INDEX OF BIOTIC INTEGRITY (IBI) MONITORING

IN THE

UPPER LITTLE TENNESSEE WATERSHED

2003

REPORT TO:	Little Tennessee Watershed Association Watershed Action Team, TVA National Forest Foundation SAMAB
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INTRODUCTION

Beginning in 1990, samples of fish (and in some cases macroinvertebrates) have been carried out using an Index of Biotic Integrity (IBI) protocol, at a total of (to date) 134 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, several other sites have been monitored annually and so become de facto fixed stations. Rationale for selection of the original 8 fixed stations is documented in McLarney (1993). Rationale for additional fixed stations is offered in McLarney, 1996b (Little Tennessee at head of Lake Emory, Rabbit Creek at Rabbit Creek Rd. and Skeenah Creek at North Carolina Welcome Center), McLarney, 2000b, (Little Tennessee River at Wolf Fork) and McLarney, 2001 (two stations on Sutton Branch at Rabun Gap-Nacoochee School).

Over the course of time, it was found necessary to move one fixed station (Cullasaja River at Wells Grove, see McLarney, 1996b) and 3 stations have been abandoned. Iotla Creek at Macon County Airport was abandoned in 1999 (See McLarney, 1999a, 2000b) . The two Sutton Branch sites were dropped as fixed stations after the 2002 season, McLarney 2002 DRAFT), but may be reinstated.

Another fixed station, Little Tennessee River at Wolf Fork (RM 142.9), which we failed to sample in 2002, was provisionally abandoned beginning in 2003. See discussion in the Results and Discussion section.

This year, due to almost continual high water levels during the sampling season, we were unable to monitor all of the fixed stations. There was literally not one day between May 15 and August 15 when two sites requiring use of the TVA shocker boat (Little Tennessee River at Needmore and Little Tennessee River at head of Lake Emory) could have been monitored. We were also unable to schedule 2 of the 4 largest sites normally monitored with backpack shockers only (Cullasaja River at Wells Grove and Little Tennessee River at State Line).

This report covers biomonitoring of those 6 fixed stations we were able to sample, plus 16 sites monitored in previous years and 3 sites never before monitored. The total number of sites monitored (25) is the lowest since 1991. We were also able to carry out a habitat assessment for each of the sites monitored, using the USDA Stream Visual Assessment Protocol (SVAP).

Rationale for selection of all non-fixed station sites for monitoring in 2003 is given in the following section. IBI scoring criteria for different types of sites are given in Tables 1-7. Table 8 relates IBI scores to Bioclass Ratings, with general characteristics of each bioclass. Locations of all stream sites monitored during 2003 are shown in Figure 1.

Following Figure 1, the bulk of the report is devoted to results. First we discuss biomonitoring results for each site, based on fish samples at each station, plus benthic macroinvertebrate samples for 4 sites with watershed drainage areas of less than 4 sq. mi. For ease

of comparison, the SVAP score for each site is given with the biomonitoring information, but SVAP methodology and results are also discussed in a separate section.

Finally we append a report describing the results of a second attempt to evalute the effects of stream bank stabilization work on fish communities along the shoreline of the Little Tennessee River above Franklin, and its tributary, Cartoogechaye Creek. While during 2003 this work was not funded through the LTWA or supported by TVA or NFF, it builds on work done under the TVA/LTWA aegis in 1999, and is otherwise highly relevant to both our "traditional" biomonitoring work and the larger mission of the LTWA.

RATIONALE FOR NON-FIXED STATION SITES

Restoration Sites

A general rationale for focusing on restoration sites was discussed in last year's report (McLarney, 2003 DRAFT), as was our inability to date to demonstrate improvement in biotic integrity related to stream bank restoration and stabilization sites on our larger streams. An argument was made for focusing monitoring related to restoration efforts on very small streams, and some examples of past and future monitoring sites on streams with watershed drainage areas of less than 4 sq. mi. were offered.

This year we carried out fish and benthic macroinvertebrate monitoring at only 2 sites directly related to restoration activities. Blaine Branch on the Sam Greenwood property was first monitored in 2002, at which time it was scheduled for an ambitious DOT mitigation project, with restoration of natural meanders. As noted in McLarney (2003 DRAFT) "our 'before' sample was not taken until after cattle had been removed from the stream for a full year, but there is every reason to believe that this site will be a successful long term monitoring site." For various reasons, DOT's schedule was set back and no work was done on Blaine Branch during 2003. However, we were able to document change due to the continuation of natural processes. Assuming restoration measures go forward, we see Blaine Branch as a candidate for fixed station status.

One of 3 new sites monitored for the first time this year relates to a planned restoration project. A very small (watershed area 0.8 sq.mi.), badly degraded stream which joins the Little Tennessee at precisely the same point on the right bank where the Cullasaja River empties into the Little Tennessee, was slated for restoration by Macon County following purchase of the property through which the lower 0.2 mi. of its course flows. This stream, to be referred to as Fox Run or Salali Branch (see discussion of naming below), will be monitored annually if restoration proceeds.

The "Results" section also includes discussion of the possible reincorporation of Sutton Branch as a monitoring site, pending further discussion with the landowner (Rabun Gap-Nacoochee Schoool). Yet another small stream restoration site on the Rabun Gap-Nacoochee School campus (Jerry Branch), monitored in 2002 (McLarney, 2003 DRAFT) was not revisited in 2003, based on a perception of no significant change. However, if restoration plans move forward it will likely be monitored again in the future.

Betty Creek Watershed

Betty Creek (watershed drainage area 17.2 sq. mi.) is one of the most significant tributary watersheds of the upper Little Tennessee and, in general terms, one of the healthiest. IBI scores from 17 samples at 6 sites on Betty Creek during the years 1990-2003 have always (with one significant exception to be discussed) been in the GOOD bioclass.

Betty Creek is also important by virtue of its size. It is the largest tributary upstream of Cartoogechaye Creek, and the largest tributary in Georgia by a wide margin. At the point where it

enters the Little Tennessee, in Rabun Gap, Georgia, it nearly doubles the size of the river, which has a watershed drainage area of 19.4 sq. mi. upstream of this point. The positive effect on water quality is immediately apparent.

In addition, Betty Creek represents a unique conservation opportunity at this time. The pattern of land ownership along the 8 mi. mainstem is unique in our watershed, with 4 large landowners controlling more than 60% of the riparian length. They are in order, from the source to the mouth:

- The US Forest Service, Wayah Ranger District, controls the uppermost 1.5 mi. comprising over 15% of the total watershed, located in Macon County, North Carolina. The great majorit of this area is thoroughly protected within the Southern Nantahala Wilderness. Smaller portions of the lower watershed in headwater areas in Georgia belong to the Chattahoochee National Forest, Clayton Ranger District.
- Starting 0.2 mi. below the North Carolina/Georgia state line, most of 1.3 mi. of the mainstem riparian area (and a total of XXX acres of the watershed) belong to the Hambidge Center for Creative Arts and Science. The Hambidge Center has always practiced a strong conservation ethic. In 1996, they commissioned the author of this report to do a study of Betty Creek, its tributaries and related wetlands on the Hambidge Center property (McLarney, 1996a). Recently the board of the Hambidge Center voted to not consider sale of any portion of the property as a solution to financial problems. The Hambidge Center is presently practicing passive wetland restoration in pasture areas, and in a process of discussion of further conservation opportunities with The Land Trust for the Little Tennessee.
- XX mi. downstream of the Hambidge Center lower boundary, both banks of the mainstem are included in an XX acre private farm which has preserved adequate buffer zones and otherwise managed the property well. However, following the death of the owner it cannot be taken for granted that the heirs will be able to maintain the integrity of the property indefinitely.
- More than a mile of one or both banks of the lower reaches of Betty Creek are located on the campus of Rabun Gap-Nacoochee School, a private high school which professes and teaches a conservation ethic. While there have been some internal conflicts related to operation of the school farm, it can be said that stewardship is both good and improving.. There is presently an active stream restoration site (Sutton Branch, discussed above and below) on campus. Another on-campus stream (Jerry Branch, not tributary to Betty Creek, see above) is proposed for restoration.

Partly related to this series of positive factors and opportunities, biomonitoring has been somewhat concentrated on Betty Creek and 3 of its tributaries (Sutton Branch, Patterson Creek and Barkers Creek) in recent years. However, our interest in Betty Creek is also motivated by perceived deterioration at one site (Betty Creek at Messer Creek Rd., RM 4.8) in the past 3 years.

For a combination of reasons, then, we scheduled 3 sites on Betty Creek, plus one on a tributary, for 2003. The Messer Creek Rd. site was selected for a third straight year of monitoring, for obvious reasons. Two downstream sites were selected. One site designated “Hambidge Center” because it is located on Hambidge Center property directly across from their offices, previously monitored in 1996. (McLarney, 1997a), was selected for its proximity to the Messer Creek Rd. site

(0.5 mi. downstream) to help define the range of the perceived problem by measuring any change at this site in the ensuing years. A frequently monitored site below US Highway 441 in Dillard, Georgia (RM 0.6), was selected to continue to evaluate the quality of water delivered to the Little Tennesee by Betty Creek.

We also elected to revisit a site on one of the two largest tributaries, Barkers Creek, because of the suspicion that operation of a mill and/or development activity upstream on Barkers Creek was a cause of the problem perceived at Messer Creek Rd. (The other principal tributary of Betty Creek, Patterson Creek, was sampled in 2002.) When the combined results of Barkers Creek and Betty Creek samples suggested that the source of the problem was not necessarily located on Barkers Creek, an additonal site on Betty Creek at RM 5.1, above the mouth of Barkers Creek, was monitored for the first time in 2003.

Sites related to specific issues

During 2001-2002 Cat Creek immediately above our monitoring site (RM 0.5) on the Henderson farm, was heavily modified in the course of a controversial development project, which was eventually shut down due to violations of environmental regulations and other irregularities. A reach of 0.3 mi. was rechannelized, with removal of a series of beaver dams and total elimination of all riparian vegetation. Although Cat Creek at RM 0.5 has always received a POOR Bioclass Rating, the site was revisited in 2003 to determine the effect of these modifications.

Although the Bioclass Rating for the Cartoogechaye Creek fixed station (Macon County Rec Park, RM 1.0) remained within the FAIR category, the IBI score dropped from the top to the bottom of the category (45 to 37), with an especially alarming increase in the incidence of parasitization. In an effort to begin pinpointing the source of the problem an upstream site (Mt. Hope Baptist Church, RM 7.5), last visited in 1999, was monitored in 2003.

In 2003, for the third year in a row the IBI score at the Skeenah Creek fixed station (North Carolina Welcome Center, RM 0.5) was 33, when the site had scored 36-39 since 1994. While a drop of 3 points may well not be significant, the results strongly suggested sedimentation as the causative agent, and increased sedimentation was visible at the site. This in turn appeared to be a consequence of a series of land disturbing activities, including a major school construction project, 0.5 mi. upstream. Accordingly we decided to monitor the first available site on Skeenah Creek upstream of the disturbed area – at Meadow Creek Mobile Estates, RM 1.1
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Mud Creek at Kelly Creek Rd. (RM 0.7) had been sampled in 2002, but in the ensuing year a large RV park was installed immediately upstream of our monitoring site. At this time there is also great concern in Rabun County about a proposed mega-development in the Mud Creek watershed above Estatoah Falls (already the site of the Town of Sky Valley and the Ford Mountain development) which could damage water quality in Mud Creek and the Little Tennessee River downstream. So Mud Creek was revisited in 2003 both to evaluate possible damage by the RV park facility and to contribute to the discussion of the projected development in the upper watershed.

Bates Branch at US 441 was last sampled in 1995, as part of a series of samples of all streams (30) with watershed drainage areas of 1-4 sq. mi. draining into the mainstem of the Little

Tennessee River between its headwaters west of Rabun Gap, Georgia and the head of Fontana Reservoir. At that time we encountered a specimen of the striped shiner (*Notropis chrysomelas),* and believe we observed another to escape. Bates Branch was sampled using the IBI protocol in 2003, primarily because this was the best way to test for possible establishment of this exotic species.

Normal rotation:

We endeavor to revisit all significant non-fixed station sites at least once every 5 years. This was the primary reason for 2003 sampling of Ellijay Creek at Sugar Fork Rd. (RM 0.5), Coweeta Creek above Ed Conley Rd. (RM 0.5), Tessentee Creek at Windy Ridge Rd. (RM 1.3) and Blacks Creek at Yorkhouse Rd. (RM 0.3), all last visited in 1997 or 1998. The Tessentee Creek visit was also invited by a riparian landowner.

Cat Creek (see above) is another significant site which would probably have been sampled in 2003 as part of normal rotation. However, this sample was even more strongly justified by events described above.

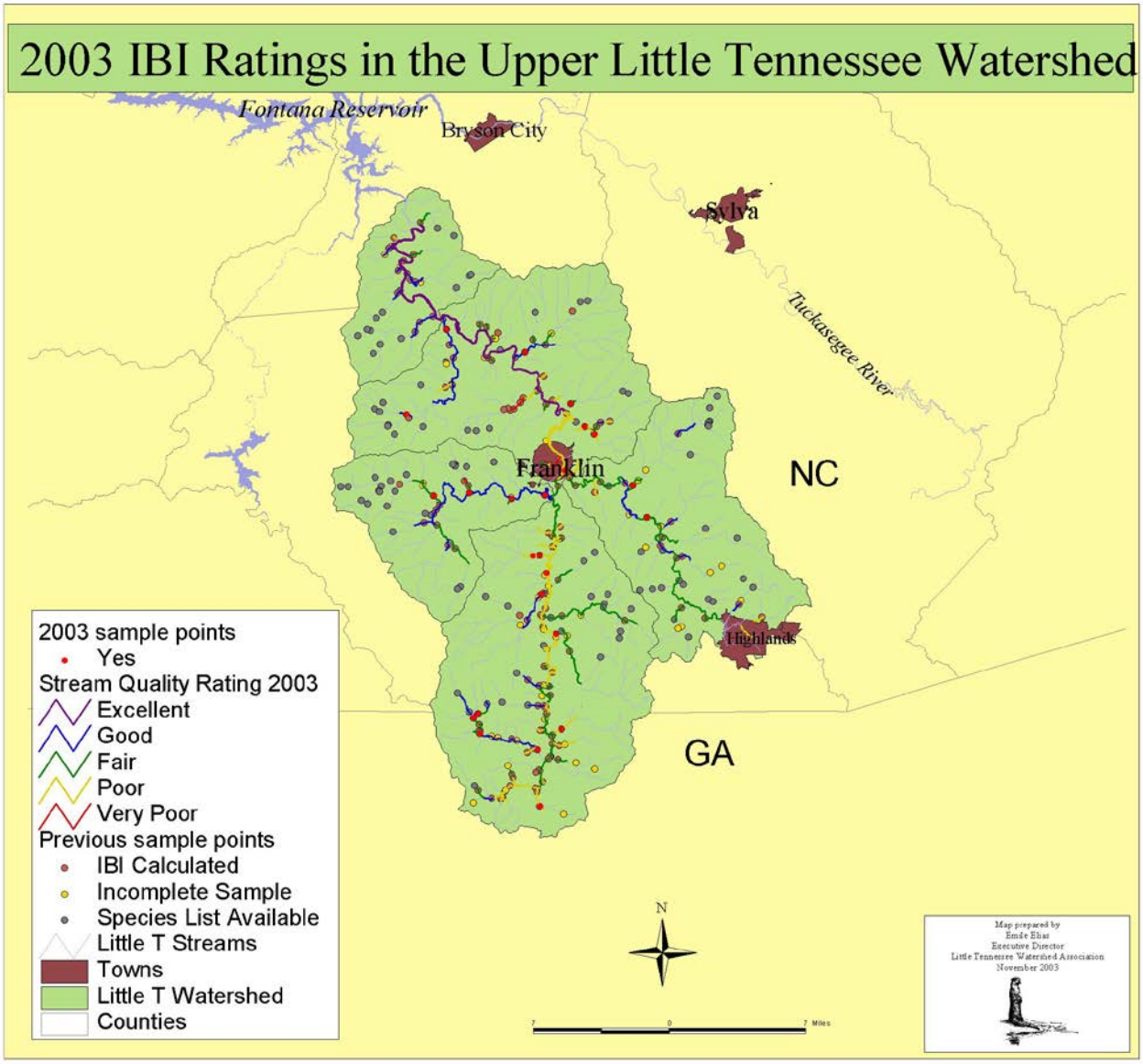
TVA rotation:

Although Burningtown Creek at Lower Burningtown Rd. (RM 0.6) and Cowee Creek at Wests Mill (RM 0.8) were last sampled in 2000 and 2002, respectively, these two tributaries (the largest tributaries below Franklin, North Carolina and Lake Emory) are of particular importance to TVA. We were requested to sample the two for TVA, in order to maintain their 5 year rotation. (Both sites were sampled in 1998.)

"Opportunistic" site selection

Watauga Creek at Berry Mill (RM XX) was last monitored in 2000, and would not normally have been selected for sampling this year. However, on the date of sampling we were confronted with the situation of a volunteer crew who had traveled a long distance, and were unable to work at a scheduled fixed station because of overnight rain in the headwaters, with consequent high water. Rather than send them home with no monitoring experience, we chose to put them to work on the nearest suitable site, which was Watauga Creek.

Figure 1:


2003 IBI Ratings in the Upper Little Tennessee Watershed
Fontana Reservoir
Bryson City
Sylva
Tuckasegee River
Franklin
NC
Highlands
GA
2003 sample points
Yes
Stream Quality Rating 2003
Excellent
Good
Fair
Poor
Very Poor
Previous sample points
IBI Calculated
Incomplete Sample
Species List Available
Little T Streams
Towns
Little T Watershed
Counties
N
Map prepared by
Emile Elias
Executive Director
Little Tennessee Watershed Association
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IBI SCORING CRITERIA

IBI scoring criteria here applied to 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, supplemented by Figure 2.

For certain types of stream sites, including those draining less than 4 sq. mi. (4 of which are included in the 2002 samples), an exclusively fish-based IBI is not appropriate. Such streams are thought to be characterized by naturally low fish diversity, such that another assemblage of organisms (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, 1999a, Table 7), both based on combined fish and benthic macroinvertebrate samples.

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). No sites in that size range were sampled in 2003.

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 Micropterus		deleted	
4.	Number of sucker species		deleted	
5.	Number of intolerant species[1]	<2	2	>2
6.	Proportion of individuals as tolerant species[2]	>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[3]	<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 Micropterus		deleted	
4.	Number of sucker species		deleted	
5.	Number of intolerant species[1]	<2	2	>2
6.	Proportion of individuals as tolerant species[2]	>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[3]	<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 Micropterus		deleted	
4.	Number of sucker species		deleted	
5.	Number of intolerant species[1]	<2	2	>2
6.	Proportion of individuals as tolerant species[2]	>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[3]	<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 Watershed, Proposed Revision, for Streams Draining 40-70 square miles.

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[1]	<2	2	>2
6.	Proportion of individuals as tolerant species[2]	>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[3]	<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 Watershed, Proposed Revision, for Streams Draining 150 - 600 square miles.

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[1]	<2	2 - 3	>3
6.	Proportion of individuals as tolerant species[2]	>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[3]	<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 Micropterus)	<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 Tennessee River Drainage Basin. ***From Williams 1996.***

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[1]
5. Proportion of individuals with disease, tumors, fin damage and other anomalies	> 5%	5 – 2%	<2%[2]
6. Proportion of individual fish as tolerant species[3]	>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.

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[1]
5. Proportion of individuals with disease, tumors, fin damage and other anomalies	> 5%	5 – 2%	<2%[2]
6. Proportion of individual fish as tolerant species[3]	>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 General Descriptions of their Attributes.

Class	Attributes	IBI Range
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

Following the format established in McLarney (1995), in Tables 9-39 data are presented for each of the 25 monitoring sites for 2002 and for the previous year of monitoring, if any (plus other years as deemed necessary for interpretation of the data). For new sites, and for any where a significant change in the physical environment was perceived to have occurred, summary data on the physical environment are presented as well. See also the following section on habitat assessment.

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 thay appeared in any of the samples included in the tables. For a complete list of fish species taken in the upper Little Tennessee River watershed, with scientific names, see McLarney (2001).

One cautionary comment on interpretation of the IBI results is necessary. Of a total of 22 previously monitored sites visited in 2003, 12 received a lower IBI score compared to the year of previous sampling, 4 scored better, while 6 received the same score in both years. In terms of Bioclass Rating, 7 sites declined, none showed improvement and 15 stayed within the same Bioclass. This data might be interpreted to suggest a general decline in water and habitat quality in the upper Little Tennessee watershed, and there are reasons to suspect a weak trend in this direction, particularly for those portions of the watershed upstream of Lake Emory. However, the data are far from conclusive in this regard, and much of the perceived decline may be due to natural conditions occurring before and during the 2003 sampling season. Two effects may be operating:

1. Frequent high and turbid water conditions throughout the watershed may have occasioned much involuntary displacement of fish, particularly the smaller species, younger individuals and weaker swimmers or pool dwellers. This year biologists across the Tennessee Valley, including those working in the upper Little Tennessee watershed, noticed a scarcity of young-of-the-year fish of most species. While this would not directly impact IBI scores (though it could reduce the food supply for predatory species), it does tend to corroborate the hypothesis of involuntary displacement of individuals. More to the point, we observed a general decline in the abundance of cyprinids of the shiner group this year as compared to previous years.

Accurate sampling of fish assemblages following involuntary displacement would reflect a temporary condition, which would be expected to ameliorate in the next year of low to moderate flows. The theoretical basis of the concept of biotic integrity would then lead us to predict that recuperation would be more rapid in those streams with higher initial IBI scores, reflecting greater resiliency. Streams which had lower IBI scores prior to 2003 would be slower to recover and more susceptible to new stresses.

2. High flows, increased depth and turbidity all create physical difficulties for fish sampling. One relatively benign result of this is lower total numbers of fish in the sample, a phenomenon observed at 18 of 22 previously sampled sites. However, difficult conditions can also exacerbate the always present factor of differential catchability, possibly leading to misrepresentation of the proportions of different species and certainly conducing to failure to capture some of the rarer species. As a general rule any error resulting from reduced efficiency of sampling will lead to understating biotic integrity. Sampling error should be particularly suspected whenever score is influenced by the sudden disappearance of species from the sample. (An example would be the redhorses, *Moxostoma*. On the one hand number of sucker species is an IBI metric in streams draining more than 40 sq. mi. On the other, redhorses are often relatively rare components of the fish assemblage, commonly found in deep water, and generally difficult to capture.) The importance of error factors may be increased in the case of crews involving inexperienced volunteers, a frequent occurrence on this project.

Both real decline in biotic integrity (temporary or permanent) and sampling error may be involved in the modest negative trend observed between 2002 and 2003. Whatever conclusion one may be predisposed to, the prudent tack is to await another year's data before drawing conclusions about any sites where there is not clear and unequivocal evidence of degradation of the fish (or macroinvertebrate) assemblage. Cases where we believe there to be such evidence are discussed in the text for each monitoring site.

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

2003 marks the first year since monitoring began in 1990 that we have not updated IBI data for the Needmore site. The timing is unfortunate for 2 reasons:

- In December, 2003 the 1,400 acre Needmore Tract, encompassing 13 miles of the Little Tennessee, including the Needmore fixed station site will become public land, under the management of the North Carolina Wildlife Resources Commission. Information from the LTWA biomonitoring project played a major role in justifying this acquisition, and it would be desirable to cite the most current biotic integrity status of the river at Needmore in the celebrations to occur.
- As noted in McLarney (XXXX) there was a suggestion of deterioration of biotic condition at this site in 2002, such that followup would be appropriate.

An SVAP habitat assessment for this site was carried out on September 13 (on which date the river was low and clear. Score was 7.8 (GOOD). No changes were perceived at this site as compared to its condition at the time of the last biomonitoring visit in 2002. However, some improvement may be expected once the NCWRC takes over management. It is highly probable that the agency will require attention to a leased cattle pasture along the left bank of the sampling site which features eroding banks and cattle in the river.

Fixed Station 2: Little Tennessee River @ Head of Lake Emory (RM 118.0)

Last year's report mentions the importance of continuing to monitor this station, which is important not only on account of its position in the watershed, but also due to changes ongoing and anticipated at the site. Between 2002 and 2003 these changes were mainly for the worst, albeit temporary. During this time the Franklin Greenway was extended, in unfinished form along the length of the monitoring site, with a foot bridge near the lower end. While the end result may be stabilization, with a paved walkway, the short term result is extensive soil disturbance and increased availability of sediment from the site. To this must be added a significant contribution from a commercial development, also in process, at the southeast corner of the US 441 overpass bridge.

These temporary disturbances are reflected in the SVAP score for the site (4.7 – POOR), which would have been a bit higher in the last year of sampling (2002).

Fixed Station 3: Little Tennessee River at Georgia/North Carolina State Line (RM 136.3)

It is particularly unfortunate that it was impossible to sample this site in 2003 due to continually high and frequently turbid water, since significant changes have occurred:

- Prompted partly by requests arising from our biomonitoring results, in 1994 the North Carolina Division of Water Quality sampled this site for the first time, resulting in a Good-Fair benthic macroinvertebrate classification and a rating of "support threatened." During the next visits (1999 and 2000) "samples from this site resulted in a Fair bioclassification. Specific conductivity values ranged from 350-427 umhos/cm suggesting impacts from point sources upstream. Biologists also reported eroding streambanks, heavily embedded substrate, few riffle areas and little mature riparian vegetation. Data indicated possible toxicity problems and low dissolved oxygen conditions, but not severe organic loading." As a consequence, the Little Tennessee from the State Line for 2.2. miles downstream to the mouth of Mulberry Creek was rated "partially supporting." (The reach immediately upstream, extending for approximately 3 mi. to the town of Dillard, is on the Georgia 303(d) list, although the reasons cited address non-point urban runoff as the impacting factor.)

- Repeated complaints may have had some effect, because when habitat assessment of this site was undertaken on September 25, 2003, aquatic macrophyte vegetation (*Podostemum*), which had been absent from the Fruit of the Loom NPDES discharge point, 2.2 mi. above the state line in Rabun Gap downstream for several miles in North Carolina, had partially recovered. Informal observations on various dates suggest that the "off and on"discoloration of the river had also abated.

- Offsetting the recovery of *Podostemum*, the single and very unstable riffle at the site, described as "recovering" in 2002, had disappeared, to be replaced only by a very small, shallow riffle segment in a side channel about 8 ft. wide.

Changes (likely offsetting) in macrophyte abundance, color and riffle habitat (but not chemical parameters) are reflected in the SVAP score of 6.5 (FAIR).

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

This site, last monitored in 2001, was chosen as a fixed station because of its convenience for an annual field trip by Macon Middle School students, sponsored by the Coweeta Hydrological Laboratory's Long Term Ecological Research (LTER) program. It has been at least temporarily suspended as a fixed station due to scheduling conflicts between the LTER program and the LTWA project director's travel schedule.

The Wolf Fork station is important as an indicator of water and habitat quality in the Little Tennessee upstream of its first major tributary. Even if it is not reinstated as a Fixed Station, it will be scheduled for monitoring no later than 2006, as part of our normal rotation for significant sites.

Fixed Station 5: Rabbit Creek at Rabbit Creek Rd. (RM 0.8) (Table 9)

IBI score for the Rabbit Creek fixed station continues to oscillate within the POOR bioclass rating. Historically this site improved from VERY POOR through POOR during 1990-1994, leveling out at a score of 36.0 during 1994-1996. From 1997-2000 it occupied the low end of the FAIR range with a consistent IBI of 38.7. In the last 3 years it has scored 33.3, 30.6 and 36.0. This history has been parallelled by a reduction in the amount of active pasture land in the watershed, and a concomitant increase in rates of residential development. The drop in score during 2001-2003 coincides with the rechannelization and removal of beaver dams and riparian vegetation along 0.3 mi. of its principal tributary, Cat Creek (which see) which joins Rabbit Creek 0.4 mi. above the fixed station site.

There does not appear to be any consistent pattern to changes observed in the fish assemblage over these 3 years. Several apparent negative trends cited in last year's report were not sustained this year.

- Increases in numbers for 2 of 3 tolerant species (creek chub, *Semotilus atromaculatus* amd white sucker, *Catostomus commersoni*) were reversed, while the number of redbreast sunfish (*Lepomis auritus*) increased only slightly. The proportion of tolerants in the sample dropped from 10.8 to 7.0%.
- The proportion of fish with disease, anomalies or parasites, which was relatively high (2.3%) in 2002, returned to the low values which have characterized Rabbit Creek since 1997.
- What appeared to be a steady increase in the population of the exotic yellowfin shiner, *Notropis lutipinnis* (absent before 2000, then 0.6, 1.0 and 8.2 % of the sample in succeeding years) dropped off in 2003, when yellowfin shiners formed 5.1% of the sample. (However, as in 2002 several hybrids of the yellowfin shiner with the warpaint shiner, *Luxilus coccogenis*, were noted.)

If Cat Creek is allowed to recover (or even actively restored) and no major new negative trends develop, Rabbit Creek may be able to recover to 1997-2000 levels. However, to quote last year's report "Recovery is retarded by the fact that Rabbit Creek empties into the forebay of Lake Emory, which reduces the possibility of reestablishment of species (notably the darters) via the Little Tennessee River mainstem."

Table 9. Fixed Station 5: Rabbit Creek @ Rabbit Creek Rd. (RM 0.8)

Species and numbers of fish taken

Species	2002	2003
Central stoneroller	28	37
Smoky dace		
Whitetail shiner	17	31
Warpaint shiner	69	88
River chub	35	42
Tennessee shiner	27	18
Yellowfin shiner	36	19
Blacknose dace	13	16
Longnose dace	1	1
Creek chub	11	1
White sucker	10	4
Northern hogsucker	32	22
Golden redhorse	4	2
Brown bullhead		
Rock bass	32	26
Redbreast sunfish	18	20
Green sunfish	4	
Warmouth		1
Bluegill	6	4
Largemouth bass		2
Mottled sculpin	45	39
TOTAL	**398**	**373**

Table 5 (continued)

Metrics and scores

Metrics	Scores			
	2002		2003	
	Observed value	Score	Observed value	Score
1. No. native spp.	15	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	10.8	4.0	7.0	6.7
7. % omnivores & herbivores	25.4	1.3	26.7	1.3
8. % specialized insectivores	28.6	4.0	37.1	4.0
10. Catch rate	33.2	6.7	29.9	6.7
11. % darters & sculpins	11.3	1.3	10.5	1.3
12. % individuals w. disease & anomalies	2.3	4.0	0.8	6.7
TOTALS		**30.6**		**36.0**
		POOR		**POOR**
SVAP Score				**6.8**
				FAIR

Fixed Station 6: Cullasaja River at Wells Grove (RM 0.9)

This site remained inaccessible for biomonitoring during the entire summer due to high water levels.

Habitat assessment on September 7 resulted in an SVAP score of 7.8 (NWCC, 1998), which seems intuitively to overrate habitat quality at this heavily sedimented site. No significant changes which could affect SVAP evaluation were observed between 2002 and 2003.

Fixed Station 7: Cartoogechaye Creek at Macon County Rec Park (RM 1.0) (Table 10)

In the Introduction, we refer to a generalized decline in IBI scores this year and its possible relation to high water levels experienced throughout the watershed in the summer of 2003, speculating that it is a temporary trend and likely not cause for alarm. However in the case of Cartoogechaye Creek at the Macon County Rec Park, and notwithstanding that this was one of the sites where we experienced the most difficulty in sampling related to water level and turbidity, the results of the 2003 sample are definitely alarming. They bear a strong resemblance to the IBI results from 1998, which led to discovery and repair of a significant point source of pollution upstream. However, this time the change (to an IBI score of 36.3, midway between the POOR and FAIR bioclass ratings) is even more drastic, and follows 2 years of FAIR bioclass ratings (IBI score 45.1) at this site which had scored GOOD in 8 out of the 10 preceding years. At least putative negative changes, several of them suggesting trends, can be described for most of the IBI metrics, as follows:

Metric 1: While still high enough to merit the high score, 15 native species is the same as recorded in 1998, and the lowest value for this metric since 1993.

Metric 2: This is the first time we have recorded less than 3 darter species at this site, and the first time that the Tuckaseigee darter (*Etheostoma blennioides gutselli*) has been missing from the sample.

Metric 6: While this metric received the high score, 6.6% is by far the highest percentage of tolerant species ever recorded here. The next highest values (3.7 and 3.4%) were recorded in 2001 and 2002 respectively.

Metric 7: Similarly 32.7% is the highest proportion of omnivores and herbivores ever recorded here. Absolute values for this metric have been below 20% every year since 1998.

Metric 8: The proportion of specialized insectivores in the sample (32.7%) was the lowest since 1996.

Metric 10: The catch per unit effort of 4.0 was the lowest ever recorded here. In the "pollution year" of 1998, catch rate was 4.1, under conditions of low, clear water. Otherwise catch rate has never dropped below 10 here. Total number of fish in the sample was only 196 (compared to 160 in 1998).

Metric 11: The proportion of darters and sculpins in the sample reached an all time low of 29.1% in 2003.

Metric 12 is probably the most alarming. For unknown reasons, the incidence of black spot, particularly on river chubs (*Nocomis micropogon*) has always been relatively high on this and other sites on Cartoogechaye Creek, driving up the value for this metric. However, the proportion of fish with this and other pathological conditions has been over 10% every year since 2000, peaking at 19.9% in 2003. As previously, blackspot was the prevalent condition, afflicting 64.4% of river chubs and 36.8% of Tennessee shiners (*Notropis leuciodus*). Infestation of individual fish was usually heavy and the "spots" observed were not only the usual small, round barely raised cysts; many were enlarged, swollen and irregularly shaped.

This site might very well be rated POOR for 2003, based on the IBI score. We have assigned a FAIR bioclass based on doubts about Metrics 2 and 4. While, as mentioned above, this was the first year that we have not taken the Tuckaseigee darter at this site, capture of a single individual of this species (or the exceedingly rare olive darter, *Percina squamata*, taken here in 1993, 2000 and 2002) would have raised the score for Metric 2 from 3.3 to the 5.5 scored in all preceding years. A similar situation exists for the suckers. Capture of a single redhorse (*Moxostoma* spp.) or white sucker (*Catostomus commersoni*, taken here in 1997, 2000 and 2002) would have raised the score for Metric 4 to 5.5. Failure to observe or capture redhorses, which typically occur in small numbers, inhabit the deepest pools and are especially difficult to capture, is quite likely. Since capture of a single individual of any of 5 species would have raised the score to 38.5, barely below the threshold of 39 for the automatic FAIR bioclass rating, and since this site has scored FAIR for the past 2 years (and never POOR), the conservative course was to label it FAIR.

A FAIR bioclass rating does little to diminish our concern. We have reported the phenomenon to the NC Division of Water Quality in the hope of finding a simple explanation for

the drastic drop in biotic integrity, as we did in 1998. We also carried out another sample on Cartoogechaye Creek upstream (Mt. Hope Baptist Church, RM 7.5, which see), which indicated that the alarming condition was limited to the lower reaches of the creek.

Below the Mt. Hope Baptist Church site, beginning about 1 mi. above the Rec Park site, Cartoogechaye Creek is subjected to a wide variety of urban and industrial stresses. It will be important to carry out a high quality sample at the Rec Park in 2004 and, if the situation persists, to plan a series of samples, along with a thorough investigation of potential pollution sources in the reach upstream as far as the Macon County Industrial Park (RM 5.6).

Table 10. Cartoogechaye Creek @ Macon County Rec Park (RM 1.0)

Species and numbers of fish taken

Species	2002	2003
Mountain brook lamprey	2	5
Rainbow trout		
Brown trout		
Brook trout		
Central stoneroller	37	14
Smoky dace		
Whitetail shiner	33	10
Common carp		
Warpaint shiner	32	14
River chub	45	45
Tennessee shiner	101	19
Yellowfin shiner	16	6
Mirror shiner	10	3
Fatlips minnow	7	
Blacknose dace		
Creek chub		
White sucker	1	
Northern hogsucker	16	3
Black redhorse		
Golden redhorse		
Brown bullhead		
Snail bullhead	9	
Rock bass	18	5
Redbreast sunfish		12
Green sunfish		1
Warmouth	1	
Bluegill	5	1
Smallmouth bass	2	
Largemouth bass		1

Black crappie		
Tuckaseigee darter	4	
Greenfin darter	55	8
Yellow perch	1	
Gilt darter	38	5
Olive darter	1	
Mottled sculpin	123	44
TOTALS	**567**	**196**

Table 10 (continued)

Metrics and scores

Metrics	**2002**		**Scores**	**2003**	
	Observed value	**Score**		**Observed value**	**Score**
1. No. native spp.	18	5.5		15	5.5
2. No. darter spp.	4	5.5		2	3.3
4. No. sucker spp.	2	5.5		1	3.3
5. No. intolerant spp.	2	3.3		2	3.3
6. % tolerants	3.4	5.5		6.6	5.5
7. % omnivores & herbivores	15.1	3.3		32.7	1.1
8. % specialized insectivores	49.6	3.3		30.1	3.3
9. No. piscivore spp.	3	5.5		2	5.5
10. Catch rate	11.5	3.3		4	1.1
11. % darters & sculpins	39.0	3.3		29.5	3.3
12. % w. disease or anomaly	10.8	1.1		19.9	1.1
TOTALS			**45.1**		**36.3**
			FAIR		**FAIR**
SVAP SCORE					**7.7**
					GOOD

Fixed Station 8: Middle Creek at West Middle Creek Rd. (RM 2.2) (Table 11)

Since 1992, stability has been the hallmark of this site. However, in 2003 there were significant changes, reflected in a bioclass rating of FAIR at a site which has rated consistently GOOD. Two metrics contributed to this drop in rating:

- Catch rate dropped from 35.3 to 16.9 fish per 300 sq. ft , the lowest value at this site

since 1990. However, this information must be interpreted in the light of the relative scarcity of fish (all species) at most sites during 2003. This may be due to the unusually high water which has prevailed throughout the upper Little Tennessee watershed this year. The across-the-board nature of this effect is underlined by the fact that of 18 species recorded in the 2002 sample, absolute numbers were lower in 2003 for 16. The only species showing modest increases were river chub (*Nocomis micropogon*) and rainbow trout (*Oncorhynchus mykiss*), both species capable of resisiting high flows.

- Perhaps more significantly, the recorded value for Metric 7 (omnivores and herbivores) increased from 8.2% to 34.6%. The highest previous value for this site was 12.6% in 1999; even in 1990, before the effects of erosion control work in the upper watershed kicked in, the value for this metric was 5.8%. This change is largely accounted for by the increase in total numbers of the river chub (23 to 28, going from the fifth most abundant species to the third), which accounted for 3.1% of the sample in 2002 and 7.8% in 2003.

These effects were partially offset by an improvement in the score for Metric 5. (no. intolerant species), based on the appearance of a single adult rock bass (*Ambloplites rupestris*). The rock bass has appeared in Middle Creek on only 2 previous occasions (1999 and 2002), both times as single individuals. The 2002 specimen was a juvenile, and thus not included in the count of intolerant species. If the individual taken in 2003 were to be discounted as a stray, the IBI score would fall to 38.7, mandating the FAIR bioclass rating.

The apparent decline in biotic integrity at this site is further supported a drop in total species count. The total number of native species recorded in 2003 (11) barely qualifies for the high score for Metric 1, and is the lowest recorded since 1990. The following species disappeared from the sample between 2002 and 2003:

- Fatlips minnow (*Phenacobius crassilabrum*) – present as 1-10 individuals during 8 of the past 12 years, including the last 5.
- Blacknose dace (*Rhinichthys atratulus*) – present every year since 1992 (and very susceptible to displacement by high flows)..
- Green sunfish (*Lepomis cyanellus*) – present during 8 of the last 12 years, but never as more than 2 individuals
- Redbreast sunfish (*Lepomis auritus*, non-native) – present during 9 of the past 14 years.

In addition, the longnose dace (*Rhinichthys cataractae*), absent for the first time in 2002, failed to appear again in 2003. Curiously, this species appears to have declined as the overall quality of Middle Creek has improved. In 1990, when this site received a POOR bioclass rating, the longnose dace was the second most abundant species (after the mottled sculpin, *Cottus bairdi*) which always accounts for over half the total catch), accounting for 12.7% of the sample. During 1992-1998 it formed 1.6-4.8% of the sample, but during 1998-2001 it fell to less than 0.5% of the catch each year. The site continues to present what appears to be ideal habitat for this species, and a high incidence of parasitism (leeches) on this species diminished to the point that no leeches were found after 1997.

Undetected changes in the benthic habitat may be occurring. In addition to the unexplained phenomenon of declining longnose dace numbers, darter numbers and diversity declined in 2003. Darters have never been abundant at this site, but one of the positive changes noted since 1990 has been an increase in darter numbers and diversity. Two additional species (Tuckaseigee darter, *Etheostoma blennioides gutselli* and greenfin darter (*Etheostoma chlorobranchium*) appeared in 1995, and numbers of the gilt darter (*Percina evides*) increased (mean of 5.0 during 1990-1993 and 9.6 during 1994-2002). The count of 3 gilt darters was the lowest recorded here since 1990, and 2 or 3 total darter species had been recorded every year but one (2000) since 1995.

Two changes in the habitat were noted between 2003 and 2004. There appeared to be some new deposition of sediment in run habitat, and there was a definite buildup of gravel along the left bank, which reduced the total width of the stream at some points. The shallow, lightly sedimented area along this bank had been the principal capture site for three of the species which disappeared in 2003 (blacknose dace, green sunfish and redbreast sunfish), plus 2 others which appeared in reduced numbers (smoky dace, *Clinostomus* sp., and creek chub, *Semotilus atromaculatus.*.

The 2004 Middle Creek sample will doubthess not solve the mystery of the longnose dace, but should indicate whether the decline recorded is permanent, or simply an artificact of high water levels in 2003. The 2003 IBI score (44.1) is at the very top of the range for assigning the FAIR bioclass rating, and it could be argued that given the apparent watershed-wide effects of high flows, plus the increased difficulty of sampling, the conservative course would be to rate this site GOOD, as it has for the past 11 years. However in addition to the IBI score, the decline in absolute values for metrics 2, 8 (% specialized insectivores) and 11 (% darters and sculpins), along with the ambiguity of the score for Metric 2, clearly justify the lower rating.

Table 11. Middle Cr. @ West Middle Creek Rd., RM 2.2

Species and numbers of fish taken

Species	2002	2003
Rainbow trout	3	4
Brown trout		2
Central stoneroller	32	18
Smoky dace	25	16
Warpaint shiner	18	8
River chub	23	28
Tennesee shiner	58	29
Yellowfin shiner	18	9
Mirror shiner	3	1
Telescope shiner		
Fatlips minnow	5	

Blacknose dace	2	
Longnose dace		
Creek chub	4	2
White sucker		
Northern hogsucker	7	6
Rock bass	1	1
Redbreast sunfish	1	
Green sunfish	1	
Tuckaseigee darter	1	
Greenfin darter		
Gilt darter	7	3
Mottled sculpin	536	231
TOTAL	**745**	**358**

Table 11 (continued)

Metrics and scores

Metrics	**Scores**			
	2002		**2003**	
	Observed value	**Score**	**Observed value**	**Score**
1. No. native spp.	15	6.7	11	6.7
2. No. darter spp.	2	4.0	1	4.0
5. No. intolerant spp.	2	4.0	3	6.7
6. % individuals as tolerants	0.8	6.7	0.6	6.7
7. % omnivores and herbivores	8.2	6.7	34.6	1.3
8. % specialized insectivores	15.7	1.3	11.5	1.3
10. Catch rate	35.3	6.7	16.9	4.0
11. % darters and sculpins	73.0	6.7	65.4	6.7
12. % w. disease or anomaly	0.0	6.7	0.0	6.7
TOTALS		**49.5**		**44.1**
		GOOD		**FAIR**
SVAP Score				**7.9**
				GOOD

Fixed Station 9. Cullasaja River @ Peaceful Cove, RM 8.3 (Table 12).

A relatively high water level reduced efficiency at this site and throws some doubt on the IBI score. Catch per unit effort (Metric 10) could have suffered, although at 9.1, it was within the range of recent years (8.6 and 12.5 in 2001 and 2002, respectively). Greater doubt is cast by Metric 4 (no. of sucker species). Three species of suckers have been recorded at this site, with the commonest being the northern hogsucker (*Hypentelium nigricans*). This species, absent from the sample here in 1995 and 1996, was represented by a single small individual in 2003. However, neither of two redhorse (*Moxostoma*) species taken here over the years was captured, nor were any redhorses seen. A single specimen of either species would have justified the high score for Metric 4. It must be noted that not only are adult redhorses among the more difficult fish to capture by our methods (compensated somewhat by their frequent visibility), but that we have had particular difficulty at this site, where redhorses have now appeared in only 6 of 12 years of sampling. Thus there is a distinct possibility that redhorses were present but not detected.

Until 2002 this site consistently rated GOOD (IBI scores of 47.3-53.9), but in both of the last 2 years it has received an IBI score of 45.1 for a bioclass rating of FAIR. Decline is also suggested by negative trends in values for 4 metrics, starting around 2000 (Table 13). It can fairly be stated that over time there has been:

- an increase in the proportional abundance of omnivores and herbivores (Metric 7), with a dramatic increase in abundance of the herbivorous central stoneroller (16-43 individuals in the sample during 1991-1999 and 83-132 since then).
- A reduction in overall fish abundance, as reflected by Metric 10.
- A dramatic decrease in the proportional abundance of darters and sculpins, with the years 2000-2003 accounting for 4 of the 5 lowest values recorded. (The relative abundance of the more sensitive darters to sculpins continues the trend identified last year, with a lower proportion of darters during 2000-2003 than in previous years.)
- A gradual increase in the incidence of disease and parasitism (principally black spot). Metric 12 has received the low score in 3 of the past 4 years (but not 2003), but only during 2 of the previous 8 years.

The causes of this decline are likely several. Increase in the abundance of omnivores and herbivores, and increased incidence of disease and parasites may be due to organic loading. On the other hand a decrease in abundance of fish in general and riffle dwelling species (darters and sculpins) in particular is more suggestive of sedimentation.

There will be a tendency in some circles to associate any decline in the condition of the Cullasaja River with the Town of Highlands' new WWTP, which went on line in December, 1995, and it may be a contributing factor. However, it should be noted that there is no identifiable negative trend in the monitoring data between 1991-1995 and 1996-1999, except possibly that 3 of the 4 highest total catch rates (Metric 10) for this site were recorded during 1991-1995. If the negative trend is real, it is likely associated with the spectrum of activities associated with urban growth and development in Highlands in recent years, with increased demand on the WWTP as one contributing factor.

Table 12. Fixed Station 8. Cullasaja River @ Peaceful Cove (RM 8.3)

Species and numbers of fish taken

Species	2002	2003
Mountain brook lamprey	10	1
Rainbow trout		
Brown trout		1
Brook trout		
Central stoneroller	132	96
Whitetail shiner	10	7
Warpaint shiner	44	35
River chub	41	61
Golden shiner		
Tennessee shiner	75	64
Mirror shiner	8	8
Fatlips minnow	1	
Longnose dace		1
Creek chub		
Northern hogsucker	8	1
Black redhorse		
Golden redhorse	1	
Rock bass	14	8
Redbreast sunfish	1	1
Green sunfish	1	
Warmouth		
Bluegill	4	
Smallmouth bass	1	2
Tuckaseigee darter	13	6
Greenfin darter	38	39
Wounded darter	6	5
Banded darter		
Yellow perch	1	
Gilt darter	6	5
Olive darter	1	
Mottled sculpin	157	162
TOTALS	**571**	**503**

Table 12 (continued)

Metrics and scores

Metrics	Scores			
	2002		2003	
	Observed value	Score	Observed value	Score
1. No. native spp.	20	5.5	16	5.5
2. No. darter spp.	5	5.5	4	5.5
4. No. sucker spp.	2	5.5	1	3.3
5. No. intolerant spp.	3	5.5	3	5.5
6. % individuals as tolerants	0.4	5.5	0.2	5.5
7. % omnivores and herbivores	32.0	1.1	31.4	1.1
8. % specialized insectivores	35.4	3.3	33.8	3.3
9. No. piscivore spp.	3	5.5	3	5.5
10. Catch rate	12.5	3.3	9.1	3.3
11. % darters and sculpins	38.7	3.3	43.1	3.3
12. % w. disease or anomaly	7.9	1.1	4.4	3.3
TOTAL		**45.1**		**45.1**
		FAIR		**FAIR**
SVAP score				**7.8**
				GOOD

Fixed Station 10: Wayah Creek @ Crawford Rd. , RM 0.6 (Table 14)

There was virtually no difference between the 2002 and 2003 fish samples at this site. With the exception of the black redhorse (*Moxostoma duquesni*) taken for the first time in 2002, all species taken last year were found again this year, although 5 were represented by single individuals. Catch rate was the lowest ever here, but a reduction in overall abundance of fish was noted at several sites, probably due to higher water levels. (High water caused us to miss 2 large fish, which could have been trout or suckers, possibly the black redhorse.)

The 2003 results suggest a slow continuation of the gradual recovery of Wayah Creek, beginning in late 2001 when the LBJ Job Corps WWTP, located 1.7 mi. upstream, went offline. However several species which one would normally expect in a stream of this type (notably the intolerant gilt darter, *Percina evides*) are still rare or absent. This site will be retained as a Fixed Station at least until we can determine whether the trend is permanent, resulting in a return to the GOOD bioclass ratings recorded as recently as 1997, and whether accelerated development in the Wayah Valley (as consequence of placing the area, including the LBJ center, on the Franklin municipal sewer line) has an offsetting effect.

Table 14. Wayah Creek @ Crawford Rd.
(RM 0.6)

Species and numbers of fish taken

Species	2002	2003
Mountain brook lamprey	10	12
Rainbow trout	1	1
Brown trout	2	5
Central stoneroller	41	33
Smoky dace	13	11
Warpaint shiner	14	1
River chub	15	10
Tennessee shiner	2	1
Mirror shiner	3	3
Blacknose dace	31	31
Longnose dace	41	16
Creek chub	1	2
Northern hogsucker	1	1
Black redhorse	1	
Golden redhorse		
Rock bass	2	2
Redbreast sunfish		
Tuckaseigee darter	3	1
Greenfin darter	8	4
Mottled sculpin	431	351
TOTALS	**601**	**485**

Table 14 (continued)

Metrics and scores

Metrics	Scores			
	2002		2003	
	Observed value	Score	Observed value	Score
1. No. native spp.	15	6.7	15	6.7
2. No. darter spp.	2	4.0	2	4.0
5. No. intolerant spp.	2	4.0	2	4.0
6. % tolerants	0.2	6.7	0.4	6.7
7. % omnivores & herbivores	16.3	4.0	18.1	4.0
8. % specialized insectivores	11.0	1.3	7.6	1.3
10. Catch rate	24.1	6.7	20.0	6.7

11. % darters and sculpins	73.5	6.7	73.6	6.7
12. % w. disease or anomaly	1.3	6.7	0.6	6.7
TOTAL		**46.8**		**46.8**
		FAIR		**FAIR**
SVAP score				**8.1**
				GOOD

Fixed Station 11. Skeenah Creek @ NC Welcome Center, RM 0.5 (Table 15).

This site, which might have been dropped as a Fixed Station, has been retained following reinstatement of the North Carolina Center for the Advancement of Teachings "Natural Rhythms of the River" course, and was once again sampled by a group composed of high school teachers from all over North Carolina enrolled in the course.

Results were very similar to those obtained in 2001 and 2002, with a POOR bioclass rating. The slight drop in IBI score (30.0 to 27.0) cannot be considered significant. Catch rate was the lowest ever recorded for this site, but this may simply reflect a watershed-wide trend related to unusually high water in 2003. The 3 species recording the greatest drops in abundance (warpaint shiner, *Luxilus coccogenis*; yellowfin shiner, *Notropis lutipinnis* and redbreast sunfish, *Lepomis auritus*) are all associated with relatively slow currents.

A few tentative positive trends may be noted:

- The proportion of tolerant species, which peaked at 26.3% in 2001, continued to drop, from 15.8% in 2002 to 12.6% in 2003.
- Both absolute and relative abundance of the exotic shiner yellowfin shiner took a surprising drop, and it dropped from the most abundant species (38.7% of the sample) to second in abundance (23.6%) behind the mottled sculpin (*Cottus bairdi*).
- Full representation of age classes of the rock bass (*Ambloplites rupestris),* present only as small juveniles in 2002, was noted. This may be a response to the increased availability in previous years of the yellowfin shiner as prey.

However, the site continues to present a stressed condition, related to a major school construction project upstream in 2000, which involved wetland drainage and rerouting of a tributary stream, as well as the normal stresses associated with extensive earthmoving. The effect was exacerbated by at least 2 smaller disturbances between the school project and the site, one of which resulted in regulatory action. (In support of this contention, see results for a new site on Skeenah Creek at RM 1.1, upstream of these disturbances.)

As of 2003, this site is experiencing a new stress. The area along the right bank of the site, which has been in forest since Skeenah Creek was first monitored in 1990, is being developed. Although at least a single row of trees have been left along the creek, most of the adjacent hillsite has been cleared. An access road runs parallel to the creek – and perilously close at one point, so that loss of riparian buffering capacity and, possibly, shade may be expected. (It was posited last

year that the virtual disappearance of the herbivorous central stoneroller, *Campostoma anomala* at this site was due to increasing shade on the opposite bank as trees planted during development of the Welcome Center property mature.) In addition, after the monitoring date, development began on a site immediately downstream, across US Highway 441, with clearing, drainage and reduction of the riparian buffer to an extremely narrow row of shrubs. The outlook for lower Skeenah Creek is not good.

Table 15. Skeenah Creek @ NC Welcome Center, RM 0.5

Species and numbers of fish taken

Species	2002	2003
Mountain brook lamprey	8	14
Rainbow trout		
Brook trout		
Central stoneroller	1	1
Smoky dace		
Whitetail shiner		1
Warpaint shiner	26	5
River chub	33	17
Tennessee shiner	16	13
Yellowfin shiner	133	47
Fatlips minnow		
Creek chub	6	
White sucker		1
Northern hogsucker	9	7
Black redhorse		1
Golden redhorse		
Brown bullhead		
Rock bass	10	11
Redbreast sunfish	53	24
Green sunfish	2	
Warmouth		
Bluegill	2	
Tuckaseigee darter	1	
Greenfin darter		2
Gilt darter		
Mottled sculpin	86	55
TOTAL	**387**	**199**

Table 15 (continued)

Metrics	Scores

	2002		2003	
	Observed value	Score	Observed value	Score
1. No. native spp.	12	7.5	12	7.5
5. No. intolerant spp.	1	1.5	1	1.5
6. % tolerants	15.8	4.5	12.6	4.5
7. % omnivores and herbivores	12.1	4.5	20.1	1.5
8. % specialized insectivores	11.6	1.5	10.6	1.5
10. Catch rate	23.6	7.5	15.9	4.5
11. % darters and sculpins	22.5	1.5	28.6	1.5
12. % w. disease or anomaly	6.2	1.5	2.0	4.5
TOTAL		**30**		**27**
		POOR		**POOR**
SVAP score				**7.6**
				FAIR

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

These 2 stations, sampled annually since 1998 and formally designated Fixed Stations in 2001 were not sampled in 2003. McLarney (2002) presents an argument for discontinuing these sites, based on the inadequacy of the restoration effort on Sutton Branch. Following discussions with Rabun Gap-Nacoochee School faculty in 2003 it was decided to revisit these sites in the spring of 2004, to see if resumption of monitoring is merited.

Burningtown Creek @ Lower Burningtown Rd., RM 0.6 (Table 16)

The slight drop in IBI Score (49.5 to 46.8) between 2000 and 2003 may not be significant, and Burningtown Creek at RM 0.6 still receives a GOOD bioclass rating. The lower score derives from Metric 2 (disappearance of the Tuckaseigee darter, *Etheostoma blennioides gutselli*) and a record low catch rate (Metric 10). The 2003 catch rate (12.4 fish per 300 sq. ft.) falls just below the threshold to receive the high score (13) and comes during a year when total fish catch was low at many sites, so should perhaps not be taken too seriously.

However, there are other worrisome trends:

- In addition to Metric 10 (catch rate), Metrics 7 (omnivores and herbivores), 8 (specialized insectivores) and 11 (darters and sculpins), had record low observed values, by wide margins in each case.

- Only 2 specimens of the intolerant rock bass (*Ambloplites rupestris*) were taken. Most good rock bass habitat was found to be inhabited by the omnivorous river chub (*Nocomis micropogon*).
- The herbivorous central stoneroller (*Campostoma anomala*), which has never been abundant here recorded a huge leap in numbers – from 9 individuals (1.2% of the total sample) to 47 (12.6%).

While the Burningtown Creek watershed as a whole remains in relatively good condition (especially considering its large size – 26.3 sq. mi.), there are 2 new stresses at the immediate monitoring site. A large new house, situated in the flood plain, is in the final stages of construction on the right bank. Approximately 150 ft. of the riparian zone has been devegetated and herbicided, providing a significant local sediment source. A new set of steps down to the water and a pile of sand on the opposite bank indicate something similar in the early stages of development.

A small Asian clam (*Corbicula*) was collected at the site. This is our first record of this invasive exotic mollusk, well established in the Little Tennessee River mainstem below Franklin, from a tributary stream.

Table 16. Burningtown Creek @ Lower Burningtown Rd. (RM 0.4)

Species and numbers of fish taken

Species	2000	2003
Rainbow trout	3	2
Brown trout	2	1
Brook trout		(1)*
Central stoneroller	9	47
Smoky dace	7	3
Whitetail shiner		2
Warpaint shiner	140	35
River chub	115	65
Tennessee shiner	194	99
Mirror shiner	86	24
Blacknose dace		3
Longnose dace	3	3
Creek chub	2	1
Northern hogsucker	20	9
Golden redhorse		
Sicklefin redhorse	1	
Rock bass	11	2
Redbreast sunfish		
Smallmouth bass	1	
Tuckaseigee darter	3	
Greenfin darter	8	5
Gilt darter	34	6

Mottled sculpin	125	68
TOTAL	**764**	**374**

* Stocker, not included in scoring

Table 16 (continued)

Metrics and Scores

	Scores			
	2000		2003	
	Observed value	Score	Observed value	Score
1. No. native spp.	16	6.7	16	6.7
2. No. darter spp.	3	6.7	2	4.0
5. No. intolerant spp.	3	6.7	3	6.7
6. % tolerants	0.3	6.7	0.3	6.7
7. % omnivores and herbivores	16.5	6.7	30.7	4.0
8. % specialized insectivores	62.2	6.7	47.3	6.7
10. Catch rate	36.3	6.7	12.4	4.0
11. % darters and sculpins	32.5	1.3	21.1	1.3
12. % w. disease and anomaly	5.1	1.3	1.6	6.7
TOTAL		**49.5**		**46.8**
		GOOD		**GOOD**
SVAP score				**7.6**
				GOOD

Cowee Creek @ Wests Mill, RM 0.7 (Table 17)

Cowee Creek at this site presents a picture almost identical to that for 2002. This year we recorded all expected species for this site except the banded darter (*Etheostoma zonale*). This darter, largely confined to the Little Tennessee River mainstem, has been found with regularity in only 2 tributary streams, Cowee Creek and Watauga Creek (where it was recorded in 2003). The two creeks are quite different in size and a number of other characteristics, but have in common that their headwaters are within 0.5 mi. of each other on Rocky Face Knob.

A notable aspect of the Cowee Creek fish assemblage is the high proportion of darters to sculpins. In 2003 this ratio was 0.64:1, as compared to 0.89:1 in 2002 and 1.16:1 in 1997. While these figures describe a decline in relative abundance of darters, the proportion of darters is still very high as compared to almost every other site in the watershed.

It should also be noted that observed values for Metric 8 (% specialized insectivores) and Metric 10 (catch rate) were the lowest recorded in 3 years of sampling here (1997, 2002, 2003) and in both cases reflect a consistent decline. However, both of these metrics may have been affected by the high water which characterized much of 2003. Low catch rates were recorded at most sites and one of the groups most affected was the shiners (4 species at this site, not counting the exotic yellowfin shiner, *Notropis lutipinnis*, which is not counted as a specialized insectivore), which account for the great majority of the decline of specialized insectivores at this site.

Table 17. Cowee Creek @ Wests Mill (RM 0.8)

Species and numbers of fish taken

Species	2002	2003
Mountain brook lamprey	9	6
Rainbow trout	1	
Brown trout	1	2
Central stoneroller	39	46
Whitetail shiner	10	2
Warpaint shiner	44	12
River chub	80	53
Tennessee shiner	45	26
Yellowfin shiner	1	
Silver shiner		
Telescope shiner	15	4
Fatlips minnow	5	3
White sucker	9	1
Northern hogsucker	29	18
River redhorse	1	
Black redhorse		1
Golden redhorse		4
Rock bass	19	16
Redbreast sunfish	16	11
Green sunfish	18	7
Bluegill		1
Smallmouth bass	2	
Largemouth bass	(1)*	
Tuckaseigee darter	7	4
Greenfin darter	23	24
Banded darter		
Gilt darter	42	40
Walleye		
Mottled sculpin	81	107
TOTAL	**487**	**384**

* Young-of-the-year, not included in scoring.

Table 17 (continued)

Metrics and scoring

Metrics	Scores			
	2002		2003	
	Observed value	Score	Observed value	Score
1. No. native spp.	17	6.7	19	6.7
2. No. darter spp.	3	6.7	3	6.7
5. No. intolerant spp.	3	6.7	3	6.7
6. % tolerants	7	6.7	4.9	6.7
7. % omnivores and herbivores	26.3	4	26.3	4
8. % specialized insectivores	37.2	4	29.9	4
10. Catch rate	14	4	8.9	4
11. % darters and sculpins	31.4	4	45.6	4
12. % w. disease or anomaly	0.4	6.7	0.3	6.7
TOTAL		**49.5**		**49.5**
		GOOD		**GOOD**
SVAP score				**7.8**
				GOOD

Watauga Creek @ Berry Mill, RM 0.5 (Table 18)

Watauga Creek continues to be the most puzzling stream in the upper Little Tennessee watershed, by virtue of its extreme variability, which defies analysis. In 2003, as compared to 2001, there appeared to be increased sediment deposition at the site, so that a significant drop in IBI (score 52.2, bioclass rating GOOD to 44.1, FAIR) is at least believable. But when we look at the history of Watauga Creek over the years, no pattern emerges. Rather it is a history of abrupt changes:

- When first monitored in 1990, Watauga Creek presented the appearance of a stream on the brink of collapse, with a high IBI score and bioclass rating (49.5, GOOD) dependent on several species barely hanging on, represented by 1 or 2 individuals in the sample.

- When the site was revisited in 1993, the results confirmed the hypothesis of impending "crash"; 3 of 4 darter species had disappeared altogether, with the fourth (the gilt darter, *Percina evides*) represented by only 2 individuals. The generalist blacknose dace (*Rhinichthys atratulus*) more than tripled its numbers, and the IBI score and bioclass rating dropped to 38.7, FAIR.

- In 1997 and 1998, for unknown reasons, the site rebounded to an IBI score of 49.5 and a bioclass rating of GOOD. The 1997 sample included 7 new native and 3 new exotic species, but none of the missing darter species reappeared. The intolerant rock bass (*Ambloplites rupestris*) completely replaced the tolerant creek chub (*Semotilus atromaculatus*) as the dominant large fish in the pools.

- In 2001, Watauga Creek "peaked" with an IBI score of 52.2, based on a resurgence of all the darter species and the addition, in large numbers, of a new intolerant, the telescope shiner (*Notropis telescopus*). However, total and native species count dropped from 17 and 15, respectively to 16 and 13.

- In 2003, one of the darters (Tuckaseigee darter, *Etheostoma blennioides gutselli*) did not appear in the sample and numbers of the other 3 species were down. The most spectacular change was in the shiner component. In 2001 we captured 101 individuals of 4 shiner species (30.6% of the sample). In 2003 the shiner catch was limited to 2 individuals of 1 species (warpaint shiner, *Luxilus coccogenis*), a scant 0.7% of the sample. This despite the fact that in a fall study of migratory cyprinids (McCown, 2002), 4 species of shiners were found to be common to abundant in this reach of Watauga Creek.

  The picture is similar if we look at individual species:

- No rainbow trout (*Oncorhynchus mykiss*) were taken in 1990 or 1993. A single adult appeared in 1997, and in 1998 rainbow trout was the fifth most abundant species, represented primarily by young, stream-bred individuals, and accounting for 3.8% of the total sample. No rainbow trout have been recorded from the site since.

- The telescope shiner was present only in 2001 (and also in McCown's fall 2002 study). In 2001 it was the third most abundant species, accounting for 9.4% of the total sample. It has not been seen since.

- The exotic yellowfin shiner (*Notropis lutipinnis*) in the upper Little Tennessee watershed has shown a pattern of invasion and expansion. It first appeared as a single individual in 1997. In 2001 5 were taken and McCown (2002) found it to be common in the fall of 2002. None were taken in 2003.

- The blacknose dace was the second most abundant species (40 individuals, or 19.0% of the total sample) in 1993, then declined to zero by 2001 (although 6 were taken in 2003). This change was concomitant with the appearance, and ultimately abundance of the rock bass, suggesting a predator-prey relationship, such as has already been posited for these 2 species in Rabbit Creek (McLarney, XXXX). The availability of an easily captured prey species may also account for the first appearance of the smallmouth bass (*Micropterus dolomieui*) in 2003.

The changes in biotic integrity observed between 1990-1993, 1993-1997 and 2001-2003 are clearly real and significant. However, with the exception of an apparent increase in sediment deposition between 2001 and 2003 (probably reflecting development activities in

the Watauga Creek watershed upstream), we are lacking in hypotheses to explain them. Wide fluctuations in species composition are a common feature of severely degraded streams, but are not expected in streams with GOOD bioclass ratings, such as Watauga Creek received in 1990 and again in 1997-2001.

Table 18. Watauga Creek @ Berry Mill (RM 0.5)

Species and numbers of fish taken

Species	2001	2003
Rainbow trout		
Central stoneroller	29	28
Warpaint shiner	29	2
River chub	28	29
Tennessee shiner	36	
Yellowfin shiner	5	
Silver shiner		
Telescope shiner	31	
Fatlips minnow	2	3
Blacknose dace		6
Longnose dace		2
Creek chub		
Northern hogsucker	10	4
Snail bullhead	2	
Rock bass	20	23
Redbreast sunfish	15	5
Bluegill		
Smallmouth bass		2
Tuckaseigee darter	1	
Greenfin darter	12	9
Banded darter	13	2
Gilt darter	23	16
Mottled sculpin	79	153
TOTAL	**330**	**284**

Table 18 (continued)

Metrics and scores

Metric	Scores			
	2001		2003	
	Observed value	Score	Observed value	Score

1. No. native spp.	13	6.7	13	6.7
2. No. darter spp.	4	6.7	3	6.7
5. No. intolerant spp.	3	6.7	2	4.0
6. % tolerants	5.2	6.7	1.8	6.7
7. % omnivores and herbivores	17.9	4.0	20.8	1.3
8. % specialized insectivores	44.5	4.0	12.0	1.3
10. Catch rate	59.4	6.7	20.7	6.7
11. % darters and sculpins	38.8	4.0	63.4	4.0
12. % w. disease or anomaly	0.6	6.7	0.0	6.7
TOTAL		**52.2**		**44.1**
		GOOD		**FAIR**
SVAP Score				**7.5**
				FAIR

Cat Creek @ upper end of Henderson farm off Ferguson Rd., RM 0.5 (Table 19)

Cat Creek, which has always scored POOR, was revisited this year to determine whether it had been affected by removal of beaver dams and riparian vegetation with severe rechannelization of an 0.3 reach immediately upstream of the monitoring site. There was no apparent effect, as Table 19 shows. It may be that the loss of habitat and presumed slug of sediment resulting from the upstream work was offset by stronger flow downstream. (The upstream reach was almost totally impounded by beavers, so that there may have been significant negative effects downstream on temperature, flow rate and dissolved oxygen.)

The increase in numbers of bluegills (*Lepomis macrochirus*) and the one largemouth bass (*Micropterus salmoides*) taken are probably due to release of fish from the beaver ponds, which in turn derived from ponds on the Holly Springs Golf Course upstream.

It was noted that with the single exception of the mottled sculpin (*Cottus bairdi*), size distribution for all species which occurred in any number was heavily skewed toward the smaller size classes. This was true even for species such as the blacknose dace (*Rhinichthys atratulus*) and creek chub (*Semotilus atromaculatus*), which characteristically inhabit, and reach their full development in streams even smaller than Cat Creek (watershed area 4.0 sq. mi.)

2003 marked the first record (7 small individuals) of the tolerant, omnivorous white sucker (*Catostomus commersoni*) in Cat Creek.

Table 19. Cat Creek @ upper end of Henderson farm, along Ferguson Rd., RM 0.3

Species and numbers of fish taken

Species	2001	2003
Central stoneroller	29	45
Warpaint shiner	20	5
River chub	34	28
Tennessee shiner	12	19
Yellowfin shiner	2	6
Blacknose dace	89	28
Longnose dace		
Creek chub	14	9
White sucker		7
Northern hogsucker	3	9
Rock bass	2	7
Redbreast sunfish	6	9
Green sunfish		
Bluegill	1	11
Largemouth bass		1
Mottled sculpin	19	21
TOTAL	**231**	**205**

Table 19 (continued)

Metrics and scoring

Metrics	Scores			
	Observed value	Score	Observed value	Score
1. No. native spp.	10	4.5	12	7.5
5. No. intolerant spp.	1	1.5	1	1.5
6. % tolerants	8.7	7.5	12.2	4.5
7. % omnivores and herbivores	71.9	1.5	57.1	1.5
8. % specialized insectivores	13.9	1.5	11.7	1.5
10. Catch rate	40.8	7.5	34.6	7.5
11. % darters and sculpins	8.2	1.5	10.2	1.5
12. % w. disease or anomaly	0.4	7.5	0.5	7.5
TOTAL		**33.0**		**33.0**
		POOR		**POOR**
SVAP Score				**4.7**

POOR

Table 20. Fox Run/Salali Branch @ Salali Greenway Access, RM 0.1

Species and numbers of fish taken

Species	2003
Central stoneroller	1
Smoky dace	2
River chub	1
Yellowfin shiner	9
Whitetail shiner	8
Blacknose dace	72
Creek chub	70
White sucker	14
Golden redhorse	1
Redbreast sunfish	2
Green sunfish	3
Bluegill	16
TOTAL	**198**

Macroinvertebrate sample results

Oligochaeta			
	Lumbricidae		2
Odonata			
	Calopterygidae		
		Calopteryx sp.	2
	Cordulidae		
		Somatochlora sp.	1
	Gomphidae		
		Gomphus sp.	1
Coleoptera			
	Gyrinidae		
		Gyrinus sp.	2
Diptera			
	Chironomidae		
		Conchapelopia sp.	1
		Polypedilum illinoense	1

Tabanidae		
	Chrysops sp.	1
Tipulidae		
	Tipula sp.	6

TOTAL NO. OF ORGANISMS	16
TOTAL NO. OF TAXA	9
TOTAL NO. EPHEMEROPTERA TAXA	0
TOTAL NO. EPT TAXA	0

Metrics and scoring

Metrics	**Scores**	
	Observed value	**Score**
1. No. Ephemeroptera taxa	0	1.5
2. No. EPT Taxa	0	1.5
3. Brook trout presence	Absent	1.5
4. Catch rate	54.2	6.0
5. % fish w. disease or anomaly	0.1	6.0
6. % tolerant fish	45.0	1.5
7. % wild trout	0.0	1.5
TOTAL		**19.5 VERY POOR**
SVAP score		**4.5 POOR**

Fox Run (Salali Branch) @ Salali Greenway Access, RM 0.1 (Table 20)

This stream, unnamed on the Franklin topo quad, was dubbed “Fox Run” in a report to The Land Trust for the Little Tennessee (McLarney, 1999b). The name was expropriated from a street

name in a housing development which is one of the salient features of its watershed. Since "run" is not a word commonly used to denote streams in the southern Appalachians, the name Salali Branch (derived from terminology adopted to designate sites on the new Franklin Greenway) may be more appropriate. Since Fox Run has already appeared in print, we include both names here.

Fox Run/Salali Branch, which joins the Little Tennessee River/Lake Emory at almost exactly the same point on the right bank as the Cullasaja River, is of marginal size for IBI monitoring (watershed area 0.8 sq. mi.); it was included because of plans for restoration of the lower reaches, which include a significant wetland area (partially intact and partially in need of restoration).

For at least 1.1 mi. of its total 1.3 mi. length, Fox Run/Salali Branch is almost totally urbanized. The upper reaches parallel US 441 (Franklin bypass) in a residential area. The stream crosses US 64 (Highlands Rd.) at the point of the 441/64 interchange. At this point it drains a major shopping center and other urban development. Above this point there is perhaps more pavement than pervious surface in the watershed.

The stream then flows for 0.4 mi. parallel to, and at a distance of perhaps 25 ft. from Highlands Rd. The left bank (away from the road) is wooded and here the stream presents a relatively natural appearance, with a rubble substrate and good riffle-pool sequences, but the right bank is very narrowly buffered from the road. It makes a 90 degree turn to the west at the entrance to the Fox Ridge development, and skirts that development for 0.1 mi. to the junction of the new Salali Greenway access drive, where Fox Ridge Rd. crosses it.

Below that point it borders a wetland with a total area of over 2 acres, located behind the berm of the Cullasaja River, and receives drainage from that wetland by a combination of ditches and natural channels. The lowermost 0.2 mi., including the wetland reach, have clearly been channelized, and flow in a straight line to the impounded portion of the Little Tennessee. This reach, including the monitoring site, is moderately well buffered, but deeply incised. See Table 21 for some physical parameters of the monitoring site.

The property parallel to the Salali access drive, including the wetland, is located at the upstream terminus of the Greenway on the right bank, and was recently purchased by Macon County. Non-wetland portions are slated to be developed as a recreational facility, but the wetland and stream are to be restored, including reestablishment of meanders, which may pass through the wetland. Thus it is to be expected that not only the character, but the actual location of the monitoring site will change in the future.

The most notable feature of the biomonitoring sample is the almost total absence of macroinvertebrates, occasioning the low score for Metrics 1 and 2. A total of 17 individual organisms, representing 9 taxa, were taken. No EPT taxa of any kind were found. Even chironomid midge larvae were extremely rare. All of the taxa reported may be considered tolerants; the least tolerant form encountered was the dragonfly *Gomphus* sp., which has a Tolerance Value of 5.8 This condition must reflect toxic pollutants, probably mostly in pavement runoff, since there was a fair amount of physical habitat for benthic organisms in the form of rocks, gravel and small woody debris. The food chain leading to fish must be almost entirely based on allocthonous inputs.

In general the fish community corresponds to the blacknose dace (*Rhinichthys atratulus*) – creek chub (*Semotilus atromaculatus*) assemblage typical of degraded small streams in the lower half of the upper Little Tennessee watershed, but with greater diversity than one normally expects from such a small stream. These 2 species together accounted for 71.7% of a sample which included a total of 12 species.

Pool habitat comprised 35.2% of the sample reach, but accounted for 70.2% of the fish sample.

Single individuals of river chub (*Nocomis micropogon*) and golden redhorse (*Moxostoma erythrurum*) may not properly belong to this sample; they were both caught at the extreme lower end of the sample reach, as was the case for 7 of 8 whitetail shiners (*Cyprinella galactura*) and 2 of 3 redbreast sunfish (*Lepomis auritus*) taken.

The capture of 2 smoky dace (*Clinostomus* sp.) near the upper end of the sample reach casts doubt on their validity as an intolerant. As of 1990, when the upper Little Tennessee biomonitoring effort began, smoky dace in our samples were counted as rosyside dace (*Clinostomus funduloides*), an undisputed intolerant. However, the endemic smoky dace, presently being described as a new species, has turned up in a variety of heavily sedimented and organically enriched streams and now in the urban stream environment of Fox Run/Salali Branch.

Fox Run/Salali Branch has much in common with another Franklin urban stream, Crawford Branch, but differs in at least one major respect. In Crawford Branch we normally record a high incidence of disease and parasitism (3 – 20%), but no disease, parasites or anomalies were observed here.

Although restoration of the adjacent wetland may be successful, and modifications to the stream channel may reduce its sediment load, the effect on the stream itself will be largely cosmetic. So long as this stream receives such a high volume of runoff from urban pavement, it cannot be expected to harbor a healthy biotic community.

Table 20. Selected Physical Parameters of Fox Run/Salali Branch at Salali Greenway Access (RM 0.1)

Watershed area (sq. mi.)	0.8
Mean width (ft.)	6 (range 4.9-7.7)
Mean depth (ft.)	
Riffles	0.4
Runs	0.5
Pools	1.2
Overall	0.7
Maximum depth (ft.)	2.2
Substrate composition (%)	
Rubble/cobble	5
Gravel	25

Sand	45
Silt	15
Clay	10
Large woody debris	Rare
Riparian buffer zone width (ft.)	
Left bank	5
Right bank	15
Canopy cover (%)	90
Land use	
Left bank	upstream half converted woodland/wetland; lower half pasture
Right bank	wooded bank, separated from large wooded wetland by Salali access drive (paved)

Ellijay Creek @ Sugar Fork Rd., RM 0.6 (Table 22)

A cursory glance at Table 22 suggests that Ellijay Creek is similar to Watauga Creek (see above) – a stream where biotic integrity yo-yos up and down for unknown reasons. However, our interpretation is of a single – downward - trend.

While a difference in IBI score of 8 points, as occurred here between 1991 and 1998, must be described as significant, the differences in observed values for the 3 metrics (no. 5, no. of intolerant species; no. 10, catch rate and no. 12, % with disease or anomaly) are modest, and all but one of the 6 values recorded lies close to the threshold between awarding the high or medium score. Capture of a single rock bass in 1991 could have raised the IBI score to 46.8, closer to the GOOD bioclass rating than the FAIR. In other words, sampling error in 1991 could have influenced the difference between that year's score and that achieved in the next year of samplig, 1998. In both years, the GOOD bioclass rating was perceived to more closely reflect the condition of the habitat.

However, not only was the difference between the 1998 and 2003 scores numerically greater, there was much less ambiguity in the observed values for the metrics:

- The proportion of omnivores and herbivores in the sample (Metric 7) increased by a factor of 2.5. This was fueled by a tremendous increase in abundance of the herbivorous central stoneroller (*Campostoma anomala*). In 1991, this was the third most abundant species, accounting for 8.4% of the total catch; in 1998 it rated fifth, with 6.0%. But in 2003, it was the most abundant species by a wide margin, and accounted for 32.2% of the total catch. Population explosions of this species normally involve either an increase in insolation to the stream bed and/or increased nutrient loading. Since canopy cover for this reach of Ellijay Creek has not changed since 1998, nutrient loading is the probable cause.
- The observed value for Metric 11 (% darters and sculpins) also dropped dramatically, based primarily on a decrease in abundance of the mottled sculpin (*Cottus bairdi*). The

mottled sculpin was (typically for rocky streams in the upper Little Tennessee watershed) the most abundant species in 1998, accounting for 50.4% of the sample. In 2003 it dropped to second place, with 20.1% of the sample. In a stream where darters have always been scarce (6, 11, and 6 individuals, respectively, in the 3 years of sampling), this suggests serious degradation in the quality of benthic habitat, especially in riffle areas.

Observed values for the other 2 metrics contributing to the lower score (no. 10, catch rate and no. 12, % with disease or anomaly) are not as unambiguous. In the case of Metric 10, a lower catch rate could have been related to the high water which has prevailed throughout the spring and summer, in one or both of 2 ways – by displacing small fish or by rendering sampling inefficient. (Total fish catch was low at most sites in 2003.)

On the other hand the score would have dropped to 36.0, near the upper end of the POOR bioclass category but for the capture of a single smoky dace (*Clinostomus* sp.), raising the total number of intolerant species (Metric 5) to 3. This small individual was taken from a large, deep pool – not typical smoky dace habitat, located not far downstream from a tiny tributary which could contain a population of this species. It was counted as part of the sample since this species formed part of the sample here in both previous years (10 and 6 individuals).

Even assuming that the single smoky dace is a legitimate part of the sample, and allowing for error in the observed values for Metrics 10 and 12, the highest possible IBI score which could have been achieved in 2003 is 44.1, still well within the FAIR category. Clearly biotic integrity in lower Ellijay Creek has declined since 1998. Specific causes cannot be pinpointed, but during those years there has been considerable development in the Ellijay Creek watershed, and several significant reaches of the mainstem have been stripped of vegetation and banks either allowed to erode or shored up with rocks.

It should be noted that these apparent negative changes took place in a context of increasing species diversity. In 2003, record high values were recorded for both total species count (23 vs. 19 in both of the 2 previous years of sampling) and native species (20 vs. 15 and 16). Ellijay Creek may serve as an example of "native invasions", discussed in last year's report (see also Scott and Helfman, 1999), whereby degradation of small streams leads to exaggerated species diversity, comparable to natural diversity in larger rivers.

2003 marked the first occurrence of 2 species in Ellijay Creek – the mirror shiner (*Notropis spectrunculus*) and the tolerant green sunfish (*Lepomis cyanellus*). Both were represented by single large adults.

Table 22. Ellijay Creek @ Sugar Fork Rd., RM 0.6

Species and numbers of fish taken

Species	1991	1998	2002

Mountain brook lamprey	1	7	8
Rainbow trout	1	1	1
Brown trout	1	1	3
Central stoneroller	19	27	109
Smoky dace	10	6	1
Whitetail shiner	1	1	21
Warpaint shiner	23	35	38
River chub	7	27	11
Tennessee shiner	8	58	18
Yellowfin shiner	1		
Mirror shiner			1
Fatlips minnow		3	1
Blacknose dace	5	6	5
Longnose dace	7	2	7
Creek chub	3	4	1
Northern hogsucker	7	30	22
Black redhorse		2	8
Rock bass		2	5
Redbreast sunfish	2	1	1
Green sunfish			1
Bluegill			1
Smallmouth bass	1		1
Tuckaseigee darter	1		
Gilt darter	5	11	6
Mottled sculpin	124	228	68
TOTAL	**224**	**452**	**339**

Table 22 (continued)

Metrics and scores

Metrics	**Scores**					
	1991		**1998**		**2003**	
	Observed value	**Score**	**Observed value**	**Score**	**Observed value**	**Score**
1. No. native spp.	15	6.7	16	6.7	20	6.7
2. No. darter spp.	2	4.0	1	4.0	1	4.0
5. No. intolerant spp.	2	4.0	3	6.7	3	6.7
6. % tolerants	2.2	6.7	1.6	6.7	0.9	6.7
7. % omnivores & herbivores	15.4	6.7	15.7	6.7	39.5	4.0
8. % specialized insectivores	24.0	4.0	25.7	4.0	27.4	4.0
10. Catch rate	11.9	4.0	20.7	6.7	9.2	1.3
11. % darters and sculpins	51.5	4.0	53.0	4.0	21.8	1.3
12. % w. disease or anomaly	2.2	4.0	1.8	6.7	2.4	4.0

TOTAL	**44.1**	**52.2**	**38.7**
	FAIR	**GOOD**	**FAIR**
SVAP score			**7.5**
			GOOD

Blaine Branch @ Sam Greenwood Property, RM 0.0-0.1 (Table 23)

The lowermost 900 ft. of Blaine Branch are still slated for restoration by the North Carolina DOT, but no work was done between May, 2002 and July, 2003. Nevertheless it was decided to revisit the site, since natural processes have been at work. It has now been over 2 years since cattle were excluded from the site and what was an abandoned pasture at the time of the 2002 sample is now a hay field. Riparian vegetation is continuing to develop, although canopy cover is still extremely limited, and almost all raw bank areas are healed.

Our impression was of shallower water, less hard substrate and especially less area and depth in the pools. Accordingly another series of measurements of environmental parameters was carried out (Table 24). However, surprisingly little difference was noted, though there was some reduction in both width and depth. This difference is probably understated, due to the relatively high water levels maintained throughout 2003, which would make the stream deeper and perhaps wider. Changes in substrate composition were certainly minimal.

Some improvement is apparent in the fish assemblage, as indicated by Metrics 6 (% tolerants) and 8 (% omnivores and herbivores). Only the change in Metric 6 (10.9 to 7.6% tolerants) affected the IBI score, but the change in observed value for Metric 8, while remaining in the low score range, was spectacular, from 76.1 to 37.5% omnivores and herbivores, a drop of nearly 50%. These changes reflect reduction in numbers of 2 of the 3 dominant fish species. While the generalist blacknose dace (*Rhinichthys atratulus*) remains the most numerous fish in the sample, the proportion of this species in the sample dropped from 65.5% to 31.2%. The tolerant, omnivorous creek chub (*Semotilus atromaculatus*) experienced a similar decline in abundance, from 9.6% to 2.7% of the sample.

However, it must be noted that the other most abundant species, the smoky dace (*Clinostomus* sp.), considered an intolerant (although there is some doubt about this designation) also declined, from 9.2% of the sample to 4.0%.

Another negative trend was the increase in proportion of fish with disease, parasites or anomalies from 1.0% to 3.1%. This was due to proliferation of blackspot. Two individuals (a warpaint shiner, *Luxilus coccogenis* and a river chub, *Nocomis micropogon*) exhibited the large, raised irregularly shaped cysts observed on many fish in 2003 at the Rec Park fixed station on Cartoogechaye Creek (to which Blaine Branch is tributary.)

The other notable change in the fish sample was the sudden presence in numbers of the whitetail shiner (*Cyprinella galactura*), absent from Blaine Branch last year. All 61 individuals taken were captured in the lower 2/3 of the sample reach, and their presence may be associated with seasonal migratory behavior. (Whitetail shiners were recently discovered to make fall runs up Little

Tennessee River tributaries) (McLarney, 2000a) Whatever the explanation may be, in July, 2003 the whitetail shiner was the second most abundant fish species in Blaine Branch.

The changes observed in the fish sample are, however, offset by the macroinvertebrate sample, which produced major drops in numbers of Ephemeroptera and EPT taxa, causing a drop in the IBI score from 36.0 to 31.5 (still within the POOR bioclass). Total taxa count and the total number of organisms in the sample, dropped as well. Perhaps offsetting this is the appearance of the intolerant stonefly *Leuctra* sp., absent in 2002, but which was the single most abundant macroinvertebrate taxon in the 2003 sample.

Clearly changes are occurring in lower Blaine Branch. At least some of the changes in physical habitat (increased vegetation of the banks and dramatic reduction of raw bank area) are clearly positive, but overall no trend can be defined. It may be that the reduced diversity and abundance of the macroinvertebrate sample is due to scouring by frequent high water in 2003. Assuming that restoration of Blaine Branch on the Greenwood property proceeds as planned, there may initially be further negative results as a consequence of disturbance attendant on restoration activities, but the long term trend in biotic integrity should be positive.

Table 23. Blaine Branch @ Sam Greenwood Property, RM 0.0-0.1

Species and numbers of fish taken

	2002	2003
Mountain brook lamprey	2	2
Smoky dace	27	9
Whitetail shiner		61
Warpaint shiner	14	25
River chub	1	4
Yellowfin shiner	2	4
Blacknose dace	192	70
Creek chub	28	6
White sucker *		2
Rock bass		2
Redbreast sunfish	4	9
Mottled sculpin	23	30
TOTAL	**293**	**224**

* Did not appear in IBI sample, but observed just downstream of the sample reach.

				02		
Gastropoda						
	Mesogastropoda					
		Pleuroceridae				
			Elimia sp.	11		12
	Basommatophora					
		Physidae				
			Physella sp.	2		1
Oligochaeta						
	Haplotaxida					
		Lumbricidae		2		
Crustacea						
	Decapoda					
		Cambaridae				
			Cambarus bartoni	present	present	
			C. georgiae	present	present	
Insecta						
	Ephemeroptera					
		Baetidae				
			Baetis sp.	34		2
			B. tricaudatus	2		
			Pseudocloeon sp.			4
		Baetiscidae				
			Baetisca carolina	1		
		Ephemerellidae				
			Ephemerella sp.	38		
			Eurolyophella sp.	2		2
			Timpanoga sp.	1		
		Ephemeridae				
			Ephemera sp.	4		
		Heptageniidae				
			Stenonema modestum	22		9
		Isoynchiidae				
			Isonychia sp.	3		
		Leptophlebiidae				
			Paraleptophlebia sp.	4		
	Odonata					
		Aeshnidae				
			Boyeria vinosa	3		3
		Calopterygidae				
			Calopteryx maculata	8		
			Calopteryx sp.			1

	Coenagrionidae			
		Argia sp.	1	
	Cordulegrastridae			
		Cordulegaster sp.	3	
	Gomphidae			
		Gomphus sp.	1	1
		Lanthus sp.		2
Plecoptera				
	Leuctridae			
		Leuctra sp.		14
	Nemouridae			
		Amphinemura sp.	2	
	Perlidae			1
		Acrononeuria abnormis	22	
		Perlesta placida sp. gp.	2	
		Perlesta sp.		1
	Perlodidae			
		Isoperla holochlora	23	
		Remensus bilobatus	3	
	Pteronarcidae			
		Pteronarcys (Allonarcys) sp.		2
Hemiptera				
	Veliidae			
		Rhagovelia obesa	1	
Trichoptera				
	Glossosomatidae			
		Glossosoma sp.	1	
	Hydropsychidae			
		unid.	1	
		Ceratopsyche sparna		1
		Ceratopsyche sp.	4	
		Hydropsyche betteni gp.	2	
	Limnephilidae			
		Goera sp.	2	
		Pycnopsyche sp.	22	5
	Psychomyiidae			
		Lype diversa	1	
	Uenoidae			
		Neophylax sp.	15	5
Coleoptera				
	Dytiscidae			1
	Elmidae			
		Ancryonyx variegata	2	
		Macronychys glabratus	11	
		Optioservus sp.	3	
	Gyrinidae			
		Dineutus sp.		1
		Gyrinus sp.		1

	Hydrophilidae		1	1
	Staphylinidae			1
Diptera				
	Ceratopogonidae			
		Bezzia/Palpomyia gp.	1	
	Chironomidae			
		Ablabesmyia mallochi	2	
		Cricotopus sp.	4	
		C. bicinctus	1	
		Cryptochironomus fulvus	1	
		Odontomesa fulva	1	
		Pagastia orthogonia	1	
		Paralauterborniella nigrohalteris		2
		Paremetriocnemus lundbecki	5	
		Parametriocnemus sp.		1
		Paratendipes sp.	10	
		Polypedilum flavum		6
		Polypedilum ilinoense	1	
		Thienemannimyia gp.	7	
		Tvetenia bavarica gp.	9	1
	Dixidae			
		Dixa sp.	5	
	Empedididae		1	
	Simulidae			
		Simulium sp.	6	
	Tipulidae			
		Antocha sp.	1	1
		Hexatoma sp.	1	
		Tipula sp.	7	2
			30	
TOTAL ORGANISMS			3	88
TOTAL TAXA			53	29
EPT taxa			22	11
Ephemeroptera taxa			10	4

Table 23 (continued)

Metrics and scores

Metrics	**2002**		**2003**	
	Observed value	**Score**	**Observed value**	**Score**
1. No. Ephemeroptera taxa	10	7.5	4	4.5

2. No. EPT taxa		22	7.5	11	4.5
3. Brook trout presence	Absent		1.5	Absent	1.5
4. Catch rate		40.1	7.5	53.1	4.5
5. % w. disease or anomaly		3.1	4.5	1.0	6.0
6. % tolerants		10.9	4.5	7.6	7.5
7. % wild trout		0.0	1.5	0.0	1.5
8. % omnivores and herbivores		76.1	1.5	37.5	1.5
TOTAL			**36.0**		**31.5**
			POOR		**POOR**
SVAP score					**5.6**
					POOR

Cartoogechaye Creek @ Mt. Hope Baptist Church, RM 7.5 (Table 25).

This site was monitored a year before it was due on the basis of regular rotation, in response to our concern about Cartoogechaye Creek downstream at the Rec Park Fixed Station (RM 1.0), which experienced a severe decline (IBI score 45.1 in 2002, but 36.3 in 2003). As Table 25 shows, there was virtually no change in the condition of this site between 1999 and 2003. The score for Metric 10 (catch rate) was lower than in 1998, but similar effects were noted at many sites in 2003, and are suspected to be due to the high water levels which prevailed over most of the year. This change was offset by an increase in the score for Metric 8 (% specialized insectivores), but the change in observed values was only 0.4%, with both values very near the threshold separating the low and medium scores for this metric. This suggests that the cause of the problems detected at the Rec Park is located somewhere in the 6.5 mi. separating the 2 sites.

Both sites had very high values for Metric 12 (% with disease or anomaly) – 12.8% at Mt. Hope vs. 19.9% at the Rec Park. In both cases this was primarily due to a high incidence of blackspot, principally on river chubs (*Nocomis micropogon*) and Tennessee shiners (*Notropis leuciodus*). However, the blackspot observed at Mt. Hope did not take the extreme form (enlarged, swollen, irregularly shaped cysts) observed at the Rec Park. It should be noted that a high incidence of blackspot has been observed at all sites on Cartoogechaye Creek from the Rec Park up at least as far as Cartoogechaye Baptist Church (RM 12.1) since 1998. While high values are observed at other sites, usually in association with localized nutrient sources, no other tributary watershed has displayed this pattern of consistently high levels of blackspot over several miles and several years.

One other observation from this site has to do with the disappearance of several native species. While the intolerant smoky dace (*Clinostomus* sp.) disappeared some time between 1993 and 1999, the following species (all previously captured only in small numbers), present in 1999, were missing in 2003 – mirror shiner (*Notropis spectrunculus*), fatlips minnow (*Phenacobius crassilabrum*), blacknose dace (*Rhinichthys atratulus*) and creek chub (*Semotilus atromaculatus*). The number of native species (13) was still high enough to merit the high score for Metric 1 and, in keeping with the concept of "native invasions" (discussed in last year's report, see also Scott and Helfman, 2000), this might actually be considered a sign of improvement, particularly in the case of

the blacknose dace and creek chub, which are not normally associated with the type of habitat presented by Cartoogechaye Creek at Mt. Hope Baptist Church.

A decline in numbers of the intolerant gilt darter (*Percina evides*) from 21 in the 1993 sample to 18 in 1999 and 9 in 2003 might be cause for concern, but the total abundance of darters (all species) remains high.

Table 25. Cartoogechaye Creek @ Mt. Hope Baptist Church (RM 7.5)

Species and numbers of fish taken

Species	1999	2003
Mountain brook lamprey	6	13
Rainbow trout		1
Brown trout	1	1
Central stoneroller	10	24
Smoky dace		
Whitetail shiner	3	1
Warpaint shiner	19	26
River chub	46	49
Tennessee shiner	54	49
Mirror shiner	2	
Fatlips minnow	1	
Blacknose dace	1	
Creek chub	2	
Northern hogsucker	4	2
Golden redhorse	1	2
Rock bass	8	12
Redbreast sunfish	6	2
Tuckasseigee darter	2	7
Greenfin darter	9	15
Gilt darter	18	9
Mottled sculpin	241	210
TOTAL	**434**	**423**

Table 25 (continued)

Metrics and scores

Metrics	Scores			
	1999		2003	
	Observed value	Score	Observed value	Score

1, No. native spp.	17	5.5	13	5.5
2. No. darter spp.	3	5.5	3	5.5
3. No. sucker spp.	2	5.5	2	5.5
5. No. intolerant spp.	2	3.3	2	3.3
6. % tolerants	1.8	5.5	0.5	5.5
7. % omnivores and herbivores	15.0	3.3	18.9	3.3
8. % specialized insectivores	24.9	1.1	25.3	3.3
9. No. piscivore spp.	2	5.5	2	5.5
10. Catch rate	18.0	5.5	9.3	3.3
11. % darters and sculpins	62.2	5.5	57.0	5.5
12. % w. disease or anomaly	6.0	1.1	12.8	1.1
TOTAL		**47.3**		**47.3**
	GOOD		**GOOD**	
SVAP Score				**7.8**
			GOOD	

Skeenah Creek @ Meadowcreek Mobile Estates, RM 1.1 (Table 26)

This site, monitored for the first time in 2003, presents a species count and metric scoring values remarkably similar to those normally achieved on Skeenah Creek at the North Carolina Welcome Center at RM 0.6 (Table 15), prior to initiation of construction on South Macon Elementary School, located between the 2 sites. This strongly supports the hypothesis that the lower IBI scores at the downstream site from 2001 on (27-30, as compared with 36-39 during 1997-2000) is a consequence of this (and possibly other) construction.

Skeenah Creek above this point flows through a watershed in transition from predominantly agricultural use to primarily residential. Narrow buffer zones are the rule, although there are reaches of bank with no buffer and small patches of forest. Table 27 shows habitat parameters for Skeenah Creek at RM 1.1.

As at RM 0.6, the dominant fish species at this site is the exotic yellowfin shiner (*Notropis lutipinnis*), which accounted for 24.5% of the sample. At least 10 of 103 individual fish recorded as yellowfin shiners appeared to be hybrids with the Tennessee shiner (*Notropis leuciodus*) or warpaint shiner (*Luxilus coccogenis*).

The mountain brook lamprey (*Ichthyomyzon greeleyi*) was unusually abundant at this site (35 individuals, forming 8.3% of the total sample). If this “herbivorous” (actually planktivorous) species is not included in scoring for Metric 7 (% omnivores and herbivores), then the observed value for this metric rises to 19.8%, and the IBI score rises to 39.0 (still POOR).

One or more species of darter is usually found to be present at RM 1.1 on Skeenah Creek, which has a watershed drainage area of 6.0 sq. mi. at that point. We normally do not expect to find darters as other than strays at sites draining less than 7 sq. mi. However, the RM 1.1 sample (watershed area 5.2 sq. mi.) contained 4 greenfin darters (*Etheostoma chlorobranchium),* including

what appeared to be a breeding pair. We have no hypothesis to account for a significant darter presence so far up Skeenah Creek.

Table 26. Skeenah Creek @ Meadowcreek Mobile Estates, RM 1.1

Species and numbers of fish taken

	2003
Mountain brook lamprey	35
Central stoneroller	32
Smoky dace	6
Warpaint shiner	43
River chub	49
Tennessee shiner	11
Yellowfin shiner	103
Creek chub	2
Northern hogsucker	18
Black redhorse	3
Rock bass	21
Redbreast sunfish	16
Bluegill	1
Grenfin darter	4
Mottled sculpin	76
TOTAL	**420**

Table 26 (continued)

Metrics and Scores

Metrics		**Scores**	
			2003
	Observed value	**Score**	
1. No. native spp.	12		7.5
5. No. intolerant spp.	2		4.5
6. % tolerants	4.3		7.5
7. % omnivores and herbivores	25.1		1.5
8. % specialized insectivores	15.3		1.5
10. Catch rate	23.5		7.5
11. % darters and sculpins	19.2		1.5
12. % w. disease or anomaly	2.1		4.5
TOTAL			**36.0**
		POOR	
SVAP Score			**7.6**
		FAIR	

Table 27. Selected Physical Parameters of the Habitat of Skeenah Creek at Meadowbrook Mobile Estates (RM 1.1)

Watershed drainage area (sq. mi.)		XX	
Mean width (range) (ft.)		15.4	12-29
Mean depth (ft.)			
	Riffles	0.7	0.5-0.8
	Runs	1.1	0.7-1.5
	Pools	1.7	1.3-2.0
	Overall	1.2	0.5-2.0
Maximum depth (ft.)		2.0	
Substrate composition (%)			
	Boulder	5	
	Rubble/cobble	40	
	Gravel	15	
	Sand	35	
	Silt	5	
Large woody debris		Rare	
Canopy cover (%)		60	
Riparian land use			
	Left bank		
	Right bank		

Bates Branch below US 441, RM 0.1 (Table 28)

In 1995 we found one (and probably 2, counting a fish which escaped before it could be examined) specimens of the striped shiner (*Notropis chrysocephalus*) at this site, in a pool immediately adjacent to the highway. No striped shiners were taken in the 2003 sample, suggesting that this was a bait bucket introduction which did not lead to establishment of this exotic species. However, we did find significant changes in the physical habitat of Bates Branch since 1995 (See Table 29).

In 1995, when US 441 was still in the process of being 4-laned, most of the reach of Bates Branch between US 441 and the Little Tennessee River was intermittently occupied by a series of small, shallow beaver ponds, and the substrate was predominantly composed of silt. By 2003 the beaver dams had been removed, and much of this material had flushed, leaving a predominantly sandy substrate. The extreme upper end of the site (ca. 60 ft.) has been converted to an artificial run reach, with a substrate of fine gravel and sand. The shoreline has been stabilized with large rocks, which also form a short artificial riffle at the downstream end. In contrast to the rest of the sample reach, this part is fully exposed to the sun. Both the run reach and the riffle were nearly devoid of fish.

Another change currently ongoing is the filling of the Little Tennessee River flood plain below US 441 to the mouth of Bates Branch on its right bank. Although a riparian buffer of large trees and associated vegetation has been left, this work is a source of sediment to Bates Branch.

Since the major changes at this site have been due to completion of highway construction (but also because our crew was short on the day of sampling), we decided to confine the IBI sample to the reach below the highway. In 1995 we had included a reach above the highway, which is where the striped shiner was caught. In 2003 we superficially fished this reach to enhance our species count, but this part of the sampling effort did not follow the IBI protocol.

The data in Table 28 thus differ from those presented in McLarney (1996a and b). While catch data are presented for both the full sample and the downsream reach, the 1995 IBI, as it appears in Table 28, is recalculated on the basis of the portion of the sample below the highway only. (There was no change in the total score or scoring for any individual metric.)

Three species included in the 1995 sample were found only above the highway in 2003 (Tennessee shiner, *Notropis leuciodus*; creek chub. *Semotilus atromaculatus* – both recorded from both sectors in 1995, and rock bass, *Ambloplites rupestris* also found only above the highway in 1995. In addition to the exotic striped shiner, the following native species failed to reappear in 2003 – golden shiner (*Notemigonus crysoleucas*), mirror shiner (*Notropis spectrunculus*), white sucker (*Catostomus commersoni*), and black redhorse (*Moxostoma duquesni*); none were abundant in 1995.

In contrast to the negligible contribution to the sample of the altered habitat immediately below the highway. a large pool located immediately below the artificial riffle accounted for exactly 50% of the total sample (41 fish), although it accounted for only 12.6% of the total sample area. This pool contained 11 of 14 total fish species taken.

Two major changes were observed in the composition of the fish assemblage. In 1995 the warpaint shiner (*Luxilus coccogenis*) accounted for 22.5% of the catch below the highway (and 25.0% overall). In 2003 it accounted for only 1.2%. (However, note that catches of all shiners were down at most sites in 2003, possibly related to continual high water levels.)

Perhaps more significant is the dominance of *Lepomis* sunfishes in 2003. In 1995, this genus accounted for 10.0% of the catch below the highway (and 11.0% overall). In 2003, *Lepomis* accounted for 39.0% of the sample, including the first appearance in Bates Branch of the exotic warmouth (*Lepomis gulosus*). This is surprising in view of the apparent greater suitability of the beaver pond habitat present in 1995 for sunfishes. Two of the sunfishes (redbreast sunfish, *Lepomis auritus* and green sunfish, *Lepomis cyanellus*) contribute to the higher observed value and lower score for Metric 7 (% tolerants), but the effect on the IBI is offset by the reduced incidence of disease and parasites.

The macroinvertebrate samples (detailed data from 1995 not available at this time) were very similar between the 2 years, with one significant difference. The total number of Ephemeroptera taxa increased from 3 to 7, including 2 very intolerant taxa (*Serratella* sp. and *Paraleptophlebia* sp.). It may be that some undetected upstream point source has abated in the intervening years.

The net result of the observed changes in the biotic assemblage is a slight, probably non-significant increase in the IBI score (from 30.0 to 33.0). Both scores fall within the POOR bioclass.

A surprising occurrence was the capture of a medium sized adult hellbender (*Cryptobranchus allegheniensis*) from this heavily sedimented site, totally lacking in the kind of rocky habitat normally preferred by this rare amphibian.

Table 28. Bates Branch below US 441 (RM 0.1)

Species and numbers of fish taken

Species	**1995 total**	**below highway**	**2003**
Mountain brook lamprey	16	5	12
Central stoneroller	7	2	1
Smoky dace	4	4	*
Whitetail shiner	12	3	9
Warpaint shiner	50	18	1
River chub	14	10	4
Golden shiner	2	1	
Striped shiner	1		
Tennessee shiner	10	6	**
Yellowfin shiner	18	11	3
Mirror shiner	3	2	
Creek chub	15	5	**
White sucker	3		
Northern hogsucker	5	2	4
Black redhorse	1	1	
Golden redhorse	4	4	11
Rock bass	1		**
Redbreast sunfish	5	3	14
Green sunfish	9	1	1
Warmouth			4
Bluegill	8	4	15
Largemouth bass	1	1	2
Mottled sculpin	11	4	3
TOTAL	**200**	**80**	**82**

* A single moribund individual, floating, not included in scoring

** These species not included in sample, but presence verified just upstream of the sample reach.

(reach included in 1995 sample)

Table 29. Selected Physical Parameters of the Habitat of Bates Branch below US 441, 1995 and 2003

	1995	2003
Watershed area (sq. mi.)	2.4	2.4
Mean width (ft.) (range)	16.6 (7-25)	12.9 (10-15)
Mean depth. (ft.)		
Riffles	no riffles	0.6 (1 riffle)
Runs	0.9 (0.6-1.4)	1 (0.6-1.7)
Pools	1.6 (1.3-2.0)	1.6 (1.0-2.2)
Overall	1.2 (0.6-2.0)	1.2 (0.6-2.2)
Maximum depth (ft.)	2.3	2.7
Substrate composition (%)		
Boulder	<5	5 (artificial)
Rubble/cobble	5	<5
Gravel	5	15
Sand	15	55
Silt	75	20
Clay	<5	5
Large woody debris	Rare	Rare
Canopy cover (%)	65	65
Riparian land use		
L bank	Pasture w. single tree buffer	Pasture w. single tree buffer
R bank	Hay field, abandoned field	Commercial development site, being filled

Coweeta Creek above Ed Conley Rd., RM 0.5 (Table 30)

This sample site was moved a few hundred yards upstream from the 1997 site, which was limited by excessively deep pools. In every other respect the 2 sites are similar. As is normal for Coweeta Creek, a bioclass rating of GOOD was achieved. This is always surprising considering the high percentage of residential development, with carefully manicured lawns, in the watershed. While the riparian buffer zone is less than functional over much of the length of the creek, it should also be noted that serious erosion sites are scarce.

While the IBI score for 2003 (49.5) was nominally higher than for 1997 (46.8), observed values were poorer for Metrics 6 (% tolerants), 7 (% omnivores and herbivores), 10 (catch rate) and 11 (% darters and sculpins). The change in Metric 7 is particularly striking, from 12.3 to 19.8%, barely meeting the criteria for the good score. On the other hand, the lower observed value for Metric 10 is in conformity with a general tendency toward low overall fish abundance in this high water year.

Another troubling trend is in the proportion of the 3 *Notropis* shiners. In 1997, the Tennessee shiner (*N. leuciodus*) was dominant, accounting for 73.5% of the *Notropis* catch (in ideal Tennessee shiner habitat). The remainder was made up of mirror shiners (*N. spectrunculus*, 16.3%) and the exotic yellowfin shiner, *N. lutipinnis* (10.2%). In 2003, the Tennessee shiner was still the most numerous, but was less dominant, accounting for 55.4% of the *Notropis* catch. The yellowfin shiner advanced to second place in order of abundance (40.6%), with mirror shiners barely present (4.0%). Yellowfin shiners are known to compete with other shiners, and to hybridize with the Tennessee shiner, among other species. (However, no apparent hybrids were seen from Coweeta Creek.)

Metric 5 (No. intolerant spp.) did not receive the high score because one of 3 intolerant species present (smoky dace, *Clinostomus* sp.) was represented only by a single juvenile (vs. 4 adults in 1997).

This marked the first record for the smallmouth bass (*Micropterus dolomieui*) represented by a large juvenile, from the Coweeta Creek watershed. There has been a general trend for this piscivore, more typical of the Little Tennessee River mainstem, to extend its range upstream in both the mainstem and tributaries in recent years.

Table 30. Coweeta Cr. above Ed Conley Rd. (RM 0.5)

Species and numbers of fish taken

Species	1997	2003
Mountain brook lamprey	3	6
Rainbow trout	1	2
Central stoneroller	28	45
Smoky dace	4	1
Warpaint shiner	47	57
River chub	52	53
Tennessee shiner	108	56
Yellowfin shiner	15	41
Mirror shiner	24	4
Fatlips minnow	6	4
Longnose dace	2	5
White sucker		1
Northerh hogsucker	13	4
Golden redhorse	1	
Rock bass	9	9
Redbreast sunfish	6	7
Bluegill	5	
Smallmouth bass		1
Tuckaseigee darter		1

Greenfin darter	2	16
Gilt darter	27	29
Mottled sculpin	320	188
TOTAL	**673**	**530**

Table 30 (continued)

Metrics and scoring

Metrics	**Scores**			
	1997		**2003**	
	Observed value	**Score**	**Observed value**	**Score**
1. No. native spp.	16	6.7	17	6.7
2. No. darter spp.	2	4.0	3	6.7
5. No. intolerant spp.	3	6.7	2	4.0
6. % tolerants	0.9	6.7	1.5	6.7
7. % omnivores and herbivores	12.3	6.7	19.8	6.7
8. % specialized insectivores	32.7	4.0	32.6	4.0
10. Catch rate	19.6	6.7	14.6	6.7
11. % darters and sculpins	51.9	4.0	44.2	4.0
12. % w. disease or anomaly	5.1	1.3	4.5	4.0
TOTAL		**46.8**		**49.5**
		GOOD		**GOOD**
SVAP Score				**8.1**
				GOOD

Tessentee Creek @ Windy Ridge Rd., RM 1.3 (Table 31)

Data for 3 years of monitoring are presented in Table 31 to elucidate a trend which is not uncommon in the upper Little Tennessee watershed. In 1990, when this site was first sampled, much of the watershed of Tessentee Creek was in agriculture, and the IBI score of 44.1 (Bioclass FAIR) probably reflected the effects of runoff from crop and pasture land. By 1998 agriculture was in severe decline in the area, with sigificant amounts of former row crop or pasture land converting to “old field” status, thus permitting an increase in IBI score to 52.2 (Bioclass GOOD). In recent years, the Tessentee watershed has experienced severe residential development pressure, with the usual accompanying stresses, and in 2003 the IBI score dropped to 41.4 (Bioclass FAIR).

The most notable change was the decline in omnivores (25.6 to 10.2%) between 1990 and 1998, followed by an increase to 23.2% in 2003. The principal species contributing to this was the river chub (*Nocomis micropogon*), which comprised 6.7% of the total catch in 1990, fell to 4.0% in 1998 and rose to 11.7 % in 2003.

Other trends noted include:

- The disappearance of the Tuckaseigee darter (*Etheostoma blennioides gutselli*) between 1998 and 2003.
- A continual decline in number of the intolerant smoky dace (*Clinostomus* sp.) over all the years of study.
- The total absence of trout for the first time in 2003. In 1990, a single rainbow trout, *Oncorhynchus mykiss*, was recorded. In 1998 this reach of Tessentee Creek functioned as valuable nursery habitat for this species and also the brown trout, *Salmo trutta.*
- The incidence of disease and anomalies (Metric 12) has parallelled the trend in IBI score.
- The population of the exotic yellowfin shiner (*Notropis lutipinnis*), exploded between 1998 and 2003. In 1990 and 1998 this species accounted for less than 1% of the total catch, but in 2003 it accounted for 5.1% of the sample. This pattern is common in degrading streams throughout the watershed, and is usually accompanied by hybridization with native cyprinids. In 2003 we observed yellowfin shiner hybrids with the Tennessee shiner (*Notropis leuciodus*) and the smoky dace in Tesssentee Creek.
- Total abundance of fish, as reflected in catch per unit effort (Metric 10) has declined steadily over the period 1990-2003.
- The proportion of darters and sculpins in the sample (Metric 11) peaked in 1998, when sedimentation was probably at its lowest. The value for this metric for 2003 is very similar to that for 1990, and is associated with partially sedimented streams.

The tolerant creek chub (*Semotilus atromaculatus*) was recorded for the first time from an IBI sample at this site in 2003, however this species was observed in casual sampling at this site in 1995, as was another intolerant which has not appeared in our samples here, the redbreast sunfish (*Lepomis auritus*).

It would appear that Tessentee Creek at RM 1.3 offers an unusually clear example of a trend which is occurring throughout much of the upper Little Tennessee River watershed. It remains to be seen whether conservation measures being promoted will prove adequate to stem this trend, or if further deterioration is to be expected in the more densely populated tributary watersheds.

A medium sized hellbender (*Cryptobranchus allegheniensis*) was observed, but not captured at this site. We have observed hellbenders fairly frequently at this and other sites on Tessentee Creek.

Table 31. Tessentee Creek @ Windy Ridge Rd., RM 1.3

Species and Numbers of Fish Taken

Species	1990	1998	2003
Rainbow trout	1	10	
Brown trout		4	
Central stoneroller	77	28	64
Smoky dace	28	13	9
Warpaint shiner	18	8	36
River chub	27	18	66
Tennessee shiner	33	28	16
Yellowfin shiner	2	4	29
Mirror shiner	4	5	
Telescope shiner	8		
Fatlips minnow	6		2
Creek chub			1
Northern hogsucker	12	9	8
Black redhorse		4	
Golden redhorse			10
Rock bass	10	4	19
Bluegill	1		
Tuckaseigee darter	2	1	
Greenfin darter	9	7	6
Gilt darter	7	9	23
Mottled sculpin	161	301	276
TOTAL	406	453	565

Table 31 (continued)

Metrics and Scoring

Metric	1990		1998		2003	
	Observed value	Score	Observed value	Score	Observed value	Score
1. No. native spp.	15	6.7	13	6.7	13	6.7
2. No. darter spp.	3	6.7	3	6.7	2	4.0
5. No. intolerant spp.	4	6.7	3	6.7	3	6.7
6. % tolerants	0.0	6.7	0.0	6.7	0.2	6.7
7. % omnivores & herbivores	25.6	1.3	10.2	4.0	23.2	1.3
8. % specialized insectivores	28.3	4.0	15.7	1.3	16.3	1.3
10. Catch per unit effort	33.9	6.7	26.3	6.7	18.6	6.7
11. % darters & sculpins	44.1	4.0	70.2	6.7	49.8	4.0

12. % with disease or anomaly	5.4	1.3	0.7	6.7	2.8	4.0
TOTALS		**44.1**		**52.2**		**41.4**
		FAIR		**GOOD**		**FAIR**
SVAP score						**8.1**
						GOOD

Mud Creek @ Kelly Creek Rd. , RM 0.7 (Table 32)

Mud Creek, which drains the town of Sky Valley, Georgia, has suffered a multitude of indignities over the years. Over half of the 1.3 mi. reach of the creek between Estatoah Falls (above which Sky Valley is perched) was long ago channelized, with total elimination of large riparian vegetation. A number of small tributary streams are channelized as well. Almost all of this reach on both sides of the stream (as well as some acreage on headwater tributaries) has been in intensive agricultural use until very recently, and much of it still is, with cabbage being replaced by ornamentals as the main crop. In the 1970's there was a famous episode in conjunction with the initial development of Sky Valley, when Estatoah Falls resembled a "chocolate milkshake", and sedimentation related to upstream development continues to be a problem. Since 1998, when Mud Creek was last monitored, a significant portion of the agricultural area has been converted to a large RV park. Whether or not renewed ditching of tributaries, installation of a septic system and a fair amount of impermeable surface more than offsets the environmental benefits of eliminating agricultural runoff remains to be seen. The new owners appear to be willing to allow the reestablishment of riparian vegetation along much of the creek bank.

At least 4 trends, 2 of them readily susceptible to interpretation, are perceptible from examination of the data from the 3 monitoring dates:

- The continuing drop in abundance of darters and sculpins (Metric 11), corresponds very well to increasing sedimentation at the site. With the exception of some large rocks artifically placed to channel the flow of water directly below the bridge on Kelly Creek, and along the bank to prevent erosion, the substrate at the site has deteriorated steadily. As of 2003, there are no riffles and, with the exceptions just noted, the substrate is almost entirely composed of unstable sand and pea gravel, with some silt along the shoreline.

- The trend in catch rate (Metric 10) reflects what was probably overfertility during the peak period of agricultural use, with more moderate total abundance of fish in 2003.

- Less easily explained are two changes which occurred between 1990 and 1998, both of which were sustained between 1998 and 2003. The proportion of tolerant species declined abruptly during the first period, while the proportion of specialized insectivores (Metric 8) increased greatly. The latter trend is particularly puzzling in view of the increased sedimentation of the site.

Part of our methodology is to sample as nearly as possible the exact same reach of stream in

each year of monitoring. This may provide a partial explanation for the maintenance of substantial numbers of specialized insectivores, but may also reflect a flaw in site selection. In 1990, and to a lesser but significant extent in 1998, there was a fair amount of pool habitat, and some riffle habitat at this site. By 2003, the only pool habitat was a plunge pool located below a concrete apron immediately downstream of the culvert at Kelly Creek Rd. It was included in the sample precisely because it is the only available pool habitat. This area also provided some of the aspects of riffle habitat, where the swiftest current at the site passes along a shoreline reinforced with large chunks of rock. Of the two most abundant specialized insectivore species, 55.7% of the total catch of the warpaint shiner (*Luxilus coccogenis*) and 73.1% of the Tennessee shiners (*Notropis leuciodus*) came from this area, which comprised only 19.9% of the total sample area.

If the plunge pool area is disallowed as "unnatural" habitat, scores for Metrics 1 (no. native species), 5 (no. intolerant species), 8 (% specialized insectivores) and 10 (catch rate) are lowered, and the IBI score drops from 36.0 (FAIR) to 25.0 (VERY POOR). This may be a more accurate reflection of conditions at a site which is clearly deteriorating physically (although there is some increase in growth of riparian buffering vegetation, with concomitant reduction in the extent of raw bank).

The most obvious change in the fish assemblage over time is a further indication of deterioration of water and habitat quality. The catch of the exotic yellowfin shiner (*Notropis lutipinnis*) increased from 18 individuals (10.7% of the total sample) in 1990 to 139 (20.4%) in 1998 (at which date it became the single most abundant species) and 178 (39.3%) in 2003. The yellowfin shiner is well adapted to unstable sand substrates. Under such conditions not only does it tend to displace native cyprinids, but to hybridize with them. We observed several such hybrids, with the warpaint and Tennessee shiners, in 2003.

What might appear to be a positive trend is the drop in abundance of the herbivorous central stoneroller (*Campostoma anomala*) between 1998 and 2003. This may have to do with a reduction in organic loading of Mud Creek, but it may also have to do with the virtual lack of stable substrate needed to grow benthic algae, regardless of water fertility.

The saga of Mud Creek is not over; while there may be modest improvements in store as riparian buffering vegetation reestablishes, both on agricultural lands and the RV park property, there are also plans for a controversial new megadevelopment in the Sky Valley area, which could bring yet more sediment, along with further nutrient loading in the next few years.

TABLE 32. Mud Creek @ Kelly Creek Rd. (RM 0.7)

Species and numbers of fish taken

Species	1990	1998	2003
Mountain brook lamprey	2	9	15
Rainbow trout		1	

Brown trout				1
Central stoneroller		7	76	28
Smoky dace			12	5
River chub		22	93	48
Whitetail shiner		1		
Warpaint shiner		1	41	79
Tennessee shiner		7	107	11
Yellowfin shiner		18	139	178
Mirror shiner			8	
Fatlips minnow			9	
Longnose dace	yoy*		2	
Creek chub		3	13	5
White sucker		2		
Northern hogsucker		28	33	11
Brown bullhead		1		1
Golden redhorse				
Rock bass		3		1
Redbreast sunfish		2	5	3
Green sunfish		9		
Bluegill		1	5	3
Largemouth bass		1	1	1
Gilt darter		1	7	2
Mottled sculpin		60	120	46
TOTAL		169	681	453

***** Young-of-the-year only, included in species count, but not in other aspects of scoring.

Table 32 (continued)

Metrics and Scoring

Metric	**1990**		**1998**		**2003**	
	Observed value	Score	Observed value	Score	Observed value	Score
1. No native spp.	15	6.7	16	6.7	13	6.7
2. No. darter spp.	1	4.0	1	4.0	1	4.0
5. No. intolerant spp.	2	4.0	3	6.7	2	4.0
6. % tolerants	10.1	4.0	2.6	6.7	1.9	6.7
7. % omnivores & herbivores	21.9	1.3	28.0	1.3	21.1	1.3
8. % specialized insectivores	5.9	1.3	27.3	4.0	27.4	4.0
10. Catch per unit effort	14.5	4.0	84.3	6.7	21.2	6.7
11. % darters and sculpins	36.1	4.0	18.6	1.3	10.3	1.3
12. %J w. disease or anomaly	3.8	4.0	1.0	6.7	5.8	1.3

TOTAL	**33.3**	**44.1**	**36.0**
	POOR	**FAIR**	**POOR**
SVAP score			**4.5**
			POOR

Betty Creek at Dillard, below US 441, RM 0.6 (Table 33) and the Hambidge Center, RM 4.3 (Table 34).

Over the years, Betty Creek, at various sites from RM 4.3 downstream nearly to its mouth, has consistently received a bioclass rating of GOOD, with IBI scores in the range of 47-55. Above RM 4.3 there have been some apparent problems in recent years (see following section), but based on two 2003 samples, lower Betty Creek continues to merit its rating as the most consistently good quality major tributary of the upper Little Tennessee River.

The Dillard site has been monitored on 7 occasions since 1990, while the Hambidge Center site had been monitored only once previously, in 1996. Tables 33 and 34 immediately point out one difference between the 2 sites. Whereas a total of 19 species of fish have been taken at the Hambidge Center site, 29 species have been taken at the Dillard site, including all those recorded from farther upstream. This is not surprising considering the greater size, but especially the proximity to the Little Tennessee mainstem, of the Dillard site. Note that the total number of native species in any given year is very similar for the 2 sites.

If we turn our attention to the IBI scoring, the similarities between the two sites are striking. Both score relatively low for Metric 8 (% specialized insectivores), probably indicating a minor sedimentation problem. Both sites are remarkably free of disease and parasites (Metric 12.) The percentage of darters and sculpins (Metric 11) is significantly lower at the Dillard site, consistent with a visibly higher sediment load there. However, the greenfin darter (*Etheostoma chlorobranchium*), once considered extirpated from the Georgia waters of the Little Tennessee watershed, and first recorded again from Georgia at the Dillard site in 1996, has not yet made it up to RM 4.3. It is historically known from the Hambidge Center property and should eventually reestablish there.

Other notable differences in species composition between the 2 sites are the abundance of the longnose dace (*Rhinichthys cataractae*) in the powerful riffles characteristic of RM 4.3, and the comparable abundance of the rock bass (*Ambloplites rupestris*) at RM 0.6.

An extremely surprising result of the 2003 Hambidge Center sample was the total absence of the Tennessee shiner (*Notropis leuciodus*), which was the second most abundant species (after the dominant mottled sculpin, *Cottus bairdi*), in 1996. This was coupled with the first ever record for the exotic yellowfin shiner (*Notropis* lutipinnis) from this relatively high gradient site, as well as a first record here for the native mirror shiner (*Notropis spectrunculus*), which like the yellowfin shiner, is associated with sandy substrates.

Although the Hambidge Center site received a GOOD bioclass rating in 2003, the IBI score was lower (46.8 as compared to 52.2 in 1996). In addition to the absence of the Tennessee shiner (also noted at RM 4.8, see below), one other possible negative trends was noted. The abundance of the herbivorous central stoneroller (*Campostoma anomala*) increased greatly. This species, commonly associated with increased nutrient loading and/or removal of shade from streams (the latter definitely not a problem on Betty Creek), increased from 1.0% of the total sample at RM 4.3 in 1996 to 5.9% in 2003, during which year it was the second most abundant species at this site.

The Hambidge Center site is separated from the Messer Creek Road site (see following section) by only 0.5 mi. It may be that the problems afflicting Betty Creek at Messer Creek Road for the past 3 years are beginning to move downstream.

TABLE 33. Betty Creek @ Dillard, below US 441, RM 0.6

Species and numbers of fish taken

Species	2002	2003
Mountain brook lamprey	8	13
Rainbow trout		
Brown trout	1	1
Central stoneroller	45	37
Smoky dace	3	4
Whitetail shiner	2	4
Warpaint shiner	79	89
River chub	47	24
Golden shiner	1	
Tennessee shiner	27	20
Yellowfin shiner	65	20
Mirror shiner	16	3
Fatlips minnow	9	3
Longnose dace		3
Creek chub	1	
White sucker		
Northern hogsucker	3	2
Black redhorse	1	
Golden redhorse		2
Rock bass	37	24
Redbreast sunfish	1	
Green sunfish		
Warmouth		
Bluegill		
Largemouth bass	1	

Tuckaseigee darter	3	5
Greenfin darter	5	4
Gilt darter	17	11
Mottled sculpin	301	427
TOTAL	**673**	**714**

Table 33 (continued)

Metrics and Scoring

Metric	2002 Observed value	2002 Score	2003 Observed value	2003 Score
1. No. native 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. % tolerants	0.3	6.7	0.0	6.7
7. % omnivores & herbivores	15.1	4.0	10.2	6.7
8. % specialized insectivores	24.0	4.0	20.4	4.0
10. Catch per unit effort	19.9	6.7	25.0	6.7
11. % darters & sculpins	48.6	4.0	62.6	4.0
12. % w. disease or anomaly	1.9	6.7	1.1	6.7
TOTAL		**52.2**		**54.9**
		GOOD		**GOOD**
SVAP score				**8.3**
				GOOD

Table 34. Betty Creek @ Hambidge Center, RM 4.3

Species and numbers of fish taken

Species	1996	2003
Mountain brook lamprey	36	15
Rainbow trout	16	4
Central stoneroller	9	35
Smoky dace	17	14

Warpaint shiner	27	30
River chub	11	17
Tennessee shiner	38	
Yellowfin shiner		1
Mirror shiner		4
Longnose dace	30	24
Northern hogsucker	5	7
Golden redhorse	1	2
Creek chub	1	2
Rock bass	1	4
Redbreast sunfish	4	1
Green sunfish	9	1
Tuckaseigee darter	2	1
Gilt darter	13	7
Mottled sculpin	672	425
TOTAL	**892**	**594**

Table 34 (continued)

Metrics and Scoring

Metric	**1996**		**2003**	
	Observed value	**Score**	**Observed value**	**Score**
1. No. native spp.	16	6.7	15	6.7
2. No. darter spp.	2	4.0	2	4.0
5. No. intolerant spp.	3	6.7	3	6.7
6. % tolerants	1.7	6.7	0.7	6.7
7. % omnivores & herbivores	6.4	6.7	11.6	4.0
8. % specialized insectivores	14.3	1.3	13.5	1.3
10. Catch per unit effort	25.4	6.7	15.6	4.0
11. % darters & sculpins	76.9	6.7	73.0	6.7
12. % with disease or anomaly	1.2	6.7	0.5	6.7
TOTAL		**52.2**		**46.8**
		GOOD		**GOOD**
SVAP score				**9.0**
				GOOD

Betty Creek @ Messer Creek Rd., RM 4.8 (Table 35) and above mouth of Barkers Creek, RM 5.1 (Tables 36 and 37).

When monitored in 1997, Betty Creek at Messer Creek Rd. (RM 4.8) received an IBI score of 52.2 for a bioclass rating of GOOD – consistent with historical scores along the length of Betty's Creek since 1990 (with the Messer Creek Rd.site representing the uppermost sample). However, when revisited in 2001, the site scored 44.1 (bioclass rating FAIR), and this score was repeated in 2002 and again in 2003. The most significant changes observed were:

- A large increase in the proportional abundance of omnivores and herbivores (Metric 7), based largely on a population explosion by the omnivorous river chub (*Nocomis micropogon*).

- A drastic reduction in catch per unit effort (Metric 10); the 2003 sample amounted to less than 25% of the numbers for 1996 and 1997. (However, it should be noted that total fish abundance was low at many sites in the upper Little Tennessee watershed in 2003, for reasons perhaps related to consistently high water levels.)

- Between 1997 and 2000, a precipitous decline in the proportion of darters and sculpins in the sample (Metric 11) occurred. This number has since rebounded; in 2003, while the number of individual darters and sculpins in the sample was only 33.8% of the average catch of these fishes in 1996 and 1997, the proportional abundance of this group of rocky substrate-dependent fishes was virtually the same as for those years.

- The abundance of rainbow trout (*Oncorhynchus mykiss*) declined drastically after 1997.

These changes were accompanied by a perceived increase in the prevalence of slippery periphyton on rocks at this site (but not at downstream sites on Betty Creek). In fact it was this observation, by Hambidge Center staff, which occasioned the resampling of the Messer Creek Rd. site in 2001. Curiously, though, this change was not accompanied by any increase in the abundance of the herbivorous central stoneroller (*Campostoma anomala*).

The decreased abundance of column dwelling cyprinids, chiefly the shiner group, was striking in 2003. Especially notable was the total absence of the Tennessee shiner, *Notropis leuciodus,* along with the near disapperance of the exotic yellowfin shiner (*Notropis lutipinnis*), which has often been observed to increase in abundance when numbers of other shiners decrease. .

While the IBI data leave many questions to be answered, the data from 2001, 2002 and 2003 leave no doubt that drastic changes are occurring at RM 4.8 on Betty Creek, and the 2003 data from the Hambidge Center site (RM 4.3, see above) suggest that this change may be creeping downstream. In an attempt to isolate the source of this problem, a new Betty Creek site was added. 2003 represents the first year that Betty Creek above the mouth of Barkers Creek (the uppermost major tributary) has been monitored. Table 36 shows the results of this sample, while Table 37 summarizes physical habitat parameters of Betty Creek at RM 5.1 above the mouth of Barkers Creek.

While the results reflect differences due to stream size (principally reflected in lower species divrersity) and higher gradient (dominance by the mottled sculpin, *Cottus bairdi*), comparison of the 2 sites clearly shows what is clearly a healthier situation at the upper site (located just 0.3 mi. above

Messer Creek Rd.) , with an IBI score of 51.0 (bioclass rating GOOD). Further, no unusual abundance of periphyton was observed above the mouth of Barkers Creek.

These results led first to replication of a 1996 IBI sample at RM 0.5 on Barkers Creek, and then to a visual survey of the 200 ft. of Betty Creek between the upper end of the Messer Creek Rd. site and the mouth of Barkers Creek, plus the 0.5 mi. of Barkers Creek from the mouth to the lower end of the IBI site. Results for the Barkers Creek IBI are shown in the following section. While Barkers Creek received an IBI score of 43.5 (bioclass rating FAIR) – down from 52.5 , bioclass rating GOOD in 1996 and comparable to the Messer Creek Rd. site on Betty Creek, periphyton at the Barkers Creek IBI site was very moderate, and it was not clear that the source of the problem affecting Betty Creek below Barkers Creek since at least 2001 was located at or above that site.

The visual survey of lower Barkers Creek revealed dense patches of filamentous algae on rocks (even though the reach is heavily shaded) from the mouth up to RM 0.2, at which point the right bank of the creek begins to border a large plant nursery. Just above the nursery property boundary is an artificial pond, separated from the creek by only about 50 ft. The pond was seen to be highly fertile, with large patches of floating filamentous algae. While there was no apparent drain from the pond to the creek (other than a small overflow channel, dry at the time of survey) it was clear that the occurrence of dense periphyton growth originated there. It is worthy of note that the nursery changed hands in late 2000. It is strongly suggested that this situation be investigated in the hope of rectifying what appears to be a growing problem on the upper reaches of Betty Creek, generally considered the healthiest major tributary of the upper Little Tennessee River.

TABLE 35. Betty Creek @ Messer Creek Rd. (RM 4.8)

Species and numbers of fish taken

Species	2002	2003
Mountain brook lamprey	38	13
Rainbow trout	6	8
Brown trout		
Central stoneroller	8	8
Smoky dace	8	8
Warpaint shiner	10	10
River chub	8	8
Tennessee shiner	3	
Yellowfin shiner	13	1
Mirror shiner	2	1
Fatlips minnow	6	
Longnose dace	18	3
Creek chub	6	2

White sucker	1	
Northern hogsucker	16	8
Black redhorse		2
Golden redhorse		2
Rock bass	5	1
Redbreast sunfish	3	1
Green sunfish	2	1
Largemouth bass	1	
Tuckaseigee darter	2	2
Gilt darter	8	7
Mottled sculpin	329	178
TOTAL	**649**	**264**

Table 35 (continued)

Metrics and scoring

Metric	2002		2003	
	Observed value	Score	Observed value	Score
1. No. native spp.	17	6.7	17	6.7
2. No. darter spp.	2	4	2	4
5. No. intolerant spp.	3	6.7	3	6.7
6. % tolerants	1.8	6.7	1.1	6.7
7. % omnivores & herbivores	20	1.3	11.7	4
8. % specialized insectivores	22.2	4	11.7	1.3
10. Catch per unit effort	17.4	4	6.1	1.3
11. % darters and sculpins	27.8	4	70.8	6.7
12. % w. disease or anomaly	2.6	6.7	1.5	6.7
TOTAL		**44.1**		**44.1**
		FAIR		**FAIR**
SVAP score				**8.4**
				GOOD

Barkers Creek below Barkers Creek Mill, RM 0.5 (Table 38)

Superficial examination of the IBI data from this site and the 2 Betty Creek sites bracketing the mouth of Barkers Creek (see immediately above) might lead one to conclude that the source of the problem detected in Betty Creek immediately below Barkers Creek since 2001 has its origin in upper Barkers Creek. Certainly Barkers Creek at RM 0.5 has deteriorated since it was last

monitored in 1996 (drop in IBI score from 52.5, GOOD to 40.5, FAIR). However, the apparent cause of the deterioraton of Barkers Creek at RM 0.5 is sedimentation, not nutrification leading to proliferation of periphyton and a trend toward dominance by omnivorous fishes, as observed in Betty Creek. Investigation of the lower reaches of Barkers Creek (see section immediately above) shows that this problem originates on Barkers Creek at about RM 0.2 and is unrelated to the condition of Barkers Creek at the IBI monitoring site. (Although obviously increased sedimentation in Barkers Creek has at least some negative effect on Betty Creek downstream.) Thus, the remainder of this discussion will focus on Barkers Creek at RM 0.5 and above, without further reference to Betty Creek.

The following changes in the fish assemblage between 1996 and 2003 were noted for Barkers Creek:

- Virtual elimination of lower Barkers Creek as trout nursery habitat. The majority of the 23 rainbow trout (*Oncorhynchus mykiss*) and 2 brown trout (*Salmo trutta*) taken in 1996 were parr, whereas all 3 rainbow trout taken in 2003 were young adults. The proportion of wild trout in the total sample dropped by a factor of 12, resulting in a lower score for Metric 7.

- The proportion of omnivores and herbivores in the sample increased almost tenfold. The major contributor, numerically, to this change was the river chub (*Nocomis micropogon*), but during sampling the contribution of the creek chub (*Semotilus atromaculatus*) was equally notable. In pool habitat where one would have expected adult trout in 1996, large creek chubs tended to occupy the best habitat.

- A nearly eightfold increse in the abundance of the mountain brook lamprey (*Icthyomyzon greeleyi*) is apparently due to the greater availability of silted shoreline habitat suitable for the ammocoete larvae of this species.

While what appeared to be an exaggerated overall abundance of fish (Metric 4) in 2003 suggests some degree of excess fertility, the other changes observed appeared to be related to sedimentation, which was clearly greater than that observed in 1996.

The benthic macroinvertebrate sample, on the other hand, superficially appeared to be healthier in 2003 than in 1996, although scoring for the 2 macroinvertebrate-based IBI metrics did not change. At least the total taxa count and EPT count were significantly higher in 2003. However, we suspect that the quality of sampling may have been better in 2003. The most abundant forms in 2003 (and so far as memory serves, in 1996, when sample analysis was purely qualitative) were all intolerant forms, suggesting the absence of toxic pollution problems. It is suggested that quantitative sampling of macroinvertebrates would have revealed significant differences between the 1996 and 2003 results, and it is likely that it is the relative abundance of macroinvertebrates which is affecting the fish assemblage, and thus the IBI score.

Increased sediment deposition at the site is readily visible, but the source is not known. It should be mentioned that the pattern of sediment deposition here has always been unusual. The upstream end of the monitoring site is located not far downstream of the Barkers Creek Mill dam,

which is still used for milling flour. When the mill dam is operating, it produces sudden high flows, with flushes of sediment, followed by a rapid drop in water level and velocity, leading to a pattern of settling very different from that in undammed streams. However, this factor has been more or less constant over the years, and the search for the source of increased sediment deposition should be concentrated above the small impoundment created by the Barkers Creek Mill dam. There are various rumors of erosion from development sites in the watershed upstream of this point, in both the Georgia and North Carolina portions of the watershed, but detailed searches have not been carried out.

Table 38. Barkers Creek below Barkers Creek Mill (RM 0.5)

Species and Numbers of Fish Taken

Species	1996	2003
Mountain brook lamprey	2	17
Rainbow trout	23	3
Brown trout	2	
Smoky dace	26	35
Warpaint shiner	3	5
River chub	2	15
Longnose dace	4	1
Creek chub	2	9
Northern hogsucker		1
Rock bass		1
Green sunfish	2	2
Mottled sculpin	160	234
TOTAL	**226**	**324**

Macroinvertebrate sample results		1996*	2003
Mesogastropoda			
Pleuroceridae			
	Elimia sp.		56
Nematophora			
Gordidae			1
Ephemeroptera			
Baetidae			
	Baetis sp.	X	
	Baetis tricaudatu		1

		s		
		Pseuedocloeon	X	
	Ephemerellidae			
		Dannella	X	
		Drunella	X	
		Eurylophella sp.		1
		Serratella sp.	X	11
	Heptageniidae			2
		Epeorus	X	
		Heptagenia sp.	X	3
		Stenonema		
		Stenonema modestum		4
	Isonychiidae			
		Isonychia sp.	X	2
	Leptophlebiidae			
		Leptophlebia		
		Paraleptophlebia sp.		1
Odonata				
	Calopterygidae			
		Caloptery x sp.		1
	Cordulegastridae			
		Corduleg aster sp.		1
	Gomphidae			
		Gomphus sp.		2
		Lanthus sp.	X	2
Plecoptera				
	Chloroperlidae			
		Utoperla	X	
	Leuctridae			
		Leuctra sp.	X	43
	Nemouridae			
		Amphinemura sp.		1
	Peltoperlidae			
		Peltoperla	X	
		Tallaperla sp.		58

	Perlidae			2
		Acroneuria	X	
		Acroneuria abnormis		3
		Perlesta	X	
	Perlodidae			
		Isoperla sp.	X	3
		Malirekus hastatus		19
	Pteronarcidae			
		Pteronarcys (Allonarcys) sp.	X	44
Megaloptera				
	Corydalidae			
		Nigronia serricornis		1
Trichoptera				
	Brachycentridae			
		Brachycentrus sp.	X	15
	Glossosomatidae			
		Agapetus sp.		1
		Glossosoma sp.		4
	Hydropsychidae			6
		Ceratopsyche sparna		9
		Diplectrona	X	
		Diplectrona modesta		4
		Symphitopsyche		
	Lepidostomatidae			
		Lepidostoma	X	
	Limnephilidae			
		Pycnopsyche sp.		4
	Rhyacophilidae			
		Rhyacophila sp.	X	2
		Rhyacophila fuscula		1

	Uenoidae				
		Neophylax sp.	X		2
	Polycentropidae				
		Neureclipsis	X		
Coleoptera					
	Dryopidae				
		Helichus basalis			4
	Elmidae				
		Dubiraphia	X		
		Optioservus ovalis			5
		Promoresia tardella			1
Diptera					
	Blephariceridae				
		Blepharicerus	X		
	Chironomidae		X**		
		Diamesa sp.			1
		Pareleuterborniella nigrohalteralis			1
		Parametriocnemus sp.			2
		Prodiamesa olivacea			1
		Tanytarsus sp.			1
	Simulidae				
		Simulium sp.	X		1
	Tipulidae				
		Dicranota	X		
		Hexatoma sp.			1
		Pedicia sp.			1
		Tipula sp.	X		2
TOTAL NO. ORGANISMS					**371**
TOTAL NO. TAXA				**28**	**46**
TOTAL NO. EPHEMEROPTERA TAXA				**8**	**8**
TOTAL NO. EPT TAXA				**21**	**27**

* 1996 sample identified to genus only
** Chironomidae not identified past family

Table 38 (continued)

Metrics and scoring

Metric	1996 Observed value	1996 Score	2003 Observed value	2003 Score
1. No. Ephemeroptera taxa	8	7.5	8	7.5
2. No. EPT taxa	21	7.5	27	7.5
3. Brook trout presence	Absent	1.5	Absent	1.5
4. Catch per unit effort	45.3	7.5	64.9	4.5
5. % w. disease or anomaly	0.4	6	0.3	6
6. % tolerants	1.8	7.5	3.4	7.5
7. % wild trout	11.1	7.5	0.9	4.5
8. % omnivores and herbivores	2.7	7.5	26.5	1.5
TOTAL		**52.5**		**40.5**
		GOOD		**FAIR**
SVAP score				**7.5**
				FAIR

Blacks Creek @ Yorkhouse Rd., RM 0.3 (Table 39)

Blacks Creek at RM 0.3 scored 36.0 (bioclass POOR) in 1998, as did a site at RM 1.0 in 1990. The principal cause of the poor rating is probably channelization – the entire lower reach of Blacks Creek, extending for more than a mile above the mouth, was severely channelized in the early part of this century during construction of the Tallulah Falls Railroad. Other contributing factors undoubtedly include agricultural runoff, sedimentation from other sites and possible industrial pollution.

The 2003 sample showed a mix of positive and negative trends. On the positive side, the percentage of the mottled sculpin (*Cottus bairdi*) in the sample was the highest ever, and corresponded with the visually determined presence of more clean rocky substrate than ever before. This led to the highest ever observed value and score for Metric 11 (but still not in the high score range).

More surprising was the total absence of the tolerant, omnivorous creek chub (*Semotilus atromaculatus*), often dominant in small, severely modified streams like Blacks Creek. This led to a rare occurrence – 0.0% of tolerant fishes (Metric 6).

However, these positive trends were more than offset by the poorest values ever for Metrics 7 (% omnivores and herbivores), 8 (% specialized insectivores) and 10 (catch per unit effort).

Metrics 8 and 10 were particularly affected by a precipitous drop in total number of the 2 native shiner species (warpaint shiner, *Luxilus coccogenis* and Tennessee shiner, *Notropis leuciodus*) from 96 (37.2% of total catch) to 8 (6.3%). This, and not any increase in actual sculpin abundance, accounted for the improvement in Metric 11.

It should be noted that both total fish catch and abundance of shiners were down at many sites in the upper Little Tennessee watershed during 2003. Taking this into account (and notwithstanding the disappearance of the creek chub), IBI score declined from 36.0 to 30.0. While the measured decline in biotic integrity (although remaining in the POOR bioclass) appears to be significant, it may be asked whether it is a long term trend, or whether it will rebound in the next year characterized by more normal spring and summer flow levels.

Table 39. Blacks Creek @ Yorkhouse Rd., RM 0.3

Species and numbers of fish taken

Species	1998	2003
Mountain brook lamprey	1	8
Rainbow trout		
Central stoneroller	24	16
Smoky dace		
Warpaint shiner	63	5
River chub	39	15
Tennessee shiner	33	3
Yellowfin shiner	17	12
Fatlips minnow	3	
Longnose dace		1
Creek chub	3	
White sucker		
Northern hogsucker	11	3
Rock bass	5	2
Mottled sculpin	69	60
TOTAL	**258**	**126**

Metrics and scoring

Metric	1998		2003	
	Observed value	Score	Observed value	Score

1. No. native spp.	10	4.5	9	4.5
5. No. intolerant spp.	1	1.5	1	1.5
6. % tolerants	1.2	7.5	0.0	7.5
7. % omnivores & herbivores	22.1	1.5	31.7	1.5
8. % specialized insectivores	37.2	4.5	7.1	1.5
10. Catch per unit effort	27.4	7.5	4.8	1.5
11. % darters & sculpins	28.7	1.5	47.6	4.5
12. % with disease or anomaly	0.8	7.5	1.6	7.5
TOTAL		**36.0**		**30.0**
		POOR		**POOR**
SVAP score				**5.8**
				POOR

STREAM VISUAL ASSESSMENT PROTOCOL (SVAP) METHODS AND RESULTS

At each of the 2003 biomonitoring sites we applied a slightly modified version of the USDA Stream Visual Assessment Protocol (NWCC, 1998), which scores instream habitat quality on a scale of 1-10, and assigns a class rating from Very Poor to Excellent. Table 40 shows the possible range of SVAP scores and class ratings.

TABLE 40 Possible SVAP Scores and Corresponding Habitat Class Values

SVAP Score*	Class
9.6 - 10.0	Excellent
7.7 - 8.5	Good
6.1 - 7.0	Fair
3.1 - 5.3	Poor
1.0 - 2.2	Very Poor

* In the case of scores falling between the ranges corresponding to the various classes, a class rating will be assigned at the discretion of the biologist in charge

SVAP was used exactly as in Pringle (1998) with the exception that we applied a modification of Metric 13 on riffle embeddedness. We have found that there is a great deal of confusion, even among experienced professionals, attendant on the estimation of degree of embeddedness of individual rocks in riffles. We found that by disturbing the substrate in the upper reaches of a riffle with the foot and counting the number of seconds required for the water to clear we could achieve a satisfactory quantitative approximation of the amount of sediment embedded in a riffle. We observed in practice, both in the Little Tennessee watershed and in the Talamanca region of Costa Rica and Panama, that a wide variety of observers, with educational levels ranging from primary school to Ph. D., found the modified metric more understandable and easy to apply, and came up with more consistent results using it. Table 41 is a copy of the SVAP score sheet used in the field, including the modified Metric 13.

SVAP scores and class ratings are presented for each site with the IBI data. We also present SVAP and IBI scores for all sites monitored in 2003 in Table 42 and Figure 2. The data show a generally good correlation between biological (IBI) and habitat (SVAP) assessment, in the sense that the best and worst sites as determined by IBI are the same as the best and worst sites as determined by SVAP. However, there was a tendency for SVAP to result in higher class ratings than those determined through IBI biomonitoring. Of a total of 25 sites for which both protocols were applied, in 10 instances the result as determined by SVAP was one class rating higher than

that determined with IBI. The remaining 15 sites achieved the same class rating using both methods. No site received an SVAP class rating lower than its IBI bioclass rating.

It should be noted that there was a general decline in IBI scores this year, which we tentatively ascribe to the unusually high water levels which prevailed in 2003 in the months before and during the biomonitoring season. This may have caused temporary perturbations in the fish assemblage and/or our ability to sample it, which would have affected the IBI score, but not a habitat assessment protocol such as SVAP. Another season's work is necessary to evaluate the actual correlation between IBI and SVAP in the upper Little Tennessee watershed. (See above for a more detailed discussion of presumed high water effects on our fish samples.)

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My principal field assistants this year were Jeff Alexander and Clint Barden.

A list of 97 individuals who volunteered their time in the field appears at the end of this section. "Frequent Flyers" are noted by asterisks; this year's most active volunteer was Roger Makepeace. Kathy Whitehead acted as volunteer coordinator. Volunteer groups were recruited by Donna Glee Williams and Chris Dyke (North Carolina Center for the Advancement of Teaching), Ron Huff (Upward Bound Math and Science Program, Western Carolina University), Robin Swaby, Brian Kloeppel (LTER Program, Coweeta Hydrologic Laboratory) and Ben Long (The Mountain).

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List of 2003 Volunteers

Dale Allen	Jessica Allen	Brittany Bailey**
Mick Bailey*	Betsy Baste*	Austin Bauman
Reid Bauman	Travis Best	Sheba Beverly
Natalie Brabson	Lynn Bronson	Eric Buddington*
Annie Campbell	Eva-Marie Canan	Sara Carlson
Toni Chaney	Laci Coggins	David Crisp
Joseph Cyphers	Jacqueline Dagenet	Dennis Desmond
Adrian Dewhurst	Andre Dewhurst	Don Dewhurst
Tangula Diggs	Gustavo Duran	Sharon Edwards
Emile Elias	Susan Ervin**	Judy Ford
Danielle Graham	Kay Graham	Dick Heywood
Gill Heywood	Josh Hina	Marilyn Hogue
Laurence Holden*	Jack Hornsby	Justin Hornsby*
Rita Hubbs*	Tori Huger	Ericka Hunt
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Doug Johnson	Ernest Johnson	Jack Johnston
John Judy*	Margaret Kosko	Peter Julius
Carol Lang	Coulter Loeb	Ben Long
Jason Love	Jennifer Love	Roger Makepeace***
Kenny Marcus	Brent Martin	Christie Matthews
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Mort Meadors*	Alex Melamed	Cheryl Metcalf
Alice Miller	Kathryn Mitchell	Rex Mitchell
Alan Moore	Nichole Nettleton	Jim Parham
Kristi Perino	Davis Pinner	Stan Polanski
Michelle Proctor	Gene Schley	Warren Schmidt*
Angela Stephenson	Jennifer Stevens	Craig Stickney
Elsa Stiles	Everett Stiles	Warren Stiles
Bill Stose	Phil Sturges*	Chelsea Surfus
Howard Suzuki	Andrielle Swaby	Robin Swaby*
Ragan Tayloe	Elena Traister*	Tawny Versprill
Ben Watkins	Mark Whitehead	Margaret Williams
Jennifer Wood		

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