

INDEX OF BIOTIC INTEGRITY (IBI) MONITORING  
IN THE  
UPPER LITTLE TENNESSEE WATERSHED  
2001

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## INTRODUCTION

Beginning in 1990 samples of fish (and in some cases benthic macroinvertebrates) have been carried out using the Index of Biotic Integrity protocol, at a total of 125 (to date) sites in the Little Tennessee River watershed upstream of Fontana Reservoir in Swain and Macon Counties, North Carolina and Rabun County, Georgia (McLarney, 1991 and annual reports since then). In 1992, 8 of these sites were selected as “fixed stations” to be monitored annually. Since then, 4 other sites have been monitored annually and so become de facto fixed stations. Rationale for selection of the initial 8 fixed stations is documented in McLarney (1993). Rationale for 3 of the other 4 (Little Tennessee River at head of Lake Emory, Rabbit Creek and Skeenah Creek) is offered in McLarney, 1996, and for one additional station (Little Tennessee River at Wolf Fork), in McLarney, 2000. One of the original fixed stations (Iotla Creek) was abandoned in 1999 (McLarney, 1999, 2000).

Two stream restoration sites on Sutton Branch, located on the campus of Rabun Gap-Nacoochee School in Rabun Gap, Georgia have been monitored annually since 1998. Assuming that we can resolve problems related to analysis of macroinvertebrate samples, these sites may merit elevation to fixed station status.

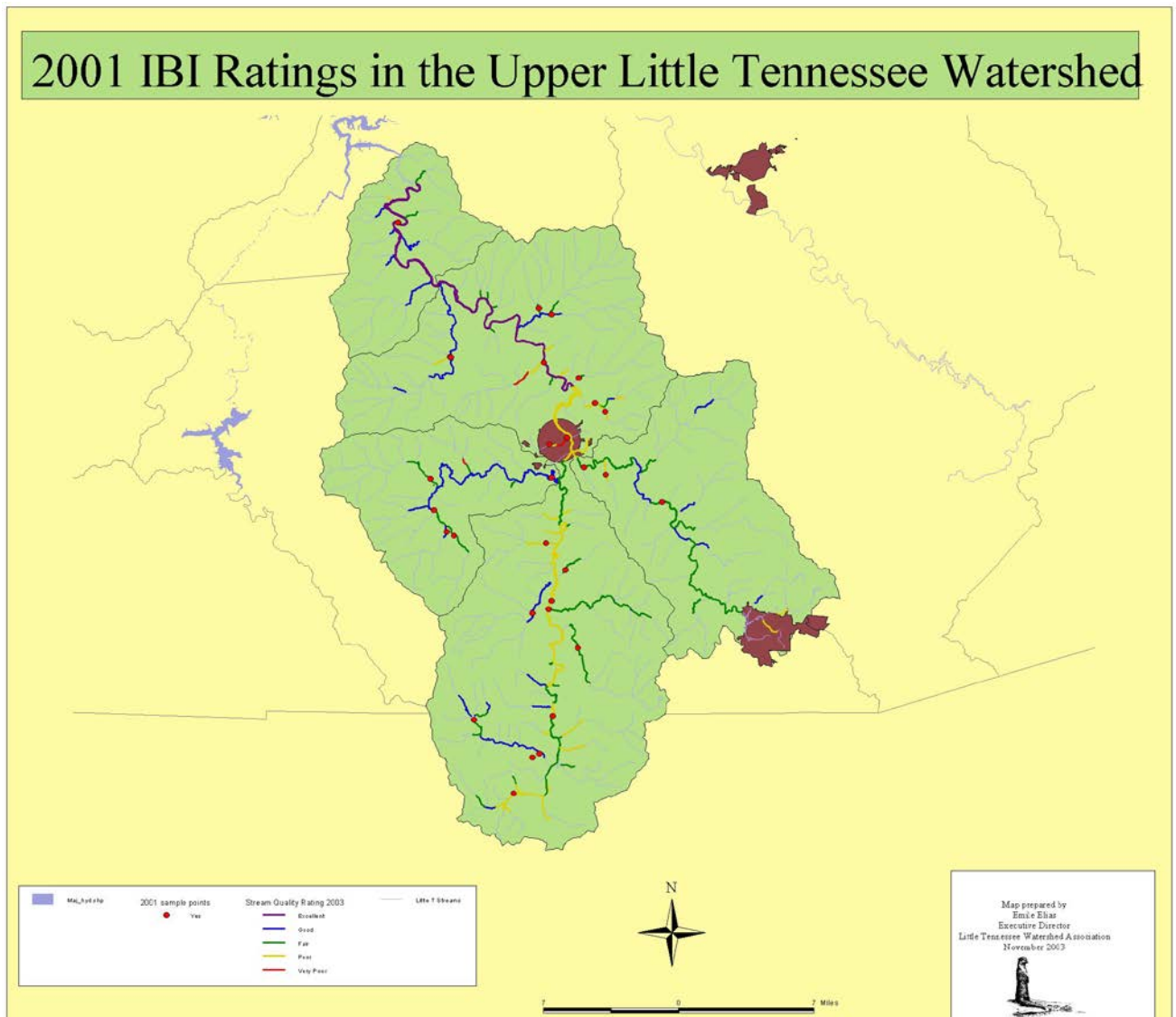
This report covers biomonitoring of 10 of the 11 fixed stations (We failed to sample the Little Tennessee River at head of Lake Emory station in 2001.), and 20 additional stations monitored during May-August, 2001. IBI scores are here presented for all of these stations, based on fish samples at each, plus macroinvertebrate samples at five stations with watershed drainage areas of less than 4 sq. mi..

Rationale for selection of new sites and replication of old sites (other than fixed stations) is given in the following section. IBI scoring criteria for different types of sites are given in Tables 1-7.

This report also includes information from one non-IBI sample – a fish species survey from approximately RM 3.5-4.2 on the Cullasaja River. Aspects of the 2001 project work not dealing with fish sampling or IBI are covered in the annual Executive Summary.

Locations of all stream sites marketed during 2001 are shown in Figure 1.

Figure 1: Map Showing Biomonitoring Sites in the Upper Little Tennessee River Watershed, 2001.



## RATIONALE FOR NON-FIXED STATION SITES

### **Restoration sites**

In last year's report (McLarney, 2001b) we referred to a tentative decision to monitor 2 restoration-related sites on Cartoogechaye Creek at the Killian Farm on an every other year basis, which implied monitoring during 2001. The first IBI monitoring effort on these sites was carried out in 1996 by a North Carolina Wildlife Resources Commission (NCWRC) team, with members of the LTWA/TVA project team as volunteer assistants (McLarney, 1999); repeat monitoring was carried out as part of this project during 1999 (McLarney, 2000). While McLarney, 2001a was in preparation, we were informed that NCWRC wished to repeat their monitoring effort in 2001. For whatever reasons, the end result was that the Killian Farm sites were not monitored. We have scheduled these sites for monitoring as part of the LTWA/TVA project in 2002.

Restoration efforts did provide the rationale for repeat monitoring of 2 sites on Sutton Branch, one on Mashburn Branch and 2 on Crawford Branch.

Sutton Branch is part of a long term restoration project, and both sites there have tentatively been elevated to fixed station status. (See preceding section.)

In the case of Mashburn Branch, the property was sold prior to the initiation of the 2001 monitoring season, and much of the restoration effort was undone. It was decided to monitor Mashburn Branch in 2001 primarily for purposes of measuring the damage. However, it is doubtful whether there is much value in continuing to monitor this site.

It was hoped that Crawford Branch, an urban stream in Franklin, North Carolina would eventually be the site of a restoration project, and considerable effort has been expended toward this end by a local Crawford Branch Committee, the Little Tennessee Watershed Non-Point Source Team and Land-of-Sky Regional Council (Crawford Branch Watershed Management Council and Land-of-Sky Regional Council, 2001). However, it now appears that (apart from a demonstration warm water wetland planned for a site near the stream's mouth) no restoration work will be done in the near future. Therefore 2001 may represent the last monitoring effort on Crawford Branch for some years to come.

### **Sites Requested by Landowners**

Tessentee Creek (RM 0.2) and Little Tennessee River (RM 128.6) at Tessentee Farm: In 1999, the Franklin-based Land Trust for the Little Tennessee (LTLT) purchased a 64 acre farm located at the juncture of the Little Tennessee River and Tessentee Creek. In 2001, the LTLT requested a fish species survey as part of a faunal and floral inventory of the property. This was carried out, using the IBI protocol, as part of the LTWA/TVA project (with some additional effort aimed at completing the species list.)



Betty Creek at Messer Creek Road (RM 5.5): This site, previously monitored in 1996 and 1997, was monitored in 2001 at the request of the landowner (The Hambidge Center for Creative Arts and Sciences), based on visual observation of increased and increasingly frequent turbidity and the perception of increased periphyton growth as evidenced by increasingly slippery rocks.

Big Creek (Highlands) below Randall Dam (RM 1.3): This site was first monitored in 1999 as part of our focus on the Cullasaja River watershed above Cullasaja Falls (Highlands Plateau) (McLarney, 2000). Follow-up monitoring was done in 2000 to help assess damage done by the precipitous draining of Randall Lake, a 2 acre impoundment. Downstream property owners planning to bring suit against the dam owner requested further monitoring during 2001. However, the request came toward the end of our monitoring season when a spate of rainy weather in Highlands made it impossible to carry out the samples. We hope to monitor Big Creek in 2002.

### **Sites Related to Specific Problems or Issues**

Little Tennessee River at Iotla Bridge (RM 111): This site was previously monitored once, in 1999, in order to fill out the picture of the Little Tennessee River between Porters Bend Dam (RM 113.1) and the high pool of Fontana Reservoir (RM 88), which constitutes one of the most important aquatic biodiversity conservation opportunities in the southern Appalachian region, but which has been adequately sampled for fish only at the TVA Needmore fixed station (RM 95.5– see this and previous reports). It was monitored again this year in response to public demand related to a proposed 199 unit RV park and cabin development located just 0.4 mi. upstream. If the project is completed as planned, it will include a package wastewater treatment plant which would be the first point source discharge on this critical reach of the Little Tennessee. There is widespread support by the local public and government for upgrading the classification of the reach (presently class C) to ORW, and also strong local opposition to the permit per se. Therefore it was deemed advisable to have the most up-to-date possible information on the site.

Watauga Creek at Berry Mill (RM 0.7): This site, previously monitored in 1990, 1993, 1997 and 1998 has displayed a remarkable and unexplained improvement in biotic integrity, beginning in the period 1993-1997. A further suggestion of improvement was provided by a 1999 report of the intolerant, and threatened spotfin chub (*Cyprinella monacha*) from a site upstream of Berry Mill (personal communication, Andrew Sutherland). In the future we will likely monitor Watauga Creek at intervals of less than 5 years.

Cat Creek (RM 0.5): Cat Creek first suffered intensive environmental damage from sedimentation during the construction of the Holly Springs Golf Course during the 1970's. Only half of the course was completed at that time, and part of the property extending for 0.4 mi. along Cat Creek upstream from the IBI monitoring site was essentially left fallow. The creek eventually became a string of beaver ponds. In 2000, development of what was originally planned as the lower 9 holes of the golf course resumed, as part of a residential development which has been cited for numerous environmental violations. In the process, all the beaver ponds were removed, along with all woody riparian vegetation, and the entire

0.4mi., plus approximately 0.1 mi. of a small tributary, was rechannelized. A 2001 IBI sample was taken at a site located immediately below the channelized reach and previously monitored in 1991 and 1997 to quantify damage to the aquatic community from these actions.

Burningtown Creek above Younce Creek Rd. (RM 4.9): One of the areas of the upper Little Tennessee River watershed which has been substantially neglected by the LTWA/TVA project has been Burningtown Creek upstream of its uppermost major tributary (Younce Creek). This site was selected as the first of a series of sites monitoring of which will rectify this situation.

Jones Creek below Jones Creek Rd. (RM 0.6) and Allison Creek at Allison Creek Rd. (RM 0.4) These two sites were monitored in 1999 as part of our normal rotation, but produced apparently anomalous results (based on visual assessment and previous monitoring in 1993). Remonitoring was tentatively planned for 2000, but not actually carried out until 2001.

### **Normal Rotation**

We plan to sample every IBI site on a rotation of 5 years or less, although inevitably some sites fall behind in the rotation. Among sites monitored in 2001 for this reason, the most glaring example was Coweeta Creek (Dryman Fork) at Coweeta Creek Campground (RM 2.3), last monitored in 1990. Hickory Knoll Creek at Slep Orchard Rd. (RM 0.5) was last monitored in 1995.

Matlock Creek at Snow Hill Rd. (RM 0.4) and Caler Fork (RM 0.3 at the corner of Leatherman Gap and Ruby Mine Roads fell within their rotation period; each was previously monitored in 1997.

One additional site, Cartoogechaye Creek at Cartoogechaye Baptist Church (RM 12.1) was last monitored in 1999, and would not normally have been selected for monitoring in 2001. It was substituted for the Little Tennessee River at Head of Lake Emory (RM 118.0) fixed station at the last minute, when that site was determined to be too deep and turbid to work. Since a group of student volunteers was available, it was decided to select a relatively high diversity monitoring site which would provide an educational experience for the students. Since all other suitable essential sites had been completed by the sampling date (August 3), this one was chosen.

## IBI SCORING CRITERIA, WITH A NOTE ON MACROINVERTEBRATES

IBI scoring criteria here applied to most sites with watershed drainage areas of 4 sq. mi. or more are those proposed by McLarney (1995a), as modified from Saylor and Ahlstedt (1990). These criteria are presented in tables 1-5.

For the following categories of stream sites, an exclusively fish-based IBI is not appropriate:

- sites with watershed drainage areas of less than 4 sq. mi.
- sites located at above 3,000 ft. elevation.
- sites located above major natural barriers to upstream movement of fish
- streams with a consistent gradient of over 100 ft./mile.

Such sites are characterized by naturally low fish diversity, such that another assemblage of organisms (normally benthic macroinvertebrates) must be taken into account in assessing biotic integrity. This was the rationale for development of the Williams (1996) “brook trout:” IBI criteria (Table 6) and a modified version of these metrics, proposed by this author (McLarney, 1999) (Table 7), both based on combined fish and benthic macroinvertebrate samples.

Most streams in the categories listed above are small. However, the Cullasaja River above Cullasaja Falls on the Highlands Plateau drains a watershed area of 38 sq. mi. and reaches widths of 75 ft or more. Application of the “Williams” or “modified Williams” IBI to such streams may be questioned, but no alternative is available at this time..

A more serious question, from the point of view of this project, has to do with the processing of macroinvertebrate samples. It has repeatedly proven difficult to impossible to get such samples identified in a timely manner for inclusion in reports such as the present one, or for use in decision making (hence the late appearance of this report). Until this bottleneck can be opened, it is questionable whether it is worthwhile to continue to carry out macroinvertebrate samples as part of the LTWA/TVA project.

. Inclusion of fish and (where available) macroinvertebrate sampling data for all sites will enable the reader to recalculate IBI scores according to other sets of criteria or to make modifications as desired. (It should be noted that the identification protocol for macroinvertebrates has not been held constant by TVA over the years, which may affect the validity of comparisons between years. While the 2001 samples were all from sites expected to rate Poor to Fair, it was noted that EPT counts were lower for all 5 samples than in the previous year of monitoring.)

Note that no criteria are given for stream sites with watershed areas of 70-150 sq. mi., since there is not enough experience on sites in that size range in the Tennessee Valley to

permit establishment of criteria (Saylor and Ahlstedt, 1990). Sites in that size range (2 in this report) are scored using criteria for the next smaller or larger size category, according to the judgement of the project director.

Table 8 assigns Bioclass Ratings to the total possible range of IBI scores, from 12 to 60, with general information on the attributes of fish assemblages corresponding to each bioclass (Karr, et al., 1986).

Table 1. IBI Metric Scoring Criteria for the Upper Little Tennessee River Watershed, Proposed New Revision, for Streams Draining 4-7 square miles

Metric	Possible Scores		
	1.5	4.5	7.5
1. Total number of native species	<6	6-10	>10
2. Number of darter species		deleted	
3. Number of centrarchid species, other than <i>Micropterus</i>		deleted	
4. Number of sucker species		deleted	
5. Number of intolerant species <sup>1</sup>	<2	2	>2
6. Proportion of individuals as tolerant species <sup>2</sup>	>20%	10 – 20%	<10%
7. Proportion of individuals as omnivores, generalist feeders, and herbivores	>20%	10 – 20%	<10%
8. Proportion of individuals as specialized insectivores	<20%	20 – 45%	>45%
9. Number of species of piscivores		deleted	
10. Catch rate per unit of effort <sup>3</sup>	<11	11-18	>18
11. Proportion of individuals as darters and sculpins	<35%	35 – 65%	>65%
12. Proportion of individuals with disease, tumors, fin damage and other anomalies	>5%	2 – 5%	<2%

1. Replace northern hogsucker with rock bass on list of intolerant species.

2. Add redbreast sunfish and green sunfish to list of tolerant species.

3. If catch rate is less than 3, low scores should be automatically given for Metrics 8, 11 and 12.

Table 2. IBI Metric Scoring Criteria for the Upper Little Tennessee River Watershed, Proposed Revision, for Streams Draining 7-15 square miles.

Metric	Possible Scores		
	1.3	4.0	6.7
1. Total number of native species	<6	6-10	>10
2. Number of darter species	0	1-2	>2
3. Number of centrarchid species, other than <i>Micropterus</i>		deleted	
4. Number of sucker species		deleted	
5. Number of intolerant species <sup>1</sup>	<2	2	>2
6. Proportion of individuals as tolerant species <sup>2</sup>	>20%	10 – 20%	<10%
7. Proportion of individuals as omnivores, generalist feeders, and herbivores	>20%	10 – 20%	<10%
8. Proportion of individuals as specialized insectivores	<20%	20 – 45%	>45%
9. Number of species of piscivores		deleted	
10. Catch rate per unit of effort <sup>3</sup>	<11	11-18	>18
11. Proportion of individuals as darters and sculpins	<35%	35 – 65%	>65%
12. Proportion of individuals with disease, tumors, fin damage and other anomalies	>5%	2 – 5%	<2%

1. Replace northern hogsucker with rock bass on list of intolerant species.

2. Add redbreast sunfish and green sunfish to list of tolerant species.

3. If catch rate is less than 3, low scores should be automatically given for Metrics 8, 11 and 12.

Table 3. IBI Metric Scoring Criteria for the Upper Little Tennessee River Watershed, Proposed Revision, for Streams Draining 15-40 square miles.

Metric	Possible Scores		
	1.3	4.0	6.7
1. Total number of native species	Varies with drainage (see Figure 2 in Saylor and Ahlstedt, 1990)		
2. Number of darter species	0	1-2	>2
3. Number of centrarchid species, other than <i>Micropterus</i>		deleted	
4. Number of sucker species		deleted	
5. Number of intolerant species <sup>1</sup>	<2	2	>2
6. Proportion of individuals as tolerant species <sup>2</sup>	>20%	10 – 20%	<10%
7. Proportion of individuals as omnivores, generalist feeders, and herbivores	>45%	20 - 45%	<20%
8. Proportion of individuals as specialized insectivores	<20%	20 – 45%	>45%
9. Number of species of piscivores		deleted	
10. Catch rate per unit of effort <sup>3</sup>	<7	7 – 13	>13
11. Proportion of individuals as darters and sculpins	<35%	35 – 65%	>65%
12. Proportion of individuals with disease, tumors, fin damage and other anomalies	>5%	2 – 5%	<2%

1. Replace northern hogsucker with rock bass on list of intolerant species.

2. Add redbreast sunfish and green sunfish to list of tolerant species.

3. If catch rate is less than 3, low scores should be automatically given for Metrics 8, 11 and 12.

Table 4. IBI Metric Scoring Criteria for the Upper Little Tennessee River  
Proposed Revision, for Streams Draining 40-70 square miles.

Watershed,

Metric	Possible Scores		
	1.3	3.3	5.5
1. Total number of native species	Varies with drainage (see Figure 2 in Saylor and Ahlstedt, 1990)		
2. Number of darter species	0	1	>1
3. Number of centrarchid species, other than Micropterus	deleted		
4. Number of sucker species	0	1	>1
5. Number of intolerant species <sup>1</sup>	<2	2	>2
6. Proportion of individuals as tolerant species <sup>2</sup>	>20%	10 – 20%	<10%
7. Proportion of individuals as omnivores, generalist feeders, and herbivores	>30%	15 - 30%	<15%
8. Proportion of individuals as specialized insectivores	<25%	25 – 50%	>50%
9. Number of species of piscivores	0		≥1
10. Catch rate per unit of effort <sup>3</sup>	<7	7 – 13	>13
11. Proportion of individuals as darters and sculpins	<25%	25 – 50%	>50%
12. Proportion of individuals with disease, tumors, fin damage and other anomalies	>5%	2 – 5%	<2%

1. Replace northern hogsucker with rock bass on list of intolerant species.

2. Add redbreast sunfish and green sunfish to list of tolerant species.

3. If catch rate is less than 3, low scores should be automatically given for Metrics 8, 11 and 12.

Table 5. IBI Metric Scoring Criteria for the Upper Little Tennessee River  
Proposed Revision, for Streams Draining 150 - 600 square

miles.

Watershed,

Metric	Possible Scores		
	1	3	5
1. Total number of native species	<10	10-18	>18
2. Number of darter species	<3	3-4	>4
3. Number of centrarchid species, other than Micropterus	0	1	>1
4. Number of sucker species	<2	2 – 4	>4
5. Number of intolerant species <sup>1</sup>	<2	2 - 3	>3
6. Proportion of individuals as tolerant species <sup>2</sup>	>20%	10 – 20%	<10%
7. Proportion of individuals as omnivores, generalist feeders, and herbivores	>30%	15 - 30%	<15%
8. Proportion of individuals as specialized insectivores	<25%	25 – 50%	>50%
9. Proportion of individuals as piscivores	<1%	1 – 2%	>2%
10. Catch rate per unit of effort <sup>3</sup>	<7	7 – 13	>13
11. Proportion of individuals as darters and sculpins	<10%	10 –25%	>25%
12. Proportion of individuals with disease, tumors, fin damage and other anomalies	>5%	2 – 5%	<2%

1. Replace northern hogsucker with rock bass on list of intolerant species.

2. Add redbreast sunfish and green sunfish to list of tolerant species.

3. If catch rate is less than 3, low scores should be automatically given for Metrics 8, 11 and 12.



Table 6. IBI Metric Scoring Criteria for Reservoir Lakes in the Blue Ridge.

Metric	Possible Scores		
	1	3	5
1. Total number of species (excluding exotics)	<8	8 – 15	>15
2. Mean number of individuals per run*			
a. Electrofishing	<30	30 – 60	>60
b. Gill Nets	<30	30 – 60	>60
3. Number of sunfish species (except <i>Micropterus</i> )	<3	3	>3
4. Number of benthic invertivore species	<3	3 – 4	>4
5. Number of intolerant species	<2	2	>2
6. Percent individuals as tolerants*			
a. Electrofishing	15	15 – 30	<15
b. Gill Nets	>20	10 – 20	<10
7. Number of piscivore species	<3	3 – 5	>5
8. Percent individuals as omnivores*			
a. Electrofishing	>10	5 – 10	<5
b. Gill Nets	>30	15-30	<15
9. Percent individuals as invertivores*			
a. Electrofishing	<75	75 – 85	>85
b. Gill Nets	<3	3 – 7	>7
10. Percent individuals as single dominant species*			
a. Electrofishing	>60	40 – 60	<40
b. Gill Nets	>50	30 – 50	<50
11. Number of species of lithophilic spawners	<3	3 – 5	>5
12. Number of exotic species	<2	2 – 5	>5
13. Percent individuals with disease or anomalies	>5	2 – 5	<2

\* For metrics which are split by capture methods (electrofishing or gill net), award half of possible score based on each method.

*Multiply score obtained by 0.923 to obtain final IBI score, in order to compensate for 13 metrics.*

Table 7A. IBI Metric Scoring Criteria for Stream Sites Draining Less than 10 Square Miles and Located at Elevations of 1,800 feet or more in the River Drainage Basin. *From Williams 1996.*

Tennessee

Metric	Possible Scores		
	2	6	10
1. Total Ephemeroptera taxa	<3	3 – 5	>5
2. Total EPT taxa	<8	8 – 15	>15
3. Brook trout presence or absence	Absent	Sympatric	Allopatric
4. Catch rate (mean number of individual fish per five minute shocking run)	<5	5 – 9	>9 <sup>1</sup>
5. Proportion of individuals with disease, tumors, fin damage and other anomalies	> 5%	5 – 2%	<2% <sup>2</sup>
6. Proportion of individual fish as tolerant species <sup>3</sup>	>20%	10 – 20%	<10%

1. Score 6 if > 50

2. Score 8 if >0 but <2%.

3. Add redbreast sunfish and green sunfish to list of tolerant species.

Table 7B. Proposed Modified Version of Williams (1996) “Brook Trout” IBI (see Table 7) for Stream Sites Located at Elevations of 1,700 feet or more in the Upper Tennessee River Watershed.

the

Metric	Possible Scores		
	1.5	4.5	7.5
1. Total Ephemeroptera taxa	<3	3 – 5	>5
2. Total EPT taxa	<8	8 – 15	>15
3. Brook trout presence or absence	Absent	Sympatric	Allopatric
4. Catch rate (mean number of individual fish per five minute shocking run)	<5	5 – 9	>9 <sup>1</sup>
5. Proportion of individuals with disease, tumors, fin damage and other anomalies	> 5%	5 – 2%	<2% <sup>2</sup>
6. Proportion of individual fish as tolerant species <sup>3</sup>	>20%	10 – 20%	<10%
7. Proportion of individual fish as wild trout (all species)	Absent	0 – 10%	>10%
8. Proportion of individual fish as omnivores, generalist feeders and herbivores	>20%	20 – 10%	<10%

1. Score 4.5 if > 50

2. Score 6.0 if >0 but <2%.

3. Add redbreast sunfish and green sunfish to list of tolerant species.

Table 8. Biotic Integrity Classes Used in Assessing Fish Communities Along With Descriptions of their Attributes.

General

<b>Class</b>	<b>Attributes</b>	<b>IBI Range</b>
Excellent	Comparable to the best situations without influence of man; all regionally expected species for the habitat and stream size, including the most intolerant forms, are present with full array of age and sex classes; balanced trophic structure.	58 – 60
Good	Species richness somewhat below expectation, especially due to loss of most intolerant forms; some species with less than optimal abundance or size distribution; trophic structure shows some signs of stress.	48 – 52
Fair	Signs of additional deterioration include fewer intolerant forms, more skewed trophic structure (e.g., increasing frequency of omnivores); older age classes of top predators may be rare.	39 – 44
Poor	Dominated by omnivores, pollution-tolerant forms, and habitat generalists; few top carnivores; growth rates and condition factors commonly depressed; hybrids and diseased fish often present.	28 – 35
Very Poor	Few fish present, mostly introduced or very tolerant forms; hybrids common; disease, parasites, fin damage and other anomalies regular.	12 – 23
No Fish	Repetitive sampling fails to turn up any fish.	

## RESULTS AND DISCUSSION

### Introduction

Following the format established in McLarney (1995b), in Tables 9-21, 23-27, 29, 31-38, and 40-41 data are presented for each of the 30 monitoring sites for 2001 and for the previous year of monitoring, if any (plus other years as deemed necessary for interpretation of the data

Only common names of fish are used in the tables. For all sites, all species ever taken at that site are listed, whether or not they appeared in any of the samples included in the tables.

### Fixed Station 1: Little Tennessee River at Needmore (RM 95.5)

As in every year since TVA began to monitor the Needmore fixed station in 1990, biotic integrity was in the Good-Excellent range. The IBI score, or if not the score, at least the total catch and catch rate (Metric 10) might have been higher were it not for a series of difficulties.

- Due to late arrivals and crew cancellations all shoreline samples, and haul seine samples, along with 5 of a total 34 shocker/seine samples were done by a “skeleton” crew.
- Due to technical difficulties, it was not possible to do the wading samples and the boat shocker sample on the same day. On the second day, when the boat shocker was available, the water had risen and was slightly turbid, so that visibility may have affected the catch rate.
- High water and nascent turbidity may also have adversely affected the last few shocker/seine runs.

In interpreting the above information it should be kept in mind that unusually low, clear water in 2000 made for easy sampling, and may have inflated the catch totals and rate for that year.

The only potentially worrisome trend observed in 2001 was that the total catch of the 6 redhorse (*Moxostoma*) species (10) was equal to the lowest redhorse catch ever at the site, made in 1998.

On the other hand the proportion of omnivores and herbivores in the catch (Metric 7) returned to normal (6.6%). Last year’s apparent population explosion of the river chub (*Nocomis micropogon*) seems to have been a temporary phenomenon.

The proportion of piscivores (Metric 9) recorded in the 2001 sample (10.7%) was extraordinarily high. This may have been related to the monitoring date. We normally endeavor to sample each site at approximately the same date each year; Needmore is normally sampled in June. However in 2001, due to a combination of factors (weather, reduced crews at TVA, other demands on the shocker boat), the Needmore sample was not completed until August 3, by which date considerable attrition on populations of prey fish may have occurred.

There was a shift in the percentage composition of the darter community as compared to previous years. In every previous year, the most numerous of the 6 darter species recorded from the site has been the gilt darter (*Percina evides*), which constituted 28.9% of the total darter catch in the first year of monitoring (1990) and has accounted for 42-84% of the total every year since, but this year accounted for only 22.2%, based on a record low catch of 26 individuals.. This year the most numerous darter was the banded darter (*Etheostoma zonale*), which accounted for 35.9 % of the darter total, based on a record catch of 42 individuals. In previous years, proportion of banded darters in the total darter catch has been 2.5-15.1%. The gilt darter, while intolerant of most forms of pollution, is the most tolerant of the Little Tennessee watershed darters with regard to sedimentation, and is frequently found over substrates dominated by sand. The banded darter is strongly associated with submerged aquatic vegetation (which at the site consists almost entirely of riverweed, *Podostemum*).

The proportion of the total catch as darters and sculpins (Metric 11), while still very low as compared to the norm for Needmore, represents a considerable improvement over the record low recorded in 2000 (17.0 vs. 12.8%).

Overall, and notwithstanding the ever-increasing stress on the upstream watershed associated with the rapid development of Macon County, the Little Tennessee downstream of Lake Emory, as evidenced by monitoring at Needmore (and at Iotla Bridge, which see) seems to be holding its own as the premier cool-to-warm water river of the Blue Ridge in terms of biodiversity and biotic integrity.

Table 9. Fixed Station 1 - Little Tennessee River at Needmore (RM 95.5)

#### Species and Numbers of Fish Taken

Species	Number of Fish Taken	
	2000	2001
Mountain brook lamprey	3	1
Gizzard shad		
Rainbow trout		
Muskellunge		
Central stoneroller	5	5
Whitetail shiner	186	72
Spotfin chub	23	13
Common carp	1	1
Warpaint shiner	108	68
River chub	145	39
Golden shiner		
Tennessee shiner	29	76
Silver shiner	4	
Rosyface shiner	141	106
Mirror shiner	33	50
Telescope shiner	28	31

Fatlips minnow	*	5
Creek chub	1	
Northern hogsucker	20	9
Silver redhorse	2	1
River redhorse	12	3
Black redhorse	10	1
Golden redhorse	5	2
Shorthead redhorse	26	3
Sicklefin redhorse	1	
Channel catfish	1	2
Stonecat		1
Flathead catfish	4	3
White bass**	1	
Rock bass	56	47
Redbreast sunfish	20	10
Green sunfish	2	1
Warmouth	1	
Bluegill	8	1
Redear sunfish		
Smallmouth bass	9	24
Largemouth bass		
Black crappie	1	
White crappie	1	
Tuckaseegee darter		
Greenfin darter	34	19
Wounded darter	5	29
Banded darter	11	42
Yellow perch		
Tangerine darter	3	1
Gilt darter	73	26
Walleye		
Mottled sculpin	5	1
TOTALS	1018	693

\* no adults, but numerous young-of-the-year

\*\* probable "wiper" (white bass/striped bass hybrid), stocked in Fontana Reservoir

## Metrics and Scores

Metric	Observed value	2000	Observed value	2001
		Score		Score
1. No. native spp.	32	5	30	5
2. No. darter spp.	5	5	5	5
3. No. sunfish spp.	4	5	4	5
4. No. sucker spp.	7	5	6	5
5. No. intolerant spp.	5	5	5	5
6. % individuals as tolerants	2.4	5	1.7	5
7. % individuals as omnivores and herbivores	15.3	3	6.6	5
8. % individuals as specialized insectivores	66.5	5	77.6	5
9. % individuals as piscivores	6.9	5	10.7	5
10. Catch rate	13.1	5	8.1	3
11. % individuals as darters and sculpins	12.8	3	17.0	3
12. % individuals with disease and anomalies	0.2	5	0.4	5
<b>TOTALS</b>		<b>56</b>		<b>56</b>
		<b>EXCELLENT</b>		<b>EXCELLENT</b>

## **Fixed Station 2 – Little Tennessee River at Head of Lake Emory (RM 118.0)**

Due to a combination of factors including weather, turbidity, short crews at TVA, other demands on the TVA shocker boat and bad planning, we were unable to monitor this site (which scored 38, bioclass rating FAIR in 2000) during the 2001 season. This omission is unfortunate, not only because station reflects the condition of the Little Tennessee as it enters Lake Emory and the Franklin urban area, but also because of changes which are expected in the years to come. In addition to both accelerating development and concerted efforts to control sedimentation by improving riparian conditions in upstream portions of the watershed, the following changes are foreseen for the immediate area:

- The Franklin Greenway will pass along the entire length of the sample reach on one side or the other, incorporating a foot bridge. The Greenway has been billed as a conservation project, and to some extent it will be. But it will also exponentially increase human use of the riparian area. In portions which are already being developed further downstream, it has already occasioned some amount of short term damage through removal of vegetation and soil erosion.
- The new Macon campus of Southwestern Community College will ultimately be located at the juncture of the Little Tennessee River and Cartoogechaye Creek, located just 1 mi. upstream, on what is presently a semi-abandoned farm. Construction and development of the campus will inevitably have some impact on the river.
- A large convention center facility is already under construction on high ground adjacent to part of the monitoring site. While erosion control measures have been adequate, there are inevitably impacts associated with such a large development.

All three of the items just cited are no more than fragments of extremely intensive development which is expected to develop around the junction of highways 64 and 441 west of the bridge which crosses the Little Tennessee near the lower end of this site. Plans, some of which will be opposed, include altering highway access and connecting the Whistle Stop Mall area, located on US 441 at Cartoogechaye Creek with the future SCC campus and the Convention Center on the opposite bank of the river. Ultimately as much as 2 mi. each of the Little Tennessee and Cartoogechaye Creek could be directly impacted.

There is also a need, independently of projected future development, to attempt to restore the right bank of the river and its riparian zone on and immediately upstream of the monitoring site. This reach (on rented pasture land) and two shorter reaches on lower Cartoogechaye Creek and the left bank of the Little Tennessee just above its mouth constitute one of the most heavily damaged and damaging reaches of stream bank in the entire watershed.

For all of these reasons the Head of Lake Emory station must be regarded as a priority monitoring site for 2002 and the years to come.



### Fixed Station 3 – Little Tennessee River at North Carolina/Georgia State Line (RM 136.9)

Although the 2001 IBI score at the State Line fixed station was slightly (not significantly) higher than that for 2000, the perception was one of deterioration. Symptoms noted were:

- Very few fish on shoreline habitat. As in 1999, the tolerant green sunfish (*Lepomis cyanellus*), a species very much associated with shoreline habitat and usually common at this site, has disappeared.
- Few fish in the main pool on the site, where several adult redhorse (*Moxostoma*) of two species were taken last year.
- Continued high conductivity of the water, as evidenced by the difficulty of selecting an effective combination of voltage and wave form. (Most of the sample was done at a setting of 300 volts.) On the one hand this may have led to undercounting of total numbers of fish, or some groups. On the other, it strongly suggests a chemical pollution problem.
- Continued preponderance of small individuals of most species, with total lack of adults of piscivorous species.

The remainder of the report for this site paraphrases the report for 2000:

A steady decline in IBI scores which began after 1997 (and has apparently plateaued out in 2001) has coincided with the appearance of problems associated with the Fruit of the Loom discharge, located 2.2 miles upstream. As reported by McLarney (2000) these problems have included:

- Extremely high conductivity, as evidenced by the necessity to operate electrofishers at very low voltage
- Reddish discoloration of the water for several miles below the discharge point (well past the State Line station.)
- The complete elimination of aquatic macrophytes (*Podostemum*) below the discharge. This condition also exists well past the State Line station.

It should also be noted that the decline in numbers of the exotic yellowfin shiner (*Notropis lutipinnis*) cited last year as a possible positive trend in 2000 (McLarney, 2001b) was reversed this year, with the yellowfin shiner ascending to the level of the second most abundant species at the site.

In the previous report (McLarney, 2001b) I stated that “There has arguably been a slight decline in the always poor habitat quality at State Line over the years 1990-2000, as evidenced mainly by sedimentation and reduction in size of a riffle area.” In 2001, the riffle, which had been on the point of disappearing, appeared to be reestablishing itself. However, overall the site continues to be unstable.

Although, as contrasted to 2000, in 2001 no monitoring was done in the reach between State Line and the Fruit of the Loom discharge, there is still visible evidence of alteration of the river environment below the discharge. It would also appear to be true “that the drastic and apparently ongoing deterioration observed in the quality of the Little Tennessee River between RM 139.4 – Fruit of the Loom discharge – and RM 136.9 at the state line, is the consequence of synergies, in which the Fruit of the Loom discharge plays a significant but undefined role.”

Samples in the reach of the river immediately upstream of the state line were not planned for 2000 in part based on the hope that state and/or federal agencies would take an interest in the situation. Despite the fact that the Georgia/North Carolina line marks the upstream limit of designated critical habitat for the threatened spotfin chub (*Cyprinella monacha*) and proposed for the Appalachian elktoe mussel (*Alasmidonta raveneliana*), and despite the increased attention being given to the Little Tennessee in North Carolina as a biodiversity conservation site, agency interest in the situation here has not been perceptible.

As stated previously (McLarney, 2000) “Until we have a firmer grasp of the factors causing the oscillation in IBI score at this site we cannot feel confident that we are even approaching the conditions required for adequate management of the Little Tennessee River at any point along the more than 50 miles between the Fruit of the Loom plant and Fontana Reservoir.”

Table 10. Fixed Station 3 - Little Tennessee River at North Carolina/Georgia State Line (Rm 136.9)

**Species and numbers of fish taken:**

Species	Number of fish taken	
	2000	2001
Mountain brook lamprey	3	9
Rainbow trout		2
Central stoneroller	127	66
Whitetail shiner	10	10
Warpaint shiner	16	3
River chub	69	27
Golden shiner	2	
Tennessee shiner	24	26
Yellowfin shiner	27	42
Mirror shiner	9	8
Fatlips minnow	5	1
Longnose dace		
Creek chub	2	
White sucker	6	3
Northern hog sucker	16	2
Black redhorse	10	1

Golden redhorse	2	1
Brown bullhead		
Snail bullhead	4	1
Rock bass	9	7
Redbreast sunfish	14	4
Green sunfish	12	
Warmouth	1	
Bluegill	2	1
Largemouth bass		1
Tuckasegee darter		
Gilt darter	1	2
Mottled sculpin	12	7
TOTALS	383	224

## Metrics and Scoring

Metric	2000		2001	
	Observed value	Score	Observed value	Score
1. No. native spp.	19	5.5	17	5.5
2. No. darter spp.	1	3.3	1	3.3
4. No. sucker spp.	4	5.5	4	5.5
5. No. intolerant spp.	1	1.1	1	1.1
6. % individuals as tolerants	9.9	5.5	3.6	5.5
7. % individuals as omnivores and herbivores	55.6	1.1	47.3	1.1
8. % individuals as specialized insectivores	15.7	1.1	22.3	1.1
9. No. piscivore spp.	0	1.1	0	1.1
10. Catch rate	11.6	3.3	7.0	3.3
11. % individuals as darters and sculpins	3.4	1.1	4.0	1.1
12. % individuals with disease and anomalies	5.2	1.1	4.0	3.3
TOTALS		29.7		31.9
		POOR		POOR

#### Fixed Station 4 – Little Tennessee River at Wolf Fork (RM 142.9)

IBI scores for the past two years here reinforce the suggestion that the higher score (44.1) in 1999 was anomalous. The site continues to be heavily impacted by sediment, and the dramatic increase in catch rate (by far the highest ever recorded here) suggests that excess nutrient loading may be occurring as well.

The site may also offer evidence for the hypothesis of Scott and Helfman (2001), based on the work of Mayden (1987, 1988) and the river continuum concept (Vannote et al, 1980), that in the southern Appalachians we are witnessing “native invasion” - the replacement of “upland endemic” species by a suite of more generalized “southeastern” fishes. This argument has already been made for the upper Little Tennessee watershed based on 1990 and 2000 samples from Darnell Creek (McLarney, 2001b) and North Prong Ellijay Creek in 1991 and 1999 (McLarney, 2000). Consider the following “generalized southeastern” species found at RM 142.9 in 2001.

- Whitetail shiner (*Cyprinella galactura*): Generally considered a “river fish”, 10 individuals of this species were taken in 2001, whereas it had been found here only as an isolated stray in one of 4 previous samples.
- Golden shiner (*Notemigonus crysoleucas*): First time here; represented by 10 individuals.
- Smallmouth bass (*Micropterus dolomieu*): A large juvenile taken here in 2001 represents the farthest upstream record for this species in the Little Tennessee watershed. Prior to capture of a single individual at RM 138.4 in 2000, this species had not been recorded from the Georgia portion of the watershed.
- Yellow perch (*Perca flavescens*): A small adult from this site, and a reliable anglers report from about RM 120 represent the first records for this species upstream of the Head of Lake Emory fixed station (RM 118.0).

In addition to the above 4 species, in 2001 we recorded the highest number ever at this site for the following species, none of them considered to be “upland endemics”: river chub (*Nocomis micropogon*); Tennessee shiner (*Notropis leuciodus*); mirror shiner (*Notropis spectrunculus*); golden redhorse (*Moxostoma erythrurum*) and rock bass (*Ambloplites rupestris*).

In other respects, results for this site were within expectations:

There was some evidence of hybridization of the exotic yellowfin shiner (*Notropis lutipinnis*) with the native warpaint shiner (*Luxilus coccogenis*) and Tennessee shiner.

Somewhat surprisingly in view of the level of sedimentation (but not surprisingly in view of previous samples), we once again captured an adult hellbender (*Cryptobranchus alleggheniensis*) at this site.

Table 11. Fixed Station 4 - Little Tennessee River at Wolf Fork (RM 142.9)

**Species and Numbers of Fish Taken**

Species	Numbers of Fish Taken	
	2000	2001
Mountain brook lamprey	3	4
Rainbow trout	1	*
Central stoneroller	3	3
Smoky dace		
Whitetail shiner		10
Warpaint shiner	59	87
River chub	57	113
Golden shiner		10
Tennessee shiner	13	35
Yellowfin shiner	30	84
Mirror shiner	3	12
Creek chub	7	7
White sucker		2
Northern hogsucker	1	15
Black redhorse		
Golden redhorse	3	22
Rock bass	3	17
Redbreast sunfish	6	6
Green sunfish		
Bluegill		1
Smallmouth bass		1
Largemouth bass		
Tuckasegee darter		
Yellow perch		1
Gilt darter	1	
Mottled sculpin	14	6
TOTALS	204	436

**Metrics and Scoring**

Metric	1999		2001	
	Observed Score value		Observed Score value	
1. No Native spp.	12	6.7	17	6.7
2. No.darter spp.	1	4.0	0	1.3
5. No. intolerant spp.	2	4.0	1	1.3
6. % individuals as tolerants	6.4	6.7	3.4	6.7
7. % individuals as omnivores and				

herbivores	34.5	1.3	31.9	1.3
8. % individuals as specialized insectivores	37.4	4.0	33.0	4.0
10. Catch per unit effort	16.2	4.0	42.3	6.7
11. % individuals as darters and sculpins	7.4	1.3	1.4	1.3
12. % individuals with disease or anomalies	3.4	4.0	3.0	4.0
<b>TOTALS</b>		36.0		33.3
		<b>FAIR</b>		<b>POOR</b>

## Fixed Station 5 – Rabbit Creek at Rabbit Creek Rd. (formerly Holly Springs Rd.) (RM 0.8)

Although this site has never scored higher than 38.7 (bioclass FAIR) on the IBI, there has been a tendency toward improvement, which we have attributed principally to a major reduction in the amount of livestock with access to the stream. Over the last several years, both the IBI and the structure of the fish community have been remarkably stable. In 1999-2000 we began to observe changes in the fish community, but these did not affect the IBI. These changes have included:

- Dramatic increase in the proportion of column dwelling cyprinids (from 25-35% of samples during 1990-1998 to 60% in 1999, then 41 and 46% respectively in 2000 and 2001.
- A major increase in numbers of the only piscivorous species at the site (rock bass, *Ambloplites rupestris*), beginning in 2000 – during which year the maximum and average size of rock bass taken was also notably greater.
- Disappearance in 2000 of the column dwelling blacknose dace (*Rhinichthys atratulus*), which had previously made up from 4% to as much as 16% of the total fish catch.
- An across the board decline in all 5 resident benthic species (considering the golden redhorse, *Moxostoma erythrurum* as a transient), since 1996. Resident benthic species made up 70.2% of the total catch in 1996, but only 37.8 and 35.8%, respectively in 2000 and 2001. (It must be noted that the longnose dace, *Rhinichthys cataractae*, which had been steadily declining in numbers since 1996, and had all but disappeared by 2000, made a modest comeback. It was represented in the 2000 sample by a single juvenile, whereas 3 adults were captured in 2001.)

In 2001 these trends continued, concurrent with a significant drop in the IBI score to 33.3, the lowest since 1992. If we look at the observed values for individual metrics, only those metrics based on species count, plus metric 12 (% individuals with disease and anomalies) were unchanged and values for two of the species count metrics (No. 2 and No.5, no. darter spp. and no. intolerant spp., respectively) have historically been extremely low.

- The proportion of tolerant fish (Metric 6) was the highest since 1990, when the site scored 17.1 (bioclass VERY POOR) on the IBI.
- Observed values for metrics 10 (catch rate) and 11 (proportion of individuals as darters and sculpins) were the lowest since 1992.
- The proportion of omnivores, generalists and herbivores (Metric 7) was the highest since 1995.
- The proportion of specialized insectivores (Metric 8) was the lowest since 1996.

Trends may also be detected at the level of abundance of individual species and species groups. In 1990, the first year that this site was monitored, the dominant fish group was the centrarchids (36.6% of the total sample). Over the years, lower Rabbit Creek has become more like a typical mountain stream (albeit lacking two significant components –



darters and trout), and in 1995 the Centrarchidae constituted only 3.8% of the total sample. In 2000 and 2001, respectively, this percentage had increased to 13.8 and 25.3%. The 2 Centrarchid species which have historically occurred in significant numbers (rock bass, *Ambloplites rupestris* and redbreast sunfish, *Lepomis auritus*) were both taken in record numbers in 2001 and a third species, the green sunfish (*Lepomis cyanellus*), previously taken only as single individuals in some years, was represented by 22 individuals.

The other species which recorded a record high in 2001 was the whitetail shiner (*Cyprinella galactura*), normally considered a “river species.” This species, normally present as single strays and/or juveniles, had all size classes represented in 2001.

Perhaps the most telling numbers, in terms of individual species, are for the mottled sculpin (*Cottus bairdi*). This benthic species is by far the dominant fish in many streams in the upper Little Tennessee watershed, and is strongly associated with rocky substrates. In 1990-1992 the mottled sculpin accounted for less than 10% of the total catch at this site, but during 1996-1998 it was the dominant species, accounting for 30.8-48.5% of the total catch. Beginning in 1999 its numbers declined sharply. By 2001 it was only the fifth most abundant species, accounting for but 9.5% of the total catch.

Oscillations in sculpin numbers, the IBI score and other parameters of the fish assemblage in lower Rabbit Creek appear to correlate well with perceived sediment load. In 1990, most of the rocky substrate outside of one very swift riffle was heavily embedded and in many places completely covered by fine sediment. By 1995 this condition could be seen to have improved dramatically (though Rabbit Creek was still far from a healthy mountain stream in this regard). Starting in the summer of 2000, visible sediment on the substrate increased significantly, concurrent with removal of beaver dams, destruction of riparian vegetation and rechannelization on its principal tributary, Cat Creek, which joins Rabbit Creek about 0.4 mi. upstream of Fixed Station 5. (See also Cat Creek IBI monitoring results, in this report.)

The development associated with this damage has received a number of citations for environmental violations, and may be in financial trouble. Management of this situation may be key to determining whether lower Rabbit Creek enters another recovery phase or continues to decline in biotic integrity.

Table 12. Fixed Station 5 - Rabbit Creek at Rabbit Creek Rd. (RM 0.6)

#### Species and Numbers of Fish Taken

Species	Numbers of Fish Taken	
	2000	2001
Central stoneroller	14	39
Smoky dace		
Whitetail shiner	7	17
Warpaint shiner	52	39
River chub	44	41

Tennessee shiner	44	14
Yellowfin shiner	2	3
Blacknose dace		2
Longnose dace	1	3
Creek chub	2	6
White sucker	2	4
Northern hogsucker	12	32
Golden redhorse	5	3
Brown bullhead		
Rock bass	27	36
Redbreast sunfish	15	16
Green sunfish		22
Warmouth		
Bluegill	2	1
Largemouth bass	1	
Mottled sculpin	95	28
TOTALS	325	296

### Metrics and Scoring

Metric	2000		2001	
	Observed value	Score	Observed value	Score
1. No. native spp.	14	6.7	15	6.7
2. No. darter spp.	0	1.3	0	1.3
5. No. intolerant spp.	1	1.3	1	1.3
6. % individuals as tolerants	5.8	6.7	16.2	4.0
7. % individuals as omnivores and herbivores	19.1	4.0	31.0	1.3
8. % individuals as specialized insectivores	32.3	4.0	24.6	4.0
10. Catch rate	51.9	6.7	25.4	6.7
11. % individuals as darters and sculpins	29.2	1.3	9.4	1.3
12. % individuals with disease or anomalies	0.9	6.7	0.3	6.7
<b>TOTALS</b>		<b>38.7</b>		<b>33.3</b>
		<b>FAIR</b>		<b>POOR</b>

## Fixed Station 6 – Cullasaja River at Macon Middle School (RM 0.9)

This site has historically been characterized by a low catch rate, and returned to that condition this year after an uncharacteristically high catch (which still would not have been high for most sites) in 2000.

A bioclass rating of FAIR seems to overrate this site, and two of the metrics could arguably have been scored lower:

- For metric 2 (no. darter spp.) it could be argued that the single greenfin darter (*Etheostoma chlorobranchium*) taken (a juvenile) was a stray from more suitable habitat upstream. This species is not taken every year at this site, and always in very low numbers.
- The most abundant piscivorous species at the site (rock bass, *Ambloplites rupestris*) was present only as juveniles. The largemouth bass (*Micropterus salmoides*) was represented in the sample by a single large and definitely piscivorous juvenile. A slightly larger *Micropterus* (species not determined), was seen escaping. Based on these two individuals, piscivores were determined to be present.

Specimens of the common carp (*Cyprinus carpio*), recorded for the first time from this site (or anywhere in the Cullasaja River watershed) in 2000, were seen on the site shortly before the sampling date, but none were seen or captured. A few large fish, judged to be redhorses (*Moxostoma*) were seen to escape during sampling. While the volunteer crew worked well, there was a measure of inefficiency, particularly with respect to large pool fishes, because water level was somewhat above optimum for this site. However, we consider the sampling effort to be adequate.

Instability of the predominantly sandy substrate continues to be the main factor limiting biotic integrity at this site. The most important habitat is provided by large woody debris along shore; much of the midchannel is nearly devoid of fish.

Table 13. Fixed Station 6 - Cullasaja River at Macon Middle School (RM 0.9)

### Species and Numbers of Fish Taken

Species	Numbers of Fish Taken	
	2000	2001
Mountain brook lamprey	1	3
Central stoneroller	33	2
Smoky dace		
Whitetail shiner	73	42
Common carp	2	
Warpaint shiner	95	22
River chub	22	18

Golden shiner		
Tennessee shiner	44	35
Yellowfin shiner	1	4
Silver shiner		
Mirror shiner	14	5
Telescope shiner		
Fatlips minnow	8	
Creek chub	1	5
White sucker		
Northern hogsucker	25	1
Black redhorse	6	
Golden redhorse	2	1
Snail bullhead	1	
Rock bass	1	4
Redbreast sunfish	20	19
Green sunfish		1
Warmouth		2
Bluegill	2	7
Smallmouth bass	2	
Largemouth bass		1
Tuckaseigee darter	6	
Greenfin darter		1
Gilt darter	17	8
Olive darter		
Mottled sculpin	21	17
TOTALS	397	198

**Metrics and Scoring** (scored as for sites with drainage areas of 40-70 sq. mi.)

Metric	2000		2001	
	Observed value	Score	Observed value	Score
1. No; native spp.		18 3.3	18	3.3
2. No. darter spp.		2 5.5	2	5.5
4. No. sucker spp.		3 5.5	2	5.5
5. No. intolerant spp.	1*	1.1	1*	1.1
6. % individuals as tolerants	6.0	5.5	12.1	3.3
7. % individuals as omnivores and herbivores	15.1	3.3	14.1	5.5
8. % individuals as specialized insectivores	64.7	5.5	55.1	5.5
9. No. piscivorous spp.	0*	1.1	1	5.5
10. Catch rate	8.5	3.3	4.0	1.1
11. % individuals as darters and sculpins	11.1	1.1	13.1	1.1

12. % individuals with disease and anomalies	2.8	3.3	6.1	1.1
<b>TOTALS</b>		<b>38.5</b> <b>FAIR</b>		<b>38.5</b> <b>FAIR</b>

\* Rock bass represented only by small juveniles

## Fixed Station 7 – Cartoogechaye Creek at Macon County Rec Park (RM 1.0)

With the exception of 1998, when the IBI sample (score 40.7, bioclass FAIR) was the first clue leading to discovery of a point source pollution problem upstream, the Rec Park site has usually been rated GOOD. This year's score (45.1, bioclass FAIR) ties with that from 1992 as the second lowest score at the site. It also marks the second straight year of decline, from 53.9 in 1999 and 47.3 in 2000. Several observations suggest that the decline may be real:

- Lowest absolute value ever for Metric 11 (proportion of darters and sculpins)
- Lowest catch rate, except for 1998. As in 1998, shoreline habitat was particularly poor. One 240 ft. subsample yielded only 3 fish.
- Both piscivore species (largemouth bass, *Micropterus salmoides* and the intolerant rock bass (*Ambloplites rupestris*) were represented only by individuals of marginal size for use in scoring, casting some doubt on the scores for Metrics 5 (no. intolerant spp.) and 9 (no. piscivore spp.)
- Although Metric 6 (proportion of tolerants) received the high score, the absolute value (6.1%) was more than double the previous high of 2.6%, from 1998, the year of the pollution event.

One visibly detectable factor which may have contributed to the relatively low IBI score was the presence of large amounts of newly deposited sediment, particularly along the banks. However, this may have been a temporary phenomenon, since the sample followed close on a heavy rain event.

The weather also occasioned persistent turbidity, which affected the quality of sampling. Unfortunately, sampling quality was also low due an extremely poor volunteer crew. Of particular concern in this regard is Metric 4 (no. sucker spp.). While redhorses (*Moxostoma*) have not always been taken at this site, 1 or 2 species have been taken in 6 of 10 sampling years. In 2001, several large fish, which may have been redhorses, were seen to escape. Capture of even one redhorse would have raised the score for Metric 4, and with it the IBI to 49.5 (equal to that for 2000).

An unprecedented number of bluegills (*Lepomis macrochirus*) was taken in 2001 (34, as compared to a previous maximum of 3). All were juveniles, of uniform size. It is suggested that their presence (along with the first record for the largemouth bass from this site) may have been weather-related (escapees from a damaged or overflowing pond somewhere upstream.)

The lower reaches of Cartoogechaye Creek, beginning about 1 mile upstream of the Rec Park, are located in a rapidly urbanizing area. Even if the difference between the 2000 and 2001 IBI's is not real, it would not be surprising to see a decline in the score here. There is a particular need for a high quality monitoring effort at this site in 2002.

Table 14. Fixed Station 7. Cartoogechaye Creek @ Macon County Rec Park  
(RM 1.0)

**Species and numbers of fish taken**

Species	Numbers of fish taken	
	2000	2001
Mountain brook lamprey	5	2
Rainbow trout	3*	
Brown trout	2	
Brook trout	2*	
Central stoneroller	25	18
Smoky dace		
Whitetail shiner	29	22
Common carp		
Warpaint shiner	30	19
River chub	40	32
Tennessee shiner	60	73
Yellowfin shiner	12	26
Mirror shiner	9	5
Fatlips minnow	1	1
Blacknose dace		
Creek chub	1	1
White sucker	1	
Northern hogsucker	13	5
Black redhorse	2	
Golden redhorse		
Brown bullhead		2
Snail bullhead		
Rock bass	11	4
Redbreast sunfish	8	20
Green sunfish		
Warmouth	3	
Bluegill	1	34
Smallmouth bass		
Largemouth bass		1
Black crappie		
Tuckaseegee darter	3	1
Greenfin darter	26	20
Gilt darter	28	18
Olive darter	2	
Mottled sculpin	166	76
TOTALS	478	380

\* Stockers, not included in scoring

# Metrics and scoring

Metric	2000		2001	
	Observed value	Score	Observed value	Score
1. No. native spp.	19	5.5	18	5.5
2. No. darter spp.	4	5.5	3	5.5
4. No. sucker spp.	2	5.5	1	3.3
5. No. intolerant spp.	2	3.3	2	3.3
6. % individuals as tolerants	2.2	5.5	6.1	5.5
7. % individuals as omnivores and herbivores	17.2	3.3	14.5	5.5
8. % individuals as specialized insectivores	43.5	3.3	41.8	3.3
9. No. piscivore spp.	2	5.5	2	5.5
10. Catch rate	13.3	5.5	10.1	3.3
11. % individuals as darters & sculpins	41.5	3.3	30.3	3.3
12. % individuals with disease or anomaly	14.2	1.1	10.5	1.1
TOTALS		47.3		45.1
		<b>GOOD</b>		<b>FAIR</b>



### Fixed Station 8 – Middle Creek at West Middle Creek Rd. (RM 2.2)

Since improving during 1990-1992, this site has displayed remarkable stability, with consistent GOOD scores. If one looks at individual components of the data, some tentative positive trends can be identified.

Possible positive trends include:

- Evidence of quite successful reproduction of both trout species, with the total trout catch (11) the second highest ever at this site.
- Second appearance of the greenfin darter (*Etheostoma chlorbranchium*) at the site.
- The native Tennessee shiner (*Notropis leuciodus*) apparently holding its own numerically in the face of competition and hybridization by the exotic yellowfin shiner (*Notropis lutipinnis*) since 1998.

Apparent negative trends include:

- Decline and near disappearance of the longnose dace (*Rhinichthys atratulus*), represented this year by a single individual.
- High numbers of the herbivorous central stoneroller (*Camptostoma anomala*) and record catch of the tolerant, omnivorous creek chub (*Semotilus atromaculatus*).
- High incidence of hybridization in two groups: The yellowfin shiner appears to be hybridizing with the Tennessee shiner, smoky dace (*Clinostomus* sp.), and possibly the warpaint shiner (*Luxilus coccogenis*). And 3 of 4 *Lepomis* taken appeared to be hybrids between redbreast sunfish (*Lepomis auritus*) and green sunfish (*Lepomis cyanellus*).

Table 15. Fixed Station 8 - Middle Creek at West Middle Creek Rd. (RM 2.2)

#### Species and Numbers of Fish Taken

Species	Number of fish taken	
	2000	2001
Rainbow trout	2	7
Brown trout	2	4
Central stoneroller	5	28
Smoky dace	47	21
Warpaint shiner	13	7
River chub	37	28

Tennessee shiner	120	85
Yellowfin shiner	45	18
Mirror shiner	4	3
Telescope shiner		
Fatlips minnow	3	2
Blacknose dace	3	5
Longnose dace	2	1
Creek chub	2	13
White sucker		
Northern hogsucker	5	8
Rock bass		
Redbreast sunfish		3
Green sunfish		1
Tuckasegee darter		2
Greenfin darter		1
Gilt darter	9	7
Mottled sculpin	405	476
TOTALS	704	720

### Metrics and scoring

Metric	2000		2001	
	Observed value	Score	Observed value	Score
1. No. native spp.	13	6.7	16	6.7
2. No. darter spp.	1	4	3	6.7
5. No. intolerant spp.	2	2	2	4.0
6. % individuals as tolerants	0.3	6.7	2.4	6.7
7. % individuals as omnivores and herbivores	6.7	6.7	10.3	4.0
8.. % individuals as specialized insectivores	28.1	4.0	17.9	1.3
10. Catch rate	50.0	6.7	34.1	6.7
11. % individuals as darters and sculpins	58.8	4.0	67.5	6.7
12. % individuals with disease or anomalies	0.3	6.7	0.7	6.7
TOTALS		49.5		49.5
		GOOD		GOOD

### Fixed Station 9 – Cullasaja River at Peaceful Cove Rd. (RM 8.3)

In 2001, the Peaceful Cove site registered the same IBI score (47.3, bioclass rating GOOD) as in 2000, or slightly lower than the norm for this site. Observed values for Metrics 7 (proportion of omnivores and herbivores) and 11 (proportion of darters and sculpins) were the lowest ever observed at this site, but the difference cannot be considered to be significant.

Once again there was a very high incidence of blackspot on cyprinids at this site. Observed values for Metric 12 (proportion of individuals with disease or anomaly) were in excess of 10% for the third consecutive year.

The population of the wounded darter (*Etheostoma vulneratum*) at this site continues to be disturbingly low. For the fourth consecutive year the catch of this species was between 6 and 9 individuals, whereas the mean catch for the mean for the preceding 6 years is 19.8, with a low count of 12.

Table 16. Fixed Station 9 - Cullasaja River at Peaceful Cove (RM 0.3)

#### Species and numbers taken

Species	Number of fish taken	
	2000	2001
Mountain brook lamprey	9	4
Rainbow trout	1	
Brown trout	2	
Central stoneroller	85	83
Whitetail shiner	2	7
Warpaint shiner	23	26
Golden shiner	1	
Tennessee shiner	59	66
Mirror shiner	32	23
Fatlips minnow	1	1
Longnose dace		1
River chub	42	41
Creek chub		
Northern hogsucker	7	2
Black redhorse		
Golden redhorse		2

Rock bass	16	9
Redbreast sunfish	2	1
Warmouth		
Bluegill		
Smallmouth bass	1	
Tuckasegee darter	10	8
Greenfin darter	40	40
Wounded darter	6	9
Banded darter		
Gilt darter	22	11
Olive darter		
Mottled sculpin	182	125
TOTALS	543	459

### Metrics and Scoring

Metric	2000		2001	
	Observed value	Score	Observed value	Score
1. No. native spp.	17	5.5	17	5.5
2. No. darter spp.	4	5.5	4	5.5
4. No. sucker spp.	1	3.3	2	5.5
5. No. intolerant spp.	3	5.5	3	5.5
6. % individuals as tolerants	0.4	5.5	0.2	5.5
7. % individuals as omnivores and herbivores	25.5	3.3	27.9	3.3
8. % individuals as specialized insectivores	36.9	3.3	41.8	3.3
9 No. piscivore spp.	2*	5.5	1	5.5
10. Catch rate	19.9	5.5	8.6	3.3
11. % individuals as darters and sculpins	47.9	3.3	42.0	3.3
12. % individuals with disease or anomaly	12.0	1.1	11.3	1.1
<b>TOTALS</b>		<b>47.3</b>		<b>47.3</b>
		<b>GOOD</b>		<b>GOOD</b>

\* Brown trout present only as juveniles

### Fixed Station 10 – Wayah Creek at Crawford Rd. (RM 0.6)

In 2001, the IBI score for the Wayah Creek fixed station, which has oscillated between 44.1 and 49.5 since 1990, hit a historic low of 38.7, still in the FAIR bioclass range, but clearly a significant drop. The main contributing factor appears to be a population explosion of the herbivorous central stoneroller (*Campostoma anomala*). A total of 97 individuals of this species were taken, as compared to a high of 50 (mean 23.7) in 7 previous samples.

The abundance of stonerollers directly affects Metric 7 (proportion of omnivores and herbivores). It may also indirectly affect Metric 11 (proportion of darters and sculpins) if the benthic stonerollers compete for habitat space with darters and sculpins. This was the first year since 1990 that this metric had not scored high. Stonerollers were also the principal species contributing to the highest ever incidence of disease and anomalies at this site (Metric 12), with various rates of occurrence of blackspot, scoliosis, finrot, leeches and an unknown ectoparasite.

Nevertheless recovery of fish biodiversity in the depleted lower Wayah Creek fauna may be continuing. A single specimen of the Tennessee shiner (*Notropis leuciodus*) was the first individual of this species taken at this site since 1990, although it is common just 0.6 mi. downstream in Cartoogechaye Creek. Another possibly positive trend is the return to abundance of the longnose dace (*Rhinichthys cataractae*), represented by 21 individuals in 2001, as compared to only 7 in 2000.

As of the date of sampling (June 2) there was no visible evidence of sedimentation related to construction of a sewer line into the Wayah Valley, although effects have been observed on Cartoogechaye Creek.

Sampling of pools may have been deficient since, due to an unexpectedly short crew, we were not able to run 2 shockers at a time.

Table 17. Fixed Station 10 - Wayah Creek at Crawford Rd. (RM 0.6)

#### Species and Numbers of Fish Taken

Species	Numbers of Fish Taken	
	2000	2001
Mountain brook lamprey	5	1
Rainbow trout	3	2
Brown trout	10	16
Central stoneroller	30	97
Smoky dace	11	27
Warpaint shiner	8	9
River chub	30	26
Tennessee shiner		1

Mirror shiner	7	13
Blacknose dace	48	68
Longnose dace	7	21
Creek chub		
Northern hogsucker	3	3
Golden redhorse		
Rock bass		1
Redbreast sunfish		
Tuckasegee darter	3	2
Greenfin darter	10	9
Mottled sculpin	556	455
TOTALS	731	751

### Metrics and scoring

Metric	2000		2001	
	Observed value	Score	Observed value	Score
1. No. native spp.	12	6.7	14	6.7
2. No. darter spp.	2	4	2	4
5. No. intolerant spp.	1	1.3	2	4
6. % individuals as tolerants	0.0	6.7	0.0	6.7
7. % individuals as omnivores and herbivores	15.7	4.0	25.6	1.3
8. % individuals as specialized insectivores	6.3	1.3	10.9	1.3
10. Catch rate	71.5	6.7	35.6	6.7
11. % individuals as darters and sculpins	77.9	6.7	62.1	4.0
12. % individuals with disease or anomaly	1.2	6.7	3.5	4.0
<b>TOTAL</b>		<b>44.1</b>		<b>38.7</b>
		<b>FAIR</b>		<b>FAIR</b>

*Fixed Station 11 – Skeenah Creek at North Carolina Welcome Center (RM 0.5)*

Although all expected fish species were taken, total catch at this site was barely half that of the last few years. A total of 4 normally common species (mountain brook lamprey, *Ichthyomyzon greeleyi*; smoky dace, *Clinostomus* sp.; Tennessee shiner, *Notropis leuciodus* and mottled sculpin, *Cottus bairdi*) were taken in record low numbers. Most notable was the smoky dace, which was limited to a single freshly dead specimen observed lying near the bank. If this individual were disallowed, the score for Metric 5 (no. intolerant spp.) would drop and the IBI score would decline to 27.

The only species which appeared in increased numbers was the exotic, tolerant redbreast sunfish (*Lepomis auritus*), of which 52 individuals – more than double the previous high of 25 – were taken. This dropped Metric 6 (proportion of tolerants) from the high to the low score.

Absolute values for 2 other metrics (8 – proportion of specialized insectivores and 12 – proportion with disease or anomaly) were by far the lowest ever recorded here. Poor physical condition was also noted for a number of individual cyprinids.

It appears that the drop in IBI score is real and significant. The likeliest causative factor appears to be sedimentation. More sediment was observed on run habitat than in previous years. This may be related to a controversial school construction project located less than a mile upstream, which involved a certain amount of riparian deforestation, wetland drainage and channelization of a portion of tributary stream, in addition to the usual soil disturbing activities.

Table 18. Fixed Station 11 - Skeenah Creek at North Carolina  
Welcome Center (RM 0.5)

#### Species and Numbers of Fish Taken

Species	Numbers of fish taken	
	2000	2001
Mountain brook lamprey	7	3
Rainbow trout		
Brook trout		
Central stoneroller	13	6
Smoky dace	7	1
Whitetail shiner		
Warpaint shiner	51	14
River chub	59	22
Tennessee shiner	23	9
Yellowfin shiner	94	34
Fatlips minnow		
Creek chub	3	3
White sucker		3
Northern hogsucker	6	7
Black redhorse		
Golden redhorse		2
Brown bullhead		
Rock bass	10	13
Redbreast sunfish	25	52
Green sunfish	1	1

Warmouth	1	
Bluegill	1	
Tuckasegee darter		
Greenfin darter	4	
Gilt darter		
Mottled sculpin	120	58
<b>TOTALS</b>	<b>425</b>	<b>228</b>

### Metrics and Scoring

Metric	2000		2001	
	Observed value	Score	Observed value	Score
1. No. native spp.	13	7.5	13	7.5
5. No. intolerant spp.	2	4.5	2	4.5
6. % individuals as tolerants	6.8	7.5	26.3	1.5
7. % individuals as omnivores and herbivores	19.3	4.5	16.2	4.5
8. % individuals as specialized insectivores	20.9	4.5	10.5	1.5
10. Catch rate	32.9	7.5	18.5	7.5
11. % individuals as darters and sculpins	29.2	1.5	25.4	1.5
12. % individuals with disease or anomaly	6.4	1.5	11.4	1.5
<b>TOTALS</b>		<b>39</b>		<b>30</b>
		<b>FAIR</b>		<b>POOR</b>



### **Fixed Stations 12 and 13, Sutton Branch at Rabun Gap-Nacoochee School (RM 0.0 and 0.5)**

These 2 sites, located within an ongoing stream restoration project site on the campus of Rabun Gap-Nacoochee School in Rabun Gap, Georgia, are tentatively listed as new fixed stations. This implies that we will resolve the problems related to timely analysis of macroinvertebrate samples. If this cannot be achieved, these sites may be dropped. Note that as of the time the 2000 report was finalized, macroinvertebrate data were still not available. They were included as an addendum, which has some errors. Data appearing here (Table 19) are to be considered correct. (However, note that there may be some doubt as to the quality of the 2001 macroinvertebrate data, as compared to previous years, due to changes in personnel and procedures by TVA.)

While improvement in the quality of the riparian zone at RM 0.0 is obvious (replacement of exotic shrubs and vines which formerly dominated the site by native alders and other trees), neither site can as yet be said to be demonstrating "restoration" of the aquatic biota. In fact, the IBI score declined by 6 and 12 points at the lower and upper sites, respectively, with a drop in bioclass rating from FAIR to POOR at the upper site. Observed values dropped for 4 of the 8 metrics in the Improved Williams IBI at the lower site, and for 5 of 8 at the upper site. Among the specific changes observed:

- A drastic decline in mayfly (*Ephemeroptera*) taxa at the upper site (11 to 5 taxa), with a concomitant but less significant drop in stoneflies (*Plecoptera*) and caddisflies (*Trichoptera*)
- A sudden jump in catch per unit effort of fish to record levels at both sites, after a steady record of declining catch rate in previous years suggests an increase in nutrient loading from some source. A record high incidence of disease and parasitism (6.0%) at the lower site suggests the same. A severe fungus condition was noted on several creek chubs, and finrot was observed on several species.
- The proportion of tolerant fish (creek chub, *Semotilus atromaculatus*) also reached record highs at both sites.
- The proportion of omnivores and herbivores at both sites also increased, to a record high at the upper site and a near-record level at the lower site.
- Another possible stress indicator, not reflected in the IBI metrics, was the appearance at both sites of several individuals which appeared to be creek chub-smoky dace (*Clinostomus sp.*) hybrids.

One possible positive trend is a reduction in total species numbers at both sites - from 11 to 9 to 8 at the lower site and 5 to 7 to 3 at the upper site. This reduction in use by "native invaders" more characteristic of larger streams may be a factor in increased dominance by creek chubs, which are an expected species in streams the size of Sutton Branch.

If biotic integrity in Sutton Branch is in fact declining, it is not because of the failure of restoration measures per se. Fencing has been effective in keeping cattle out of most of the stream length in both sectors. Survival of planted trees and shrubs in the riparian zone has

been high, and is complemented by natural regeneration of native vegetation (with selective management.) Large rocks placed in the stream were seen to be being colonized by aquatic insects.

However, it is noteworthy that cattle have access to the stream at two points, one located near the upper end of each of the monitoring n more modest restoration goals are cast into doubt) so long as the nutrient and sediment sources mentioned above persist.

Table 19. Fixed Stations 12 and 13 (tentative) - Sutton Branch at Rabun Gap-  
Nacoochee School

(RM 0.0 and RM 0.5)

#### Species and Numbers of Fish Taken

Species	RM 0.0		RM 0.5	
	2000	2001	2000	2001
Mountain brook lamprey	1	2		
Central stoneroller	10	13	1	
Smoky dace	25	65	88	80
River chub	8	2	1	
Tennessee shiner				
Yellowfin shiner	14	6	8	
Mirror shiner				
Creek chub	25	58	30	68
Rock bass	7	5		
Redbreast sunfish	1			
Green sunfish	1			
Mottled sculpin	19	15	24	7
TOTALS	111	166	152	155

#### Macroinvertebrate Taxa Collected (EPT Forms only)

Taxon	RM 0.0		RM 0.5	
	2000	2001*	2000	2001*
<i>Ephemeroptera</i>				
Baetidae		3		1
(early instars)			X	
<u>Baetis intercalaris</u>	X		X	
<u>B. pluto</u>	X		X	
<u>Pseudocloeon propinquus</u>	X		X	
<i>Ephemerellidae</i>		2		2

(early instars)				X
<i>Attenella attenuata</i>				X
<i>Ephemerella catawba</i>				X
<i>Serratella deficiens</i>	X			X
S.sp. (early instars)	X			
<i>Ephemeridae</i>				
<i>Ephemera</i> sp.	X			
<i>Heptageniidae</i>		1		1
(early instars)	X			
<i>Epeorus rubidus/subpallidus</i>	X			
<i>Stenacron pallidum</i>	X			
<i>S. ithaca/modestum</i>	X			
<i>S. merivulanum</i>			X	
<i>Isonychiidae</i>		1		
<i>Isonychia</i> sp.	X		X	
<i>Leptophlebiidae</i>		1		
<i>Habrophlebiodes</i> sp.			X	
<i>Paraleptophlebia adoptiva/mollis</i>	X		X	
<i>Oligoneuridae</i>				1
<b>TOTAL EPHEMEROPTERA TAXA</b>	<b>11</b>	<b>8</b>	<b>11</b>	<b>5</b>
<u><i>Plecoptera</i></u>				
<i>Leuctridae</i>		1		
<i>Leuctra</i> sp.			X	
<i>Peltoperlidae</i>				
<i>Tallaperla/Peltoperla</i> sp.			X	
<i>Perlidae</i>				2
<i>Perlesta</i> sp.	X			
<i>Perlodidae</i>				
<i>Remenus bilobatus</i>			X	
<i>Isoperla holochlora</i>	X		X	
<i>Pteronarcyidae</i>				
<i>Pteronarcys proteus</i> sp. gr.	X			
<b>TOTAL PLECOPTERA TAXA</b>	<b>3</b>	<b>1</b>	<b>4</b>	<b>2</b>
<u><i>Trichoptera</i></u>				
<i>Glossosomatidae</i>		1		
<i>Glossosoma</i> sp.			X	
<i>Hydropsychidae</i>		3		1
<i>Lepidostomatidae</i>				1
<i>Lepidostoma</i> sp.			X	
<i>Limnephilidae</i>		1		1
<i>Pycnopsyche guttifer</i> sp. gr.	X			

<i>P. luculenta</i> sp. gr.			X	
<i>Molannidae</i>		1		
<i>Philopotamidae</i>		1		
<i>Dolophilodes</i> sp.			X	
<i>Polycentropidae</i>				
<i>Polycentropus</i> sp.			X	
<i>Uenoidae</i>		1		1
<i>Neophylax ornatus</i>	X			
<i>N. auris/etnieri</i>			X	
<b>TOTAL TRICHOPTERA TAXA</b>		<b>2</b>	<b>8</b>	<b>6</b>
<b>TOTAL EPT TAXA</b>		<b>16</b>	<b>17</b>	<b>21</b>

\* Species identity not available for 2001 sample

## Metrics and Scoring

### 1. Williams "brook trout" IBI

Metric*	RM 0.0 2000 Observed value	RM 0.0 # Score	RM 0.0 # Observed value	RM 0.0 2001 Score	RM 0.5 2000 Observed value	RM 0.5 ### Score	RM 0.5 2001 Observed value	RM 0.5 2001 Score
1	11	#	8	10	11	10	5	6
2	16	#	#	10	21	10	11	6
3	Absent		2 Absent	2	Absent		2 Absent	2
4	22.2	#	#	6	36.4	10	93.5	6
5	2.7	6	6	2	0.7	8	0.6	8
6	24.3	2	#	2	19.7	6	43.9	2
<b>TOTALS</b>		<b>#</b>		<b>32</b>		<b>46</b>		<b>30</b>

### 2. Modified Williams IBI

1	11	8	8	7.5	11	7.5	5	4.5
2	16	8	#	7.5	21	7.5	11	4.5
3	Absent		2 Absent	1.5	Absent		1.5 Absent	1.5
4	22.2	8	#	4.5	36.4	7.5	93.5	4.5
5	2.7	5	6	1.5	0.7	6	0.6	6
6	24.3	2	#	1.5	19.7	4.5	43.9	1.5
7	0.0	#	#	1.5	0.0	1.5	0.0	1.5

	8	39.8	2	#	1.5	33.3	1.5	43.9	1.5
<b>TOTALS</b>		<b>#</b>			<b>27</b>		<b>38</b>		<b>25.5</b>
		<b>POOR</b>			<b>POOR</b>		<b>FAIR</b>		<b>POOR</b>

\* For parameters for metrics, see Table 8.

## Younce Creek above Younce Creek Rd. (RM 0.2)

A previous attempt was made to carry out a fish-based IBI on Younce Creek in 1997 (McLarney, 1998b). Younce Creek is of marginal size for this purpose (watershed drainage area between 3.9 and 4.0 sq. mi.) and has a significant tributary (Dave's Creek – watershed drainage area 0.9 sq. mi.) which joins the main stream just 0.2 mi. above its mouth at Burningtown Creek. A sample taken at RM 0.5, using the fish-only IBI protocol was not sufficiently diverse (total 8 species) to permit a credible IBI. Qualitative sampling at RM 0.2, just below the mouth of Dave's Creek, produced 3 additional species, but no attempt was made to calculate an IBI.

In 2001, during a period of rainy weather, when sampling opportunities were limited, it was decided to attempt a fish-based IBI at RM 0.2 on Younce Creek. A total of 12 species, including all native species taken at both sites in 1997, plus 3 new species (but not including the exotic rainbow trout, *Oncorhynchus mykiss* and brown trout, *Salmo trutta*) was taken, and an IBI was computed, which appears to be credible. If Younce Creek at RM 0.2 were treated as a "brook trout" stream, with a watershed drainage area of less than 4 sq. mi. and a modified Williams IBI applied, assuming the high score for the 2 macroinvertebrate-based metrics (which seems reasonable based on observations made during and after the fish sample), then the identical IBI score (45, bioclass rating FAIR) would be achieved.

Of the new species, 2 (bluegill, *Lepomis macrochirus* and greenfin darter, *Etheostoma chlorobranchium*) were represented by single individuals. Both of these species are characteristic of larger streams (and in the case of the bluegill, slower moving waters). If both are disallowed as strays then the score for Metric 1 (no. native spp.) would drop. In the case of the bluegill it is likely that it is a pond escapee. However, we have repeatedly seen greenfin darters in streams of this size and type, so it was included in scoring.

It should be noted that if the 2001 IBI sample is compared to the 1997 qualitative sample, we will find 4 previously unrepresented species (the two mentioned above, plus the Tennessee shiner, *Notropis leuciodus* and the northern hogsucker, *Hypentelium nigricans*, found in 1997 at RM 0.5, but not at RM 0.2). In addition, 3 of the 7 remaining species changed in abundance. The smoky dace (*Clinostomus* sp.) went from common to abundant, becoming the most numerous species at the site. The river chub (*Nocomis micropogon*) went from rare to common and the central stoneroller (*Campostoma anomala*) declined from abundant to common. In addition, the mottled sculpin (*Cottus bairdi*), although it would still be considered abundant, appears to have declined abruptly in numbers, from a catch of 342 in the 1997 RM 0.5 sample to 84 at RM 0.2 in 2001.. No obvious hypothesis about biotic integrity in Younce Creek emerges from examination of these numbers.

As in 1997, the macroinvertebrate community at RM 0.2 appeared abundant and diverse, with stoneflies (*Plecoptera*) particularly notable for their abundance. In 1997, this was the site for the first record of the endemic Little Tennessee River crayfish (*Cambarus georgiae*) from downstream of Lake Emory. Therefore notes were made on crayfish in the 2001 sample. Of a total of 21 crayfish taken, 19 were *Cambarus bartoni*, and 2 were *C. georgiae*.

An abundance and diversity of Desmognathid salamanders was also noted at the site.

We failed to measure environmental parameters for the site, as was done for the RM 0.5 site in 1997 (McLarney, 1998b). However, there is much more bedrock at RM 0.2, with some boulders. The reach parallels Younce Creek Rd. and may have been channelized at some point. There was a fairly heavy sediment load (mitigated by the many swift riffles) and some slippery green algae on rocks in the few places where the channel was exposed to the sun. The stream was heavily canopied, and choked by alders at one point where it passes under a power line.

Table 20 - Younce Creek above Younce Creek Rd. (RM 0.2)

#### Species and Numbers of Fish Taken

Species	Numbers of fish taken (or relative abundance*)		
	RM 0.5	RM 0.2	RM 0.2
	1997	###	2001
Rainbow trout	7		
Brown trout	4		
Smoky dace	15	C	123
Central stoneroller	1	A	21
Warpaint shiner		C	9
River chub	2	R	14
Tennessee shiner			3
Blacknose dace	36	C	14
Longnose dace	11	R	2
Creek chub	7	C	7
Northern hogsucker	2		4
Bluegill			1
Greenfin darter			1
Mottled sculpin	342	A	84
TOTALS	427		283

#### Metrics and Scoring (2001 sample only)

Metric	Observed value	Score
1. No. native spp.	12	7.5
5. No. intolerant spp.	1	1.5
6. % individuals as tolerants	2.5	7.5

7. % individuals as omnivores and herbivores	19.8	4.5
8. % individuals as specialized insectivores	48.8	7.5
10. Catch rate	35.4	7.5
11. % individuals as darters and sculpins	30.0	1.5
12. % individuals with disease or anomaly	0.0	7.5
<b>TOTAL</b>		<b>35 FAIR</b>



### **Burningtown Creek above Younce Creek Rd. (RM 4.9)**

We have been remiss in sampling Burningtown Creek (the second largest tributary to the Little Tennessee downstream of Franklin) above the lower reaches. We began to rectify this situation in 1999 with a sample taken at Outside Inn Campground (RM 3.0) and this sample continues the process. The sample site is located near, but upstream of, a development site which released a large amount of sediment to Burningtown Creek in 2000, resulting in regulatory action. While it might be useful to assess the biological effects of this episode, the function of this sample was to measure the biotic integrity of Burningtown Creek above its uppermost major tributary (Younce Creek).

Our original work plan for the site was varied substantially due to unavoidable events in the field. However, based on the RM 3.0 sample, all “expected” species (with the possible exception of the telescope shiner, *Notropis telescopus*) were taken and the sample is considered to be representative of the fish assemblage. There may have been a bias toward slack water forms, but the high score for Metric 11 (% darters and sculpins) largely vitiates that concern.

One of the intolerant species (rock bass, *Ambloplites rupestris*) did not appear during the regular sample. Based on its presence at RM 3.0 in 1999, and the experience of one of the volunteers in catching rock bass precisely at this site, we decided to dedicate 10 minutes of additional shocker time to searching for rock bass in optimum habitat. A small adult was taken after 117 seconds of shocking, and the species included in the IBI.

Brown trout (*Salmo trutta*) taken in this sample appeared to be wild fish. Some of the rainbow trout (*Oncorhynchus mykiss*) may have been stockers, but some definitely appeared to be wild fish. All trout were included in calculating the IBI.

This sample supports the reputation of upper Burningtown Creek as one of the higher quality streams in its size range in the upper Little Tennessee watershed.

Table 22 lists physical parameters of Burningtown Creek at this site.

Table 21. Burningtown Creek above Younce Creek Rd. (RM 4.9)

**Species of fish and numbers taken - 2001**

Rainbow trout	6
Brown trout	4
Central stoneroller	74
Smoky dace	24
Whitetail shiner	1
Warpaint shiner	51
River chub	37
Tennessee shiner	73
Mirror shiner	32
Blacknose dace	6
Longnose dace	6
Creek chub	2
Northern hogsucker	13
Rock bass	1
Tuckaseigee darter	6
Greenfin darter	10
Gilt darter	10
Mottled sculpin	214
<b>TOTAL</b>	<b>570</b>

**Metrics and Scoring**

<b>Metric</b>	<b>Observed value</b>	<b>Score</b>
1. No. native spp.	16	6.7
2. No. darter spp.	3	6.7
5. No. intolerant spp.	3	6.7
6. % individuals as tolerants	0.4	6.7
7. % individuals as omnivores and herbivores	21	4.0
8. % individuals as specialized insectivores	37	4.0
10. Catch rate	21	6.7
11. % individuals as darters and sculpins	42	4.0
12. % individuals with disease or anomaly	0.7	6.7
<b>TOTAL</b>		<b>52.2</b>
		<b>GOOD</b>

**Table 22. Physical Parameters of Burningtown Creek  
above Younce Creek Rd. (RM 4.9)**

Drainage area (sq. mi.)		17.1
Mean width (ft.)		21.1
Mean depth (ft.)		
Riffles		1.0
Runs		1.1
Pools		1.7
Overall		1.2
Maximum depth (ft.)		3.0
Approximate substrate composition (%)		
Bedrock		25
Boulder		10
Rubble		30
Gravel	tr	
Sand		30
Silt		5
% canopy cover		75
Woody debris	Uncommon	
Riparian land use		
L bank	abandoned home site, pasture	
R bank	well buffered highway embankment	
Riparian buffer zone width (ft.)		
L bank		25-50
R bank		20

### **Caler Fork @ Eula Holbrook property (RM 0.3)**

Conditions for carrying out the 2001 Caler Fork sample were marginal. The water was turbid from recent rains, and the crew was minimal (3 people). This may be reflected in the low total catch (205 fish as compared to 332 in 1997), and perhaps in the low catch of benthic species (darters, sculpins and larval lampreys). Nevertheless, and notwithstanding a decline in Metric 11 (proportion of darters and sculpins) from the high to the low score category, Caler Fork appears to have improved dramatically (IBI Score of 38.7, bioclass rating FAIR to 49.5, bioclass rating GOOD. Note that in McLarney, 1998b, the IBI for Caler Fork was erroneously calculated using the IBI for streams with watershed areas of 4-7 sq. mi, when in fact it drains 7.5 sq. mi. at the monitoring site; this is corrected in Table 23.) Consider the following changes:

- Total number of native species increased from 9 to 13, with the addition of the river chub (*Nocomis micropogon*), telescope shiner (*Notropis telescopus*), fatlips minnow (*Phenacobius crassilabrum*) and rock bass (*Ambloplites rupestris*).
- Appearance of 2 new intolerant species (telescope shiner and rock bass).
- Dramatic reduction in the proportion of tolerant species (12.3 to 2.9%) with total disappearance of one intolerant species (the exotic redbreast sunfish, *Lepomis auritus*)
- Even more dramatic increase in proportion of specialized insectivores. Not only did numbers of these species increase, they are better distributed. In 1997 the warpaint shiner (*Luxilus coccogenis*) was taken in only 1 of 9 subsamples, and the Tennessee shiner (*Notropis leuciodus*) in 2. This year, both species appeared in 8 of 9 subsamples.

Under conditions of some turbidity, the likeliest species to be missed are benthics. Capture of only 7 more specimens of the gilt darter (*Percina evides*) and/or mottled sculpin (*Cottus bairdi*) would have raised the score for Metric 11 (proportion of darters and sculpins) by one category, and the IBI score to 52.2.

The cause of the improvement in Caler Fork is not immediately evident. Stresses identified in 1997 included channelization, removal of most of the larger woody vegetation from the banks, and sedimentation. The first two of these conditions have not changed. With regard to sedimentation, one local source (a new house site bleeding sediment into the stream just upstream of the sample reach) has stabilized. The main source of sediment to Caler Fork in recent times is presumed to be the Cowee Valley gem mines, which are concentrated along Caler Fork further upstream. Many of these businesses have shut down over the last few years.

We also cannot rule out toxic pollutants or nutrients associated with agriculture or tourist facilities other than the gem mines. In addition to the upstream mines, the site is immediately downstream from an ornamental aquatic plant business, part of whose pond facilities drain directly to Caler Fork. This is almost certainly the source of the single individual of the mosquitofish (*Gambusia*) taken in the sample. (Note that the specimen was

a female and not identified to species. See McLarney, 2000 for a discussion of *Gambusia* in the upper Little Tennessee watershed.)

One change which could be interpreted as negative was the dramatic drop in abundance of rainbow trout (*Oncorhynchus mykiss*). In 1997, Caler Fork appeared to be serving as nursery habitat for this species, whereas the single rainbow trout taken in 2001 (and also the lone brown trout, *Salmo trutta*) was a small adult.

All in all, and the lack of adequate explanations for observed phenomena notwithstanding, it appears that the health of Caler Fork has improved significantly. Certainly the GOOD bioclass rating is more in keeping with what is known of the biotic condition of Cowee Creek immediately downstream (McLarney, 1998b).

Table 23. Caler Fork @ Eula Holbrooks property (RM 0.3)

#### Species and Numbers of Fish Taken

Species	Number of Fish Taken	
	1997	2001
Mountain brook lamprey	20	3
Rainbow trout	18	1
Brown trout		1
Central stoneroller	2	8
Warpaint shiner	5	35
River chub		14
Tennessee shiner	3	50
Telescope shiner		14
Fatlips minnow		1
Creek chub	14	1
Northern hogsucker	2	2
Mosquitofish		1
Rock bass		3
Redbreast sunfish	6	
Green sunfish	21	4
Gilt darter	34	18
Mottled sculpin	198	49
TOTAL	323	205

#### Metrics and Scoring

Metric	1997		2001	
	Observed value	Score	Observed value	Score

1. No. native spp.	9	4.0	13	6.7
2. No. darter spp.	1	4.0	1	4.0
5. No. intolerant spp.	1	1.3	3	6.7
6. % individuals as tolerants	12.7	4.0	2.9	6.7
7. % individuals as omnivores and herbivores	11.1	4.0	12.7	4.0
8. % individuals as specialized insectivores	13.0	1.3	58.0	6.7
10. Catch rate	25.6	6.7	29.5	6.7
11. % individuals as darters and sculpins	71.8	6.7	32.7	1.3
12. % individuals with disease or anomaly	0.03	6.7	0.0	6.7
<b>TOTALS</b>		<b>38.7</b>		<b>49.5</b>
		<b>FAIR</b>		<b>GOOD</b>

### Matlock Creek @ Snow Hill Rd. (RM 0.4)

The change in biotic integrity in Matlock Creek between 1997 and 2001 is opposite that for Caler Fork, also tributary to Cowee Creek. While the IBI score for Caler Fork increased by 11 points and one bioclass, that for Matlock Creek dropped by 9 points and one bioclass.

Superficial inspection of the data suggests that the main change was an increase in abundance of omnivores, generalist feeders and herbivores (Metric 7). In fact, the total number of individuals of the 4 species belonging to these categories (central stoneroller, *Campostoma anomala*; river chub, *Nocomis micropogon*; blacknose dace, *Rhinichthys atratulus* and creek chub, *Semotilus atromaculatus*) is virtually identical for the 2 years – 46 in 1997 and 50 in 2001. The change appears to be due primarily to a tremendous decline in numbers of the mottled sculpin (*Cottus bairdi*), from 558 to 119. Similar declines in numbers of this, generally the most widespread and abundant fish in the upper Little Tennessee watershed, were observed at several other sites in 2001.

The total number of non-sculpins in the sample was also very similar in the two years (118 in 1997 and 100 in 2001). It is possible that the change in IBI is not in fact significant, but that the significance of the data in 1997 was masked by what we have sometimes referred to as "sculpin swamping." However, the Matlock Creek watershed upstream of this point is a rapidly developing area, and there appeared to be a major increase in the amount of the sediment in the substrate at Snow Hill Rd. in 2001 as compared to 1997..

Nutrient problems cannot be ruled out. The right bank at the site was closed off to cattle in 1997, but they now have limited access to the creek, and there was a perceived increase in green algae at the site. In our opinion, the negative change in biotic integrity at this site is real.

Table 24. Matlock Creek @ Snow Hill Rd. (RM 0.4)

#### Species and Numbers of Fish Taken

Species	Number of Fish Taken	
	1997	2001
Rainbow trout	9	2
Brown trout	1	1
Central stoneroller	14	11
Warpaint shiner	9	18
River chub	11	23
Tennessee shiner		4
Fatlips minnow	1	
Blacknose dace	11	13
Longnose dace	7	5

Creek chub	10	3
Northern hogsucker	7	3
Rock bass	2	3
Green sunfish	4	
Bluegill		1
Tuckaseegee darter	2	
Gilt darter	30	13
Mottled sculpin	558	119
<b>TOTALS</b>	<b>676</b>	<b>219</b>

### Metrics and Scoring

Metric	1997		2001	
	Observed value	Score	Observed value	Score
1. No. native spp.	13	7.5	12	7.5
5. No. intolerant spp.	2	4.5	2	4.5
6. % individuals as tolerants	2.1	7.5	1.4	7.5
7. % individuals as omnivores and herbivores	6.8	7.5	22.8	1.5
8. % individuals as specialized insectivores	7.2	1.5	18.3	1.5
10. Catch rate	45.7	7.5	26.3	7.5
11. % individuals as darters and sculpins	87.3	7.5	60.3	4.5
12. % individuals with disease or anomaly	0.6	7.5	0.0	7.5
<b>TOTALS</b>		<b>51</b>		<b>42</b>
		<b>GOOD</b>		<b>FAIR</b>



## Little Tennessee River at Iotla Bridge (RM 111.1)

While a change of 2 points in IBI score (according to upper Little Tennessee metrics; see discussion below re Metric 11) cannot be certified as significant, even when it leads to a change in bioclass rating – in this case from EXCELLENT (56) in 1999 to GOOD (54) in 2001, it appears that there has been a slight negative change at the Iotla Bridge site. This change is most apparent in Metric 6 (proportion of tolerants) and particularly in the abundance of the exotic redbreast sunfish (*Lepomis auritus*).

While numbers of other tolerant species remain low, the redbreast sunfish went from being the fourth most abundant species (45 individuals, 8.6% of the sample) in 1999 to by far the most abundant (108 individuals, 18.1% of the sample) in 2001. Extreme abundance of redbreast sunfish has signaled decline in water and habitat quality at several other sites.

It must be noted, however, that the water on the sample date (July 6) was somewhat more turbid than during the 1999 sample, which hampered both backpack shocker operation (particularly with respect to benthic species) and use of the boat shocker. This could have artificially affected metrics 8 (proportion of specialized insectivores) and 11 (proportion of darters and sculpins.)

Values for Metrics 8 and 11 could also have been driven down by management of the boat shocker sample. It was necessary to invest more effort than normal in the boat shocker work (19.4% of effort, as compared to 10.3% in 1999), with the result that the proportion of pool fish in the sample increased from 21.6% to 40.8%. Even at that, it was not possible to achieve species depletion, but it was decided to discontinue shocking to prevent excessive stress on the fish.

Note also that TVA for Metric 11 uses proportion of individuals as hybrids. No hybrids were noted (in either year), so it may be that no measurable change has occurred, IBI score remains at 56 and bioclass rating at EXCELLENT. This is the version of the IBI which has been reported to the North Carolina Division of Water Quality in discussions of a requested water quality classification upgrade for the reach of the Little Tennessee between Porter's Bend Dam and Fontana Reservoir, including this site.

This was the first year we have captured the intolerant, threatened spotfin chub (*Cyprinella monacha*) at this site. However, it is known to occur upstream all the way to the base of Porters Bend Dam (RM 113.1), as does at least one sensitive mussel species, the endangered Appalachian elktoe (*Alasmidonta raveneliana*). Numbers of the spotfin chub (3 in 2001) are apparently lower than at Needmore (RM 95.5) where a mean of 13.2 individuals have appeared in annual samples since 1990. Nevertheless, presence of these sensitive and protected species provides one valid argument against the permitting of a package wastewater treatment plant at a proposed RV park development on the river just 0.4 mi. upstream.

Now that we have 2 years of data from the Iotla Bridge site it may be informative to compare the site with the Needmore fixed station. Although not clearly indicated by the IBI, it appears that biodiversity is somewhat less at Iotla Bridge than at Needmore. Among species yet to be observed at Iotla Bridge are two which appear in most years in the Needmore

sample (mountain brook lamprey, *Ichthyomyzon greeleyi* and silver redhorse *Moxostoma anisurum*) as well as two rare forms (the undescribed sicklefin redhorse, *Moxostoma sp.* and the stonecat, *Noturus flavus*).

Table 25. Little Tennessee River at Iotla Bridge (RM 111.1)

**Species and Numbers of Fish Taken**

Species	Numbers of fish taken	
	1999	2001
Rainbow trout	1	
Central stoneroller	7	6
Whitetail shiner	71	67
Spotfin chub		3
Common carp	3	4
Warpaint shiner	53	18
River chub	30	32
Golden shiner		1
Tennessee shiner	41	15
Silver shiner	2	
Rosyface shiner	24	39
Mirror shiner	3	4
Telescope shiner	32	34
Fatlips minnow	1	1
Northern hogsucker	2	5
River redhorse	6	4
Black redhorse	1	21
Golden redhorse	12	21
Shorthead redhorse	4	5
Channel catfish	1	
Flathead catfish		1
Rock bass	35	67
Redbreast sunfish	45	108
Green sunfish		1
Warmouth	1	
Bluegill	4	47
Smallmouth bass	6	17
Largemouth bass	5	3
Black crappie	1	1
White bass	1	
Tuckaseegee darter	12	7
Greenfin darter	13	11
Wounded darter	20	2

Banded darter	11	16
Tangerine darter	2	
Gilt darter	56	32
Walleye		1
Mottled sculpin	17	4
<b>TOTALS</b>	<b>523</b>	<b>598</b>

### **Metrics and Scoring**

<b>Metric</b>	<b>Observed value</b>	<b>1999 Score</b>	<b>Observed value</b>	<b>2001 Score</b>
1. No. native spp.	29	5	30	5
2. No. darter spp.	6	5	5	5
3. No. sunfish spp.	5	5	5	5
4. No. sucker spp.	5	5	5	5
5. No. intolerant spp.	4	5	5	5
6. % individuals as tolerants	0.6	5	19.0	3
7. % individuals as omnivores and herbivores	7.8	5	7.0	5
8. % individuals as specialized insectivores	51.6	5	41.4	3
9. % individuals as piscivores	9.2	5	14.9	5
10. Catch rate	15.0	3	13.0	5
11. % individuals as darters and sculpins	25.0	5	11.6	3
12. % individuals with disease or anomaly	2.3	3	1.2	5
<b>TOTALS</b>		<b>56</b>		<b>54</b>
		<b>EXCELLENT</b>		<b>GOOD</b>

## Watauga Creek at Berry Mill (RM 0.5)

With a non-significant increase in IBI score since 1998 (from 49.5 to 52.2, both with a bioclass rating of GOOD), it is possible to cautiously suggest that the improvement of biological health in Watauga Creek, first observed between 1993 and 1997, continues, although there are trends in both directions.

The most notable change between 1998 and 2001 is the recovery of darter diversity. The gilt darter (*Percina evides*) never completely disappeared from lower Watauga Creek, but was represented by only 2 individuals in the 1993 sample. By 1998 it had rebounded (45 individuals in the sample) and was represented by 23 individuals in 2001. After 1990, the three other darter species which were barely represented in the 1990 sample (all expected species for a stream of this size) disappeared and were not found in the 1993 or 1997 samples. The Tuckaseegee darter (*Etheostoma blennioides gutselli*) returned in small numbers in 1998, and 2001 marks the return of the greenfin darter (*Etheostoma chlorobranchium*) and banded darter (*Etheostoma zonale*), both in good numbers. Similarly the ratio of darters to sculpins in the samples has changed as follows: 1990, 0.09; 1993, 0.01; 1997, 0.17; 1998, 0.26; 2001, 0.62.

The reestablishment of the remaining darter species, so that Watauga Creek is once again one of two Little Tennessee tributaries downstream of Franklin with a full complement of darter species (the other being Cowee Creek) increased the score for Metric 2 (no. darter spp.). There was also an increase in score for Metric 5 (no. intolerant spp.) with the first appearance of the telescope shiner (*Notropis telescopus*) in Watauga Creek. In addition the proportion of specialized insectivores (Metric 8) showed a large increase, which is part of a consistent trend, but failed to reach the 45% level required to score high for this metric. (Proportion of specialized insectivores in the sample by years: 1990, 7.4; 1993, 1.0; 1997, 19.6; 1998, 24.2; 2001, 43.9.)

However, consider the following possible negative trends:

- There was a drop in score for Metric 11 (proportion of darters and sculpins), related to a record low catch of the mottled sculpin (*Cottus bairdi*). However, the trend toward lower sculpin catches was observed in other streams in 2001, and may be weather-related.
- One of the 4 metrics which showed an increase in observed value (Metric 10, catch rate) may in fact reflect the early stages of nutrient enrichment and over-fertility. This is suggested by record catches of the omnivorous river chub, (*Nocomis micropogon*); the tolerant, exotic redbreast sunfish, (*Lepomis auritus*) and the herbivorous central stoneroller, (*Campostoma anomala*) This trend is partially offset by the disappearance of the tolerant, omnivorous creek chub (*Semotilus atromaculatus*). (For further discussion of this dynamic see McLarney, 2000)
- For a majority of the metrics (5) there was a drop in absolute value.
- 2001 was the first year we have taken more than 1 individual of the exotic yellowfin shiner (*Notropis lutipinnis*) in Watauga Creek (or anywhere downstream of Lake Emory). One of these fish appeared to be a yellowfin/Tennessee shiner hybrid.

- In 1998, juvenile rainbow trout (*Oncorhynchus mykiss*) were common in Watauga Creek. In 2001 no trout of any kind were taken.

Disappearance of the generalist blacknose dace (*Rhinichthys atratulus*), concurrent with a general increase in column dwelling cyprinids (16.0% in 1998 and 41.4% in 2001) and both record abundance and large average size of rock bass (*Ambloplites rupestris*), replicates a dynamic seen in Rabbit Creek in 1999-2000 (McLarney, 2000).

There is the appearance of more sediment in the substrate at the Berry Mill site than in 1997-1998, and there is a great deal of development occurring in the upper reaches of the Watauga Creek watershed. It is quite likely that simultaneous, overlapping trends are occurring here, so that it is not clear whether the long term prognosis is for further improvement or degradation.

Table 26. Watauga Creek at Berry Mill (RM 0.7)

#### Species and Numbers of Fish Taken

Species	Number of fish taken	
	1998	2001
Rainbow trout	12	
Central stoneroller	6	29
Warpaint shiner	10	29
River chub	9	28
Tennessee shiner	14	36
Yellowfin shiner		5
Telescope shiner		31
Silver shiner	1	
Fatlips minnow	3	2
Blacknose dace	15	
Longnose dace	1	
Creek chub	2	
Northern hogsucker	4	10
Snail bullhead	1	2
Rock bass	5	20
Redbreast sunfish	3	15
Bluegill		
Tuckaseegee darter	3	1
Greenfin darter		12
Banded darter		13
Gilt darter	45	23
Mottled sculpin	185	79
TOTALS	319	335

## Metrics and Scoring

Metric	Observed value	1998 Score	Observed value	2001 Score
1. No. native spp.	16	6.7	13	6.7
2. No. darter spp	2	4.0	4	6.7
5. No. intolerant spp.	2	4.0	3	6.7
6. % individuals as tolerants	1.9	6.7	5.1	6.7
7. % individuals as omnivores and herbivores	10.1	4.0	17.6	4.0
8. % individuals as specialized insectivores	24.2	4.0	43.9	4.0
10. Catch rate	31.4	6.7	60.3	6.7
11. % individuals as darters and sculpins	73.0	6.7	37.3	4.0
12. % individuals with disease or anomaly	0.3	6.7	0.6	6.7
<b>TOTALS</b>		<b>49.5</b>		<b>52.2</b>
		<b>GOOD</b>		<b>GOOD</b>

### Cat Creek @ Henderson Farm (RM 0.5)

Although the IBI score increased slightly between 1997 and 2001 (30 to 33, bioclass rating POOR in both cases), the perception is of deterioration at this site. One of the two metrics which showed improvement over the two year period was Metric 10 (catch rate) for which the observed value more than doubled. This could in fact reflect the effects of nutrient pollution.

Apparent indicators of deterioration include:

- Reduced number of native species (Metric 1) with disappearance of the longnose dace (*Rhinichthys cataractae*).
- Tremendous, and continuing increase in the number of the generalist blacknose dace (*Rhinichthys atratulus*) in the sample (4 in 1992, 31 in 1997 and 89 in 2001).
- First appearance of the exotic yellowfin shiner (*Notropis lutipinnis*) in Cat Creek (farthest penetration to date by this species in the Rabbit Creek watershed).
- Poor condition of specialized insectivores (warpaint shiner, *Luxilus coccogenis* and Tennessee shiner, *Notropis leuciodus*).

There was also visible deterioration in the physical habitat (See Table 28.) Particularly notable was the virtual disappearance of pool habitat. In 1992 and 1997, several areas had definite pool structure, with substantial areas deeper than the surrounding waters (1.1 – 1.6 ft.). In 2001 pools were indistinguishable from runs on the basis of depths; the bottom of all former pools was covered with a layer of fresh sediment and maximum depth was 1.0 ft. (less in most “pools”).

During 2000, 0.4 mi. of Cat Creek located immediately above this site, plus 0.1 mi. of a small tributary were rechannelized, with total removal of woody riparian vegetation. Most of this reach had been a series of beaver ponds, and the work released enough fine sand to completely blanket all but the swiftest portions of the downstream reach. Failure of the IBI to respond to this degradation of habitat may reflect compensatory effects such as better supply of water during drought periods, lowering of summer water temperatures or greater freedom of movement of fishes between lower and upper Cat Creek. All this notwithstanding, it is difficult to look at lower Cat Creek today and not conclude that development activities upstream have made a bad site worse.

The work on Cat Creek also had an apparent effect on Rabbit Creek downstream. See Fixed Station 5, Rabbit Creek at Rabbit Creek Rd. (RM 0.6) in this report.

Table 27. Cat Creek at Henderson Farm (RM 0.5)

#### Species and Numbers Taken

Species	Numbers of fish taken	
	1997	2001
Central stoneroller	9	29
Warpaint shiner	9	20
River chub	17	34
Tennessee shiner	2	12
Yellowfin shiner		2
Blacknose dace	31	89
Longnose dace	3	
Creek chub	10	14
Northern hogsucker	12	3
Rock bass	4	2
Redbreast sunfish	6	6
Green sunfish		
Bluegill		1
Largemouth bass	6	
Mottled sculpin	39	19
TOTALS	148	231

#### Metrics and Scoring

Metric	1997		2001	
	Observed value	Score	Observed value	Score
1. No. native spp.	11	7.5	10	4.5
5. No. intolerant spp.	1	1.5	1	1.5
6. % individuals as tolerants	10.8	4.5	8.7	7.5
7. % individuals omnivores & herbivores	45.3	1.5	71.9	1.5
8. % individuals as specialized insectivores	9.5	1.5	13.9	1.5
10. Catch rate	15.6	4.5	40.8	7.5
11. % individuals as darters and sculpins	26.4	1.5	8.2	1.5
12. % individuals with disease or anomaly	1.3	7.5	0.4	7.5
TOTALS		30		33
		POOR		POOR

Table 28. Selected Parameters of the Physical Environment of Cat Creek @ Henderson Farm (RM 0.5)

for Two Years

1992

2001



Watershed drainage area (sq. mi.)	4.0		4.0
Mean width (ft.)	6.9		5.9
Mean depth (ft.)			
Riffles	0.6		0.5
Runs	0.7		0.5
Pools	1.5		0.6
Overall	0.8		0.5
Maximum depth (ft.)	1.6		1.0
Substrate composition (%)			
Boulder	5	tr	
Rubble	40		10
Gravel	5		25
Sand	20		40
Silt	30		25
Large woody debris	none	none	
% canopy	0		0
Riparian buffer width (ft.)	ft.)		
L bank	0		0
R bank	0		0
Riparian land use			
L bank	unfenced pasture	unfenced pasture	
R bank	unfenced pasture	fenced pasture	

### **Crawford Branch @ East Main St. (RM 0.3)**

The IBI score for this, which continues to be the worst site we have monitored in the upper Little Tennessee watershed, improved slightly between 2000 and 2001, due to a significant change in the observed value for Metric 5 (proportion of fish with disease or anomaly). In 2000 although, to our surprise, we did not observe the nearly ubiquitous blackspot, 8.7% of the total fish catch had visible disease, parasite or anomaly symptoms. Among the conditions observed were scoliosis, eroded gill covers, body fungus, fin rot and especially, lesions – in several cases in the form of ulcerated areas on the head. In 2001, there was a moderate incidence of blackspot and fewer and minor lesions.

In every other respect except for catch rate, which is good, this site continues to appear very poor. The omnivorous river chub (*Nocomis micropogon*) and the tolerant green sunfish (*Lepomis cyanellus*), each represented by a single individual in 2000, disappeared, to be replaced by single individuals of the Tennessee shiner (*Notropis leuciodus*) and, for the first time in Crawford Branch, the exotic yellowfin shiner (*Notropis lutipinnis*). More interesting than changes in rare species is the continued reduced number of species, for reasons unknown. Table 30 shows the total number of species and native species at E. Main St. since the site was first monitored in 1995. The drop between 1997 and 1998 may be explained by a major sedimentation event, and was accompanied by a drastic reduction in total number of fish. But no explanation is apparent for the drop between 1999 and 2000.

Perhaps even more puzzling than the drop in species diversity is the nature of some of the changes. After 1999, the tolerant white sucker (*Catostomus commersoni*) disappeared, while the presumably intolerant smoky dace (*Clinostomus sp.*) appears to be increasing in numbers. (“Presumably:” because tolerance has not been determined for this new species, which was formerly considered to be a form of the intolerant rosyside dace, *Clinostomus funduloides*).

This year also saw a reduction in the total number of fish, to the second lowest ever recorded for this site, again without an apparent cause. While catch rate did not drop low enough to affect Metric 4, a drop of nearly 50% may represent further degradation of water or habitat quality. Overall, what appears to be happening is the loss of stability of the fish assemblage, usually a sign of degradation.

The macroinvertebrate data are even less encouraging. ETP count dropped from 10 in 2000 to 1 (a Limnephelid caddisfly) in 2001. (However, note that there are some doubts about the quality of the macroinvertebrate i.d. in 2001.)

The obvious need for remedial measures at this site notwithstanding, 2001 may be the last year that Crawford Branch is monitored on a regular basis. It was first monitored in 1995 as part of a program to monitor all upper Little Tennessee River tributaries with drainage areas of 1-4 sq. mi. Monitoring was continued in the hope that spotlighting the very poor quality would spark an interest in restoration by the Town of Franklin. This has simply not occurred and, until there is a significant improvement in the awareness by the town

government of the present and potential value of Crawford Branch, our energy is perhaps better spent elsewhere.

It should be noted that physical habitat at the East Main Street site has improved somewhat, with the establishment of a riparian buffer of sorts. When we first began to sample this channelized site (1995) it was sandwiched between streets and parking lots and restrained by extensive riprap. Riparian vegetation was largely limited to coarse grasses and shade was nearly non-existent. In the intervening years shrubs and small trees (albeit mostly weedy types, with a predominance of exotics) have become established, and now provide leaf drop and considerable shade, canopying the channel in some places. This does not seem to be reflected in the aquatic biota.

On other small stream sites, we have treated a decline in fish diversity as a possible positive trend, based on the concepts of Scott and Helfman (2001) and it may be that something similar is occurring here. Combining this with some of the modestly encouraging trends in the fish data mentioned above, and our doubts about the 2001 macroinvertebrate data, it is possible to conclude that some improvement is occurring. Even if this be the case, Crawford Branch at East Main St. remains an ecological disgrace, meriting the attention it is not likely to get in the short run.

Table 29. Crawford Branch at E. Main St., Franklin (RM 0.3)

#### Species and numbers of fish taken

Species	Numbers of fish taken	
	2000	2001
Central stoneroller	10	4
Smoky dace	10	15
Whitetail shiner		
Warpaint shiner		
River chub	1	
Golden shiner		
Tennessee shiner		1
Yellowfin shiner		1
Blacknose dace	72	47
Creek chub	134	58
White sucker		
Northern hogsucker		
Golden redhorse		
Mosquitofish		
Brown bullhead		
Redbreast sunfish	14	9
Green sunfish	1	
Warmouth		
Bluegill		
Largemouth bass		

Mottled sculpin

TOTALS	242	135
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**Macroinvertebrate Taxa Collected (EPT Forms Only)**

Taxon		2000	2001*
<i>Ephemeroptera</i>			
	<i>Baetidae</i>		
	<i>Acentrella sp.</i>	X	
	<i>Baetis tricaudatus</i>	X	
	<i>Ephemerellidae</i>		
	<i>Drunella wayah</i>	X	
	<i>Serratella sp.</i> (early instars)	X	
	<i>Timpanoga lita</i>	X	
<b>TOTAL EPHEMEROPTERA TAXA</b>		<b>4</b>	<b>0</b>
<i>Plecoptera</i>			
<b>TOTAL PLECOPTERA TAXA</b>		<b>0</b>	<b>0</b>
<i>Trichoptera</i>			
	<i>Brachycentridae</i>		
	<i>Micrasema charonis</i>	X	
	<i>Hydropsychidae</i>		
	<i>Cheumatopsyche sp.</i>	X	
	<i>Diplectrona modesta</i>	X	
	<i>Hydropsyche betteni</i>	X	
	<i>Limnephilidae</i>		1
	<i>Pycnopsyche gentilis</i>	X	
	<i>P. scabripennis sp. gr.</i>	X	
<b>TOTAL TRICHOPTERA TAXA</b>		<b>6</b>	<b>1</b>
<b>TOTAL EPT TAXA</b>		<b>10</b>	<b>1</b>

**Metrics and Scoring**

**1. Williams "brook trout" IBI**

Metric	2000		2001	
	Observed value	Score	Observed value	Score
1. Total Ephemeroptera taxa	4	6	0	2
2. Total EPT taxa	10	6	1	2
3. Brook trout presence	Absent	2	Absent	2
4. Catch rate	28.1	10	15.6	10
5. % individuals with disease or anomaly	8.7	2	3.0	6
6. % individuals as tolerants	61.6	2	49.3	2
<b>TOTALS</b>		<b>28</b>		<b>24</b>
		<b>POOR</b>		<b>VERY POOR</b>

## 2. Modified Williams IBI

1. Total Ephemeroptera taxa	4	4.5	0	1.5
2. Total EPT taxa	10	4.5	1	1.5
3. Brook trout presence	Absent	1.5	Absent	1.5
4. Catch rate	28.1	7.5	15.6	7.5
5. % individuals with disease or anomaly	8.7	1.5	3.0	4.5
6. % individuals as tolerants	61.6	1.5	49.3	1.5
7. % individuals as wild trout	0.0	1.5	0.0	1.5
8. % individuals as omnivores and herbivores	89.7	1.5	80.6	1.5
<b>TOTALS</b>		<b>24</b>		<b>21</b>
		<b>VERY POOR</b>		<b>VERY POOR</b>

\* Species identity not available for 2001 sample

Table 30. Numbers of total and native fish species in Crawford Branch at E. Main St., Franklin

(RM 0.3) - 1995-2001

Year	Total Species	Native Species
1995	13	13
1996	15	13
1997	15	13
1998	9	6
1999	15	13
2000	7	6
2001	7	5

Total

21

16

### Crawford Branch at Franklin Memorial Park (RM 0.9)

The IBI score for the Franklin Memorial Park site declined between 2000 and 2001, due to an increase in catch rate (back to approximately the level of 1999), possibly indicating nutrient enrichment, and an unexplained decline in caddis fly (Trichoptera) diversity, from 7 taxa to 2. While total fish species diversity remains constant, with 5 species appearing every year, dominance by a single species increases steadily. Following is a list of the proportion of the sample comprised by the blacknose dace (Rhinichthys atratulus) each year since this site was first sampled:

1996	32.2%
1997	20.6%
1998	50.4%
1999	50.2%
2000	56.4%
2001	61.9%

Clearly the Franklin Memorial Park site is healthier than the E. Main St. site, located 0.6. mi. downstream. But it is also clearly an urban stream at the upper site, with dominance by omnivores and generalist feeders.

The single specimen of the channel catfish (*Ictalurus punctatus*), a ca. 6 inch TL juvenile, was the first record for this species upstream of Lake Emory Dam. It is highly likely that this fish was introduced.

For further comment on Crawford Branch in the context of this project, see the preceding site (Crawford Branch at E. Main St.).

Table 31. Crawford Branch at Franklin Memorial Park (RM 0.9)

#### Species and numbers of fish taken

Species	Numbers of fish taken	
	2000	2001
Rainbow trout		
Central stoneroller	1	
Goldfish	1	
Smoky dace	3	11
Blacknose dace	131	279
Creek chub	66	99
Northern hogsucker	6	2

Channel catfish		1
Mottled sculpin	24	56
TOTALS	232	448

#### Macroinvertebrate Taxa Collected (EPT Forms Only)

Taxon		2000	2001
<i>Ephemeroptera</i>			
	<i>Baetidae</i>		2
	<i>Acentrella turbida</i>	X	
	<i>Baetis intercalaris</i>	X	
	<i>B. pluto</i>	X	
	<i>Pseudocloeon propinquus</i>	X	
	<i>Caenidae</i>		
	<i>Brachycercus</i> sp.	X	
	<i>Ephemerellidae</i>		2
	<i>Serratella deficiens</i>	X	
	<i>S. sp.</i> (early instars)	X	
	<i>Ephemeridae</i>		
	<i>Ephemera</i> sp.	X	1
	<i>Heptageniidae</i>		2
	<i>Leptophlebiidae</i>		2
	<i>Habrophlebiodes</i> sp.	X	
	<i>Paraleptophlebia adoptiva/mollis</i>	X	
<b>TOTAL EPHEMEROPTERA TAXA</b>		<b>9</b>	<b>9</b>
<i>Plecoptera</i>			
	<i>Capnidae</i>		1
	<i>Leuctridae</i>		
	<i>Leuctra</i> sp.	X	
	<i>Nemouridae</i>		
	<i>Amphineura delosa/nigrita</i>	X	
<b>TOTAL PLECOPTERA TAXA</b>		<b>2</b>	<b>1</b>
<i>Trichoptera</i>			
	<i>Glossosomatidae</i>		
	<i>Glossosoma</i> sp.	X	
	<i>Hydropsychidae</i>		1
	<i>Ceratopsyche sparna</i>	X	



	<i>Diplectrona modesta</i>	X	
	<i>Hydropsyche betteni</i>	X	
	<i>H. venularis</i>	X	
<i>Leptoceridae</i>			
	<i>Triaenodes taenia</i>	X	
<i>Limnephilidae</i>			1
	<i>Pycnopsyche luculenta</i> sp. gr.	X	
<b>TOTAL TRICHOPTERA TAXA</b>		<b>7</b>	<b>2</b>
<b>TOTAL EPT TAXA</b>		<b>18</b>	<b>12</b>

\* Species identity not available for 2001 sample

#### 1. Williams "brook trout" IBI

Metric	2000		2001	
	Observed value	Score	Observed value	Score
1. No. Ephemeroptera taxa	9	10	9	10
2. No. EPT taxa	18	10	12	6
3. Brook trout presence	Absent	2	Absent	2
4. Catch rate	25.1	10	60.5	6
5. % individuals with disease or anomaly	0.9	8	0.4	8
6. % individuals as tolerants	28.9	2	22.1	2
<b>TOTALS</b>		<b>42</b>		<b>34</b>
		<b>FAIR</b>		<b>POOR</b>

#### 2. Modified Williams IBI

1. No. Ephemeroptera taxa	9	7.5	9	7.5
2. No. EPT taxa	18	7.5	12	4.5
3. Brook trout presence	Absent	1.5	Absent	1.5
4. Catch rate	25.1	7.5	60.9	6
5. % individuals with disease or anomaly	0.9	6	0.4	6
6. % individuals as tolerants	28.9	1.5	22.1	1.5
7. % individuals as wild trout	0.0	1.5	0.0	1.5
8. % individuals as omnivores and herbivores	85.8	1.5	84.6	1.5
<b>TOTALS</b>		<b>33.5</b>		<b>30</b>
		<b>FAIR</b>		<b>POOR</b>

### **Mashburn Branch @ Schley-Seaton property (RM 0.4)**

Until this year we had counted on this site as a long term opportunity to monitor the biological results of restoration on a small stream (watershed drainage area 1.6 sq. mi.) In addition to about 1,000 ft. of stream on the Seaton-Schley property, where the riparian zone had been restored by removal of cattle, planting trees and allowing the natural vegetation to reestablish, we were able to monitor a downstream “control” site (included in the original 1996 fish and macroinvertebrate samples) where cattle continued to have access.

Although maintenance of planted trees was poor, and the restoration effort did nothing, at least in the short run, to correct the effects of channelization, improvement was clearly perceptible in the restored sector in 1999. The IBI score jumped from 36 (bioclass rating FAIR) to 48 (bioclass rating GOOD). Five of 8 metrics in the modified Williams IBI showed improvements in observed values (including the two macroinvertebrate metrics, which already scored high). The only negative change was an increase in catch per unit effort from 43.7 to 55.4 fish per 300 sq. ft. standard sample, thus passing the threshold (50 fish per sample) where excess nutrient loading may be suspected. A more modest improvement was shown in the downstream “control” section, including the appearance of a single juvenile brown trout (*Salmo trutta*).

For reasons unknown, TVA failed to complete the macroinvertebrate sample for this site for 2000, so we are not able to provide an IBI for that year. However, the property was sold in that year, and the first thing the new owner did was to remove all the woody riparian vegetation, including the planted trees, because he wanted to “see the stream.” While there are still no cattle on the property, so the worst damage may be averted, the biotic community has largely reverted to its former condition. As of summer, 2001, the fish assemblage is once again characterized by a high percentage of tolerant and omnivorous species. Catch per unit effort dropped by more than half (although in this case, this tended to raise the IBI score) and diversity is the lowest ever. If a large plunge pool on the formerly restored reach is excluded (as we do for the IBI, see discussion below) in 2001 we counted only the two historically dominant species (mottled sculpin, *Cottus bairdi* and creek chub, *Semotilus atromaculatus*), instead of the normal 5 species.

A large, deep plunge pool, formed where a somewhat undersized culverts passes under a farm access road, has been excluded from the IBI samples because there is no comparable habitat in the downstream “control” sector. Each year it is found to contain all or nearly all the species taken in the sample, but with heavy dominance by the creek chub. This situation did not change in 2001. However, while inclusion of the pool in the IBI calculations for this year would not change scoring for any of the fish-based metrics, its inclusion in 2000 would result in lower scores for Metrics 6 (proportion of tolerants) and 8 (proportion of omnivores and herbivores).

As for the macroinvertebrate component, the gains made during 1996-1999 have been completely cancelled out; the diversity of all 3 EPT groups is almost exactly the same as it was in 1996. This was accompanied by an inexplicable drop in the number of non-EPT taxa, from 15 to 2, implying disappearance of several tolerant forms.

Table 32 presents selected Mashburn Branch results in the way we believe best elucidates the history of the site and makes the most important points. Fish capture data for the restored sector and the plunge pool are given for the 3 post-restoration sampling years. IBI metrics and scores are shown for the 3 years for which there are adequate data to do so – in 1999 and 2001 for the restored section only and in 1996, pre-restoration, for a longer sample reach which included portions of the downstream “control” sector.

Whatever the future may hold in store, this site clearly represents both lost effort (including a special report to the landowners, McLarney, 1998a) and a lost opportunity. The major lesson learned is not biological. It is clear from this experience that time, money and effort spent on restoration amount to a dubious investment if conservation easements are not obtained concurrently.

Table 32. Mashburn Branch @ Seaton-Schley Property (RM 0.4)

### Species and numbers of fish taken

#### 1. Restored Sector

	1999	2000	2001
Central stoneroller		1	
Blacknose dace		4	
Longnose dace	4		
Creek chub	12	18	28
Northern hogsucker	1	*	
Redbreast sunfish	1		
Mottled sculpin	156	89	59
TOTALS	174	112	87

\* present as young-of-the-year only

#### 2. Restored Sector Plus Plunge Pool

Central stoneroller	1	
Smoky dace	1	1
Creek chub	41	66
Blacknose dace	4	
White sucker	2	3
Northern hogsucker	1	1
Redbreast sunfish	3	3
Mottled sculpin	93	61
TOTALS	146	135

# Macroinvertebrate Taxa Collected (EPT Forms Only)

Taxon	1996	1999	2001*
<i>Ephemeroptera</i>			
<i>Baetidae</i>			1
<i>Acentrella</i> sp. 2		X	
<i>Baetis flavistriga</i>	X	X	
<i>B. pluto</i>		X	
<i>B. tricaudatus</i>		X	
<i>Pseudocloeon</i> sp. cf.			
<i>ephippiatus</i>	X	X	
<i>Caenidae</i>			
<i>Brachycercus</i>	X		
<i>Ephemerellidae</i>			4
<i>Ephemerella catawba</i>	X	X	
<i>E. dorothea</i>		X	
<i>Serratella deficiens</i>	X	X	
<i>S. sp.</i>		X	
<i>Timpanoga lita</i>		X	
<i>Ephemeridae</i>			
<i>Ephemera</i> sp.		X	
<i>Heptageniidae</i>			2
<i>Heptagenia</i> sp.	X		
<i>Epeorus rubidus/subpallidus</i>		X	
<i>Leucrocuta</i> sp.		X	
<i>Stenonema carlsoni</i>	X	X	
<i>S. pudicum</i>		X	
<i>S. ithaca/modestum</i>		X	
<i>S. sp.</i>		X	
<i>Isonychiidae</i>			
<i>Isonychia</i> sp.	X	X	
<i>Leptophlebiidae</i>			2
<i>Habrophlebiodes</i> sp.		X	
<i>Paraleptophlebia</i> sp.	X		
<i>Neoephemeridae</i>			
<i>Neoephemera purpurea</i>		X	
<b>TOTAL EPHEMEROPTERA TAXA</b>	<b>9</b>	<b>20</b>	<b>9</b>
<i>Plecoptera</i>			
<i>Chloroperlidae</i>			1
<i>Leuctridae</i>			1
<i>Leuctra</i> sp.	X	X	

<i>Perlidae</i>				2
	<i>Acroneuria abnormis</i>	X	X	
	<i>Perlesta</i> sp.	X	X	
<i>Perlodidae</i>				1
	<i>Isoperla holochlora</i>		X	
<i>Pteronarcyidae</i>				
	<i>Pteronarcys</i> sp.	X	X	
<b>TOTAL PLECOPTERA TAXA</b>		<b>4</b>	<b>5</b>	<b>5</b>
<u><i>Trichoptera</i></u>				
<i>Brachycentridae</i>				
	<i>Micrasema</i> sp.		X	
<i>Glossosomatidae</i>				
	<i>Glossosoma</i> sp.	X	X	
<i>Hydropsychidae</i>				1
	<i>Cheumatopsyche</i> sp.	X	X	
	<i>Diplectrona modesta</i>	X	X	
	<i>Hydropsyche venularis</i>		X	
	<i>H. sp. cf.. Betteni</i>	<i>betteni</i>	X	
	<i>Symphitopsyche</i> sp.	X		
<i>Lepidostomatidae</i>				
	<i>Lepidostoma</i> sp.		X	
<i>Limnephilidae</i>				1
	<i>Pychnopsyche</i> sp. ( <i>luculenta</i> sp. gr.)		X	
<i>Philopotamidae</i>				1
	<i>Dolophilodes</i> sp.	X		
<i>Polycentropidae</i>				
	<i>Polycentropus</i> sp.		X	
<i>Psychomiidae</i>				
	<i>Psychomyia flavida</i>		X	
<i>Rhyacophilidae</i>				1
	<i>Rhyacophila fuscula</i>	X	X	
<i>Uenoidae</i>				2
	<i>Neophylax consimilis</i>	X	X	
<b>TOTAL TRICHOPTERA TAXA</b>		<b>7</b>	<b>12</b>	<b>6</b>
<b>TOTAL EPT TAXA</b>		<b>20</b>	<b>37</b>	<b>20</b>

\* Species identities not available for 2001 sample.

**Metrics and Scoring (not including pool)**

## 1. Williams "brook trout" IBI

Metric	1996 - overall		1999 - restored		2001- restored	
	Observed value	Score	Observed value	Score	Observed value	Score
1. No. Ephemeroptera taxa	9	10	20	10	7	10
2. No. EPT taxa	20	10	37	10	20	10
3. Brook trout presence	Absent	2	Absent	2	Absent	2
4. Fish catch rate	43.7	10	55	6	20.0	10
5. % individuals with disease or anomaly	5.8	2	0.0	10	2.2	6
6. % individuals as tolerants	37.6	2	6.9	10	32.2	2
<b>TOTALS</b>		<b>36</b>		<b>48</b>		<b>40</b>
		<b>FAIR</b>		<b>GOOD</b>		<b>FAIR</b>

## 2. Modified Williams IBI

1. No. Ephemeroptera taxa	9	7.5	20	7.5	7	7.5
2. No EPT taxa	20	7.5	37	7.5	20	7.5
3. Brook trout presence	Absent	1.5	Absent	1.5	Absent	1.5
4. Fish catch rate	43.7	7.5	55	4.5	20.0	7.5
5. % individuals with disease or anomaly	5.8	1.5	0.0	7.5	2.2	4.5
6. % individuals as tolerants	37.6	1.5	6.9	7.5	32.2	1.5
7. % individuals as wild trout	0.0	1.5	0.0	1.5	0.0	1.5
8. % individuals as omnivores and herbivores	68.1	1.5	6.9	7.5	32.2	1.5
<b>TOTALS</b>		<b>30</b>		<b>45</b>		<b>33</b>
		<b>POOR</b>		<b>FAIR</b>		<b>POOR</b>

### Cartoogechaye Creek @ Cartoogechaye Baptist Church (RM 12.1)

The slight drop in the IBI score at this site (44.1 to 41.4, bioclass rating FAIR in both cases) between 1999 and 2001 is probably not significant. However, it does reflect a precipitous decline in numbers of the mottled sculpin (*Cottus bairdi*) –from 521 in the sample in 1993 to 327 in 1999 and 129 in 2001. This decline is at least partially responsible for the consistent increase in observed values for Metrics 7 (proportion of omnivores and herbivores) and 8 (proportion of specialized insectivores).

By 2001 the decline of the mottled sculpin, normally the single most dominant species in rocky streams in the upper Little Tennessee watershed, had progressed far enough that it ranked second in numbers to the omnivorous river chub (*Nocomis micropogon*). Together with an explosion in river chub numbers, the observed value for Metric 7 has gone from 10.8% in 1993 to 24.1% in 1999 and now to 40.7%

Over the same period, there has been a similar increase in observed values for Metric 12 (proportion with disease or anomaly) – 2.4, 5.6 and 19.5%, respectively. The last number represents an extremely high incidence of blackspot on cyprinids. Together these two metrics suggest increased nutrient loading.

This site continues to score poorer than all downstream sites on Cartoogechaye Creek. The only plausible hypothesis for this condition is the relative lack of riparian shade from this point upstream to the headwaters at the junction of Jones and Allison Creeks.

Also notable at this site in 2001 was the capture of a small adult hellbender (*Cryptobranchus alleggheniensis*).

Table 33. Cartoogechaye Creek at Cartoogechaye Baptist Church (RM 12.1)

#### Species and Numbers of Fish Taken

Species	Number taken	
	1999	2001
Mountain brook lamprey	2	4
Rainbow trout	1	1
Brown trout	5	12
Central stoneroller	39	95
Smoky dace	19	4
Whitetail shiner		4
Warpaint shiner	52	84
River chub	125	152
Tennessee shiner	143	98
Mirror shiner	3	3
Blacknose dace	19	19
Longnose dace	1	2

Creek chub	4	1
White sucker	1	
Northern hogsucker	11	17
Black redhorse	2	
Golden redhorse	1	
Rock bass	5	10
Redbreast sunfish	10	7
Largemouth bass	2	
Tuckaseigee darter	5	3
Greenfin darter	10	17
Gilt darter	2	4
Mottled sculpin	327	129
<b>TOTALS</b>	<b>789</b>	<b>666</b>

### Metrics and Scoring

Metric	1999		2001	
	Observed value	Score	Observed value	Score
1. No. native fish spp.	19	6.7	17	6.7
2. No. darter spp.	3	6.7	3	6.7
5. No. intolerant spp.	3	6.7	3	6.7
6. % individuals as tolerants	1.9	6.7	1.2	6.7
7. % individuals as omnivores and herbivores	24.1	1.3	40.7	1.3
8. % individuals as specialized insectivores	29.8	4.0	32.9	4.0
10. Catch rate	51.2	6.7	30.8	6.7
11. % individuals as darters and sculpins	43.3	4.0	23.0	1.3
12. % individuals with disease or anomaly	5.6	1.3	19.5	1.3
<b>TOTALS</b>		<b>44.1</b>		<b>41.4</b>
		<b>FAIR</b>		<b>FAIR</b>



## Jones Creek @ Jones Creek Rd. (RM 0.6)

Although the bioclass rating for Jones Creek, which dropped from GOOD to FAIR between 1993 and 1999, remains in the FAIR category, the 2001 score (45) is much closer to that for 1993 (48), and more closely responds to our intuitive perception of this stream.

The number of native species (Metric 1) was the highest for the 3 times this site has been monitored, and may throw the choice of sampling reach into question. The list includes 2 species (central stoneroller, *Camptostoma anomala* and white sucker (*Catostomus commersoni*) taken for the first time at this site. Both were represented by a single large individual captured during a demonstration shocker run in a pool just downstream of the designated sample reach. Since no effort was made to capture all fish during this run, other individuals of these species may be present. One must thus ask whether the 1993 and 1999 samples were truly representative of the site, or whether these species represent a new invasion. The latter explanation would fit the hypothesis of Scott and Helfman (2001) replacement of “upland endemic” fishes by a suite of “generalized Southeastern” species. (See discussion for Fixed Station 4, Little Tennessee River at Wolf Fork.)

Further evidence for this hypothesis might be the steadily increasing proportion of omnivores and generalists (including the river chub, *Nocomis micropogon* and blacknose dace *Rhinichthys atratulus*) in the sample. However, this train of thought must be tempered by the observation that over the same time period the percentage of specialized insectivores in the sample (Metric 8) has also steadily increased, with the principal contributor being the smoky dace (*Clinostomus* sp.). These apparently contradictory trends both derive partly from the continued decline of the single most dominant species, the mottled sculpin (*Cottus bairdi*) from 75.6% of the total sample in 1993 to 60.7% in 1999 and 43.5% this year. This is yet another example of the phenomenon of sculpins “swamping” data in upper Little Tennessee River watershed fish samples.

Catch per unit effort (Metric 10) is artificially low. One crew member had to leave early, leaving us with a skeleton crew and the project director running the shocker. This, combined with lack of experienced dipnetters, caused numerous fish to be missed. All reservations aside, however, we believe this sample and the IBI score are reasonably representative of lower Jones Creek. At 0.6 miles downstream of this point, Jones Creek joins with Allison Creek (See following section.) to form Cartoogechaye Creek.

Table 34. Jones Creek at Jones Creek Rd. (RM 0.6)

### Species and Numbers of Fish Taken

Species	Numbers of fish taken		
	1993	###	2001
Mountain brook lamprey	8	2	9
Rainbow trout	2	1	1

Brown trout	4	9	2
Central stoneroller			*
Smoky dace	9	22	40
River chub	8	4	32
Warpaint shiner	2	9	27
Mirror shiner	3		3
Blacknose dace	32	48	58
Longnose dace	15	17	6
Creek chub	1	1	5
White sucker			*
Northern hogsucker	3	6	27
Rock bass	1		1
Mottled sculpin	272	184	158
TOTAL	360	303	369

## Metrics and Scoring

Metric	Observed	Score	Observed	Score	Observed	Score
	value		value		value	
		1993		1999		2001
1. No. native spp.	11	7.5	9	4.5	13	7.5
5. No. intolerant spp.	2	4.5	1	1.5	2	4.5
6. % individuals as tolerants	0.3	7.5	0.3	7.5	1.4	7.5
7. % individuals as omnivores and herbivores	13.6	4.5	18	4.5	28.2	1.5
8. % individuals as specialized insectivores	8.1	1.5	16	1.5	20.6	4.5
10. Catch rate	30.0	7.5	31	7.5	19.6	7.5
11. % individuals as darters and sculpins	75.6	7.5	61	4.5	42.8	4.5
12. % individuals with disease or anomaly	1.1	7.5	1.3	7.5	0.8	7.5
<b>TOTALS</b>		<b>48</b>		<b>39</b>		<b>45</b>
		<b>GOOD</b>		<b>FAIR</b>		<b>FAIR</b>

### Allison Creek at Allison Creek Rd. (RM 0.4)

The 1993 samples for this site and Jones Creek (See preceding section), which together form Cartoogechaye Creek, conformed to our expectations. As compared to Allison Creek, Jones Creek has a less developed watershed, a substantial portion of the upper watershed in National Forest, and a reputation as a good trout stream. Allison Creek, not known as a trout stream, would appear to experience more human impact, typically (including at the monitoring site) has less riparian shade and appeared to have more sediment in the substrate. Thus it was no surprise when Jones Creek received the higher IBI score and bioclass rating (48 – GOOD vs. 42 – FAIR for Allison Creek).

However, in 1999, the situation was reversed. Jones Creek scored 39 (FAIR) whereas Allison Creek scored 48 (GOOD). As no explanation was evident, the two samples were repeated in 2001. This time Jones Creek once again scored 48, suggesting possible sampling error in 1999 (See preceding section). But Allison Creek retained its GOOD rating with another IBI of 48.

One factor which may account for the better score in 1999 and 2001 was our failure to sample a large, deep pool in 1993. Superficial sampling of this pool turned up 2 species not found in the regular sample – the exotic redbreast sunfish (*Lepomis auritus*) and the native white sucker (*Catostomus commersoni*). If the latter species is included in the native species count (Metric 1) it would raise the score for that metric and the total score to 45 (still FAIR). With 2 shockers available we were able to efficiently fish this pool in 1999 and after, and species count has gone up.

However, pool sampling capability does not account for 2 new species which turned up in 2001. While the single individual of the gilt darter (*Percina evides*) taken in the sample might be dismissed as a stray, the greenfin darter (*Etheostoma chlorobranchium*), represented by 7 individuals, including 2 large fully colored reproductive males, is clearly a member of the Allison Creek fish assemblage. If the gilt darter is discounted, then the observed value for Metric 2 (no. intolerant spp.) drops to 2 and the IBI score to 45. This may be yet another site in support of the hypothesis of Scott and Helfman (2001) re replacement of “upland endemic” fishes by a suite of “generalized Southeastern” species. (See discussion under Fixed Station 4, Little Tennessee River at Wolf Fork, and also for Jones Creek, above.)

Another metric which might be questioned is Metric 12. The proportion of fish with diseases, parasites or anomalies came out to 1.99%, precisely on the cusp between the high and intermediate score for this metric. Two of the anomalies observed were lesions on adult northern hogsuckers (*Hypentelium nigricans*), which may have been related to fighting. If these are not considered in computing the score for Metric 12, then clearly the higher score is merited. This was considered to be the more conservative course, and the high score was awarded.

An adult hellbender (*Cryptobranchus alleganiensis*) was taken at this site in 2001.

Table 35. Allison Creek @ Allison Creek Rd. (RM 0.4)

### Species of fish taken and numbers

Species	Number of fish taken		
	1993	1999	2001
Mountain brook lamprey	1	17	5
Brown trout	2	5	22
Central stoneroller		1	3
Smoky dace	19	29	35
Warpaint shiner	3	76	40
River chub	10	58	50
Tennessee shiner		20	23
Mirror shiner			5
Blacknose dace	16	9	25
Longnose dace	8	18	7
Creek chub	6		1
White sucker		*	
Northern hogsucker	9	14	12
Rock bass	2	2	2
Redbreast sunfish		*	1
Tuckaseigee darter		4	2
Greenfin darter			7
Gilt darter			1
Mottled sculpin	166	400	161
TOTALS	242	653	402

\* Species taken in informal shocking after completion of sample, not included in scoring

### Metrics and Scoring

Metric	Observed value	Score		Observed value	Score	
		1993			1999	2001
1. No. native spp.	10	4.5	12	7.5	16	7.5
5. No. intolerant spp.	2	4.5	2	4.5	3	7.5
6. % individuals as tolerants	2.5	7.5	0.0	7.5	0.5	7.5
7. % individuals as omnivores and herbivores	13.6	4.5	11	4.5	20.9	1.5
8. % individuals as specialized insectivores	12.4	1.5	23	4.5	29.9	4.5
10. Catch rate	24.5	7.5	101	7.5	29.3	7.5
11. % individuals as darters and sculpins	68.6	7.5	62	4.5	42.5	4.5
12. % individuals with disease or anomaly	2.9	4.5	0.3	7.5	2.0	7.5

TOTALS

42  
FAIR

48  
GOOD

48  
GOOD

### Hickory Knoll Creek @ Slep Orchard Rd. (RM 0.5)

The difference in IBI score at this site between 1995 and 2001 is probably non-significant, but there are changes which should be noted:

On the positive side:

- The increased number (and good condition) of juvenile rainbow trout (*Oncorhynchus mykiss*) indicates good quality nursery habitat, and is an improvement over 1995.
- Three new native species were taken in 2001. The tolerant white sucker (*Catostomus commersoni*), represented by a single individual, may have no significance. The same may be true of the intolerant rock bass (*Ambloplites rupestris*), however it was taken into account in scoring Metric 5 (no. intolerant spp.) Of perhaps more interest is the unusual number (especially for such a small stream) of the fatlips minnow (*Phenacobius crassilabrum*).

On the negative side:

- In 1995 we commented on the surprisingly small number (2) of the longnose dace (*Rhinichthys cataractae*) in what would appear to be good habitat. In 2001, to our greater surprise, this species was not taken.
- Hickory Knoll Creek, as of 2001 provides a spectacular example of the continuing invasion of the upper Little Tennessee watershed by the exotic yellowfin shiner (*Notropis lutipinnis*). In 1995, the Tennessee shiner (*Notropis leuciodus*) was the most abundant cyprinid, and the second most abundant fish overall, whereas the yellowfin shiner was represented by a single individual. In 2001 we took 47 yellowfin shiners and only 5 small Tennessee shiners. Several of these fish appeared to in fact be yellowfin x Tennessee hybrids.

- The increase in the observed value for Metric 7 (% omnivores and herbivores) suggests a degree of nutrient enrichment. Particularly notable in this regard is the increase in numbers of the herbivorous central stoneroller (*Campostoma anomala*) in the sample, from 24 in 1995 to 68 in 2001. This may also, however, be related to greater insolation permitted by recent removal of most of the woody riparian vegetation from the right bank at the site.

Visual inspection suggested an increased amount of sediment in the substrate. Some of it may be from local sources, related to bushhogging the right bank, but some probably is due to upstream development. Hickory Knoll Creek may bear watching in the future.

Table 36. Hickory Knoll Creek @ Slep Orchard Rd. (RM 0.5)

#### Species and Numbers of Fish Taken

Species	Number of fish taken	
	1995	2001
Rainbow trout	7	18
Central stoneroller	24	68
Smoky dace	15	4
Warpaint shiner	4	21
River chub	11	32
Tennessee shiner	27	5
Yellowfin shiner	1	47
Fatlips minnow		6
Longnose dace	4	
Creek chub	2	
White sucker		1
Northern hogsucker	1	
Rock bass		1
Redbreast sunfish	4	1
Green sunfish	2	7
Bluegill	2	
Mottled sculpin	550	364
TOTALS	654	575

#### Metrics and Scoring

Metric	Observed value	Score	Observed value	Score
		1995		2001
1. No. native spp.	11	7.5	10	4.5
5. No. intolerant spp.	1	1.5	2	4.5

6. % individuals as tolerants	1.2	7.5	1.6	7.5
7. % individuals as omnivores and herbivores	5.7	7.5	17.6	4.5
8. % individuals as specialized insectivores	7.6	1.5	5.6	1.5
10. Catch rate	43.6	7.5	78.1	7.5
11. % individuals as darters and sculpins	84.1	7.5	63.3	4.5
12. % individuals with disease or anomaly	2.4	4.5	0.5	7.5
	45		42	
	FAIR		FAIR	

### **Coweeta Creek (Dryman Fork) @ Coweeta Creek Campground (RM 2.3)**

Depending on which map or local “expert” you consult, the stream draining Coweeta Creek Campground is Coweeta Creek (RM 2.3) or Dryman Fork (RM 0.2), which joins the North Fork of Coweeta Creek just 0.2 mi. below the Campground boundary. In either case, it visually appears to be one of the healthier streams in its size category in the upper Little Tennessee watershed, and both the 1990 and 2001 IBI samples bear this out.

However, the 2001 sample was considerably more diverse, including 5 species not taken in 1990. Four of these species were taken in a 1994 qualitative sample, as was the white sucker (*Catostomus commersoni*), not taken in 2001. Particularly notable for their numbers were the exotic brown trout (*Salmo trutta*), not taken in 1994 and the gilt darter (*Percina evides*), which was the third most abundant species in 2001. The difference in number of native species between 1990 (14) and 2001 (17) did not affect the IBI score, but one must ask whether this was a positive or negative change. See discussion under Fixed Station 3, Little Tennessee River at Wolf Fork.

Apart from the additional species (including two darters, the gilt darter and the Tuckaseegee darter, *Etheostoma blennioides gutselli*), the most notable difference between the two samples was the greatly increased abundance of the exotic yellowfin shiner (*Notropis lutipinnis*), represented by a single individual in 1990, but the second most abundant species in 2001. This species was seen in a mixed spawning group with the Tennessee shiner (*Notropis leuciodus*), and a few individuals appeared to be hybrids.

The difference between the 1990 and 2001 IBI scores (52.2 and 54.9, respectively) was not large enough to be considered significant. Although a score of 54.9 is high enough to justify a bioclass rating of Excellent, the conservative decision is to retain the GOOD rating. This conservative approach is supported by the abundance of yellowfin shiners and the

tendency to hybridization, plus the fact that the observed values for Metrics 7 ( proportion of omnivores and herbivores), 11 (proportion of darters and sculpins) and 12 (proportion with disease or anomaly) were all near the threshold for receiving a lower score.

Table 37 Coweeta Creek (Dryman Fork) at Coweeta Creek Campground  
(RM 2.3)

### Species and Numbers of Fish Taken

Species	Number of fish taken	
	1990	2001
Mountain brook lamprey		1
Rainbow trout	1	1
Brown trout		12
Central stoneroller	19	27
Smoky dace	29	35
Warpaint shiner	18	13
River chub	7	29
Tennessee shiner	20	21
Yellowfin shiner	1	56
Mirror shiner	10	14
Fatlips minnow	1	
Longnose dace	1	6
Creek chub	1	2
White sucker		
Northern hogsucker	4	6
Black redhorse		1
Golden redhorse	1	6
Rock bass	4	4
Tuckaseigee darter		1
Greenfin darter	5	17
Gilt darter		36
Mottled sculpin	339	409
TOTAL	461	697

### Metrics and Scoring

Metric	Observed Value		Score		Observed Value		Score	
				1990				2001
1. No. native spp.			14	6.7		17		6.7



2. No. darter spp.	1	4.0	3	6.7
5. No. intolerant spp.	3	6.7	3	6.7
6. % individuals as tolerants	0.2	6.7	0.3	6.7
7. % individuals as omnivores and herbivores	5.9	6.7	9.6	6.7
8. % individuals as specialized insectivores	18.2	1.3	21.4	4.0
10. Catch rate	25.6	6.7	38.7	6.7
11. % individuals as darters and sculpins	74.6	6.7	66.4	6.7
12. % individuals with disease or anomaly	1.1	6.7	4.9	4.0
<b>TOTALS</b>		<b>52.2</b>		<b>54.9</b>
		<b>GOOD</b>		<b>GOOD</b>

#### **Little Tennessee River at Tessentee Farm (RM 128.6)**

This site and the following one on Tessentee Creek were monitored at the request of the Land Trust for the Little Tennessee (LTLT) which in 1999 purchased a 64 acre property the southwest corner of which is defined by the juncture of Tessentee Creek and the Little Tennessee River, and which includes, respectively, 2300 and 2800 ft. of frontage on the two streams. The principal interest of the LTLT was to carry out fish inventories of the two streams as part of a more comprehensive faunal and floral survey of the property, which is now referred to as "Tessentee Farm." It was decided that use of the IBI protocol was appropriate for purposes of the requested survey and it offered the added advantage of providing an educational opportunity for a volunteer force made up of LTLT board members and their families.

From the point of view of the LTWA/TVA project this site provides one more IBI sample on the most thoroughly degraded reach of the Little Tennessee River. Two nearby upstream sites have been monitored in the past. A site at the former Sycamore Park (RM 128.9) was monitored in 1990 and one just below Tessentee Road (RM 129.1) was monitored in 1995 and 1998. The Tessentee Farm site is not totally comparable to these two sites since it is located immediately downstream of a source of relatively high quality water in Tessentee Creek.

As was the case with the Sycamore Park and Tessentee Road sites, the Tessentee Farm site falls into a watershed size category (70-150 sq. mi.) for which TVA has not established IBI metric criteria. As in the case of the other two sites, we have chosen to apply criteria for sites draining 40-70 sq. mi.

As compared to these other sites, the Tessentee Farm site scores marginally better in the IBI (36.3), as compared to 31.9, 27.5 and 34.1 for the other sites (in chronological order).

However, it still must be considered to be a POOR site. The marginal difference is in total number of native species (17 vs. 15 or less), the presence of one darter species (gilt darter, *Percina evides*) and a relatively strong population of the intolerant rock bass (*Ambloplites rupestris*).

If this difference is considered to be significant, it may be attributed to water and/or habitat quality. Better water quality would be attributable to the dilution effect of Tessentee Creek. Insofar as habitat is concerned, this site, like the others is virtually devoid of hard substrate; the streambed consists of a highly unstable mix of fine sand and silt, and natural habitat for cover-dependent species consists solely of tree roots and woody debris. However, supplemental habitat has been provided in the form of whole tree revetments installed as part of an erosion control program carried out by the LTWA and Macon Soil and Water Conservation District. A previous study of revetments on the Little Tennessee as fish habitat (McLarney, 2000) did not show any significant benefit to fish in the short run. However, the revetments installed at Tessentee farm incorporated single very large logs at the base. Whereas other revetments have created largely “brushy” habitat near shore, these large logs have produced substantial “undercuts”, which we found to be well populated by fish, particularly Catostomids and Centrarchids.

The score for Metric 1 may be exaggeratedly high, with several native species marginally present. The whitetail shiner (*Cyprinella galactura*), white sucker (*Catostomus commersoni*) and golden redhorse (*Moxostoma erythrurum*) were each represented by single individuals, the black redhorse (*Moxostoma duquesni*) and bluegill (*Lepomis macrochirus*) were represented by 2 juveniles each, and all 4 specimens of the golden shiner (*Notemigonus crysoleucas*) were taken from a small, specialized habitat (grassy backwater). On the other hand, as noted in this author’s report to the LTLT (McLarney, 2001), 8 additional native species (and 4 exotics) are known from the Little Tennessee both up and downstream of Tessentee Farm and must at least pass through the property on occasion.

Further detail on this and the following site is provided in McLarney (2001a).

Table 38. Little Tennessee River at Tessentee Farm  
(RM 126.9)

#### Species and Numbers of Fish Taken

Mountain brook lamprey	11
Central stoneroller	4
Common carp	1
River chub	35
Whitetail shiner	1
Warpaint shiner	24
Golden shiner	4
Tennessee shiner	16
Yellowfin shiner	34

Mirror shiner	5
White sucker	1
Northern hogsucker	5
Black redhorse	2
Golden redhorse	1
Snail bullhead	1
Rock bass	10
Redbreast sunfish	11
Bluegill	2
Gilt darter	2
<b>TOTAL</b>	<b>170</b>

### **Metrics and Scoring**

<b>Metric</b>	<b>Observed value</b>	<b>Score</b>
1. No. native fish spp.	15	5.5
2. No. darter spp.	1	3.3
4. No. sucker spp.	4	5.5
5. No. intolerant spp.	2	3.3
6. % individuals as tolerants	8.2	5.5
7. % individuals as omnivores and herbivores	33.5	1.1
8. % individuals as specialized insectivores	28.2	3.3
9. No. piscivore spp.	1	5.5
10. Catch rate	4.5	1.1
11. % individuals as darters and sculpins	1.2	1.1
12. % individuals with disease or anomaly	8.2	1.1
<b>Total</b>		<b>36.3</b>
		<b>POOR</b>

### **Tessentee Creek @ Tessentee Farm (RM 0.1)**

We would not ordinarily do an IBI sample just 0.1 mi. above the mouth of a tributary of this size (watershed drainage area 15.1 sq. mi.). However, since the primary purpose of the

sample was to compile a complete list of fish species inhabiting Tessentee Creek at The Land Trust for the Little Tennessee's Tessentee Farm, this site was chosen.

Over the length of Tessentee Creek on the Land Trust property (2,300 ft.), the stream changes character significantly and rather abruptly. Roughly the upper half of this reach is similar in character to the site sampled in 1990 and 1998, at RM 1.3. (While there was a dramatic change in IBI score at that site between 1990 and 1998, from 44.1 – FAIR to 52.2 – GOOD, both of these scores are significantly higher than the 2001 score of 38.7 – FAIR at RM 0.1.)

Above the IBI sample reach, the substrate is dominated by rubble and cobble (with a fair amount of algal growth, not observed at RM 1.3, and probably related to a small hog raising facility just upstream), and sedimentation is moderate. The right bank (on Tessentee Farm) is forested and the left bank is fairly well buffered by large trees and herbaceous vegetation. The site monitored, however, consisting of 500 ft of incised channel extending upstream from a point about 300 ft. above the mouth, has an unstable substrate almost entirely composed of sand and pea gravel. The left bank (not on Tessentee Farm) is in intensive agricultural use, with grass as the only vegetation along much of the riparian zone. The right bank is an old field, abandoned for several years. Natural vegetation, supplemented by planted trees, is beginning to form a riparian buffer, but it cannot yet be described as well buffered, and there are long reaches of high, vertical, raw bank. Table 40 shows some comparative characteristics of the two Tessentee Creek IBI sites.

A single species, the exotic yellowfin shiner (*Notropis lutipinnis*) made up over 35% of the biomonitoring sample. Most of these individuals were members of a single large spawning group. Compared to some other sites in the watershed, few of these individuals appeared to be hybrids. Apart from being of concern as a dominant exotic, the high percentage of yellowfin shiners casts some doubt on the validity of the IBI, since scoring criteria have not been officially established for this species. We presently consider the yellowfin shiner as a non-specialized insectivore, a compromise classification which minimizes its effect on IBI scores. If it were to be considered a specialized insectivore like its congeners, then the observed value for Metric 8 rises to 60.0%, the score for that metric rises to 6.7 and IBI score becomes 41.4 (still FAIR). (If we were to consider it an omnivore, the observed value for Metric 7 becomes an extremely high 65.2%, but there is no effect on the IBI since this metric already scores low, without including the yellowfin shiner.) And if we follow the lead of the state of Georgia, and consider it as a tolerant species, then the observed value for Metric 6 becomes 36.6%, the IBI score drops to 32.3 and the bioclass rating drops to POOR.

Apart from questions involving the yellowfin shiner, the results are well within expectations for a stream in such a degraded condition. The inclusion of the intolerant smoky dace (*Clinostomus* sp.) might be questioned, since it was represented by only 2 individuals, both taken near the upstream end of the sample reach.

To insure the maximum representation of species, spot sampling was continued upstream to the Tessentee Farm property line. Sampling here focused on habitat for expected species not taken in the IBI sample. One such species, the greenfin darter (*Etheostoma*

*chlorobranchium*) was not found, although it is known to occur not far upstream, and was in fact taken just above the property line later in the year. The only additions to the species list were single adult individuals of golden redhorse (*Moxostoma erythrurum*) and brown trout (*Salmo trutta*). Two species taken in the IBI sample (fatlips minnow, *Phenacobius crassilabrum* and creek chub, *Semotilus atromaculatus*), were not taken. Three species (northern hogsucker, *Hypentelium nigricans*; rock bass, *Ambloplites rupestris* and redbreast sunfish, *Lepomis auritus*) appeared to be both more common and represented by larger individuals above the IBI sample reach. The yellowfin shiner, as well as the central stoneroller (*Campostoma anomala*), warpaint shiner (*Luxilus coccogenis*), Tennessee shiner (*Notropis leuciodus*), mirror shiner (*Notropis spectrunculus*) and gilt darter (*Percina evides*) all appeared to be less abundant.

More striking than species differences was what appeared to be a very much reduced rate of blackspot upstream. While the incidence of disease and parasites was not counted in the upstream reach, it was noted during the course of the IBI sample, that in the uppermost 2 subsamples, located near the transition point, only 2 of 64 fish (3.1%) had blackspot, whereas 67 of 561 individuals (12.2%) were infested in the rest of the sample. This is a very high rate of incidence, and this observation suggests that management of the agricultural field on the left bank plays a role, while the livestock facility at RM 1.0 would not appear to be implicated.

Table 39. Tensentee Creek @ Tensentee Farm (RM 0.1)

#### Species and Numbers of Fish Taken

Species	Number of Fish Taken
Mountain brook lamprey	38
Rainbow trout	1
Central stoneroller	63
Smoky dace	2
Warpaint shiner	58
River chub	75
Golden shiner	1
Tennessee shiner	71
Yellowfin shiner	217
Mirror shiner	8
Fatlips minnow	1
Creek chub	4
White sucker	4
Northern hogsucker	17
Rock bass	4
Redbreast sunfish	3
Gilt darter	15
Mottled sculpin	33

TOTAL

615

### Metrics and Scoring

Metric	Observed value	Score
1. No. native spp.	15	6.7
2. No. darter spp.	1	4.0
5. No. intolerant spp.	3	6.7
6. % individuals as tolerants	1.3	6.7
7. % individuals as omnivores and herbivores	29.9	1.3
8. % individuals as specialized insectivores	25.2	4.0
10. Catch rate	27.6	6.7
11. % individuals as darters and sculpins	7.8	1.3
12. % individuals with disease or anomaly	11.2	1.3
<b>Total</b>		<b>38.7</b>
		<b>FAIR</b>

Table 40. Selected Environmental Parameters of Tessentee Creek - RM 1.3 (monitored 1997) and RM 0.1 (monitored 2001)

	RM 1.3	RM 0.1
River Mile	1.3	0.1
Watershed drainage area (sq. mi.)	14.3	15
Mean width (ft.)	30.9	15
Mean depth (ft.)		
Riffles	0.9	1.0
Runs	1.2	0.9
Pools	1.9	1.8
Maximum depth (ft.)	3.1	3.4
Approximate Substrate Composition (%)		
Bedrock	10	0
Boulder	5	0
Rubble/cobble	40	trace
Gravel	15	45
Sand	25	45
Silt	5	5
Clay	0	5

Canopy cover (%)	75	10
Large woody debris	Rare	Rare
Riparian land use	Old field, residential	Old field, agriculture

### **Betty Creek @ Messer Creek Rd. (RM 5.5)**

This site, located partly on the property of the Hambidge Center for Creative Arts and Sciences, was previously monitored in 1997 and 1998, with IBI scores of 49.5 and 52.2 (both GOOD), respectively. It was done again in 2001 at the request of Hambidge Center director Judy Barber, who had noted an increase in slippery periphyton on the rocks in various parts of the approximately 1 mi. Hambidge Center reach. While we did not note this difference, there did appear to be considerably more sediment at the site than in previous visits. More importantly, this site (the only Betty Creek site monitored in 2001) received an IBI score of 44.1 – FAIR. This is of particular concern, since Betty Creek has historically been the healthiest of the tributaries of the Little Tennessee River above Fontana Reservoir with watershed drainage areas of 4 sq. mi. or more. Over the years 1990-2000 we have carried out 11 IBI monitoring samples at 6 sites over Betty Creek between RM 4.8 and 0.6, and this one represents not only the lowest score, but the first site on Betty Creek to score less than GOOD.

Among the changes noted which could be interpreted as negative:

- A tremendous increase in numbers of the omnivorous river chub (Nocomis micropogon), from 7 in 1997 and 9 in 1998 to 61 in 2001. This was paralleled by an increase in numbers of another native omnivore (also a tolerant), the creek chub (Semotilus atromaculatus) – 0,1 and 9, respectively. In 2001, the creek chub catch was notable for apparent representation of all size classes.
- A tremendous decline in the number of the dominant species, the mottled sculpin (Cottus bairdi). This may be related to increased sedimentation.
- Appearance for the first time at this site of the exotic yellowfin shiner (Notropis lutipinnis). While this species has been found in the Georgia waters of the upper Little Tennessee watershed at least since 1989, this represents its farthest upstream penetration in Betty Creek.
- Sharp drop in the number of rainbow trout (Salmo gairdneri) from 24 in 1997 and 27 in 1998 to 6 in 2001. In contrast to the other 2 years, the 2001 sample included only juveniles of this species.

- Concurrent increase in the abundance of the rock bass (Ambloplites rupestris), represented by a single individual in each of the previous samples, but with a catch of 14 in 2001. While the rock bass is an intolerant, apparent replacement of a coldwater species (rainbow trout) with a cool or warm water fish (rock bass) is not necessarily a good thing in streams of this size, at this altitude (ca. 2,400 ft.).
- The increase in total species count (16 to 20) may indicate degradation, with transformation of a community dominated by upland endemics to one with more “generalized southeastern” species, more typical of larger rivers. (Scott and Helfman, 2001. See discussion under Fixed Station 4, Little Tennessee River at Wolf Fork.) Among the species recorded for the first time at this site, in addition to the yellowfin shiner and rock bass, the fatlips minnow (Phenacobius crassilabrum) and largemouth bass (Micropterus salmoides) could also reflect this trend. (Although the single individual of the latter species may well be a pond escapee.)

One observation which does not fit neatly with the above is the decline in numbers of the herbivorous central stoneroller (Camptostoma anomala), from 25 in 1997 to 16 in 1998 and 9 (apparently of a single age class) in 2001. Abundance of this species is usually associated with high levels of nutrient, and would be consistent with an observation of increased periphyton growth.

The observation on the central stoneroller notwithstanding, the trend suggested by this sample is alarming, and calls for further monitoring of Betty Creek in 2002. It is the more puzzling because both of the putative sources of pollution in the watershed upstream of RM 5.5 (a nursery and a trout farm) have greatly reduced their output in the last few years, and there has been no great surge in development upstream.

Table 41. Betty Creek at Messer Creek Rd. (RM 5.5)

#### Species and Numbers of Fish Taken

	1997	2001
Mountain brook lamprey	45	26
Rainbow trout	27	6
Brown trout	1	
Central stoneroller	16	9
Smoky dace	41	26
Warpaint shiner	64	55
River chub	9	61
Tennessee shiner	19	8
Yellowfin shiner		12
Fatlips minnow		3
Longnose dace		13
Creek chub	1	9
Northern hogsucker	18	19



Black redbhorse		2
Golden redbhorse		
Rock bass	1	14
Redbreast sunfish	10	5
Green sunfish	3	1
Largemouth bass		1
Tuckaseigee darter	1	2
Gilt darter	4	7
Mottled sculpin	718	269
<b>TOTAL</b>	<b>978</b>	<b>548</b>

Metrics and Scoring	1998		2001	
	Observed value	Score	Observed value	Score
1. No. native species	14	6.7	18	6.7
2. No. darter species	2	4.0	2	4.0
5. No. intolerant species	3	6.7	3	6.7
6. % individuals as tolerants	1.4	6.7	2.6	6.7
7. % individuals as omnivores and herbivores	7.3	6.7	19.2	4.0
8. % individuals as specialized insectivores	13.2	1.3	20.8	6.7
10. Catch per unit effort	27.9	6.7	14.7	4.0
11. % individuals as darters and sculpins	73.9	6.7	50.7	4.0
12. % individuals with disease or anomaly	0.6	6.7	2.6	4.0
<b>TOTALS</b>		<b>52.2</b> <b>GOOD</b>		<b>46.8</b> <b>GOOD</b>

### **Non-IBI Site: Cullasaja River @ RM 3.4-4.1.**

In May, 2001 we received a second hand report of a university researcher encountering several specimens of the Threatened spotfin chub (*Cyprinella monacha*) from a site at about RM 4 on the Cullasaja River. At present, the spotfin chub is known from the Little Tennessee system only in the reach between Porters Bend Dam, which impounds Lake Emory at RM 113.1 and the high pool level of Fontana Reservoir at about RM 88, although the entire length of the Little Tennessee from the North Carolina/Georgia state line (RM 136.9) is Designated Critical Habitat for this species.

The Cullasaja is tributary to the Little Tennessee at RM 117.4, and around 8 miles of its length (roughly RM 2 - 10) would appear to contain habitat suitable for the spotfin chub. However, this species has never been reported from upstream of RM 113.1 on the Little Tennessee or from any tributary to the river above this point.

According to the report we received, *C. monacha* was sufficiently common that several specimens were taken with a dip net. Some of the specimens reportedly displayed vivid blue or turquoise coloration unique to spawning males of this species. The purpose of the investigation was not to search for spotfin chubs and, since the investigator did not have an endangered species permit, no specimens were preserved. The report was sufficiently interesting that it was decided to spend an entire day, with a 3 person crew (electrofischer operator and 2 dipnetters) searching for *C. monacha* in an 0.7 mile reach bracketing the reported capture site.

All habitats present in this reach were sampled, in an effort to derive a list of all fish species present. However, emphasis was placed on habitat presumed to be suitable for *C. monacha* at this time of year (McLarney, 1989) and during netting, preference was given to silvery cyprinids of the general size of the spotfin chub. For these reasons quantitative data was not kept, and no effort was made to compute an IBI. All species taken and their relative abundance are listed in Table 42. This list comprises 27 of the 33 species ever taken from the Cullasaja River between RM 0.4 and 5.2 during 1990-2001. The 6 species not taken have all been of infrequent occurrence and relatively rare in our samples.

No spotfin chubs were taken. However, the two species which could conceivably be mistaken for *C. monacha* were taken. The congeneric whitetail shiner (*Cyprinella galactura*) was one of the most abundant species and the catch included numerous large individuals in nuptial color. The mirror shiner (*Notropis spectunculus*) was common, with an unusual number of large individuals, some of which displayed more of a blue tint than is usual. While neither species could be mistaken for *C. monacha* by anyone who has ever handled a spawning male of that species, this misidentification could conceivably be made by someone lacking that experience. It is our opinion, based on this effort, and the results of 24 IBI samples taken over a 12 year period from 5 sites in the lower 10 miles of the Cullasaja identified as having suitable habitat for spotfin chub, that this threatened species does not occur in the Cullasaja River.

Table 42. Species and Numbers of Fish Found in the Cullasaja River, RM 3.4-4.1 on July 5, 2001, with Relative Abundance

Mountain brook lamprey	R
Rainbow trout	R
Central stoneroller	A
Whitetail shiner	A
Warpaint shiner	C
River chub	A
Tennessee shiner	A
Yellowfin shiner	C
Silver shiner	R
Mirror shiner	C
Creek chub	R
Northern hogsucker	C
Black redhorse	R
Golden redhorse	C
Snail bullhead	R
Brown bullhead	R
Rock bass	C
Redbreast sunfish	R
Warmouth	R
Bluegill	C
Smallmouth bass	R
Tuckaseegee darter	C
Greenfin darter	C
Wounded darter	R
Gilt darter	C
Olive darter	R
Mottled sculpin	A

TOTAL 27 SPECIES, 21 NATIVE

A =

R =

C =

## COMMENTS ON THE MOTTLED SCULPIN (*Cottus bairdi*)

TVA biologists have long commented on the pronounced abundance of the mottled sculpin (*Cottus bairdi*)\* in the Little Tennessee and the neighboring Hiwassee River watersheds, as compared to most other parts of the Tennessee Valley. In the first of these reports, McLarney (1991) noted that, although 54 species were reported in that year, sculpins “comprised 50.4 percent of the total number of fish captured at the 28 IBI sites. It was the most numerous species at 16 sites and accounted for 50-82% of the catch at 10 sites.” This has been more or less the situation since then; for example in 2000 it was the most numerous species at 13 of 23 IBI sites (excluding 2 sites on the Highlands Plateau where *C. bairdi* has never been recorded) and accounted for over 50% of the total catch at 6 sites.

This abundance of a single species gives rise to what McLarney (1995a) referred to as “sculpin swamping”, which reduces the power of the IBI. Apart from contributing to Metrics 1 (native species count) and 10 (catch per unit effort), *C. bairdi* does not function as an “indicator species” because it is not included in any of the categories which directly influence IBI scoring, i.e. it is not considered tolerant or intolerant and has relatively unspecialized feeding habits. McLarney (1995) attempted to take this into account by substituting for TVA’s Metric 11 (proportion of hybrids) a metric based on “obligate benthic fishes”, provisionally considered to include sculpins and darters. Even so, a high sculpin count in an IBI sample can obscure relationships which might otherwise appear to be significant.

However, an across the board reduction in numbers of sculpins was noticed in 2001. Table 43 shows the total number of sculpins and their percent contribution to the total fish catch at each of 25 sites where sculpins were taken. These numbers are compared to those for the last previous year of sampling.

Total number of individuals is taken to be a fair indicator since the amount of effort invested at a site is held fairly constant. The total number of sculpins taken declined at 22 of the 25 sites between 2001 and the last previous sample (dates ranging from 1990 to 2000.) When expressed as a percentage of the total fish catch, sculpins declined at 21 of the sites, and one had the same percentage in both years.

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\* All *Cottidae* from the Little Tennessee watershed are presently assigned to *Cottus bairdi*. However, as reported in McLarney, 2001, there may in fact be no true *C. bairdi* in the watershed, and there may be more than one species present. As Jenkins and Burkhead (1993) noted: “Many workers consider the process of identifying sculpins to be among the most difficult encountered among North American freshwater fish groups.” Until some undetermined time in the future, it will be most prudent, for biomonitoring purposes, to consider all sculpins from the Little Tennessee watershed as *C. bairdi*.

These figures are remarkably consistent across a range of positions in the watershed, stream size, water and habitat quality and other factors. They also hold true across the total range of sculpin abundance – from the Little Tennessee River at Needmore (RM 95.5), where sculpins made up only 0.5 and 0.1% of the total catch in 2000 and 2001, respectively, to Hickory Knoll Creek (RM 0.5), where the corresponding figures are 84.1 and 63.3%.

For every site for which we have sufficient data it is possible to observe fluctuations in sculpin abundance, both absolute and in proportion to other species. However, the observations for 2001 are unprecedented. For example for the Fixed Station on the Cullasaja River at Peaceful Cove, the proportion of sculpins in the sample has oscillated between 32 and 54%; 2001 marks the first time the figure has dipped below 30% (27.2%). Similarly at the Wayah Creek Fixed Station (RM 0.6), sculpins have comprised 73-88% of a total catch of 14-17 species, the 60.6% recorded for 2001 marks a drastic drop. The trend (if that is what it is) appears to have started early at one Fixed Station (Middle Creek, RM 2.2). Prior to 1998, the proportion of sculpins in that sample was 70-82%. During 1998-2001 the range has been 52-66%.

It is interesting to speculate as to whether this trend will continue, and what might be its causes. (A rise in average stream temperatures during mild winters is an attractive hypothesis.) But it is perhaps more important to consider the implications for use of IBI. If a single species is not only so dominant at many sites as to “swamp” the data and reduce the power of the IBI, that is a problem. But if that species is subject to large fluctuations in abundance it may be a larger problem. In most cases, if a particular species were to decline for reasons not directly related to water or habitat quality, we would expect a compensatory increase in numbers of a competitor species. (For example relative abundance of various species in the shiner group tends to fluctuate more than the total number of shiners, across several species, at a site.) But, barring an increase in darter numbers (which has not occurred, with the possible exception of one site), there is really no other fish which can “compensate” for the absence of sculpins.

If, for example, the absolute number of omnivores and the total number of individual fish other than sculpins hold constant at a site, while sculpin numbers decline abruptly, what is the significance if the percentage of omnivores increases across the threshold from a high to a medium or low score for Metric 7? What if the change is positive, e.g. an increase in the proportion of specialized insectivores in the sample without an increase in absolute numbers of shiners or darters?

It would appear that the best that can be hoped for in the short run (until we learn a great deal more about stream fish assemblages) is that this is a short term phenomenon and that sculpin numbers soon return to historic levels, so that we can continue to compare our results with those from 1990-2000. In the long run, it would appear to be necessary to better understand the role of sculpins in the ecosystem.

Table 43. Relative Abundance of the Mottled Sculpin (*Cottus bairdi*) in IBI Fish Samples in the Upper Little Tennessee River Watershed, 2001 as

Compared to the Previous Year of Sampling

Site	No. of <i>C. bairdi</i> Year	Change*	% <i>C. bairdi</i>
Little Tennessee R., RM 95.5	#	5	0.5
	#	1	0.1
Caler Fork, RM 0.3	#	198	59.6
	#	49	23.9
Matlock Cr., RM 0.6	#	558	82.5
	#	119	54.3
Little Tennessee R., RM 111.1	#	17	3.3
	#	4	0.7
Watauga Cr., RM 0.7	#	185	58.0
	#	79	23.9
Rabbit Cr., RM 0.6	#	95	29.2
	#	28	9.5
Cat Cr., RM 0.5	#	39	26.4
	#	19	8.2
Crawford Br., RM 0.9	#	24	10.3
	#	56	12.4
Cullasaja R., RM 0.9	#	21	5.3
	#	17	8.6
Mashburn Br., RM 0.4	#	93	63.7
	#	61	45.2
Cullasaja R., RM 8.3	#	182	33.5
	#	125	27.2
Cartoogechaye Cr., RM 1.0	#	166	34.7
	#	76	20.0
Wayah Cr., RM 0.6	#	556	76.1
	#	455	60.6
Cartoogechaye Cr., RM 12.1	#	327	41.4
	#	129	19.4
Jones Cr., RM 0.6	#	184	60.7
	#	158	43.5
Allison Cr., RM 0.4	#	400	61.3
	#	161	40.0
Skeenah Cr., RM 0.5	#	120	28.2
	#	58	25.4
Hickory Knoll, Cr., RM 0.5	#	550	84.1
	#	364	63.3
Coweeta Cr., RM 2.3	#	339	75.5
	#	409	58.7

Middle Cr., RM 2.2	#	405		51.7
	#	476	<b>71+</b>	66.1
Sutton Br., RM 0.0	#	19		17.1
	#	15	-4	9.0
Sutton Br., RM 0.5	#	24		15.8
	#	7	-17	4.5
Betty Cr., RM 5.5	#	718		73.4
	#	269	-449	49.1
Little Tennessee R., RM 136.9	#	12		3.1
	#	7	-5	3.1
Little Tennessee R., RM 142.9	#	14		6.9
	#	6	-8	1.4

\* Positive changes in **bold** type.

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Continuation of biomonitoring and other work in the upper Little Tennessee River watershed for the 12<sup>th</sup> consecutive year was made possible by a grant from the Tennessee Valley Authority (TVA), through the Little Tennessee Watershed Association (LTWA), with administrative assistance from the Southwestern North Carolina Resource, Conservation and Development Council (RC&DC). Gary Williams continued to oversee the work at TVA, while Executive Director Jamie Johnston and Treasurer Kay Coriell played vital roles in the LTWA. Following Jamie's resignation, LTWA president Sharon Taylor and the board closed all the gaps so that the project continued to function in the interim.

Another transition occurred when the LTWA received its full nonprofit status. Tim Garrett at the RC&DC was especially conscientious and helpful in managing the financial aspect of this transition.

This change was concurrent with internal changes in TVA which, absent the particular efforts of Gary Williams and Charlie Saylor, might have resulted in a loss of continuity. Even so, were it not for the efforts of Tom Gilbert and others at Southern Appalachian Man and the Biosphere (SAMAB), plus Jon Loney at TVA, the work might be facing a funding crisis. Thanks to these individuals and a consequent grant from the National Forest Foundation to SAMAB, the project director was able to feel secure about funding for the 2002 season and to focus his energies on the work to be done during 2001.

My principal field assistant this year was Jeff Alexander, who quickly evolved into a first rate helper. He was doubled at times by last year's project assistant, Cal Yonce (who also assisted at times on a voluntary basis).

Clerical assistance was provided by Martha Hudson of the RC&D Council and Carla Norwood of the LTWA.

Once again, the number of volunteers who participated in the field work was 141. By far the most frequent volunteer this year was Rose McLarney. Overall, 15 individuals participated on multiple occasions. A complete list of volunteers appears at the end of this section.

Special thanks go to those individuals who helped recruit and manage organized groups who participated in the work. They include old friends Joan Willis (Franklin High School), Mark Guy and Michelle Hubbs (Macon Middle School), Donna Glee Williams and Marcia Jarrell (North Carolina Center for the Advancement of Teaching), and Dr. Dan Perlmutter (Upward Bound Program at Western Carolina University). The Long Term Ecological Research (LTER) program at Coweeta Hydrological Laboratory assisted in the work with Macon Middle School and also provided intern assistance at other sites. Thanks go to Dr. Brian Kloeppe, Barry Clinton, Susan Steiner and Paige Carruthers for their parts in maintaining this relationship. This year we also formed a new partnership with Newbridge School, thanks to the initiative of Holly Parr and Panthea Crawford.



Thanks to Paul Carlson of the Land Trust for the Little Tennessee (LTLT) for encouraging us to monitor 2 stream sites on the LTLT'S Tessentee Farm (for which most of the volunteer assistance was provided by LTLT board members).

As has become traditional, the specialized skills of Dave Matthews of American Aquatics/TVA were invaluable at two sites which required the use of a boat shocker. The same may be said of Steve Fraley of TVA, who carried out the necessary macroinvertebrate identifications for certain sites. We especially appreciate the assistance of Gary Williams and Steve Akers of TVA at certain sites; when project administrators actually get out in the field with staff and volunteers it makes a major, if sometimes intangible, contribution to the success of the work.

As in years past, we owe thanks to the western office of the Western North Carolina Alliance (Roger Turner, director) for use of their office for storage, copying, phone calls, meetings and just a place to decompress in Franklin. Major contributions to storage needs were also made by Jamie Johnston and George and Sharon Taylor.

Much valued local media coverage was received thanks to participation (as field volunteer and interested citizen, as well as journalist) by Candace Cunningham of the Macon County News.

## Appendix: Biomonitoring Volunteers

Adam Ranke	Dave Johnson	Jessica Gasperin	Michael Egan	Susan Steiner
Alan Snow	Dave Matthews	Jill Getgen	Michael Lambert	Tanner Cook
Alethia Skinner	Dave Moccia	Joan Willis	Michelle Hubbs	Terry Seehorn**
Amanda Ellis	Dawn Eberhard	John Huddleston	Monica Robison	Tesca Byrd
Andrea Sorrow	Dawn Geverd	John Judy*	Mort Meadors*	Thomas Pignato*
Angela Ouzts	Derik Breedlove	Jonathan Brege	Nathan	Tim Bergman
Anna Faye	Dick Heywood*	Josh Corbin	Nathaniel Fenton	Tim Cooper
Anthony D'Alto	Donna Caulder	Josh Moffit	Nick Shorene	Todd McGuire
Ariel Terry	Donna Glee Williams	Josh Ward	Paige Carruthers**	Tom Hill**
Ashley Williams	Drew	Kate Seeder	Patrick Phillippe	Tom Quigley
Autumn Woodward	Duane VanHook*	Katherine Fair	Paul Pittman	Trinity Watson
Becky Stallworth	Ebony Evans	Kenny Houck	Phil Sturges	Tyler Pignato*
Beverly Leonard	Elena Carlson	Kenny Ramirez	Phil Williams	Will Davis
Beverly Williams	Elise Bacon	Kevin Ellis	Qingwen Xu	Will Ellis
Bill Crawford	Erin Prosser	Kevin Fitzpatrick	Richard Brown	
Brittany O'Kelly	Gary Chappell	Larry Kirk	Rita Hubbs	
C.J. Baldwin	Gary Williams**	Laurence Holden	Robbie Rogers	
Cabriny Blain	Gill Heywood*	Leandra Showalter	Robert Duelfer	
Cal Yonce*	Gillian Barrett	Leona Pridgen	Rose McLarney*****	
Candice Cunningham	Gina Johngrass	Leslie Jenkins	Ryan Adkins	
Carlile Stuart	Gloria Williams	Levi Pignato	Ryan Coggins	
Carol Hall	Heather Bell	Liz Cornelius	Sandra Weeks	
Cassidy Chanza	Holly Parr*	Liz Graves	Sara Mizell	
Cheryl Fields	Jack Johnston	Lorraine Pevia	Sarah Fenton	
Chris Cook	Jamie Gregory	Marcia Jarrell	Sean Althouse	
Chris Durm**	Jason Holland*	Marcia Rooney	Sean Quigley	
Christina Pacillo	Jason Love	Maria Moccia	Stan Polanski	
Claire Graham	Jennifer Cripivek	Marjorie Donkel	Steve Eakers	
Clara Jean Quigley	Jennifer Haddix	Mark	Steven Foster	
Dan Hazazer	Jennifer Love	Mary Quigley	Sunner Negron	
Dan Perlmutter	Jennifer Oberlin	Mary Smith	Susan Ervin	



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