decreased slightly relative to other surveys (Figure 13). 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 14). 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 2015 representing the highest catch recorded to date (Figure 14).

Figure 13. Blackside dace and arrow darter population trends in Hudson Branch 2011-15.



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

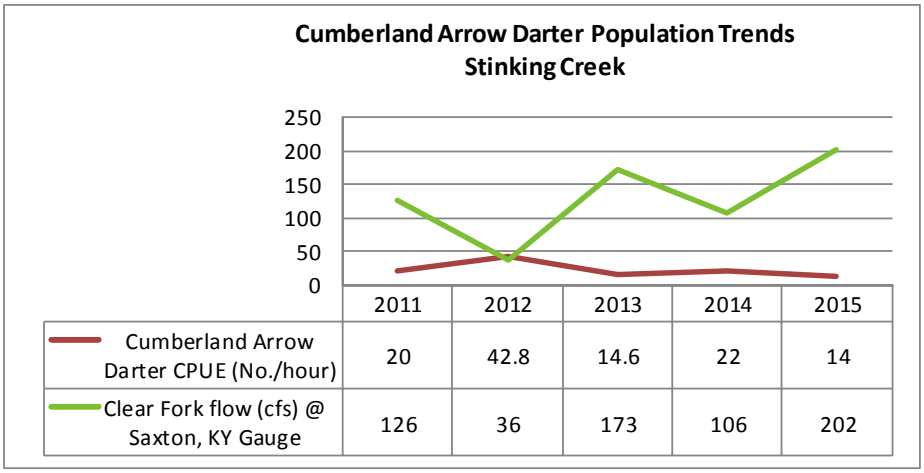
Figure 14. Blackside dace and arrow darter population trends in Terry Creek 2011-15.



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

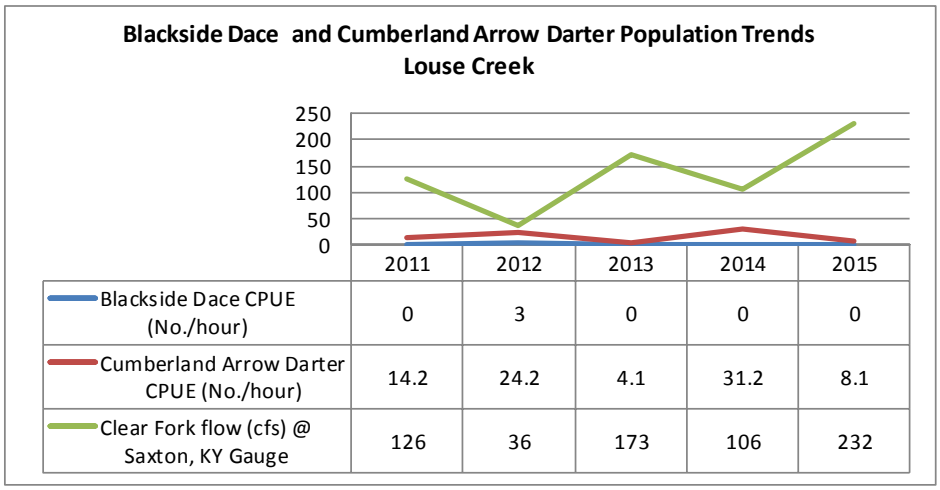
Stinking Creek consistently has high catches of Cumberland arrow darter and represents the most consistent stream of the five where it persists. Our catch in 2015 represented the lowest value we have observed during the survey period. Surveys conducted during higher flow usually result in a decreases capture efficiency for this species as illustrated in Figure 15. 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 consistently 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 16). We have collected specimens of blackside dace farther upstream during surveys conducted in 2002. Cumberland arrow darter has been observed during all surveys, although 2015 proved to be one of lowest catches observed during the survey period (Figure 16).

Figure 15. Arrow darter population trends in Stinking Creek 2011-15.



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

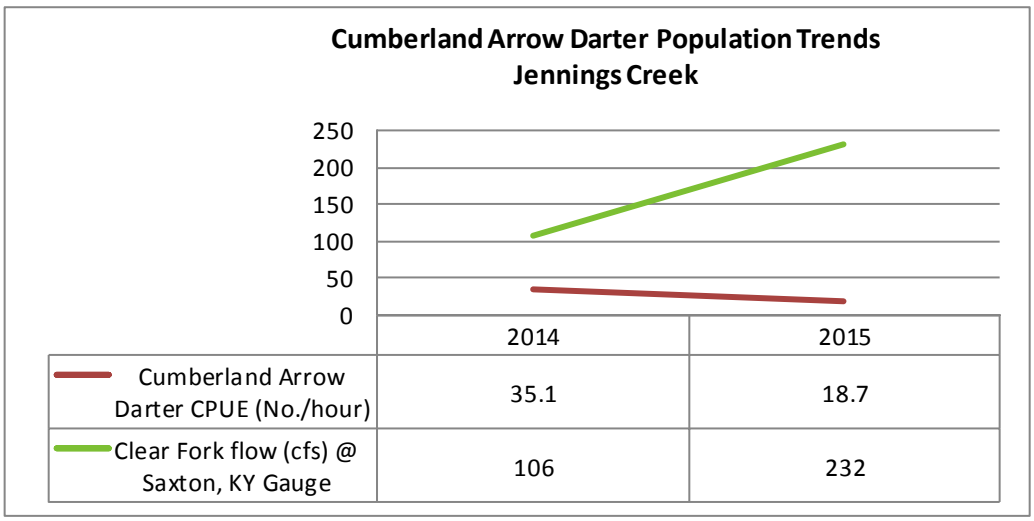
Figure 16. Blackside dace and arrow darter population trends in Louse Creek 2011-15.



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

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 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 2015, the catch declined by about half but was most likely associated with the high flow conditions encountered during the survey (Figure 17). 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 17. Cumberland arrow darter population trends in Jennings Creek 2014-15.



TWRA is committed to continuing monitoring efforts within the identified HCP streams and monitoring sites 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 in the region (e.g. coal mining) where these species may be impacted. Collected data has already been utilized by the USFWS to address permitting request for coal mining activities within the region.

Collection Efforts to Locate Tennessee Dace in Seven 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 2015 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-five 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 May to December of 2015.

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 a person assisting with a dipnet. Sample lengths were approximated in most cases and averaged around 200 m, but varied from about 50 to 600 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 collection 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), Page et al. (2013), and Powers and Mayden (2007).

Results and Discussion

Fish were collected from 55 electrofishing samples on 45 streams in Blount, Greene, Johnson, Knox, Monroe, Sevier, and Union counties. Six of the 45 streams had multiple

samples. Tennessee Dace were collected from 21 of the 45 streams sampled. Three were from historic locations and all the rest (18) represented new records. Thirty-two other sample sites produced no Tennessee Dace.

Tennessee Dace were collected from 21 streams in Blount, Greene, Knox, Monroe, and Sevier counties. The majority (14) came from streams in the East Fork (Little Pigeon River) and the Little Pigeon River watersheds in Sevier County. Four were in Blount County, and one each in Greene, Knox, and Monroe counties. Tennessee Dace were collected from three historical locations, Reed Creek in Blount County, Brice Branch in Knox County, and Mill Creek in Sevier County. Reed Creek is the type locality for Tennessee Dace (Starnes and Jenkins 1988) and they were present in two sample sites on Reed Creek and in two of its tributary streams.

Fifteen streams where Tennessee Dace were collected had the electrofishing time recorded for each sample, the rest did not. On those 15 streams, the sample time (switch-on time) averaged 1, 232 sec. and ranged from 391 to 2,193 sec. The sample length (approx.) averaged about 200 m and ranged from 50 to 600 m. And, Catch Per Unit Effort (CPUE) averaged 82.3 fish/hr. and ranged from 3.5 to 325.1 fish/hr. The average number of Tennessee Dace collected per sample from the 21 streams averaged 15.5 per sample (range of 2 to 69 fish). The most collected in any one sample (69) came from Kinzel Branch in Blount Co.

While looking for Tennessee Dace in the Doe Creek watershed of Johnson County, we collected *Chrosomus oreas* from a small Doe Creek tributary (Stalcup Branch) near Doeville. Thirty-two Mountain Redbelly Dace were collected from two sample areas on Stalcup Branch. This is the first known collection of this species in the Watauga River system in Tennessee. They have been collected from Dutch Creek in Watauga County at Valle Crucis, North Carolina in the Watauga River system as recent as 2013 and are common in that stream (personal communication; Bryn H. Tracy, Sr. Environmental Specialist, NC Division of Water Resources, NC Department of Environmental Quality). The only other collection of this species in Tennessee is from Laurel Creek in Johnson County. Mountain Redbelly Dace were collected in 2001 and again in 2010 (TWRA Cat. # 11.579, Cat. # 11.847, and UTEIC Cat. # 44.9825). Laurel Creek is in the South Holston River system. Specimens from the Stalcup Branch collection were sent to the UTEIC and also catalogued into the TWRA Collection (TWRA # 11.1421).

Sport Fish Surveys

French Broad River

Introduction

Like many of the larger rivers in east Tennessee, the French Broad has a long history of pollution related problems stemming from industry, urbanization, and agricultural activities within the watershed. Ichthyological studies within the watershed date back to the mid to late 1800's when Cope and Jordan made some of the first collections in the river (Harned 1979). The TVA (Harned 1979) probably conducted the most comprehensive survey of the river and watershed tributaries to date. One hundred seventeen sample stations were surveyed on the mainstem French Broad and four of its tributaries during the summer of 1977.

Study Area and Methods

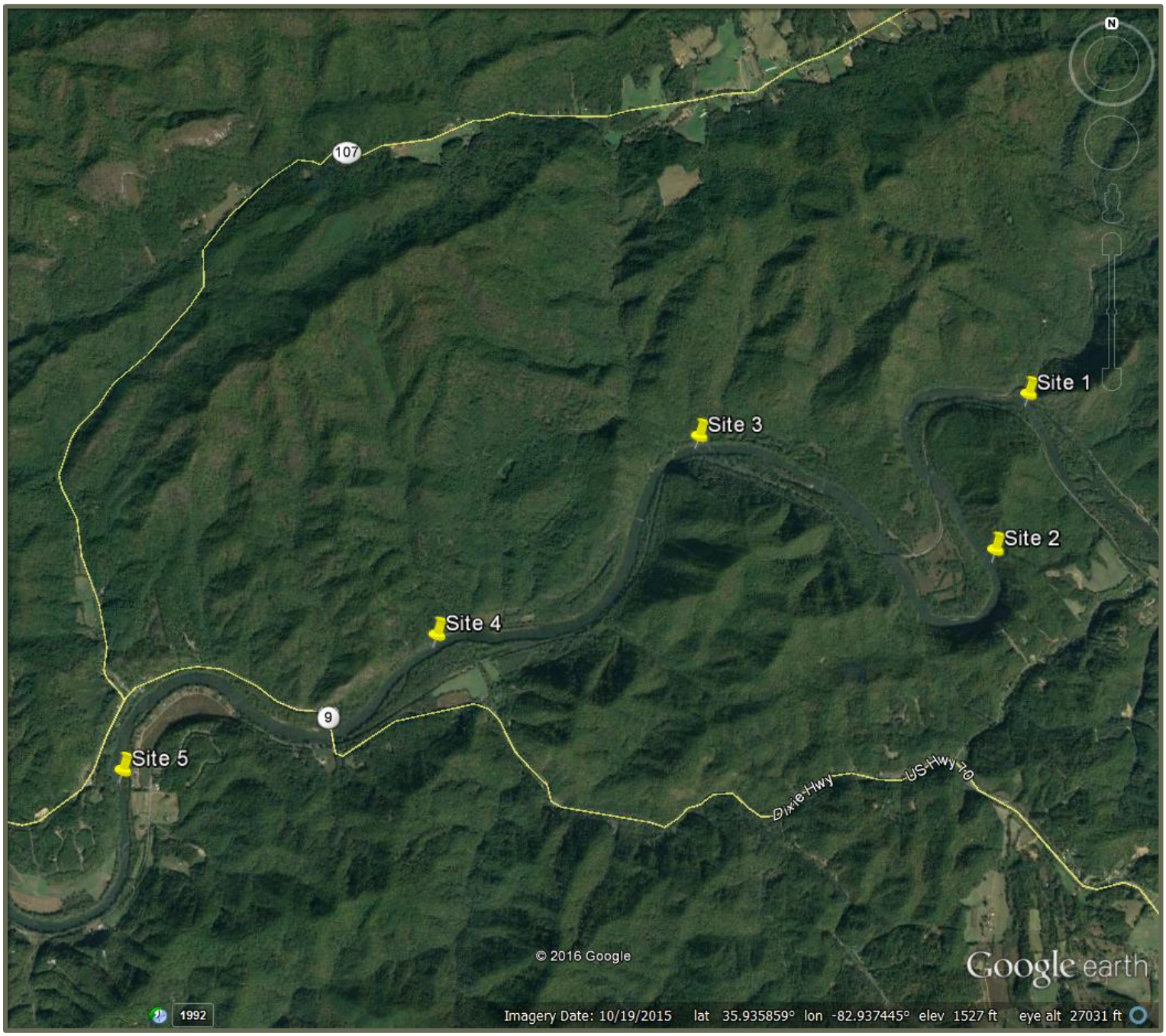
The French Broad River originates near Rosman, North Carolina and flows in a southwesterly direction before combining with the Holston River near Knoxville to form the Tennessee River. The French Broad has a drainage area of 13,177 km^2 and courses some 349 km from its headwaters to the confluence with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

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

Between April 22 and May 18, 2015 we sampled 14 sites (5 above Douglas Reservoir, 9 below Douglas Reservoir) (Figures 18 and 19). Boat electrofishing was used at both localities. Due to the nature of the river above Douglas Reservoir, we used our inflatable cataraft to

survey this section of the river. This boat allows us to survey in rough water where conventional aluminum electrofishing boats do not work. In the reach of river we sampled,

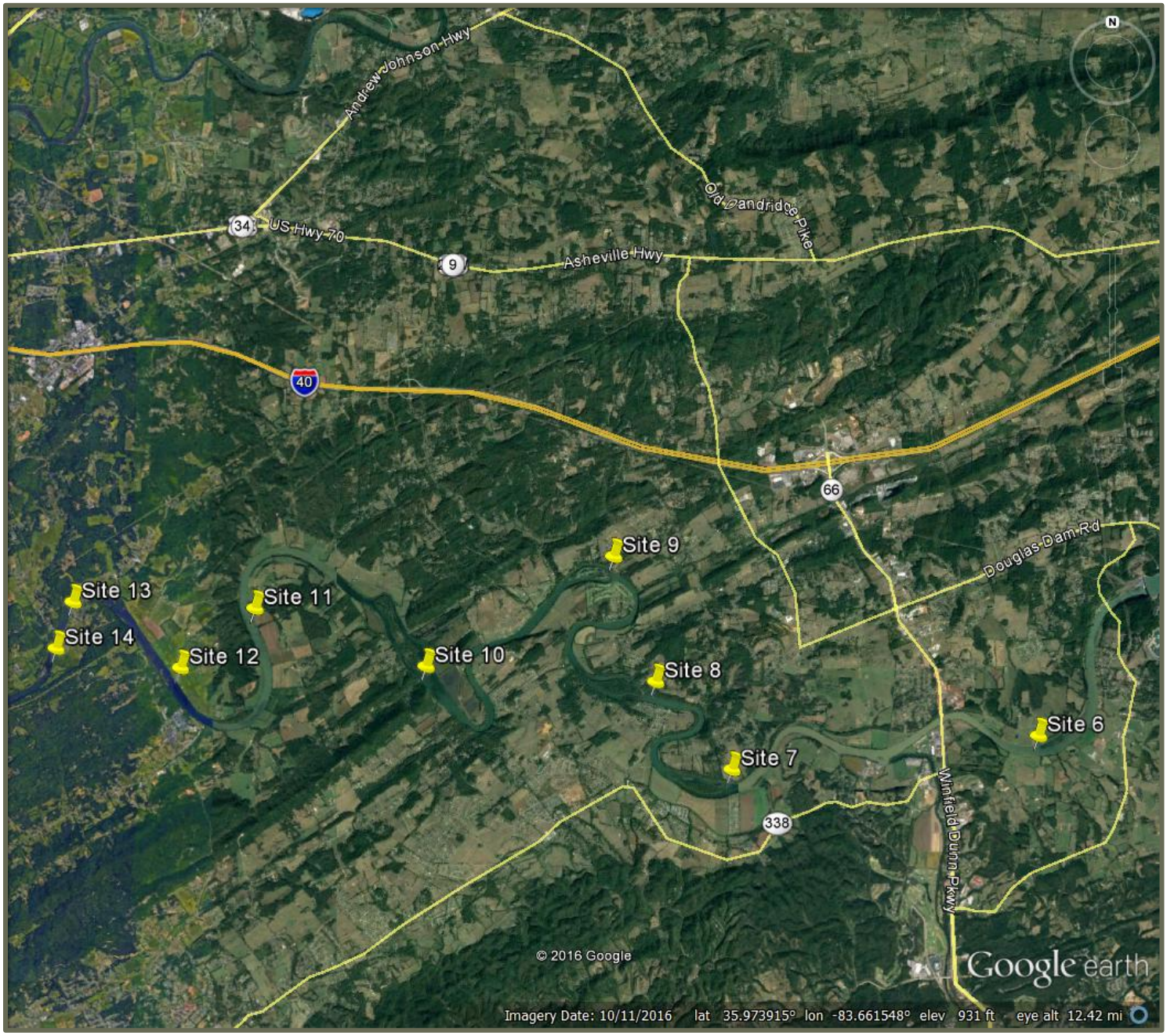
Figure 18. Locations of samples conducted in the French Broad River above Douglas Reservoir during 2015.



the native riparian vegetation was for the most part intact. There is more agricultural development in the tailwater reach of the river due to more suitable topography. Submerged

woody debris was scarce in most of our sample areas. The river substrate was predominately bedrock and boulder with some cobble in the riffle areas. Measured channel widths ranged

Figure 19. Site locations for samples conducted in the French Broad River below Douglas Reservoir during 2015.



from 61 to 304 m, while site lengths fell between 230 and 1246 m (Table 6). Water temperatures ranged from 10.5 to 23.8 C. Conductivity varied from 60 to 130 µs/cm (Table 16).

Table 16. Physiochemical and site location data for samples conducted on the French Broad River during 2015.

Site Code	Site	County	Quad	River Mile	Latitude	Longitude	Mean Width (m)	Length (m)	Temp.	Cond.	Secchi (m)
420150601	1	Cocke	Paint Rock 182NW	99.5	35.94394	-82.89837	109	500	23	60	-
420150602	2	Cocke	Paint Rock 182NW	98.9	35.93274	-82.90164	86	494	23.2	60.2	-
420150603	3	Cocke	Paint Rock 182NW	97.3	35.94114	-82.9277	72	496	23.4	60.3	-
420150604	4	Cocke	Paint Rock 182NW	95.3	35.92685	-82.95068	85.5	431	24	60.8	-
420150605	5	Cocke	Paint Rock 182NW	93.6	35.91739	-82.97733	61	230	23.8	60.5	-
420150606	6	Sevier	Douglas Dam 156NE	29.5	35.93250	-83.56306	146.6	1246	10.5	130	-
420150607	7	Sevier	Douglas Dam 156NE	25.1	35.92667	-83.63028	221	551	14	105	-
420150608	8	Sevier	Boyds Creek 156NW	22.4	35.94222	-83.64694	91.5	845	14.5	110	-
420150609	9	Sevier	Boyds Creek 156NW	19.5	35.96444	-83.65611	167	1027	-	-	-
420150610	10	Knox	Boyds Creek 156NW	15.5	35.94500	-83.69722	304	818	18	110	-
420150611	11	Knox	Boyds Creek 156NW	11.8	35.95528	-83.73472	175	759	17	130	-
420150612	12	Knox	Boyds Creek 156NW	9.3	35.94472	-83.75111	183	927	16	128	-
420150613	13	Knox	Shooks Gap 147NE	7.3	35.95639	-83.77472	127	277	15.5	120	-
420150614	14	Knox	Shooks Gap 147NE	6.6	35.94806	-83.77806	123	921	16	120	-

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 523 to 2107 seconds. Catch-per-unit-effort (CPUE) values were calculated for each target species at each site. Length categorization indices were calculated for target species following Gabelhouse (1984).

Results

CPUE estimates for smallmouth bass above Douglas Reservoir averaged 9.5/hour (SD 4.2), while the spotted bass and largemouth bass estimates were 0.5/hour (SD 1.2) and 0/hour, respectively (Table 17). Comparatively, mean CPUE estimates in 2012 were 26.6/hour for smallmouth bass and 2.0/hour for spotted bass (Figure 20). The smallmouth bass catch decreased 64% when compared to 2012. One rock bass were collected upstream of the reservoir in 2015. The mean catch rate for this species was 0.7/hour (SD 1.7). In samples conducted below Douglas Reservoir in 2015, smallmouth bass catches averaged 40.8/hour (SD 26.8). Spotted bass and largemouth bass catch rates were lower at 0.6/hour (SD 1.3) and 1.8/hour (SD 3.2), respectively. In comparison, the CPUE value for smallmouth bass in 2015 was about 30% lower than the value recorded in 2012 (Figure 21). Rock bass catches in this part of the river averaged 25.6/hour (SD 18.3) during 2015 (Table 17) and were considerably lower (64%) than the 2012 value (Figure 21).

Table 17. Catch per unit effort and length categorization indices of target species collected at 14 sites on the French Broad River during 2015 (Sites 1-5 above Douglas Reservoir, sites 6-14 below Douglas Reservoir)

Site Code	Smallmouth Bass CPUE	Spotted Bass CPUE	Largemouth Bass CPUE	Rock Bass CPUE
420150601	9.1	2.7	-	-
420150602	7.7	-	-	-
420150603	11.1	-	-	-
420150604	4	-	-	-
420150605	15.4	-	-	3.8
MEAN	***9.5***	***0.5***	-	***0.7***
STD. DEV.	***4.2***	***1.2***	-	***1.7***
Sites 1-5	Length-Categorization Analysis	Length-Categorization Analysis	Length-Categorization Analysis	Length-Categorization Analysis

Table 17. Continued.

	PSD = 60	PSD = 100	PSD = 0	PSD = 0
	RSD-Preferred = 0	RSD-Preferred = 0	RSD-Preferred = 0	RSD-Preferred = 0
	RSD-Memorable = 0	RSD-Memorable = 0	RSD-Memorable = 0	RSD-Memorable = 0
	RSD-Trophy = 0	RSD-Trophy = 0	RSD-Trophy = 0	RSD-Trophy = 0
420150606	16.2	-	7.7	10.8
420150607	86.1	-	-	58.3
420150608	74.2	3.2	-	19.3
420150609	31.0	-	1.7	17.2
420150610	33.3	-	-	27.2
420150611	48.0	-	-	8
420150612	53.8	-	-	7.7
420150613	14.3	-	7.1	50
420150614	10.8	2.7	-	32.4
MEAN	***40.8***	***0.6***	***1.8***	***25.6***
STD. DEV.	***26.8***	***1.3***	***3.2***	***18.3***
Sites 6-14	Length-Categorization Analysis	Length-Categorization Analysis	Length-Categorization Analysis	Length-Categorization Analysis
	PSD = 26.5	PSD = 50	PSD = 100	PSD = 35.6
	RSD-Preferred = 13.2	RSD-Preferred = 50	RSD-Preferred = 100	RSD-Preferred = 2.7
	RSD-Memorable = 3.6	RSD-Memorable = 0	RSD-Memorable = 0	RSD-Memorable = 0
	RSD-Trophy = 0	RSD-Trophy = 0	RSD-Trophy = 0	RSD-Trophy = 0

Figure 20. Trends in mean catch rate of black bass and rock bass collected between 2007-2015 from the French Broad River above Douglas Reservoir.

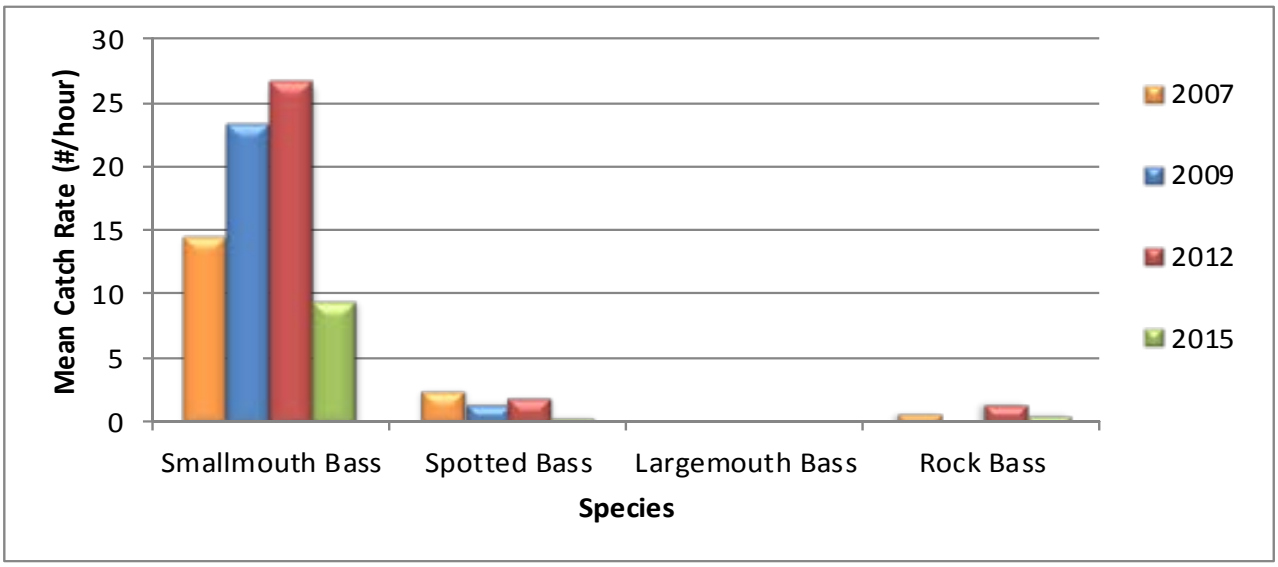
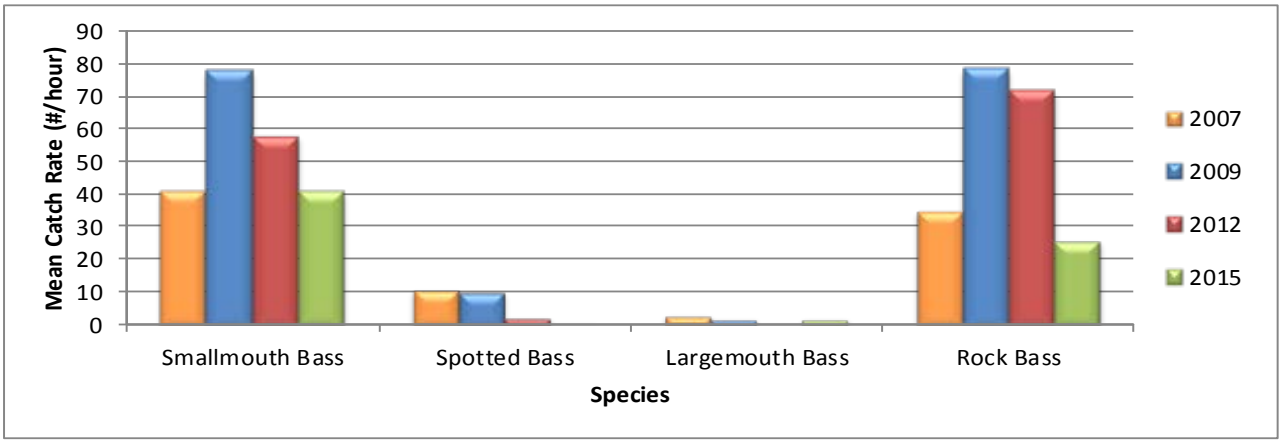
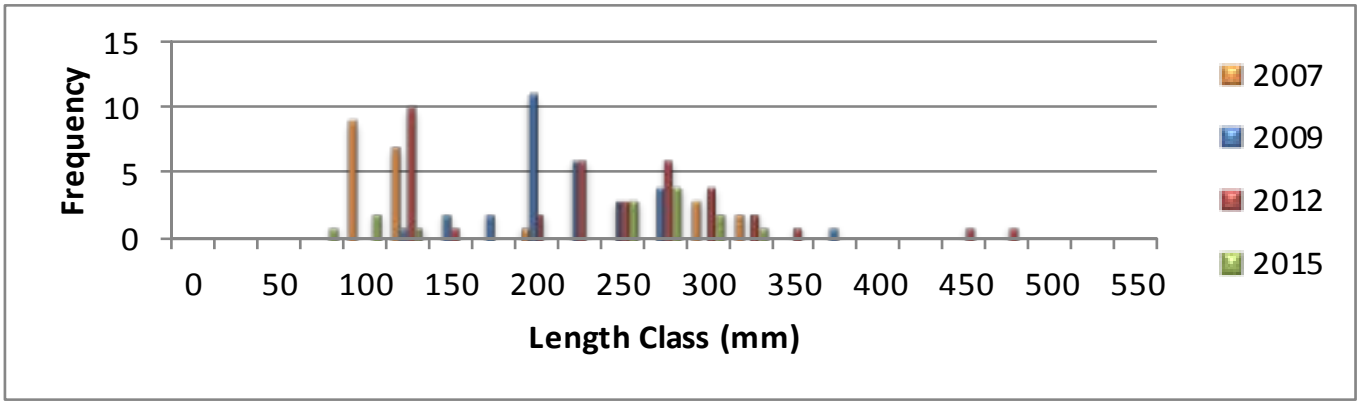


Figure 21. Trends in mean catch rate of black bass and rock bass collected between 2007-2015 in the French Broad River below Douglas Reservoir.



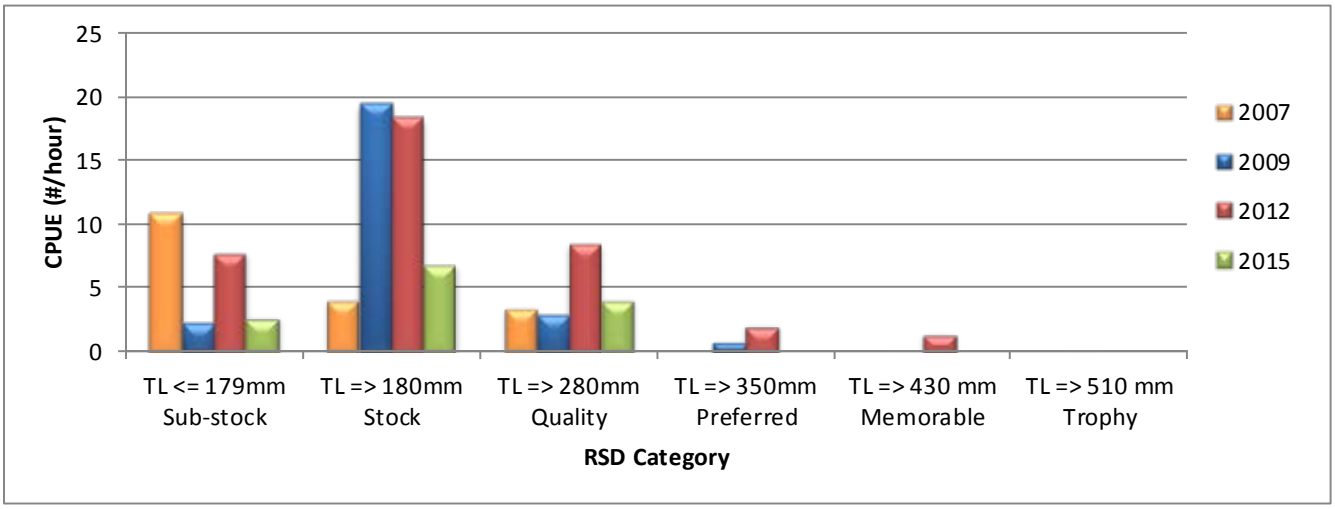
The length distribution of smallmouth bass above Douglas Reservoir was mainly comprised of individuals in the 250 to 325 mm size range. The overall distribution of size classes decreased in 2015 when compared to the previous survey. The catch of smallmouth bass was down significantly in 2015 with only 14 individuals represented in the five site survey (Figure 22).

Figure 22. Length frequency distributions for smallmouth bass collected from the French Broad River above Douglas Reservoir between 2007- 2015.



The 2015 Relative Stock Density (RSD) for preferred smallmouth bass (TL ≥ 350 mm) above the reservoir was 0. This was a slight decrease from the 2012 value of 1.5. We observed declines in all other RSD categories when compared to 2012. The PSD of smallmouth bass (ratio of quality size bass to stock size bass) was 60. The relative strength of the stock category observed in 2012 was encouraging but did not seem to carry forward to larger size categories (Figure 23).

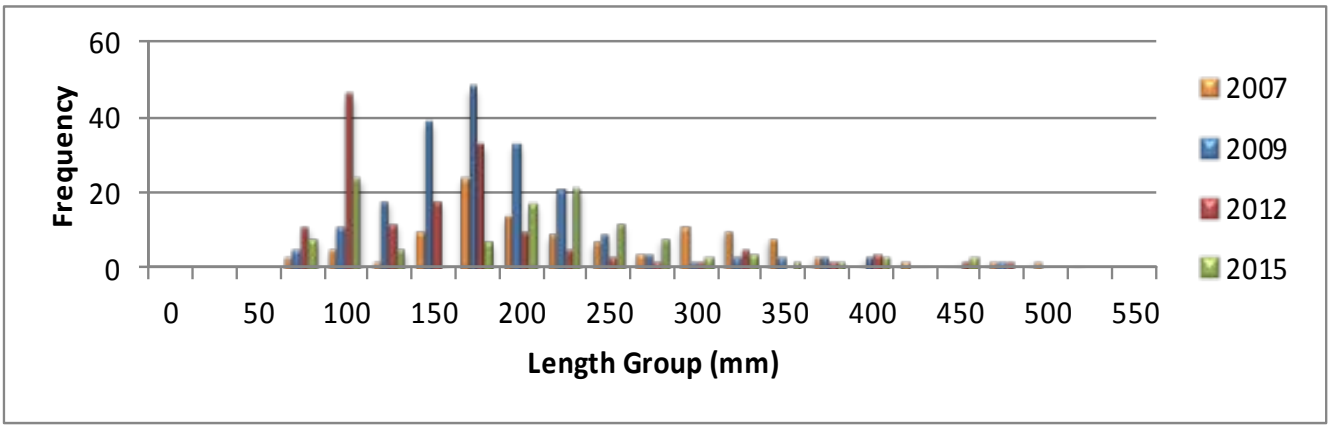
Figure 23. Relative stock density (RSD) catch per unit effort by category for smallmouth bass collected from the French Broad River above Douglas Reservoir between 2007-2015.



The length distribution of smallmouth bass below Douglas Reservoir was predominantly comprised of individuals in the 200 to 275 mm size range. We did collect three bass that were

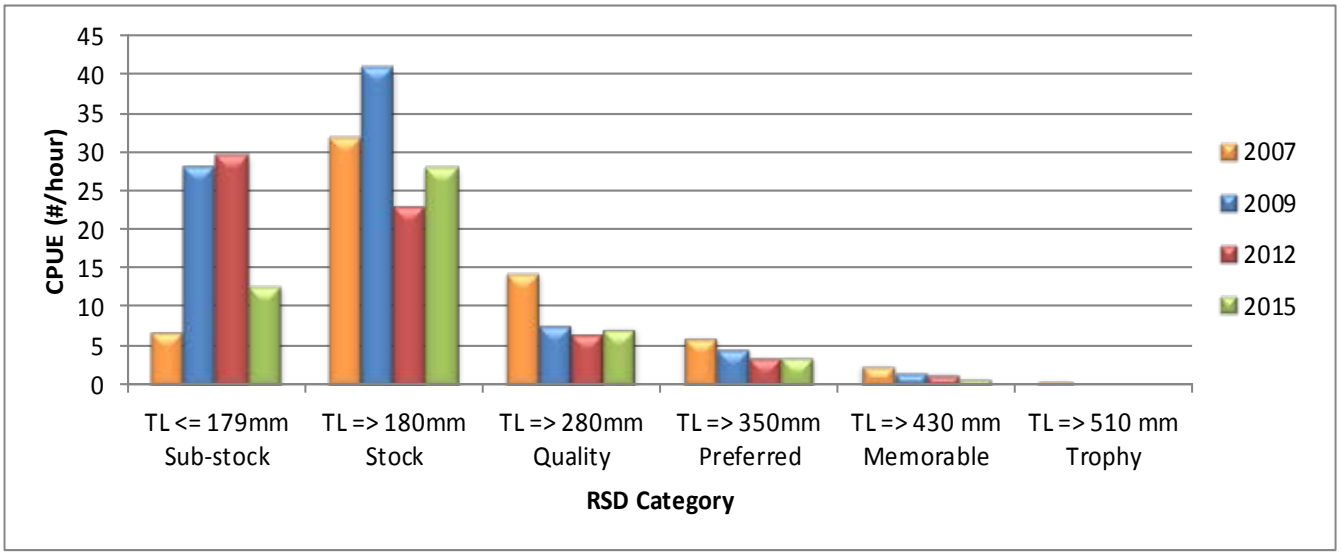
in the 17-18 inch class. Overall, the abundance of quality size bass in this section of the river was somewhat improved over the collection in 2012 (Figure 24).

Figure 24. Length frequency distribution for smallmouth bass collected from the French Broad River below Douglas Reservoir between 2007-2015.



Trends in catch per unit effort by RSD category below Douglas Reservoir appeared to follow a downward trend with the exception of the 2015 stock and quality class which increased slightly over the 2012 value (Figure 25). The PSD for smallmouth bass decreased slightly to 26.5 in 2015 from the 28.9 value in 2012.

Figure 25. Relative stock density (RSD) catch per unit effort by category for smallmouth bass collected from the French Broad River below Douglas Reservoir between 2007-2015.

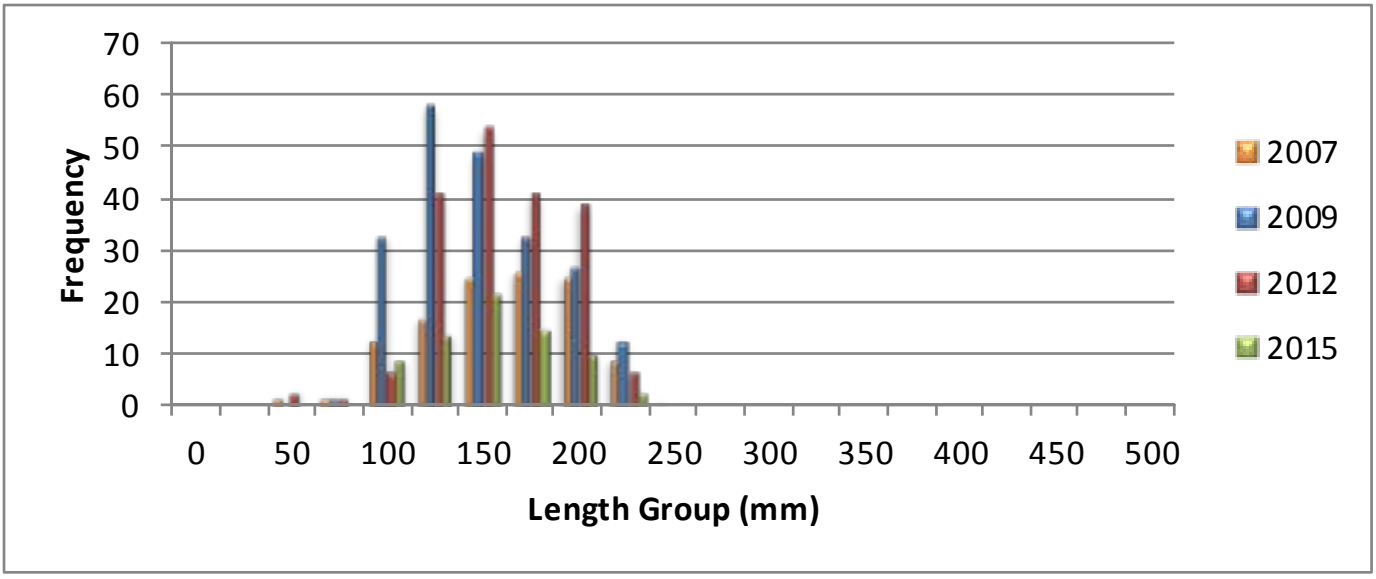


The three spotted bass collected from the French Broad River during 2015 ranged between 210 and 404 mm. Only one spotted bass spotted was collected from the upper French Broad. Because of the low number, no analyses were conducted for these fish.

Very few (3) largemouth bass were collected in the French Broad during 2015. None were collected in samples above Douglas Reservoir. Of those collected below the reservoir, size ranged from 88 to 422 mm. Because of the low number, no analyses were conducted for these fish.

We did collect one rock bass in the French Broad above Douglas Reservoir in 2015 (two in 2012, none in 2009 and one in 2007). We are hopeful that this species continues to persist in this section of the river. Rock bass are fairly intolerant to pollution and therefore are good indicators of habitat quality. We were encouraged to see them show up again in our 2015 sample and will be monitoring trends in future surveys. A total of 73 rock bass were collected in our survey of the lower French Broad River. This was down from 194 collected in the 2012 surveys. The size distribution was fairly typical of other riverine populations with the bulk of the fish falling in the 125 mm to 225 mm length range in 2015 (Figure 26).

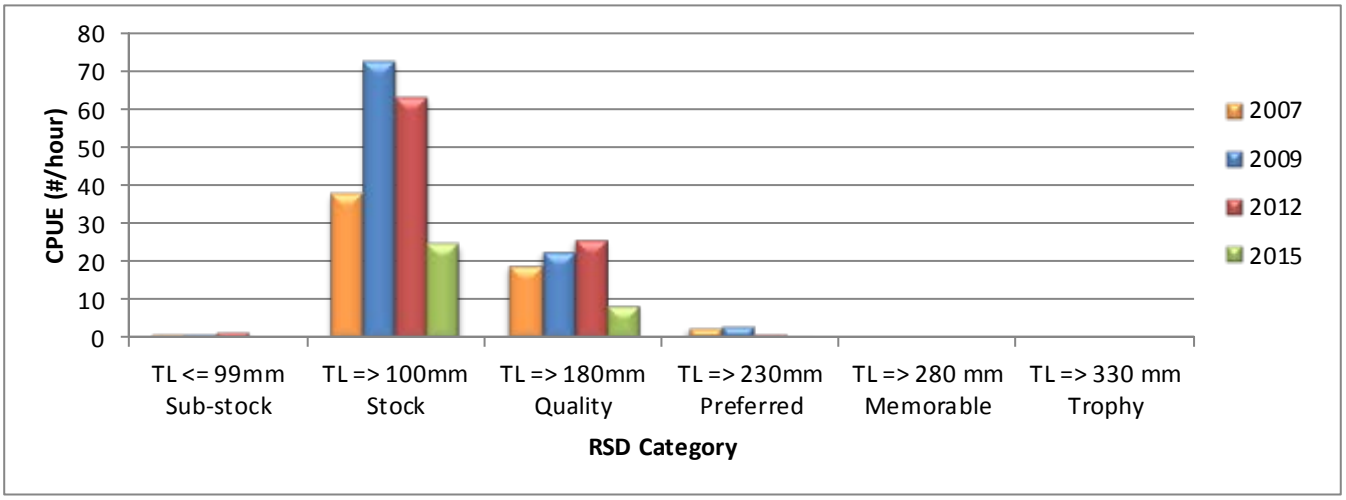
Figure 26. Length frequency distributions for rock bass collected from the French Broad River below Douglas Reservoir between 2007-2015.



PSD for the rock bass population in the lower French Broad was 35.6. This was down from the 2012 value of 41.2. The value for preferred rock bass (TL $\geq$ 230 mm) was 2.7. Memorable (TL $\geq$ 280 mm) and trophy (TL $\geq$ 330 mm) rock bass values were 0. Sub-stock catch of rock bass is typically low (Figure 27), however, this does not necessarily indicate the lack of reproduction. The vulnerability of these smaller fish to the electrofishing gear is

considerably lower. Recruitment of rock bass into the stock and quality size was lower in 2015, but proportional to the number of fish observed in the sample. About 36% of the captured fish were of quality size or better during 2015.

Figure 27. Relative stock density (RSD) catch per unit effort by category for rock bass collected in the French Broad River below Douglas Reservoir between 2007-2015.



Discussion

The French Broad River represents a valuable resource for the state. Although degraded over the years from residential, municipal, and agricultural growth, the river has seen improvement in water quality and maintains many of its scenic and natural characteristics. It supports and active whitewater rafting industry and is an important recreational resource for local residents. The fishery above Douglas reservoir is moderate at best, but does provide adequate angling opportunities that deserve management consideration. Probably the most abundant species we have encountered that would be sought by anglers is the channel catfish, although observed numbers have been low in recent surveys. In the section of the river below Douglas Reservoir, smallmouth bass fishing opportunities could be ranked as one of the region's best, producing some trophy size bass and numerous smallmouth that would be considered quality size. Water quality improvements to the tailwater section of the river by TVA have allowed for the recovery of selected species of fish and mussels. The snail darter, listed as threatened, is the most notable success story in the tailwater. Lake sturgeon stockings into the tailwater are continuing in hopes of recovering this species to some of its former range.

The establishment of a musky *(Esox masquinongy)* fishery in the reach of river upstream of Douglas Reservoir was initiated in 2009. The North Carolina Wildlife Resource Commission currently stocks 1,000 to 1,500 musky (Ohio Strain) in the French Broad River

every other year and until 2009 was the only possibility for musky to enter the Tennessee portion of the river. Since 2009 the French Broad has been receiving sporadic stockings of musky between river mile 77.4 and 100. In 2012, there were no musky stocked into the French Broad due to low survival at the hatchery. Three hundred were stocked in 2014 that were acquired from Table Rock Hatchery in North Carolina. We will continue to pursue out sources of musky for release into the French Broad as TWRA currently does not have a musky production program.

Access along the river is somewhat limited, although a good portion of the upper reach of the river is located on U.S. Forest Service land. There are three developed access points upstream of Douglas Reservoir, two are maintained by the USFS and one by TDOT. The USFS has one access just downstream of the Wolf Creek Bridge and another downstream of the Hwy. 107 bridge in Del Rio. The TDOT park and float access is located at the Hwy 70 bridge in Bridgeport. Developed public access downstream of Douglas Reservoir is limited to ramps at Douglas Dam (TVA), Highway 66 Bridge (TWRA) near Sevierville, Seven Islands and at Huffaker Ferry in Kodak. There are a few primitive ramps and pull-outs along some of the roads paralleling the river above and below Douglas Reservoir. We are scheduled to return to the French Broad in 2018.

Management Recommendations

1. Initiate an angler use survey on the river.
2. Develop additional public access above Douglas Reservoir.
3. Continue musky stocking program upstream of Douglas Reservoir.

Holston River

Introduction

The Holston River represents a valuable recreational resource to the state as it provides water based recreation to several communities, towns, and cities along its course. It is also an important source of drinking water for many populations between Kingsport and Knoxville. Historically, the Holston River has been subjected to many man-induced alterations including channelization, damming, and pollution. Two dams regulate most of the flow outside of tributaries that enter the river above and below these dams. Fort Patrick Henry Dam located on the South Fork Holston River near Kingsport controls the river between Boone Reservoir and Cherokee Reservoir. Releases from Fort Patrick Henry coincide with lake level management activities and the need for water at Eastman in Kingsport and the TVA John Sevier steam plant near Rogersville. With the completion of Cherokee Dam in 1941, much of the free flowing characteristics of the river basin within Tennessee were eliminated. Although a "controlled" river, the Holston still boasts a fairly diverse fish assemblage and is home to at least two threatened species (spotfin chub *Erimonax monacha* and snail darter *Percina tanasi*) and thirteen species of freshwater mussels (Ahlstedt 1986). Our 2015 surveys focused on re-evaluating the black bass and rock bass populations in the river above and below Cherokee Dam. We conducted the first intensive survey of these sport fish species in 2000 characterizing black bass and rock bass population structure and developing a fish species list for TADS. Historical surveys have been conducted on the river by various agencies, with the majority of these focusing on community assessment.

Gizzard Shad

Study Area and Methods

The Holston River originates near Kingsport with the confluence of the North Fork Holston and South Fork Holston rivers. These rivers along with the Middle Fork all originate in Virginia. The Holston flows in a southwesterly direction before combining with the French Broad River to form the headwaters of the Tennessee River. The river has a drainage area of approximately 9,780 km^2 at its confluence with the French Broad River. In Tennessee, approximately 184 kilometers of the Holston River flows through the Ridge and Valley ecological province before joining the French Broad River near Knoxville. Public access along the river is primarily private; however, there are some "pull-outs" along public roads paralleling the river. The TWRA manages three public access areas along the river, which include boat

ramps near Hunt Creek, the community of Surgoinsville, and Nance Ferry downstream of Cherokee Dam. TVA maintains access below Cherokee Dam. The cities of Church Hill and Kingsport both have public ramps at their city parks.

Between April 6 and September 30, 2015, we conducted 10 fish surveys between Kingsport and Mascot (Figures 28, 29). Because this reach of river is a tailwater, habitat availability fluctuates with water releases. However, in our survey sites, the habitat consisted primarily of wooded shorelines with interspersed rock outcroppings.

Figure 28. Site locations for samples conducted on the Holston River above Cherokee Reservoir during 2015.

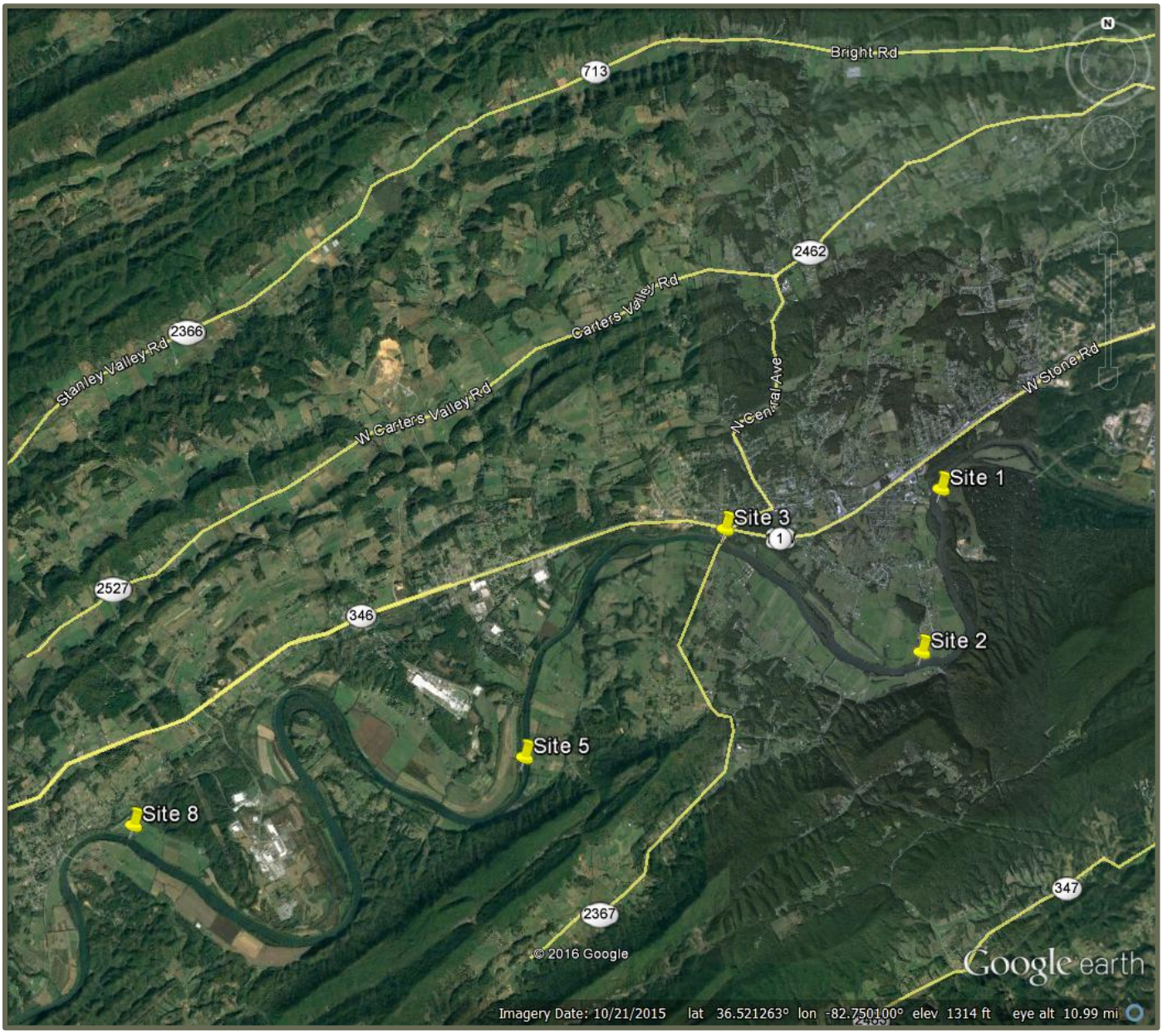
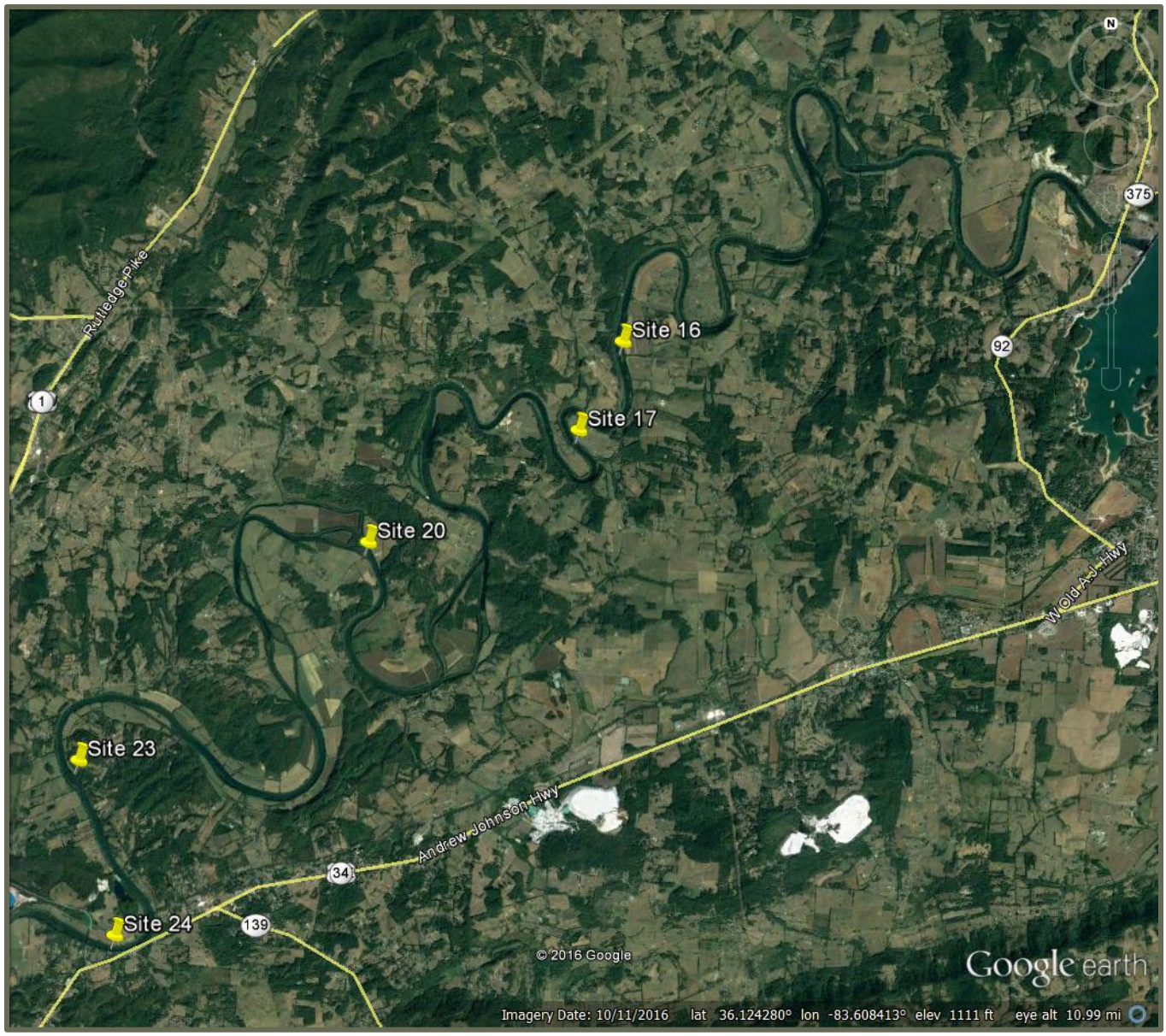


Figure 29. Site locations for samples conducted on the Holston River below Cherokee Reservoir during 2015.



Submerged woody debri was scarce in most of our sample areas. The river substrate was predominately bedrock and boulder with some cobble in the riffle areas. Measured channel widths ranged from 68 to 145 m, while site lengths fell between 125 and 1108 m (Table 18). Water temperatures ranged from were 13 to 14 C upstream of Cherokee Reservoir and 22.4 to 24 C downstream of Cherokee Reservoir. Conductivity varied from 210 to 250 upstream of the reservoir and 280 to 289 µs/cm downstream of the reservoir (Table 18). Because we were able to conduct the samples earlier in the year we were not hindered by the stargrass in that portion of the river above Cherokee Reservoir. This made navigating the river much easier

and probably increased our sampling efficiency to some degree. In recent years, the river channel becomes choked with this aquatic vegetation making navigation difficult during the summer months.

Table 18. Physiochemical and site location data for samples conducted on the Holston River during 2015.

Site Code	Site	County	Quad	River Mile	Latitude	Longitude	Mean Width (m)	Length (m)	Temp.	Cond.	Secchi (m)
420150501	1	Hawkins	Church Hill 188SW	136.3	36.52389	-82.68167	127	1108	13	250	-
420150502	2	Hawkins	Lovelace 189NW	134.1	36.49740	-82.68520	123	596	13	225	-
420150503	3	Hawkins	Church Hill 188SW	131.5	36.51694	-82.72306	111	375	14	210	-
420150505	5	Hawkins	Stony Point 180NE	127.5	36.48167	-82.76250	145	576	13	220	-
420150508	8	Hawkins	Stony Point 180NE	118.8	36.47167	-82.83833	139	419	13	220	-
420150516	16	Grainger/Jefferson	Joppa 155NE	38.8	36.14972	-83.60167	134.5	468	22.8	286	-
420150517	17	Grainger/Jefferson	Joppa 155NE	37.5	36.13583	-83.61028	68	125	23	289	-
420150520	20	Grainger/Jefferson	Mascot 155SW	28	36.11861	-83.65139	137.5	654	24	286	-
420150523	23	Jefferson/Knox	Mascot 155SW	19.7	36.08417	-83.70722	144	554	22.9	280	-
420150524	24	Knox	Mascot 155SW	17	36.05694	-83.70000	107.5	443	22.4	286	-

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 900 to 1028 seconds. Catch-per-unit-effort (CPUE) values were calculated for each target species at each site. Length categorization indices were calculated for target species following Gabelhouse (1984).

Results

CPUE estimates for smallmouth bass above Cherokee Reservoir averaged 29.2/hour (SD 25.9). This was a 61.4% decrease in the overall mean catch of smallmouth bass from the value observed in 2012 and was the lowest observed since 2007. There were no spotted bass and only one largemouth bass collected in this portion of the river (Table 19). Rock bass CPUE was 11.7/hour (SD 16.9) upstream of the reservoir in 2015. This represented a 69.5% decrease from the sample taken in 2012 and was only slightly higher than the lowest value recorded in 2007 (Figure 30). In samples conducted below Cherokee Reservoir, smallmouth bass catches averaged 82.6/hour (SD 50.2). Spotted bass and largemouth bass catch rates remained low or absent with only two largemouth bass being collected. In comparison, the smallmouth bass catch rate increased by 32.3% in 2015 from the catch recorded in 2012 (Figure 31) and was second only to the values recorded in 2009. Rock bass catches in this part of the river averaged 28.6/hour (SD 14.8) during 2015 (Figure 31). This was the lowest recorded value for rock bass in the section of the river since 2007.

Table 19. Catch per unit effort and length-categorization indices of target species collected at ten sites on the Holston River during 2015 (Sites 1-8 above Cherokee Reservoir, sites 16-24 below Cherokee Reservoir).

Site Code	Smallmouth Bass CPUE	Spotted Bass CPUE	Largemouth Bass CPUE	Rock Bass CPUE
420150501	7.1	-	-	-
420150502	21.4	-	-	3.6
420150503	72	-	-	40
420150505	12	-	-	-
420150508	33.3	-	3.0	15.1
MEAN	***29.2***		***0.6***	***11.7***
STD DEV.	25.9		1.3	16.9
Sites 1-8	Length-Categorization Analysis	Length-Categorization Analysis	Length-Categorization Analysis	Length-Categorization Analysis
	PSD = 66.6	PSD = 0	PSD = 100	PSD = 33.3
	RSD-Preferred = 45.8	RSD-Preferred = 0	RSD-Preferred = 100	RSD-Preferred = 0
	RSD-Memorable = 4.2	RSD-Memorable = 0	RSD-Memorable = 0	RSD-Memorable = 0
	RSD-Trophy = 0	RSD-Trophy = 0	RSD-Trophy = 0	RSD-Trophy = 0

Table 19. Continued.

420150516	68	-	-	40
420150517	80	-	-	12
420150520	48	-	5.7	20
420150523	169.2		-	23.1
420150524	48	-	-	48
MEAN	***82.6***	-	***1.1***	***28.6***
STD DEV.	50.2	-	2.5	14.8
Sites 16-24	Length-Categorization Analysis	Length-Categorization Analysis	Length-Categorization Analysis	Length-Categorization Analysis
	PSD = 34.8	PSD = 0	PSD = 0	PSD = 40.6
	RSD-Preferred = 13.9	RSD-Preferred = 0	RSD-Preferred = 0	RSD-Preferred = 3.1
	RSD-Memorable = 0	RSD-Memorable = 0	RSD-Memorable = 0	RSD-Memorable = 0
	RSD-Trophy = 0	RSD-Trophy = 0	RSD-Trophy = 0	RSD-Trophy = 0

Figure 30. Trends in mean catch rate of black bass and rock bass collected between 2007-2015 from the Holston River above Cherokee Reservoir.

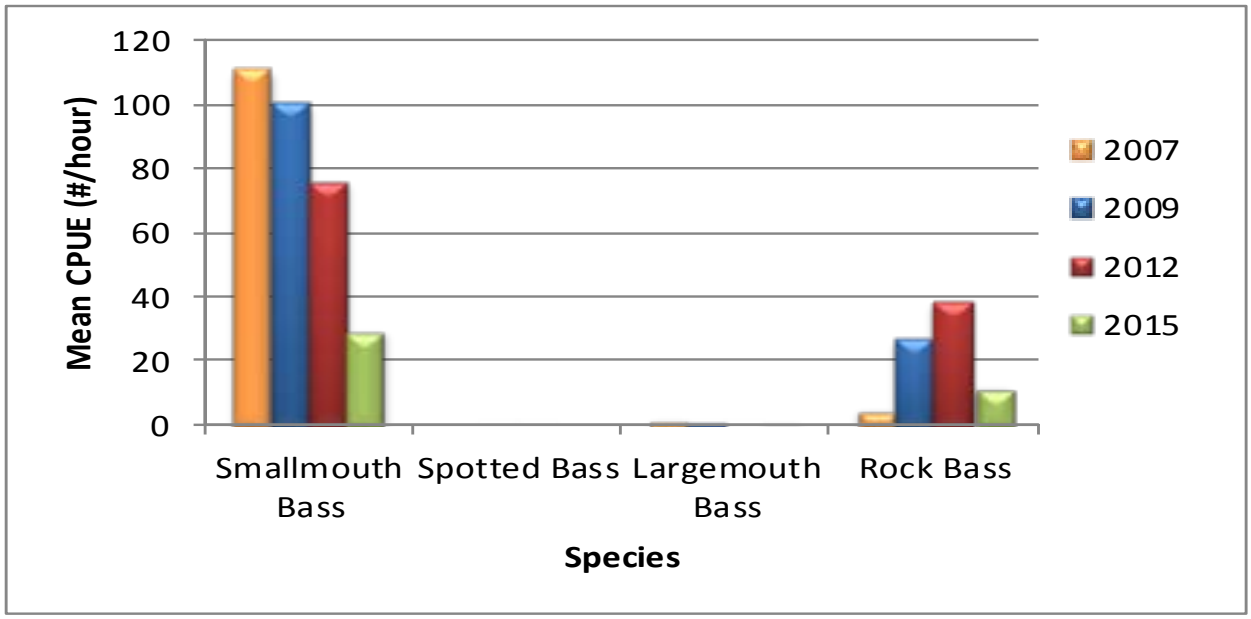
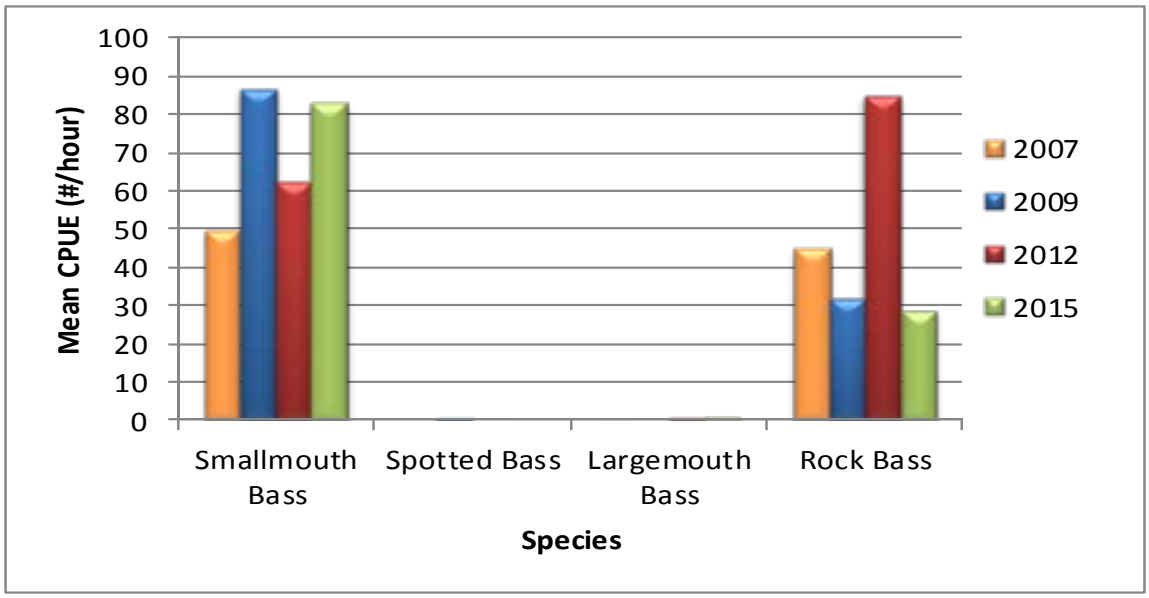


Figure 31. Trends in mean catch rate of black bass and rock bass collected between 2007 -2015 from the Holston River below Cherokee Reservoir.



The majority of the smallmouth bass collected from the Holston River during 2015 fell within the 125 mm to 275 mm length range both above and below Cherokee Reservoir (Figures 32 and 33). There were only 40 bass collected above the reservoir compared to 105 in the reach below Cherokee Dam.

Figure32. Length frequency distributions for smallmouth bass collected from the Holston River above Cherokee Reservoir between 2007 and 2015.

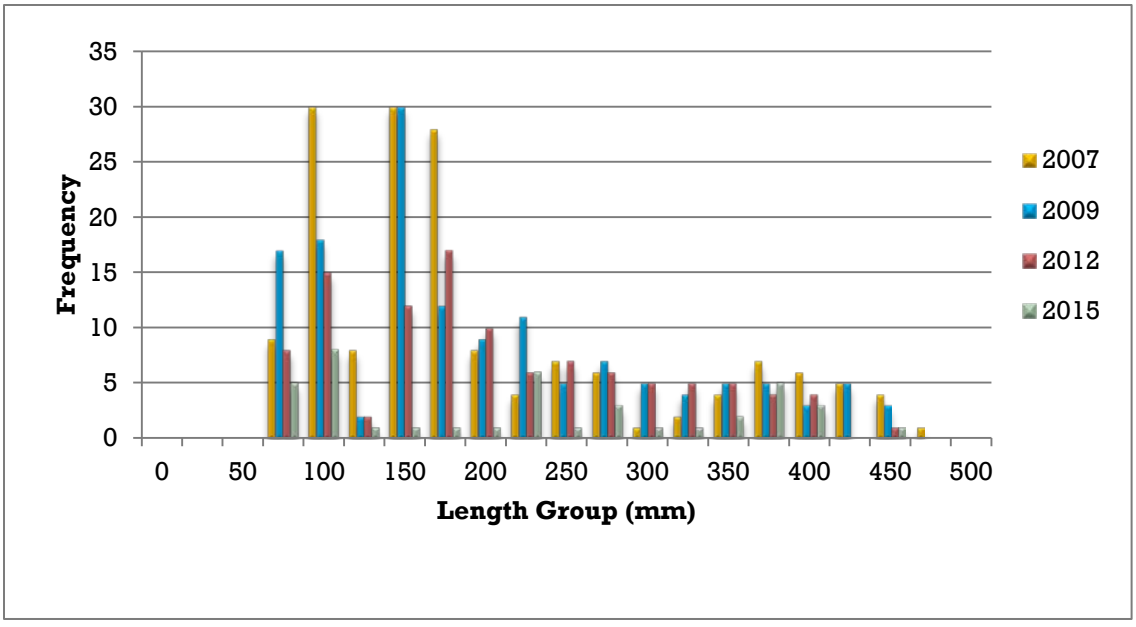
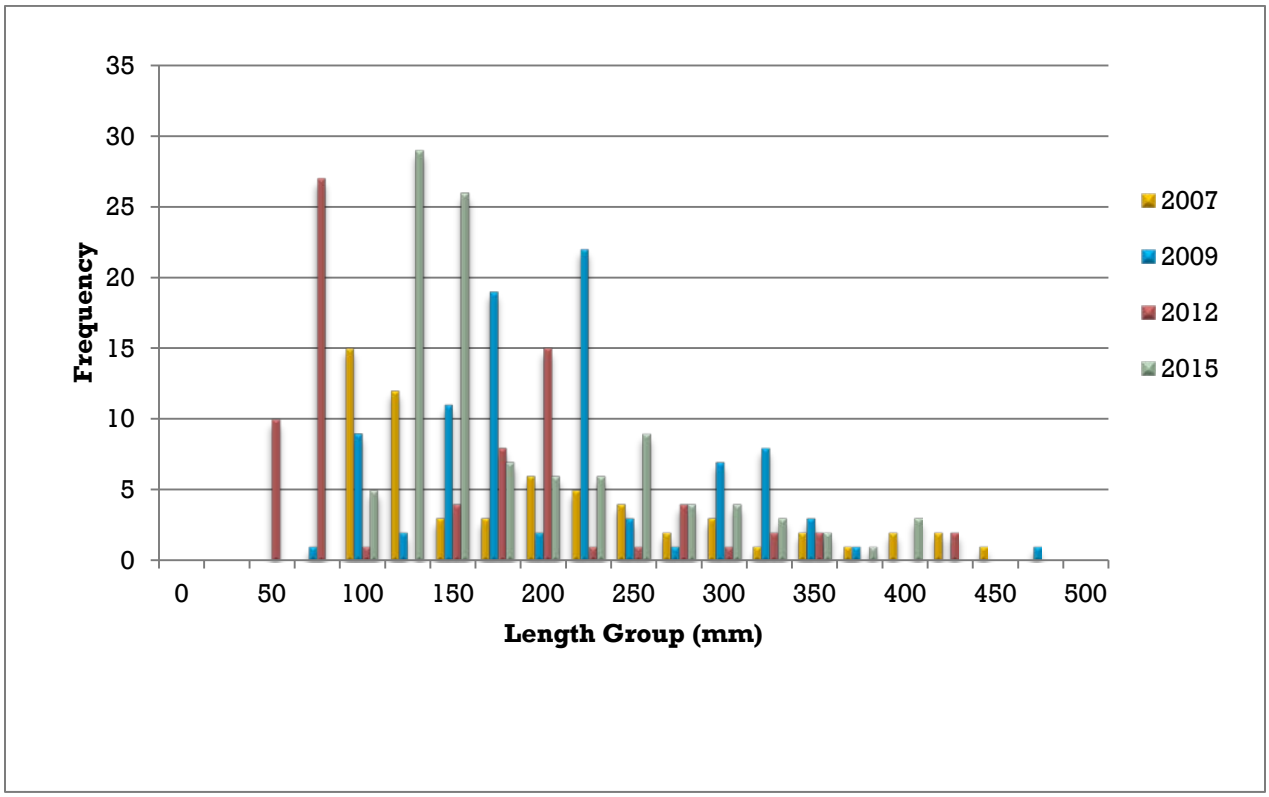
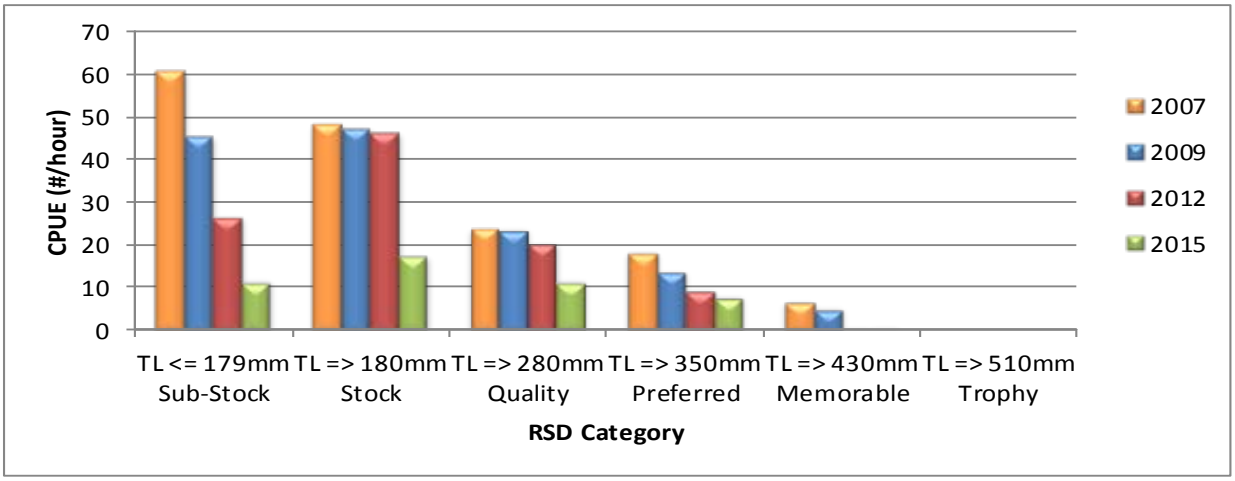


Figure 33. Length frequency distributions for smallmouth bass collected from the Holston River below Cherokee Reservoir between 2007 and 2015.



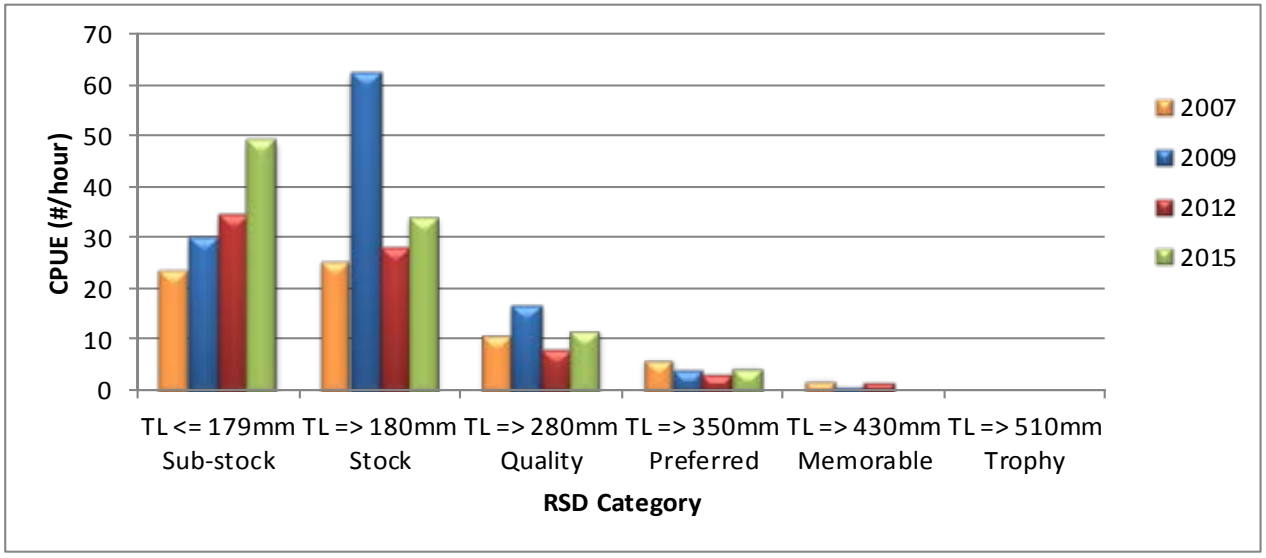
The 2015 Relative Stock Density (RSD) for preferred smallmouth bass (TL ≥ 350 mm) above and below the reservoir was 45.8 and 13.9, respectively. The observed values for this same category in 2012 were 20.5 above the reservoir and 11.4 below. RSD for memorable (TL ≥ 430 mm) and trophy (TL ≥ 510 mm) size bass during 2015 were 4.2 and 0 above the reservoir and 0 for both below the reservoir. These were the lowest recorded since 2007 (Figure 34). Overall we observed a decrease in the percentage of preferred and memorable size smallmouth when compared to the previous samples. The PSD of smallmouth bass (ratio of quality size bass to stock size bass) was 66.6 above the reservoir and 34.8 below the reservoir during 2015. Although we did not collect any trophy size bass during the 2015 sample we have taken smallmouth in excess of 510 mm (20 in) in this reach of the river.

Figure 34. Relative stock density (RSD) catch per unit effort for smallmouth bass collected in the Holston River above Cherokee Reservoir between 2007 and 2015.



Trends in catch per unit effort by RSD category below Cherokee Reservoir increased over those values observed in 2012. We observed the highest sub-stock catch since 2007 and saw slight increases in the stock, quality, and preferred categories when compared to 2012 (Figure 35).

Figure 35. Relative stock density (RSD) catch per unit effort for smallmouth bass collected in the Holston River below Cherokee Reservoir between 2007 and 2015.

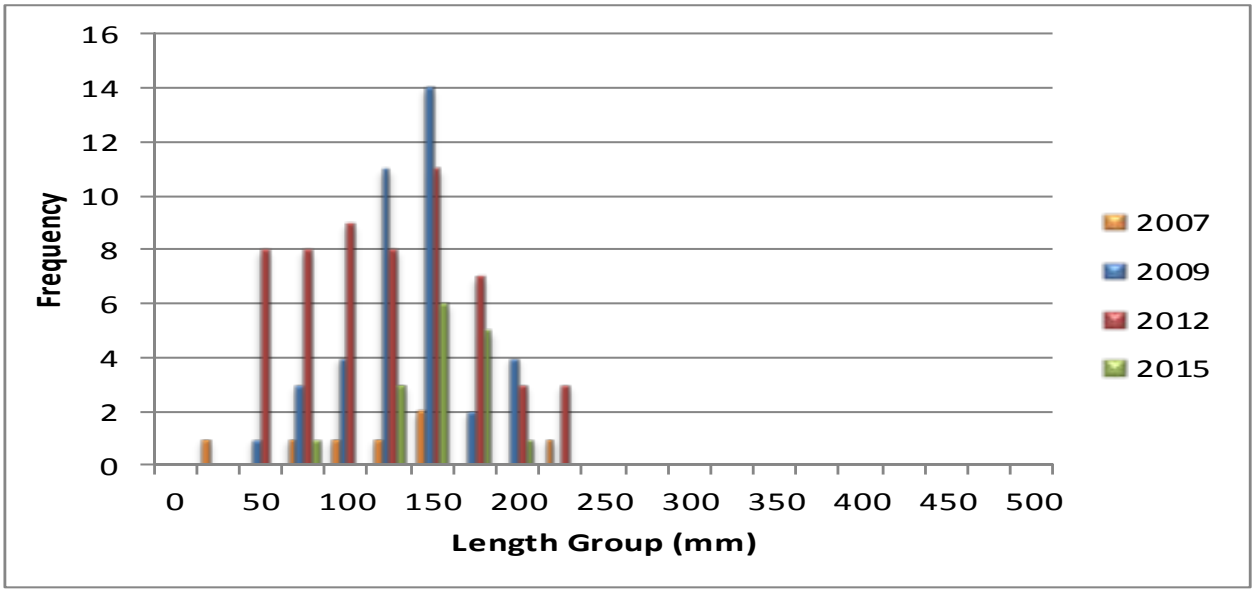


There were no spotted bass collected above or below Cherokee Reservoir during 2015. Riverine occurrence of spotted bass in most larger east Tennessee rivers is sporadic at best with the exception of the Nolichucky River where there is a viable fishery for this species.

Like spotted bass, largemouth bass tend to occur sporadically and unpredictably in larger rivers of east Tennessee. Where found, they tend to inhabit the more sluggish reaches of rivers usually associated with some type of woody cover. There were three collected during 2015, one collected above Cherokee Reservoir and two below.

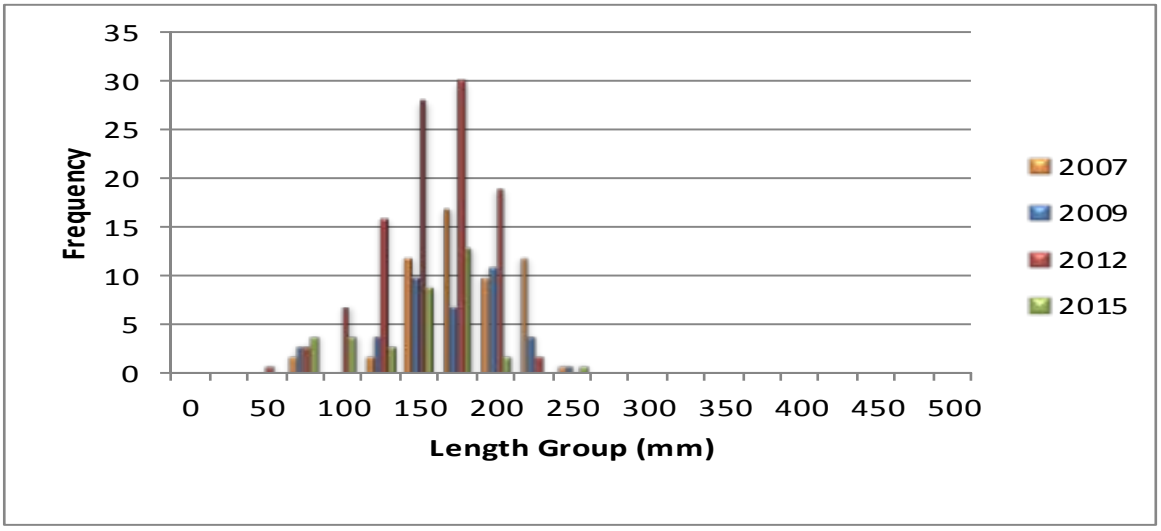
Individuals in the 125 to 200 mm range represented the majority of rock bass in our sample above Cherokee Reservoir. The number of fish collected in 2015 was only slightly better than 2007 and far below the numbers seen in 2009 and 2012 (Figure 36). Although rock bass persist in the upper Holston, they are usually not very abundant. Remarks from anglers fishing the river often refer to the decline in abundance of rock bass in this section of the river. It is unclear why the numbers of rock bass are at the levels currently observed. Since rock bass is a fairly intolerant species it could be several factors such as flow regimes or decrease in habitat quality that are regulating this species. One noticeable change that has taken place in recent history is the significant increase in the growth of aquatic vegetation during the summer months. During peak growth much of the river channel is occupied by stargrass which may have a negative influence on habitat availability for rock bass.

Figure 36. Length frequency distributions for rock bass collected from the Holston River above Cherokee Reservoir between 2007 and 2015.



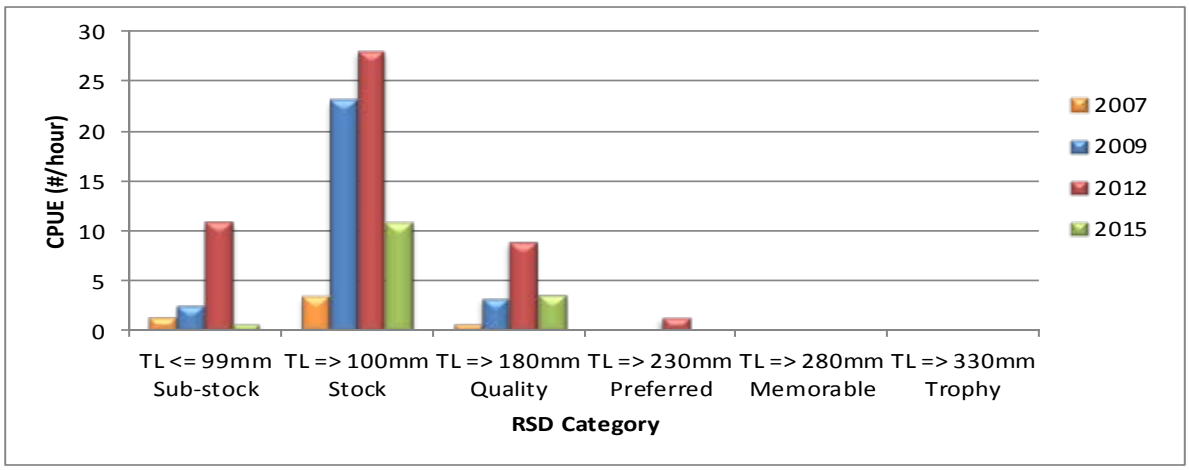
Below Cherokee Reservoir the size distribution for rock bass during the 2015 samples was primarily composed of fish in the 125 to 200 mm size group (Figure 37). Very similar to our observation in the river above the reservoir, rock bass abundance was down when compared to the 2009 and 2012 samples.

Figure 37. Length frequency distributions for rock bass collected from the Holston River below Cherokee Reservoir between 2007 and 2015.



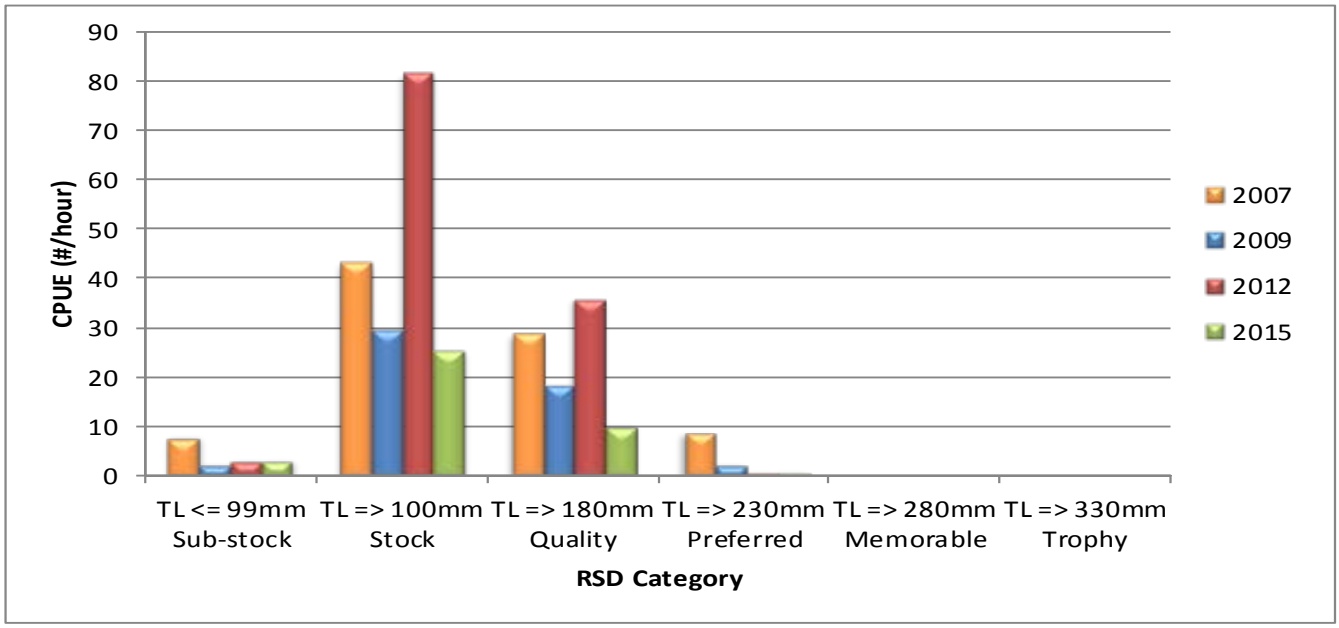
The RSD of preferred (TL ≥ 230 mm) rock bass was 0 above the reservoir and 3.1 below the reservoir. RSD for memorable (TL ≥ 280 mm) and trophy (TL ≥ 330 mm) size rock bass was 0 both above and below the reservoir. The 2015 PSD of rock bass was 33.3 above the reservoir and 40.6 below the reservoir. Catch per unit effort estimates by RSD category above Cherokee Reservoir indicated the majority of our catch was stock size fish during 2015 (Figure 38). Overall, we did observe decreases in all represented categories when compared to previous surveys.

Figure 38. Relative stock density (RSD) catch per unit effort for rock bass collected from the Holston River above Cherokee Reservoir between 2007 and 2015.



In our samples collected below the reservoir, we observed similar trends of lower catch rates in the stock and quality categories when compared to 2009 and 2012. Overall, 2015 represented the lowest catch rates by category of any samples collected since 2007 (Figure 39).

Figure 39. Relative stock density (RSD) catch per unit effort for rock bass collected from the Holston River below Cherokee Reservoir between 2007 and 2015.



Angler Survey

The angler survey program was modified in 2012 to incorporate a more comprehensive sampling scheme that would include river fisheries. During 2014, an angler survey was conducted in the Holston River below Cherokee Dam. This is the first occurrence of this type of survey on the river and has provided much needed information that will aid in the management of this resource. The following information (from Black 2015) summarizes the data collected and gives detailed information regarding the use of the fisheries resource in the segment of the Holston River below Cherokee Dam.

MONTHLY ANGLING EFFORT FOR ALL ANGLERS - 2014

LOCATION=CHEROKEE TW

MONTH	ANGLER HOURS	RELATIVE STANDARD ERROR	HOURS PER ACRE	ANGLER TRIPS	TRIPS PER ACRE	PERCENT EFFORT
02 FEBRUARY	62	100.0	.	23	.	0.1
03 MARCH	4731	25.0	.	1198	.	8.4
04 APRIL	8243	19.0	.	1545	.	14.7
05 MAY	16807	25.6	.	3253	.	29.9
06 JUNE	11361	20.7	.	2431	.	20.2
07 JULY	4027	29.4	.	1108	.	7.2
08 AUGUST	4262	42.7	.	1139	.	7.6
09 SEPTEMBER	1557	33.9	.	577	.	2.8
10 OCTOBER	2094	31.2	.	482	.	3.7
11 NOVEMBER	1396	29.6	.	254	.	2.5
12 DECEMBER	1594	40.4	.	411	.	2.8
TOTAL	56134			12421		

SUMMARY OF SPECIES CATCH STATISTICS - 2014

LOCATION=CHEROKEE TW

SPECIES	TOTAL NUMBER FISH CAUGHT	RSE FOR CATCH	SPECIES CATCH COMPOSITION (%)	INTENDED NUMBER CAUGHT	TOTAL NUMBER FISH HARVESTED	RSE FOR HARVEST	SPECIES HARVEST COMPOSITION (%)	INTENDED NUMBER HARVESTED	% OF CAUGHT FISH RELEASED	AVERAGE WEIGHT (LBS)	NUMBER FISH RECORDED
RIVER CARPSUCKER	44	712.3	0.1	0	44	712.3	0.3	0	0.0	.	1
CHANNEL CATFISH	660	171.4	1.9	540	233	402.2	1.6	233	64.7	.	3
RAINBOW TROUT	20438	19.8	57.3	18920	9168	24.9	64.6	8263	55.1	.	81
BROWN TROUT	2948	91.4	8.3	2667	1028	124.3	7.2	800	65.1	.	9
WHITE BASS	1114	99.3	3.1	603	0	.	0.0	0	100.0	.	0
STRIPED BASS	306	197.7	0.9	131	0	.	0.0	0	100.0	.	0
CHEROKEE BASS	500	224.0	1.4	250	102	570.4	0.7	0	79.6	.	1
BLUEGILL	167	241.4	0.5	134	55	121.3	0.4	55	67.1	.	3
SMALLMOUTH BASS	3474	57.7	9.7	1184	524	157.8	3.7	393	84.9	.	4
SPOTTED BASS	158	261.0	0.4	0	89	227.8	0.6	0	43.7	.	1
LARGEMOUTH BASS	640	377.7	1.8	640	0	.	0.0	0	100.0	.	0
WHITE CRAPPIE	1338	62.2	3.8	1338	843	75.7	5.9	843	37.0	0.34	12
BLACK CRAPPIE	339	148.5	1.0	254	261	157.5	1.8	261	23.0	.	6
SAUGER	102	570.4	0.3	0	102	570.4	0.7	0	0.0	.	1
FRESHWATER DRUM	151	289.8	0.4	151	37	207.7	0.3	37	75.5	.	2

SUMMARY OF FISHING EFFORT AND CATCH RATES FOR INTENDED SPECIES GROUPS - 2014

LOCATION=CHEROKEE TW

INTENDED SPECIES	ANGLER HOURS	RSE FOR ANGLER HOURS	ANGLER TRIPS	PERCENT EFFORT	NUMBER CAUGHT PER HOUR	RSE FOR CATCH PER HOUR	NUMBER HARVESTED PER HOUR	RSE FOR HARVEST PER HOUR	NUMBER OF INTERVIEWS
RAINBOW TROUT	3903	28.1	956	7.0	0.61	39.6	0.29	53.1	14
ANY TROUT	30203	14.3	6515	53.8	0.83	30.7	0.31	32.0	91
STRIPED BASS	129	132.2	24	0.2	0.00		0.00		1
ANY BLACK BASS	1372	52.1	332	2.4	0.00		0.00		5
SMALLMOUTH BASS	4830	26.4	1309	8.6	0.32	68.2	0.05	168.1	20
LARGEMOUTH BASS	482	95.5	116	0.9	0.75		0.00		2
ANY CRAPPIE	1138	40.5	277	2.0	1.32	65.0	0.84	74.7	10
ANY SPECIES	14075	19.2	2894	25.1	0.43	35.0	0.21	66.4	41
TOTAL	56132		12423						

SUMMARY OF RELATIVE SPECIES CATCH RATES WITHIN TARGET GROUPS - 2014

LOCATION=CHEROKEE TW

TARGET GROUP	SPECIES WITHIN TARGET GROUPS	RELATIVE CATCH RATE	RELATIVE HARVEST RATE
ANY TROUT			
	RAINBOW TROUT	0.73	0.28
	ANY TROUT	0.00	0.00
	BROWN TROUT	0.10	0.03
ANY BLACK BASS			
	SMALLMOUTH BASS	0.18	0.06
	SPOTTED BASS	0.00	0.00
	LARGEMOUTH BASS	0.10	0.00
ANY CRAPPIE			
	WHITE CRAPPIE	1.11	0.64
	BLACK CRAPPIE	0.21	0.20

SUMMARY OF TRIP EXPENDITURES AND CONSUMER SURPLUS FOR INTENDED SPECIES - 2014

LOCATION=CHEROKEE TW

INTENDED SPECIES	TOTAL TRIP EXPENDITURES	TOTAL CONSUMER SURPLUS	TOTAL VALUE BY ANGLERS	NUMBER OF INTERVIEWS
RAINBOW TROUT	17250	2120	9130	14
ANY TROUT	75810	5130	80940	91
STRIPED BASS	240	0	240	1
ANY BLACK BASS	3220	0	3220	5
SMALLMOUTH BASS	13170	1220	12920	20
LARGEMOUTH BASS	4640	0	1460	2
ANY CRAPPIE	1130	0	1130	10
ANY SPECIES	33080	2980	36060	41
TOTAL	**148540**	**11450**	**145100**	**184**

SUMMARY OF SOCIOLOGICAL QUESTIONS - 2014

LOCATION=CHEROKEE TW

DISTRIBUTION OF STATES OF RESIDENCE OF INTERVIEWED ANGLERS

STATE	NUMBER ANGLERS INTERVIEWED	PERCENT CONTRIBUTION
TN	288	100

DISTRIBUTION OF COUNTIES OF RESIDENCE OF INTERVIEWED ANGLERS

COUNTY	NUMBER ANGLERS INTERVIEWED	PERCENT CONTRIBUTION
GRAINGER	113	39.2
JEFFERSON	52	18.1
KNOX	61	21.2
OTHERS IN TN	62	21.5

DISTRIBUTION OF ONE-WAY MILEAGE OF ANGLERS INTERVIEWED

ONE-WAY MILES TRAVELED	NUMBER ANGLERS INTERVIEWED	PERCENT CONTRIBUTION
A) 0-25	251	87.5
B) 26-100	36	12.5

DISTRIBUTION OF NUMBER OF DAYS IN TRIPS OF INTERVIEWED ANGLERS

NUMBER DAYS IN TRIP	NUMBER ANGLERS INTERVIEWED	PERCENT CONTRIBUTION
A) 1	184	97.4
B) 2-5	5	2.6

Discussion

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

Efforts made by the Tennessee Valley Authority to improve water quality downstream of Cherokee Dam have for the most part been responsible for the observed improvements below the dam. Dissolved oxygen management in the forbay of Cherokee Reservoir has drastically improved the D.O. levels in the tailwater resulting in restoration projects that would have historically not been considered. Our next scheduled sample of the Holston River will be in 2018.

Management Recommendations

1. Continue the Cherokee tailwater rainbow and brown trout put-and-take program.
2. Continue to cooperate with lake sturgeon re-introduction efforts.

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