# BASINWIDE ASSESSMENT REPORT

# LITTLE TENNESSEE RIVER BASIN

NORTH CAROLINA
DEPARTMENT OF ENVIRONMENT AND NATURAL RESOURCES
Division of Water Quality
Environmental Sciences Section

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## OVERVIEW

The Little Tennessee River basin is located within the Blue Ridge Province of the Appalachian Mountains of western North Carolina. It encompasses about 1,800 $mi^2$ in Swain, Macon, Clay, Graham, Cherokee, and Jackson counties (Figure 1). Much of the land within the basin is federally owned (49%) and in the U.S. Forest Service's Nantahala National Forest (including the Joyce Kilmer/Slick Rock Wilderness Area) or the Great Smoky Mountains National Park (GSMNP). The basin also includes the Cherokee Indian Reservation. Subbasins within the Little Tennessee River basin are described by a six digit code (040401 - 040404), but are often referred to by their last two digits (e.g. Subbasin 01).

The North Carolina section of the Little Tennessee River is typical of many other mountain rivers. The gradient is relatively steep in most reaches of the river and the substrate is dominated by riffle habitats. The headwater reaches of the Little Tennessee River are located in Georgia. Most tributaries are high gradient streams capable of supporting trout populations in the upper reaches. Most of the basin is forested. However, lower reaches of many tributary catchments are farmed or developed resulting in the increased potential for nonpoint source problems.

The Little Tennessee River is one of three major tributaries of Fontana Lake. The other two are the Nantahala River and the Tuckasegee River. The Cheoah River, the fourth major tributary of the Little Tennessee River in North Carolina, has its confluence with the river below Fontana Lake.

In the upper section of the Little Tennessee River watershed, twenty of the 27 sites monitored for benthic macroinvertebrates or fish were rated Good or Excellent; no sites were rated Poor. The two sites rated Fair were the Little Tennessee River near the NC-GA state line and the upper reaches of the Cullasaja River near the Town of Highlands. Streams that have consistently been rated Excellent were Coweeta, Turtle Pond, Burningtown, and Tellico Creeks. This area is within the Nantahala National Forest and most tributaries are high gradient streams capable of supporting trout populations in the upper reaches. The water quality of rivers and streams in this area is generally high.

Principal tributaries to the Little Tennessee River in the middle watershed area are the Oconaluftee River, the Tuckasegee River, Hazel Creek, and Deep Creek. The Tuckasegee River is the largest tributary watershed in the Little Tennessee River basin in North Carolina. Fontana Lake is the largest impoundment in this region and is operated by the Tennessee Valley Authority (TVA). Much of its immediate watershed lies within either the Great Smoky Mountains National Park or the Cherokee Indian Qualla Boundary. Most streams on the north side of Fontana Lake are in a roadless wilderness region and can be reached only by boat (across the lake) or by hiking. All of the twenty three benthos samples in this middle watershed portion had either Excellent (13) or Good (10) bioclassifications. The five rateable fish sites were either Good (3) or Good-Fair (2).

Below Fontana Lake, the Cheoah River and significant sections of most tributary catchments are within the Nantahala National Forest and are minimally impacted. Robbinsville is the only urban area in this lower watershed. Good (2) or Excellent (1) bioclassifications were recorded at three benthic macroinvertebrate monitoring locations in 2004. Tulula Creek and the Cheoah River declined from Excellent in 1999, and a fish community sample from Tulula Creek was rated Good-Fair.

More detailed overviews are presented at the beginning of each subbasin.

## LITTLE TENNESSEE RIVER SUBBASIN 01

### Description

This subbasin contains the uppermost reaches of the Little Tennessee River and its tributaries in North Carolina (Figure 1). The headwater reaches of the river, however, begin in Rabun County, GA. Except for the Nantahala River watershed in the west-southwest portion of the county and headwater streams of the Chattooga River in the southeastern part of the county, all waters of Macon County flow into the Little Tennessee River. The Little Tennessee River valley from the state line to the Swain-Macon county line is located within the Broad Basins Level IV ecoregion. Most of the remainder of the subbasin is located in the Southern Crystalline Ridges and Mountains; smaller portions are located within the Southern Metasedimentary and High Mountains ecoregions (Griffith *et al*. 2002).

The subbasin contains approximately 35 miles of the Little Tennessee River from the state line to the Macon-Swain county line below Tellico Creek. The river upstream of Lake Emory (Porters Bend Dam) has a very gradual gradient as it flows through a broad valley. Below the lake, the gradient changes to more swift flow as it flows through the Needmore Tract towards Fontana Reservoir. Major tributaries to the Little Tennessee River in this subbasin include the Cullasaja River and Cartoogechaye Creek; smaller tributaries include Middle, Coweeta, Cowee, and Burningtown Creeks.

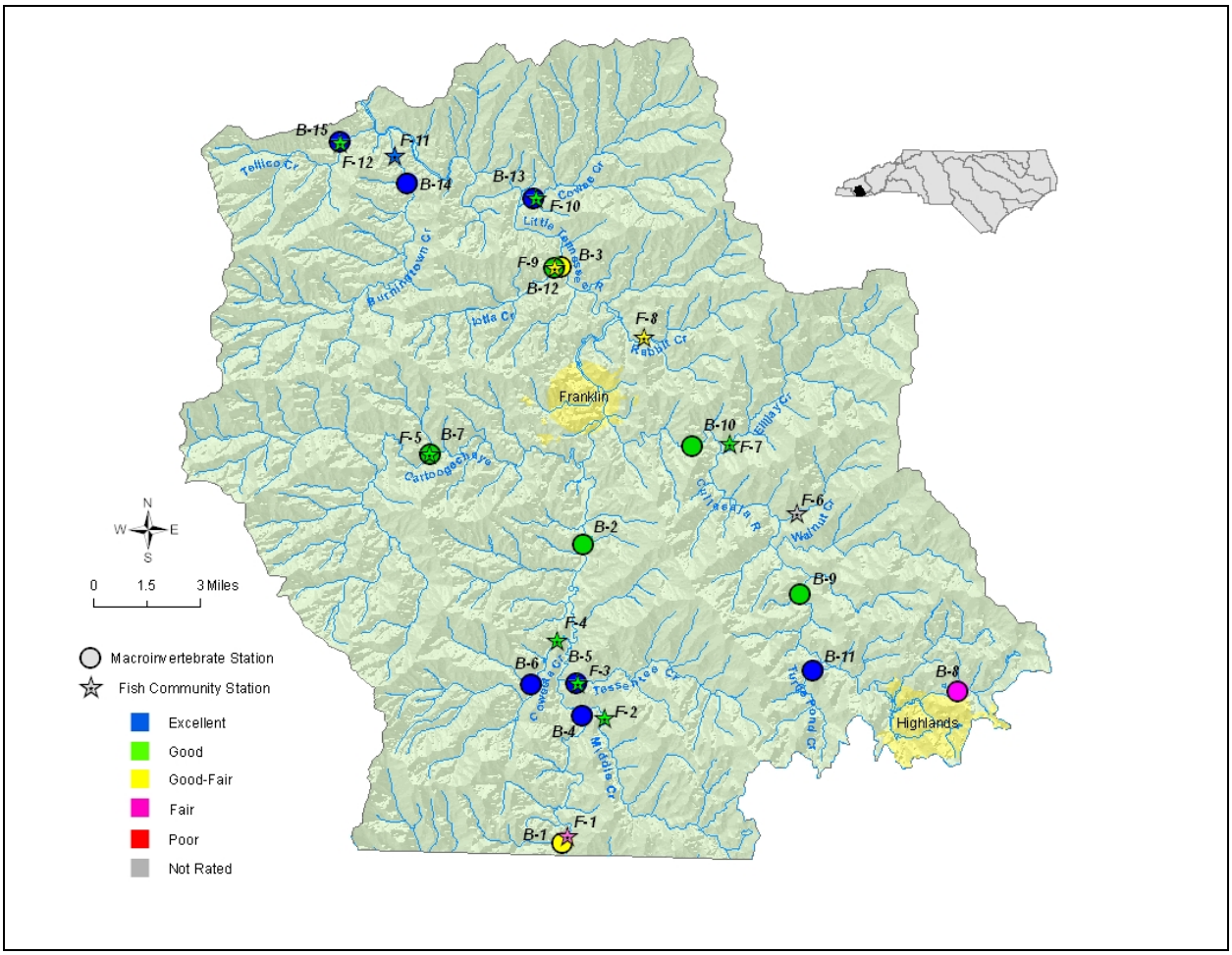



**Figure 1. Sampling sites in Subbasin 01 in the Little Tennessee River basin. Monitoring sites are listed in Table 2.**

Headwaters of many of the tributaries are protected within the US Forest Service's Nantahala National Forest. Most tributaries are high gradient streams capable of supporting trout populations in their upper reaches. In the lower reaches, many of the watersheds are farmed or developed and the tributaries are affected by erosion, scour, and sediment deposition. The Town of Franklin and a portion of the Town of Highlands are the only large population centers in this subbasin. Strip development also occurs along US 23/441 south from Franklin towards Dillard, Rabun Gap, and Mountain City, GA. Despite the development, almost 90 percent of the subbasin is forested (Table 1).

**Table 1. Land use (in North Carolina) in Subbasin 01. Based upon CGIA coverage 1993 - 1995 (total area in North Carolina = 370 square miles (NCDENR 2002).**

| Land use | Percent |
|---|---|
| Water | 0.3 |
| Cultivated crop | 0.9 |
| Pasture | 8.8 |
| Urban | 0.9 |
| Forest | 89.1 |

There are 12 NPDES permitted dischargers in this subbasin (Basinwide Information Management System query December 2004). The largest is the Town of Franklin's WWTP which discharges 1.65 MGD into the Little Tennessee River (Lake Emory). This facility is required to monitor it's effluent's toxicity.

## Overview of Water Quality

In this subbasin during 2004, 15 sites were monitored for benthic macroinvertebrates, 12 sites for fish community assessments, and 3 sites for ambient chemistry monitoring (Table 2, in part). None of the water quality variables analyzed as part of the ambient chemistry program had statistically significant exceedances over the five year monitoring period (1999 – 2004) for the Little Tennessee River at Prentiss, for the Little Tennessee River at Iotla, and for Cartoogechaye Creek near Franklin.

Twenty of the 27 sites monitored for benthic macroinvertebrates or fish were rated Good or Excellent; no sites were rated Poor. The two sites rated Fair were the Little Tennessee River near the NC-GA state line and the upper reaches of the Cullasaja River near the Town of Highlands. The Little Tennessee River has at times experienced elevated conductivity due to permitted dischargers in Georgia and the instream and riparian habitats continued to suffer from poor landuse and watershed practices. The upper Cullasaja River continued to be impaired by landuse practices in the Town of Highlands area. Streams that have consistently been rated Excellent were Coweeta, Turtle Pond, Burningtown, and Tellico Creeks.

The riparian zones at many of the sites in the subbasin were narrow, sparsely vegetated with mature trees and mowed lawns, or in pasture. Less than optimal habitats were attributable to gradient, chronic erosion, and nonpoint source sedimentation. Many of the sites would benefit from bank stabilization and stream restoration techniques.

**Table 2. Waterbodies monitored in Subbasin 01 in the Little Tennessee River basin for basinwide assessment, 1999 and 2004.**

| Map #[1] | Waterbody | County | Location | 1999 | 2004 |
|---|---|---|---|---|---|
| B-1 | L Tennessee R | Macon | off SR 1629 | Fair | Good-Fair |
| B-2 | L Tennessee R | Macon | SR 1651 | Good-Fair | Good |
| B-3 | L Tennessee R | Macon | NC 28 | Good-Fair | Good-Fair |
| B-4 | Middle Cr | Macon | SR 1635 | Good-Fair | Excellent |
| B-5 | Tessentee Cr | Macon | SR 1684 | --- | Excellent |
| B-6 | Coweeta Cr | Macon | SR 1114 | Excellent | Excellent |
| B-7 | Cartoogechaye Cr | Macon | SR 1146 | Excellent | Good |
| B-8 | Cullasaja R | Macon | US 64 | Fair | Fair |
| B-9 | Cullasaja R | Macon | SR 1678 | Excellent | Good |
| B-10 | Cullasaja R | Macon | US 64/SR 1668 | Excellent | Good |
| B-11 | Turtle Pond Cr | Macon | SR 1620 | Excellent | Excellent |
| B-12 | Iotla Cr | Macon | SR 1372 | Good | Good |
| B-13 | Cowee Cr | Macon | NC 28 | Good | Excellent |
| B-14 | Burningtown Cr | Macon | SR 1371 | Excellent | Excellent |
| B-15 | Tellico Cr | Macon | SR 1367 | Excellent | Excellent |
| | | | | | |
| F-1 | Little Tennessee R | Macon | off SR 1683 | --- | Fair |
| F-2 | Middle Cr | Macon | SR 1635 | Good-Fair[2] | Good |
| F-3 | Tessentee Cr | Macon | SR 1636 | Good | Good |
| F-4 | Coweeta Cr | Macon | SR 1119 | Good-Fair[3] | Good |
| F-5 | Cartoogechaye Cr | Macon | SR 1146 | Good[4] | Good |
| F-6 | Walnut Cr | Macon | SR 1533 | --- | Not Rated |
| F-7 | Ellijay Cr | Macon | SR 1524 | --- | Good |
| F-8 | Rabbit Cr | Macon | SR 1504 | --- | Good-Fair |
| F-9 | Iotla Cr | Macon | off SR 1378 | --- | Good-Fair |
| F-10 | Cowee Cr | Macon | SR 1340 | --- | Good |
| F-11 | Burningtown Cr | Macon | SR 1364 | --- | Excellent |
| F-12 | Tellico Cr | Macon | SR 1367 | --- | Good |

[1]B = benthic macroinvertebrate monitoring sites; F = fish community monitoring sites.
[2]at first bridge on SR 1635
[3]at US 23/441
[4]at SR 1168

## River and Stream Assessment

Ten of the 12 fish community sites were sampled for the first time in 2004; 10 of these sites are also supplementally classified as trout waters (Tr). Tessentee, Cartoogechaye, Ellijay, and Burningtown Creeks are managed as Hatchery Supported Trout Waters by the North Carolina Wildlife Resources Commission. Wild, not stocked, trout were collected from Middle, Coweeta, Walnut, Ellijay, and Tellico Creeks. There are no NPDES facilities within the watersheds of the fish community sites on Middle, Tessentee, Coweeta, Cartoogechaye, Walnut, Ellijay, Rabbit, Iotla, and Cowee Creeks (Basinwide Information Management System query December 2004; Sam Buckles, GA DNR, February 02, 2005, pers. com.). Many of the streams sampled in this subbasin as part of the fish community monitoring program were turbid, not exhibiting the expected clarity of most mountain streams.

**Little Tennessee River, off SR 1629**

This segment of the Little Tennessee River is 11 meters wide. Most of the catchment immediately upstream of this location was light commercial and is associated with the US 441 road corridor. Agriculture, scattered residences, and forest comprised the remainder of the watershed. Substrate here was a slightly embedded mix of boulder (10%), rubble (30%), gravel (20%), sand (30%) and silt (10%). The primary habitat drawbacks at this location were the broken riparian zone and the lack of pools. The habitat received a score of 64 and the conductivity was somewhat elevated at 28 µmhos/cm.

The Little Tennessee River has been sampled at this location on two previous occasions. In 1994 this reach received a Good-Fair bioclassification while in 1999 it declined to Fair. The 1994 sample resulted in 27 EPT taxa and a NCBI of 5.3 while in 1999 the EPT taxa declined dramatically to 14 and the NCBI increased to 6.2. The conductivity at the time of the 1999 sample was extremely high (427 µmhos/cm) clearly indicating a large point source discharge from Georgia. The enormous spike in conductivity during the 1999 sample was probably the reason for the lowered bioclassification that year. In 2004, this site rebounded to Good-Fair and the conductivity was drastically reduced (28 µmhos/cm). The NCBI decreased to 5.6 and the EPT taxa collected increased to 22. EPT taxa common or abundant in 1994 and 2004 not collected in 1999 included the mayflies *Baetis intercalaris*, *B. pluto*, *Epeorus rubidus*, and the caddisfly *Micrasema wataga*.

**Little Tennessee River, off SR 1683**

This site on the Little Tennessee River is approximately one mile downstream from the NC-GA state line, thus most of the stream's 55.9 square mile watershed lies outside of North Carolina. There are four NPDES permitted facilities within the river's watershed in Georgia: the Town of Dillard's WWTP, Rabun Apparel, Inc., National Textiles, and Vulcan Materials (Sam Buckles, GA DNR, February 02, 2005, pers. com.). The specific conductance (233 µmhos/cm) was the greatest of any fish community site in the basin in 2004 (Appendix F-7). This fish community site represented the largest watershed that was assessed in 2004 (55.9 square miles) (Appendix F-5).

The fish community was rated Fair (NCIBI = 38) in 2004. It had the fewest fish (n = 178) and the greatest percentage of tolerant fish (11 percent) of any site in the basin (Appendix F-5). The community was diverse, but had only one species of darter, an abundance of omnivores+herbivores (river chub, central stoneroller, white sucker, and golden shiner) and a high percentage of tolerant fish (redbreast sunfish, white sucker, flat bullhead, and golden shiner). The river chub was the numerically dominant species. This was the only site in the basin in 2004 where the tolerant golden shiner and flat bullhead were collected. More exotic species were also collected at this site than at any other site in the basin in 2004. These species were golden shiner, yellowfin shiner, snail bullhead, flat bullhead, redbreast sunfish, and yellow perch.

**Little Tennessee River, SR 1651**

This site on the Little Tennessee River was approximately 14 meters in width. This reach is actually contained within a historical man-made diversion slough that is attached to the main stem of the Little Tennessee River. This site was moved from the nearby basin site (which is approximately 400 meters further down SR 1651) due to the excessive depths (even during low flows) at the basin site. Landuse upstream of this reach was a mix of light commercial, agriculture, scattered residences, and broken tracts of forest. Immediately upstream and downstream of the sample location, a very large tomato farm dominated the landuse on both banks. Substrate was a slightly embedded mix of rubble (10%), gravel (10%), sand (50%) and silt (40%). The obvious habitat problems included the very poor riparian zone (non existent in most areas), the lack of pools, and infrequent riffles. The habitat received a low score of 53 and the conductivity was identical to the upstream location at 28 µmhos/cm.

The nearby basin site (about 400 meters away) was sampled in 1999 and received a Good-Fair bioclassification with 29 EPT taxa, an EPT BI of 3.5, and a NCBI of 4.4. In 2004, this relocated location on the Little Tennessee improved receiving a Good bioclassification with 37 EPT taxa present, an EPT BI of 3.9, and a NCBI of 5.4.

This is not an ideal sample location as it is located in a man-made slough. However, the traditional basinwide site (also on SR 1651) is too deep (even at low flow) for safe sampling. Both of the SR 1651 road crossings should be discontinued and the monitoring site moved downstream to either US 64 or near the confluence of the Little Tennessee River with an unnamed tributary (just upstream from Hays Mill Creek) off Teague Road. Alternatively, an upstream site off Hickory Knoll Road could also be assessed if none of the SR 1651 sites are retained as basin sites.

**Little Tennessee River, NC 28**

At approximately 45 meters wide, this site is considered a large river. The substrate was largely bedrock with a moderate amount of boulders and rubble. These rocks as well as a line of downed trees along the left bank provided instream habitat. The pH was 6.9 s.u. and the dissolved oxygen (DO) concentration was 7.4 mg/l. The conductivity was 37 µmhos/cm, down from 128 µmhos/cm in 1999. This drastic drop in conductivity may be due to the recent reduction in activity at several local gem mines. The habitat score was 73, due largely to the homogeneous substrate, minimal riparian vegetation, and an open canopy.

This site has rated Good-Fair since 1983 (with one Good rating in 1994) and was Good-Fair again in 2004. The EPT S was 32, same as the 1999 basinwide sampling, however the total taxa richness decreased from 86 to 70. The biotic index also remained quite stable at 5.25 (5.33 in 1999). Three stonefly taxa, *Pteronarcys*, *Leuctra*, and *Suwallia* were present in the 2004 sample compared to none in 1999. Many of the abundant and common macroinvertebrates at this site indicate a more tolerant fauna than usually seen in smaller mountain streams. However, larger streams naturally have higher BI values due to a greater number of niches and generally higher levels of disturbance. In addition, the bioclassification has remained stable over the past 20 years and several

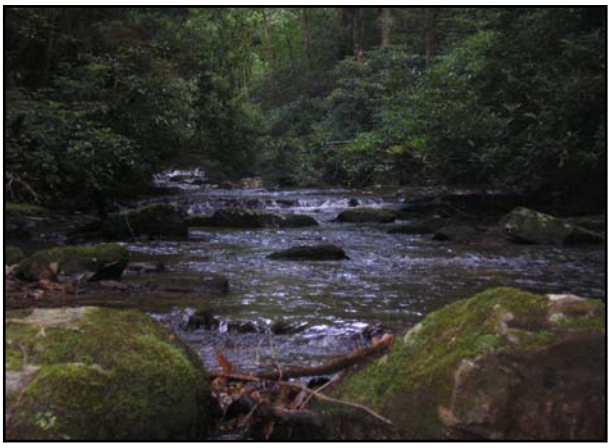
intolerant taxa were also present, indicating the difference in BI was largely natural and not anthropogenic.

**Middle Creek, SR 1635 (second bridge above mouth)**

The first sizeable tributary to the Little Tennessee River in North Carolina is Middle Creek. It's watershed drains southern and southeastern Macon County and a small portion of northern Rabun County, GA. The 2005 monitoring site was located approximately 1.1 miles upstream of the site monitored in 1995 and coincided with a Little Tennessee Watershed Association monitoring site (LTWA 2003; W. McLarney, May 17, 2004, pers. com). The difference in watershed size between the two sites was 1.2 square miles. The downstream site was approximately 300 ft. upstream of the creek's confluence with the river.

The fish community was rated Good (NCIBI = 56) in 2004. There was only one species of darter collected and the most abundant species was the mottled sculpin. In 1995, the downstream site was rated Good-Fair (NCIBI = 46) and the dominant species were the river chub and the Tennessee shiner. This fish community in this stream is diverse, 21 species are known from the two sites. Although not hatchery supported trout waters, "pet" stocked rainbow trout (460 – 530 mm total length) were collected from an artificially constructed trout pool in the creek. In 2004 young-of-year brown trout and rainbow trout were also present.

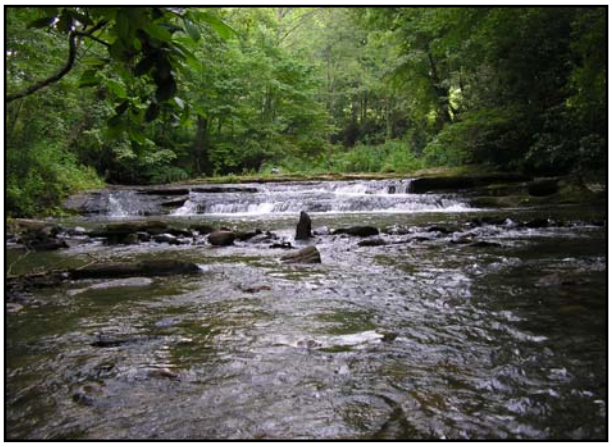
**Middle Creek, SR 1635 (first bridge above mouth)**



Middle Creek at this road crossing is five meters in width and has a drainage area of 13.5 square miles. The majority of Middle Creek's catchment is forested with only limited agriculture and residential influences. Substrate was a generally unembedded mix of boulder (20%), rubble (30%), gravel (20%) and sand (30%). The primary habitat deficiencies included a lack of well-developed pools, the broken riparian zone, and the high proportion of sand. Habitat score was low at 61 and the conductivity was 24 µmhos/cm.

This site was sampled once previously in 1999 at which time it received a Good-Fair bioclassification with 25 EPT taxa collected and an EPT BI of 4.1. In 2004, this site improved dramatically and received an Excellent bioclassification with 43 EPT taxa present and an EPT BI of 2.9. EPT taxa that were common or abundant in 2004 but absent in 1999 included the mayflies *Epeorus dispar* and *Serratella serrata*, the stoneflies *Perlesta* and *Isoperla holochlora*, and the caddisflies *Brachycentrus spinae*, *Lepidostoma*, and *Neophylax consimilis*. It is unclear what changes have occurred in this largely forested watershed to warrant such a dramatic shift in the benthic community between years.

**Tessentee Creek, SR 1684**



This segment of Tessentee Creek is approximately six meters wide and has a drainage area of 14.4 square miles. Nearly all of the catchment upstream of this site is forested with only sparse residential and agricultural inputs. Substrate was an unembedded mix of boulder (30%), rubble (30%), gravel (20%), sand (10%), and bedrock (10%). No significant habitat problems were observed. The habitat received a score of 83 and the conductivity was 18 µmhos/cm.

This is the first benthic collection on Tessentee Creek. This waterbody received an Excellent bioclassification with 47 EPT taxa collected and an EPT BI of 3.0. Given the comparatively large drainage area and the land use along the US 441 corridor, it is recommended that this stream be retained for basinwide monitoring.

**Tessentee Creek, SR 1636**

The watershed of Tessentee Creek is just north of that for Middle Creek. It also drains southeastern Macon County.

The fish community was rated Good (NCIBI = 52) in 2004; no tolerant species were collected, and the mottled sculpin was the most abundant species present. In 1995 the fish community was also rated Good (NCIBI = 56, ); no tolerant species were collected, and the mottled sculpin, Tennessee shiner, and warpaint shiner were the most abundant species. There have been no substantial changes in this community between the monitoring periods.

**Coweeta Creek, SR 1114**

This location is downstream from the Coweeta Creek Hydrological Laboratory and land use in the catchment is predominantly undisturbed forest. Stream width is five meters and the drainage area is 12.1 square miles. Substrate was an unembedded mixture of boulder (10%), rubble (40%), gravel (30%), and sand (20%). No serious habitat problems were found and the site received a habitat score of 82. Conductivity was 15 µmhos/cm.

Coweeta Creek has been sampled here in 1994 (39 EPT) and 1999 (39 EPT) with each sample resulting in an Excellent bioclassification with an EPT BI of 2.9 and 3.0 respectively. In 2004, this site also received an Excellent bioclassification with an all-time EPT diversity (45) and an all time-low EPT BI of 2.6. Previously absent taxa collected in 2004 included the mayflies *Eurylophella funeralis* and *Rhithrogena*, the stoneflies *Amphinemura* and *Isoperla holochlora*, and the caddisflies *Lype diversa*, *Micrasema wataga*, and *Oecetis persimillis*.

**Coweeta Creek, SR 1119**

The first sizeable tributary to the Little Tennessee River draining the southwestern portion of Macon County is Coweeta Creek. It's watershed begins along the eastern slopes of the Nantahala Mountains. Much of the upper watershed is within the US Forest Services' Coweeta Experiment station. The specific conductance (16 µmhos/cm) at this site was the lowest of any fish community site in the basin in 2004 (Appendix F-6). The site in 2004 was moved approximately 0.5 miles upstream from the 1995 site to avoid the discharge from the Willowbrook Park WWTP and to sample at a location that was more reflective of the stream rather than the more developed site at US 23/441. The downstream site was rated Good-Fair in 1995.

The fish community was rated Good (NCIBI = 56) in 2004. The community was diverse (n = 20, including 3 species of darters, 7 species of cyprinids, and 4 intolerant species) and was dominated by mottled sculpin and central stoneroller.

**Cartoogechaye Creek, SR 1146**

Cartoogechaye Creek is the second largest tributary to the Little Tennessee River in this subbasin. It joins the river near the back waters of Lake Emory. The creek's watershed drains west-central Macon County, west of the Town of Franklin. The fish community site sampled in 2004 was moved approximately 2.1 miles upstream from the site sampled in 1995. The difference in watershed size was five square miles.

The width at this site was 13 meters and the drainage area was 41.2 square miles. The substrate was silt, cobble, gravel, and boulder but sedimentation and embeddedness were evident, possibly due to upstream development. The benthic habitat available was mostly rocks with some root mats and occasional snags and leafpacks. During benthic sampling, water chemistry results were similar to those found in 1999. Dissolved oxygen (DO) was 8.0 and conductivity was 31 µmhos/cm as compared to 33 µmhos/cm in 1999. The overall habitat score was also stable at 80 (84 in 1999). However, the much longer 600 ft. fish community reach was scored a 53 (Appendix F-2).

The benthic community rated Good in 2004, down from the Excellent rating in 1999. EPT S declined from 41 to 31; the EPT N decreased from 202 in 1999 to 89 in 2004; and the number of mayflies decreased from 21 in 1999 to 15 in 2004. *Heptagenia marginalis*, *Hexagenia*, *Neoephemera purpurea*, *Paraleptophlebia*, *Procloeon*, and *Stenacron pallidum*, all present in 1999, were not collected in 2004. The biotic index also increased to 3.70 (3.18 and 3.29 in 1999 and 1994 respectively) indicating only a slightly more tolerant community. Because the habitat score remained high, this most likely indicates that the lower bioclassification is due to changes in water quality rather than habitat changes due to sedimentation from upstream agriculture and development.

The fish community was rated Good (NCIBI = 56) in 2004 and was dominated by mottled sculpin. Eight stocked rainbow trout were collected but no young-of-year or wild trout were present. The downstream site was also rated Good (NCIBI = 56) in 1995. Pooling the data from these two sites, the fish community

in this segment of the creek was very diverse (n = 26 species, including 3 species of darters, 12 species of cyprinids and 4 species of suckers).

**Cullasaja River, US 64**

The land use upstream of this location is primarily residential subdivisions, golf courses, light commercial activity associated with US 64, and forest. This segment is also downstream from Lake Ravenel and upstream of Mirror Lake. Stream width here was six meters and drainage area was 3.7 square miles. Substrate was a generally unembedded mix of boulder (30%), rubble (20%), gravel (10%), sand (30%), and bedrock (10%). The primary habitat problems here included a lack of well-developed pools, riffles, and a large quantity of sand. Habitat received a score of 67 and the conductivity (47 µmhos/cm) was among the highest recorded at benthic macroinvertebrate sites in this subbasin.

The Cullasaja River has been sampled at this road crossing on five previous occasions receiving four Fair bioclassifications (1990, 1991, 1996, and 1999) and one Poor bioclassification (1991). In 2004, this location also resulted in a Fair bioclassification with the number of EPT taxa (14) and the NCBI (5.7) unchanged since the 1999 collection. It is clear that this site routinely experiences low dissolved oxygen levels as even rocks in the riffle had significant sponge growth. In addition to sponge, other low dissolved oxygen tolerant taxa present included the gastropod *Physella*, which was nearly abundant. Other highly pollution tolerant taxa present included the chironomids *Procladius* and *Cricotopus bicinctus* and the crustacean *Crangonyx*. This site remains adversely impacted by upstream landuse practices.

**Cullasaja River, SR 1678 (above Jackson Hole)**

Locating a suitable sampling site was difficult given the depths and flow at locations around Jackson Hole. The selected site, near a public picnic area 1-2 miles upstream of Jackson Hole (and Brush Creek) off US 64/NC 28, was 12 meters wide, averaging 0.5 meters deep and had good flow. Substrate was a mix of boulder (20%), rubble (20%), and gravel (20%), with a large amount of sand (40%). The drained area at this location is 29.2 square miles. The habitat scored 75 (out of 100) reflecting a healthy, mature forested riparian zone and plentiful organic microhabitat. This reach lacked any pools however. Conductivity measured 27 µmhos/cm.

This site was classified as Good, with 36 EPT taxa collected and a biotic index of 4.21. In 1999, a site slightly downstream at SR 1678 received an EPT S of 50, a BI of 3.7 and a bioclassification of Excellent. Seventy-eight total taxa were found at this location including the rarely collected tanypod *Alotanypus* (Chironomidae).

**Cullasaja River, US 64/SR 1668**

The downstream site on the Cullasaja River was sampled at SR 1668, near the Town of Cullasaja and just prior to the City of Franklin where it enters the Little Tennessee River. An average depth of 0.5 meters and a width of 17 meters characterized this site. Flow was moderate with one large run that dropped 0.5 meters over a very short distance (upstream in photo). Substrate differed from the upstream location but was still a mix of boulder (10%), rubble (20%), gravel (20%), and sand (50%) with traces of silt and fine particles. The percentages of substrate also have appeared to have changed from 1999, particularly sand (30% more in 2004) and boulders (25% less in 2004), suggesting increases in embeddedness. The drainage area at this location is 86.0 square miles. The habitat scored 73 (out of 100) in 1999 and 2004. In 2004 there was an overall lack of shading, a compromised riparian zone on one side (road), and the presence of erosional areas associated with the road side of the river. Trash, including appliances and numerous tires, were seen in this reach. Conductivity measured 22 µmhos/cm.

The Cullasaja River at SR 1668 received a bioclassification of Good in 2004 down from Excellent in 1999. Total taxa (86 versus 99) and EPT taxa (42 versus 51) were lower in 2004 compared to 1999. Also, the biotic index was higher in 2004 (4.67) compared to 1999 (3.94) suggesting some degradation of water quality here. EPT taxa that were common or abundant in 1999 but were absent in 2004 were *Baetis flavistriga*, *Drunella allegheniensis*, *Stenacron pallidum*, and *Setodes stehri*.

**Turtle Pond Creek, SR 1620**

The stream width at this most downstream road crossing was seven meters and drainage area was 5.5 square miles. Landuse in this catchment is entirely forest and contains large portions of the Nantahala Game Land. Substrate was an unembedded mix of boulder (10%), rubble (20%), gravel (40%), and sand (30%). This reach was very near the confluence of the Cullasaja River and stream gradient was fairly low. This lowered gradient accounted for the primary habitat problems as riffles and pools were infrequent. Habitat received a score of 76 and conductivity was low at 13 µmhos/cm.

Turtle Pond Creek was sampled at this location in 1999 when it received an Excellent bioclassification with 42 EPT taxa collected and an EPT BI of 1.9. In 2004, this site also received an Excellent bioclassification with 49 EPT taxa collected an EPT BI of 2.1. It is recommended this site be added to the basinwide sampling cycle as a reference site for this area of the subbasin.

**Walnut Creek, SR 1533**

Walnut Creek is a tributary to the middle reaches of the Cullasaja River and is adjacent to the Ellijay Creek watershed. It is a high gradient Southern Appalachian-type trout stream with plunge pools and riffles. There are no NPDES permitted facilities within the Walnut Creek watershed. At this crossing, the instream, riparian, and watershed characteristics are of exceptionally high quality (habitat score = 90); and qualified the site as a new fish community regional reference site (Appendix F-2). The habitat score was the highest of any fish community site in the basin in 2004, except for Panther Creek (Subbasin 02) which also had a score of 90. The site is also monitored by the Little Tennessee Watershed Association (LTWA 2003; W. McLarney, pers. com., May 18, 2004). This fish community site represented the smallest watershed that was assessed in 2004 (6.1 square miles).

As is typical of many, unimpacted trout streams, the fish community was made up of only six species (rainbow trout, brown trout, longnose dace, western blacknose dace, creek chub, and mottled sculpin). This stream and Conley and Panther Creeks (Subbasin 02) had the fewest species of any streams in the basin in 2004. Almost 90 percent of the fish collected from Walnut Creek were mottled sculpin. This was the only stream in the basin in 2004 where the central stoneroller and the northern hog sucker were not collected. The stream supported a wild, reproducing population of rainbow trout; one wild brown trout and one stocked brook trout were also collected.

**Ellijay Creek, SR 1524**

This creek is a tributary to the Cullasaja River and drains the east-northeast portion of Macon County. The creek's watershed is adjacent to that of Walnut Creek. The site is also monitored by the Little Tennessee Watershed Association (LTWA 2003; W. McLarney, pers. com., May 20, 2004).

The fish community was rated Good (NCIBI = 56) in 2004 and was dominated by mottled sculpin. The community was diverse (n = 20) including 2 species of darters, 9 species of cyprinids, and 4 intolerant species. The 2004 sample also included rockbass, smallmouth bass, and wild, rainbow trout. Stocked trout that were collected included 1 brown trout, 8 rainbow trout, and 2 brook trout. Two wild, young-of year (39 and 44 mm ) rainbow trout were also collected.

**Rabbit Creek, SR 1504**

Rabbit Creek is a tributary to Lake Emory, northeast of the Town of Franklin. The site, located approximately 1.2 miles above its confluence with Lake Emory, is also monitored by the Little Tennessee Watershed Association (LTWA 2003; W. McLarney, pers. com., May 20, 2004). The water was more turbid and the conductivity was also elevated (41 µmhos/cm) in Rabbit Creek compared to many of the other fish community sites, . The overall riparian habitat was in need of restoration. The riparian zones include manicured lawns, pastures, unstable banks, and invasive weeds such as privet, Japanese honeysuckle, and multi-floral rose.

Despite some habitat problems, the fish community in 2004 was rated Good-Fair (NCIBI = 44) and was dominated by warpaint shiner and mottled sculpin. The community was the only non-trout-type stream that did not have any species of darters and only one intolerant species. However, fish were abundant and the stream supported a good reproducing population of rock bass.

**Iotla Creek, SR 1372**

At this site below the Macon County Airport, Iotla Creek was three meters wide and the drainage area was 9.5 square miles. Trash was dumped in the riparian zone and many anthropogenic items were found in the stream. Agricultural practices (cattle, hay, and corn) upstream most likely resulted in the sedimentation problems observed. The substrate was largely comprised of boulders, rubble and sand. Water chemistry was similar to that found in 1999. Dissolved oxygen (DO) was 8.1 mg/L and conductivity was 43 µmhos/cm. The habitat score, however, increased from 54 in 1999 to 72 in 2004.

This site retained its Good rating from 1999 in 2004. EPT S declined slightly from 35 to 32 and EPT BI increased from 3.80 to 3.94. Although these scores indicate a slight decrease in biological integrity, no major changes in the community were observed. This site may experience periods of low DO and organic enrichment as suggested by the presence of the snail *Physella*, the chironomids *Clinotanypus pinguis* and *Rheotanytarsus*, the freshwater mussel *Pisidium*, and the damselfly *Argia*. The presence of eight odonate taxa also supported this assertion.

**Iotla Creek, off SR 1378**

This creek is a small tributary to the Little Tennessee River and joins the river downstream of Lake Emory. The creek's watershed is just north of that of Cartoogechaye Creek. The monitoring site is approximately 0.2 miles above the creek's mouth. The 2004 site was moved approximately one mile downstream from the site sampled in 1995 because the 1995 site (at SR 1372) was above Malonee Mill which is a significant barrier to fish movement and limits the diversity of the community in the upstream reaches (W. L. McLarney, pers. com. May 11, 2004). This 2004 site had the lowest habitat score of any fish community site in the basin (habitat score = 47); although the lower one-third of the reach had a higher gradient and better habitats than did the upper two-thirds of the reach. Compared to many of the other fish community sites, the conductivity was also elevated (39 µmhos/cm) in Iotla Creek.

Like Rabbit Creek, the fish community in this stream was also rated Good-Fair (NCIBI = 44). Only 185 fish were collected, the second fewest of any site in the basin in 2004; tolerant fish (white sucker, redbreast sunfish, and green sunfish) were common as were omnivores+herbivores (central stoneroller, river chub, and white sucker). The most abundant species was the river chub.

**Cowee Creek, SR 1340**

Downstream from Iotla Creek, Cowee Creek is the next major tributary to the Little Tennessee River. It's watershed drains the northeast corner of Macon County.

In 2004 the fish community in Cowee Creek was rated Good (NCIBI = 56). More total species, species of darters, and intolerant species were collected at this site than at any other site in the basin in 2004 (n = 21, 4, and 5, respectively). The dominant species were the gilt darter and the mottled sculpin; they could be found inhabiting the abundant riffles and runs at this site. This was the only site in the basin in 2004 where the intolerant telescope shiner was collected.

**Cowee Creek, NC 28**

Cowee Creek was nine meters wide with a watershed of 25.7 square miles at the sample site. Several gem mines are located upstream possibly causing the turbid water conditions and slight sedimentation. The substrate consisted of mostly rubble with the remainder boulder, sand and gravel. The rocks provided most of the habitat in the stream. Dissolved oxygen (DO) was 8.2 mg/L in 2004. The conductivity readings remained stable at 23 µmhos/cm (21 µmhos/cm in 1999). The overall habitat score rose from 66 to 81 in 2004.

The rating at this site has consistently increased since a Good-Fair rating in 1994. It rated Good in 1999 and then Excellent in 2004. From 1999 to

2004, the EPT S increased from 35 to 38. The number of mayflies increased from 9 in 1994 to 19 in 2004. However, the biotic index (BI) increased slightly from 3.06 in 1999 to 3.24 in 2004 and the EPT N decreased from 162 to 115.

**Burningtown Creek, SR 1371**

Burningtown Creek is the most downstream tributary of the Little Tennessee River in this subbasin. It was eight meters wide and has a drainage area of 24.8 square miles. The substrate was a good mix of boulder, rubble, and gravel, with sand accumulating in slow areas. This stream received a habitat score of 69, but conductivity was very low (19 µmhos/cm). The stream flows through low density residential and agricultural areas, but most of the watershed is within Nantahala National Forest. Wayah Bald is near its source.

EPT S increased from 39 in 1999 to 43 in 2004. This site retained it's Excellent bioclassification found in 1999. The benthic macroinvertebrate fauna was represented by a fairly diverse assemblage. Abundant taxa were somewhat intolerant, and included *Epeorus, Baetis pluto, B. intercalaris, Acroneuria abnormis, Leuctra, Tallaperla, Perlesta, Micrasema wataga*, and *Symphitopsyche sparna*. Glossosomatids were conspicuously absent compared to the upstream special study site, indicating possible sedimentation impacts to monitor in future studies.

**Burningtown Creek, SR 1364**

About eight miles below the mouth of Cowee Creek is Burningtown Creek, the next major tributary to the Little Tennessee River. It watershed drains the north central portion of Macon County. At this site the stream channel is fairly straight as the road parallels the left side of the creek; the riparian zone along the right shoreline is also narrowed by a field.

In 2004 the fish community was rated Excellent (NCIBI = 58). The most abundant species collected was the mottled sculpin. The site is a popular fishing location because the creek is Hatchery Supported Trout Waters. Four stocked brook trout (258 – 290 mm), nine stocked rainbow trout (224 - 294 mm), and four stocked brown trout (210 – 303 mm) were collected; one wild, young-of-year rainbow trout (57 mm) was also present.

**Tellico Creek, SR 1367**

Tellico Creek is the last and northern-most tributary to join the Little Tennessee River in this subbasin. The stream originates near Wayah Bald and it's watershed drains the northwestern corner of Macon County. There is one NPDES permitted facility within the creek's watershed. Tellico Trout Farms (NCG6530071), located approximately 1.8 miles upstream of the monitoring site, is the largest commercial hatchery in the eastern United States. There were no reported permit violations for the facility (Basinwide Information Management System query January 18, 2005). The pH (5.2 s.u.) was the lowest of any fish community site in the basin in 2004 (Appendix F-7); however the conductivity was naturally low, 17 µmhos/cm, and was not elevated due to the facility's operation. The conductivity was also 17 µmhos/cm during the benthic macroinvertebrate monitoring later in summer. The site has high quality instream and riparian habitats (habitat score = 86 during fish and benthic community monitoring) and consists of high gradient riffles, runs, and plunge pools.

In 2004. the fish community was rated Good (NCIBI = 50). More species of cyprinids (n = 9) were collected at this site than at any other site in the basin in 2004, except for at Ellijay Creek which had nine cyprinid species as well. However, the number of fish, number of species of darters, and species with multiple age classes were lower than expected and the percentage of tolerant fish (five percent) was also elevated compared to the regional reference sites. The most abundant species were the central stoneroller and the gilt darter.

The benthic community has received an Excellent rating during all three basinwide collections. The NCBI (range = 3.46 - 3.61) and EPT BI (range = 2.61 - 2.69) have been remarkably stable. Nine more EPT taxa were collected under low-flow conditions in 1999 than under high flow conditions in 1994 and 2004. The 2004 benthic fauna was dominated by *Symphitopsyche sparna, Stenonema modestum, Leuctra*, and the midge, *Polypedilum flavum*.

## SPECIAL STUDIES

### Cullasaja River

Two sites on the Cullasaja River below the gorge were resampled in October 1999 to determine if any changes had occurred in the fish community since it was last sampled in October 1996 and to determine if there were any downstream impacts attributable to the Town of Highland's WWTP discharge. In 1999, the fish community at SR 1677 was rated Good (NCIBI = 50) and was not impacted by the WWTP discharge. The community had also been rated Good (NCIBI = 52) in 1996. The fish community further downstream at SR 1653 was rated Good-Fair (NCIBI = 46) in 1999, it had been rated Fair (NCIBI = 34) in 1996. The community at SR 1653 was affected by poor landuse practices in the lower watershed (Biological Assessment Unit Memorandum F-20010427).

### Watershed Assessment and Restoration Project (WARP) on the Cullasaja River, Mill Creek, and Selected Tributaries

The Cullasaja River and Mill Creek have been considered impaired as early as 1990 when first evaluated using benthic communities. Twelve sites were sampled in 2000 and 2001 as part of a special study on the effects of development in the Town of Highlands area. Results suggested that impairment may be due to a combination of factors including pesticides from golf courses and residential areas, changes in hydrology and sedimentation due to increased impervious area, and small impoundments that restrict downstream drift of macroinvertebrates. (See Biological Assessment Unit Memorandum B-20020311 for more information).

**Cullasaja River, US 64, above Dry Falls**
This site was sampled in 2000 as part of a Watershed Assessment and Restoration Project study. The habitat scored low at 66 and the site received a Good-Fair bioclassification based on the benthos. (Not collected by BAU so no report written).

**Little Tennessee River, off SR 1629**
This Little Tennessee River basinwide site was sampled again in 2000. The substrate was sandy and embedded and erosion was present. The site received a bioclassification of Fair. (No report was written for this site).

**Jones Creek, SR 1303**

At the request of the Asheville Regional Office, Jones Creek, a tributary of Cartoogechaye Creek above SR 1146, was sampled to determine the extent of degradation due to development in the upper portions of the watershed. A large deforested area adjacent to Dill Creek was adding large amounts of sediment into the stream. Dill Creek enters Jones Creek just above SR 1303 and a plume of turbid water entering Jones Creek was clearly observable. Jones Creek was nine meters wide at the time of sampling with a watershed area of 13.6 square miles. A good mix of substrate types with some embeddedness characterized the stream.

Available habitat consisted mostly of rocks with some macrophytes and a few rootmats and sticks. Although sedimentation from Dill Creek may become a serious issue, Dill Creek did not alter the water chemistry of Jones Creek. Measurements above and below the confluence of Dill Creek were consistent. Dissolved oxygen was 8.0 mg/L and conductivity was 34 µmhos/cm. The habitat score was somewhat low at 66, reflecting sedimentation, a lack of pools, and the condition of the riparian zone.

Despite the obvious intrusion of sediments, Jones Creek rated Excellent based on the benthos. EPT S was 38 and EPT N was 161. The EPT BI was 3.07. This upstream site rated better than Cartoogechaye Creek at SR 1146 on all biological parameters. (See Biological Assessment Unit Memorandum B-20050218 for more information).

**Big Creek, SR 1548, above the water treatment plant**
Big Creek was sampled in 2000 at the request of the Asheville Regional Office to assess the effects of a sediment release from an upstream impoundment in 1999. Although the site received a Good rating, the fauna was sparse and sedimentation was evident. (No report was written).

**Walnut Creek, SR 1533**

This site was sampled at the request of the Asheville Regional Office due to complaints of dead fish, soapy waters, and development. The habitat at Walnut Creek appears to be declining. The site scored only 56 out of 100 in 2004, a decline from 83 in 1999. In 2004, the stream was significantly embedded with sand, limiting in-stream habitat. A forested riparian zone of young trees was present on both sides of the stream, providing good shade. However this riparian zone was narrow (less than 6 meters) and was encroached upon by livestock and residential activities. It appears that sedimentation and increased residential development and agricultural activities in the watershed are affecting the riparian habitat and in-stream habitats.

Walnut Creek rated Excellent in 2004, up from the Good rating it received in 1999. There appeared to be little change in the macroinvertebrate community. The number of EPT taxa increased from 34 in 1999 to 38 in 2004. The EPT BI increased slightly from 2.0 in 1999 to 2.1 in 2004. Notable taxa collected in 2004 included the caddisflies: *Goera calcarata*, *Hydatophylax,* and *Oligostomis pardalis*. Sedimentation is still an issue at this site. (See Biological Assessment Unit Memorandum B-20050218 for more information).

**Iotla Creek, SR 1485**

Due to changing land use in the upper portions of the watershed, the Asheville Regional Office requested a sample above the Macon County Airport on Iotla Creek in conjunction with the site at SR 1372. There was quite a bit of agricultural land use and an agricultural ditch entered Iotla Creek just upstream of the sample location, adding to the sedimentation problems in this section of the stream. At the sampling point, the stream was three meters wide with a drainage area of 4.3 square miles. The substrate was mostly sand and gravel with a small section of rubble near a small bridge. Available habitat consisted of mostly leafpacks and sticks with a few rocks interspersed. The conductivity was lower (29 µmhos/cm) at this upper site than at the downstream site (43 µmhos/cm). Dissolved oxygen (DO) was similar at both sites at 7.6 mg/L (upstream) and 8.1 mg/L (downstream). The habitat score at the upper site was 61, mostly due to poor substrate and lack of habitat for macroinvertebrates.

Despite the agricultural influences, this site rated Good, the same score as the downstream site. The EPT S was 35 and the EPT BI scored 3.53. This was slightly better than the downstream site. The mayflies *Serratella deficiens*, *Stenonema modestum*, and *Pseudocloeon propiquum* as well as the caddisfly *Cheumatopsyche*, the stonefly *Leuctra*, and the odonate *Ophiogomphus* were abundant at this site. The beetle *Helichus* and the snail *Elimia* were also present in large numbers. See Biological Assessment Unit Memorandum B-20050218 for more information).

**Burningtown Creek, SR 1392**

At the request of the Asheville Regional Office, a second site on Burningtown Creek was sampled for benthos upstream of the basinwide site. Regional office staff were concerned that increased residential development in the watershed was causing water quality problems. The width at this site was seven meters and the DO was 8.3 mg/L. Conductivity measured 18 µmhos/cm. Although pools were filling in with sand, this site had slightly better habitat (score 78) compared to the basinwide site.

This site had slightly less diverse community structure compared to the basinwide site. Its rating was Good (Table 2) with nine fewer mayfly taxa than downstream. Some of the taxa changes may be due to the smaller watershed size at this site, as seen by the appearance of *Diplectrona modesta*, which is generally restricted to small streams. The much lower EPT BI value (2.50 vs. 3.12 downstream) indicates that though the EPT fauna was reduced, overall there was a more intolerant fauna upstream. The influence from development in this catchment is affecting the biological community only slightly. (See Biological Assessment Unit Memorandum B-20050218 for more information).

## ADDITIONAL DATA

### Little Tennessee River Watershed Association

The Little Tennessee River Watershed Association (LTWA) has conducted a fish community monitoring program in the Little Tennessee River watershed, primarily in Macon County, NC and Rabun County, GA, since 1990. Many of the watersheds are small (less than two square miles), but there are others that are as large as those monitored by DWQ. Some of the watersheds monitored by DWQ in 2004 were at the same sites as those monitored by LTWA (e.g. Middle, Iotla, Cowee, and Brush Creeks). The LTWA also applies an index of biotic integrity to summarize these data. However, the index is different than the one used by DWQ and scores and ratings are not equivalent. The data can be used to “screen” waterbodies in need of further monitoring by DWQ or in need of local restoration efforts. Within the Little Tennessee River watershed, the LTWA has identified 36 streams as degraded (rated Fair or Poor) and 13 streams as Good. Most of the degraded streams were in the watersheds from the Little Tennessee River headwaters to Cartoogechaye Creek and from Lake Emory to the Needmore Tract. Complete site listings, data summaries, and watershed impairments are described in LTWA (2003).

## LITTLE TENNESSEE RIVER SUBBASIN 02

### Description

This subbasin is located in the western portion of the mountain ecoregion (Figure 2) and drains an area of 1,021 square miles. The subbasin is nearly 94% forested (Table 3), and, due to its size, encompasses three ecoregions (Level IV). The higher elevations are grouped into the High Mountains ecoregion; the southeastern one-half of the subbasin is in the Southern Crystalline Ridge and Mountains; and the northwestern one-half of the subbasin is in the Southern Metasedimentary Mountains (Griffith et al. 2002).

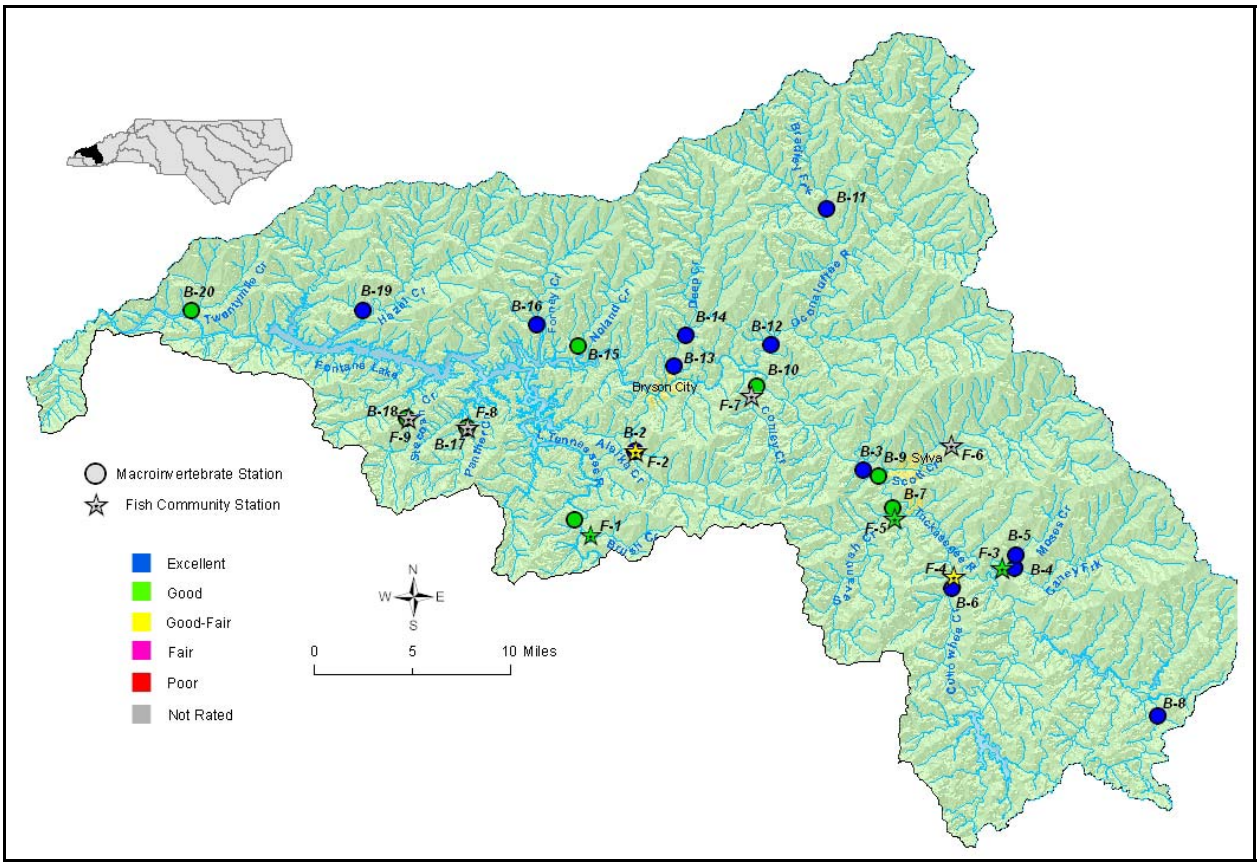



**Figure 2.** **Sampling sites in Subbasin 02 in the Little Tennessee River basin. Monitoring sites are listed in Table 4.**

**Table 3.** **Land use in Subbasin 02. Based upon CGIA coverage 1993 - 1995 (total area = 1,021 square miles (NCDENR 2002).**

| Land use | Percent |
|---|---|
| Water | 2.3 |
| Cultivated crop | 0.3 |
| Pasture | 3.3 |
| Urban | 0.6 |
| Forest | 93.5 |

Fontana Lake is the largest impoundment in this region and the body of water to which all streams in this subbasin flow. Fontana Lake/Reservoir, operated by the Tennessee Valley Authority, is the result of damming the Little Tennessee River in the 1940's near Fontana Village on the Graham/Swain County line. Flood control and hydroelectric power generation are the primary purposes for Fontana Lake, though recreational use is growing steadily. The principle tributaries to the Little Tennessee River are the

Oconaluftee River and the Tuckasegee River. This subbasin contains over 1,421 miles of streams and rivers and 2,276 acres of lakes and ponds.

Much of the catchment to the north of the Little Tennessee River is within either the Great Smoky Mountain National Park or the Cherokee Indian Qualla Boundary. Most streams on the north side of the lake are in a roadless area and can only be reached by boat across Fontana Lake or hiking trails.

This subbasin contains some of the most famous trout streams in North Carolina, including Hazel Creek, Forney Creek, Deep Creek and Noland Creek. Most of the rest of this subbasin is included in the Nantahala National Forest, although this does not preclude other land uses.

The area also contains some of the most pristine and some of the highest quality waters of the State. Portions of Alarka Creek, the Tuckasegee River, Caney Fork, and most of the Oconaluftee River catchment have been supplementally classified as High Quality Waters (HQW). Small streams, formally classified for water supply, have also been reclassified as HQW: Whiterock, Wolf, Clingman's, and Twentymile Creeks and Long, Jenkins, Dednan, and Moore Spring Branches. The Tuckasegee River upstream of Tanassee Creek is classified as Outstanding Resource Waters.

The largest towns are Bryson City, Cherokee, Cullowhee, and Sylva. There are 25 NPDES permitted dischargers in this subbasin, but only three have permitted flows greater than 0.5 MGD: the Tuckasegee Water & Sewer Authority (0.5 MGD to Scott Creek); the Town of Dillsboro's WWTP (1.5 MGD to the Tuckasegee River), and the Town of Bryson City's WWTP (0.6 MGD to the Tuckasegee River). Only the latter two facilities are required to monitor their effluents' toxicity.

### Overview of Water Quality

The Good to Excellent water quality in the streams of this subbasin appears to be generally stable (Table 4, in part). Five of the 20 sites sampled in this subbasin for macroinvertebrates did change bioclassifications. Of those five, one site improved from the 1999 survey, the Tuckasegee River off SR 1377 (from Good to Excellent, Table 2). Four sites declined in bioclassification, from Excellent in 1999 to Good in 2004: Conely, Noland, Panther, and Stecoah Creeks. The lack of some EPT taxa at these sites may not signal a decline in water quality however, as the EPT BI remained very low suggesting the continued persistence of a very intolerant macroinvertebrate assemblage. Overall, of the 19 sites that were sampled in 1999 and 2004, 15 experienced a lowered EPT BI in 2004 compared with 1999, and at 10 of the 19 sites, a greater number of overall taxa were collected in 2004.

The improvement in water quality seen at Scott Creek from 1994 (Good-Fair) to 1999 (Good) appeared to have stabilized at Good (2004). The upper reaches of Scott Creek also seemed to be in a non-degraded condition as it currently supports reproducing populations of trout as confirmed by fish community studies in 2004. In 1999, fish community studies were not conducted in this subbasin.

In addition to Scott Creek, eight other fish community sites in this subbasin were sampled for the first time in 2004. The only stream not supplementally classified as trout waters (Tr) was Brush Creek. Alarka, Cullowhee, Conley, Panther, Stecoah, and Scott Creeks are managed as Hatchery Supported Trout Waters by the North Carolina Wildlife Resources Commission. Wild trout were collected from all fish community sites in this subbasin except for Brush Creek. There are no NPDES facilities within the watersheds of the fish community sites on Caney Fork or Brush, Alarka, Cullowhee, Savannah, Panther, and Stecoah Creeks (Basinwide Information Management System query December 2004).

**Table 4. Waterbodies monitored in the Little Tennessee subbasin 02 for basinwide assessments from 1999 and 2004.**

| Map # | Waterbody | County | Location | 1999 | 2004 |
|---|---|---|---|---|---|
| B-1 | L Tennessee R | Swain | Off SR 1113 | Good | Good |
| B-2 | Alarka Cr | Swain | SR 1185 | Excellent | Excellent |
| B-3 | Tuckasegee R | Jackson | SR 1140 | Excellent | Excellent |
| B-4 | Caney Fk | Jackson | SR 1740 | Excellent | Excellent |
| B-5 | Moses Cr | Jackson | SR 1739 | Excellent | Excellent |
| B-6 | Cullowhee Cr | Jackson | SR 1001 | Excellent | Excellent |
| B-7 | Savannah Cr | Jackson | SR 1367 | Good | Good |
| B-8 | Tuckasegee R | Jackson | Off SR 1377 | Good | Excellent |
| B-9 | Scott Cr | Jackson | SR 1556 | Good | Good |
| B-10 | Conley Cr | Swain | SR 1177 | Excellent | Good |
| B-11 | Bradley Fk | Swain | Off US 441 | Excellent | Excellent |
| B-12 | Oconaluftee R | Swain | SR 1359 | Excellent | Excellent |
| B-13 | Deep Cr | Swain | Above campground | Excellent | Excellent |
| B-14 | Deep Cr | Swain | SR 1340 | Excellent | Excellent |
| B-15 | Noland Cr | Swain | Near mouth | Excellent | Good |
| B-16 | Forney Cr | Swain | Near mouth | Excellent | Excellent |
| B-17 | Panther Cr | Graham | SR 1233 | Excellent | Good |
| B-18 | Stecoah Cr | Graham | SR 1237 | Excellent | Good |
| B-19 | Hazel Cr | Swain | Near mouth | Excellent | Excellent |
| B-20 | Twentymile Cr | Swain | NC 28 | --- | Good |
| | | | | | |
| F-1 | Brush Cr | Swain | Off SR 1129 | --- | Good |
| F-2 | Alarka Cr | Swain | SR 1185 | --- | Good-Fair |
| F-3 | Caney Fk | Jackson | SR 1738 | --- | Good |
| F-4 | Cullowhee Cr | Jackson | SR 1545 | --- | Good-Fair |
| F-5 | Savannah Cr | Jackson | NC 116 | --- | Good |
| F-6 | Scott Cr | Jackson | SR 1527 | --- | Not Rated |
| F-7 | Conley Cr | Swain | SR 1183 | --- | Not Rated |
| F-8 | Panther Cr | Graham | SR 1233 | --- | Not Rated |
| F-9 | Stecoah Cr | Graham | SR 1237 | --- | Not Rated |

The primary problem in this basin continues to be nonpoint source pollution, including inputs of sediment and (or) nutrients. Although much of this subbasin is forested, development is often located along the stream corridor. Farmland and new residential areas are typically found adjacent to streams, often with inadequate riparian buffer zones. Many of the sampled sites have roads that run parallel to the stream leading to narrow riparian zones with frequent breaks. Water quality was not a problem throughout most of this area, but there was evidence of habitat problems. These included few pools, relatively uniform riffles and runs, and an embedded substrate. These changes have been shown to have less effect on the benthic macroinvertebrates than fish fauna.

Whereas actual water quality is the most important parameter for macroinvertebrates in mountain streams, fishes are affected to a higher degree, comparably, by habitat alterations (in addition to water quality), especially: the lack of riparian shading of the stream; increased nutrient loads; lack of bank stability; and siltation of plunge pools and riffles. The lack of stream shading raises water temperatures, excluding sensitive cold-water fishes such as trout. An increase in nutrient loads causes a shift in species composition towards dominance of the system by the central stoneroller and the river chub. Siltation, caused by unstable banks and overland runoff limits habitats in riffles, resulting in a low number or complete lack of darters and sculpin.

Some streams in this subbasin were sampled for fish community and macroinvertebrates. At these sites, fishes and macroinvertebrates emphasized specific stressors affecting these streams. Due to the relatively low impacts of humans in this subbasin only subtle differences were seen. For example, Stecoah Creek rated Good for macroinvertebrates but was degraded when the fish community was investigated. The macroinvertebrates in Stecoah Creek suggested nonpoint source pollution (elevated nutrients) as a degrader in the system. River chubs and central stonerollers, species that thrive in nutrient enriched and silted-in benthos conditions (in the mountain ecoregions), dominated the fish community and confirmed the nonpoint source pollution. But in addition, the fish community suggested that siltation (as seen by both sampling teams at different times of the year) was affecting the stream.

Alarka Creek, which rated Excellent for macroinvertebrates, rated only Good-Fair for fish community. The large number of fishes captured and the species composition suggested an excess of nutrients in the system. These additional nutrients, however, did not exceed the thresholds needed to decrease macroinvertebrate diversity. In fact, the diversity and abundance of macroinvertebrates increased, to the highest level seen at this site since it was first sampled in 1988 (although the Biotic Index also was the highest suggesting a more tolerant community). This is because mountain streams, in their natural condition, are oligotrophic. Small amounts of nutrients will temporarily increase macroinvertebrate populations, but eventually, diversity will decrease and the community will be dominated by a much smaller number of tolerant species. At Alarka Creek, it appears that nutrients were to the level that adversely affected fish, but had not yet begun to decrease macroinvertebrate diversity.

There are two ambient water quality monitoring sites in this subbasin: the Oconaluftee River at SR 1359 (also a macroinvertebrate sampling location) and the Tuckasegee River at SR 1364. The Oconaluftee River site was discontinued in May 2000. Prior data, though, showed no change in water quality parameters. Data from the Tuckasegee River site also showed that water quality was not impaired. Within the last five years, exceedances were noted only for total iron and turbidity.

There are two facilities required to monitor their effluents' toxicity, Tuckasegee Water & Sewer Authority and Bryson City's WWTP. During the last five years Bryson City WWTP has no Whole Effluent Toxicity (WET) NPDES permit limit violations, while Tuckasegee Water & Sewer Authority had two, one in November 2001 and one in November 2004. These two WET tests failures are not considered significant.

## River and Stream Assessment

### Little Tennessee River, SR 1113

This location represents the most downstream point of benthic sampling on the Little Tennessee River in North Carolina. The river drains an area of 375 miles here and is over 50 meters wide and averages 0.75 meters in depth. There is a large island upstream of the sampling location where the river flows equally on either side. At the time of sampling, it was not possible to wade completely across the river. Substrate was a mix of boulder (20%), rubble (40%), gravel (20%), and sand (20%). A moderate amount of aufwuchs was present. The habitat scored 68 in 1999 and 2004. In 2004, habitat was limited by the lack of in-stream pools, breaks in the riparian zone and the lack of shading, except on the very edges of the river. Conductivity measured 48 µmhos/cm.

In 2004, this site received a Good bioclassification, the same as the previous three samplings. The macroinvertebrate composition and biotic index appear very stable here (Figure 3), with limited differences among the four samplings. In 2004 though, the mayfly *Acentrella turbida* was collected for the first time (abundant) along with the caddisflies *Goera* and *Nectopsyche exquisite* (both common), and the exotic clam *Corbicula fluminea* (abundant).

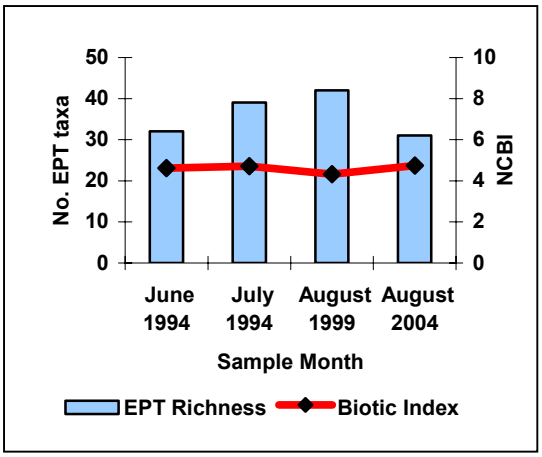



**Figure 3.** **Little Tennessee River at SR 1113 (1994 - 2004); number of EPT taxa collected and the North Carolina Biotic Index.**

**Brush Creek, off SR 1129**

Brush Creek, in southern Swain County, is the first tributary to join the Little Tennessee River as the river flows from Subbasin 01 to Subbasin 02 and is the next tributary to the river downstream of Tellico Creek (Subbasin 01). The monitoring site, approximately 0.2 miles above its mouth, is within the recently purchased and state-owned Needmore Tract. There are no NPDES permitted facilities within the creek's watershed. At this crossing, the instream, riparian, and watershed characteristics are of high quality (habitat score = 85) and qualified this small watershed site as a new fish community regional reference site (Appendix F-2).

The fish community in Brush Creek in 2004 was rated Good (NCIBI = 50). The diversities of darters and cyprinids and the abundance of omnivores+herbivores were slightly lower than expected. The mottled sculpin was the numerically dominant species; the greenfin darter, warpaint shiner, and mountain brook lamprey were also abundant. The intolerant species at this site were rock bass, smallmouth bass, greenfin darter, and gilt darter.

**Alarka Creek, SR 1185**

Alarka Creek is a medium-size tributary to the Little Tennessee River Arm of Fontana Reservoir. The creek's watershed drains southern Swain County. Alarka Creek is six meters wide and 0.2 meters deep with a uniform riffle/run habitat. Substrate was a mix of boulder (30%), rubble (40%), gravel (20%) and sand (10%). The drainage area at this location is 25.0 square miles. Habitat appears to be declining scoring 58 (out of 100) in 2004, and 77 in 1999. Besides being somewhat embedded, in-stream habitat lacked pools, snags, logs or root mats for macroinvertebrate colonization. Residential development compromised the riparian habitat (see picture) by promoting landscaping (i.e. removal of native vegetation) down to the edge of the stream. The lower reaches were also in need of riparian restoration as domestic animals had access to the

stream. The densely vegetated bluff at the upper end of the reach was atypical for this section of the creek; beyond the forested reach, the stream canopy was open and the banks were in pasture or fields. Conductivity measured 30 µmhos/cm, somewhat elevated for a mountain stream of this size.

Alarka Creek rated Excellent in 2004 for macroinvertebrates, the same rating it received in 1988, 1994, and 1999. The highest total diversity (101) to date was recorded in 2004. The highest Biotic Index to date was also recorded in 2004 (3.8) though the EPT BI was the lowest (2.6). The burrowing mayfly *Hexagenia* was collected in 2004 for the first time as was the caddisfly *Hydatophylax argus*. Currently, this site appears stable, but should undergo continued monitored to ensure that increased residential development in this watershed does not adversely affect water quality.

In 2004 the fish community was rated Good-Fair (NCIBI = 46). More fish (n = 1,503) were collected at this site than at any other site in the basin in 2004. The large number of fish collected suggested that the community was stimulated by upstream nonpoint or straight-pipe sources of nutrients. The most abundant species collected was the mottled sculpin, but the Tennessee shiner, river chub, warpaint shiner, and rosyside (smoky) dace were also very abundant. Only one species of darter was present (greenfin darter), and it was represented by only one fish. Wild and stocked adult brown trout and rainbow trout were collected, as were wild, young-of-year brown trout and rainbow trout. One stocked brook trout was also captured.

**Tuckasegee River, SR 1140**

This headwater site is located below Panthertown Valley, a wilderness area where Panthertown Creek and Greenland Creek come together to form the Tuckasegee River. The river was about 13 meters wide with a very sandy substrate, typical for that geological area. The water was distinctly tannic colored, due to the numerous bogs in Panthertown Valley. Conductivity was very low (8 µmhos/cm), the same value found in 1999. The habitat scored low (62) because of the extensive amount of sand, and lack of riffles and pools.

EPT samples from 1994 through 2004 have produced an Excellent rating. The benthic macroinvertebrate abundance was sparse in 2004. Of the 36 EPT taxa collected in 2004, 22 taxa (61%) were Rare (1or 2 specimens). In 1999, 39% were Rare, and in 1994, 43% were Rare. The fauna present, however, were very intolerant, as the EPT BI was 1.83. Rare or unusual caddisflies included *Molanna, Heteroplectron americanum, Symphitopsyche macleodi, Arctopsyche irrorata,* and *Psilotreta*.

**Caney Fork, SR 1740**

Caney Fork is a large tributary of the Tuckasegee River. It was sampled for benthos in a downstream reach, just above Moses Creek. Caney Fork also had a habitat score of 62, but this was due to the complete lack of riparian zone (road on one side, extensive country house mowed lawn on the other), and uniform riffle-run instream habitat. While there was a good mix of boulder, rubble and gravel substrate, the rocks were very embedded. The stream was 12 meters wide and the current was swift. Much of its upper watershed is in the Balsam Mountains.

An Excellent rating was also assigned to this site from 1994 through 2004 basinwide collections. In contrast to the upstream Tuckasegee River, this stream was very productive, most likely due to the open canopy. The biotic index was slightly elevated (3.25 to 3.68) relative to reference sites, although this site had very high and consistent EPT S (56, 53, 54). The 54 EPT taxa in 2004 were the highest collected in this subbasin, despite the degraded habitat. The caddisfly fauna was especially diverse with 25 taxa. Both species of the rare caddisfly, *Setodes*, were found here, and another rare caddisfly, *Micrasema bennetti*, was abundant. The high total taxa richness value of 107, suggests that the combination of high water quality and open canopy are allowing this stream to function like a larger river, where high taxa richness values are most often found.

**Caney Fork, SR 1738**

Caney Fork, a tributary to the Tuckasegee River, is located in east-central Jackson County where it drains the Great Balsam Mountains. This fish community site represented the second largest watershed that was assessed in 2004 (50.2 square miles). The lower one-third of the site has pasture and a road along its right and left shorelines, but is protected further upstream by a narrow forested buffer.

In 2004 the fish community was rated Good (NCIBI = 56); the most abundant species was the mottled sculpin. No tolerant fish were represented in the sample. Young-of-year, wild rainbow trout and brown trout were also collected.

**Moses Creek, SR 1739**

Moses Creek is a small (4 – 5 meter wide), high gradient, tributary of Caney Fork with better habitat (78). The substrate was dominated by rubble and gravel, with little sand, although the stream became turbid just from walking around in it. The conductivity was 23 μmhos/cm, similar to the value in Caney Fork.

The bioclassification at this site improved from Good in 1994 to Excellent in 1999 and 2004. EPT S has steadily increased from 34 in 1994 to 37 in 1999 to 46 in 2004. The EPT BI was extremely low -- 1.71. Caddisflies found only at this site in this subbasin were *Fattigia pele, Agapetus*, and *Hydropsyche scalaris*. Another unusual occurrence was the collection of four species of the mayfly genus *Serratella*. These faunal differences likely are related to the fact that this was the smallest stream sampled in this subbasin and it drains from steep forested topography.

**Cullowhee Creek, SR 1001**

Cullowhee Creek flows through Western Carolina University campus before entering the Tuckasegee River. However, this monitoring site was upstream from this urban area in an area of light commercial development upstream. There was a city park and ball fields downstream on one side and a general store on the other. The stream at this location was six meters wide with good boulder and rubble habitat, though sand was estimated at about 30%. The habitat score was only 58. Lots of trash in the stream reflected its urban setting.

Similar to Moses Creek, the bioclassification for this site improved from Good in 1994 to Excellent in 1999 and 2004, and EPT S has steadily increased from 32 to 43 to 47. In addition, there was a significant increase in EPT N in 2004 (243 vs. 150 *vs*. 153) when 19 different EPT taxa were abundant. It is unlikely that these changes can be attributed to differences in flow, since 1999 was the lowest flow year.

**Cullowhee Creek, SR 1545**

Cullowhee Creek is the next major tributary to the Tuckasegee River downstream from Caney Fork. The creek's mouth is near the Town of Cullowhee, just north of Western Carolina University. The fish community monitoring site was upstream of the University and NC 107.

In 2004, the fish community was rated Good-Fair (NCIBI = 46); the most abundant species was the mottled sculpin. Only one species of darter (gilt darter) was collected. The percentage of tolerant fish was slightly elevated and the percentage of omnivores + herbivores was lower than expected.

**Savannah Creek, NC 116**

Savannah Creek is the next major downstream tributary to the Tuckasegee River downstream from Cullowhee Creek. For most of its length, NC 116 and then US 441 parallel the creek all the way to its headwaters. The creek's watershed drains the northwest portion of Jackson County. At this site, there was minimal canopy, the riparian zones were in pasture, and an attempt had been made to stabilize portions of the banks with riprap and concrete slabs.

The fish community at this site in 2004 was rated Good (NCIBI = 50). No tolerant fish were collected, but the total species diversity and the diversity of darters were slightly lower than expected; the percentage of insectivores was slightly elevated. Although the creek is not a Hatchery Supported Trout Waters, one stocked brook trout was collected. The most abundant species was the mottled sculpin.

**Savannah Creek, SR 1367**

Savannah Creek when sampled in 2004 was 7 meters wide and very fast flowing after thunderstorms the day before. Fast flow and large, immovable rocks made sampling difficult, as was the case in 1994 and 1999. The stream enters the Tuckasegee River near Webster, outside of Sylva, in a suburban area, approximately a quarter mile downstream of this sampling site. A habitat score of 74, however, indicated no major habitat problems.

This site declined from Excellent in 1994 to Good in 1999 and 2004. EPT S (40) in 2004 returned to the 1994 value, but the BI value was slightly higher (4.14) in 2004 compared to 1994 (3.81). This was enough to keep it from being rated Excellent. The EPT BI was the lowest in 2004 at 3.10, and EPT N was the highest (173), despite the difficult sampling conditions. An unusually diverse beetle fauna had 10 taxa.

**Tuckasegee River, off SR 1378**

The Tuckasegee River at Dillsboro is another large river site, with a width of at least 50 meters, and a drainage area of 347 square miles. The substrate at this site was 60-70% rubble and gravel, with extensive areas of bedrock. The only riffle area shallow enough to sample was found around a small island near the west bank. The 1999 and 2004 samples were collected under high flows.

The Dillsboro site had shown a steady improvement in water quality from 1984 to 1994, changing from a Good-Fair rating to an Excellent rating. The rating declined to Good in 1999, but returned to Excellent in 2004. Only three stonefly taxa were collected, but this is not unusual for large rivers. In contrast, four different *Brachycentrus* species were collected: *B. appalachia, B. lateralis, B. numerosus, and B. spinae*. Midges were very sparse, with only three of the 18 taxa common in abundance, and all the rest rare. *Stenonema ithaca* was very abundant.

**Scott Creek, SR 1527**

Scott Creek is a large, swift tributary to the Tuckasegee River. Draining northeastern Jackson County, the creek is paralleled for most of its length by US 19/23 and Old US 19/23. The fish community site was in the middle part of the watershed. There is one NPDES facility (NC0032808) within the creek's watershed; it is located approximately 1.5 miles upstream of the monitoring site. The facility discharges 0.0085 MGD to Blanton Branch, a tributary to Scott Creek. Since 2000 there have been occasional permit violations for flow, total suspended solids, and fecal coliform bacteria (Basinwide Information Management System query January 18, 2005). The habitats at this site consisted of very fast chutes and riffles.

This site was not rated in 2004 because it had characteristics of a trout stream (low total species diversity, low diversities of darters and cyprinids, a low percentage of omnivores+herbivores, and a high percentage of insectivores) and criteria have yet to be developed for this type of fish community. Two-thirds of all the fish collected were mottled sculpin. Wild, young-of-year and stocked adult brown trout were collected as were wild, young-of-year, juvenile, and adult rainbow trout. Species collected at this site but not typically found in trout streams included redbreast sunfish (5), bluegill (7), and largemouth bass (1). The community seemed to be supporting its designated uses for aquatic life and as trout (Tr) waters.

**Scott Creek, SR 1556**

The monitoring site on Scott Creek is downstream of the Sylva WWTP as well as several other small dischargers. However, conductivity was only 41 μmhos/cm. Scott Creek was seven meters wide, with a good boulder, rubble, and gravel substrate. The benthos sampling site was adjacent to the parking lot of the Great Smoky Mountains Railroad in downtown Dillsboro. Land use near the monitoring site is urban, and the stream flows along US 23 Business and through Sylva, before land use in upstream areas changes to forested and agricultural. The stream channel is highly modified within the town as much of the bank is protected by rip-rap. The low habitat score (55) reflects the poor riparian zone in Dillsboro, plus a relatively uniform riffle/run habitat. The stream was very turbid after storms during the week, with water levels rising and falling quickly, reflecting the high amount of impervious surface in the watershed.

A high Biotic Index in 1994 indicated dominance by facultative and tolerant taxa, including midges, worms, blackflies, baetid mayflies, and hydropsychid caddisflies. The site was rated Good-Fair in 1994. In 1999 and 2004 a Good bioclassification was assigned based on benthic data. Metrics such as Total S, EPT S, BI, and EPT BI were basically the same in 1999 and 2004. The only notable change in fauna was an abundance of the intolerant caddisfly, *Brachycentrus spinae* in 2004.

**Conley (Connelly) Creek, SR 1183**

Conley Creek (also spelled Connelly Creek) is a small tributary (six meters wide), to the Tuckasegee River in the southeastern corner of Swain County. There is one NPDES facility (NC0084441) within the creek's watershed. It is located approximately 0.6 miles upstream of the fish community monitoring site. The facility discharges 0.012 MGD to Conley Creek. Since 2001 there have been three permit violations -- fecal coliform bacteria and parameter missing (dissolved oxygen) (Basinwide Information Management System query January 18, 2005).

During benthic sampling conductivity was slightly high for a mountain stream at 26 μmhos/cm, but the stream parallels the road that has residential development all along it. The substrate was diverse and rocky, but the rocks were covered with periphyton and slippery. The riparian zones were narrow with minimal shading, but the banks were stable resulting in a habitat score of 74. The actual sampling site was moved less than a quarter mile upstream from the prior basinwide sampling site to the SR 1183 bridge where parking was safer.

Conley Creek was Excellent in 1994 and 1999. In 2004 the bioclassification declined to Good, when EPT taxa declined from 44 in 1999 to 34 in 2004. The biggest decline was in the number of mayfly taxa from 22 to 15. It is interesting that, in contrast, the EPT BI improved from 3.17 to 2.82, and EPT overall abundance was about the same. Intolerant taxa such as *Glossosoma, Malirekus hastatus*, and *Neophylax consimilis* became abundant in 2004. Because this was an EPT sample, the decrease in the number of facultative baetid taxa may be masking no real change in water quality, especially when stonefly taxa richness and abundance values were similar both years.

Like the fish community in Scott Creek, this site was not rated in 2004 because it had characteristics of a trout stream (low total species diversity and low diversities of darters and cyprinids) and criteria have yet to be developed for this type of fish community. Only nine species were collected and approximately 46 percent of all the fish collected were mottled sculpin. No tolerant fish were collected, but the intolerant species were only represented by rainbow trout. Wild, young-of-year and stocked adult brown trout were collected, as were wild, young-of-year and adult rainbow trout. The community seemed to be supporting its designated uses for aquatic life and as trout (Tr) waters.

**Bradley Fork, off US 441**

This scenic stream was sampled at the back end of the Great Smoky Mountains National Park's Smokemont campground. This site was about 12 meters wide with high quality habitat (94), and very swift flow. Conductivity at the time of the benthic invertebrate sampling was 14 µmhos/cm. The Bradley Fork watershed is completely forested with some hiking trails. The substrate is largely boulder and rubble.

As would be expected for a stream in a natural setting, the site has been given an Excellent bioclassification during all three basinwide surveys. EPT S was 47 in 2004 compared to 39 and 42 in 1999 and 1994. Interesting taxa included three species of *Drunella*, *Nixe flowersi*, *Symphitopsyche alhedra*, *Acroneuria carolina*, and a yet to be identified leech.

**Oconaluftee River, Jenkins Crossing Bridge, near Birdtown**

The Oconaluftee River and its tributaries (including Bradley Fork) drain the Great Smoky Mountains National Park and the Cherokee Indian Qualla Boundary. The lower portion of this stream (near Birdtown) receives heavy recreational use and urban runoff from the Town of Cherokee. The river was approximately 40 meters wide and has a drainage area of 284 square miles at this location. Conductivity was only 14 µmhos/cm. Sampling was easy due to the dominance of rubble in the substrate, with few boulders. The habitat score of 72 is influenced by the larger size of the river with roads on both sides.

The bioclassification of the river has been Good twice and Excellent five times since 1983. The lower rating is thought to be due to high flows. The Excellent rating, total (106) and EPT (51) taxa richness in 2004 were unchanged from 1999. Hydropsychid caddisflies and heptageniid mayflies were dominant. The rarely collected stonefly, *Agnetina flavipes*, was abundant.

**Deep Creek, above campground**

This site, located within Great Smoky Mountain National Park (GSMNP), is a popular tubing area and receives heavy use during summer months. The channel is 11 meters wide with an average depth of 0.3 meters. Substrate appeared to be somewhat embedded. Benthic substrate was a mix of boulder (30%), rubble (30%), gravel (30%) and sand (10%). The drainage area at this location is 39.7 square miles. The habitat scored 75 (out of 100) in 2004, down from 91 in 1999. In 2004, habitat was limited by the lack of pools, some embeddedness, and lack of woody debris available for macroinvertebrate colonization. Due to the protected nature of Deep Creek's forested catchment, conductivity measured only 12 µmhos/cm.

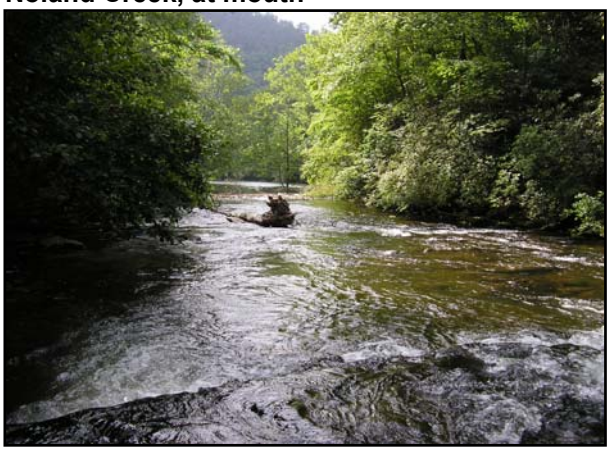
Deep Creek rated Excellent in 2004; the same rating it received the previous two samplings (1994, 1999). Species composition (43 EPT taxa) and EPT BI (2.1) appear to have changed very little here. A slightly more sensitive macroinvertebrate community persisted here compared with the downstream SR 1340 location. Very intolerant taxa (tolerance value = 0.0) found here that were absent at the downstream location were the mayflies *Nixe*, *Serratella carolina*, the stonefly *Agnetina flavescens*, and the caddisflies *Psilotreta*, *Rhyacophila carolina*, and *Nyctiophylax nephophilus* (t.v. = 0.8).

**Deep Creek, SR 1340**

This site is located outside Great Smoky Mountain National Park, approximately three miles downstream of the other sampling location on Deep Creek. The area is a mix of agricultural areas and residential development. The stream is 12 meters wide with an average depth of 0.3 meters. Lower stream gradients here and a typical riffle, run, pool sequence distinguishes this section from the upstream Park section. Benthic substrate differed little from the upstream section. The drainage area at this location is 42.8 square miles. Though the land use around this location is very different from the upstream site, the overall habitat score was similar (73 out of 100). In 2004, undercut banks and root mats, provided microhabitats for colonization. However, the riparian zone was narrow in many places along this section and consisted primarily of grasses instead of mature trees. Conductivity though, remained low (12 µmhos/cm).

Deep Creek at SR 1340 rated Excellent in 2004; the same rating it received the previous two samplings (1994, 1999). Species composition was similar to the upstream location but did contain a higher number of slightly more pollution tolerant species, such as the caddisfly *Cheumatopsyche* (t.v. = 6.2), and the stonefly *Perlesta* (t.v. = 4.7), resulting in a slightly higher EPT BI (2.18) than the upstream site (2.13). New taxa found in 2004 that were not found previously or at the upstream location include the caddisflies *Hydroptila* and *Triaenodes*. The EPT BI was the lowest in 2004, indicating a more pollution intolerant community than existed in 1999 (EPT BI = 2.95) and 1994 (EPT BI = 2.42).

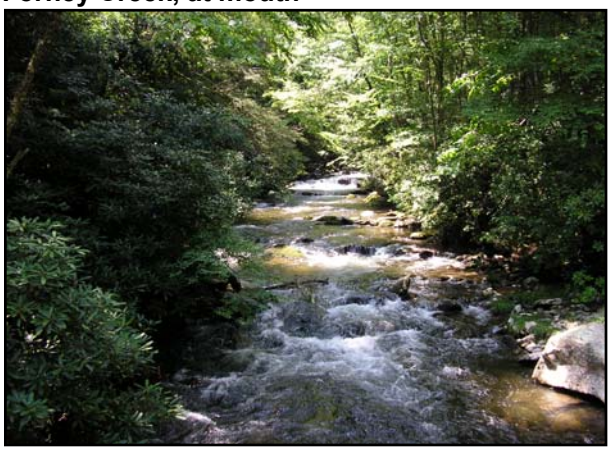
**Noland Creek, at mouth**



This site is located within Great Smoky Mountain National Park, just above the confluence of Noland Creek with the Tuckasegee River/Fontana Lake. This high velocity stream is 10 meters wide with an average depth of 0.5 meters. Benthic substrate consisted of approximately 40% bedrock, 40% boulder and 20% rubble. Trace amounts of gravel and sand were also present. The drainage area at this location is 20.2 square miles. The habitat here is intact, with wide riparian zones of mature vegetation. Conductivity was very low (10 µmhos/cm).

Noland Creek rated Good in 2004; down from Excellent during the previous survey (1999). In 1999, 40 EPT taxa were collected compared to 35 in 2004. Similar numbers of stoneflies and mayflies were collected in both years but in 2004 five fewer caddisfly taxa were seen. In 1999, three species of *Rhyacophila* were collected (*R. carolina*, *R. fuscula*, and *R. mycta*), though none were found in 2004. *Ceratopsyche alhedra* (abundant), *Ceraclea ancylus* (abundant), and *Dolophilodes* (common) were collected in 1999, but were absent in 2004. The EPT BI was identical in both years (1.9), indicating a very sensitive benthic fauna, but also suggesting that little change in water quality has occurred at this site. The cause for lower caddisfly diversity in 2004 is unknown.

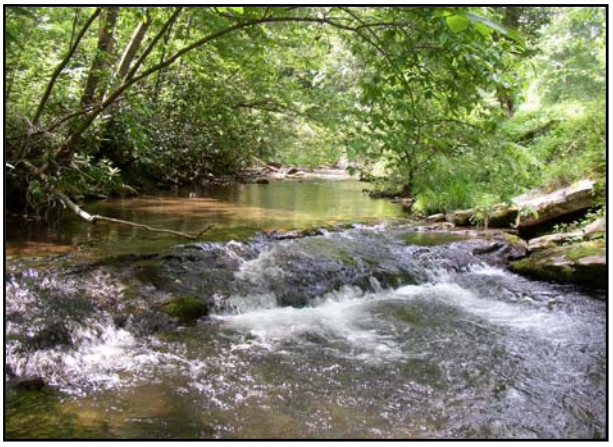
**Forney Creek, at mouth**



This site is located within Great Smoky Mountain National Park, just above to the confluence of Forney Creek with Fontana Lake. This high gradient stream is eight meters wide with an average depth of 0.5 meters. Benthic substrate consists of 60% boulder, 20% rubble, 10% gravel and 10% sand. The drainage area at this location is 28.0 square miles. The habitat here is very healthy, with wide riparian zones of mature vegetation. The habitat scored 89 out of 100. Conductivity was very low (9 µmhos/cm).

Forney Creek rated Excellent in 2004; the same rating as in 1994 and 1999. In 2004, 42 EPT taxa were collected. This is similar to 1994 and 1999 when 46 EPT were found. In 2004, the Biotic Index measured 2.5, comparable to 1994 (2.4 BI) and 1999 (2.6 BI). Numerous pollution sensitive species resided in this stream, including *Serratella carolina*, *Rhithrogena uhari*, and *Epeorus dispar* (first collected in 2004). Another sensitive species however, was not found in 2004 after being abundant in 1994 and 1999, *Arctopsyche irrorata*. A rarely collected species known to occur in the Park, *Cheatocladius ligni*, was found in 2004. The total number of taxa collected and species composition changed little over the three sampling periods however (i.e. 79 in 1994, 81 in 1999 and 78 in 2004), indicating a very stable benthic community.

**Panther Creek, SR 1233**



Panther Creek, in northeastern Graham County, is a high gradient tributary to the Panther Creek Arm of Fontana Reservoir. This site is approximately 0.3 miles above the reservoir. The drainage area at this location is 9.2 square miles. There are no NPDES permitted facilities within the creek's watershed. At this crossing, the instream, riparian, and watershed characteristics are of exceptionally high quality (habitat score = 90) and qualified the site as a new fish community regional reference site (Appendix F-2). The habitat score was the highest of any fish community site in the basin in 2004, except for Walnut Creek (Subbasin 01) whose score also was 90.

During benthic sampling, Panther Creek was 0.2 meters deep and five meters wide. The substrate is a mix of bedrock (30%), boulder (20%), rubble (20%), gravel (20%), and sand (10%). Moderate amounts of aufwuchs were present making the bedrock very slippery and suggesting possible nutrient enrichment. The habitat scored only 68 (out of 100). Pool habitat was limited and erosional areas were present, particularly where the road comes within a few meters of the stream. In these areas the riparian zone is narrow (< three meters) and consists mostly of grasses or young trees. Conductivity measured 22.0 µmhos/cm.

Panther Creek rated Good in 2004 for macroinvertebrates, a decline from Excellent in 1994 and 1999. EPT S decreased from 37 in 1994 and 39 in 1999 to 35 in 2004. However, EPT BI remained comparable among years (1.8 in 1994, 2.2 in 1999, and 2.0 in 2004). Taxa common in 1994 and 1999 that were absent in 2004 include the mayfly *Baetis flavistriga*, and the very pollution sensitive *Goera* sp. Conversely, *Stenonema modestum* and *Perlesta* sp., two taxa that are less sensitive to pollution, were collected for the first time in 2004. Though increased residential land use, as seen by new construction in 2004, and continued light agriculture documented from 1999 may be affecting this stream, the EPT BI suggested that water quality may not have declined significantly.

Like the fish communities in Scott and Conley Creeks, this site was not rated in 2004 because it had characteristics of a trout stream (low total species diversity and low diversities of darters and cyprinids) and criteria have yet to be developed for this type of fish community. Only nine species were collected including only three species of cyprinids and one intolerant species (rainbow trout). Wild, young-of-year and stocked brown trout were collected, as were wild, young-of-year, juvenile, and adult rainbow trout. Species collected at this site but not typically found in trout streams included green sunfish (10) and bluegill (1); they had probably migrated upstream from the reservoir. Although mottled sculpins were abundant, the dominant species was the herbivorous central stoneroller. Approximately two-thirds of all the fish collected were of this species. Its abundance may indicate that straight-piping or nonpoint-source runoff may be contributing excess nutrients to this stream. Even though the community seemed to be supporting its designated uses for aquatic life and as trout (Tr) waters, the abundance of central stonerollers, indicative of excessive nutrients, warrants additional monitoring in the future.

**Stecoah Creek, SR 1237**

Stecoah Creek, in northeastern Graham County, is a small tributary to Fontana Reservoir. The site is approximately 1.5 miles above its mouth. The recent NC 28 widening project occurred in the middle part of its watershed. This stream is located in a more densely developed (residential) drainage than other streams in the subbasin.

During benthic sampling, this small mountain stream was five meter wide and 0.3 meters in depth. The substrate is a mix of boulder (30%), rubble (20%), gravel (10%), sand (20%) and silt (20%). Some channelization has occurred. A significant amount of substrate (larger rocks) has been removed from the streambed for retaining walls around adjacent livestock areas or stream bank protection (see photo). Moderate amounts of aufwuchs were present. Also, the water appeared slightly turbid, yet it had not recently rained. The drainage area at this location is 8.9 square miles. The habitat scored only 57 out of 100. Pool habitat was nonexistent and substrate in riffle areas was 50% embedded. More silt was seen on the benthic substrate here than other sites in the subbasin. Erosional areas along the bank were near the residential and agricultural areas (see photo). Riparian vegetation consisted of mostly grasses and a few trees. Conductivity was elevated measuring 44 µmhos/cm (i.e. four times what was measured in streams from Great Smoky Mountain National Park) as was pH (6.7 s.u.).

Stecoah Creek rated Good in 2004, as in 1994, though the site received an Excellent in 1999. EPT S decreased from 39 in 1999 to 30 in 2004, similar to the 29 EPT collected in 1994. The EPT BI was similar in 2004 (2.9) and 1999 (3.0), an improvement from 1994 (3.7). This stream was identified in 1999 as one that is adversely affected by high flows, due to nonpoint sources (e.g. agricultural and residential runoff) located within the watershed. In years of above average flows, such as 1994 and 2004, more pollutants are carried into the stream, degrading water quality. In years of normal or low flows, the lack of pollutants running off the landscape allows a more diverse and intolerant macroinvertebrate community to exist. This is supported by the Excellent rating in 1999, a year of normal flow. In 1999, eight taxa were collected that were not found in 1994 or 2004, including many very pollution intolerant taxa such as the caddisflies *Rhyacophila carolina*, *Nyctiophylax*, and *Brachycentrus spinae*, and the mayflies *Heptagenia marginalis* and *Drunella allegheniensis*. The average tolerance value of the eight taxa was 2.2, much lower than EPT BI in either 1994 or 2004. As predicted in the previous report, this site will continue to fluctuate between ratings depending on flow conditions.

Like the fish communities in Scott, Conley, and Panther Creeks, this site was not rated in 2004 because it had some characteristics of a trout stream (low total species diversity and low diversities of darters) and criteria have yet to be developed for this type of fish community. Only 10 species were collected, including seven species of cyprinids and only one intolerant species (rainbow trout). Young-of-year and wild, adult rainbow trout and one each, stocked brook trout and brown trout were collected.

However, unlike other trout streams in the basin that were monitored in 2004, this site appeared and seemed to be degraded. Only 202 fish were collected and of those, less than 10 percent of them were mottled sculpins. The most abundant species was the omnivorous river chub. This species and the herbivorous central stoneroller represented approximately 50 percent of all the fish collected, indicating that straight-piping or nonpoint-source runoff may be contributing nutrients to this stream. Even though the community seemed to be supporting its designated uses for trout (Tr) waters, the abundance of river chubs and central stonerollers, the silt on the substrate, and the widening of NC 28 in the Stecoah Valley warrants additional monitoring of this site in the future.

**Hazel Creek, at mouth**

This site is located within Great Smoky Mountain National Park, approximately 0.5 km upstream of the confluence of Hazel Creek with Fontana Lake. The stream is 10 meters wide with an average depth of 0.5 meters. Benthic substrate consists of 20% boulder, 50% rubble, 20% gravel and 10% sand. The drainage area at this location is 44.8 square miles. The habitat here is very healthy, consistent with a protected watershed. Conductivity was very low (11 µmhos/cm).

Hazel Creek rated Excellent in 2004; the same rating as in 1994 and 1999. In 2004, 46 EPT taxa were collected and the Biotic Index measured 3.2. This is very similar to 1994 (46 EPT, 2.4 BI). In 1999, 56 EPT (3.0 BI) were collected under low flow conditions of that year. Numerous pollution sensitive species reside in this stream such as the following collected in each of the three samplings: the caddisflies *Ceratopsyche alhedra*, *Rhyacophila carolina*, *Micrasema wataga*, and *M. rickeri*; the mayflies *Serratella serrata*, *Drunella tuberculata*, and *D. cornutella,* and the midge *Pagastia*.

**Twentymile Creek, NC 28**

This site is located within Great Smoky Mountain National Park behind the ranger station off NC 28. This site had not previously been sampled by NCDWQ and was added in 2004 to represent the western area of GSMNP in North Carolina. This stream had the highest gradient sampled in the LTN 02 and contained many waterfalls and plunge pools. Benthic substrate consists of a high percentage of boulder (60%), with 20% rubble and 20% gravel. Typical of other sites in GSMNP, the habitat was minimally disturbed, scoring 95 out of 100. The site was lacking woody debris and other organic microhabitats, typical of very high gradient streams. The drainage area at this location is 15 square miles. Conductivity was very low (9 µmhos/cm).

Twentymile Creek rated Good in 2004 with 29 EPT taxa and an EPT BI of 2.15. Though supporting a very intolerant macroinvertebrate community, the lack of organics (sticks, logs, leaf packs) limited the total fauna in this high gradient stream. It is likely that increased downstream transport of these microhabitats occurs more quickly with each storm event, leading to a naturally oligotrophic condition. Continued monitoring of this stream is recommended to determine if the oligotrophic conditions seen in 2004 are normal for this stream.

## LITTLE TENNESSEE RIVER SUBBASIN 03

### Description

This subbasin contains most of the Nantahala River catchment (Figure 4). The northern half of the subbasin is in the Southern Metasedimentary Mountain ecoregion characterized by steep dissected, biologically diverse mountains. The geologic make-up is of Pre-Cambrian origins and the Appalachian oak and northern hardwood forests dominate the landscape. The southern portion of the subbasin is within the Southern Crystalline Ridges and Mountains ecoregion. This area is 1,200 to 4,500 feet in elevation with Pre-Cambrian geology and well drained, acidic, loamy soils supporting a chestnut oak forest (Griffith *et al*. 2002).

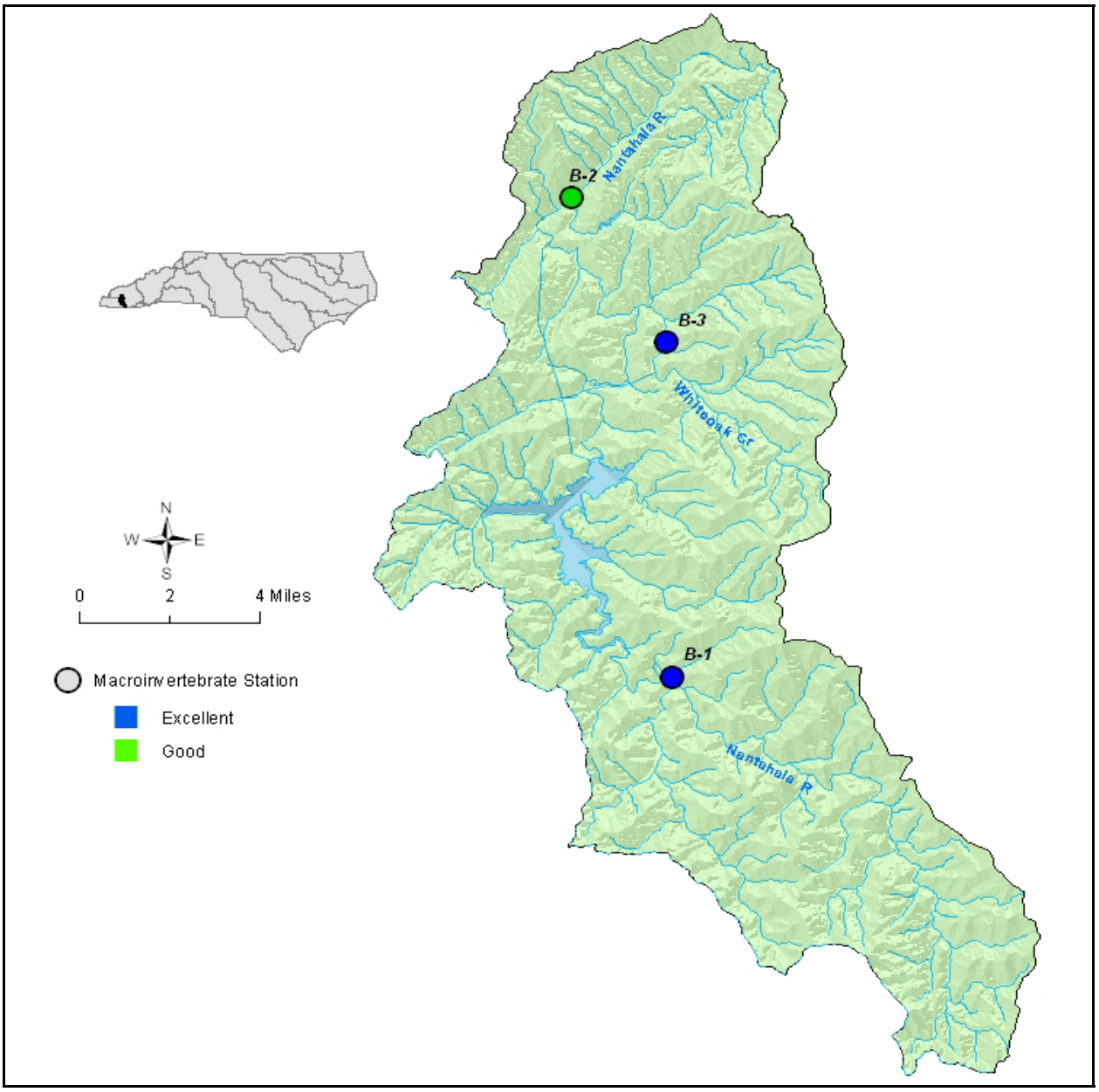



**Figure 4.** **Sampling sites in Subbasin 03 of the Little Tennessee River basin. Monitoring sites are listed in Table 6.**

Headwaters of the Nantahala River are entirely within the Nantahala National Forest. The river, from its source to the confluence with Roaring Fork, is supplementally classified ORW. Much of the land adjacent to this reach is privately owned. The river and most tributaries are high gradient systems capable of supporting wild trout populations.

Nantahala Power and Light Company impounded the river creating Nantahala Lake. Flow is diverted to downstream generators at Beechertown, bypassing a seven-mile reach of the river prior to discharging back into the original channel above the Nantahala Gorge. The regulated reach of the river below the powerhouse is very popular for rafting and canoeing. Development has increased along the gorge corridor as it relates to the recreational industry. Ninety six percent of the subbasin is forested (Table 5).

**Table 5. Land use in Subbasin 03. Based upon CGIA coverage 1993 - 1995 (total area = 155 square miles (NCDENR 2002).**

| Land use | Percent |
|---|---|
| Water | 1.7 |
| Cultivated crop | 0.1 |
| Pasture | 1.8 |
| Urban | 0.2 |
| Forest | 96.2 |

## Overview of Water Quality

Overall, the water quality in this subbasin is good (Table 6). The Nantahala River at FSR 437, within the Nantahala National Forest, has rated Excellent based on benthos samples since summer sampling began in 1985. Downstream, off US 19/74, the Nantahala retained its Good bioclassification from 1999, although this reach is affected by daily summer releases from the Nantahala Reservoir. Whiteoak Creek off SR 1310, below Whiteoak Dam, improved from Good in 1999 to Excellent in 2004. The bioclassification at Dicks Creek off SR 1401 declined from Good to Good-Fair, possibly due to lingering effects of the 2002 drought. Whiteoak Creek at SR 1397 improved from Fair in 1990 to Good-Fair in 2004. However, this site is still affected by an upstream trout farm. No fish community assessments were conducted in the subbasin in 2004.

There is only one ambient monitoring site within this subbasin – the Nantahala River at FSR 437. Only two measurements for turbidity exceeded water quality standards from 1999 to 2004.

**Table 6. Waterbodies monitored in Subbasin 03 in the Little Tennessee River basin for basinwide assessment, 1999 and 2004.**

| Map # | Waterbody | County | Location | 1999 | 2004 |
|---|---|---|---|---|---|
| B-1 | Nantahala R | Macon | FSR 437 | Excellent | Excellent |
| B-2 | Nantahala R | Swain | US 19/74 | Good | Good |
| B-3 | Whiteoak Cr | Macon | Off SR 1310 | Good | Excellent |

**Nantahala River, FSR 437**

The Nantahala River at FSR 437, within the Nantahala National Forest, was 22 meters wide with a watershed area of 51.7square miles. Boulders and rubble comprised most of the substrate while gravel and sand were present. Plenty of suitable habitat was available in the form of rocks and snags. The pH was 7.0 s.u. and the dissolved oxygen (DO) concentration was 9.0 mg/l. The conductivity was 17 µmhos/cm. The habitat score was also constant at 87 (84 in 1999).

This site has rated Excellent since 1984 and 2004 was no exception. All biological parameters observed in 2004 were relatively similar to 1999 values. The EPT S remained constant at 49 while the BI declined slightly from 3.43 in 1999 to 3.19 in 2004. The total taxa richness also declined from 100 to 92 in 2004. Notable intolerant taxa include *Rhithrogena exilis*, *Oligostomis pardalis*, and *Rhyacophila acutiloba*.

**Nantahala River, US 19/74**

This site is in the regulated reach of the river below Nantahala Lake. The width at this site was 13 meters and the drainage area was 141.9 square miles. The substrate was mostly rubble but some boulders and gravel were also present. The habitat available for colonization was mostly rocks covered with *Podostemum* and some root mats. Water chemistry results were similar to those found in 1999 except for conductivity. Dissolved oxygen (DO) was 9.6 mg/L and conductivity was 45 µmhos/cm. In 2004 water chemistry measurements were taken after an upstream impoundment began to release. The overall habitat score increased from 71 to 81.

The Nantahala River at US 19/74 rated Good in 2004, the same rating received in 1999. The EPT BI, EPT N, and EPT S also remained stable at 2.26 (2.29 in 1999), 125 (143 in 1999) and 35 (35 in 1999) respectively. *Paraleptophlebia*, *Leuctra*, and *Lepidostoma* remained the dominant taxa. No major changes in the biological community were evident.

**Whiteoak Creek, off SR 1310**

At this site above an impoundment, Whiteoak Creek was three meters wide and the drainage area was 15.0 square miles. The entire right bank was cleared of trees down to the stream to make way for electric and phone lines that paralleled the stream. The substrate was largely comprised of boulders, with some rubble, gravel, and sand. Dissolved oxygen (DO) was 8.8 mg/L and conductivity increased from 19 µmhos/cm in 1999 to 52 µmhos/cm in 2004. The habitat score of 85, however, was similar to that received in 1999 (82).

Despite the increase in conductivity and the lack of riparian zone on the right bank, the rating at this site improved from Good in 1999 to Excellent in 2004. The EPT S increased from 31 to 34 in 2004. The EPT BI also decreased from 2.14 in 1999 to 1.68 in 2004. The EPT N remained fairly constant at 159 (168 in 1999).

**SPECIAL STUDIES**
**Dick's Creek, off SR 1401**

At the request of the Asheville Regional Office, Dick's Creek, a small tributary of the Nantahala River, was sampled to determine the biological integrity of the stream prior to a water reintroduction project by Duke Power. This site was also sampled in 1999. Dick's Creek was six meters wide at the time of sampling with a watershed area of 4.5 square miles. The substrate consisted mostly of rubble and gravel but boulders and sand were also present. Available habitat included plunge pools and snags. The dissolved oxygen (DO) measurement was 9.4 mg/L in 2004. Conductivity readings increased slightly to 21 µmhos/cm (17 µmhos/cm in 1999). The overall habitat score was 91 out of 100 in 2004.

The rating at this site declined from Good in 1999 to Good-Fair in 2004. The EPT S declined from 34 to 27 and the EPT N declined from 200 in 1999 to 146 in 2004. Although the EPT BI decreased from 1.93 to 1.59, it was not enough to maintain a Good rating at Dick's Creek. The number of Trichopteran taxa declined from 15 in 1999 to 9 in 2004. Missing taxa included *Arctopsyche irrorata*, *Nyctiophylax nephophilus*, *Polycentropus*, and several *Rhyacophila* species. (See BAU Memorandum B-20050218 for more information).

**Whiteoak Creek, SR 1397**

The Asheville Regional Office requested a sample below a trout farm in conjunction with the basinwide site downstream of the Whiteoak Creek dam off SR 1310. At this sampling point, the stream was five meters wide with a drainage area of 7.1 square miles. The substrate was mostly rubble with some boulder and gravel present. Available habitat consisted of mostly rocks with a few snags available for colonization. The conductivity was lower (23 µmhos/cm) at this upper site than at the downstream site (52 µmhos/cm). Dissolved oxygen (DO) was similar at both sites at 8.8 mg/L (downstream) and 8.4 mg/L (upstream). The habitat score at the lower site was 72 due mostly to poor canopy cover and riparian areas.

This site was last sampled in 1990 and received a Fair bioclassification. In 2004, the rating increased to Good-Fair. Although the total taxa richness stayed constant at 62, the EPT S increased from 20 in 1990 to 26 in 2004. Additionally, the BI decreased from 5.90 to 4.26, indicating a more intolerant community. However, the snail *Physella* and oligocheates dominated the macroinvertebrate community below the trout farm, indicating low DO and organic inputs are issues. (See BAU Memorandum B-20050218 for more information).

## LITTLE TENNESSEE RIVER SUBBASIN 04

### Description

This subbasin contains the Cheoah River and all of its tributaries (Figure 5). Most of the subbasin is in the Southern Metasedimentary Mountain ecoregion characterized by steep dissected, biologically diverse mountains. The geologic make-up is of Pre-Cambrian origins and the Appalachian oak and northern hardwood forests dominate the landscape. A small portion on the western boundary is in the High Mountain ecoregion. This area is above 4,500 feet in elevation with more severe boreal-like climate, frigid soils, and evergreen red spruce and Fraser fir forests (Griffith *et al*. 2002).

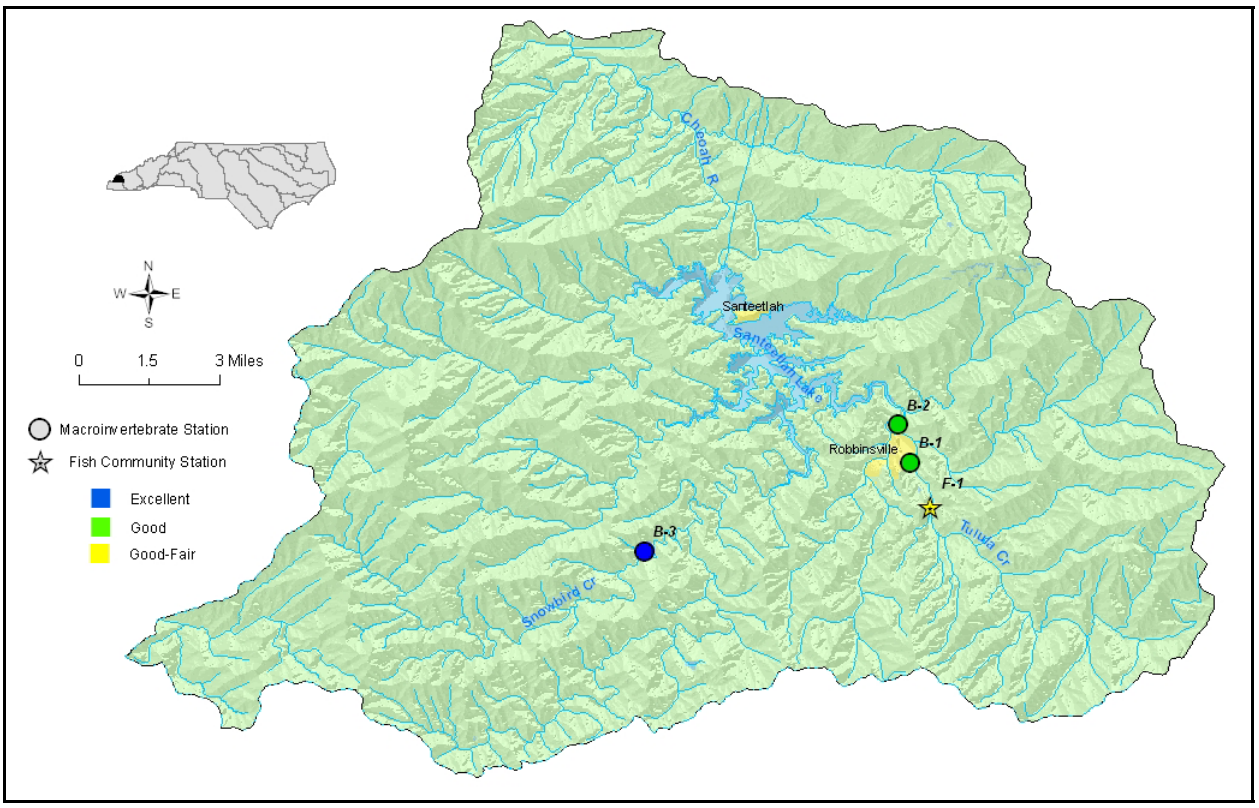



**Figure 5. Sampling sites in Subbasin 04 of the Little Tennessee River basin. Monitoring sites are listed in Table 8.**

Significant sections of most tributary catchments are within the Nantahala National Forest and are minimally impacted. These tributaries are typically high-gradient streams capable of supporting trout populations. However, lower reaches of some tributaries and corridors along Tulula Creek, Sweetwater Creek, Little Snowbird Creek, Yellow Creek, and the Cheoah River are not in the national forest. Thus, they are more likely to be impacted by land disturbing activities. Tulula Creek flows through the Town of Robbinsville, where the stream becomes the Cheoah River at its confluence with Sweetwater Creek.

Robbinsville is the only urban area in this subbasin. There are only three NPDES permitted dischargers in this subbasin (Basinwide Information Management System query December 2004). The Wastewater Treatment Plant (WWTP) for the town of Robbinsville, a minor municipal discharger releases 0.63 MGD into Long Creek, a tributary of the Cheoah River. The town's water treatment plant discharges 0.1 MGD to Rock Creek, a headwater tributary to Long Creek. Wide Creek Trout Sales has an unlimited discharge to Snowbird Creek, a tributary to Lake Santeetlah. None of these facilities is required to monitor their effluent's toxicity. The Cheoah River is dammed below Robbinsville to form Santeetlah Lake. Tapoco, Inc. manages the flow in the river and in the impoundment to provide hydroelectric power for the

Aluminum Company of America. The de-watered tailwater reach is approximately nine river miles in length prior to its confluence with the Little Tennessee River below Cheoah Dam. Ninety four percent of the subbasin is forested (Table 7).

**Table 7. Land use in Subbasin 04. Based upon CGIA coverage 1993 - 1995 (total area = 221 square miles (NCDENR 2002).**

| Land use | Percent |
|---|---|
| Water | 2.1 |
| Cultivated crop | 0.2 |
| Pasture | 3.2 |
| Urban | 0.5 |
| Forest | 94.0 |

## Overview of Water Quality

The Tulula River at SR 1275 above the Town of Robbinsville and the Cheoah River off SR 1138 below Robbinsville declined from Excellent in 1999 to Good in 2004. This suggested that neither the town nor its WWTP were the cause of the decrease in bioclassification, but rather that a more system wide disturbance was to blame. The Cheoah River at SR 1147, below Santeetlah Dam, was impaired due to the impoundment, but recovered downstream at the USGS gauge as tributaries added water to the system. Snowbird Creek retained an Excellent bioclassification from 1999. Most of the watershed is within the Nantahala National Forest. The one fish site on the Tulula River at SR 1260 received a Good-Fair bioclassification.

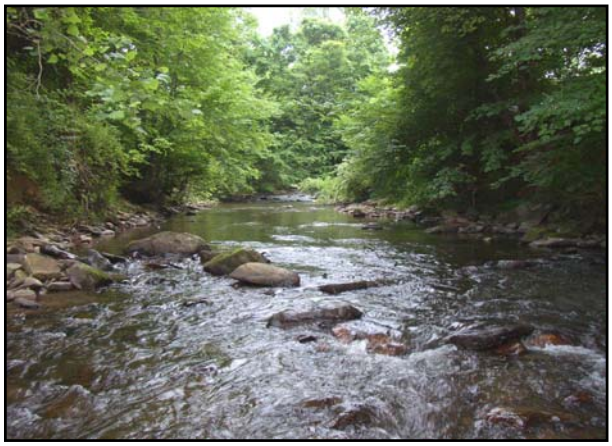
There is one ambient monitoring site within the subbasin -- the Cheoah River below the Town of Robbinsville. Only five measurements exceeded water quality standards or action levels between 1999 and 2004; once for pH, twice for turbidity, and once for copper and iron.

**Table 8. Waterbodies monitored in Subbasin 04 in the Little Tennessee River basin for basinwide assessment, 1999 and 2004.**

| Map # | Waterbody | County | Location | 1999 | 2004 |
|---|---|---|---|---|---|
| B-1 | Tulula Cr | Graham | SR 1275 | Excellent | Good |
| B-2 | Cheoah R | Graham | Off SR 1138 | Excellent | Good |
| B-3 | Snowbird Cr | Graham | SR 1120 | Excellent | Excellent |
| F-1 | Tulula Cr | Graham | SR 1260 | --- | Good-Fair |

## River and Stream Assessment

### Tulula Creek, SR 1260



The Tulula River watershed lies within the southeastern corner of Graham County. For much of its length, US 129 and a railroad parallel the creek as it courses down the valley. At this site, most of the habitats were of high quality, except at the upper reach along the right shoreline where there was no canopy and the riparian zone was a well manicured residential lawn.

The Tulula Creek fish community site was sampled for the first time in 2004; it is supplementally classified as trout waters (Tr) and is managed as Hatchery Supported Trout Waters by the North Carolina Wildlife Resources Commission. Wild, not stocked, trout were collected from Tulula Creek. In 2004, the fish community in Tulula Creek was rated Good-Fair (NCIBI = 46). The most abundant species

was the herbivorous central stoneroller; mottled sculpin and the omnivorous river chub were also abundant. The total diversity of species and diversities of darters and cyprinids were lower than expected. The abundance of omnivores+herbivores were much greater than expected and indicated upstream straight-piping or nonpoint-source erosion contributions of nutrients. This was the only site in the basin where the uncommon, tangerine darter was collected and only one of them was collected. Wild, young-of-year and adult rainbow trout and three stocked brown trout were also collected.

**Tulula Creek, SR 1275**

Tulula Creek at SR 1275 is located upstream of the Robbinsville Wastewater Treatment Plant (WWTP) and was approximately nine meters wide with a watershed area of 28.5 square miles. The substrate was largely boulders and rubble with a moderate amount of gravel and sand. These rocks as well as occasional sticks and rootmats provided habitat. Water chemistry readings were similar to those recorded in 1999. The pH was 6.3 s.u. (7.2 s.u. in 1999) and the dissolved oxygen (DO) concentration was 7.4 mg/l. The conductivity was 32 µmhos/cm (31 µmhos/cm in 1999). The habitat score was 68, considerably lower than the 82 received in 1999. This decrease was due mostly to poor scores on instream habitat, pool variety, and riparian zones.

This site had rated Excellent in 1999 but declined to Good in 2004. This was due to a decrease in taxa. Total taxa richness decreased by 24 to 61 and the EPT S declined from 40 in 1999 to 32 in 2004. Missing taxa include *Symphitopsyche bronta*, *Neophylax consimilis*, *Nectopsyche exquisita*, *Chimarra*, *Serratella serrata*, *Ephemerella catawba*, and *Dannella simplex*. The Biotic index (BI) remained almost unchanged over the five year period (3.99 in 1999 and 3.95 in 2004). The drop in biological integrity may be due to habitat losses as indicated by the lower habitat score. Urbanization in Robbinsville may also be a factor affecting biological integrity in this reach.

**Cheoah River, off SR 1138**

The Cheoah River was sampled below the Town of Robbinsville's WWTP. Sewage odors were present during sampling. The width here was 13 meters and the drainage area was 55.0 square miles. Bedrock, boulders, rubble and gravel were fairly evenly dispersed throughout the reach. Habitat consisted mainly of rocks and undercut rootmats. Water chemistry results were similar to those found in 1999. Dissolved oxygen (DO) was 8.1 mg/L and conductivity was 37 µmhos/cm as compared to 36 µmhos/cm in 1999. The overall habitat score declined slightly from 90 in 1999 to 82 in 2004.

This site was rated Good, down from the Excellent rating in 1999. EPT S declined substantially from 48 to 38 and the EPT N decreased from 280 in 1999 to 180 in 2004. The biotic index (BI) also rose to 3.96 from 3.48 in 1999, indicating only a slightly more tolerant community. There was no difference in bioclassification between sites upstream and downstream of the WWTP. This suggests that the declines at Tulula Creek and the Cheoah River may be due to a more system wide disturbance affecting habitat.

**Snowbird Creek, SR 1120**

At this site, Snowbird Creek was 14 meters wide and the drainage area was 16.9 square miles. The substrate was largely comprised of rubble with some boulders and a little sand and gravel present. These rocks constituted most of the habitat available. Water chemistry was similar to that found in 1999. Dissolved oxygen (DO) was 8.9 mg/L. Conductivity was 9 µmhos/cm in 1999 and 2004. The habitat score of 91 was similar to that recorded in 1999 (87).

Snowbird Creek retained its Excellent rating from 1999 in 2004. The EPT S decreased slightly from 52 in 1999 to 48 in 2004. The EPT N decreased from 215 to 140, also indicating a slight decline in the macroinvertebrate community. However, the EPT BI indicated a slight improvement from 2.56 to 2.00. Dominant taxa included *Drunella tuberculata*, *Baetis pluto*, *Brachycentrus spinae*, *Symphitopsyche sparna*, and *Tallaperla*, many of which were dominant in 1999.

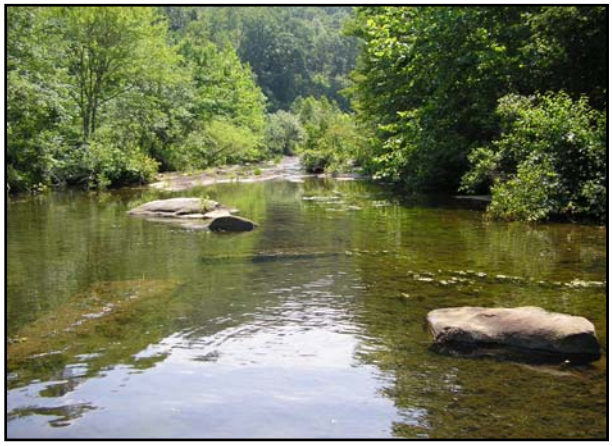
**SPECIAL STUDIES**

**Little Santeetlah Creek, above footbridge**

At the request of the lead biologist at the Division of Water Quality's Biological Assessment Unit, Little Santeetlah Creek was sampled as a possible new reference stream in the mountain ecoregion. The site is located within Joyce Kilmer Memorial Forest. The stream at this point was six meters wide with a watershed area of 5.6 square miles. Boulders made up the majority of the substrate but rubble was also present in moderate amounts. The habitat was comprised mostly of rocks, sticks and leafpacks. The dissolved oxygen (DO) measured 9.0 mg/L and the conductivity was 10 µmhos/cm. The habitat scored 96 out of 100.

Despite the very high habitat score, the bioclassification at this site was Good. Thirty two EPT taxa were observed with an EPT N of 141. The biotic index (BI) was 2.8. Notable taxa included *Drunella walkerii*, *Stenonema pudicum*, *Psilotreta labida*, and *Hydropsyche macleodi*. (See BAU Memorandum B-20050218 for more information).

**Cheoah River, SR 1147**



Tapoco, Inc. plans to reintroduce water to the dewatered section of the Cheoah River below the dam. The Asheville Regional Office and the Division of Water Resources requested a sample below Santeetlah Reservoir in order to obtain pre-release data. At the sampling point, the stream was eight meters wide with a drainage area of 174.5 square miles. The substrate was mostly bedrock with a thick layer of flocculent fine particles filling in the deeper sections. Available habitat consisted of a few rocks interspersed throughout the reach. Due to the upstream impoundment, flow was minimal and the temperature was a warm 29.5 $^{o}$C. The conductivity was 41 µmhos/cm and the dissolved oxygen (DO) measured 8.2 mg/L. The habitat scored a 53 out of 100. This was mostly due to poor instream habitat, the lack of riffles, and a lack of canopy cover.

The bioclassification at this site was Fair. Only 19 EPT taxa were present with an abundance of 67 EPT individuals in the sample. The biotic index (BI) was high at 5.71. The predominance of the bivalve *Pisidium*, the damselfly *Calopteryx*, and the snail *Physella* indicated low flow, low DO, and possible organic enrichment as impairment sources of this site. In addition, the presence of nine odonate taxa is a factor of the slow flow in this reach. (See BAU Memorandum B-20050218 for more information).

**Cheoah River at USGS gauge**

This is the most downstream location sampled on the Cheoah River, and is approximately three miles from where the Cheoah River enters the Little Tennessee River at Tapoco. This site was sampled to determine if there was any recovery downstream of the site at SR 1147. The Cheoah River is 16 meters wide here with an average depth of 0.5 meters. Substrate was a mix of boulders (60%), rubble (20%), gravel (10%) and silt (10%). An abundance of aufwuchs was seen here, especially in the slower portions of the river. The drainage area is 206 square miles. The habitat scored 69 (out of 100), reflecting a lack of pools and a riparian zone with large amounts of the exotic vine kudzu. Conductivity measured 21 µmhos/cm and pH was neutral (7.0 s.u.).

The Cheoah River rated Excellent in 2004 based on an EPT sample, indicating that full recovery was achieved downstream. The number of EPT taxa collected here was 42, including 23 mayfly and 17 caddisfly taxa. Several unusual taxa found here in 2004 included the mayfly *Brachycercus* sp, and the caddisflies *Oecetis* sp. F and *O*. sp. A. (See BAU Memorandum B-20050218 for more information).

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## GLOSSARY

| | |
|---|---|
| $7Q_{10}$ | A value which represents the lowest average flow for a seven day period that will recur on a ten year frequency. This value is applicable at any point on a stream. $7Q_{10}$ flow (in cfs) is used to allocate the discharge of toxic substances to streams. |
| Bioclass or Bioclassification | Criteria have been developed to assign bioclassifications ranging from Poor to Excellent to each benthic sample based on the number of taxa present in the intolerant groups (EPT) and the Biotic Index value. |
| cfs | Cubic feet per second, generally the unit in which stream flow is measured. |
| CHL *a* | Chlorophyll *a*. |
| Class C Waters | Freshwaters protected for secondary recreation, fishing, aquatic life including propagation and survival, and wildlife. All freshwaters shall be classified to protect these uses at a minimum. |
| Conductivity | In this report, synonymous with specific conductance and reported in the units of $\mu$mhos/cm at 25 $^{o}$C. Conductivity is a measure of the resistance of a solution to electrical flow. Resistance is reduced with increasing content of ionized salts. |
| Division | The North Carolina Division of Water Quality. |
| D.O. | Dissolved Oxygen. |
| Ecoregion | An area of relatively homogeneous environmental conditions, usually defined by elevation, geology, vegetation, and soil type. Examples include Mountains, Piedmont, Coastal Plain, Sand Hills, and Carolina Slate Belt. |
| EPT | The insect orders (Ephemeroptera, Plecoptera, Trichoptera); as a whole, the most intolerant insects present in the benthic community. |
| EPT N | The abundance of Ephemeroptera, Plecoptera, Trichoptera insects present, using values of 1 for Rare, 3 for Common and 10 for Abundant. |
| EPT S | Taxa richness of the insect orders Ephemeroptera, Plecoptera and Trichoptera. Higher taxa richness values are associated with better water quality. |
| HQW | High Quality Waters. Waters which are rated Excellent based on biological and physical/chemical characteristics through Division monitoring or special studies, primary nursery areas designated by the Marine Fisheries Commission, and all Class SA waters. |
| Major Discharger | Greater than or equal to one million gallons per day discharge (≥ 1 MGD). |
| MGD | Million Gallons per Day, generally the unit in which effluent discharge flow is measured. |
| Minor Discharger | Less than one million gallons per day discharge (< 1 MGD). |
| NPDES | National Pollutant Discharge Elimination System. |

| | |
|---|---|
| NCBI (EPT BI) | North Carolina Biotic Index, EPT Biotic Index. A summary measure of the tolerance values of organisms found in the sample, relative to their abundance. Sometimes noted as the NCBI or EPT BI. |
| NCIBI | North Carolina Index of Biotic Integrity (NCIBI); a summary measure of the effects of factors influencing the fish community. |
| NSW | Nutrient Sensitive Waters. Waters subject to growths of microscopic or macroscopic vegetation requiring limitations on nutrient inputs. |
| NTU | Nephelometric Turbidity Unit. |
| ORW | Outstanding Resource Waters. Unique and special waters of exceptional state or national recreational or ecological significance which require special protection to maintain existing uses. |
| Parametric Coverage | A listing of parameters measured and reported. |
| SOC | A consent order between an NPDES permittee and the Environmental Management Commission that specifically modifies compliance responsibility of the permittee, requiring that specified actions are taken to resolve non-compliance with permit limits. |
| Total S (or S) | The number of different taxa present in a benthic macroinvertebrate sample. |
| UT | Unnamed tributary. |
| WWTP | Wastewater treatment plant |

**Appendix B-1. Benthic macroinvertebrate data, sampling methods, and criteria.**

**Benthic Macroinvertebrate Data Summary**

Based on benthic macroinvertebrate data, water quality in the Little Tennessee River basin is Excellent to Good. Since 1999, 80 benthic macroinvertebrate basinwide samples have been collected with 48 (60%) receiving Excellent bioclassifications, 24 (30%) resulting in Good bioclassifications, five (6%) receiving Good-Fair bioclassifications, and three (4%) receiving Fair bioclassifications. Comparisons of benthos data from 1999 to 2004 between repeat sites show that three sites (Cowee Creek, Whiteoak Creek, and the Tuckasegee River) improved from Good to Excellent, one site (Little Tennessee River off SR 1629) improved from Fair to Good-Fair, one site improved from Good-Fair to Good (Little Tennessee River at SR 1651), and Middle Creek improved from Good-Fair to Excellent. However, nine sites (Cullasaja River at US64/SR 1688 and at SR 1678, Cartoogechaye Creek, Conley Creek, Noland Creek, Panther Creek, Stecoah Creek, Tulula Creek, and Cheoah Creek) declined from Excellent to Good. Overall water quality in the Little Tennessee River is generally unchanged since 1999.

Several rare invertebrate taxa were collected in the Little Tennessee River basin in 2004 including the mayflies *Serratella spiculosa* (Turtle Pond Creek), *Rhithrogena fuscifrons* (Turtle Pond Creek, Bradley Fork, Hazel Creek), *Rhithrogena exilis* (Cullowhee Creek, Nantahala River, Whiteoak Creek, Deep Creek) *Nixie*, (Bradley Fork), the caddisflies *Molanna tryphena*, *Agarodes* (Iotla Creek), *Mayatrichia ayama*, *Oecetis avara* (Snowbird Creek), *Rhyacophila amicis*, *Neotrichia* (Hazel Creek), *Micrasema rickeri* (Cheoah River), and the stoneflies *Agnetina flavescens* (Oconaluftee River, Forney Creek, Hazel Creek, Deep Creek), and *Beloneuria* (Whiteoak Creek). Of particular interest, Caney Fork at SR 1740 set the second highest EPT diversity (54) and total species diversity (107) ever recorded in the Little Tennessee River basin.

**Standard Qualitative (Full Scale) or EPT Sampling Methods**

Benthic macroinvertebrates can be collected from wadeable, freshwater, flowing waters using two sampling procedures. The Biological Assessment Unit's standard qualitative (Full Scale) sampling procedure includes 10 composite samples: two kick-net samples, three bank sweeps, two rock or log washes, one sand sample, one leafpack sample, and visual collections from large rocks and logs (NCDENR 2003). The samples are picked on-site. The purpose of these collections is to inventory the aquatic fauna and produce an indication of relative abundance for each taxon. Organisms are classified as Rare (1 - 2 specimens), Common (3 - 9 specimens), or Abundant (≥ 10 specimens).

Benthic macroinvertebrates can also be collected using the EPT sampling procedure. Four rather than 10 composite qualitative samples are taken at each site: 1 kick, 1 sweep, 1 leafpack and visual collections. Only EPT taxa are collected and identified and only EPT criteria are used to assign a bioclassification.

**Habitat Evaluation**

An assessment form has been developed by the Biological Assessment Unit to better evaluate the physical habitat of a stream . The habitat score, which ranges between 1 and 100, is based on the evaluation of channel modification, amount of instream habitat, type of bottom substrate, pool variety, bank stability, light penetration, and riparian zone width. Higher numbers suggest better habitat quality, but no criteria have been developed to assign impairment ratings.

**Data Analysis**

Criteria for bioclassifications for standard qualitative samples in mountain ecoregions are given below and are based on EPT S and the NCBI. Tolerance values for individual species and biotic index values have a range of 0 - 10, with higher numbers indicating more tolerant species or more polluted conditions. Water quality scores (5 = Excellent, 4 = Good, 3 = Good-Fair, 2 = Fair and 1 = Poor) assigned with the biotic index numbers are averaged with EPT S scores to produce a final bioclassification. Criteria for mountain streams are used for the Watauga River basin. EPT N and Total S calculations also are used to help examine between-site differences in water quality.

**Criteria for Standard Qualitative (Full Scale).**

| | BI Values | EPT Values |
|---|---|---|
| **Score** | **Mountain** | **Mountain** |
| **5** | <4.00 | > 43 |
| **4.6** | 4.00 – 4.04 | 42-43 |
| **4.4** | 4.05 – 4.09 | 40-41 |
| **4** | 4.10 – 4.83 | 34-39 |
| **3.6** | 4.84 – 4.88 | 32-33 |
| **3.4** | 4.89 – 4.93 | 30-31 |
| **3** | 4.94 – 5.69 | 24-29 |
| **2.6** | 5.70 – 5.74 | 22-23 |
| **2.4** | 5.75 – 5.79 | 20-21 |
| **2** | 5.80 – 6.95 | 14-19 |
| **1.6** | 6.96 – 7.00 | 12-13 |
| **1.4** | 7.01 – 7.05 | 10-11 |
| **1** | > 7.05 | 0-9 |

EPT S and BI values can be affected by seasonal changes. DWQ criteria for assigning bioclassification are based on summer sampling: June - September. For samples collected outside summer, EPT S can be adjusted by subtracting out winter/spring Plecoptera or other adjustment based on resampling of summer site. The BI values also are seasonally adjusted for samples outside the summer season.

Criteria for bioclassifications for EPT samples in mountain ecoregions are given below and are based on EPT S.

**Criteria for EPT Samples.**

| | EPT Values |
|---|---|
| **Bioclassification** | **Mountain** |
| **Excellent** | >35 |
| **Good** | 28-35 |
| **Good-Fair** | 19-27 |
| **Fair** | 11-18 |
| **Poor** | 0-10 |

**Table B-1. Benthic macroinvertebrate basinwide monitoring data collected in the Little Tennessee River basin, 1999 - 2004. Basinwide sites are in bold.**

| Sub/Waterbody | Location | County | Index No. | Date | ST | EPT | BI | EPTBI | BioClass |
|---|---|---|---|---|---|---|---|---|---|
| ***040401*** | | | | | | | | | |
| **L Tennessee R** | SR 1629 | Macon | 2-(1) | 7/21/2004 | 70 | 22 | 5.59 | 3.81 | Good-Fair |
| | | | | 9/11/2000 | 67 | 15 | 6.29 | 3.99 | Fair |
| | | | | 8/12/1999 | 60 | 14 | 6.23 | 4.75 | Fair |
| **L Tennessee R** | SR 1651 | Macon | 2-(1) | 7/22/2004 | 93 | 37 | 5.46 | 3.95 | Good |
| | | | | 10/20/1999 | 62 | 29 | 4.42 | 3.49 | Good-Fair |
| **L Tennessee R** | NC 28 | Macon | 2-(1) | 7/22/2004 | 70 | 32 | 5.3 | 4.28 | Good-Fair |
| | | | | 8/24/1999 | 86 | 32 | 5.3 | 3.75 | Good-Fair |
| **Middle Cr** | SR 1635 | Macon | 2-(8) | 7/22/2004 | --- | 43 | --- | 2.93 | Excellent |
| | | | | 8/24/1999 | --- | 25 | --- | 4.15 | Good-Fair |
| **Tessentee Cr** | SR 1684 | Macon | 2- 9 | 7/22/2004 | --- | 47 | --- | 3.02 | Excellent |
| **Coweeta Cr** | SR 1114 | Macon | 2-10 | 7/22/2004 | --- | 45 | --- | 2.62 | Excellent |
| | | | | 8/21/1999 | --- | 39 | --- | 3.01 | Excellent |
| **Cartoogechaye Cr** | SR 1146 | Macon | 2-19-(1) | 7/21/2004 | --- | 31 | --- | 3.70 | Good |
| | | | | 8/24/1999 | --- | 41 | --- | 3.05 | Excellent |
| Jones Cr | SR 1303 | Macon | 2-19-2 | 7/21/2004 | --- | 38 | --- | 3.07 | Excellent |
| **Cullasaja R** | US 64 | Macon | 2-21-(0.5) | 7/21/2004 | 58 | 14 | 5.74 | 4.67 | Fair |
| | | | | 7/25/2001 | 41 | 10 | 6.55 | 5.93 | Fair |
| | | | | 8/28/2000 | 65 | 18 | 6.34 | 5.13 | Fair |
| | | | | 6/23/1999 | 47 | 14 | 5.70 | 4.97 | Fair |
| Cullasaja River | River Court | Macon | 2-21 (0.5) | 7/26/2001 | 56 | 16 | 5.77 | 4.64 | Not Rated |
| | | | | 5/16/2000 | 61 | 25 | 4.85 | 3.71 | Not Impaired |
| Cullasaja River | US 64, ab Dry Falls | Macon | 2-21 (0.5) | 8/11/2000 | 20 | 20 | 4.17 | 4.17 | Good-Fair |
| UT Cullasaja River | US 64 | Macon | | 7/25/2001 | 46 | 23 | 3.32 | 2.39 | Not Impaired |
| Salt Rock Branch | Highlands Falls | Macon | 2- 21 1 | 7/26/2001 | 43 | 5 | 6.54 | 5.52 | Not Rated |
| Ammons Branch | Spruce Lane | Macon | 2-21 2 | 7/25/2001 | 47 | 20 | 2.94 | 1.15 | Not Impaired |
| Mill Creek | 5th Street | Macon | 2-21 3 | 8/29/2000 | 41 | 11 | 6.14 | 5.36 | Not Rated |
| | | | | 5/17/2000 | 37 | 13 | 5.54 | 4.51 | Not Rated |
| Mill Creek | Brookside Lane | Macon | 2-21 3 | 8/28/2000 | 47 | 17 | 5.48 | 4.51 | Not Rated |
| Big Creek | SR1538 | Macon | 2-21 5 1 (0.5) | 7/25/2001 | 49 | 29 | 2.86 | 2.22 | Good |
| | | | | 8/29/2000 | 103 | 41 | 3.52 | 2.44 | Excellent |
| Big Creek | SR 1548, Ab WTP | Macon | 2-21 5 1(0.5) | 9/11/2000 | 30 | 30 | 2.92 | 2.92 | Good |
| Houston Branch | Simon Speed Rd | Macon | 2-21 5 1 3 (2) | 8/29/2000 | 47 | 25 | 2.65 | 1.95 | Not Impaired |
| **Cullasaja R** | Off US 64, Jackson H | Macon | 2-21 (5.5) | 8/5/2004 | 77 | 36 | 4.21 | 3.44 | Good |
| | | | | 6/22/1999 | | 49 | 2.70 | 2.86 | Excellent |
| **Cullasaja R** | US 64/SR 1668 | Macon | 2-21 (5.5) | 8/5/2004 | 86 | 42 | 4.68 | 3.84 | Good |
| | | | | 8/10/1999 | 99 | 51 | 3.94 | 3.32 | Excellent |
| N Skitty Creek | N Cliffside Rec Area | Macon | 2-21 6 1 | 8/29/2000 | 45 | 28 | 2.35 | 1.62 | Not Impaired |
| **Turtle Pond Cr** | SR 1620 | Macon | 2-21 8 | 7/23/2004 | --- | 49 | --- | 2.10 | Excellent |
| | | | | 6/22/1999 | --- | 42 | --- | 1.90 | Excellent |
| Walnut Cr | SR 1533 | Macon | 2-21 17 | 8/6/2004 | 68 | 38 | 2.94 | 2.16 | Excellent |
| | | | | 6/21/1999 | 34 | 34 | 2.04 | 2.04 | Good |
| **Iotla Cr** | SR 1372 | Macon | 2-27 | 7/22/2004 | 73 | 32 | 4.8 | 3.94 | Good |
| | | | | 8/10/1999 | --- | 35 | --- | 3.84 | Good |
| Iotla Cr | SR 1485 | Macon | 2-27 | 7/22/2004 | 48 | 35 | 3.9 | 3.53 | Good |
| **Cowee Cr** | NC 28 | Macon | 2-29 | 7/22/2004 | --- | 38 | --- | 3.24 | Excellent |
| | | | | 8/10/1999 | --- | 35 | --- | 3.06 | Good |
| **Burningtown Cr** | SR 1371 | Macon | 2-38 | 8/3/2004 | --- | 43 | --- | 3.12 | Excellent |
| | | | | 8/10/1999 | --- | 39 | --- | 3.20 | Excellent |
| Burningtown Cr | SR 1392 | Macon | 2 38 | 8/3/2004 | 68 | 34 | 3.18 | 2.51 | Good |
| **Tellico Cr** | SR 1367 | Macon | 2 40 | 8/3/2004 | 93 | 44 | 3.62 | 2.68 | Excellent |
| | | | | 8/9/1999 | 108 | 54 | 3.57 | 2.62 | Excellent |
| ***040402*** | | | | | | | | | |
| **L Tennessee R** | off SR 1113 | Swain | 2-(1) | 8/5/2004 | 95 | 42 | 4.33 | 3.35 | Good |
| | | | | 8/9/1999 | 75 | 31 | 4.74 | 3.67 | Good |
| **Alarka Cr** | SR 1185 | Swain | 2-69-(2.5) | 8/2/2004 | 101 | 46 | 3.80 | 2.67 | Excellent |
| | | | | 8/9/1999 | 86 | 51 | 3.66 | 3.11 | Excellent |
| **Tuckasegee R** | SR 1140 | Jackson | 2-79-(0.5) | 8/2/2004 | 36 | 36 | 1.83 | 1.83 | Excellent |
| | | | | 7/19/1999 | 46 | 46 | 1.96 | 1.96 | Excellent |

| Sub/Waterbody | Location | County | Index No. | Date | ST | EPT | BI | EPTBI | BioClass |
|---|---|---|---|---|---|---|---|---|---|
| **Caney Fk** | SR 1740 | Jackson | 2-79-28-(2.5) | 8/2/2004 | 107 | 54 | 3.63 | 2.68 | Excellent |
| | | | | 7/20/1999 | 97 | 53 | 3.68 | 3.03 | Excellent |
| **Moses Cr** | SR 1739 | Jackson | 2-79-28-8 | 8/2/2004 | 46 | 46 | 1.71 | 1.71 | Excellent |
| | | | | 7/20/1999 | 37 | 37 | 1.91 | 1.91 | Excellent |
| **Cullowhee Cr** | SR 1001 | Jackson | 2-79-31 | 8/4/2004 | --- | 47 | --- | 2.61 | Excellent |
| | | | | 7/20/1999 | 43 | 43 | 2.96 | 2.96 | Excellent |
| **Savannah Cr** | SR 1367 | Jackson | 2-79-36 | 8/4/2004 | 91 | 40 | 4.15 | 3.11 | Good |
| | | | | 7/21/1999 | 53 | 32 | 3.80 | 3.48 | Good |
| **Tuckasegee R** | off SR 1378 | Jackson | 2-79-(38) | 8/4/2004 | 84 | 44 | 4.27 | 3.44 | Excellent |
| | | | | 7/21/1999 | 75 | 40 | 4.39 | 3.82 | Good |
| **Scott Cr** | SR 1556 | Jackson | 2-79-39 | 8/4/2004 | 74 | 35 | 4.07 | 3.23 | Good |
| | | | | 7/21/1999 | 70 | 36 | 4.14 | 3.22 | Good |
| **Conley Cr** | off SR 1177 | Swain | 2-79-39 | 8/3/2004 | 34 | 34 | 2.82 | 2.82 | Good |
| | | | | 7/21/1999 | --- | 44 | --- | 3.17 | Excellent |
| **Bradley Fk** | off US 441 | Swain | 2-79-55-12-(11) | 8/3/2004 | 79 | 47 | 2.59 | 2.02 | Excellent |
| | | | | 7/22/1999 | 67 | 39 | 2.67 | 1.87 | Excellent |
| **Oconaluftee R** | SR 1359 | Swain | 2-79-55-(16.5) | 8/5/2004 | 106 | 51 | 3.96 | 2.97 | Excellent |
| | | | | 7/22/1999 | 104 | 53 | 3.93 | 3.20 | Excellent |
| **Deep Cr** | AB Campground | Swain | 2-79-63-(16) | 8/2/2004 | --- | 43 | --- | 2.13 | Excellent |
| | | | | 8/9/1999 | --- | 47 | --- | 2.67 | Excellent |
| **Deep Cr** | SR 1340 | Swain | 2-79-63-(21) | 8/2/2004 | --- | 38 | --- | 2.18 | Excellent |
| | | | | 8/9/1999 | --- | 45 | --- | 2.95 | Excellent |
| **Noland Cr** | near mouth | Swain | 2 90 | 8/3/2004 | --- | 35 | --- | 1.92 | Good |
| | | | | 8/11/1999 | --- | 40 | --- | 1.98 | Excellent |
| **Forney Cr** | near mouth | Swain | 2 97 | 8/3/2004 | 78 | 44 | 2.58 | 1.80 | Excellent |
| | | | | 8/11/1999 | 81 | 46 | 2.66 | 1.68 | Excellent |
| **Panther Cr** | SR 1233 | Graham | 2 115 | 8/4/2004 | --- | 35 | --- | 2.07 | Good |
| | | | | 8/10/1999 | --- | 39 | --- | 2.24 | Excellent |
| **Stecoah Cr** | SR 1237 | Graham | 2 130 | 8/4/2004 | --- | 30 | --- | 2.94 | Good |
| | | | | 8/11/1999 | --- | 39 | --- | 3.02 | Excellent |
| **Hazel Cr** | near mouth | Swain | 2-146-(19) | 8/3/2004 | 96 | 46 | 3.26 | 2.17 | Excellent |
| | | | | 8/11/1999 | 106 | 56 | 2.95 | 1.97 | Excellent |
| **Twenty Mile Cr** | NC 28 | Swain | 2-178-(4) | 8/4/2004 | --- | 29 | --- | 2.15 | Good |
| ***040403*** | | | | | | | | | |
| **Nantahala R** | FSR 437 | Macon | 2-57-(0.5) | 7/21/2004 | 92 | 49 | 3.2 | 1.93 | Excellent |
| | | | | 8/24/1999 | 100 | 49 | 3.4 | 2.45 | Excellent |
| **Nantahala R** | US 19/74 | Swain | 2-57-(22.5) | 7/20/2004 | 83 | 35 | 4.2 | 2.26 | Good |
| | | | | 8/23/1999 | --- | 35 | --- | 2.29 | Good |
| **Dicks Cr** | off SR 1401 | Macon | 2-57-42 | 7/21/2004 | --- | 27 | --- | 1.59 | Good-Fair |
| | | | | 8/13/1999 | --- | 34 | --- | 1.93 | Good |
| Whiteoak Cr | SR 1397 | Macon | 2-57-45 | 7/21/2004 | 63 | 26 | 4.3 | 2.33 | Good-Fair |
| **Whiteoak Cr** | off SR 1310 | Macon | | 7/20/2004 | 78 | 34 | 3.5 | 1.68 | Excellent |
| | | | | 8/13/1999 | --- | 31 | --- | 2.14 | Good |
| ***040404*** | | | | | | | | | |
| **Tulula Cr** | SR 1275 | Graham | 2-190-2-(0.5) | 7/19/2004 | 61 | 31 | 4.0 | 3.24 | Good |
| **Cheoah R** | off SR 1138 | Graham | 2-190-(3.5) | 7/19/2004 | 84 | 38 | 4.0 | 3.14 | Good |
| | | | | 8/12/1999 | 89 | 48 | 3.5 | 2.84 | Excellent |
| **Snowbird Cr** | SR 1120 | Graham | 2-190-9-(15.5) | 7/20/2004 | --- | 48 | --- | 2.06 | Excellent |
| | | | | 8/12/1999 | --- | 52 | --- | 2.56 | Excellent |
| L Santeetlah Cr | Ab Footbridge | Graham | 2-190-19-7 | 7/20/2004 | 59 | 32 | 2.9 | 1.65 | Good |
| Cheoah R | SR 1147 | Graham | 2-190-(22) | 7/4/2005 | 54 | 19 | 5.7 | 3.92 | Fair |
| Cheoah R | At gauge | Graham | 2-190-(22) | 08/04/2004 | --- | 42 | --- | 3.00 | Excellent |

**Appendix F-1. A summary of fish community assessment data.**

Twenty two sites were sampled from mid-May to early June 2004; 19 of the sites had not been previously sampled. Fish communities in the basin were last sampled in 1995. The most commonly collected species in 2004 was the mottled sculpin (collected at all sites); the central stoneroller and the northern hog sucker were collected at 21 of the 22 sites. The mottled sculpin was also the most abundant species, representing about one-third of all the fish collected.

Seventeen of the 22 streams were evaluated using the North Carolina Index of Biotic Integrity (NCIBI) (Appendices F-3 – F-6). NCIBI ratings ranged from Fair to Excellent with the scores ranging from 38 to 58 (Figures 1 and 2). The streams rated Fair and Excellent were the Little Tennessee River and Burningtown Creek, respectively. The remaining five streams were not evaluated using the NCIBI, were considered trout streams, and were not assigned a rating. However, Stecoah Creek did show signs of being degraded.

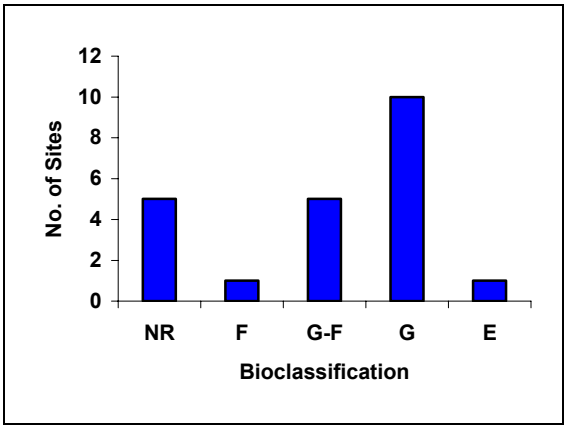



**Figure 1. Distribution of the ratings of 22 fish community basinwide sites in the Little Tennessee River basin, 2004. Abbreviations are: NR = Not Rated, F = Fair, G-F = Good-Fair, G = Good, and E = Excellent.**

Habitat characteristics and examples of high and low quality habitats at fish community sites in the basin are presented in Appendix F-2. The instream and riparian habitat assessment scores at the 22 sites ranged from 47 to 90. In general, fish communities in the basin that rated Good or Excellent could be found where the habitats were of moderate to high quality; communities rated Good-Fair or Fair were also found where the habitats were of lower quality, but also at some sites where the habitats were of moderate quality. The Not Rated streams were trout streams that generally had moderate to high quality habitats. It seems that many fish communities in the basin are still rated Good, even though there were substantial habitat problems stemming from long-term nonpoint erosion, sedimentation, bank instability, and narrow riparian corridors. Streams with moderate to high quality habitats but lower than expected ratings seemed to be affected by nonpoint source nutrients.

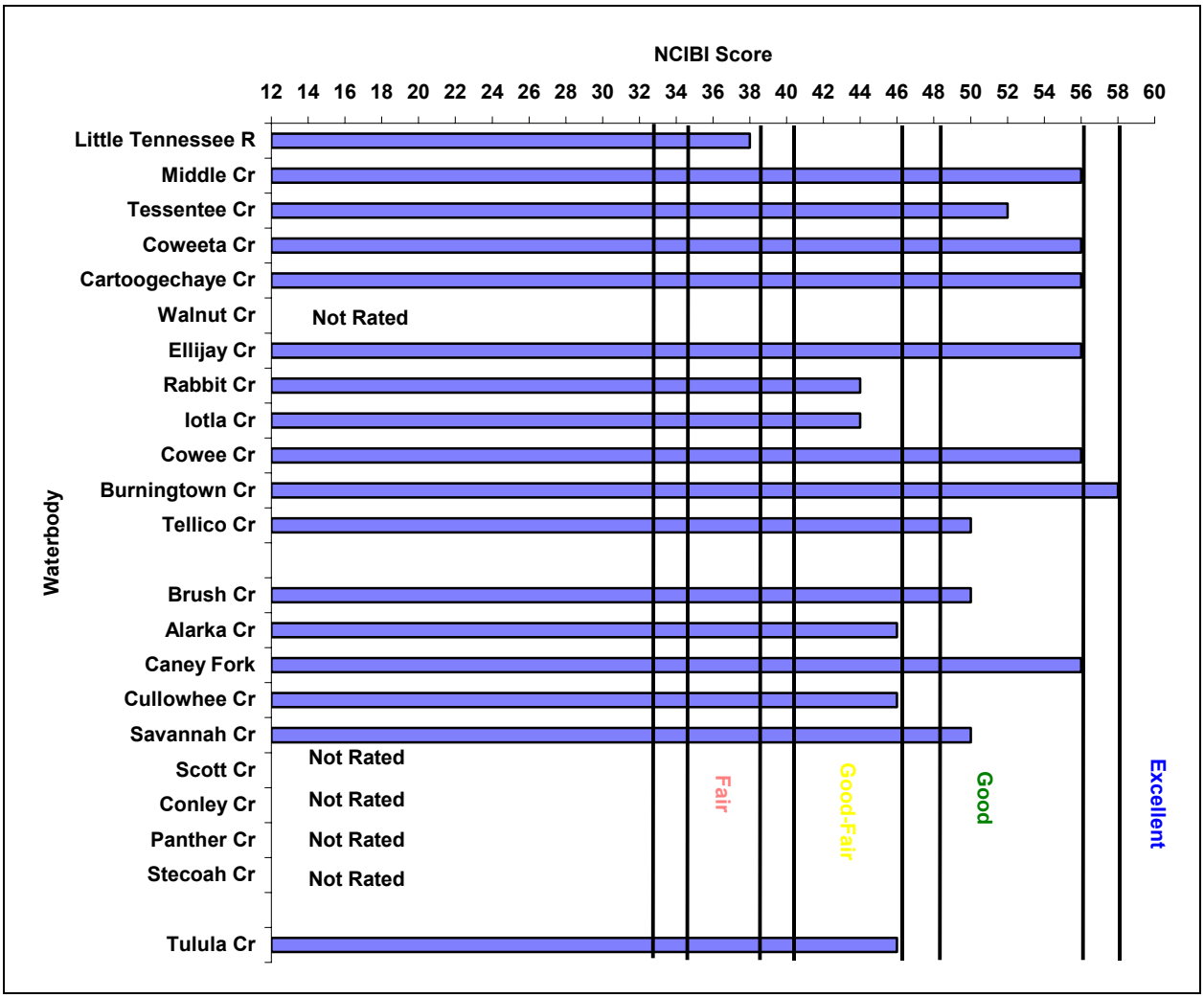



**Figure 2.** NCIBI scores and ratings of 22 fish community basinwide sites in the Little Tennessee River basin, 2004.

**Appendix F-2. Habitat evaluations and stream and riparian habitats at 22 fish community monitoring sites in the Little Tennessee River basin.**

**Habitat Assessments**

A method has been developed by the Biological Assessment Unit to evaluate the physical habitats of a stream (NCDENR 2001). The habitat score, which ranges between 1 and 100, is based on the evaluation of channel modification, amount of instream habitat, type of bottom substrate, pool variety, bank stability, light penetration, and riparian zone width. Higher numbers suggest better habitat quality, but criteria have not been developed to assign impairment ratings. Habitat metric scores for all fish community sites in the Little Tennessee River basin which were evaluated in 2004 are listed in Table 1.

Fish community sampling was conducted in 2004 at 22 sites. Habitat scores ranged from 47 (Iotla Creek) to 90 (Walnut and Panther Creeks) (Tables 1 and 2). Thirteen streams had overall moderate to high quality habitats (score ≥ 65); whereas nine streams had overall low to poor quality habitats (score < 65). Major differences between the two types were in the instream habitats, substrates, riffles, and bank stabilities (Table 3). Differences were not as pronounced in the abundance of pools, extent of canopy cover, or width of riparian zones. The riparian zones at many of the sites in the basin were narrow, sparsely vegetated with mature trees and mowed lawns or in pasture (Table 1). Low scores were attributable to gradient, chronic erosion, and nonpoint source sedimentation. Many of the sites would benefit from bank stabilization and stream restoration techniques.

**Table 2. Rankings of 22 waterbodies in the Little Tennessee River basin according to the total habitat scores, 2004.**

| Subbasin | Waterbody | Location | County | Score |
|---|---|---|---|---|
| | | **High to Moderate Quality Habitats** | | |
| 1 | Walnut Cr | SR1533 | Macon | 90 |
| 2 | Panther Cr | SR 1233 | Graham | 90 |
| 1 | Tellico Cr | SR 1367 | Macon | 86 |
| 2 | Brush Cr | off SR 1129 | Swain | 85 |
| 1 | Coweeta Cr | SR 1119 | Macon | 82 |
| 3 | Tulula Cr | SR 1260 | Graham | 82 |
| 2 | Scott Cr | SR 1527 | Jackson | 78 |
| 2 | Stecoah Cr | SR 1237 | Graham | 78 |
| 2 | Alarka Cr | SR 1185 | Swain | 77 |
| 2 | Caney Fk | SR 1738 | Jackson | 72 |
| 2 | Conley Cr | SR 1183 | Swain | 71 |
| 1 | Cowee Cr | SR 1340 | Macon | 68 |
| 2 | Cullowhee Cr | SR 1545 | Jackson | 67 |
| | | **Low to Poor Quality Habitats** | | |
| 1 | Tessentee Cr | SR 1636 | Macon | 61 |
| 2 | Savannah Cr | NC 116 | Jackson | 60 |
| 1 | Ellijay Cr | SR 1524 | Macon | 59 |
| 1 | Cartoogechaye Cr | SR 1146 | Macon | 53 |
| 1 | Rabbit Cr | SR 1504 | Macon | 53 |
| 1 | Burningtown Cr | SR 1364 | Macon | 52 |
| 1 | Middle Cr | SR 1635 | Macon | 51 |
| 1 | Little Tennessee R | off SR 1683 | Macon | 49 |
| 1 | Iotla Cr | off SR 1378 | Macon | 47 |

**Table 3. Mean habitat scores for 22 fish community sites in the Little Tennessee River basin, 2004.**

| Habitat characteristics | Low - Poor Quality Habitat | Moderate - High Quality Habitat | Maximum score |
|---|---|---|---|
| Instream habitat | 13.6 | 16.8 | 20 |
| Substrate | 5.7 | 12.2 | 15 |
| Riffle | 9.1 | 14.7 | 16 |
| Bank stability (right and left) | 6.0 | 10.9 | 14 |

**Table 1. Habitat evaluations at 22 basinwide fish community sites in the Little Tennessee River basin, 2004.**

| Subbasin | Stream | Location | County | Width (m) | Channel | Instream Habitat | Substrate | Pools | Riffles | Bank Stability-L | Bank Stability-R | Shade | Riparian Zone-L | Riparian Zone-R | Total Score |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| ***040401*** | | | | | | | | | | | | | | | |
| | Little Tennessee R | off SR 1683 | Macon | 13 | 4 | 14 | 4 | 8 | 3 | 3 | 3 | 7 | 1 | 2 | 49 |
| | Middle Cr | SR 1635 | Macon | 11 | 4 | 14 | 5 | 6 | 12 | 2 | 2 | 4 | 2 | 0 | 51 |
| | Tessentee Cr | SR 1636 | Macon | 6 | 5 | 14 | 8 | 6 | 15 | 2 | 2 | 4 | 5 | 0 | 61 |
| | Coweeta Cr | SR 1119 | Macon | 7 | 5 | 16 | 14 | 10 | 15 | 4 | 6 | 7 | 2 | 3 | 82 |
| | Cartoogechaye Cr | SR 1146 | Macon | 13 | 5 | 14 | 6 | 6 | 7 | 3 | 3 | 7 | 1 | 1 | 53 |
| | Walnut Cr | SR1533 | Macon | 4 | 5 | 18 | 13 | 10 | 16 | 6 | 6 | 10 | 3 | 3 | 90 |
| | Ellijay Cr | SR 1524 | Macon | 6 | 4 | 12 | 8 | 6 | 14 | 3 | 3 | 5 | 2 | 2 | 59 |
| | Rabbit Cr | SR 1504 | Macon | 5 | 5 | 12 | 3 | 9 | 8 | 3 | 3 | 7 | 2 | 2 | 53 |
| | Iotla Cr | off SR 1378 | Macon | 4 | 5 | 12 | 3 | 3 | 4 | 5 | 3 | 7 | 3 | 2 | 47 |
| | Cowee Cr | SR 1340 | Macon | 8 | 5 | 16 | 11 | 6 | 15 | 2 | 6 | 5 | 0 | 2 | 68 |
| | Burningtown Cr | SR 1364 | Macon | 9 | 4 | 14 | 6 | 6 | 5 | 4 | 4 | 5 | 2 | 2 | 52 |
| | Tellico Cr | SR 1367 | Macon | 8 | 5 | 18 | 12 | 8 | 15 | 6 | 6 | 10 | 3 | 3 | 86 |
| ***040402*** | | | | | | | | | | | | | | | |
| | Brush Cr | off SR 1129 | Swain | 5 | 5 | 18 | 12 | 5 | 14 | 6 | 6 | 10 | 5 | 5 | 85 |
| | Alarka Cr | SR 1185 | Swain | 10 | 4 | 18 | 12 | 6 | 16 | 5 | 5 | 7 | 2 | 2 | 77 |
| | Caney Fk | SR 1738 | Jackson | 11 | 5 | 16 | 12 | 5 | 14 | 5 | 5 | 5 | 3 | 2 | 72 |
| | Cullowhee Cr | SR 1545 | Jackson | 10 | 4 | 16 | 10 | 6 | 7 | 4 | 6 | 7 | 2 | 5 | 67 |
| | Savannah Cr | NC 116 | Jackson | 10 | 3 | 16 | 8 | 8 | 14 | 3 | 3 | 2 | 1 | 2 | 60 |
| | Scott Cr | SR 1527 | Jackson | 10 | 5 | 17 | 12 | 5 | 16 | 6 | 6 | 7 | 2 | 2 | 78 |
| | Conley Cr | SR 1183 | Swain | 5 | 5 | 15 | 13 | 5 | 16 | 5 | 5 | 3 | 2 | 2 | 71 |
| | Panther Cr | SR 1233 | Graham | 7 | 5 | 18 | 14 | 8 | 16 | 7 | 6 | 9 | 5 | 2 | 90 |
| | Stecoah Cr | SR 1237 | Graham | 5 | 5 | 16 | 11 | 5 | 16 | 5 | 5 | 9 | 3 | 3 | 78 |
| ***040404*** | | | | | | | | | | | | | | | |
| | Tulula Cr | SR 1260 | Graham | 11 | 4 | 16 | 12 | 6 | 15 | 6 | 6 | 9 | 5 | 3 | 82 |
| **Maximum possible scores** | | | | | **5** | **20** | **15** | **10** | **16** | **7** | **7** | **10** | **5** | **5** | **100** |

Characteristics of moderate to high quality habitat streams are (Figure 1):

- instream habitats composed of rocks (often covered with *Podostemum*), sticks, leafpacks, snags, logs, undercut banks and root mats;
- a substrate of boulder, cobble, and gravel with low embeddedness;
- frequent pools and riffles of varying depths and widths; and
- stable banks with a good tree canopy and a medium to wide riparian zone with no or rare breaks.

**Figure 1. Instream habitats composed of boulder, cobble, and gravel rocks, sticks, leafpacks, snags, logs, and root mats (Figure A, Alarka Creek, SR 1185, Swain County) and wide riparian zones offering a good tree canopy (Figure B, Brush Creek, off SR 1129, Swain County).**

Characteristics of low to poor quality habitat streams are (Figure 2):

- a substrate of primarily sand with instream bar development;
- an absence of riffles; if present, they are usually caused by embedded, coarse woody debris;
- narrow and sparsely vegetated riparian zones; and
- deeply entrenched channel with unstable, vertical, and sparsely vegetated banks.

**Figure 2. Sandy substrates with few riffles (Figure A, Iotla Creek, off SR 1378, Macon County) and unstable banks with narrow riparian zones (Figure B, Middle Creek, SR 1653, Macon County).**

**Habitat and NCIBI Relationships**

Fish communities in the Little Tennessee River basin that rated Good or Excellent could be found where the habitats were of moderate to high quality (Table 4) or where the habitats were of slightly lower quality (habitat scores = 51 - 61). Communities rated Good-Fair or Fair were also found where the habitats were

of lower quality, but also at sites where the habitats were of moderate quality. The Not Rated streams were trout streams that generally had moderate to high quality habitats.

**Table 4. NCIBI ratings and habitat quality for 22 streams in the Little Tennessee River basin, 2004.[1]**

| NCIBI Rating | Waterbodies with Low to Poor Quality Habitat (Score < 65) | Waterbodies with Moderate to High Quality Habitat (Score ≥ 65) |
|---|---|---|
| Excellent | Burningtown | --- |
| Good | Middle, Tessentee, Cartoogechaye, Ellijay, Savannah | Coweeta, Cowee, Tellico, Brush, Caney |
| Good-Fair | Rabbit, Iotla | Alarka, Cullowhee, Tulula |
| Fair | Little Tennessee | --- |
| Poor | --- | --- |
| Not Rated | --- | Walnut, Scott, Conley, Panther, Stecoah |

[1]Blue denotes streams with moderate to high quality habitats and fish communities rated Good or Excellent. Red denotes streams with low to poor quality habitats and fish communities rated Fair.

It seems that many fish communities in the basin are still rated Good, even though there were substantial habitat problems stemming from long-term nonpoint erosion, sedimentation, bank instability, and narrow riparian corridors. Streams with moderate to high quality habitats but lower than expected ratings seemed to be affected by nonpoint source nutrients.

**Appendix F-3. Fish community sampling methods and criteria.**

In 2004, fish community assessments were performed at 22 sites in the basin. The drainage areas of the assessed watersheds ranged from 6.1 to 55.9 square miles. Seventeen of the sites had never been sampled, including all of the sites in Subbasins 02 and 04. One of the sites was on the impaired streams list (Table 1). Some of these unassessed sites were in rural watersheds where there are no NPDES dischargers and were selected as potential candidates for regional reference sites. Other sites were sampled at more appropriate locations to coincide with sites previously sampled by the Little Tennessee Watershed Association (LTWA 2003; W. McLarney, pers. com., May 17 – 21, 2004). Two sites on the Cullasaja River were not resampled in 2004 because there were already sufficient data collected in 1999 to assess these sites. Basinwide fish community sampling was not conducted in 1999, rather special studies were performed to refine and calibrate the assessment program.

**Table 1. Fish community sites monitored in 2004 that are on the state's 303(d) list of impaired waters (NCDENR 2003).**

| Subbasin/ Waterbody | Reach Affected | Cause(s) of Impairment | Potential Sources |
|---|---|---|---|
| ***040401*** | | | |
| Little Tennessee River | From NC-GA state line to the confluence of Mulberry Creek | Cause unknown | Sources outside of state jurisdiction |

**Sampling Methods**

At each sample site, a 600 ft. section of stream was selected and measured. The fish in the delineated stretch of stream were then collected using two backpack electrofishing units (except at the Little Tennessee River site where three electrofishers were used) and usually, two or more persons netting the stunned fish. Biological Assessment Unit Staff were assisted in 2004 by staff from DWQ's Asheville Regional Office, the US Fish & Wildlife Service, the Little Tennessee Watershed Association (Dr. William McLarney and Cal Yonce), and interns from North Carolina State University. After collection, all readily identifiable fish were examined for sores, lesions, fin damage, or skeletal anomalies, measured (total length to the nearest 1 mm), and then released. Those fish that were not readily identifiable were preserved and returned to the laboratory for identification, examination, and total length measurement.

**NCIBI Analysis**

The NCIBI is a modification of the Index of Biotic Integrity initially proposed by Karr (1981) and Karr, *et al*. (1986). The IBI method was developed for assessing a stream's biological integrity by examining the structure and health of its fish community. The scores derived from this index are a measure of the ecological health of the waterbody and may not directly correlate to water quality. For example, a stream with excellent water quality, but with poor or fair fish habitat, would not be rated excellent with this index. However, in many instances, a stream which rated excellent on the NCIBI should be expected to have excellent water quality.

The Index of Biological Integrity incorporates information about species richness and composition, trophic composition, fish abundance, and fish condition. The NCIBI summarizes the effects of all classes of factors influencing aquatic faunal communities (water quality, energy source, habitat quality, flow regime, and biotic interactions). While any change in a fish community can be caused by many factors, certain aspects of the community are generally more responsive to specific influences. Species composition measurements reflect habitat quality effects. Information on trophic composition reflects the effect of biotic interactions and energy supply. Fish abundance and condition information indicate additional water quality effects. It should be noted, however, that these responses may overlap. For example, a change in fish abundance may be due to decreased energy supply or a decline in habitat quality, not necessarily a change in water quality.

For the Little Tennessee River basin, the assessment of biological integrity using the North Carolina Index of Biotic Integrity (NCIBI) is provided by the cumulative assessment of 10 parameters or metrics. The values provided by the metrics are converted into scores on a 1, 3, or 5 scale. A score of 5 represents conditions which would be expected for undisturbed reference streams in the specific river basin or ecoregion, while a score of 1 indicates that the conditions deviate greatly from those expected in

undisturbed streams of the region. Each metric is designed to contribute unique information to the overall assessment. The scores for all metrics are then summed to obtain the overall NCIBI score. Finally, the score (an even number between 12 and 60) is then used to determine the ecological integrity class of the stream from which the sample was collected.

The NCIBI has recently been revised (NCDENR 2001b). Currently, the focus of using and applying the NCIBI has been restricted to wadeable streams that can be sampled by a crew of four persons. The bioclassifications and criteria have also been recalibrated against regional reference site data (Biological Assessment Unit Memorandum F-20010105) (Tables 2 - 5). To qualify as a reference site, the site had to satisfy all seven criteria in the order listed in Table 2. Reference sites represented the least impacted or the most minimally impacted streams and the overall biological conditions of the fish communities that could be attained. [Note: Coweeta Creek at US 23/441was originally classified as a fish community regional reference site. However, the recent discovery that a wastewater treatment plant was located approximately 0.3 miles above the monitoring site resulted in its discontinuance in 2004 as a reference site.]

**Table 2. Reference site selection hierarchy -- a watershed-based approach for mountain streams.**

| Criterion | Qualification |
|---|---|
| 1 -- Habitat | Total habitat score ≥ 65 |
| 2 – NPDES dischargers | No NPDES dischargers ≥ 0.01 MGD above the site or if there are small dischargers (~≤ 0.01 MGD), the dischargers are more than one mile upstream |
| 3 – Percent urbanization | < 10% of the watershed is urban or residential areas |
| 4 – Percent forested | ≥ 70% of the watershed is forested or in natural vegetation |
| 5 – Channel incision | At the site, the stream is not incised beyond natural conditions |
| 6 – Riparian zone integrity | No breaks in the riparian zones or, if there are breaks, the breaks are rare |
| 7 – Riparian zone width | Width of the riparian zone along both banks is ≥ 6m |
| Exception 1 | If the site satisfied Criteria 1 - 6, except one of the two riparian widths was less than 6 m, then the site still qualified as a reference site |
| Exception 2 | If the site satisfied Criteria 1 - 3 and 5 - 7, but the percentage of the watershed in forest or natural vegetations was ≥ 60% (rather than ≥ 70%), then the site still qualified as a reference site. [Note: in the New River Basin this last exception is ≥ 50%.] |

**Table 3. Revised scores and classes for evaluating the fish community of a wadeable stream using the North Carolina Index of Biotic Integrity in the French Broad, Hiwassee, Little Tennessee, New, and Watauga River basins.**

| NCIBI Scores | NCIBI Classes |
|---|---|
| 58 or 60 | Excellent |
| 48, 50, 52, 54, or 56 | Good |
| 40, 42, 44, or 46 | Good-Fair |
| 34, 36, or 38 | Fair |
| ≤ 32 | Poor |

Criteria and ratings applicable only to wadeable streams in the Little Tennessee River basin are the same as those for the Hiwassee, French Broad, New, and Watauga River Basins. Metrics and ratings should not be applied to non-wadeable streams and trout streams in each of these basins.

**Blackspot and Other Diseases**

Blackspot and yellow grub diseases are naturally occurring, common infections of fish by an immature stage of flukes. The life cycle involves fish, snails, and piscivorous birds. Although heavy, acute infections can be fatal, especially to small fish, fish can carry amazingly high worm burdens without any apparent ill effects (Noga 1996). The infections may often be disfiguring and render the fish aesthetically unpleasing (Figure 1).

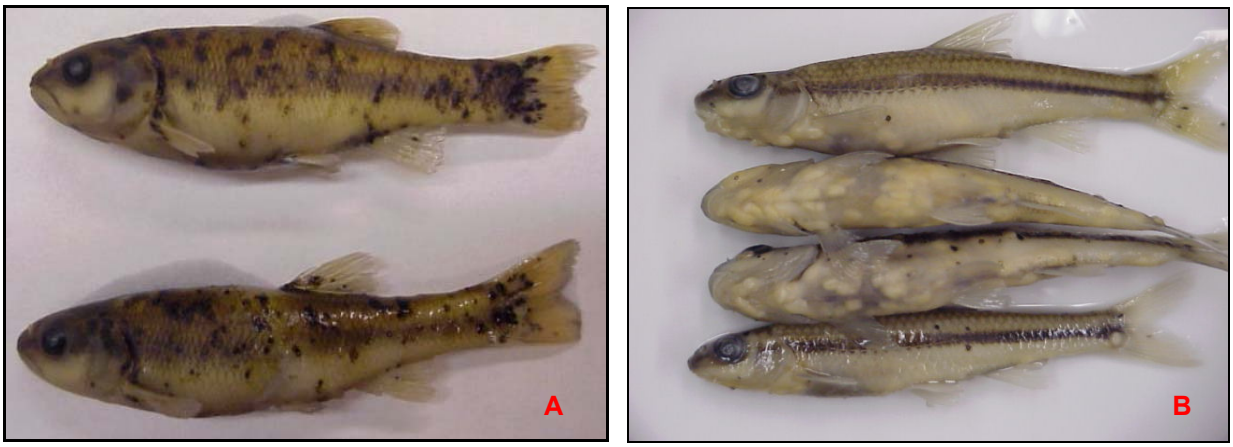



**Figure 1. Heavy infestation of blackspot disease in creek chub (A) and yellow grub in bigeye chub (B).**

Although some researchers incorporate the incidence of black spot and yellow grub into indices of biotic integrity (e.g., Steedman 1991), others, because of a lack of a consistent, inverse relationship to environmental quality, do not (e.g., Sanders *et al*. 1999). The diseases are not considered in the NCIBI because it is widespread, affecting fish in all types of streams. This disease was noted in Coweeta, Cartoogechaye, and Tulula Creeks. Species affected (although not at all sites) included river chub, Tennessee shiner, and northern hog sucker.

**Table 4. Scoring criteria for the NCIBI for wadeable streams in the Western and Northern Mountains of the French Broad (including the Pigeon River), Hiwassee, Little Tennessee, New, and Watauga River basins with watersheds ranging between 3.1 and 161 mi$^2$.**

| No. | Metric | | Score |
|---|---|---|---|
| 1 | **No. of species** | | |
| | ≥ 16 species | | 5 |
| | 12-15 species | | 3 |
| | < 12 species | | 1 |
| 2 | **No. of fish** | | |
| | 320-1,000 fish | | 5 |
| | 205-319 fish | | 3 |
| | < 205 fish | | 1 |
| | > 1,000 fish | | 3 |
| 3 | **No. of species of darters** | | |
| | French Broad & Little Tennessee River Basins | New River, Pigeon River, Watauga[1], & Hiwassee River Basins | |
| | ≥ 4 species | ≥ 3 species | 5 |
| | 2 or 3 species | 1 or 2 species | 3 |
| | 0 or 1 species | 0 species | 1 |
| 4 | **No. of species of rock bass, smallmouth bass, and trout** | | |
| | ≥ 2 species | | 5 |
| | 1 species | | 3 |
| | 0 species | | 1 |
| 5 | **No. of species of cyprinids** | | |
| | All basins, except Pigeon River Basin | Pigeon River Basin | |
| | ≥ 8 species | ≥ 6 species | 5 |
| | 6 or 7 species | 4 or 5 species | 3 |
| | ≤ 5 species | ≤ 3 | 1 |
| 6 | **No. of intolerant species** | | |
| | All basins, except New River Basin | New River Basin | |
| | ≥ 3 species | ≥ 5 species | 5 |
| | 2 species | 3 or 4 species | 3 |
| | 0 or 1 species | 0, 1, or 2 species | 1 |
| 7 | **Percentage of tolerant individuals** | | |
| | ≤ 2% | | 5 |
| | 2-10% | | 3 |
| | > 10% | | 1 |
| 8 | **Percentage of omnivorous + herbivorous individuals** | | |
| | 10-36% | | 5 |
| | 37-50% | | 3 |
| | > 50% | | 1 |
| | < 10% | | 1 |
| 9 | **Percentage of insectivorous individuals** | | |
| | 55-85% | | 5 |
| | 40-54% | | 3 |
| | < 40% | | 1 |
| | > 85% | | 1 |
| 12 | **Percentage of species with multiple age groups** | | |
| | ≥ 65% of all species have multiple age groups | | 5 |
| | 45-64% all species have multiple age groups | | 3 |
| | < 45% all species have multiple age groups | | 1 |

[1]Tentative for the Watauga River basin; also includes *Cottus bairdii* (mottled sculpin) and *Noturus insignis* (margined madtom). The Watauga River basin is the only basin in North Carolina where these three benthic, insectivorous groups (darters, mottled sculpin, and margined madtom) are sympatric. Recently (in 2001), *N. insignis* was found in the Toxaway River (Savannah River basin) in North Carolina.

**Table 5. Tolerance ratings and adult trophic guild assignments for fish in the Little Tennessee River basin. Species collected in 2004 are highlighted in blue. Common and scientific names follow Nelson, et al. (2004).**

| Family/Species | common name | Tolerance Rating | Trophic Guild of Adults |
|---|---|---|---|
| **Petromyzontidae** | **lampreys** | | |
| *Ichthyomyzon greeleyi* | mountain brook lamprey | Intermediate | Non-feeding |
| **Lepisosteidae** | **gars** | | |
| *Lepisosteus osseus* | longnose gar | Tolerant | Piscivore |
| **Clupeidae** | **herrings** | | |
| *Dorosoma cepedianum* | gizzard shad | Intermediate | Omnivore |
| *D. petenense* | threadfin shad | Intermediate | Omnivore |
| **Cyprinidae** | **carps and minnows** | | |
| *Campostoma anomalum* | stoneroller | Intermediate | Herbivore |
| *Carassius auratus* | goldfish | Tolerant | Omnivore |
| *Clinostomus funduloides* | rosyside dace | Intermediate | Insectivore |
| *C. sp. cf. funduloides* | "smoky" dace | Intermediate | Insectivore |
| *Cyprinella galactura* | whitetail shiner | Intermediate | Insectivore |
| *Cyprinus carpio* | common carp | Tolerant | Omnivore |
| *Erimonax monachus* | spotfin chub | Intolerant | Insectivore |
| *Luxilus chrysocephalus* | striped shiner | Intermediate | Omnivore |
| *L. coccogenis* | warpaint shiner | Intermediate | Insectivore |
| *Nocomis leptocephalus* | bluehead chub | Intermediate | Omnivore |
| *N. micropogon* | river chub | Intermediate | Omnivore |
| *Notemigonus crysoleucas* | golden shiner | Tolerant | Omnivore |
| *Notropis leuciodus* | Tennessee shiner | Intermediate | Insectivore |
| *N. lutipinnis* | yellowfin shiner | Intermediate | Insectivore |
| *N. micropteryx* | highland shiner | Intolerant | Insectivore |
| *N. photogenis* | silver shiner | Intolerant | Insectivore |
| *N. rubricroceus* | saffron shiner | Intermediate | Insectivore |
| *N. spectrunculus* | mirror shiner | Intermediate | Insectivore |
| *N. telescopus* | telescope shiner | Intolerant | Insectivore |
| *N. volucellus* | mimic shiner | Intolerant | Insectivore |
| *Phenacobius crassilabrum* | fatlips minnow | Intermediate | Insectivore |
| *Rhinichthys cataractae* | longnose dace | Intermediate | Insectivore |
| *R. obtusus* | western blacknose dace | Intermediate | Insectivore |
| *Semotilus atromaculatus* | creek chub | Tolerant | Insectivore |
| **Catostomidae** | **suckers** | | |
| *Catostomus commersonii* | white sucker | Tolerant | Omnivore |
| *Hypentelium nigricans* | northern hog sucker | Intermediate | Insectivore |
| *Moxostoma anisurum* | silver redhorse | Intermediate | Insectivore |
| *M. carinatum* | river redhorse | Intermediate | Insectivore |
| *M. duquesnei* | black redhorse | Intermediate | Insectivore |
| *M. erythrurum* | golden redhorse | Intermediate | Insectivore |
| *M. macrolepidotum* | shorthead redhorse | Intermediate | Insectivore |
| *M.* sp. cf. *macrolepidotum* | sicklefin redhorse | Intermediate | Insectivore |
| *M.* sp. cf. *macrolepidotum* | smallmouth redhorse | Intermediate | Insectivore |
| **Ictaluridae** | **North American catfishes** | | |
| *Ameiurus brunneus* | snail bullhead | Intermediate | Insectivore |
| *A. melas* | black bullhead | Tolerant | Insectivore |
| *A. nebulosus* | brown bullhead | Tolerant | Omnivore |
| *A. platycephalus* | flat bullhead | Tolerant | Insectivore |
| *Ictalurus punctatus* | channel catfish | Intermediate | Omnivore |
| *Noturus flavus* | stonecat | Intermediate | Insectivore |
| *Pylodictis olivaris* | flathead catfish | Intermediate | Piscivore |
| **Esocidae** | **pikes** | | |
| *Esox masquinongy* | muskellunge | Intermediate | Piscivore |
| **Salmonidae** | **trouts and salmons** | | |
| *Oncorhynchus mykiss* | rainbow trout | Intolerant | Insectivore |
| *Salmo trutta* | brown trout | Intermediate | Piscivore |
| *Salvelinus fontinalis* | brook trout | Intolerant | Insectivore |

**Table 5 (continued).**

| Family/Species | Common Name | Tolerance Rating | Trophic Guild of Adults |
|---|---|---|---|
| **Cottidae** | **sculpins** | | |
| *Cottus bairdii* | mottled sculpin | Intermediate | Insectivore |
| | | | |
| **Moronidae** | **temperate basses** | | |
| *Morone chrysops* | white bass | Intermediate | Piscivore |
| | | | |
| **Centrarchidae** | **sunfishes** | | |
| *Ambloplites rupestris* | rock bass | Intolerant | Piscivore |
| *Lepomis auritus* | redbreast sunfish | Tolerant | Insectivore |
| *L. cyanellus* | green sunfish | Tolerant | Insectivore |
| *L. gibbosus* | pumpkinseed | Intermediate | Insectivore |
| *L. gulosus* | warmouth | Intermediate | Insectivore |
| *L. macochirus* | bluegill | Intermediate | Insectivore |
| *L. microlophus* | redear sunfish | Intermediate | Insectivore |
| *Micropterus dolomieu* | smallmouth bass | Intolerant | Piscivore |
| *M. punctulatus* | spotted bass | Intermediate | Piscivore |
| *M. salmoides* | largemouth bass | Intermediate | Piscivore |
| *Pomoxis annularis* | white crappie | Intermediate | Piscivore |
| *P. nigromaculatus* | black crappie | Intermediate | Piscivore |
| | | | |
| **Percidae** | **darters and perches** | | |
| *Etheostoma chlorobranchium* | greenfin darter | Intolerant | Insectivore |
| *E. gutselli* | Tuckasegee darter | Intermediate | Insectivore |
| *E. rufilineatum* | redline darter | Intermediate | Insectivore |
| *E. vulneratum* | wounded darter | Intolerant | Insectivore |
| *E. zonale* | banded darter | Intermediate | Insectivore |
| *Perca flavescens* | yellow perch | Intermediate | Piscivore |
| *Percina aurantiaca* | tangerine darter | Intolerant | Insectivore |
| *P. burtoni* | blotchside logperch | Intolerant | Insectivore |
| *P. evides* | gilt darter | Intolerant | Insectivore |
| *P. squamata* | olive darter | Intolerant | Insectivore |
| *Sander vitreus* | walleye | Intermediate | Piscivore |

**Appendix F-4. Fish community data collected from the Little Tennessee River basin, 1993 - 2004. Current basinwide sites are in bold font.**

| Subbasin/Waterbody | Location | County | Index No. | Date | NCIBI Score | NCIBI Rating |
|---|---|---|---|---|---|---|
| ***040401*** | | | | | | |
| **Little Tennessee R** | off SR 1683 | Macon | 2-(1) | 05/17/04 | 38 | Fair |
| **Middle Cr** | SR 1635 - 2nd bridge | Macon | 2-8 | 05/17/04 | 56 | Good |
| Middle Cr | SR 1635 - 1st bridge | Macon | 2-8 | 05/03/95 | 46 | Good-Fair |
| **Tessentee Cr** | SR 1636 | Macon | 2-9 | 05/18/04 | 52 | Good |
| | | | | 05/03/95 | 56 | Good |
| **Coweeta Cr** | SR 1119 | Macon | 2-10 | 05/20/04 | 56 | Good |
| Coweeta Cr | US 23/441 | Macon | 2-10 | 05/01/95 | 44 | Good-Fair |
| **Cartoogechaye Cr** | SR 1146 | Macon | 2-19-(1) | 05/18/04 | 56 | Good |
| Cartoogechaye Cr | SR 1168 | Macon | 2-19-(10.5) | 05/02/95 | 56 | Good |
| Cullasaja R | SR 1677 | Macon | 2-21-(5.5) | 10/19/99 | 50 | Good |
| | | | | 10/15/96 | 52 | Good |
| Cullasaja R | SR 1653 | Macon | 2-21-(5.5) | 10/20/99 | 46 | Good-Fair |
| | | | | 10/16/96 | 34 | Fair |
| **Walnut Cr** | SR 1533 | Macon | 2-21-17 | 05/18/04 | --- | Not Rated |
| **Ellijay Cr** | SR 1524 | Macon | 2-21-23 | 05/20/04 | 56 | Good |
| **Rabbit Cr** | SR 1504 | Macon | 2-23 | 05/20/04 | 44 | Good-Fair |
| Iotla Cr | SR 1372 | Macon | 2-27 | 05/03/95 | 22 | Poor |
| **Iotla Cr** | off SR 1378 | Macon | 2-27 | 05/19/04 | 44 | Good-Fair |
| **Cowee Cr** | SR 1340 | Macon | 2-29 | 05/19/04 | 56 | Good |
| **Burningtown Cr** | SR 1364 | Macon | 2-38 | 05/21/04 | 58 | Excellent |
| **Tellico Cr** | SR 1367 | Macon | 2-40 | 05/21/04 | 50 | Good |
| ***040402*** | | | | | | |
| **Brush Cr** | off SR 1129 | Swain | 2-46 | 05/19/04 | 50 | Good |
| **Alarka Cr** | SR 1185 | Swain | 2-69-(2.5) | 06/03/04 | 46 | Good-Fair |
| **Caney Fk** | SR 1738 | Jackson | 2-79-28-(2.5) | 06/01/04 | 56 | Good |
| **Cullowhee Cr** | SR 1545 | Jackson | 2-79-31 | 06/02/04 | 46 | Good-Fair |
| **Savannah Cr** | NC 116 | Jackson | 2-79-36 | 06/02/04 | 50 | Good |
| **Scott Cr** | SR 1527 | Jackson | 2-79-39 | 06/01/04 | --- | Not Rated |
| **Conley Cr** | SR 1183 | Swain | 2-79-52 | 06/02/04 | --- | Not Rated |
| **Panther Cr** | SR 1233 | Graham | 2-115 | 06/03/04 | --- | Not Rated |
| **Stecoah Cr** | SR 1237 | Graham | 2-130 | 06/03/04 | --- | Not Rated |
| ***040403*** | | | | | | |
| Nantahala R | SR 1401 | Macon | 2-57-(22.5) | 11/15/93 | --- | Not Rated |
| Whiteoak Cr | SR 1310/1404 | Macon | 2-57-45 | 11/15/93 | --- | Not Rated |
| Silvermine Cr | SR 1103 | Swain | 2-57-55 | 11/16/93 | --- | Not Rated |
| ***040404*** | | | | | | |
| **Tulula Cr** | SR 1260 | Graham | 2-190-2-(0.5) | 06/04/04 | 46 | Good-Fair |

**Appendix F-5. Fish community metric values from 22 wadeable streams in the Little Tennessee River basinwide monitoring program, 2004.[1]**

| Subbasin Waterbody | Location | County | d. a. ($mi^2$) | Date | No. Species | No. Fish | No. Sp. Darters | No. Sp. RST | No. Sp. Cyprinids | No. Intol. Sp. | % Tolerant | % Omni. +Herb. | % Insect. | % MA |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| ***040401*** | | | | | | | | | | | | | | |
| Little Tennessee R | off SR 1683 | Macon | 55.9 | 05/17/04 | 20 | 178 | 1 | 2 | 7 | 3 | 11 | 40 | 52 | 65 |
| Middle Cr | SR 1635 | Macon | 12.2 | 05/17/04 | 16 | 515 | 1 | 2 | 8 | 3 | 2 | 27 | 71 | 69 |
| Tessentee Cr | SR 1636 | Macon | 14.8 | 05/18/04 | 16 | 578 | 2 | 1 | 7 | 3 | 0 | 17 | 71 | 81 |
| Coweeta Cr | SR 1119 | Macon | 16.8 | 05/20/04 | 20 | 799 | 3 | 3 | 7 | 4 | 1 | 32 | 63 | 65 |
| Cartoogechaye Cr | SR 1146 | Macon | 41.2 | 05/18/04 | 18 | 473 | 2 | 1 | 8 | 3 | 1 | 16 | 66 | 67 |
| Walnut Cr | SR 1533 | Macon | 6.1 | 05/18/04 | 6 | 290 | 0 | 2 | 3 | 1 | 0 | 0 | 100 | 50 |
| Ellijay Cr | SR 1524 | Macon | 20.0 | 05/20/04 | 20 | 590 | 2 | 3 | 9 | 4 | 1 | 15 | 82 | 60 |
| Rabbit Cr | SR 1504 | Macon | 8.8 | 05/20/04 | 15 | 635 | 0 | 1 | 8 | 1 | 9 | 24 | 71 | 73 |
| Iotla Cr | off SR 1378 | Macon | 10.0 | 05/19/04 | 18 | 185 | 3 | 2 | 6 | 4 | 10 | 34 | 51 | 56 |
| Cowee Cr | SR 1340 | Macon | 25.2 | 05/19/04 | 21 | 468 | 4 | 2 | 7 | 5 | 5 | 11 | 84 | 76 |
| Burningtown Cr | SR 1364 | Macon | 26.1 | 05/21/04 | 18 | 448 | 3 | 2 | 8 | 4 | 1 | 24 | 71 | 72 |
| Tellico Cr | SR 1367 | Macon | 11.4 | 05/21/04 | 16 | 276 | 2 | 2 | 9 | 4 | 5 | 29 | 71 | 56 |
| ***040402*** | | | | | | | | | | | | | | |
| Brush Cr | off SR 1129 | Swain | 7.5 | 05/19/04 | 16 | 364 | 2 | 2 | 7 | 4 | 1 | 9 | 74 | 69 |
| Alarka Cr | SR 1185 | Swain | 25.0 | 06/03/04 | 12 | 1503 | 1 | 2 | 7 | 2 | 0 | 18 | 82 | 75 |
| Caney Fk | SR 1738 | Jackson | 50.2 | 06/01/04 | 16 | 443 | 3 | 2 | 7 | 4 | 0 | 26 | 67 | 81 |
| Cullowhee Cr | SR 1545 | Jackson | 19.5 | 06/02/04 | 16 | 391 | 1 | 3 | 7 | 3 | 3 | 9 | 85 | 75 |
| Savannah Cr | NC 116 | Jackson | 36.5 | 06/02/04 | 15 | 469 | 2 | 2 | 8 | 3 | 0 | 13 | 87 | 73 |
| Scott Cr | SR 1527 | Jackson | 43.0 | 06/01/04 | 12 | 336 | 1 | 1 | 4 | 2 | 1 | 4 | 96 | 58 |
| Conley Cr | SR 1183 | Swain | 13.1 | 06/02/04 | 9 | 439 | 1 | 1 | 5 | 1 | 0 | 21 | 79 | 78 |
| Panther Cr | SR 1233 | Graham | 9.2 | 06/03/04 | 9 | 564 | 1 | 1 | 3 | 1 | 2 | 64 | 36 | 78 |
| Stecoah Cr | SR 1237 | Graham | 9.0 | 06/03/04 | 10 | 202 | 0 | 1 | 7 | 1 | 3 | 50 | 50 | 70 |
| ***040404*** | | | | | | | | | | | | | | |
| Tulula Cr | SR 1260 | Graham | 27.4 | 06/04/04 | 14 | 690 | 3 | 2 | 7 | 4 | 0 | 51 | 49 | 71 |

[1]Abbreviations are d. a. = drainage area, No. = number, Sp. = species, RST = rockbass, smallmouth bass, and trout, Intol. = intolerants, Omni. + Herb. = omnivores+herbivores, Insect. = insectivores, and MA = species with multiple age groups.

**Appendix F-6. Fish distributional records for the Little Tennessee River basin.**

Based upon Menhinick (1991), TVA's data, NC DWQ's data, and data from other researchers, 73 species have been collected from the Little Tennessee River basin in North Carolina (Table 5 in Appendix F-2). The known species assemblage includes 24 species of minnows, 9 species of suckers, 12 species of sunfish and bass, and 11 species of darters. At least 19 of the 73 species (26 percent of the total basin fauna) are exotics that were introduced either as sportfish, baitfish, or for reasons unknown. All of the streams had at least one exotic species present.

In 2004, 36 of the 73 species were collected during NC DWQ's fish community monitoring program (Table 5 in Appendix F-4). The most commonly collected species were the mottled sculpin (collected at all sites) and the central stoneroller and northern hog sucker (each collected at 21 of the 22 sites). The most abundant species was the mottled sculpin which constituted almost one-third of all the fish collected. It was also the numerically dominant species at 14 of the 22 sites.

Eight of the 73 species have been given special protection status by the by the United States Department of the Interior, the North Carolina Wildlife Resources Commission, or the North Carolina Natural Heritage Program under the North Carolina State Endangered Species Act (G.S. 113-311 to 113-337 (LeGrand, *et al*. 2004; Menhinick and Braswell 1997) (Table 1). Additional information on these eight species may be found in Menhinick and Braswell (1997). In 2004, only one of these eight species was collected as part of the fish community monitoring program. The smoky dace was collected from Middle, Tessentee, Ellijay, Burningtown, Tellico, Brush, and Alarka Creeks and from Caney Fork. The species was very abundant in Alarka Creek were 121 specimens were netted.

**Table 1. Species of fish listed as endangered, rare, threatened, or of special concern in the Little Tennessee River basin in North Carolina.**

| Species | Common Name | State or Federal Status | State Rank[1] |
|---|---|---|---|
| *Clinostomus funduloides ssp 1* | smoky dace | State - Special Concern | S2 |
| *Erimonax monachus* | spotfin chub | Federal – Threatened | S1 |
| *Luxilus chrysocephalus* | striped shiner | State – Threatened (Proposed Special Concern) | S2 |
| *Notropis lutipinnis* | yellowfin shiner | State - Special Concern | S3 |
| *Moxostoma* sp. cf. *macrolepidotum* | sicklefin redhorse | State – Significantly Rare (Proposed Threatened) | S2 |
| *Noturus flavus* | stonecat | State - Endangered | S1 |
| *Etheostoma vulneratum* | wounded darter | State - Special Concern | S2 |
| *Percina squamata* | olive darter | State - Special Concern | S2 |

[1]S1 = critically imperiled in North Carolina because of extreme rarity or because of some factor(s) making it especially vulnerable to extirpation from North Carolina; S2 = imperiled in North Carolina because of rarity or because of some factor(s) making it very vulnerable to extirpation from North Carolina; S3 = rare or uncommon in North Carolina (LeGrand *et al*. 2004).

New distributional records in 2004 from DWQ's fish community monitoring efforts were:

- Snail bullhead -- Little Tennessee River and Coweeta Creek (Macon County);
- Flat bullhead -- Little Tennessee River (Macon County);
- Green sunfish – Middle, Iotla, Cowee, Ellijay, Burningtown, and Tellico Creeks (Macon County), Brush Creek (Swain County), and Panther Creek (Graham County); and
- Yellow perch -- Little Tennessee River (Macon County).

**Appendix F-7. Water quality at fish community sites in the Little Tennessee River basin, 2004.**

In 2003 water quality data were collected at every site during fish community assessments (Table 1). Conductivity (specific conductance) ranged from 16 to 233 µmhos/cm at Coweeta Creek and Little Tennessee River, respectively (Figure 1). The elevated conductivity in the Little Tennessee River reflected the upstream dischargers and landuse practices in Georgia. Compared to many of the other sites, conductivity was also elevated in Rabbit, Iotla, and Stecoah Creeks.

All dissolved oxygen concentrations were greater than the water quality standard of 5 mg/L. Dissolved oxygen saturation ranged from 84 percent at Burningtown Creek shortly after sunrise to 97 percent at Savannah Creek during the late morning hours. Thirteen of the pH measurements were less than the water quality standard for non-swamp waters and ranged from 5.2 to 6.7 s.u. at Tellico and Stecoah Creeks, respectively.

**Table 1. Water quality measurements at 22 fish community sites in the Little Tennessee River basin, 2004.**

| Subbasin/ Waterbody | Location | County | Date | Temperature (˚C) | Specific conductance (µmhos/cm) | Dissolved oxygen (mg/L) | Saturation (%) | pH (s.u.) |
|---|---|---|---|---|---|---|---|---|
| ***040401*** | | | | | | | | |
| Little Tennessee R | off SR 1683 | Macon | 05/17/04 | 17.6 | 233 | 8.9 | 93 | 6.5 |
| Middle Cr | SR 1635 | Macon | 05/17/04 | 18.1 | 24 | 8.5 | 90 | 5.8 |
| Tessentee Cr | SR 1636 | Macon | 05/18/04 | 16.4 | 17 | 8.9 | 91 | 5.9 |
| Coweeta Cr | SR 1119 | Macon | 05/20/04 | 18.5 | 16 | 8.0 | 85 | 6.0 |
| Cartoogechaye Cr | SR 1146 | Macon | 05/18/04 | 15.2 | 30 | 8.8 | 88 | 5.8 |
| Walnut Cr | SR 1533 | Macon | 05/18/04 | 15.9 | 32 | 8.9 | 90 | 6.1 |
| Ellijay Cr | SR 1524 | Macon | 05/20/04 | 15.2 | 32 | 8.6 | 86 | 5.8 |
| Rabbit Cr | SR 1504 | Macon | 05/20/04 | 17.5 | 41 | 8.2 | 86 | 6.0 |
| Iotla Cr | off SR 1378 | Macon | 05/19/04 | 16.4 | 39 | 8.3 | 85 | 5.9 |
| Cowee Cr | SR 1340 | Macon | 05/19/04 | 15.8 | 22 | 8.5 | 86 | 5.9 |
| Burningtown Cr | SR 1364 | Macon | 05/21/04 | 15.5 | 18 | 8.4 | 84 | 5.4 |
| Tellico Cr | SR 1367 | Macon | 05/21/04 | 14.8 | 17 | 8.8 | 87 | 5.2 |
| ***040402*** | | | | | | | | |
| Brush Cr | off SR 1129 | Swain | 05/19/04 | 16.9 | 28 | 8.7 | 90 | 6.5 |
| Alarka Cr | SR 1185 | Swain | 06/03/04 | 14.1 | 25 | 9.7 | 94 | 6.0 |
| Caney Fk | SR 1738 | Jackson | 06/01/04 | 18.2 | 21 | 8.8 | 93 | 5.9 |
| Cullowhee Cr | SR 1545 | Jackson | 06/02/04 | 13.1 | 33 | 10.0 | 95 | 5.8 |
| Savannah Cr | NC 116 | Jackson | 06/02/04 | 14.7 | 28 | 9.8 | 97 | 6.0 |
| Scott Cr | SR 1527 | Jackson | 06/01/04 | 15.7 | 26 | 9.5 | 96 | 6.0 |
| Conley Cr | SR 1183 | Swain | 06/02/04 | 18.2 | 23 | 8.6 | 91 | 5.9 |
| Panther Cr | SR 1233 | Graham | 06/03/04 | 14.7 | 22 | 8.9 | 88 | 5.8 |
| Stecoah Cr | SR 1237 | Graham | 06/03/04 | 19.8 | 44 | 8.6 | 94 | 6.7 |
| ***040404*** | | | | | | | | |
| Tulula Cr | SR 1260 | Graham | 06/04/04 | 16.2 | 29 | 8.8 | 90 | 5.8 |

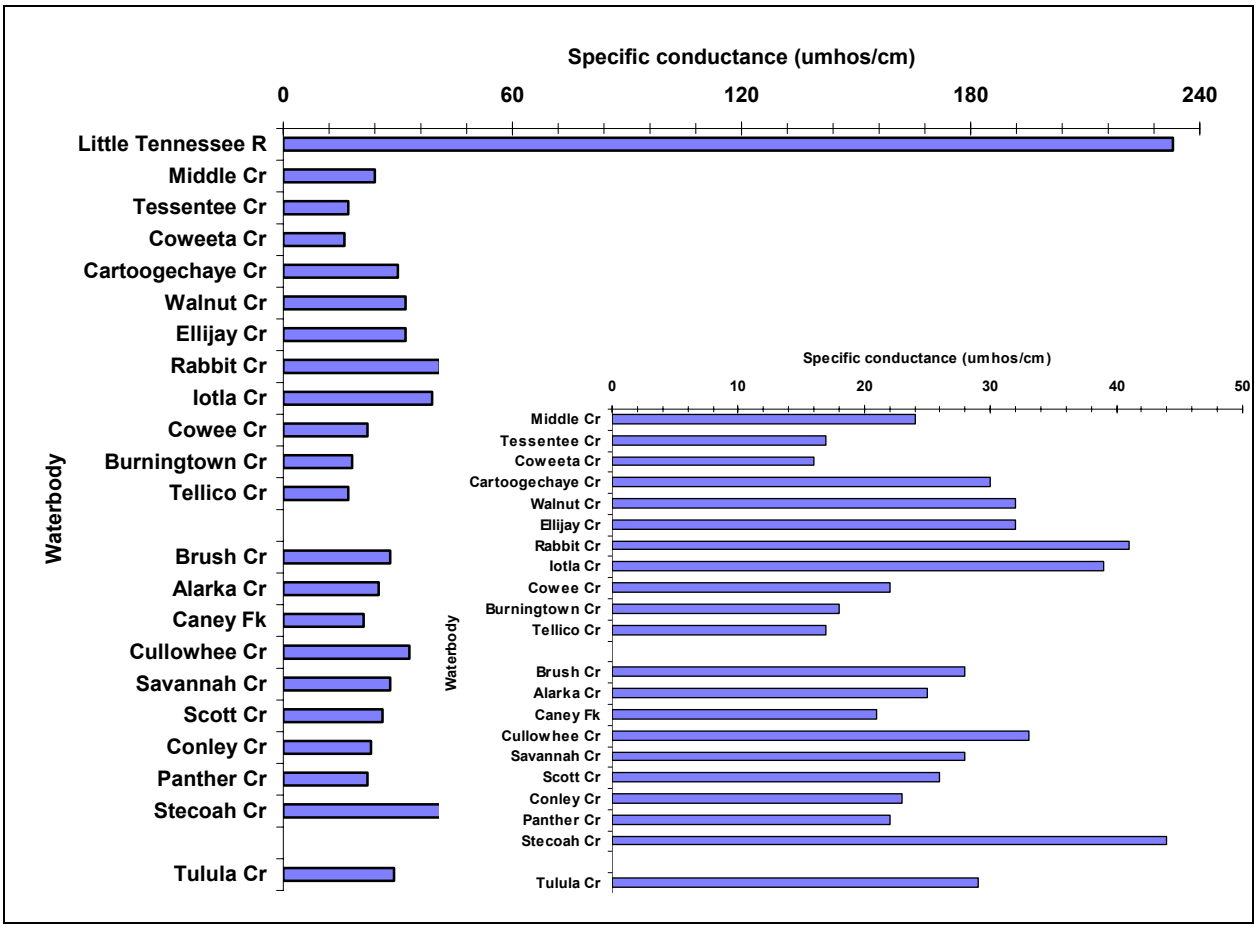



**Figure 1.** **Specific conductance at 22 fish community sites in the Little Tennessee River basin, 2004. The insert represents measurements at all sites except for that at the Little Tennessee River.**

**Appendix F-8. Web links.**

NC Wildlife Resources Commission (stocking information) -- http://www.ncwildlife.org/pg03_fishing/pg3b.htm

NC Division of Water Quality (fish community sampling methods) -- http://h2o.enr.state.nc.us/esb/BAUwww/IBI%20Methods%202001.pdf

NC Division of Water Quality (fish community data) -- http://h2o.enr.state.nc.us/esb/NCIBI.htm

Tellico Trout Farms -- http://www.tellicotrout.com/index.html

# LAKE & RESERVOIR ASSESSMENTS – Little Tennessee River Basin

## *Assessment Overview*

Ten lakes were sampled in the Little Tennessee River Basin by DWQ in 2004. All of these lakes were sampled three times during the summer (June, July and August). Lake Sequoyah and Wolf Creek Reservoir were also sampled in September as part of an extended sampling period special study. Data collected during this sampling effort determined that all ten lakes supported their designated uses; however, sedimentation concerns related to construction are a factor at several of the lakes. Local efforts might need to be directed towards preventing sedimentation into the tributaries of these lakes.

## <u>Subbasin 040401</u>

***Lake Sequoyah – Macon County***

**Lake Sequoyah** was monitored in June, July and August of 2004. This lake was described as appearing muddy on the June 1st sampling trip and the low Secchi depths (range = 0.9 to 1.1 meters) agreed with these observations. Turbidity values ranged form 8.3 to 10.0 NTU. The state water quality standard for turbidity for waters designated as Trout Waters (Tr) states that turbidity shall not exceed 10 NTU (NCDENR, August 1, 2004). Low surface dissolved oxygen values (range = 4.4 mg/L to 5.2 mg/L) suggested an increase in oxygen consumption via biological activity. No definitive reason for these low values was obvious; however, organic materials on the lake bottom may have been disturbed due to recent hydraulic events thus causing oxygen demand and the low dissolved oxygen values found in June. Total phosphorus concentrations were elevated (range of 0.04 to 0.05 mg/L) and could support increased algal activity; however, chlorophyll *a* values were low.

Secchi depths and dissolved oxygen values were greater in July and August while total phosphorus concentrations remained elevated (range = 0.02 mg/L to 0.08 mg/L). Again, chlorophyll *a* remained low. Frequent rainfall events within the lake's watershed during the summer of 2004 may have contributed to the increase in nonpoint source runoff, decreased water clarity, and increased total phosphorus in comparison with levels observed in 1999, which was a drier year. A turbidity value of 11.0 NTU was recorded at LTN006C in August.

Based on the calculated NCTSI scores, Lake Sequoyah demonstrated a potential for moderate biological productivity (mesotrophic conditions) in June and July. The score for August indicated that potential biological productivity had become low (oligotrophic conditions). This reservoir was previously determined to be mesotrophic in 1994 and eutrophic (potentially for elevated biological productivity) in 1988. While Lake Sequoyah supported all of its designated uses based on the results of the use support matrix in 2004, nonpoint source nutrient and sediment contributions to this small reservoir during rainfall events may warrant a need to add (or improve existing) best management practices within the watershed.

For further background information on this lakes (including sampling data), please go to the table later in this section and http://www.esb.enr.state.nc.us/.

## Subbasin 040402

***Wolf Creek Reservoir – Jackson County***

DWQ monitored Wolf Creek Reservoirs, Bear Creek Reservoir, Cedar Cliff Lake, Lake Thorpe and Fontana Lake in this subbasin during June, July and August, 2004.

**Wolf Creek Reservoir** is a small lake located on Wolf Creek, a tributary of the Tuckasegee River. Low nutrient and chlorophyll *a* concentrations were observed in 2004, suggesting a low potential for algal productivity. Water clarity as measured by Secchi depths was very good (range = 4.0 to 6.0 meters) despite frequent rainfall within the watershed and overcast conditions during the sampling trips. The calculated NCTSI

scores were in agreement with the low nutrient levels (oligotrophic) and very good water clarity. Wolf Creek Reservoir has been oligotrophic since it was first monitored by DWQ in 1988.

***Bear Creek Reservoir – Jackson County***

**Bear Creek Reservoir** is located downstream of the confluence of Wolf Creek on the Tuckasegee River. Nutrient and chlorophyll *a* concentrations in this reservoir continue to remain very low. Despite the frequent rainfall events within the lake's watershed in 2004, Secchi depths were similar to those recorded in 1999, with the greatest depth (5.2 meters) observed in June near the dam (LTN105D).

The shoreline and watershed of Bear Creek Reservoir are predominantly forest with a few scattered residences. This relatively undisturbed drainage area has helped to maintain the reservoir's low nutrient concentration and very clear water. Based on the calculated NCTSI scores for 2004, Bear Creek Reservoir continues to exhibit low biological productivity (oligotrophic). This reservoir has been oligotrophic since 1988 when it was first sampled by DWQ.

***Cedar Cliff Lake – Jackson County***

**Cedar Cliff Lake** is located downstream of Bear Creek Reservoir on the Tuckasegee River. The watershed and shoreline consists primarily of forests with some scattered residences. Nutrient concentrations in this reservoir were lower in 2004 than in previous sampling years and may have been due to frequent rain events, which increased the water level in the lake and decreased residence time. Additionally, runoff flows into the lake through relatively undisturbed areas with low nutrients and this would dilute nutrient levels present in the lake. As a result, chlorophyll *a* concentrations were also low (range = <1.0 to 3.0 µg/L).

Despite frequent rainfall within the watershed in 2004, the clarity of Cedar Cliff remained similar to what has been observed by DWQ staff on previous sampling trips. In August, a Secchi depth of 8.1 meters at the sampling site near the dam (LTN015H) was recorded, and was the greatest Secchi depth observed at this lake since 1988.

The potential biological productivity of Cedar Cliff Lake remains low (oligotrophic) in 2004 as determined by the calculated NCTSI scores for June, July and August sampling data. These scores were similar to the oligotrophic scores for sampling trips in 1988, 1991 and 1992.

***Thorpe Reservoir – Jackson County***

**Thorpe Reservoir (Glenville Lake)** is located at the headwaters of the West Fork Tuckasegee River. As in previous sampling years, nutrient and chlorophyll *a* concentrations in this reservoir were low in 2004. Rainfall was frequent during the summer and may have contributed to a Secchi depth of 1.9 meters at LTN015L in July. This was the lowest Secchi depth observed by DWQ for this reservoir since it was first

monitored in 1988. A combination of suspended sediments along with overcast skies may have contributed to the decrease in water clarity in this arm of the lake.

The calculated NCTSI scores for 2004 indicated that Thorpe Reservoir continues to exhibit a low potential for algal productivity (oligotrophic). This trophic state has been maintained since 1988.

The Friends of Lake Glenville initiated a local branch of the Volunteer Water Information Network (VWIN) in June 2000 (www.friendsoflakeglenville.com/water.html). Seven stream sites are monitored monthly and one control site is monitored twice annually to assess water quality conditions in streams flowing into Thorpe Reservoir (Glenville Lake). The first year of monitoring was completed with data collected in 2000 through 2001. The most frequent water quality problem observed was stream sedimentation. Rainfall was found to have an effect on stream sediment concentrations and water clarity. The most affected sites were Mill Creek, Pine Creek and Cedar Creek. These observations seem to assist in explaining the decreased Secchi depth reading by DWQ at LTN015L in July, 2004 following a rain event. This site is located near the mouth of Cedar Creek, which may have been the source of suspended sediment entering the lake and decreasing the clarity of the water. Land disturbing activities, unpaved roads, bank erosion and agriculture, particularly where livestock have access to the streams, were identified by the Friends of Lake Glenville monitoring team as potential sources of sedimentation.

***Fontana Lake – Swain and Graham Counties***

**Fontana Lake** is a large reservoir located on the Little Tennessee River. In 2004, nutrient and chlorophyll *a* values were consistently low to moderate with the exception of nitrite plus nitrate, which ranged from below DWQ water chemistry laboratory detection levels to elevated (0.11 mg/L at LTN031H and LTN031J in June). Secchi depths at these two sites in June (10 and 12 meters, respectively) were the greatest depths

recorded for this reservoir by DWQ since monitoring began in 1981. Fontana Lake was determined to be oligotrophic in 2004.

The Tennessee Valley Authority (TVA) conducts annual bacteriological sampling in recreational areas throughout the Tennessee Valley. Each summer, approximately 250 swimming areas and informal water contact recreational areas are tested for fecal coliform and/or *Escherichia coli* bacteria. In 2004, four sites at Fontana Lake were tested: Panther Creek Marina/Thomas boat dock, Tuckasegee River boat ramp, Tsali Camp boat ramp, and the Nantahala River canoe access site. Testing was conducted 11 times from July 24 through August 28. The geometric mean values for bacteria concentrations (range = 1 to 8 per 100 ml) were well below the state water quality standard of 200/100 ml for five consecutive samples taken within a 30 day period (Rebecca Hallman, 2004; NCDENR-Division of Water Quality, August 1, 2004).

TVA also evaluates the overall ecological health of Fontana Lake every other year. In 2002, this reservoir was scored Fair by TVA, which was the lowest overall ecological health score for Fontana Lake since TVA began ecological health rating in 1993. The lower rating in 2002 was a result of lower ratings for dissolved oxygen and chlorophyll *a*. Dissolved oxygen rated Poor at the TVA sampling site located on the Tuckasegee River arm. Chlorophyll *a* rated Poor in the Little Tennessee River arm and the Tuckasegee River arm in 2002 (www.tva.com/environment/ecohealth/index.htm). Although not stated by TVA, data for the 2002 ecological health survey was collected during a significant drought in NC. This may have influenced both dissolved oxygen and chlorophyll *a* in Fontana Lake.

The table later in this section provides a summary of the data collected in this basin. No parameters of concern were noted. For further background information on these lakes (including sampling data), please go to http://www.esb.enr.state.nc.us/.

## Subbasin 040403

***Nantahala Lake – Macon County***

**Nantahala Lake** was monitored by DWQ in June, July and August of 2004. The water of this reservoir was exceptionally clear despite frequent rainfall events during the summer. Secchi depths were greater than five meters at all three lake sampling sites in 2004. Nutrient concentrations and chlorophyll *a* values were very low (range = 1.0 to 2.0 µg/L). The calculated NCTSI scores determined that the biological productivity potential for this reservoir is very low (oligotrophic). The table later in this section presents a summary of the data and information collected on Nantahala Lake. No parameters of concern were found.

For further background information on these lakes (including sampling data), please go to http://www.esb.enr.state.nc.us/.

## Subbasin 040404

Lake Cheoah, Calderwood Lake and Santeetlah Lake in this subbasin were sampled by DWQ in June, July and August of 2004.

**Lake Cheoah** is located immediately downstream of Lake Fontana. The upstream region of this reservoir is located immediately downstream of Fontana Dam and has the appearance of a fast flowing mountain stream. Water entering Lake Cheoah from Fontana Lake is very cold. Secchi depths in June and August were greater than 5 meters. while nutrient and chlorophyll *a* concentrations were low. These conditions were similar to those recorded for Lake Cheoah by DWQ since it was first sampled in 1988.

On July 26$^{th}$, field notes indicated that the water in Lake Cheoah appeared greenish in color and was very turbid. This was likely due to a major rain event within the watershed prior to sampling. Secchi depths (range = 0.7 to 1.5 meters) were the lowest observed by DWQ in this reservoir, indicating a reduction in water clarity as noted by field observations. Turbidity values on July 25$^{th}$ ranged from 2.8 to 6.1 NTU. Total phosphorus (0.03 mg/L) was elevated at LTN032D and may have been due to increased nonpoint source input from the tributaries located at the upper end of the reservoir along with a possible increase in hypolimnetic water from Lake Fontana. Based on the calculated NCTSI scores, Lake Cheoah is oligotrophic (very low biological productivity potential). This reservoir was also determined to be oligotrophic in 1988 and 1994.

***Calderwood Lake – Swain and Graham Counties***

**Calderwood Lake** is located immediately downstream of Lake Cheoah on the Little Tennessee River. In June and August, conditions in this reservoir were similar to those previously observed by DWQ; nutrient and chlorophyll *a* concentrations were low and field notes indicated that the water was clear.
On July 26th, a major storm event occurred within the Calderwood Lake watershed prior to sampling. As a result, the Secchi depth at LTN040 dropped from 1.7 meters in June to 0.6 meter in July. Total phosphorus at this site (0.03 mg/L) was elevated. The increase in this nutrient along with the decrease in the clarity of the water may have been due to suspended sediments transported into the lake from nonpoint source runoff from the watershed.

Field notes taken from observations made at this sampling site indicated that the water appeared muddy. Turbidity (12.8 NTU) was greater than the state water quality standard of 10 NTU for a Trout Water, which Calderwood Lake is classified as C Tr. The turbidity value at this sampling site dropped back to <1 NTU in August, indicating that the turbidity observed in July was the result of rain event immediately prior to sampling. Based on the calculated NCTSI scores for 2004, Calderwood Lake was determined to be oligotrophic (potential for low biological productivity). This reservoir was also determined to be oligotrophic in 1994 and 1988.

***Santeetlah Lake – Graham County***

Nutrient concentrations in **Santeetlah Lake** were low in 2004. Chlorophyll a values ranged from 2 to 5 µg/L. Despite frequent rainfall within the lake's watershed, water clarity was very good with Secchi depths greater than three meters at each of the three lake sampling sites. Calculated NCTSI scores indicated that this reservoir was oligotrophic.

In addition to monitoring the ambient lake sites, sites located within Snowbird Creek and West Buffalo Creek arms of the lake were also sampled. Chlorophyll *a* values at the Snowbird Creek site (SL11) ranged from 4 to 6 ug/L and nutrients ranged from low to moderate. Concentrations of ammonia were much lower in 2004 as compared with 1993. Turbidity in 2004 was low in the Snowbird Creek arm despite frequent storm events.

As part of a follow up study of West Buffalo Creek to determine what water quality changes may have occurred since closure of the last trout farm on the creek, DWQ sampled this arm of Santeetlah Lake in May, June, July and August 2004. Chlorophyll *a* values from these sampling sites were low in 2004 (range = 2-6 µg/L). Nutrient concentrations at the sampling site immediately downstream of the trout farms were lower in 2004 as compared with 1993. This study will continue in 2005 with additional sampling to be conducted twice a month from April through October.

The three monitored reservoirs in Subbasin 040404 appear to be supporting all of their designated uses. Sedimentation may be a problem in some of the tributaries to Lake Cheoah and Calderwood (Table X). For further background information on these lakes (including sampling data), please go to http://www.esb.enr.state.nc.us/.

References:

Hallman, Rebecca L. September 16, 2004. 2004 TVA Bacteriological Data in North Carolina. Electronic mail message.

NCDENR-Division of Water Quality. August 1, 2004. Administrative Code Section : 15A NCAC 2B .0200. Classifications and Water Quality Standards Applicable to Surface Waters and Wetlands of N.C. Environmental Management Commission, Raleigh, NC.

# LAKES ASSESSMENT - LITTLE TENNESSEE RIVER BASIN

| **Subbasin** | | ***40401*** | ***40402*** | | | | | ***40403*** | ***40403*** | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| ***Waterbody*** | | ***Lake Sequoyah*** | ***Bear Creek Reservoir*** | ***Wolf Creek Reservoir*** | ***Cedar Cliff Reservoir*** | ***Thorpe Reservoir*** | ***Fontana Lake*** | ***Nantahala Lake*** | ***Lake Cheoah*** | ***Calderwood Lake*** | ***Santeetlah Lake*** |
| **Classification** | | WS-III B Tr | WSIII B Tr | WS-III B Tr | WS-III B Tr | WS-III B Tr HQW | WS-IV B CA, B TR, C | B Tr | C Tr | C Tr | B Tr |
| **Trophic Status (NC TSI)** | | Mesotrophic | Oligotrophic | Oligotrophic | Oligotrophic | Oligotrophic | Oligotrophic | Oligotrophic | Oligotrophic | Oligotrophic | Oligotrophic |
| **Mean Depth (meters)** | | 2 | 33 | 27 | 27 | 23 | 41 | 38 | 40 | 29 | 17 |
| **Volume ($10^6 m^3$)** | | 0.1 | 5.6 | 2.1 | 7.2 | 82.6 | 1782 | 160 | 287.5 | 1.6 | 195 |
| **Watershed Area ($mi^2$)** | | 14 | 75 | 40 | 81 | 37 | 1552 | 108 | 1608 | 1856 | 174 |
| **Sampling Dates** | | 06/04 – 09/04 | 06/04 – 08/04 | 06/04 – 09/04 | 06/04 – 08/04 | 06/04 – 08/04 | 06/04 – 08/04 | 06/04 – 08/04 | 06/04 – 08/04 | 06/04 – 08/04 | 06/04 – 08/04 |
| **Number of Samples** (click here to see data) | | n = 12 | n = 6 | n = 8 | n = 6 | n = 12 | n = 15 | n = 9 | n = 9 | n = 6 | n = 9 |
| ***Water Quality Standards*** | | | | | | | | | | | |
| Chlorophyll *a* | >10% above standard (N>9) = Y; exceeding 40 ug/L but not 10% of time = C | N | NE | NE | NE | N | N | NE | NE | NE | NE |
| Dissolved Oxygen | Below standard >10% of samples (N>9) | N | NE | NE | NE | N | N | NE | NE | NE | NE |
| pH | Below or above standard >10% of samples (N>9) | N | NE | NE | NE | N | N | NE | NE | NE | NE |
| Turbidity | >10% above standard (N>9) | E 8% | NE | NE | NE | N | N | NE | NE | X…1 obs | NE |
| Temperature | Minor and infrequent excursions of temperature standards due to anthropogenic activity. No impairment of species evident. (N>9) | N | NE | NE | NE | N | N | NE | NE | NE | NE |
| Metals (excluding copper, iron & zinc) | >10% above standard (N>9) | N | N | NS | NS | NS | NS | NS | NS | NS | NS |
| ***Other Data*** | | | | | | | | | | | |
| % Saturation DO | >10% above >120% | N | N | N | N | N | N | N | N | N | N |
| Algae | Documented blooms during 2 or more sampling events in 1 year with historic blooms | N | N | N | N | N | N | N | N | N | N |
| Fish | Kills related to eutrophication | N | N | N | N | N | N | N | N | N | N |
| Chemically/ Biologically Treated | For algal or macrophyte control - either chemicals or biologically by fish, etc. | N | N | N | N | N | N | N | N | N | N |
| Aesthetics complaints | Documented sheens, discoloration, etc. - written complaint and follow-up by a state | N | N | N | N | N | N | N | N | N | N |
| TSI | Increase of 2 trophic levels from one 5-yr period to next | N | N | N | N | N | N | N | N | N | N |
| Historic DWQ Data | Conclusions from other reports (link to other reports) | N | N | N | N | N | N http://www.tva.com/environment/ecohealth/fontana.htm | N | N | N | **2000 Assessment Report threatened due to eutrophication** |
| AGPT | Algal Growth Potential Test 5-9 mg/L = C 10 mg/L or more = P | NS | NS | NS | NS | NS | NS | NS | NS | NS | **NS** |
| Macrophytes | Limiting access to public ramps, docks, swimming areas; reducing access by fish and other aquatic life to habitat | N | N | N | N | N | N | N | N | N | N |
| Taste and Odor | Public complaints = P; Potential based on algal spp = C | N | N | N | N | N | N | N | N | N | N |
| Sediments | Clogging intakes – dredging program necessary = P Public/agency complaints - visual = C | **C** | N | N | N | N | N | N | N | N | N |

Note: C = of notable Concern or productive P= Problematic or highly productive
E = parameter is Exceeded, but in less than 10 percent of the measurements
N = Not a concern NS = No sample taken for this parameter
NE = Not exceeded but insufficient samples to rate as N X = parameter is Exceeded, but insufficient samples to rate as N

## Assessment Methodology

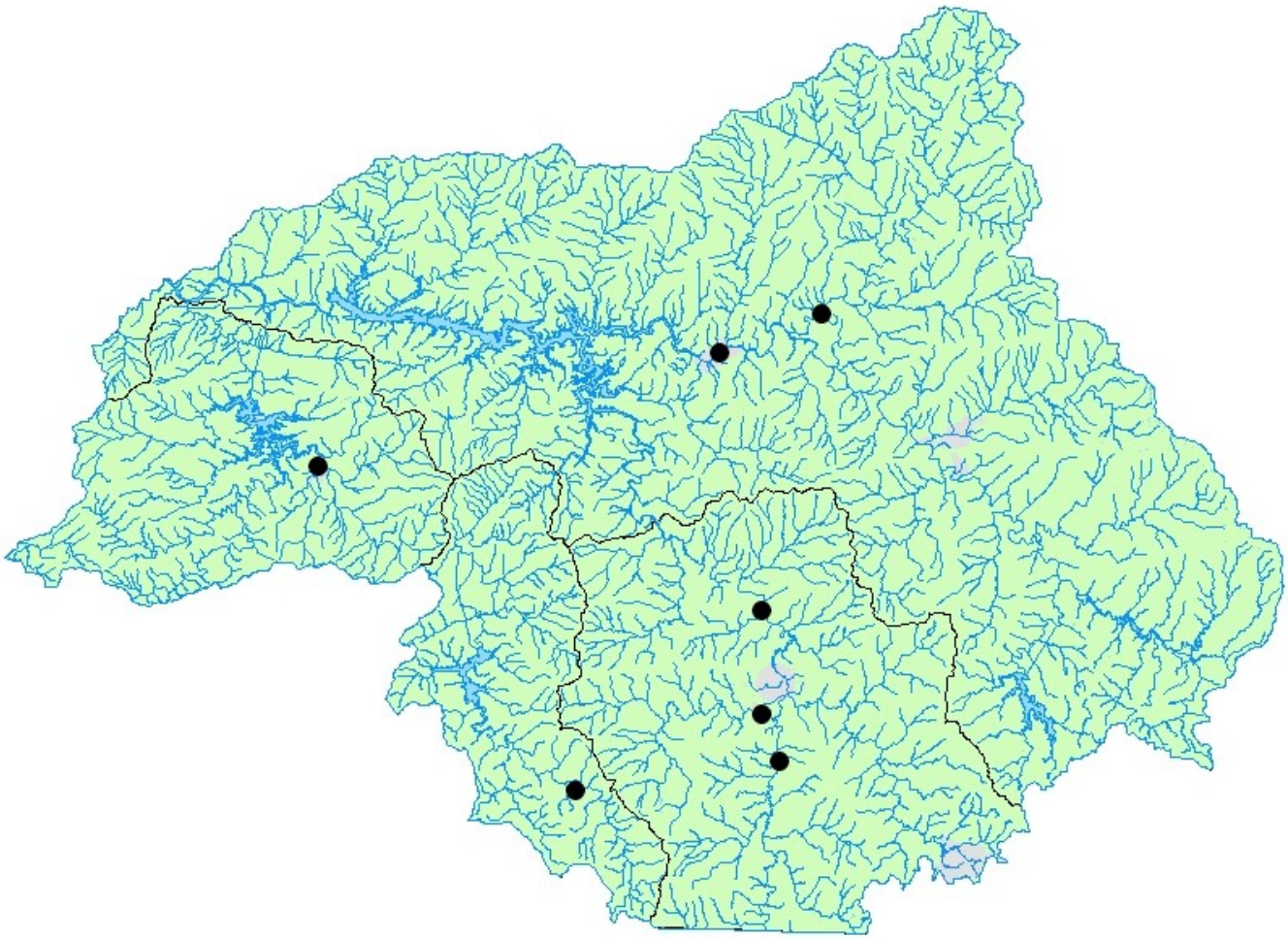
Like streams, lakes are classified for a variety of uses. Most of the lakes monitored as part of North Carolina's Ambient Lakes Monitoring Program are classified for recreation (B & SB) and water supply (WS-I through WS-V). The surface water quality numeric standard specifically associated with recreation is fecal coliform. For water supplies, there are 29 numeric standards based on consumption of water and fish. Narrative standards for B and WS classifications include aesthetics such as no odors and no untreated wastes. There are other numeric standards that also apply to lakes under protection of aquatic life and human health. These standards also apply to all other waters of the state and are listed under the Class C rules.

When possible, lake use support evaluations are made similar to free-flowing waters. Parameters with sufficient (10 or more observations), quality-assured, surface water quality data will be compared to surface water quality standards. However, for nutrient enrichment - one of the main causes of impacts to lakes and reservoirs, a more holistic or weight of evidence approach is necessary since nutrient impacts are not always reflected by the parameters sampled. For instance, some lakes have taste and odor problems associated with particular algal species, yet these lakes do not have chlorophyll *a* concentrations above 40 ug/L frequently enough to impair them based on the standard.

In addition to being moderated by biological factors, environmental factors such as climate, hydrology and morphology can impact whether nutrient loading results in lose of uses. Shorter retention times (less than 14 days) prevent excessive growth of algae even in the presence of elevated nutrients. Therefore, just measuring standard water quality parameters such as chlorophyll *a* and nutrients may not give an accurate picture of lake water quality. Where exceedances of surface water quality standards are not sufficient to impair a lake, the weight of evidence approach can take into consideration indicators and parameters not in the standards to allow a sounder determination of water quality.

The following sources of information are used in determining lake use support through the weight of evidence approach:

- Quantitative water quality parameters - dissolved oxygen, chlorophyll *a*, pH, etc.
- Algal bloom reports
- Fish kill reports
- Third party reports – citizens, water treatment plant operators, State agencies, etc.
    - Taste & odor
    - Sheens
    - Odd colors
    - Other aesthetic and safety considerations



# Little Tennessee River Basin
# Ambient Monitoring System Report

September 1, 1999 through August 31, 2004

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Evaluation Levels

In order to assist the reader in developing a rapid understanding of the summary statistics provided throughout this data review, concentrations of water quality variables may be compared to an Evaluation Level (EL). Evaluation levels may be a water quality standard, an action level, an ecological threshold, or simply an arbitrary threshold that facilitates a rapid data review. Evaluation levels are further evaluated for frequency to determine if they have been exceeded in more than 10 percent of the observed samples. This summary approach facilitates a rapid and straightforward presentation of the data but may not be appropriate for making specific use support decisions necessary for constructing lists of impaired waters under the Clean Water Act's requirements for 303(d) listings. The reader is advised to review the states 303(d) listing methodology for this purpose. (see http://h2o.enr.state.nc.us/tmdl/General_303d.htm).

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## SUMMARY

A general understanding of human activities and natural forces that affect pollution loads and their potential impacts on water quality can be obtained through routine sampling from fixed water quality monitoring stations. During this assessment period (September 1, 1999 through August 31, 2004) chemical and physical measurements were obtained by DWQ from seven stations located in the basin.

In order to confidently evaluate acceptable water quality criteria at least 10 observations are desired. If at least 10 results were collected for a given site for a given parameter, the results are then compared to water quality evaluation levels. The water quality evaluation level may be an ecological evaluation level, a narrative or numeric standard, or an action level as specified in 15A NCAC 2B .0200 (Table 3). If less then 10 results were collected, then no comparison to evaluation levels was made. When more than 10 percent of the results exceeded the evaluation level, a binomial statistical test was employed to determine if there was sufficient statistical confidence (95% confidence) to conclude that the results statistically exceed the 10% criteria. When that is found to be true, it is termed a *statistically significant exceedance* (SSE). This criterion was applied to all parameters with an evaluation level, except for fecal coliform bacteria. The criteria for fecal coliform varied based on the classification of the water body. See the Parameters section for an explanation of fecal coliform methods. The results of the data analysis are displayed in tables, box plots, scatter plots, and maps. For complete data on each station, reference the AMS Station Summary Sheets located in Appendix A.

All data were collected between September 1, 1999 and August 31, 2004. There were no SSEs in the Little Tennessee River basin. One 10 percent violation that was not an SSE occurred for total iron. The following table gives a summary of concerns in the basin.

**Table 1. Violations and Areas of Concern in the Little Tennessee River Basin**

| Subbasin/ Station ID | Location | Class | Parameter/Evaluation Level | % Exceedance | % Confidence |
|---|---|---|---|---|---|
| 2 | Oconaluftee River, Tuckasegee River, Hazel Creek, and Deep Creek | | | | |
| G8600000 | Tuckasegee River at SR 1364 at Bryson City | B | Total Iron (>1,000) | 17% | 91.5% |

Blue entries indicate violations of standards. Black entries indicate violations of action levels or evaluation levels.

## INTRODUCTION

The DWQ's Ambient Monitoring System is a network of stream, lake, and estuarine stations strategically located for the collection of physical and chemical water quality data. The stations are located at convenient access points (e.g. bridge crossings) that are sampled on a monthly basis. These locations were chosen to characterize the effects of point source dischargers and nonpoint sources such as agriculture, animal operations, and urbanization within watersheds. Currently the DWQ does not conduct probabilistic (random) monitoring.

The data are used to identify long term trends within watersheds, to develop Total Maximum Daily Loads (TMDLs) and to compare measured values with water quality standards to identify possible areas of impairment. Parametric coverage is determined by freshwater or saltwater waterbody classification and corresponding water quality standards. Under this arrangement, core parameters are based on Class C waters with additional parameters added when justified (Table 2).

Within this document, an analysis of how monitoring results compare with water quality standards and action levels is presented. A conceptual overview of water quality standards is provided at: http://www.epa.gov/waterscience/standards. Specific information on North Carolina water quality standards is provided at: http://h2o.enr.state.nc.us/csu/swstdsfaq.html.

**Table 2. Parametric coverage for the Ambient Monitoring System.[1]**

| Parameter | All Waters | Water Supply |
|---|---|---|
| Dissolved oxygen (s) | ✔ | ✔ |
| pH (s) | ✔ | ✔ |
| Specific conductance | ✔ | ✔ |
| Temperature (s) | ✔ | ✔ |
| Total phosphorus[2] | ✔ | ✔ |
| Ammonia as N[2] | ✔ | ✔ |
| Total Kjeldahl as N[2] | ✔ | ✔ |
| Nitrate+nitrite as N[2] (s) | ✔ | ✔ |
| Total suspended solids | ✔ | ✔ |
| Turbidity (s) | ✔ | ✔ |
| Fecal coliform bacteria (s) | ✔ | ✔ |
| Aluminum | ✔ | ✔ |
| Arsenic (s) | ✔ | ✔ |
| Cadmium (s) | ✔ | ✔ |
| Chromium, total (s) | ✔ | ✔ |
| Copper, total (s) | ✔ | ✔ |
| Iron (s) | ✔ | ✔ |
| Lead (s) | ✔ | ✔ |
| Mercury (s) | ✔ | ✔ |
| Nickel (s) | ✔ | ✔ |
| Zinc (s) | ✔ | ✔ |
| Manganese (s) | --- | ✔ |
| Chlorophyll *a*[2] (s) | ✔ | ✔ |

[1]A check (✔) indicates the parameter is collected and an 's' indicates the parameter has a standard or action level.
[2]Chlorophyll *a* is collected in Nutrient Sensitive Waters (NSW) and some coastal areas. Since 2001, nutrient sampling likewise is only done in areas of concern, such as NSW, estuaries, and areas with known enrichment issues.

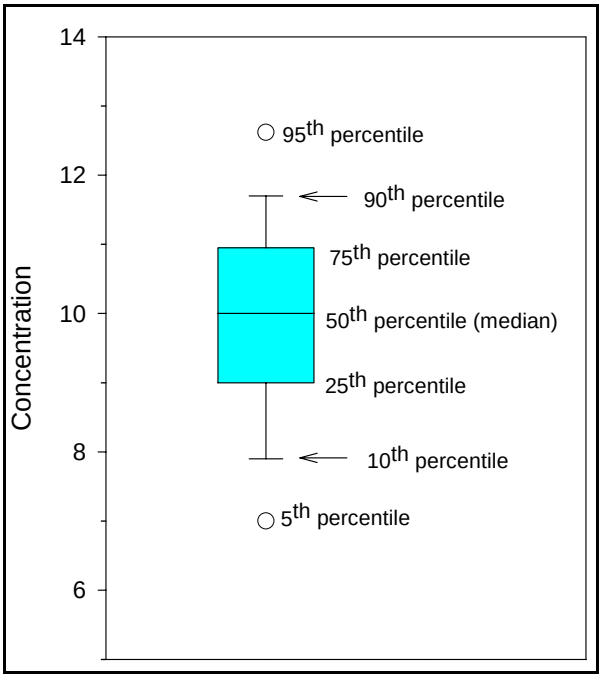



**Figure 1. Explanation of box plots.**

**Table 3. Selected water quality standards for parameters sampled as part of the Ambient Monitoring System.[1]**

| | Standards for All Freshwater | | | Standards to Support Additional Uses | | |
|---|---|---|---|---|---|---|
| **Parameter (µg/L, unless noted)** | **Aquatic Life** | **Human Health** | **Water Supply Classifications** | **Trout Water** | **HQW** | **Swamp Waters** |
| Arsenic | | 10 | | | | |
| Cadmium | 2.0 | | | 0.4 | | |
| Chloride (mg/L) | 230[2] | | 250 | | | |
| Chlorophyll *a* (corrected) | 40[3] | | | 15[3] | | |
| Chromium, total | 50 | | | | | |
| Coliform, total (MFTCC/100 ml)[4] | | | 50[3] (WS-I only) | | | |
| Coliform, fecal (MFFCC/100 ml)[5] | | 200[3] | | | | |
| Copper, total | 7[2] | | | | | |
| Dissolved oxygen (mg/L) | 5.0[6,7] | | | 6.0 | | [3, 7] |
| Hardness, total (mg/L) | | | 100 | | | |
| Iron | 1,000[2] | | | | | |
| Lead | 25[3] | | | | | |
| Manganese | | | 200 | | | |
| Mercury | 0.012 | | | | | |
| Nickel | 88 | | 25 | | | |
| Nitrate nitrogen | | | 10,000 | | | |
| pH (units) | 6.0 - 9.0[3, 7] | | | | | [3, 7] |
| Solids, total suspended (mg/L) | | | | | 10 Trout, 20 other[8] | |
| Turbidity (NTU) | 50, 25[3] | | | 10[3] | | |
| Zinc | 50[2] | | | | | |

[1]Standards apply to all classifications. For the protection of water supply and supplemental classifications, standards listed under Standards to Support Additional Uses should be used unless standards for aquatic life or human health are listed and are more stringent. Standards are the same for all water supply classifications (Administrative Code 15A NCAC 2B 0200, eff. April 1, 2001).
[2]Action level.
[3]Refer to 2B.0211 for narrative description of limits.
[4]Membrane filter total coliform count per 100 ml of sample.
[5]Membrane filter fecal coliform count per 100 ml of sample.
[6]An instantaneous reading may be as low as 4.0 mg/L, but the daily average must be 5.0 mg/L or more.
[7]Designated swamp waters may have a dissolved oxygen less than 5.0 mg/L and a pH as low as 4.3, if due to natural conditions.
[8]For effluent limits only, refer to 2B.0224(1)(b)(ii).

| | Standards for All Saltwater | | | Standards To Support Additional Uses | |
|---|---|---|---|---|---|
| **Parameter (µg/L, unless noted)** | **Aquatic Life** | **Human Health[1]** | **Class SA[2]** | **HQW** | **Swamp Waters** |
| Arsenic | | 10 | | | |
| Cadmium | 5.0 | | | | |
| Chlorophyll *a* (corrected) | 40[3] | | | | |
| Chromium, total | 20 | | | | |
| Coliform, fecal (MFFCC/100ml)[4] | | 200[3] | 14[3] | | |
| Copper, total | 3[5] | | | | |
| Dissolved oxygen (mg/L) | 5.0[9] | | | 6.0 | [3, 6] |
| Lead | 25[3] | | | | |
| Mercury | 0.025 | | | | |
| Nickel | 8.3 | | | | |
| PH (units) | 6.8 - 8.5[6] | | | | [3, 6] |
| Selenium | 71 | | | | |
| Silver | 0.1[5] | | | | |
| Solids, total suspended (mg/L) | | | | 10 PNA[7], 20 other[8] | |
| Turbidity (NTU) | 25[3] | | | | |
| Zinc | 86[5] | | | | |

[1]Standards are based on consumption of fish only unless dermal contact studies are available, see 2B.0208 for equation.
[2]Class SA = shellfishing waters, see 2B.0101 for description.
[3]See 2B.0220 for narrative description of limits.
[4]MFFCC/100ml means membrane filter fecal coliform count per 100 ml of sample.
[5]Values represent action levels as specified in 2B.0220.
[6]Designated swamp waters may have a dissolved oxygen less than 5.0 mg/L and a pH as low as 4.3 s.u., if due to natural conditions.
[7]PNA = Primary Nursery Areas.
[8]For effluent limits only, see 2B.0224.
[9]Swamp waters, poorly flushed tidally influenced streams, or embayments, or estuarine bottom waters may have lower values if caused by natural conditions.

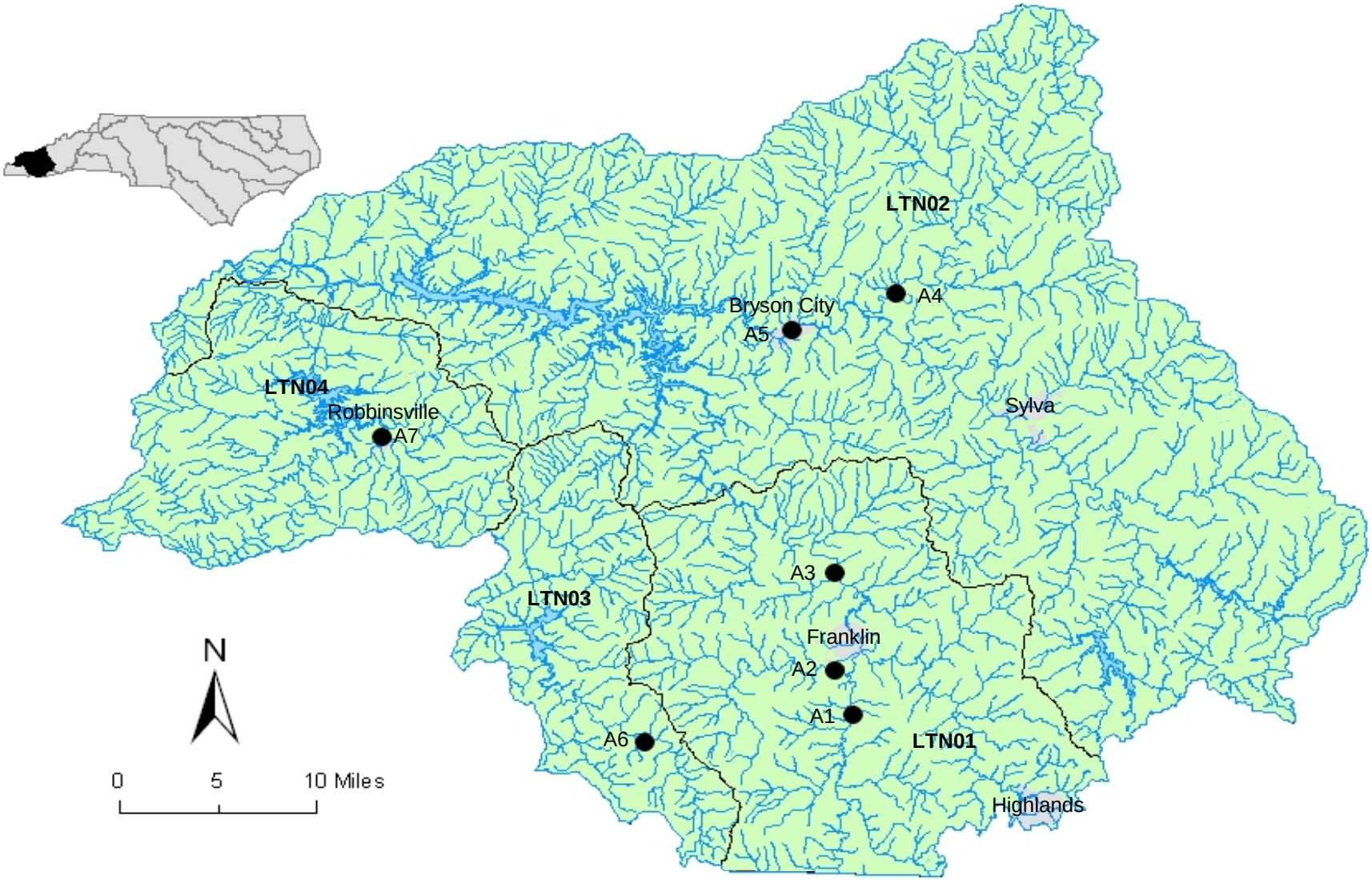



**Figure 2. DWQ's Ambient Monitoring System within the Little Tennessee River Basin.**

**Table 4. Monitoring stations in the Little Tennessee River Basin, 1999 - 2004.**

| Subbasin/ Station ID | Location | Class | Lat. | Long. | County | Map ID |
|---|---|---|---|---|---|---|
| **01** | **Little Tennessee River, Cullasaja River, and Cartoogechaye Creek** | | | | | |
| G0035000 | Little Tennessee River at SR 1651 near Prentiss | C | 35.1221 | -83.3743 | Macon | A1 |
| G0130000[1] | Cartoogechaye Creek at SR 1152 near Franklin | B Tr | 35.1580 | -83.3920 | Macon | A2 |
| G2000000 | Little Tennessee River at NC 28 at Iotla | B | 35.2349 | -83.3958 | Macon | A3 |
| **02** | **Oconaluftee River, Tuckasegee River, Hazel Creek, and Deep Creek** | | | | | |
| G8550000[2] | Oconaluftee River at SR 1359 at Birdtown | C Tr | 35.4610 | -83.3540 | Jackson | A4 |
| G8600000 | Tuckasegee River at SR 1364 at Bryson City | B | 35.4284 | -83.4460 | Swain | A5 |
| **03** | **Nantahala River** | | | | | |
| G3500000 | Nantahala River at US 64 near Rainbow Springs | B Tr ORW | 35.0942 | -83.5599 | Macon | A6 |
| **04** | **Cheoah River** | | | | | |
| G9550000 | Cheoah River at SR 1138 at Robbinsville | C Tr | 35.3291 | -83.8098 | Graham | A7 |

[1]Station G0130000 ceased sample collection on 5/25/2000.
[2]Station G8550000 ceased sample collection on 5/23/2000.

## DATA ASSESSMENT AND INTERPRETATION

Monitoring and sampling results considered in this report represent samples collected or measurements taken at less than one-meter depth.

Percentile statistics were calculated for most of the data using JMP statistical software (version 5.01; SAS Institute, Cary, NC). Values less than the minimum reporting level (non-detects) were evaluated as equal to the reporting level. Box and whisker plots (constructed using SigmaPlot version 8.02) and maps are presented for most water quality parameters collected at each monitoring station. Significant trends in water quality parameters (constructed using Microsoft Excel) are illustrated as scatterplots. Significant trends are found by assessing the probability that the linear model explains the data no better then chance. If that chance is 5% or less (an observed significance probability of 0.05 or less) then that is considered evidence of a regression effect in this document. The strength of the regression effect is given as an $r^2$ value, the portion of the data that is explained by the linear model.

### Analytical Considerations

Two issues were noted by the DWQ Laboratory Section as part of the analytical processes during this assessment period:

1) Between February and April 2001, improved analytical techniques and protocols for nutrient samples were implemented. No nutrient samples were processed during the period when the techniques and protocols were being implemented.
2) In early 2001 the Laboratory Section reviewed their internal QA/QC programs and some of the analytical methods. This effort resulted in a temporary increase in reporting levels for certain parameters. New analytical equipment and methods were subsequently acquired to establish more accurate reporting levels and rigorous quality assurance. Because of the improvements, the reporting levels quickly declined back down to or near the previous reporting levels. Nutrients were especially affected by these changes (Table 5).

**Table 5. Changes in the Laboratory Section's reporting levels for nutrients.**

| Reporting Level By Date (mg/l) | | | | |
|---|---|---|---|---|
| **Parameter** | **Pre-2001** | **3/13/2001 to 3/29/2001** | **3/30/2001 to 7/24/2001** | **7/25/2001 to present** |
| $NH_3$ | 0.01 | 0.5 | 0.2 | 0.01 |
| TKN | 0.1 | 1.0 | 0.6 | 0.20 |
| $NO_2$+$NO_3$ | 0.01 | 0.5 | 0.15 | 0.01 |
| TP | 0.01 | 0.5 | 0.1 | 0.02 |

**Providing Confidence in the Exceedances of Water Quality Standards**

NC DWQ uses guidance provided by the US EPA for determining when the number of results that exceed a water quality standard indicate potential water quality issues. Historically, the US EPA has suggested that management actions be implemented when 10 percent of the results exceeded a water quality standard. This interpretation is the same whether 1 out of 10, or 5 out of 50, or 25 out of 250 results exceed a standard. Evaluating exceedances in this manner is termed the "raw-score" approach. Although this "10 percent exceedance criterion" defines a point where potential water quality issues may be present, it does not consider uncertainty. Some results are subject to chance or other factors such as calibration errors or sample mishandling. Uncertainty levels change with sample size. The smaller the sample size, the greater the uncertainty.

This document uses a nonparametric procedure (Lin *et al.* 2000) to identify when a sufficient number of exceedances have occurred that indicate a true exceedance probability of 10 percent. Calculating the minimum number of exceedances needed for a particular sample size was done using the BINOMDIST function in Microsoft Excel®. This statistical function suggests that at least three exceedances need to be observed in a sample of 10 in order to be [about] 95 percent confident that the results statistically exceed the water quality standard more than 10% of the time. For example, there is less statistical confidence associated with a 1 exceedance out of 10 (73 percent) than when there are 3 exceedances out of 10 (93 percent confidence (Table 6).

## Table 6. Exceedance Confidence

| Number of Samples | Number of Exceedances 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 10 | 74% | 93% | **99%** | **100%** | **100%** | **100%** | **100%** | **100%** | **100%** | **100%** | | | | | | | |
| 12 | 66% | 89% | **97%** | **100%** | **100%** | **100%** | **100%** | **100%** | **100%** | **100%** | **100%** | **100%** | | | | | |
| 14 | 58% | 84% | **96%** | **99%** | **100%** | **100%** | **100%** | **100%** | **100%** | **100%** | **100%** | **100%** | **100%** | **100%** | | | |
| 16 | 51% | 79% | 93% | **98%** | **100%** | **100%** | **100%** | **100%** | **100%** | **100%** | **100%** | **100%** | **100%** | **100%** | **100%** | **100%** | |
| 18 | 45% | 73% | 90% | **97%** | **99%** | **100%** | **100%** | **100%** | **100%** | **100%** | **100%** | **100%** | **100%** | **100%** | **100%** | **100%** | **100%** |
| 20 | 39% | 68% | 87% | **96%** | **99%** | **100%** | **100%** | **100%** | **100%** | **100%** | **100%** | **100%** | **100%** | **100%** | **100%** | **100%** | **100%** |
| 22 | 34% | 62% | 83% | 94% | **98%** | **100%** | **100%** | **100%** | **100%** | **100%** | **100%** | **100%** | **100%** | **100%** | **100%** | **100%** | **100%** |
| 24 | 29% | 56% | 79% | 91% | **97%** | **99%** | **100%** | **100%** | **100%** | **100%** | **100%** | **100%** | **100%** | **100%** | **100%** | **100%** | **100%** |
| 26 | 25% | 51% | 74% | 89% | **96%** | **99%** | **100%** | **100%** | **100%** | **100%** | **100%** | **100%** | **100%** | **100%** | **100%** | **100%** | **100%** |
| 28 | 22% | 46% | 69% | 86% | 94% | **98%** | **100%** | **100%** | **100%** | **100%** | **100%** | **100%** | **100%** | **100%** | **100%** | **100%** | **100%** |
| 30 | 18% | 41% | 65% | 82% | 93% | **97%** | **99%** | **100%** | **100%** | **100%** | **100%** | **100%** | **100%** | **100%** | **100%** | **100%** | **100%** |
| 32 | 16% | 37% | 60% | 79% | 91% | **96%** | **99%** | **100%** | **100%** | **100%** | **100%** | **100%** | **100%** | **100%** | **100%** | **100%** | **100%** |
| 34 | 13% | 33% | 55% | 75% | 88% | **95%** | **98%** | **99%** | **100%** | **100%** | **100%** | **100%** | **100%** | **100%** | **100%** | **100%** | **100%** |
| 36 | 11% | 29% | 51% | 71% | 85% | 94% | **98%** | **99%** | **100%** | **100%** | **100%** | **100%** | **100%** | **100%** | **100%** | **100%** | **100%** |
| 38 | 10% | 25% | 46% | 67% | 83% | 92% | **97%** | **99%** | **100%** | **100%** | **100%** | **100%** | **100%** | **100%** | **100%** | **100%** | **100%** |
| 40 | 8% | 22% | 42% | 63% | 79% | 90% | **96%** | **98%** | **99%** | **100%** | **100%** | **100%** | **100%** | **100%** | **100%** | **100%** | **100%** |
| 42 | 7% | 20% | 38% | 59% | 76% | 88% | **95%** | **98%** | **99%** | **100%** | **100%** | **100%** | **100%** | **100%** | **100%** | **100%** | **100%** |
| 44 | 6% | 17% | 35% | 55% | 73% | 85% | 93% | **97%** | **99%** | **100%** | **100%** | **100%** | **100%** | **100%** | **100%** | **100%** | **100%** |
| 46 | 5% | 15% | 31% | 51% | 69% | 83% | 92% | **96%** | **99%** | **100%** | **100%** | **100%** | **100%** | **100%** | **100%** | **100%** | **100%** |
| 48 | 4% | 13% | 28% | 47% | 65% | 80% | 90% | **95%** | **98%** | **99%** | **100%** | **100%** | **100%** | **100%** | **100%** | **100%** | **100%** |
| 50 | 3% | 11% | 25% | 43% | 62% | 77% | 88% | 94% | **98%** | **99%** | **100%** | **100%** | **100%** | **100%** | **100%** | **100%** | **100%** |
| 52 | 3% | 10% | 22% | 40% | 58% | 74% | 86% | 93% | **97%** | **99%** | **100%** | **100%** | **100%** | **100%** | **100%** | **100%** | **100%** |
| 54 | 2% | 8% | 20% | 36% | 54% | 71% | 83% | 91% | **96%** | **98%** | **99%** | **100%** | **100%** | **100%** | **100%** | **100%** | **100%** |
| 56 | 2% | 7% | 18% | 33% | 51% | 67% | 81% | 90% | **95%** | **98%** | **99%** | **100%** | **100%** | **100%** | **100%** | **100%** | **100%** |
| 58 | 2% | 6% | 16% | 30% | 47% | 64% | 78% | 88% | 94% | **97%** | **99%** | **100%** | **100%** | **100%** | **100%** | **100%** | **100%** |
| 60 | 1% | 5% | 14% | 27% | 44% | 61% | 75% | 86% | 93% | **97%** | **99%** | **99%** | **100%** | **100%** | **100%** | **100%** | **100%** |
| 62 | 1% | 5% | 12% | 24% | 40% | 57% | 72% | 84% | 91% | **96%** | **98%** | **99%** | **100%** | **100%** | **100%** | **100%** | **100%** |
| 64 | 1% | 4% | 11% | 22% | 37% | 54% | 69% | 81% | 90% | **95%** | **98%** | **99%** | **100%** | **100%** | **100%** | **100%** | **100%** |
| 66 | 1% | 3% | 9% | 20% | 34% | 51% | 66% | 79% | 88% | 94% | **97%** | **99%** | **99%** | **100%** | **100%** | **100%** | **100%** |
| 68 | 1% | 3% | 8% | 18% | 31% | 47% | 63% | 76% | 86% | 93% | **96%** | **98%** | **99%** | **100%** | **100%** | **100%** | **100%** |
| 70 | 1% | 2% | 7% | 16% | 29% | 44% | 60% | 74% | 84% | 91% | **96%** | **98%** | **99%** | **100%** | **100%** | **100%** | **100%** |
| 72 | 0% | 2% | 6% | 14% | 26% | 41% | 57% | 71% | 82% | 90% | **95%** | **97%** | **99%** | **100%** | **100%** | **100%** | **100%** |
| 74 | 0% | 2% | 5% | 13% | 24% | 38% | 54% | 68% | 80% | 88% | 94% | **97%** | **99%** | **99%** | **100%** | **100%** | **100%** |
| 76 | 0% | 1% | 5% | 11% | 22% | 35% | 51% | 65% | 77% | 86% | 93% | **96%** | **98%** | **99%** | **100%** | **100%** | **100%** |
| 78 | 0% | 1% | 4% | 10% | 20% | 33% | 48% | 62% | 75% | 85% | 91% | **95%** | **98%** | **99%** | **100%** | **100%** | **100%** |
| 80 | 0% | 1% | 4% | 9% | 18% | 30% | 45% | 59% | 72% | 83% | 90% | **95%** | **97%** | **99%** | **99%** | **100%** | **100%** |

Note: Bold entries indicate that there is at least 95% confidence that at least 10% of the possible samples exceed the standard/action level.

### Methods Used to Summarize Results

Methods used to summarize the results in this report encompass both tabular and graphical formats. Individual summary sheets for each station provide details on station location, stream classification, along with specifics on what parameters were measured, the number of samples taken (i.e. sample size), the number of results below reporting levels, the number of results exceeding a water quality standard or action level, statistical confidence that 10% of results exceeded the evaluation level, and a general overview of the distribution of the results using percentiles. These station summary sheets provide the most details on a station-by-station basis. They are included as an appendix to this report.

### Use Support Assessment Considerations

1) The dissolved freshwater oxygen concentrations of 5.0 and 4.0 mg/L are presented as evaluation levels. Instantaneous concentrations of 4.0 mg/L or less are in violation of the standard unless caused by natural (e.g. swampy) conditions. The 5.0 mg/L evaluation level is based upon a freshwater standard which specifies "not less than a daily average of 5.0" (15A NCAC 2B.0200).
2) Action levels (copper, iron, and zinc) are used primarily as evaluation guidelines because results include fractions that may have little effect on aquatic life. Where appropriate, follow-up toxicological work will need to be conducted before use support determination can be made for these parameters.

Specific information on water quality standards and action levels can be found in 15A NCAC 2B.0200 (August 1, 2004).

## PARAMETERS

### Dissolved Oxygen

Dissolved oxygen is one of the most important of all the chemical measurements. Dissolved oxygen provides valuable information about the ability of the water to support aquatic life and the capacity of water to assimilate point and nonpoint discharges. Water quality standards for dissolved oxygen vary depending on the classification of the body of water [see, for example: 15A NCAC 02B.0211(1)(b) and 15A NCAC 02B.0220 (1)(b)] but generally results less than 4.0 mg/L can be problematic. Consistent patterns of low concentrations of dissolved oxygen can be subject to intense management review and corrective actions, although patterns of low dissolved oxygen can occur naturally in and near swamp waters.

### pH

The pH of natural waters can vary throughout the state. Low values (<< 7.0 s.u.) can be found in waters rich in dissolved organic matter, such as swamp lands, whereas high values (>> 7.0 s.u.) may be found during algal blooms. Point source dischargers can also influence the pH of a stream. The measurement of pH is relatively easy; however the accuracy of field measurements is limited by the abilities of the field equipment, which is accurate to within 0.2 S.U. This is due, in part, because the scale for measuring pH is logarithmic (i.e. a pH of 8 is ten times less concentrated in hydrogen ions than a pH of 7).

The water quality standards for pH in freshwaters consider values less than 6.0 s.u. or greater than 9.0 s.u. to warrant attention; whereas in salt waters pH values less than 6.8 or greater than 8.5 warrant attention.

### Conductivity

In this report, conductivity is synonymous with specific conductance. It is reported in micromhos per centimeter (µmhos/cm) at 25°C. Conductivity is a measure of the ability of water to conduct an electric current. The presence of ions and temperature are major factors in the ability of water to conduct a current. Clean freshwater has a low conductivity, whereas high conductivities may indicate polluted water or saline conditions. Measurements reported are corrected for temperature, thus the range of values

reported over a period of time indicate the relative presence of ions in water. Conductivities in US fresh waters commonly vary between 50 to 1,500 µmhos/cm (APHA 1998). According to a USGS study completed in 1992, North Carolina freshwater streams have a natural conductance range of 17-65 µmhos/cm.

Conductivity can be used to evaluate variations in dissolved mineral concentrations (ions) among sites with varying degrees of impact resulting from point source discharges. Generally, impacted sites show elevated and widely ranging values for conductivity. However, water bodies that contain saltwater will also have high conductivities. Therefore those wishing to use conductivity as an indicator for problems must first account for salinity.

**Turbidity**

Turbidity data may denote episodic high values on particular dates or within narrow time periods. These can often be the result of intense or sustained rainfall events; however elevated values can occur at other times. Tidal surges can also disturb shallow estuarine sediments and naturally increase turbidity.

**Metals**

A number of metals are essential micronutrients for the support of aquatic life. However, there are threshold concentrations over which metals can be toxic. Currently the DWQ monitors total (not dissolved) concentrations for aluminum, arsenic, cadmium, chromium, copper, iron, lead, mercury, manganese (Water Supply waters only), nickel, and zinc. Aluminum and iron are commonly found in soils.

**Nutrients**

Compounds of nitrogen and phosphorus are major components of living organisms and thus are essential to maintain life. These compounds are collectively referred to as "nutrients." Nitrogen compounds include ammonia-nitrogen ($NH_3$-N), total Kjeldahl nitrogen (TKN) and nitrite+nitrate nitrogen ($NO_2$+$NO_3$-N). Phosphorus is measured as total phosphorus. When nutrients are introduced to an aquatic ecosystem from municipal and industrial treatment processes, or runoff from urban or agricultural land, the growth of algae (algal blooms) and other plants may be accelerated.

In addition to the possibility of causing algal blooms, ammonia-nitrogen may combine with high pH water to form $NH_4OH$, a form toxic to fish and other aquatic organisms.

**Fecal Coliform Bacteria**

Concentrations of fecal coliform bacteria can vary greatly. The descriptive statistics used to evaluate fecal coliform bacteria data include the geometric mean and the median depending on the classification of the waterbody. For all sites in the Little Tennessee River Basin, the standard specified in Administrative Code 15A NCAC 02B.0211 (3)(e) (August 1, 2004) is applicable:

*"Organisms of the coliform group: fecal coliforms shall not exceed a geometric mean of 200/100ml (MF count) based upon at least five consecutive samples examined during any 30 day period, nor exceed 400/100ml in more than 20 percent of the samples examined during such period; violations of the fecal coliform standard are expected during rainfall events and, in some cases, this violation is expected to be caused by uncontrollable nonpoint source pollution; all coliform concentrations are to be analyzed using the membrane filter technique unless high turbidity or other adverse conditions necessitate the tube dilution method; in case of controversy over results, the MPN 5-tube dilution technique shall be used as the reference method."*

The strict application of the standard is often hindered because the monthly (*circa* 30 day) sampling frequency employed for water quality monitoring usually does not provide more than one sample per 30-day period. However, water quality problems can be discerned using monthly sampling.

Only fresh waters are present in the Little Tennessee River basin. Non-SA class sites where the geometric mean was greater that 200 colonies/100ml, or where greater than 20 percent of the results exceed 400 colonies/100ml are indicated on the respective station summary sheets.

**Table 7. Summary of Evaluation Level Exceedances**

| Subbasin | Station | Class | Percentage of Results that Exceeded the Evaluation Limit<br>Stations with less then 10 results were not evaluated | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | pH (combined)[1] | Water Temperature | Turbidity | Arsenic | Copper | Iron | Fecal Coliform |
| 1 | Little Tennessee River, Cullasaja River, and Cartoogechaye Creek | | | | | | | | |
| | G0035000 | C | 0% | 0% | 2% | 0% | 9% | 5% | 6% |
| | G0130000 | B Tr | BT | BT | BT | BT | BT | BT | BT |
| | G2000000 | B | 2% | 0% | 0% | 5% | 5% | 5% | 2% |
| 2 | Oconaluftee River, Tuckasegee River, Hazel Creek, and Deep Creek | | | | | | | | |
| | G8550000 | C Tr | BT | BT | BT | BT | BT | BT | BT |
| | G8600000 | B | 0% | 0% | 2% | 0% | 0% | **17%** | 9% |
| 3 | Nantahala River | | | | | | | | |
| | G3500000 | B Tr ORW | 0% | 2% | 4% | 0% | 0% | 0% | 0% |
| 4 | Cheoah River | | | | | | | | |
| | G9550000 | C Tr | 2% | 9% | 4% | 0% | 4% | 4% | 7% |

Notes:

**Bold** entries indicate 10% (20% for fecal coliform) or more of results exceeded the evaluation level.

**Underlined** entries indicate 95% statistical confidence that the evaluation level was exceeded at least 10% of the time, with a minimum of 10 results required before determination.

BT: Below Threshold. This station was not evaluated because less then 10 samples/measurements were collected for this paramter.

[1] If both the maximum pH (9) and the minimum pH (6) were exceeded at a site, the total of the two is displayed.

## WATER QUALITY PATTERNS IN THE LITTLE TENNESSEE RIVER BASIN

Box and whisker plots, scatterplots, and maps were used to depict differences in a variety of water quality parameters. While graphs portray information visually, specific and accurate details can only be conveyed in tables. Individual station summary sheets should be consulted when exact information is needed. For the box plots, stations with fewer then 10 data points for a given parameter were not included.

### Regional Patterns

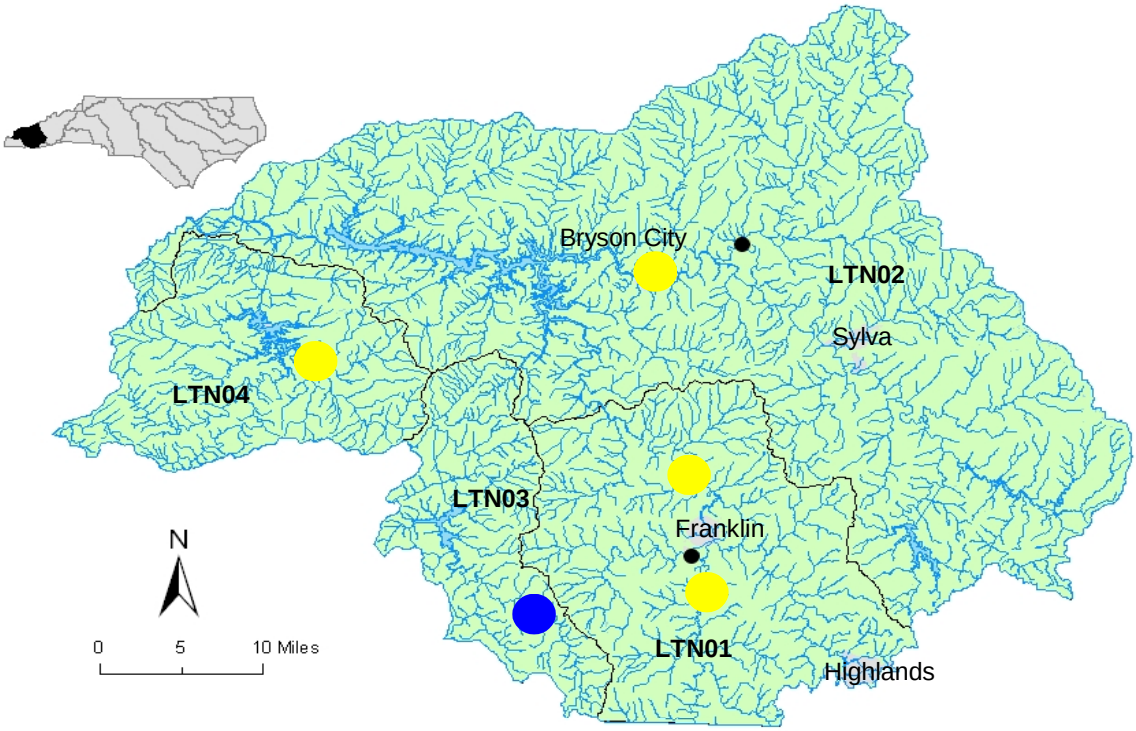
Box and whisker plots were generated for each station in the basin for each water quality parameter that has an evaluation level, plus specific conductance, total nitrate/nitrite, total kjeldahl nitrogen, total ammonia, and total phosphorus, excluding those that had less than 10 measurements.

No SSEs were recorded in this basin during the monitoring period. One violation of 10% or greater occurred for total iron.

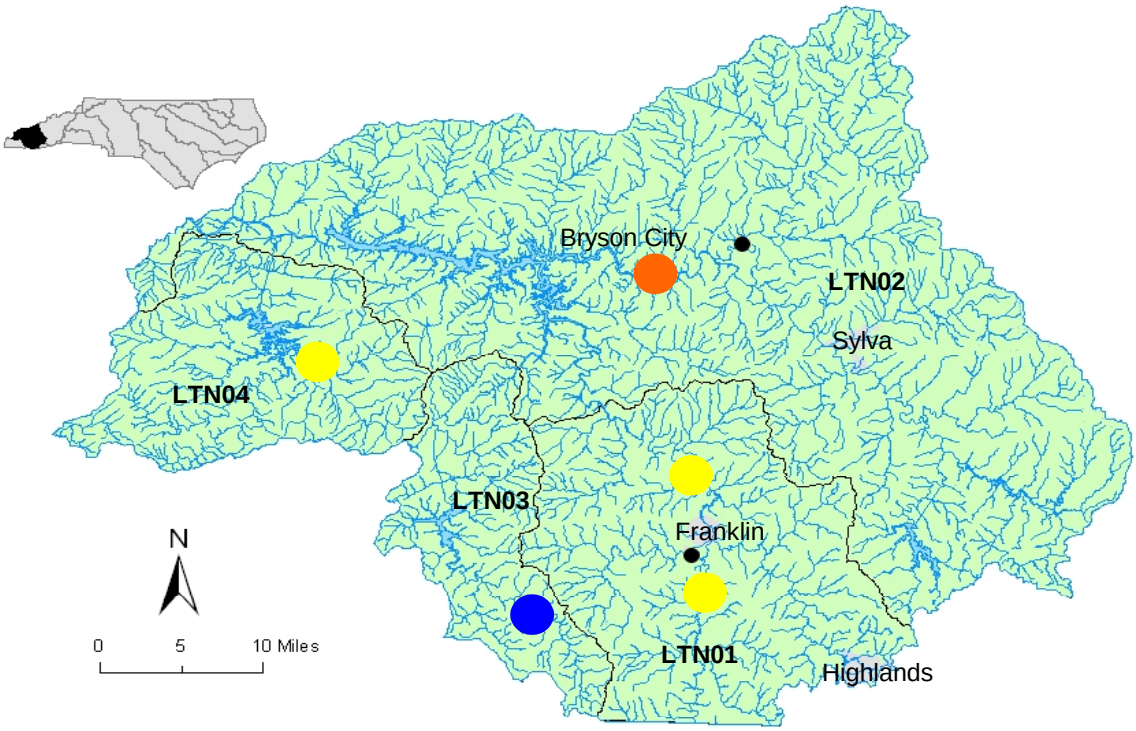
**Trends over Time**

Three trends of significant ($p < 0.05$) interest were identified in the basin. At station G0035000 (Little Tennessee River at SR 1651 near Prentiss) a decreasing pH trend was identified. pH levels have decreased from an elevated state to approximately neutral.

At both station G0035000 and station G2000000 (Little Tennessee at NC 28 at Iotla) increasing trends for fecal coliform were detected. In both cases it appears that the increasing trend is mainly caused by an increase in the variability of the samples, as the majority are still quite low.




**Fecal Coliform**




**Total Iron**

| | |
|---|---|
| >20% Exceedances | 10% to 20% Exceedances |
| 0% to 10% Exceedances | No Exceedances |

Note: Stations with no circle have no Evaluation Level or less than 10 samples for the given parameter.

Figure 3. Fecal Coliform and Iron in the Little Tennessee River Basin

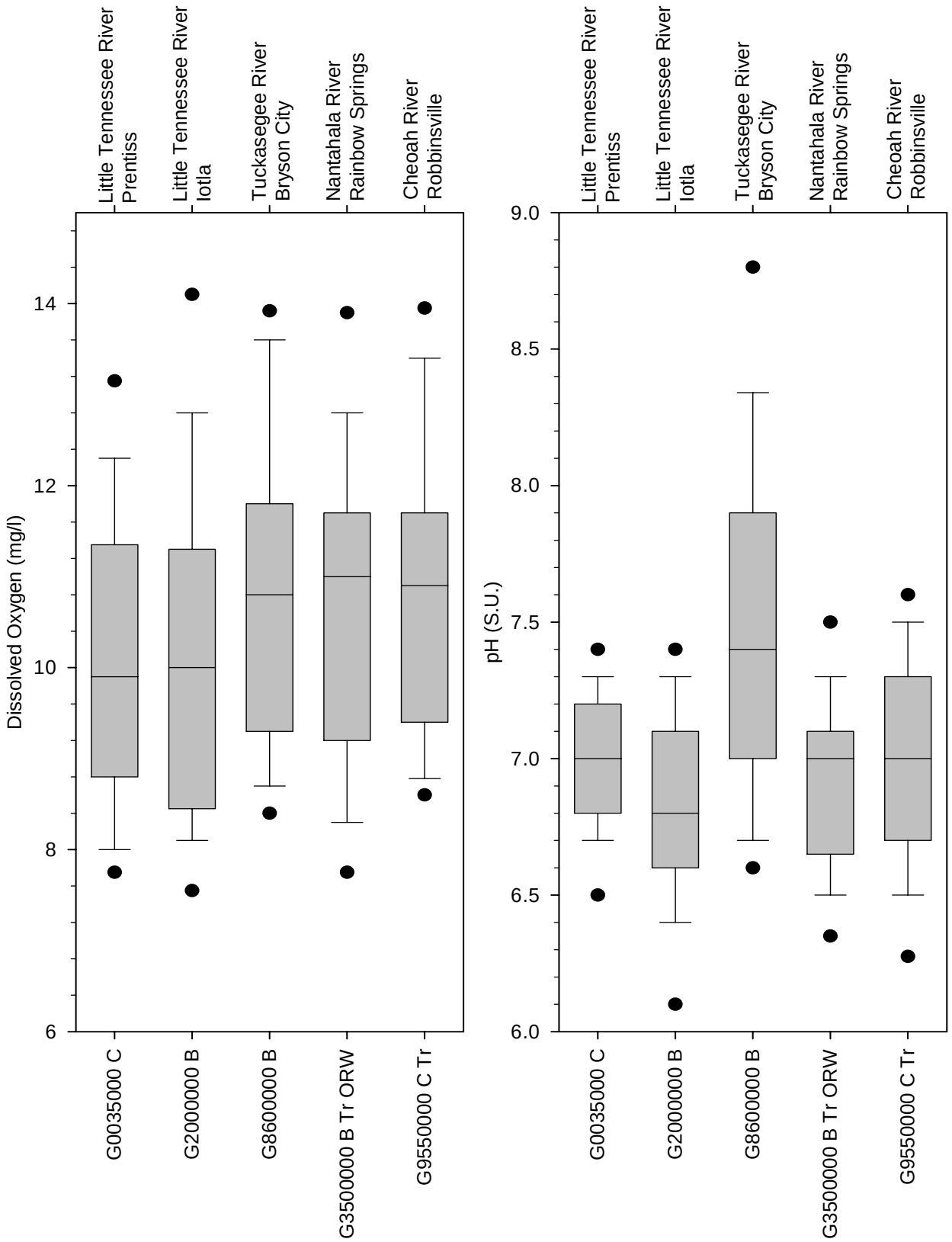



**Figure 4.** Box Plots for Dissolved Oxygen and pH in the Little Tennessee River Basin

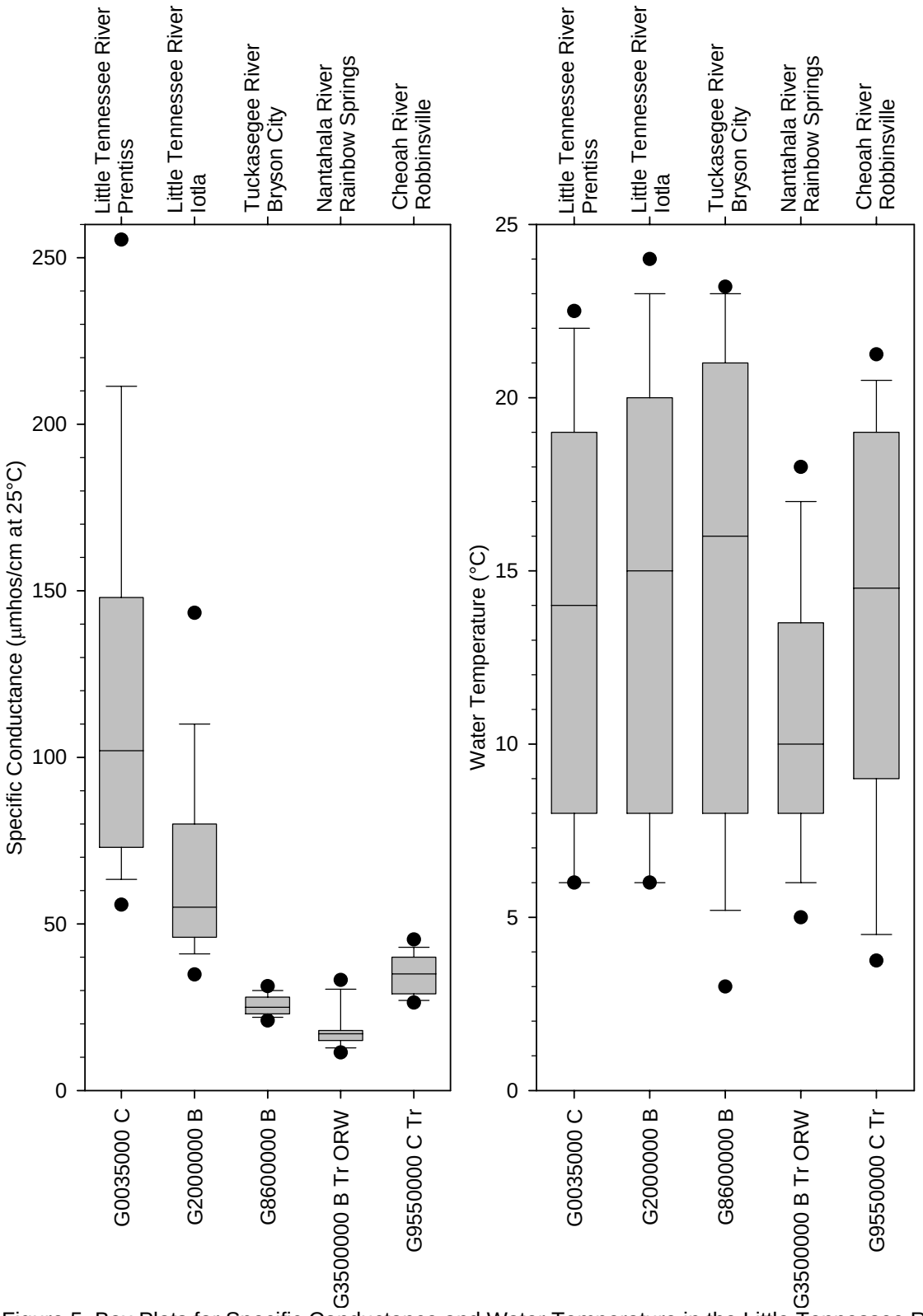



Figure 5. Box Plots for Specific Conductance and Water Temperature in the Little Tennessee River Basin

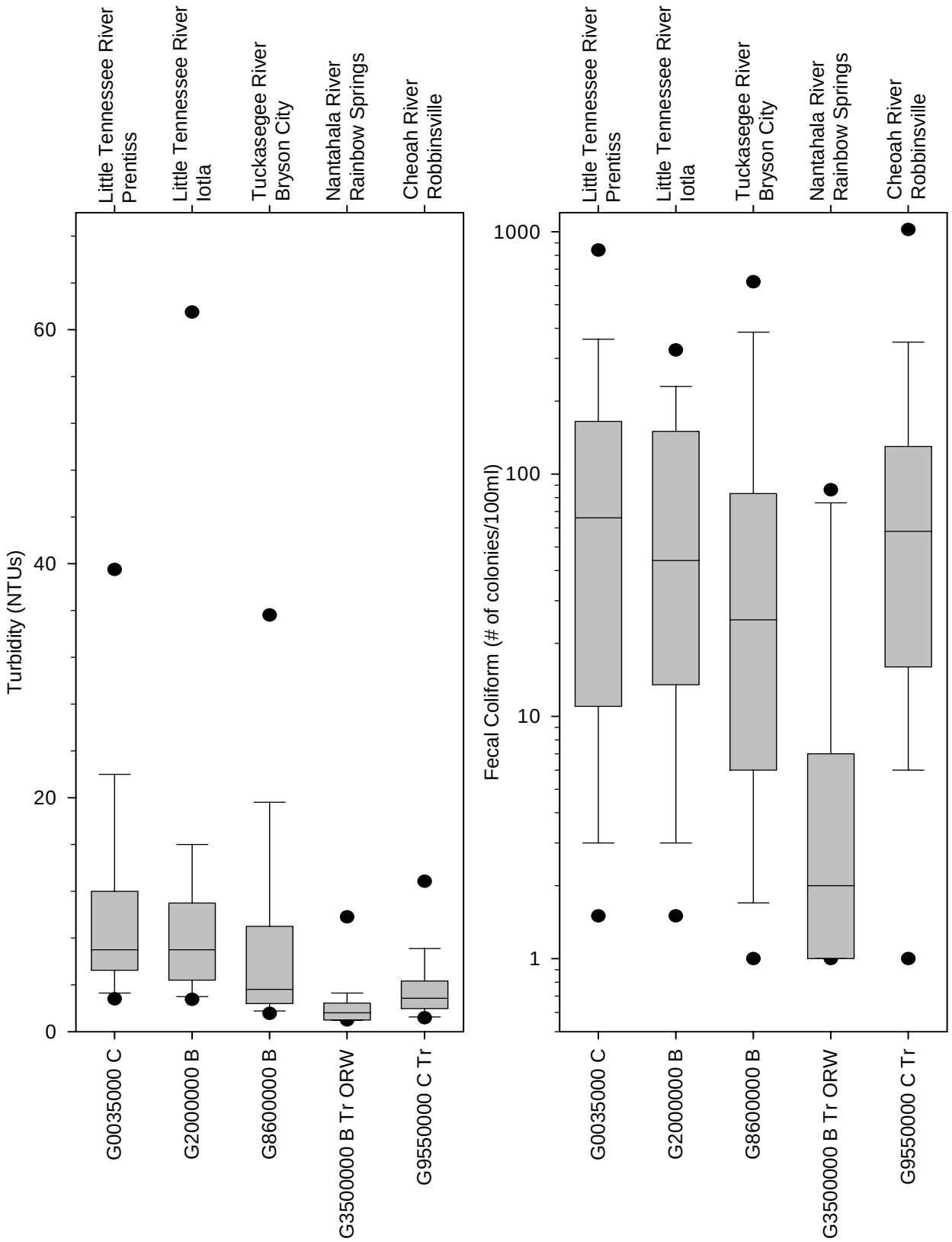



Figure 6. Box Plots for Turbidity and Fecal Coliform in the Little Tennessee River Basin

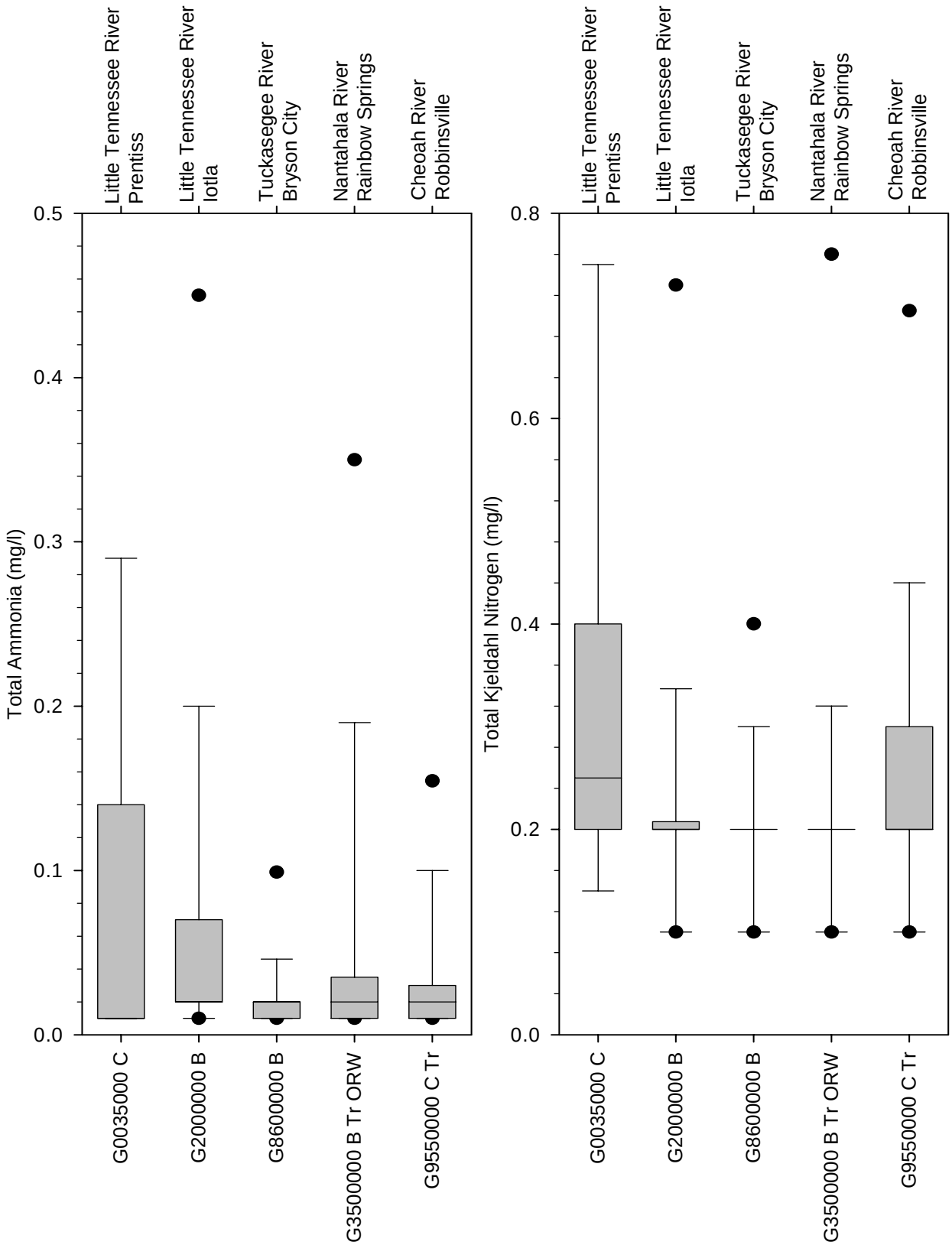



Figure 7. Box Plots for Total Ammonia and Total Kjeldahl Nitrogen in the Little Tennessee River Basin

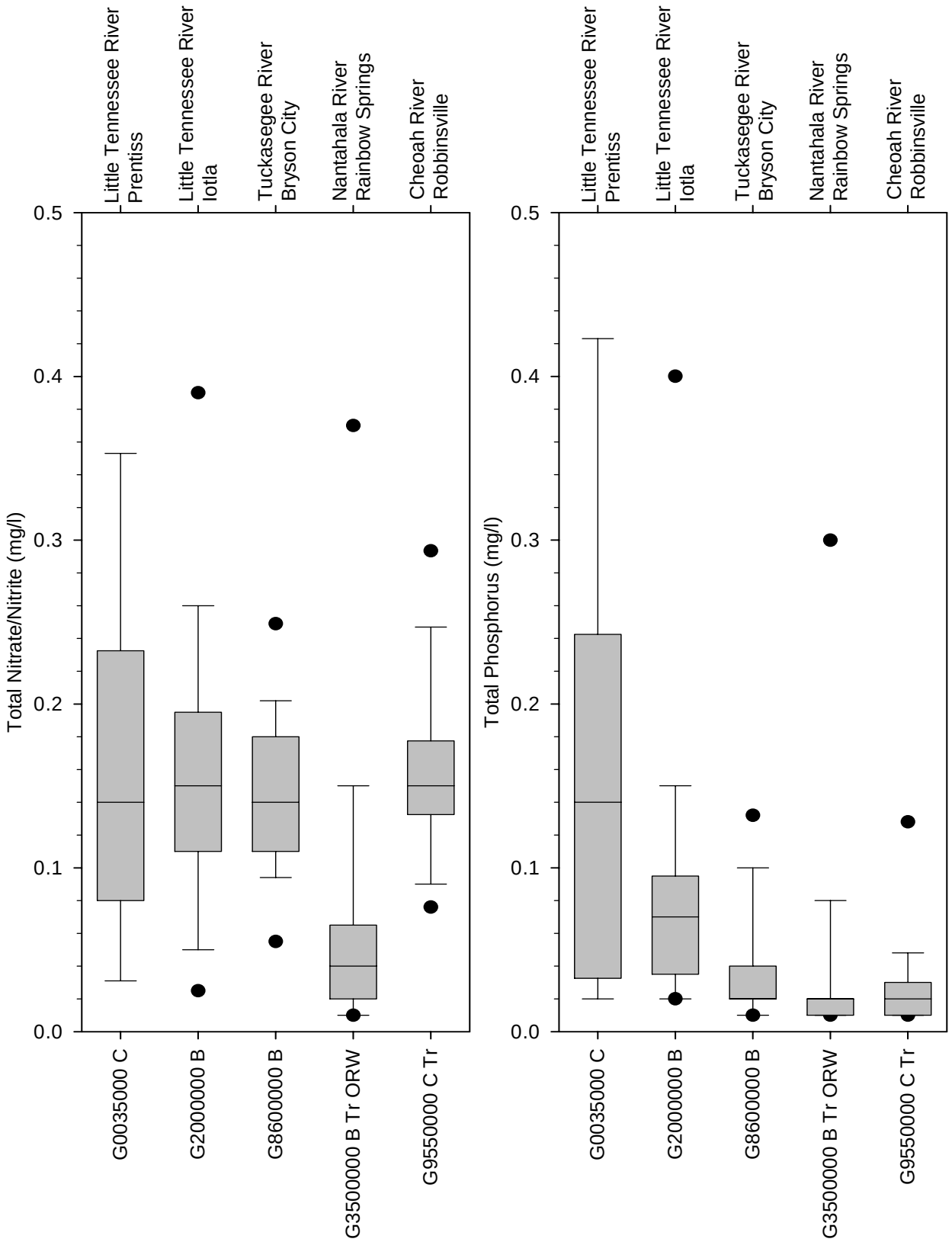



Figure 8. Box Plots for Total Nitrate/Nitrite, and Total Phosphorus in the Little Tennessee River Basin

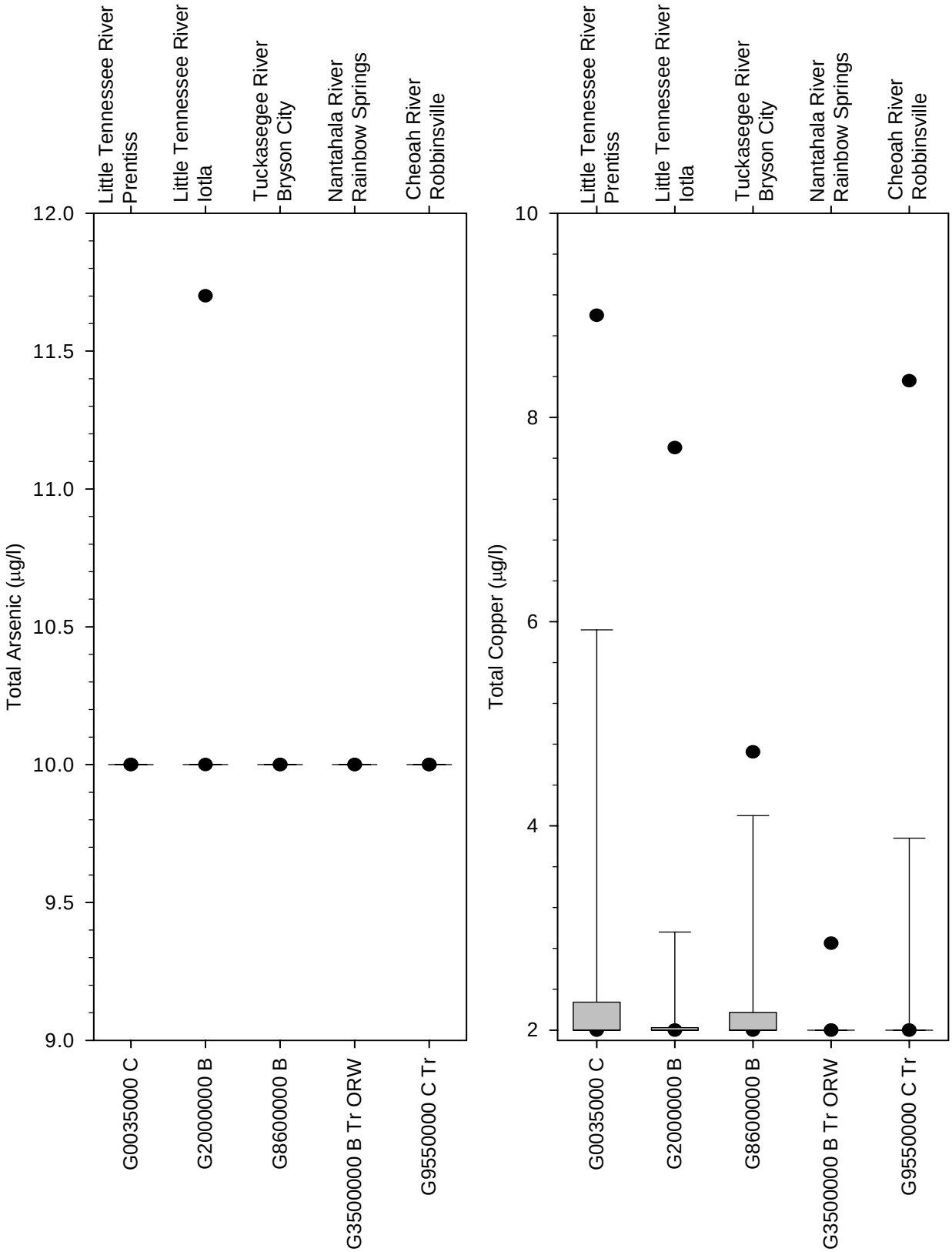



Figure 9. Box Plots for Total Arsenic and Total Copper in the Little Tennessee River Basin

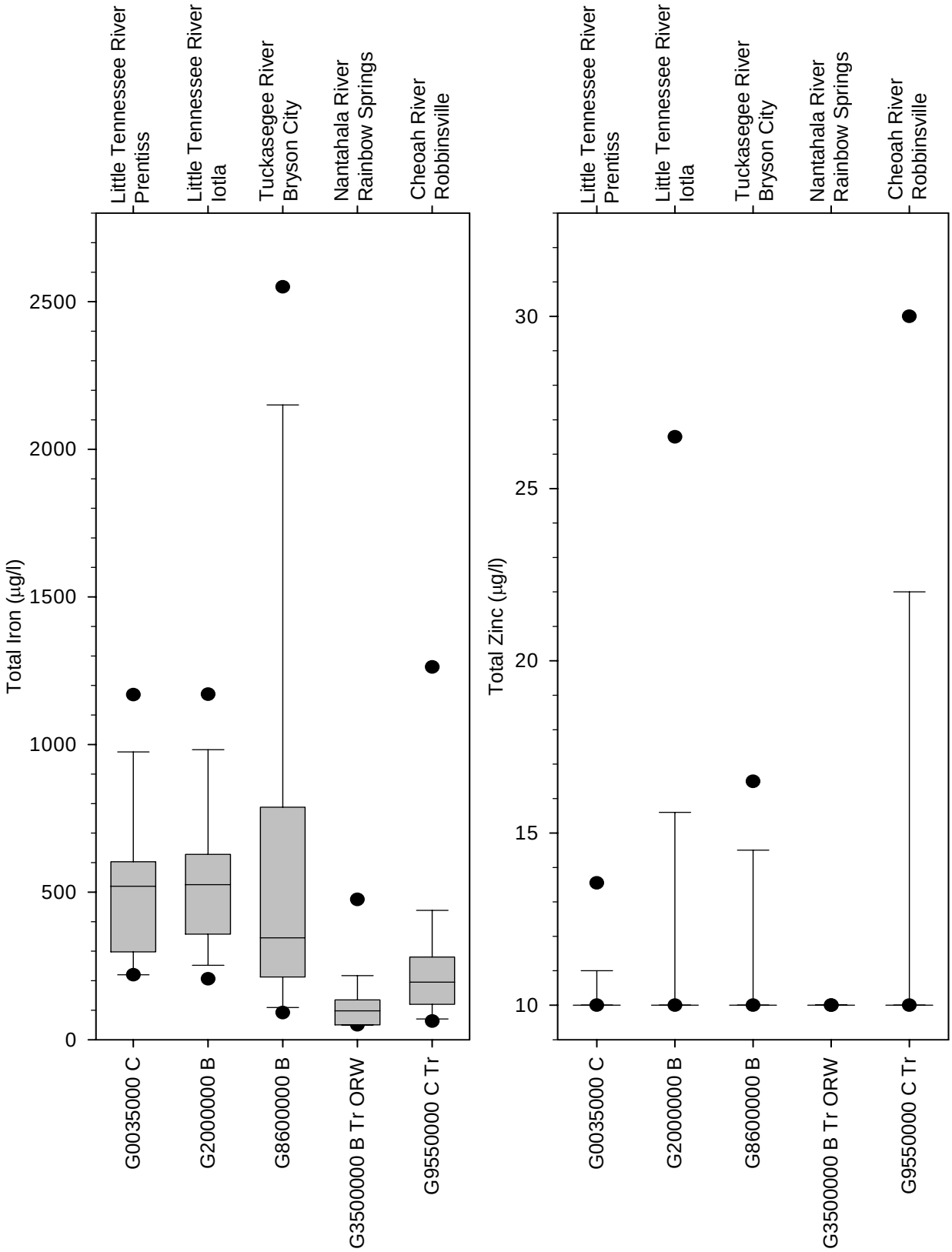
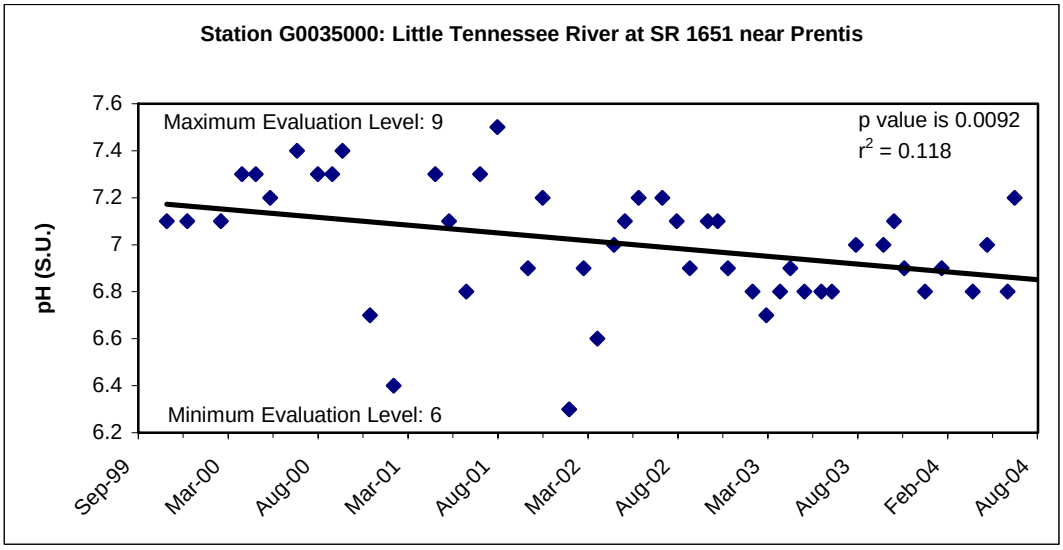
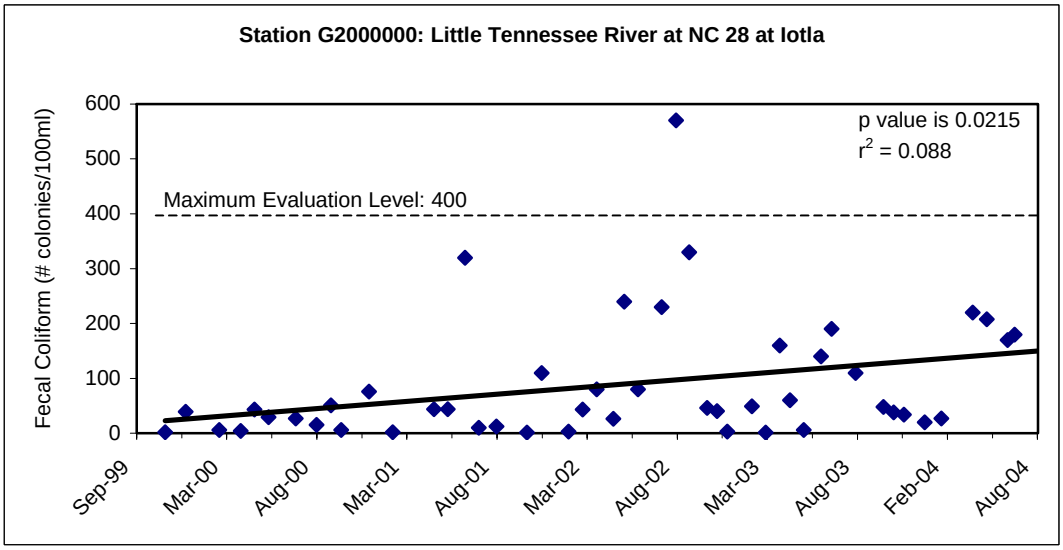



Figure 10. Box Plots for Total Iron and Total Zinc in the Little Tennessee River Basin



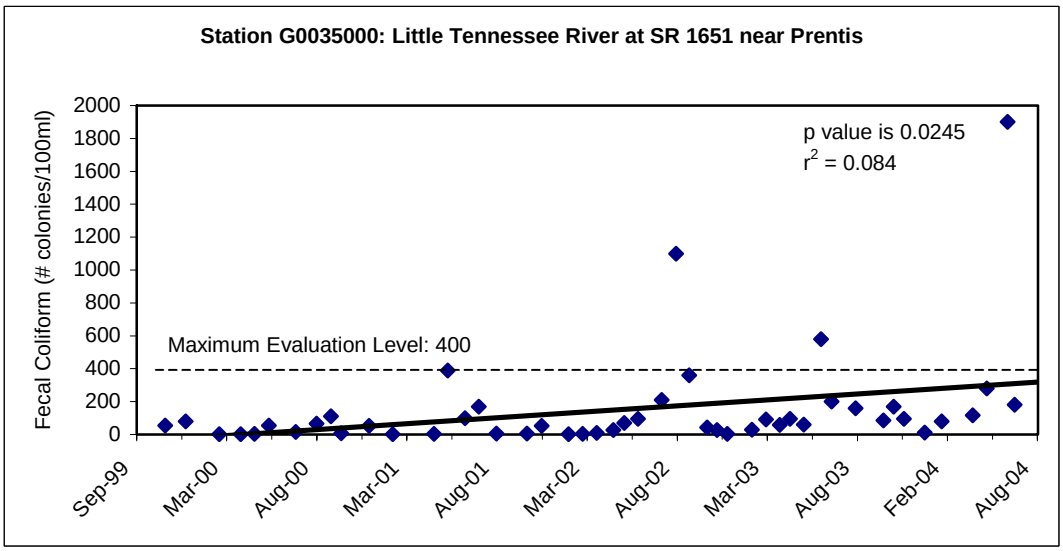




Figure 11. Trends of Interest in the Little Tennessee River Basin

## Appendix A: AMS Station Summary Sheets

**Location:** LITTLE TENNESSEE RIV AT SR 1651 NR PRENTISS
**Station #:** G0035000 **Subbasin:** LTN01
**Latitude:** 35.12215 **Longitude:** -83.37432 **Stream class:** C
**Agency:** NCAMBNT **NC stream index:** 2-(1)

**Time period:** 10/28/1999 to 08/31/2004

| | # results | # ND | EL | Results not meeting EL # | % | 95% | Min | Percentiles 10th | 25th | 50th | 75th | 90th | Max |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Field** | | | | | | | | | | | | | |
| D.O. (mg/L) | 49 | 0 | <4 | 0 | 0 | | 7.2 | 8 | 8.8 | 9.9 | 11.3 | 12.3 | 13.8 |
| | 49 | 0 | <5 | 0 | 0 | | 7.2 | 8 | 8.8 | 9.9 | 11.3 | 12.3 | 13.8 |
| pH (SU) | 49 | 0 | <6 | 0 | 0 | | 6.3 | 6.7 | 6.8 | 7 | 7.2 | 7.3 | 7.5 |
| | 49 | 0 | >9 | 0 | 0 | | 6.3 | 6.7 | 6.8 | 7 | 7.2 | 7.3 | 7.5 |
| Spec. conductance (umhos/cm at 25°C) | 47 | 0 | N/A | | | | 24 | 63 | 73 | 102 | 148 | 211 | 306 |
| Water Temperature (°C) | 49 | 0 | >29 | 0 | 0 | | 5 | 6 | 8 | 14 | 19 | 22 | 24 |
| **Other** | | | | | | | | | | | | | |
| TSS (mg/L) | 22 | 3 | N/A | | | | 2 | 2 | 5 | 8 | 12 | 20 | 23 |
| Turbidity (NTU) | 49 | 0 | >50 | 1 | 2 | | 3 | 3 | 5 | 7 | 12 | 22 | 70 |
| **Nutrients (mg/L)** | | | | | | | | | | | | | |
| NH3 as N | 16 | 9 | N/A | | | | 0.01 | 0.01 | 0.01 | 0.01 | 0.14 | 0.29 | 0.5 |
| NO2 + NO3 as N | 16 | 2 | N/A | | | | 0.01 | 0.03 | 0.08 | 0.14 | 0.23 | 0.35 | 0.5 |
| TKN as N | 14 | 1 | N/A | | | | 0.1 | 0.14 | 0.2 | 0.25 | 0.4 | 0.75 | 1 |
| Total Phosphorus | 16 | 1 | N/A | | | | 0.02 | 0.02 | 0.03 | 0.14 | 0.24 | 0.42 | 0.5 |
| **Metals (ug/L)** | | | | | | | | | | | | | |
| Aluminum, total (Al) | 22 | 0 | N/A | | | | 120 | 164 | 268 | 545 | 722 | 1170 | 1700 |
| Arsenic, total (As) | 22 | 22 | >10 | 0 | 0 | | 10 | 10 | 10 | 10 | 10 | 10 | 10 |
| Cadmium, total (Cd) | 22 | 22 | >2 | 0 | 0 | | 2 | 2 | 2 | 2 | 2 | 2 | 2 |
| Chromium, total (Cr) | 22 | 22 | >50 | 0 | 0 | | 25 | 25 | 25 | 25 | 25 | 25 | 25 |
| Copper, total (Cu) | 22 | 14 | >7 | 2 | 9.1 | | 2 | 2 | 2 | 2 | 2 | 6 | 9 |
| Iron, total (Fe) | 22 | 0 | >1000 | 1 | 4.5 | | 220 | 220 | 298 | 520 | 602 | 975 | 1200 |
| Lead, total (Pb) | 22 | 22 | >25 | 0 | 0 | | 10 | 10 | 10 | 10 | 10 | 10 | 10 |
| Mercury, total (Hg) | 22 | 22 | >0.012 | 0 | 0 | | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 |
| Nickel, total (Ni) | 22 | 22 | >88 | 0 | 0 | | 10 | 10 | 10 | 10 | 10 | 10 | 10 |
| Zinc, total (Zn) | 22 | 17 | >50 | 0 | 0 | | 10 | 10 | 10 | 10 | 10 | 11 | 14 |

**Fecal coliform (#/100mL)**

| # results: | Geomean | # > 400: | % > 400: | 95%: |
|---|---|---|---|---|
| 49 | 44 | 3 | 6 | |

**Key:**
# result: number of observations
# ND: number of observations reported to be below detection level (non-detect)
EL: Evaluation Level; applicable numeric or narrative water quality standard or action level
Results not meeting EL: number and percentages of observations not meeting evaluation level
95% : States whether there is 95% statistical confidence that the actual percentage of exceedances is at least 10% (20% for Fecal
Stations with less than 10 results for a given parameter were not evaluated for statistical confidence

**Location:** CARTOOGECHAYE CRK AT SR 1152 NR FRANKLIN
**Station #:** G0130000 **Subbasin:** LTN01
**Latitude:** 35.15800 **Longitude:** -83.39200 **Stream class:** B Tr
**Agency:** NCAMBNT **NC stream index:** 2-19-(10.5)

**Time period:** 10/28/1999 to 05/25/2000

| | # results | # ND | EL | Results not meeting EL # | % | 95% | Min | Percentiles 10th | 25th | 50th | 75th | 90th | Max |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Field** | | | | | | | | | | | | | |
| D.O. (mg/L) | 6 | 0 | <6 | 0 | 0 | | 9.1 | 9.1 | 10.9 | 11.7 | 12.3 | 12.7 | 12.7 |
| pH (SU) | 6 | 0 | <6 | 0 | 0 | | 7.1 | 7.1 | 7.1 | 7.3 | 7.4 | 7.4 | 7.4 |
| | 6 | 0 | >9 | 0 | 0 | | 7.1 | 7.1 | 7.1 | 7.3 | 7.4 | 7.4 | 7.4 |
| Spec. conductance (umhos/cm at 25°C) | 6 | 0 | N/A | | | | 29 | 29 | 29 | 33 | 40 | 45 | 45 |
| Water Temperature (°C) | 6 | 0 | >20 | 0 | 0 | | 6 | 6 | 6.8 | 9.5 | 14 | 20 | 20 |
| **Other** | | | | | | | | | | | | | |
| Chloride (mg/L) | 6 | 0 | >230 | 0 | 0 | | 1 | 1 | 2 | 2 | 2 | 4 | 4 |
| TSS (mg/L) | 6 | 0 | N/A | | | | 2 | 2 | 2 | 2 | 9 | 9 | 9 |
| Turbidity (NTU) | 6 | 0 | >10 | 0 | 0 | | 2 | 2 | 2 | 2 | 5 | 6 | 6 |
| **Nutrients (mg/L)** | | | | | | | | | | | | | |
| NH3 as N | 6 | 4 | N/A | | | | 0.01 | 0.01 | 0.01 | 0.01 | 0.04 | 0.08 | 0.08 |
| NO2 + NO3 as N | 6 | 0 | N/A | | | | 0.03 | 0.03 | 0.05 | 0.07 | 0.13 | 0.19 | 0.19 |
| TKN as N | 6 | 0 | N/A | | | | 0.1 | 0.1 | 0.18 | 0.2 | 0.3 | 0.3 | 0.3 |
| Total Phosphorus | 6 | 2 | N/A | | | | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.02 | 0.02 |
| **Metals (ug/L)** | | | | | | | | | | | | | |
| Aluminum, total (Al) | 6 | 2 | N/A | | | | 50 | 50 | 50 | 125 | 375 | 660 | 660 |
| Arsenic, total (As) | 6 | 6 | >10 | 0 | 0 | | 10 | 10 | 10 | 10 | 10 | 10 | 10 |
| Cadmium, total (Cd) | 6 | 6 | >0.4 | 0 | 0 | | 2 | 2 | 2 | 2 | 2 | 2 | 2 |
| Chromium, total (Cr) | 6 | 6 | >50 | 0 | 0 | | 25 | 25 | 25 | 25 | 25 | 25 | 25 |
| Copper, total (Cu) | 6 | 4 | >7 | 0 | 0 | | 2 | 2 | 2 | 2 | 4 | 4 | 4 |
| Iron, total (Fe) | 6 | 0 | >1000 | 0 | 0 | | 190 | 190 | 212 | 260 | 555 | 780 | 780 |
| Lead, total (Pb) | 6 | 6 | >25 | 0 | 0 | | 10 | 10 | 10 | 10 | 10 | 10 | 10 |
| Mercury, total (Hg) | 6 | 6 | >0.012 | 0 | 0 | | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 |
| Nickel, total (Ni) | 6 | 6 | >88 | 0 | 0 | | 10 | 10 | 10 | 10 | 10 | 10 | 10 |
| Zinc, total (Zn) | 6 | 6 | >50 | 0 | 0 | | 10 | 10 | 10 | 10 | 10 | 10 | 10 |

**Fecal coliform (#/100mL)**

| # results: | Geomean | # > 400: | % > 400: | 95%: |
|---|---|---|---|---|
| 6 | 9 | 0 | 0 | |

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Stations with less than 10 results for a given parameter were not evaluated for statistical confidence

**Location:** LITTLE TENNESSEE RIV AT NC 28 AT IOTLA
**Station #:** G2000000 **Subbasin:** LTN01
**Latitude:** 35.23490 **Longitude:** -83.39579 **Stream class:** B
**Agency:** NCAMBNT **NC stream index:** 2-(26.5)

**Time period:** 10/28/1999 to 08/31/2004

| | # results | # ND | EL | Results not meeting EL # | % | 95% | Min | Percentiles 10th | 25th | 50th | 75th | 90th | Max |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Field** | | | | | | | | | | | | | |
| D.O. (mg/L) | 49 | 0 | <4 | 0 | 0 | | 7.2 | 8.1 | 8.4 | 10 | 11.3 | 12.8 | 15 |
| | 49 | 0 | <5 | 0 | 0 | | 7.2 | 8.1 | 8.4 | 10 | 11.3 | 12.8 | 15 |
| pH (SU) | 49 | 0 | <6 | 1 | 2 | | 5.8 | 6.4 | 6.6 | 6.8 | 7.1 | 7.3 | 7.6 |
| | 49 | 0 | >9 | 0 | 0 | | 5.8 | 6.4 | 6.6 | 6.8 | 7.1 | 7.3 | 7.6 |
| Spec. conductance (umhos/cm at 25°C) | 47 | 0 | N/A | | | | 29 | 41 | 46 | 55 | 80 | 110 | 165 |
| Water Temperature (°C) | 49 | 0 | >29 | 0 | 0 | | 3 | 6 | 8 | 15 | 20 | 23 | 27 |
| **Other** | | | | | | | | | | | | | |
| TSS (mg/L) | 22 | 2 | N/A | | | | 1 | 2 | 4 | 6 | 9 | 14 | 16 |
| Turbidity (NTU) | 49 | 0 | >50 | 2 | 4.1 | | 2 | 3 | 4 | 7 | 11 | 16 | 140 |
| **Nutrients (mg/L)** | | | | | | | | | | | | | |
| NH3 as N | 29 | 18 | N/A | | | | 0.01 | 0.01 | 0.02 | 0.02 | 0.07 | 0.2 | 0.5 |
| NO2 + NO3 as N | 29 | 2 | N/A | | | | 0.02 | 0.05 | 0.11 | 0.15 | 0.2 | 0.26 | 0.5 |
| TKN as N | 28 | 12 | N/A | | | | 0.1 | 0.1 | 0.2 | 0.2 | 0.21 | 0.34 | 1 |
| Total Phosphorus | 29 | 1 | N/A | | | | 0.02 | 0.02 | 0.03 | 0.07 | 0.1 | 0.15 | 0.5 |
| **Metals (ug/L)** | | | | | | | | | | | | | |
| Aluminum, total (Al) | 22 | 0 | N/A | | | | 98 | 130 | 150 | 375 | 508 | 1238 | 1700 |
| Arsenic, total (As) | 22 | 21 | >10 | 1 | 4.5 | | 10 | 10 | 10 | 10 | 10 | 10 | 12 |
| Cadmium, total (Cd) | 22 | 22 | >2 | 0 | 0 | | 2 | 2 | 2 | 2 | 2 | 2 | 2 |
| Chromium, total (Cr) | 22 | 22 | >50 | 0 | 0 | | 25 | 25 | 25 | 25 | 25 | 25 | 25 |
| Copper, total (Cu) | 22 | 17 | >7 | 1 | 4.5 | | 2 | 2 | 2 | 2 | 2 | 3 | 8 |
| Iron, total (Fe) | 22 | 0 | >1000 | 1 | 4.5 | | 200 | 252 | 358 | 525 | 628 | 982 | 1200 |
| Lead, total (Pb) | 22 | 22 | >25 | 0 | 0 | | 10 | 10 | 10 | 10 | 10 | 10 | 10 |
| Mercury, total (Hg) | 22 | 22 | >0.012 | 0 | 0 | | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 |
| Nickel, total (Ni) | 22 | 22 | >88 | 0 | 0 | | 10 | 10 | 10 | 10 | 10 | 10 | 10 |
| Zinc, total (Zn) | 22 | 19 | >50 | 0 | 0 | | 10 | 10 | 10 | 10 | 10 | 16 | 28 |

**Fecal coliform (#/100mL)**

| # results: | Geomean | # > 400: | % > 400: | 95%: |
|---|---|---|---|---|
| 49 | 36 | 1 | 2 | |

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**Ambient Monitoring System Station**
NCDENR, Division of Water Quality
Basinwide Assessment

**Location:** NANTAHALA RIV AT US 64 NR RAINBOW SPRINGS
**Station #:** G3500000 **Subbasin:** LTN03
**Latitude:** 35.09422 **Longitude:** -83.55992 **Stream class:** B Tr ORW
**Agency:** NCAMBNT **NC stream index:** 2-57-(0.5)

**Time period:** 10/28/1999 to 08/31/2004

| | # results | # ND | EL | Results not meeting EL # | % | 95% | Min | Percentiles 10th | 25th | 50th | 75th | 90th | Max |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Field** | | | | | | | | | | | | | |
| D.O. (mg/L) | 49 | 0 | <6 | 0 | 0 | | 6.8 | 8.3 | 9.2 | 11 | 11.7 | 12.8 | 14.7 |
| pH (SU) | 49 | 0 | <6 | 0 | 0 | | 6.1 | 6.5 | 6.6 | 7 | 7.1 | 7.3 | 7.6 |
| | 49 | 0 | >9 | 0 | 0 | | 6.1 | 6.5 | 6.6 | 7 | 7.1 | 7.3 | 7.6 |
| Spec. conductance (umhos/cm at 25°C) | 47 | 0 | N/A | | | | 10 | 13 | 15 | 17 | 18 | 30 | 45 |
| Water Temperature (°C) | 49 | 0 | >20 | 1 | 2 | | 4 | 6 | 8 | 10 | 13.5 | 17 | 21 |
| **Other** | | | | | | | | | | | | | |
| Chlorophyll A (ug/L) | 1 | 0 | >15 | 0 | 0 | | 2 | 2 | 2 | 2 | 2 | 2 | 2 |
| TSS (mg/L) | 22 | 12 | N/A | | | | 1 | 1 | 2 | 2 | 3 | 6 | 16 |
| Turbidity (NTU) | 49 | 9 | >10 | 2 | 4.1 | | 0 | 1 | 1 | 2 | 2 | 3 | 17 |
| **Nutrients (mg/L)** | | | | | | | | | | | | | |
| NH3 as N | 29 | 21 | N/A | | | | 0.01 | 0.01 | 0.01 | 0.02 | 0.04 | 0.19 | 0.5 |
| NO2 + NO3 as N | 29 | 5 | N/A | | | | 0.01 | 0.01 | 0.02 | 0.04 | 0.06 | 0.15 | 0.5 |
| TKN as N | 27 | 16 | N/A | | | | 0.1 | 0.1 | 0.2 | 0.2 | 0.2 | 0.32 | 1 |
| Total Phosphorus | 29 | 15 | N/A | | | | 0.01 | 0.01 | 0.01 | 0.02 | 0.02 | 0.08 | 0.5 |
| **Metals (ug/L)** | | | | | | | | | | | | | |
| Aluminum, total (Al) | 22 | 7 | N/A | | | | 50 | 50 | 50 | 60 | 102 | 214 | 560 |
| Arsenic, total (As) | 22 | 22 | >10 | 0 | 0 | | 10 | 10 | 10 | 10 | 10 | 10 | 10 |
| Cadmium, total (Cd) | 22 | 22 | >0.4 | 0 | 0 | | 2 | 2 | 2 | 2 | 2 | 2 | 2 |
| Chromium, total (Cr) | 22 | 22 | >50 | 0 | 0 | | 25 | 25 | 25 | 25 | 25 | 25 | 25 |
| Copper, total (Cu) | 22 | 21 | >7 | 0 | 0 | | 2 | 2 | 2 | 2 | 2 | 2 | 3 |
| Iron, total (Fe) | 22 | 6 | >1000 | 0 | 0 | | 50 | 50 | 50 | 98 | 135 | 217 | 520 |
| Lead, total (Pb) | 22 | 22 | >25 | 0 | 0 | | 10 | 10 | 10 | 10 | 10 | 10 | 10 |
| Mercury, total (Hg) | 22 | 22 | >0.012 | 0 | 0 | | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 |
| Nickel, total (Ni) | 22 | 22 | >88 | 0 | 0 | | 10 | 10 | 10 | 10 | 10 | 10 | 10 |
| Zinc, total (Zn) | 22 | 22 | >50 | 0 | 0 | | 10 | 10 | 10 | 10 | 10 | 10 | 10 |

**Fecal coliform (#/100mL)**

| # results: | Geomean | # > 400: | % > 400: | 95%: |
|---|---|---|---|---|
| 49 | 3 | 0 | 0 | |

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**Location:** OCONALUFTEE RIV AT SR 1359 AT BIRDTOWN
**Station #:** G8550000 **Subbasin:** LTN02
**Latitude:** 35.46100 **Longitude:** -83.35400 **Stream class:** C Tr
**Agency:** NCAMBNT **NC stream index:** 2-79-55-(16.5)

**Time period:** 09/09/1999 to 05/23/2000

| | # results | # ND | EL | Results not meeting EL # | % | 95% | Min | Percentiles 10th | 25th | 50th | 75th | 90th | Max |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Field** | | | | | | | | | | | | | |
| D.O. (mg/L) | 9 | 0 | <6 | 0 | 0 | | 9.9 | 9.9 | 10.2 | 11.3 | 14.2 | 14.7 | 14.7 |
| pH (SU) | 9 | 0 | <6 | 0 | 0 | | 7 | 7 | 7 | 7.2 | 7.8 | 7.9 | 7.9 |
| | 9 | 0 | >9 | 0 | 0 | | 7 | 7 | 7 | 7.2 | 7.8 | 7.9 | 7.9 |
| Spec. conductance (umhos/cm at 25°C) | 9 | 0 | N/A | | | | 18 | 18 | 18 | 21 | 24 | 26 | 26 |
| Water Temperature (°C) | 9 | 0 | >20 | 0 | 0 | | 2 | 2 | 6 | 12 | 16 | 19 | 19 |
| **Other** | | | | | | | | | | | | | |
| TSS (mg/L) | 9 | 1 | N/A | | | | 1 | 1 | 2 | 2 | 3 | 25 | 25 |
| Turbidity (NTU) | 9 | 0 | >10 | 0 | 0 | | 1 | 1 | 1 | 2 | 2 | 8 | 8 |
| **Nutrients (mg/L)** | | | | | | | | | | | | | |
| NH3 as N | 9 | 4 | N/A | | | | 0.01 | 0.01 | 0.01 | 0.03 | 0.04 | 0.24 | 0.24 |
| NO2 + NO3 as N | 9 | 0 | N/A | | | | 0.16 | 0.16 | 0.2 | 0.24 | 0.27 | 0.37 | 0.37 |
| TKN as N | 9 | 0 | N/A | | | | 0.1 | 0.1 | 0.2 | 0.3 | 0.55 | 0.9 | 0.9 |
| Total Phosphorus | 9 | 1 | N/A | | | | 0.01 | 0.01 | 0.01 | 0.02 | 0.05 | 0.09 | 0.09 |
| **Metals (ug/L)** | | | | | | | | | | | | | |
| Aluminum, total (Al) | 9 | 3 | N/A | | | | 50 | 50 | 50 | 70 | 150 | 750 | 750 |
| Arsenic, total (As) | 9 | 9 | >10 | 0 | 0 | | 10 | 10 | 10 | 10 | 10 | 10 | 10 |
| Cadmium, total (Cd) | 9 | 9 | >0.4 | 0 | 0 | | 2 | 2 | 2 | 2 | 2 | 2 | 2 |
| Chromium, total (Cr) | 9 | 9 | >50 | 0 | 0 | | 25 | 25 | 25 | 25 | 25 | 25 | 25 |
| Copper, total (Cu) | 9 | 7 | >7 | 0 | 0 | | 2 | 2 | 2 | 2 | 2 | 5 | 5 |
| Iron, total (Fe) | 9 | 1 | >1000 | 0 | 0 | | 50 | 50 | 72 | 99 | 165 | 880 | 880 |
| Lead, total (Pb) | 9 | 9 | >25 | 0 | 0 | | 10 | 10 | 10 | 10 | 10 | 10 | 10 |
| Mercury, total (Hg) | 9 | 9 | >0.012 | 0 | 0 | | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 |
| Nickel, total (Ni) | 9 | 9 | >88 | 0 | 0 | | 10 | 10 | 10 | 10 | 10 | 10 | 10 |
| Zinc, total (Zn) | 9 | 6 | >50 | 0 | 0 | | 10 | 10 | 10 | 10 | 16 | 18 | 18 |

**Fecal coliform (#/100mL)**

| # results: | Geomean | # > 400: | % > 400: | 95%: |
|---|---|---|---|---|
| 9 | 10 | 1 | 11 | |

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**Ambient Monitoring System Station**
NCDENR, Division of Water Quality
Basinwide Assessment

**Location:** TUCKASEGEE RIV AT SR 1364 AT BRYSON CITY
**Station #:** G8600000 **Subbasin:** LTN02
**Latitude:** 35.42835 **Longitude:** -83.44595 **Stream class:** B
**Agency:** NCAMBNT **NC stream index:** 2-79-(40.5)

**Time period:** 09/09/1999 to 08/19/2004

| | # results | # ND | EL | Results not meeting EL # | % | 95% | Min | Percentiles 10th | 25th | 50th | 75th | 90th | Max |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Field** | | | | | | | | | | | | | |
| D.O. (mg/L) | 55 | 0 | <4 | 0 | 0 | | 8.4 | 8.7 | 9.3 | 10.8 | 11.8 | 13.6 | 14.7 |
| | 55 | 0 | <5 | 0 | 0 | | 8.4 | 8.7 | 9.3 | 10.8 | 11.8 | 13.6 | 14.7 |
| pH (SU) | 55 | 0 | <6 | 0 | 0 | | 6.2 | 6.7 | 7 | 7.4 | 7.9 | 8.3 | 8.9 |
| | 55 | 0 | >9 | 0 | 0 | | 6.2 | 6.7 | 7 | 7.4 | 7.9 | 8.3 | 8.9 |
| Spec. conductance (umhos/cm at 25°C) | 53 | 0 | N/A | | | | 21 | 22 | 23 | 25 | 28 | 30 | 33 |
| Water Temperature (°C) | 55 | 0 | >29 | 0 | 0 | | 2 | 5.2 | 8 | 16 | 21 | 23 | 25 |
| **Other** | | | | | | | | | | | | | |
| TSS (mg/L) | 25 | 6 | N/A | | | | 2 | 2 | 2 | 6 | 13 | 42 | 58 |
| Turbidity (NTU) | 55 | 0 | >50 | 1 | 1.8 | | 1 | 2 | 2 | 4 | 9 | 20 | 54 |
| **Nutrients (mg/L)** | | | | | | | | | | | | | |
| NH3 as N | 33 | 24 | N/A | | | | 0.01 | 0.01 | 0.01 | 0.02 | 0.02 | 0.05 | 0.12 |
| NO2 + NO3 as N | 33 | 1 | N/A | | | | 0.02 | 0.09 | 0.11 | 0.14 | 0.18 | 0.2 | 0.27 |
| TKN as N | 33 | 14 | N/A | | | | 0.1 | 0.1 | 0.2 | 0.2 | 0.2 | 0.3 | 0.4 |
| Total Phosphorus | 33 | 4 | N/A | | | | 0.01 | 0.01 | 0.02 | 0.02 | 0.04 | 0.1 | 0.16 |
| **Metals (ug/L)** | | | | | | | | | | | | | |
| Aluminum, total (Al) | 24 | 1 | N/A | | | | 50 | 70 | 122 | 260 | 572 | 1600 | 2600 |
| Arsenic, total (As) | 24 | 24 | >10 | 0 | 0 | | 10 | 10 | 10 | 10 | 10 | 10 | 10 |
| Cadmium, total (Cd) | 24 | 24 | >2 | 0 | 0 | | 2 | 2 | 2 | 2 | 2 | 2 | 2 |
| Chromium, total (Cr) | 24 | 24 | >50 | 0 | 0 | | 25 | 25 | 25 | 25 | 25 | 25 | 25 |
| Copper, total (Cu) | 24 | 17 | >7 | 0 | 0 | | 2 | 2 | 2 | 2 | 2 | 4 | 5 |
| Iron, total (Fe) | 24 | 0 | >1000 | 4 | 16.7 | No | 89 | 109 | 212 | 345 | 788 | 2150 | 2600 |
| Lead, total (Pb) | 24 | 24 | >25 | 0 | 0 | | 10 | 10 | 10 | 10 | 10 | 10 | 10 |
| Mercury, total (Hg) | 23 | 23 | >0.012 | 0 | 0 | | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 |
| Nickel, total (Ni) | 24 | 24 | >88 | 0 | 0 | | 10 | 10 | 10 | 10 | 10 | 10 | 10 |
| Zinc, total (Zn) | 24 | 18 | >50 | 0 | 0 | | 10 | 10 | 10 | 10 | 10 | 14 | 17 |

**Fecal coliform (#/100mL)**

| # results: | Geomean | # > 400: | % > 400: | 95%: |
|---|---|---|---|---|
| 56 | 24 | 5 | 9 | |

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**Ambient Monitoring System Station**
NCDENR, Division of Water Quality
Basinwide Assessment

**Location:** CHEOAH RIV AT SR 1138 AT ROBBINSVILLE
**Station #:** G9550000 **Subbasin:** LTN04
**Latitude:** 35.32910 **Longitude:** -83.80976 **Stream class:** C Tr
**Agency:** NCAMBNT **NC stream index:** 2-190-(3.5)

**Time period:** 09/09/1999 to 08/19/2004

| | # results | # ND | EL | Results not meeting EL # | % | 95% | Min | Percentiles 10th | 25th | 50th | 75th | 90th | Max |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Field** | | | | | | | | | | | | | |
| D.O. (mg/L) | 53 | 0 | <6 | 0 | 0 | | 8.4 | 8.8 | 9.4 | 10.9 | 11.7 | 13.4 | 16.1 |
| pH (SU) | 54 | 0 | <6 | 1 | 1.9 | | 5.9 | 6.5 | 6.7 | 7 | 7.3 | 7.5 | 7.8 |
| | 54 | 0 | >9 | 0 | 0 | | 5.9 | 6.5 | 6.7 | 7 | 7.3 | 7.5 | 7.8 |
| Spec. conductance (umhos/cm at 25°C) | 53 | 0 | N/A | | | | 25 | 27 | 29 | 35 | 40 | 43 | 58 |
| Water Temperature (°C) | 54 | 0 | >20 | 5 | 9.3 | | 3 | 4.5 | 9 | 14.5 | 19 | 20.5 | 23 |
| **Other** | | | | | | | | | | | | | |
| TSS (mg/L) | 23 | 7 | N/A | | | | 1 | 2 | 2 | 4 | 5 | 6 | 40 |
| Turbidity (NTU) | 54 | 1 | >10 | 2 | 3.7 | | 1 | 1 | 2 | 3 | 4 | 7 | 76 |
| **Nutrients (mg/L)** | | | | | | | | | | | | | |
| NH3 as N | 32 | 21 | N/A | | | | 0.01 | 0.01 | 0.01 | 0.02 | 0.03 | 0.1 | 0.2 |
| NO2 + NO3 as N | 32 | 1 | N/A | | | | 0.05 | 0.09 | 0.13 | 0.15 | 0.18 | 0.25 | 0.3 |
| TKN as N | 32 | 16 | N/A | | | | 0.1 | 0.1 | 0.2 | 0.2 | 0.3 | 0.44 | 0.9 |
| Total Phosphorus | 31 | 6 | N/A | | | | 0.01 | 0.01 | 0.01 | 0.02 | 0.03 | 0.05 | 0.17 |
| **Metals (ug/L)** | | | | | | | | | | | | | |
| Aluminum, total (Al) | 23 | 3 | N/A | | | | 50 | 50 | 60 | 110 | 190 | 366 | 1200 |
| Arsenic, total (As) | 23 | 23 | >10 | 0 | 0 | | 10 | 10 | 10 | 10 | 10 | 10 | 10 |
| Cadmium, total (Cd) | 23 | 23 | >0.4 | 0 | 0 | | 2 | 2 | 2 | 2 | 2 | 2 | 2 |
| Chromium, total (Cr) | 23 | 23 | >50 | 0 | 0 | | 25 | 25 | 25 | 25 | 25 | 25 | 25 |
| Copper, total (Cu) | 23 | 19 | >7 | 1 | 4.3 | | 2 | 2 | 2 | 2 | 2 | 4 | 9 |
| Iron, total (Fe) | 22 | 0 | >1000 | 1 | 4.5 | | 62 | 70 | 120 | 195 | 280 | 438 | 1400 |
| Lead, total (Pb) | 23 | 23 | >25 | 0 | 0 | | 10 | 10 | 10 | 10 | 10 | 10 | 10 |
| Mercury, total (Hg) | 23 | 23 | >0.012 | 0 | 0 | | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 |
| Nickel, total (Ni) | 23 | 23 | >88 | 0 | 0 | | 10 | 10 | 10 | 10 | 10 | 10 | 10 |
| Zinc, total (Zn) | 23 | 18 | >50 | 0 | 0 | | 10 | 10 | 10 | 10 | 10 | 22 | 31 |

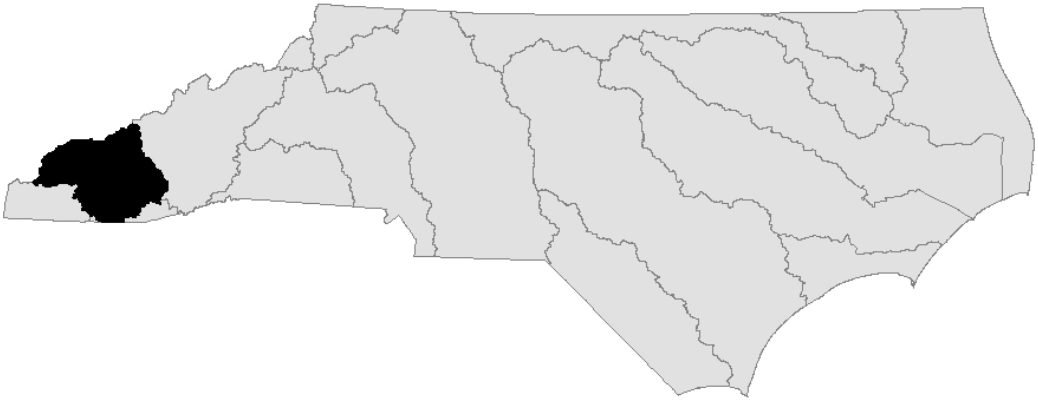
**Fecal coliform (#/100mL)**

| # results: | Geomean | # > 400: | % > 400: | 95%: |
|---|---|---|---|---|
| 55 | 44 | 4 | 7 | |

**Key:**
# result: number of observations
# ND: number of observations reported to be below detection level (non-detect)
EL: Evaluation Level; applicable numeric or narrative water quality standard or action level
Results not meeting EL: number and percentages of observations not meeting evaluation level
95% : States whether there is 95% statistical confidence that the actual percentage of exceedances is at least 10% (20% for Fecal
Stations with less than 10 results for a given parameter were not evaluated for statistical confidence

# Little Tennessee River Basin
# Basinwide Assessment Report
# Whole Effluent Toxicity Program

2000-2004



## The Division of Water Quality's Whole Effluent Toxicity Monitoring Program

Acute and/or chronic toxicity tests are used to determine toxicity of discharges to sensitive aquatic species (usually fathead minnows or the water flea, *Ceriodaphnia dubia*). Results of these tests have been shown by researchers to be predictive of discharge effects to receiving stream populations.

Many facilities are required to monitor whole effluent toxicity (WET) by their NPDES permit. Facilities without monitoring requirements may have their effluents evaluated for toxicity by DWQ's Aquatic Toxicology Laboratory. If toxicity is detected, DWQ may include aquatic toxicity testing upon permit renewal.

DWQ's Aquatic Toxicology Unit maintains a compliance summary for all facilities required to perform tests and provides a monthly update of this information to regional offices and WQ administration. Ambient toxicity tests can be used to evaluate stream water quality relative to other stream sites and/or a point source discharge.

## WET Monitoring in the Little Tennessee River Basin – 2000-2004

Three facility permits in the Little Tennessee River basin currently require whole effluent toxicity (WET) monitoring (Figure 1 and Table 1). All three facility permits have a WET limit.

**Figure 1. Little Tennessee River basin facilities required to conduct whole effluent toxicity testing**

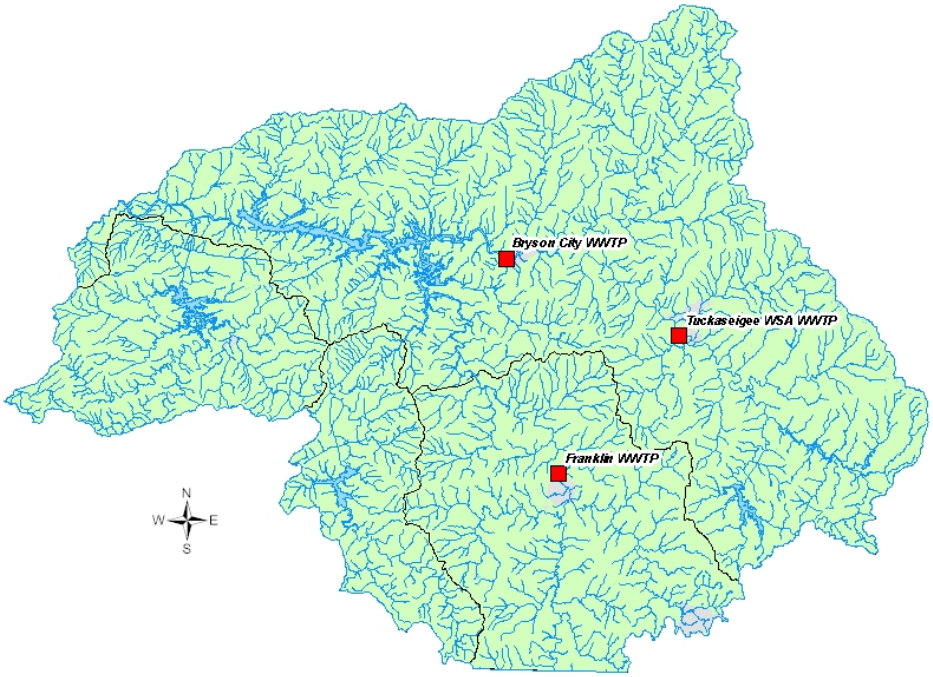


**Table 1. Little Tennessee River basin facilities required to conduct whole effluent toxicity testing**

| Subbasin/Facility | NPDES Permit No. | Receiving Stream | County | Flow (MGD) | IWC (%) | 7Q10 (cfs) |
|---|---|---|---|---|---|---|
| **04-04-01** | | | | | | |
| Franklin WWTP | NC0021547/001 | Little Tennessee R. | Macon | 1.65 | 1.6 | 157 |
| **04-04-02** | | | | | | |
| Bryson City WWTP | NC0026557/001 | Tuckasegee R. | Swain | 0.60 | 0.253 | 365.0 |
| Tuckaseigee WSA WWTP | NC0039578/001 | Tuckasegee R. | Jackson | 1.5 | 1.38 | 165.0 |

The relatively small number of facilities in this basin monitoring whole effluent toxicity increased slightly since 1987, the first year that monitoring was required. The compliance rate of those facilities has generally risen since the inception of the program. Since 1990 the compliance rate has stabilized at around 100% (Figure 1 and Table 2).

No facility in this basin has had significant toxicity issues.

**Figure 2. NPDES facility whole effluent toxicity compliance in the Little Tennessee River basin, 1990-2004. The compliance values were calculated by determining whether facilities with WET limits were meeting their ultimate permit limits during the given time period, regardless of any SOCs in force.**

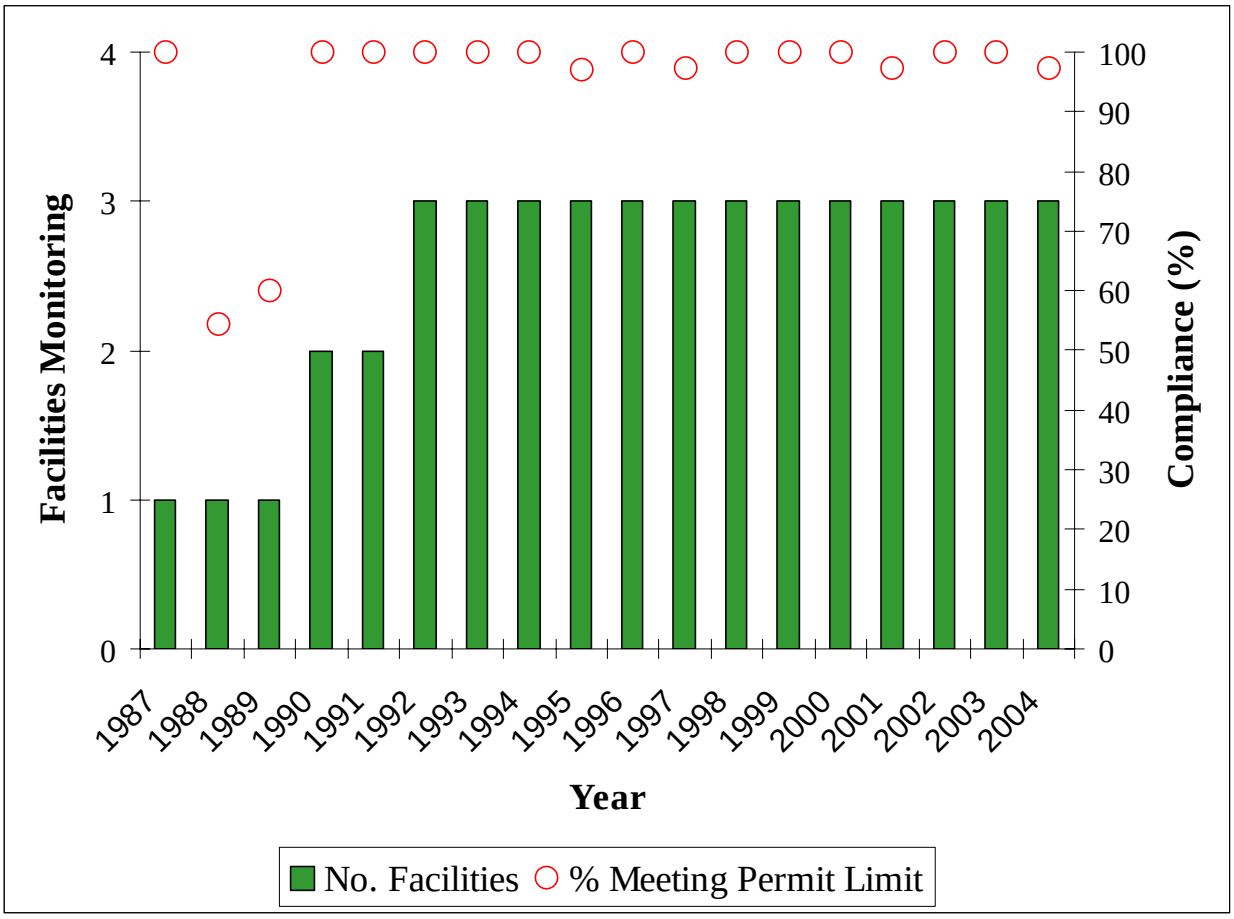



**Table 2. Recent compliance record of facilities performing whole effluent toxicity testing in the Little Tennessee River basin**

| Subbasin/Facility | NPDES Permit No. | 2000- 2003 Passes | 2000- 2003 Fails | 2004 Passes | 2004 Fails |
|---|---|---|---|---|---|
| **04-04-01** | | | | | |
| Franklin WWTP | NC0021547/001 | 16 | 0 | 4 | 0 |
| **04-04-02** | | | | | |
| Bryson City WWTP | NC0026557/001 | 16 | 0 | 4 | 0 |
| Tuckaseigee WSA WWTP | NC0039578/001 | 18 | 1 | 4 | 1 |

Note that "pass" denotes meeting a permit limit or, for those facilities with a monitoring requirement, meeting a target value. The actual test result may be a "pass" (from a pass/fail acute or chronic test), $LC_{50}$, or chronic value. Conversely, "fail" means failing to meet a permit limit or target value.