

BASINWIDE ASSESSMENT REPORT

SAVANNAH RIVER

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

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Executive Summary

This document presents a water quality assessment of the Savannah River basin. Monitoring programs covered within this report include benthic macroinvertebrates, ambient water quality, and aquatic toxicity for the period 1994 - 1999.

In general, the document is structured such that each subbasin is physically described and an overview of water quality is given at the beginning of each subbasin section. General water quality conditions are presented in an upstream to downstream format. The Savannah River subbasins are identified by six digit codes (031301 and 031302), but are often referred to by their last two digits (e.g. Subbasin 01).

Only a small portion of the Savannah River basin is located in North Carolina's southwestern mountains (Figure 1). Most of the basin is located within South Carolina and Georgia. The North Carolina portion of the watershed covers only 151 mi² in Clay, Jackson, Transylvania, and Macon counties.

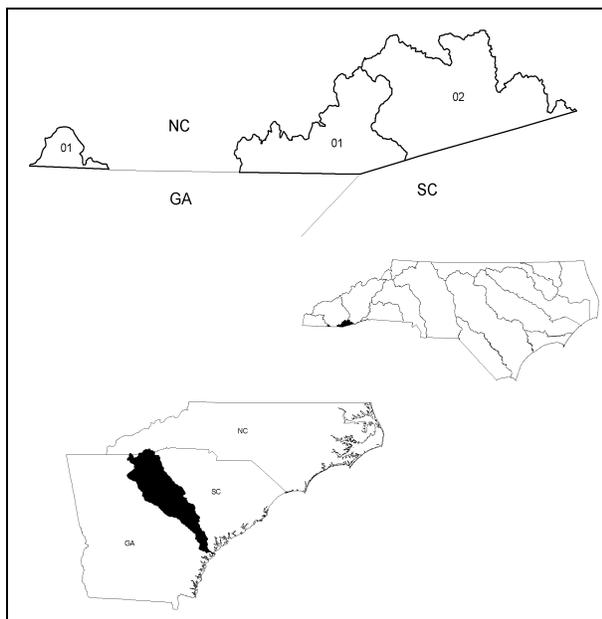


Figure 1. Geographical relationships of the upper Savannah River and its subbasins in North Carolina to the entire Savannah River drainage.

North Carolina rivers in the basin include the Tallulah, the Chattooga, the Horsepasture, the Whitewater, the Toxaway, and the Thompson rivers. Outstanding Resource Waters in this basin include the Chattooga River and many of its tributaries, Big Creek, and Overflow Creek. A portion of the Horsepasture River below NC 281 is included in the North Carolina Natural and Scenic Rivers system and in the National Wild and Scenic River system.

The basin is characterized by steep slopes and erodible soils. Much of the watershed lies within the Nantahala National Forest. While most of the land is forested, many retirement and second home developments are being built in the area. Cashiers is the largest town.

There are no major permitted dischargers located in this basin. Cashiers' WWTP, The Mountain, Carolina Mountain Water, and the Wade Hampton Club are required to monitor their effluents' toxicity.

Benthos data from basin assessment sites in 1999 documented excellent water quality for the Horsepasture River, the Whitewater River, the Chattooga River, and Big Creek. This is an improvement for the Horsepasture River from the Good bioclassification found in 1994. Indian Creek was classified Good in 1999 as it was in 1994. Excellent or Good water quality also exists in many of the smaller streams throughout this basin. Land-disturbing activities, however, appear to be the main threat to water quality in this basin.

There is only one ambient monitoring station in this basin. This monitoring site is located on the Horsepasture River. No water quality problems, based on physical or chemical measurements, have been identified. There was a pattern of low pH (< 6 s.u.) during 1991-1994 that also was observed in other mountain basins. Since 1995, values have increased to a median of 6.9.

Executive Summary By Program Area

BENTHIC MACROINVERTEBRATES

Forty-six macroinvertebrate samples have been collected from 23 streams in the Savannah River basin since 1984 (Figure 2). An Excellent or Good rating has been given to 85% of these samples; 13% of the samples were rated Good-Fair.

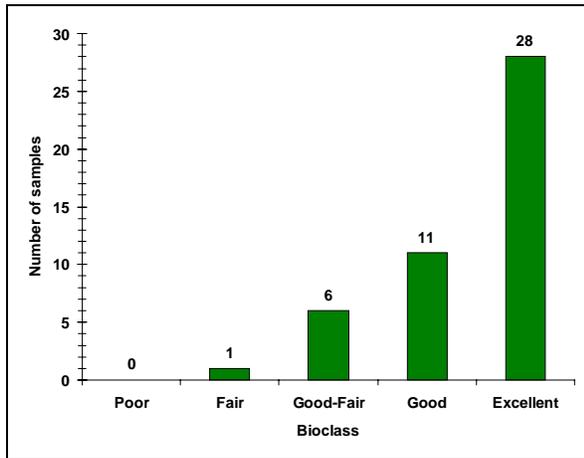


Figure 2. Bioclassifications of samples collected from the Savannah River basin, 1984 - 1999. Sample size = 46.

The five sites chosen for basinwide assessment in 1994 were repeated in 1999. All sites were rated Good or Excellent in both years.

Many of the streams in this basin flow through portions of the Nantahala National Forest. Consequently, the streams have been given supplemental classifications or designations of ORW or HQW based upon results from the benthic macroinvertebrate monitoring program. Supplemental classifications will help to provide future protection of these stream's high water quality.

FISHERIES

Fish Community Assessment

Thirty-two species of fish have been collected from the Savannah River basin in North Carolina (Menhinick 1991, 1995 (pers. comm.)). Special status has been granted to three of these species by the U. S. 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 and Hall 1999; Menhinick and Braswell 1997) (Table 1). Additional information on these three species may be found in Menhinick and Braswell (1997).

The North Carolina Index of Biotic Integrity is one of the tools the NCDWQ uses which summarizes all classes of factors such as water and habitat quality, flow regime, and energy sources which influence the freshwater fish communities of Wadeable streams throughout the state. No stream fish community basinwide monitoring was conducted during 1999 in the Savannah River basin because of recent revisions and a reexamination of the criteria and metrics.

Fish Tissue Contaminants

No fish tissue contaminant monitoring was conducted between 1995 and 1999 because of the lack of any significant contaminant issues in the basin.

Fish Kills

The Division has systematically monitored and reported on fish kill events across the state since 1996. No fish kills were reported from the Savannah River basin during this time period. Information on fish kills in other basins may be found on the Division's website (refer to the Glossary).

LAKE ASSESSMENT

No lakes in the Savannah River basin were monitored by the NCDWQ between 1995 and 1999.

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

Species	Common Name	State or Federal Status	State Rank ¹
<i>Notropis lutipinnis</i>	Yellowfin shiner	State - Special Concern	S3
<i>Notropis rubescens</i>	Rosyface chub	State - Threatened	S1
<i>Etheostoma inscriptum</i>	Turquoise darter	State - Special Concern	S1

¹S1 = critically imperiled in North Carolina because of extreme rarity or because of some factor(s) making it especially vulnerable to extirpation from North Carolina; and S3 = rare or uncommon in North Carolina (LeGrand and Hall 1999).

AMBIENT MONITORING SYSTEM

There is only one ambient water quality monitoring station in the basin. This station is located on the Horsepasture River near Union. The river at this sampling location is classified as B Trout waters.

A period of low pH was observed between 1991 and 1994, but values have returned to ranges observed before 1991 (ca. 7 s.u.). Dissolved oxygen concentrations were consistently greater than 7 mg/l. Concentrations of nitrite + nitrate as nitrogen decreased to less than 0.1 mg/l beginning in 1996. All fecal coliform bacteria samples collected since 1984 have been less than 200 colonies/100ml. Copper exceeded the action level (7 µg/l) in 16.4% of the 55 samples collected during this basinwide monitoring cycle.

AQUATIC TOXICITY MONITORING

The Town of Cashiers' wastewater treatment plant, The Mountain (formerly known as the Highlands Camp & Conference Center), Carolina Mountain Water, and the Wade Hampton Club are required by NPDES permit to monitor their effluent's toxicity. In addition, each permit has a whole effluent toxicity limit. The compliance rate of these facilities has fluctuated since the inception of the testing process, but has steadily increased since 1993.

One facility that has experienced problems meeting its permit limit is The Mountain. Historical failures seemed to be associated with the facility's chlorination/ dechlorination processes and the detergents used in dishwashing and laundry. Current failures have been attributed to the Center's well water. Benthos sampling below the discharge in 1999 indicated fauna typical of a clean mountain stream.

INTRODUCTION TO PROGRAM METHODS

The Division uses a basinwide approach to water quality management. Activities within the Division, including permitting, monitoring, modeling, nonpoint source assessments, and planning are coordinated and integrated for each of the 17 major river basins within the state. All basins are reassessed every five years, and the Savannah River basin was sampled by the Environmental Sciences Branch in 1994 and 1999.

The Environmental Sciences Branch collects a variety of biological, chemical, and physical data that can be used in a myriad of ways within the basinwide planning program. In some areas there may be adequate data from several program areas to allow a fairly comprehensive analysis of ecological integrity or water quality. In other areas, data may be limited to one program area, such as only benthic macroinvertebrate data or only fisheries data, with no other information available. Such data may or may not be adequate to provide a definitive assessment of water quality, but can provide general indications of water quality. The primary program areas from which data were drawn for this assessment of the Savannah River basin include benthic macroinvertebrates, ambient monitoring, and aquatic toxicity monitoring.

BENTHIC MACROINVERTEBRATES

Benthic macroinvertebrates, or benthos, are organisms that live in and on the bottom substrates of rivers and streams. These organisms are primarily aquatic insect larvae. The use of benthos data has proven to be a reliable monitoring tool, as benthic macroinvertebrates are sensitive to subtle changes in water quality. Since many taxa in a community have life cycles of six months to one year, the effects of short term pollution (such as a spill) will generally not be overcome until the following generation appears. The benthic community also integrates the effects of a wide array of potential pollutant mixtures.

Sampling methods and criteria have been developed to assign bioclassifications ranging from Poor to Excellent to each benthic sample from flowing waters based on the number of taxa present in the intolerant groups Ephemeroptera, Plecoptera and Trichoptera (EPT S) (Appendix B1). Likewise, ratings can be assigned with a North Carolina Biotic Index (BI). This index summarizes tolerance data for all taxa in each collection. These bioclassifications primarily reflect the influence of chemical pollutants. The major physical pollutant, sediment, is not assessed as well by a taxa richness analysis. Different

criteria have been developed for different ecoregions (mountains, piedmont and coastal) within North Carolina for freshwater flowing waterbodies.

Bioclassifications listed in this report (Appendix B2) may differ from older reports because evaluation criteria have changed since 1983. Originally, total taxa richness and EPT taxa richness criteria were used, then just EPT taxa richness, and now BI as well as EPT taxa richness criteria are used for flowing freshwater sites. Refinements of the criteria continue to occur as more data are gathered.

AMBIENT MONITORING SYSTEM

Assessments of water quality can be obtained from information about the biological communities present in a body of water or from field and laboratory measurements of particular water quality parameters. This section summarizes the field and laboratory measures of water quality, typically referred to as ambient water quality measures.

The Ambient Monitoring System is a network of stream, lake, and estuarine stations strategically located for the collection of physical and chemical water quality data. Parametric coverage is tiered 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 appended when justified (Table 2).

Summaries of water quality parameters measured during the five year period (September 01, 1994 – August 31, 1999) are provided (refer to Table 6). This table presents the number of samples collected and the number (and proportion) of samples greater than or less than a water quality reference value. In addition, a description of how the data are distributed is provided using percentiles. Percentiles describe the proportion of observations less than a specific value or concentration. For example, the 50th percentile (also called the median) provides the value (or concentration) of the parameter in which one half (50%) of the observations lie.

The water quality reference value may be a narrative or numeric standard, or an action level as specified in the North Carolina Administrative Code 15A NCAC 2B .0200. Zinc is not included in the summaries for metals because recent (since April

1995) sampling or analyses may have been contaminated with zinc and the data may be unreliable.

In this report, conductivity is synonymous with specific conductance. It is given in micromhos per centimeter ($\mu\text{mhos/cm}$) at 25 °C.

Table 2. Freshwater parametric coverage for the ambient monitoring system.¹

Parameter	All freshwater	Water Supply
Field		
Dissolved oxygen	x	x
pH	x	x
Conductivity	✓	✓
Temperature	✓	✓
Nutrients		
Total phosphorus	✓	✓
Ammonia as N	✓	✓
Total Kjeldahl as N	✓	✓
Nitrate + nitrite as N	✓	x
Other		
Total suspended solids	✓	.
Total dissolved solids	.	x
Turbidity	x	x
Hardness	✓	x
Chloride	✓	x
Bacteria		
Fecal coliform bacteria	x	x
Total coliform bacteria	.	x
Metals		
Aluminum	✓	✓
Arsenic	x	x
Cadmium	x	x
Chromium	x	x
Copper	x	x
Iron	x	x
Lead	x	x
Mercury	x	x
Nickel	x	x
Silver	x	x
Zinc	x	x
Manganese	.	x
Biological		
Chlorophyll <i>a</i> ²	x	x

¹ A check (✓) indicates the parameter is collected; an 'x' indicates the parameter is collected and has a standard or action level.

² Chlorophyll *a* is collected in Nutrient Sensitive Waters (NSW).

AQUATIC TOXICITY MONITORING

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 several researchers to be predictive of discharge effects on receiving stream populations.

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

The 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 Division administration. Ambient toxicity tests can be used to evaluate stream water quality relative to other stream sites and/or a point source discharge.

SAVANNAH RIVER SUBBASIN 01

Description

This subbasin, located near the southwestern border of North Carolina, consists of the headwaters of the Chattooga River plus the headwaters of two of its tributaries: Big Creek and Overflow Creek (Figure 3). While most of the land

is forested, many retirement and second home developments are being built around the towns of Cashiers and Highlands. Cashiers is the largest town in the subbasin.

Overview of water quality

Excellent water quality was documented for the several major streams in this subbasin in 1999: Chattooga River, Big Creek, North Fowler Creek, Norton Mill Creek, and Scotsman Creek (Table 3 and Appendix B2)). These streams and many of their tributaries are supplementally classified as ORW. Excellent or Good water quality also exists in most of the smaller streams in this subbasin. However, concern for nonpoint source effects (primarily from increased sedimentation) exists where larger tracts of land are being developed.

There are two NPDES permitted dischargers in the subbasin that are required to monitor their effluent's toxicity: Cashiers WWTP (0.1 MGD to an unnamed tributary to the Chattooga River) and The Mountain (formerly known as the Highlands Camp & Conference Center) (0.006 MGD to Abes Creek). There was concern that The Mountain might be impacting Abes Creek. However, benthic macroinvertebrate sampling in June 1999 found no indication of toxic conditions in the stream.

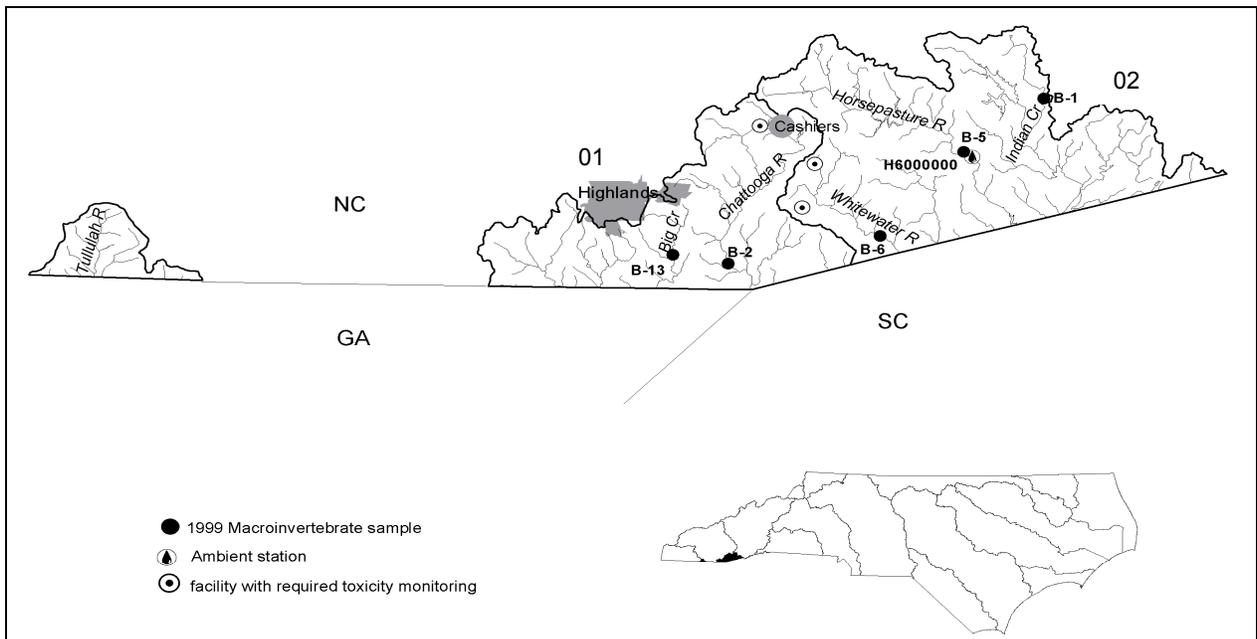


Figure 3. Monitoring sites in the Savannah River basin.

Table 3. Waterbodies monitored in Subbasin 01 in the Savannah River basin for basinwide assessment, 1994-1999.

Map #	Stream	County	Location	1994	1999
B-2 ¹	Chattooga R	Jackson	SR 1100 (off USFS Rd.)	Excellent	Excellent
B-13 ¹	Big Cr	Macon	SR 1608	Excellent	Excellent

¹Data are available prior to 1994, refer to Appendix B2.

River and Stream Assessment

Chattooga River, SR 1100

This site is near the North Carolina - Georgia border. The stream is 20 - 25 m wide, with a slightly embedded substrate of boulder and cobble. Observed sediment in the river is attributed to construction and development activities in the upper portions of the catchment around the Town of Cashiers. This area is characterized by erodible soils, so some of the sedimentation is natural.

Since January 1988, this site has been sampled five times for macroinvertebrates. Every time, it has received an Excellent rating. Some of the most intolerant EPT taxa that have been common or abundant during all sampling events include *Epeorus rubidus*, *Paraleptophlebia* spp., *Tallaperla* spp., *Dolophilodes* spp., and *Glossosoma* spp. A very rare crayfish, *Cambarus chaugaensis*, was collected at this site in 1999. Other rare collections also include *Mayatrichia ayama*, *Micrasema rickeri*, *Platycentropus*, *Nosticocladius*, and *Saetheria hirta*.

Big Creek, SR 1608

This site is located in a mostly forested area with a few residences along SR 1608. The road parallels Big Creek for much of its length. Although the sampling location is in a forested area, substantial development exists in the upper sections of the Big Creek drainage, including both residential and agricultural land use. These land use activities have apparently contributed to increased sediment loads in the stream as substrate estimates have been as high as 50% sand. The stream is approximately seven meters wide at the sampling site. In 1999, the substrate was a mix of boulder, cobble, gravel and sand, with a small cascading waterfall just upstream of SR 1608.

Big Creek has been assigned an Excellent bioclassification for all three years in which macroinvertebrates have been collected. As evidenced by the high numbers of EPT taxa that have been collected, the increased sediments in the stream did not seem to have a major negative effect on the macroinvertebrate community. Intolerant EPT taxa that were common or abundant during all sampling events included *Serratella carolina*, *Tallaperla* spp., *Dolophilodes* spp., *Lepidostoma* spp., and *Glossosoma* spp.

SPECIAL STUDIES

Potentially Sediment-Impacted Streams

A recent study suggested that five streams in the Savannah River basin were impacted because of sedimentation problems: Clear Creek, Norton Mill Creek, Fowler Creek, Big Creek, and Scotsman Creek (USEPA 1999).

These streams were subsequently sampled by the Division in June and July 1999. All streams were assigned an Excellent bioclassification based on benthos data. Two streams (Fowler Creek and Clear Creek) did have very sandy substrates, but both had high EPT values.

[Note: USEPA and Division results cannot be compared directly because of differences in sampling procedures. Joint sampling has been suggested to determine why there were such discrepancies in the final assessments of possible impairment to these streams.]

Potentially Toxic Effluent Impacting Abes Creek

Abes Creek was sampled in June 1999, at the request of Division basinwide planners. It was believed that the discharge from The Mountain was impacting Abes Creek. The stream was too small (one meter wide) to assign a bioclassification, but fauna typical of a clean mountain stream were collected.

Staff of the facility believed they had resolved toxicity problems several years ago when the detergents used in dishwashing and laundry were changed. Now, the facility staff speculate that the current toxicity problems are associated with the retreat's well water.

SAVANNAH RIVER SUBBASIN 02

Description

This subbasin is located near the southern border of North Carolina and rivers flow into the far western section of South Carolina (Figure 4). The major rivers in the subbasin are the Toxaway, Horsepasture, Thompson, and Whitewater rivers.

Most of the land area is forested and there are no large towns. A portion of the Horsepasture River (4.5 miles below NC 281) is in the North Carolina Natural and Scenic Rivers and the National Wild and Scenic River systems.

Overview of water quality

Macroinvertebrate data have shown that water quality in the Horsepasture River is Good or Excellent (Table 4 and Appendix B2)). Excellent water quality was also documented in the Whitewater River. Sampling access to the Toxaway River is difficult and little data were available from the river itself. However, tributary water quality ranged from Good in Indian Creek to Excellent in Bearwallow Creek. A portion of the Whitewater River and Bearwallow Creek are supplementally classified as HQW.

There are no major NPDES permitted dischargers in this subbasin. Carolina Mountain Water and the Wade Hampton Club are required to monitor their effluent's toxicity. These facilities discharge into an unnamed tributary to the Whitewater River and to an unnamed tributary to Silver Run Creek, respectively. Neither facility has experienced toxicity problems with its effluent in 1999. Nonpoint source runoff from land disturbing activities seemed to be the main threat to water quality in this subbasin.

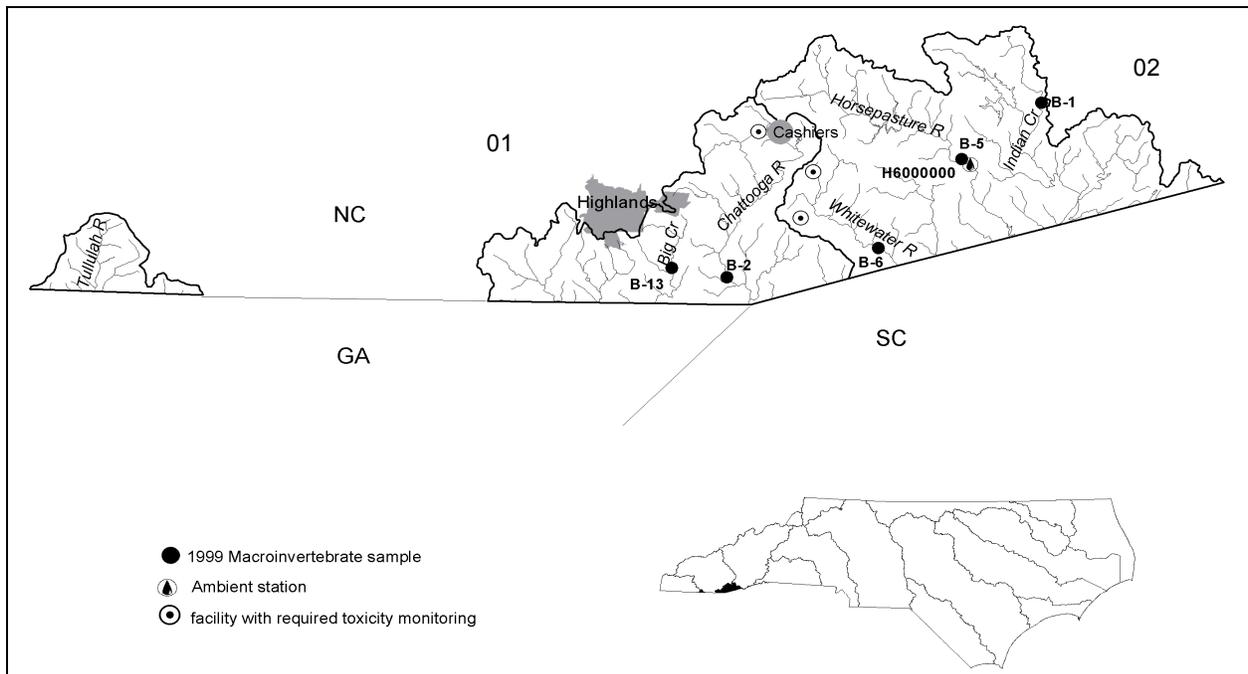


Figure 4. Monitoring sites in the Savannah River basin.

Table 4. Waterbodies monitored in Subbasin 02 in the Savannah River basin for basinwide assessment, 1994 - 1999.

Map #	Stream	County	Location	1994	1999
B-1 ¹	Indian Cr	Transylvania	US 64	Good	Good
B-5 ¹	Horsepasture R	Transylvania	NC 281	Good	Excellent
B-6 ¹	Whitewater R	Transylvania	NC 281	Excellent	Excellent

¹Data are available prior to 1994, refer to Appendix B2.

River and Stream Assessment

Indian Creek, US 64

Indian Creek drains the watershed east of Lake Toxaway. Its catchment is mainly forested, but with increasing areas of residential development near the stream. Indian Creek was 5 m wide at the sampling location with a substrate estimated to be 40-50% sand. The Good bioclassification probably reflected the slight effects of nonpoint source runoff and increased sedimentation in the stream. Although the number of EPT taxa at this site was somewhat reduced, several intolerant EPT taxa were abundant: *Epeorus rubidus*, *Tallaperla* spp., *Lepidostoma* spp., and *Dolophilodes* spp.

Horsepasture River, NC 281

Although the Horsepasture River drainage is still largely forested, there are areas of intense residential and golf course development. Development was heaviest during the 1980's, but continues, especially along some of the river's tributaries (Asheville Regional Office staff, pers. com.). There are six minor dischargers on the Horsepasture River or its tributaries which are associated with these developments.

The LBM Quarry is also located just upstream of NC 281. Staff in the Division's Asheville Regional Office have received a few complaints of turbidity in the Horsepasture River which have been attributed to runoff from this quarry. Data from the ambient monitoring station, also located at NC 281, indicated no parameters of concern on this stream. Elevated turbidity levels were recorded only once since 1994.

The land around the site itself is forested and the river was approximately 20 m wide at the collecting area. The stream had an open canopy (because of the stream width), which allowed for abundant plant growth on the rocks.

Total taxa and EPT taxa richness have fluctuated at this site, as have the bioclassifications (Table 5 and Figure 6). The lowest number of EPT taxa and the highest NCBI were recorded in 1985 when the water was turbid and the substrate was 50% sand. The highest total taxa richness (92) was collected in 1994, while the highest EPT taxa richness (42) was collected in 1999.

Table 5. Flow and bioclassifications for the Horsepasture River at NC 281, Transylvania County.

Year	Flow	Rating
1984	Normal	Good-Fair
1985	Normal	Fair
1986	Low	Good
1987	Low	Good
1989	High	Good-Fair
1994	High	Good
1999	Low	Excellent

The NCBI from 1999 was the lowest calculated from the river, and resulted in an Excellent rating for this stream for the first time. It was likely that the lower flow in 1999 aided in the collection of the high number of EPT taxa. The low flow likely reduced the effects of nonpoint pollution and scour at this site, as well as allowing access to all stream habitats.

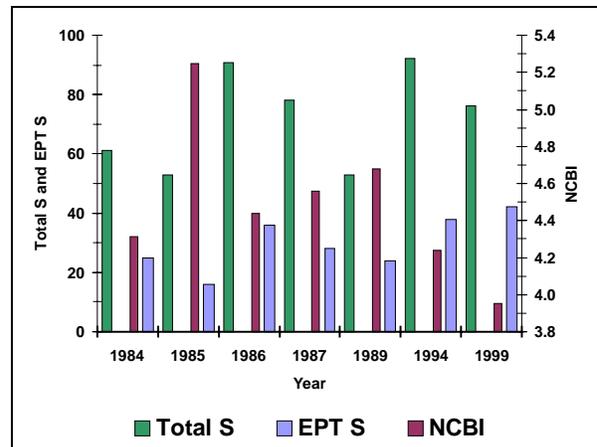


Figure 6. Total (Total S) and EPT (EPT S) taxa richness and biotic index (NCBI) for the Horsepasture River at NC 281, Transylvania County.

It is to be expected that without additional stressors this stream will continue to fluctuate between a Good and Excellent bioclassification. Several of the EPT taxa that were abundant are moderately tolerant: *Stenonema modestum*, *Isonychia* spp., and *Cheumatopsyche* spp.

Whitewater River, NC 281

The Whitewater River (20 m wide) drains a primarily forested watershed. The headwaters segment, near Highlands, has areas of development and is classified C Tr. Below Little Whitewater Creek and within the Nantahala

National Forest, the river is supplementally classified as HWQ. There are several trails along the river, so the potential for erosion is present. At the time of sampling in 1999, the water was clear, in spite of a heavy rain earlier in the day. This site was assigned an Excellent rating in both 1994 and 1999.

Epeorus rubidus, *Serratella carolina*, *Tallaperla* spp., *Glossosoma* spp, and *Nyctiophylax* spp. were the most abundant intolerant EPT taxa collected during the sampling events. *Drunella longicornis*, a rare species, was collected in 1994 and again in 1999.

AMBIENT MONITORING SYSTEM

The Division collects ambient water quality information from approximately 421 active monitoring stations statewide. There is only one ambient monitoring station within the Savannah River basin (Figure 6). It is located in Subbasin 02 on the Horsepasture River at SR 1149 near Union. The river at this sampling location is classified as B Tr.

Flow in the Savannah River is not routinely measured in North Carolina. However, regional flow patterns generally showed greater than normal flows beginning in 1994 to about 1998 (Figure 7). Beginning in 1998, yearly and monthly median flows displayed decreases. The graph depicting flow in the Hiwassee River does not include data for the water year 1998 - 1999, but the yearly median flow followed the patterns for the yearly median for the Watauga and Little Tennessee Rivers.

The previous basinwide assessment report (NCDHNR 1996) stated that three slightly depressed values of pH were observed. The patterns of low pH during 1991-1994 (Figure 8) were observed in other basins. Since 1995, values have increased. There were no known reasons for the low pH observed during the early

1990s. Atmospheric deposition has been speculated but there was also the possibilities of monitoring personnel error and pH meter equipment variability.

Graphs of field parameters, fecal coliform bacteria, laboratory measured parameters and nutrients are provided (Figures 9 - 12). Significant findings were:

- Fecal coliform bacteria concentrations were very low at this monitoring site. The maximum concentration observed was 150 colonies/100ml (Table 6 and Figure 11).
- Turbidity remained low, although one value (16 NTU on 07/24/97) exceeded the water quality standard for trout waters (10 NTU; Table 6 and Figure 11).
- Concentrations of nitrite+nitrate (as nitrogen) appeared to have decreased since 1995 (Figure 11). A maximum concentration of 0.1 mg/l was detected and 90% of the samples since September 1994 were less than 0.07 mg/l (Table 6).
- Approximately 16% of the samples for copper were greater than the action level of 7 µg/l (Table 6).

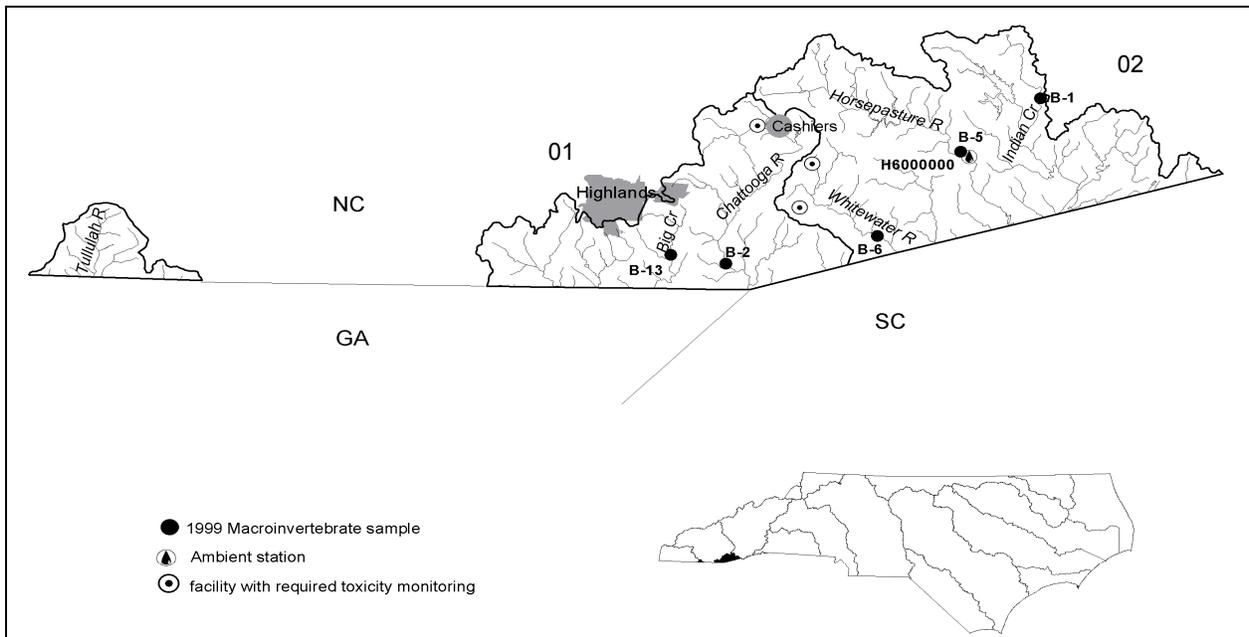


Figure 6. Monitoring sites located in the Savannah River basin.

Table 6. Summary of water quality parameters collected from the Horsepasture River (Station H6000000; Class B Tr) during the period September 1, 1994 to August 31, 1999.

Parameter	N	N < RL	Ref.	N > Ref.	% > Ref.	Min.	Max.	Percentiles				
								10	25	50	75	90
Field												
Temperature (°C)	57					4	23	6	9	12	19	21
Conductivity	57					11	31	13	15	17	19	23
Dissolved Oxygen	57		6	0		7.8	13.2	8.2	8.7	9.9	10.6	12
pH (s.u.)	56		6 to 9	0		5.5	8.9	6.5	6.7	6.9	7	7.1
Other												
Total Residue	0											
Total Sus. Solids	48	14				1	12	1	1	1	2	4
Hardness	48					1	10	2	3	5	6	7
Chloride												
Turbidity (NTU)	48	0	10	1	2.1	1	16	1.1	1.5	2.3	3.3	5.7
Bacteria												
Total coliform	0											
Fecal coliform	48	36	200	0		1	150	1	1	1	1	6
Nutrients												
NH ₃ as N	59	18				0.01	0.13	0.01	0.01	0.02	0.05	0.09
TKN as N	59	2				0.1	0.4	0.1	0.1	0.1	0.2	0.3
NO ₂ +NO ₃ as N	59	5				0.01	0.1	0.01	0.03	0.04	0.06	0.07
Total Phosphorus	59	24				0.01	0.05	0.01	0.01	0.01	0.02	0.03
Metals (total)												
Arsenic	55	54	50			10	10	10	10	10	10	10
Cadmium	55	54	0.04	N/A		2	2	2	2	2	2	2
Chromium	55	54	50	0		25	25	25	25	25	25	25
Copper	55	23	7	9	16.4	2	39	2	2	2.4	5	10
Iron	55	1	1000	0		50	930	170	233	330	460	620
Lead	55	49	25	0		10	14	10	10	10	10	10
Manganese	0											
Nickel	55	53	88	0		10	10	10	10	10	10	10
Aluminum	55	1				50	1100	59	76	100	168	220
Mercury	55	55	0.012	N/A		0.2	0.2	0.2	0.2	0.2	0.2	0.2

Abbreviations:

N Total number of samples.
 N < RL Number of samples less than the DWQ analytical reporting level (RL).
 Ref Water quality reference (standard or action level); see NC Administrative Code 15A NCAC 2B .0200.
 N > Ref Number of samples greater than (or less than) the reference.
 % > Ref Proportion (%) of samples greater than the reference.
 Min Minimum.
 Max Maximum.
 N/A Not applicable because all samples were less than the reporting level.

Units of Measurement

As noted. Conductivity = µmhos/cm; bacteria = no. colonies/100 ml; metals = µg/l; all others = mg/l.

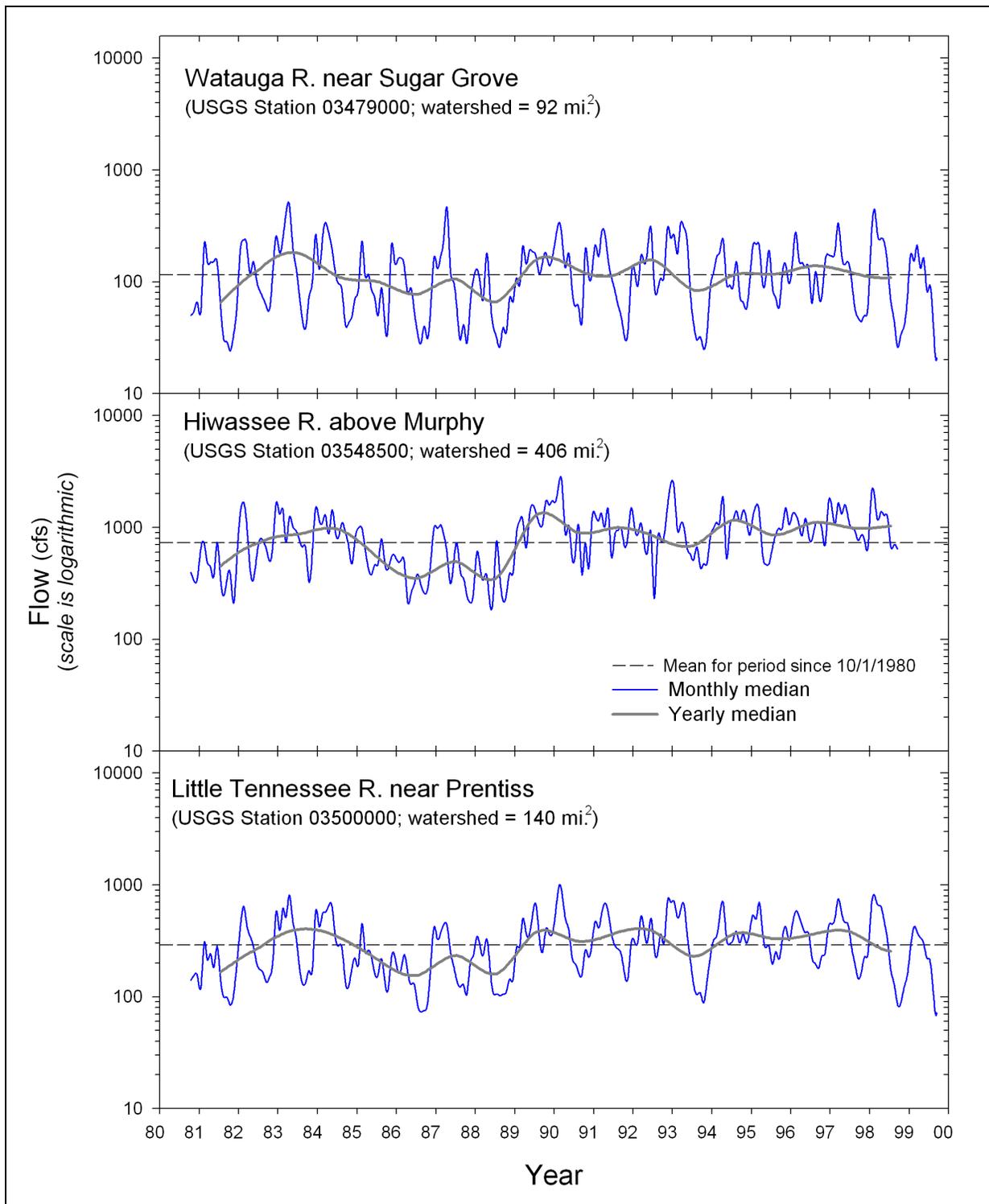


Figure 7. Regional patterns for river flow, 1980-1999. (Data from US Geological Survey: <http://nc.water.usgs.gov/>).

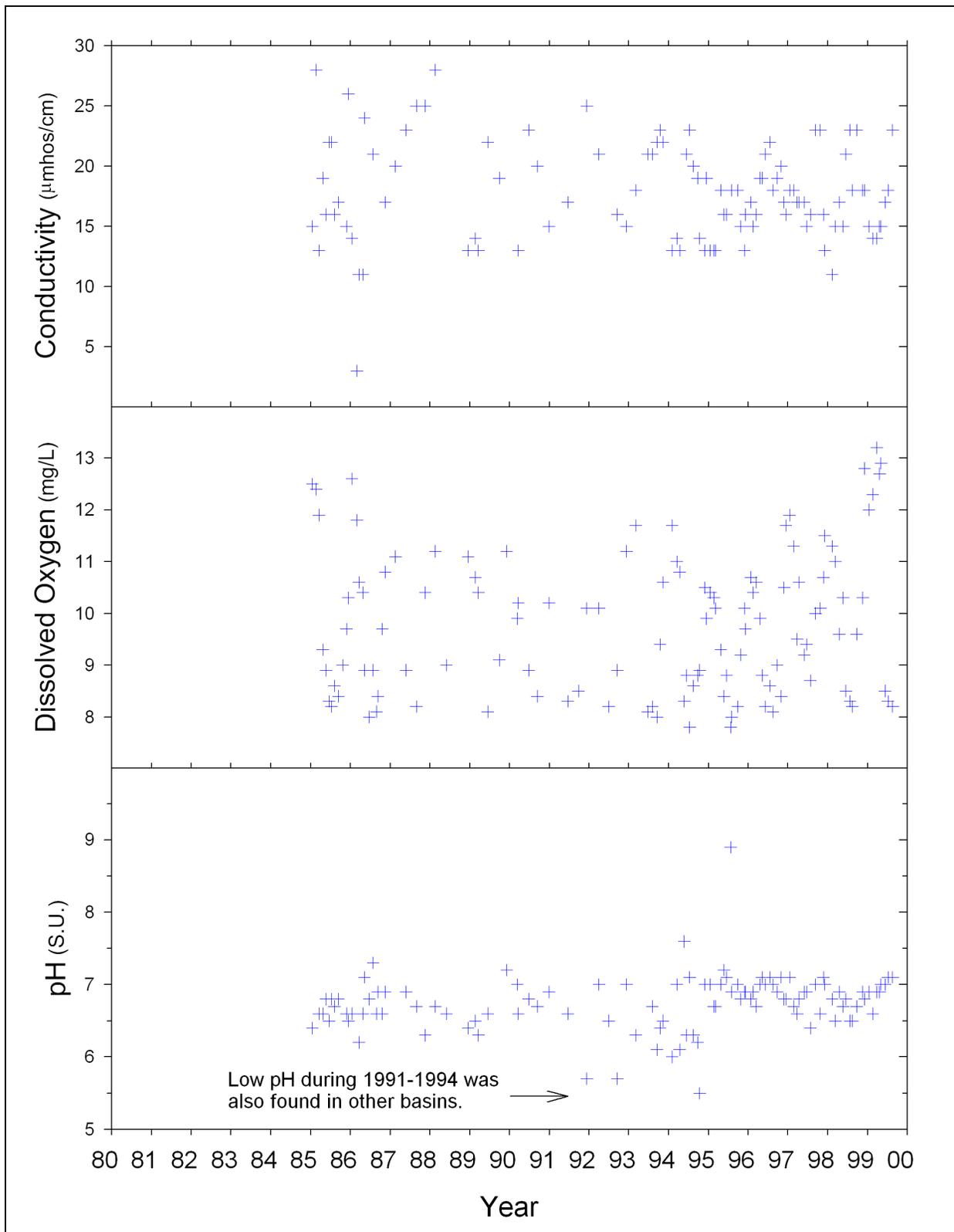


Figure 8. Temporal patterns of conductivity, dissolved oxygen, and pH observed at the Horsepasture River (Station H6000000; Class B Tr).

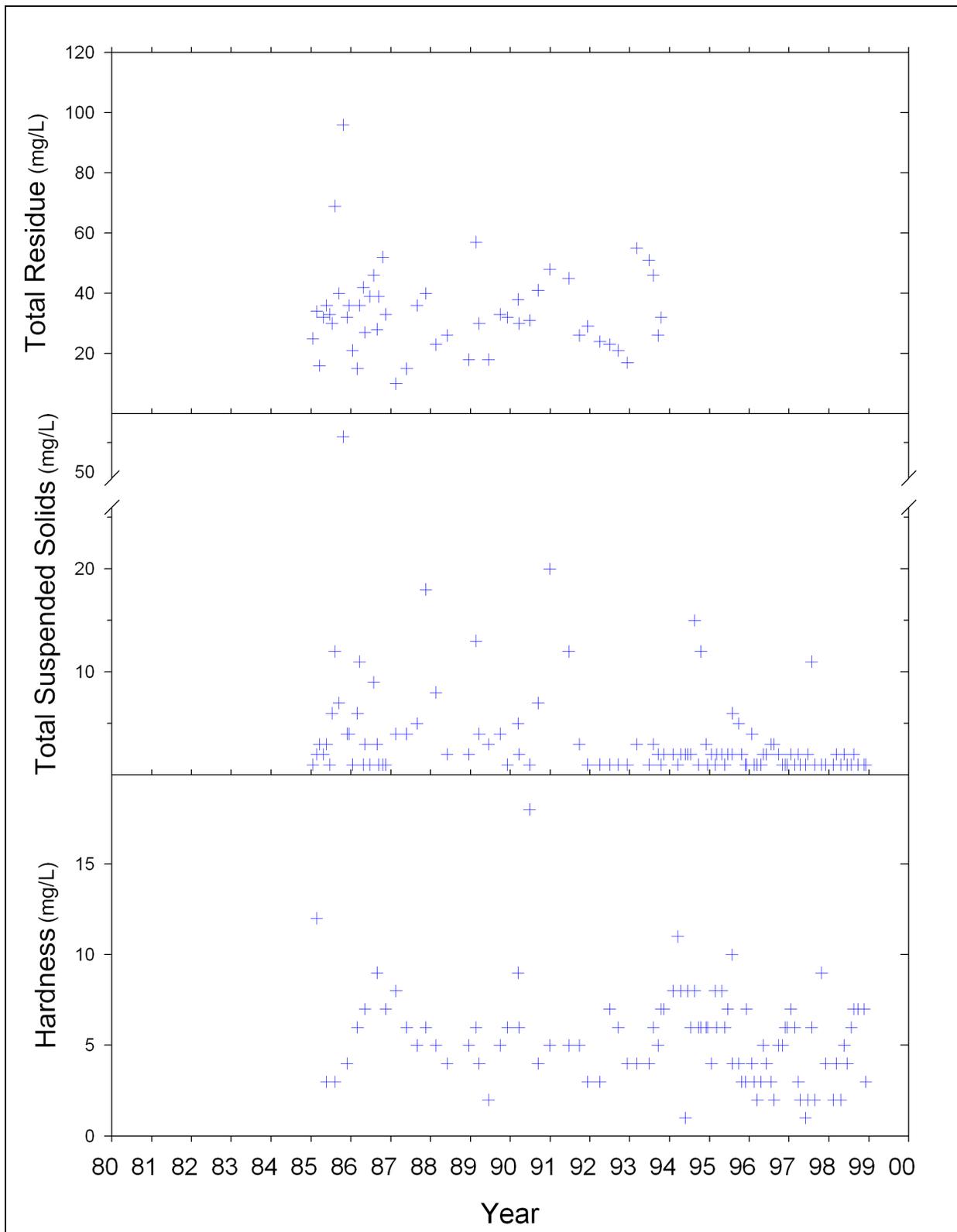


Figure 9. Temporal patterns of total residue, total suspended solids, and hardness observed at the Horsepasture River (Station H6000000; Class B Tr).

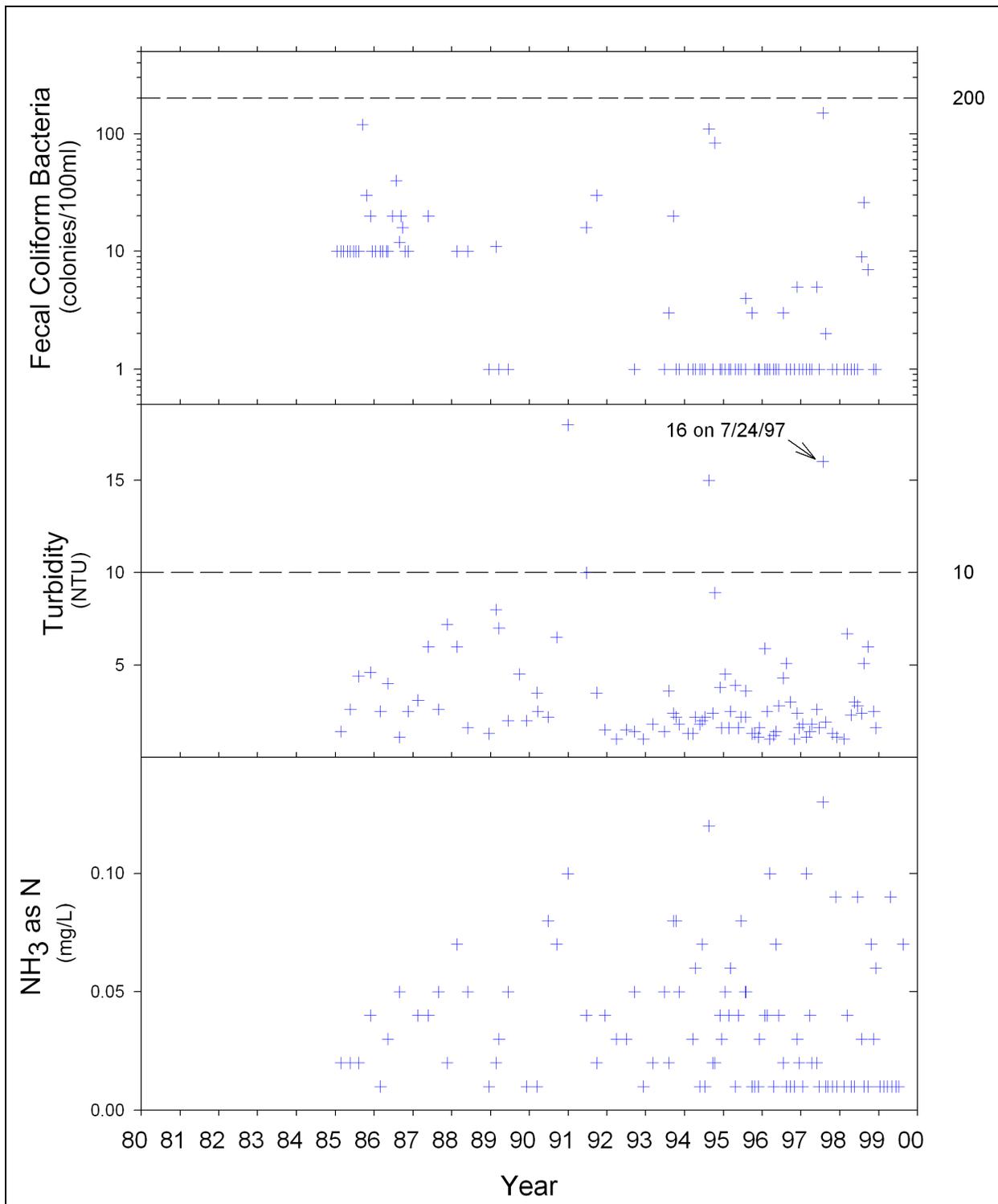


Figure 10. Temporal patterns of total fecal coliform bacteria, turbidity, and ammonia-nitrogen (NH₃) observed at the Horsepasture River (Station H6000000; Class B Tr). Dashed lines indicate water quality standards for trout waters.

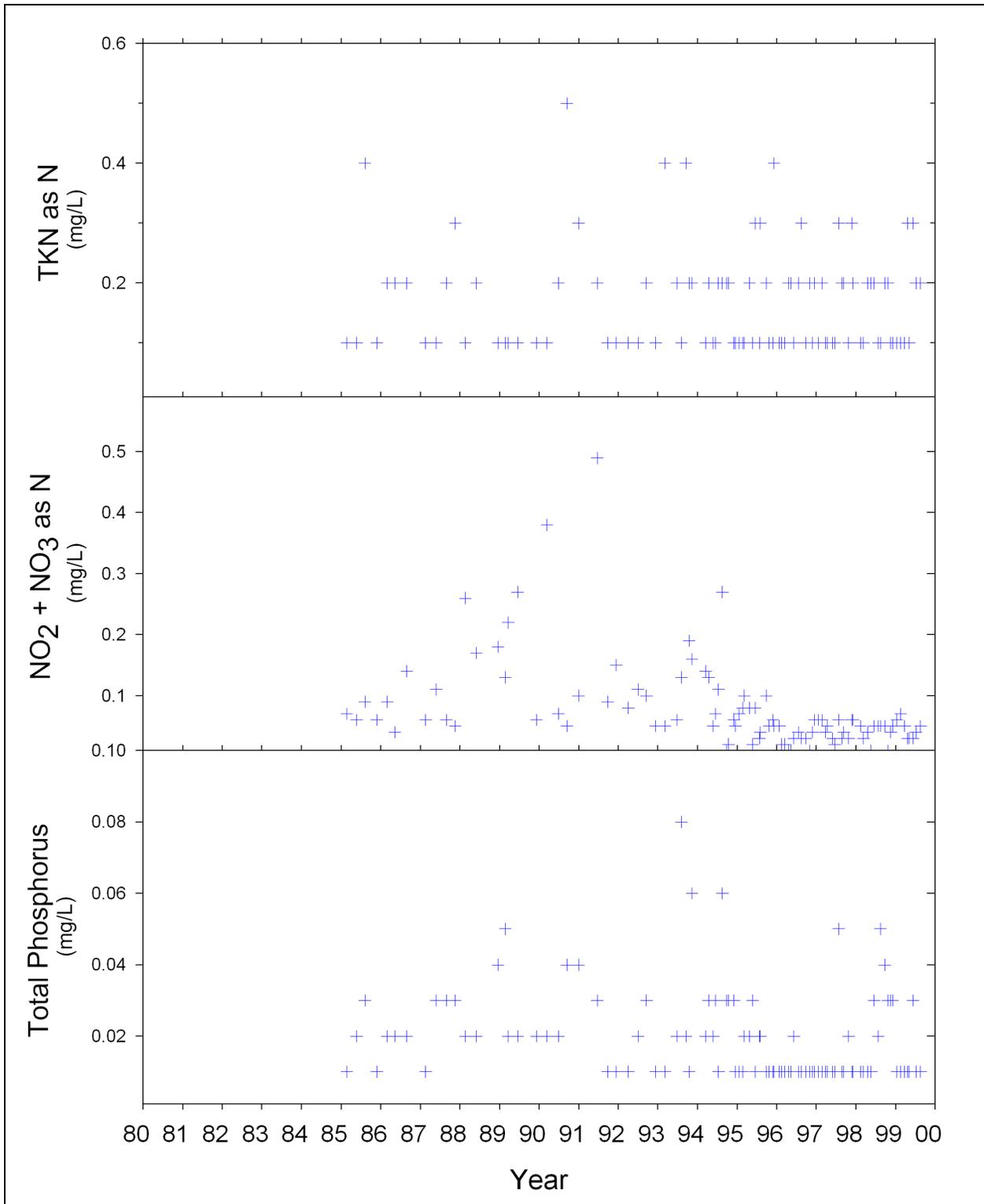


Figure 11. Temporal patterns of total Kjeldahl nitrogen (TKN), nitrite+nitrate nitrogen (NO₂+NO₃), and total phosphorus observed at the Horsepasture River (Station H6000000; Class B Tr).

AQUATIC TOXICITY MONITORING

Four facilities in the Savannah River basin have NPDES permits which require whole effluent toxicity (WET) monitoring. These facilities are the Town of Cashiers' wastewater treatment plant, The Mountain (formerly known as the Highlands Camp & Conference Center), Carolina Mountain Water, and the Wade Hampton Club (Figure 12 and Table 7). All four facilities also have a WET permit limit.

There have been few facilities monitoring for whole effluent toxicity in this basin since 1987, the first year that WET limits were written into permits in North Carolina. The compliance rates of those

facilities has fluctuated over time. But since 1993, for the four facilities overall, the compliance rates have shown gradual improvement (Figure 13).

The Mountain in Subbasin 01 has experienced problems meeting its whole effluent toxicity limit since it began monitoring in 1993 (Table 7). Only 31% of the toxicity tests have successfully passed. Some of the earlier failures seemed to be associated with the facility's choice of detergents and the chlorination/ dechlorination unit. Facility representatives now speculate that the current toxicity problems might be associated with the retreat's well water.

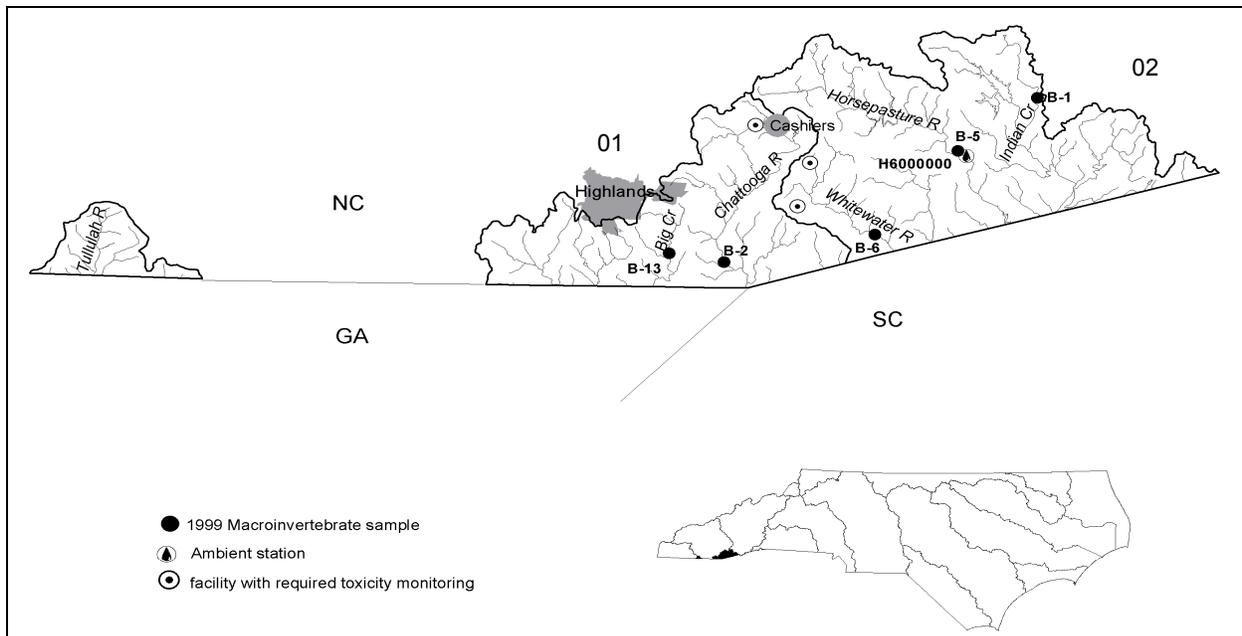


Figure 12. Location of facilities in the Savannah River basin required to perform whole effluent toxicity testing.

Table 7. Facilities in the Savannah River basin required to perform whole effluent toxicity testing and their compliance record.

Facility	Cashiers WWTP	The Mountain	Carolina Mountain Water	Wade Hampton Club
NPDES Permit No.	NC0063321/001	NC0061123/001	NC0067954/001	NC0062553/001
Receiving stream	UT Chattooga R	Abes Cr	UT Whitewater R	UT Silver Run Cr
County	Jackson	Macon	Jackson	Jackson
Permitted flow (MGD)	0.100	0.006	0.006	0.125
7Q10	0.050	0.000	0.075	0.370
IWC ¹ (%)	24	100	11	34
Pre-1999 passes ²	33	15	44	33
Pre-1999 fails	5	35	9	9
1999 passes ²	4	2	4	3
1999 fails	0	3	0	0

¹ Instream waste concentration

² Note that "pass" denotes meeting a permit limit. The actual test result may be a "pass" (from a pass/fail acute or chronic test), LC₅₀, or chronic value. Conversely, "fail" means failing to meet a permit limit or target value.

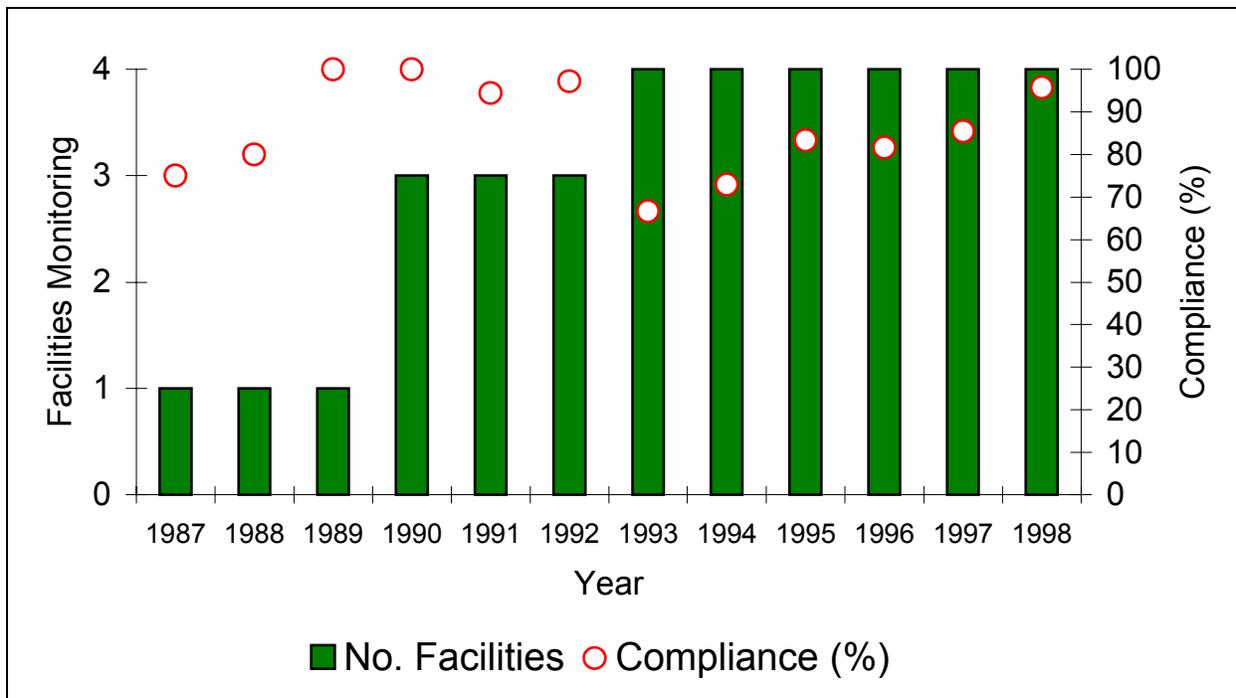


Figure 13. Compliance record of facilities in the Savannah River basin required to perform whole effluent toxicity testing, 1987-1998. The compliance values were calculated by determining whether a facility was meeting its ultimate permit limit during the given time period, regardless of any SOCs in force.

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GLOSSARY

7Q10	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. 7Q10 flow (in cfs) is used to allocate the discharge of toxic substances to streams.
Bioclass	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 <i>a</i>	Chlorophyll <i>a</i> .
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, and soil type. Examples include mountains, piedmont, coastal plain, sandhills, and 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
IWC	Instream Waste Concentration. The percentage of a stream comprised of an effluent calculated using permitted flow of the effluent and 7Q10 of the receiving stream.
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 NCBIEPT.
NCIBI	North Carolina Index of Biotic Integrity (NCIBI); a summary measure of the effects of factors influencing the fish community.
NSW	Nutrient Sensitive Waters.
NTU	Nephelometric Turbidity Unit.

GLOSSARY (continued)

ORW	Outstanding Resource Waters.
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.
Web Sites	Basinwide planning -- http://h2o.enr.state.nc.us/basinwide/basinwide/default.html Biological monitoring -- http://www.esb.enr.state.nc.us/BAU.html Fish kills -- http://www.esb.enr.state.nc.us/fishkill/fishkill00.html North Carolina Administrative Code that relates to the Division of Water Quality and water quality protection -- http://h2o.enr.state.nc.us/rules/ruleindex.html

Appendix B1. Benthic macroinvertebrate sampling and criteria for freshwater wadeable and flowing waters.

Benthic macroinvertebrates can be collected using two sampling procedures. The Division’s standard qualitative 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 (NCDEHNR 1997).

An abbreviated method (4-sample EPT) includes one kick-net sample, one bank sweep, one leaf pack sample, and visual collections from large rocks and logs. Only EPT groups are collected and identified, and only EPT criteria are used to assign a bioclassification. "EPT" is an abbreviation for Ephemeroptera + Plecoptera + Trichoptera, insect groups that are generally intolerant of many kinds of pollution. Higher EPT taxa richness values usually indicate better water quality.

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).

Several data-analysis summaries (metrics) can be produced to detect water quality problems (Table B1).

Table B1. Benthos classification criteria for flowing water systems in the mountain ecoregion.

Metric	Sample type	Bioclass	Score
EPT S	10-sample Qualitative	Excellent	> 41
		Good	32 - 41
		Good-Fair	22 - 31
		Fair	12 - 21
		Poor	0 - 11
	4-sample EPT	Excellent	> 35
		Good	28 - 35
		Good-Fair	19 - 27
		Fair	11 - 18
		Poor	0 - 10
Biotic Index (range 0 – 10)	10-sample Qualitative	Excellent	< 4.05
		Good	4.06 - 4.88
		Good-Fair	4.89 - 5.74
		Fair	5.75 - 7.00
		Poor	> 7.00

These metrics are based on the idea that unstressed streams and rivers have many invertebrate taxa and are dominated by intolerant species. Conversely, polluted streams have fewer numbers of invertebrate taxa and are dominated by tolerant species. The diversity of the invertebrate fauna is evaluated using taxa richness counts; the tolerance of the stream community is evaluated using a biotic index.

EPT taxa richness (EPT S) is used with criteria to assign water quality ratings (bioclassifications). Water quality ratings also are based on the relative tolerance of the macroinvertebrate community as summarized by the North Carolina Biotic Index (NCBI). Tolerance values for individual species and the final biotic index values have a range of 0 - 10, with higher numbers indicating more tolerant species or more polluted conditions.

Water quality ratings assigned with the biotic index numbers are combined with EPT taxa richness ratings to produce a final bioclassification, using criteria for Mountain streams. EPT abundance (EPT N) and total taxa richness calculations also are used to help examine between-site differences in water quality. If the EPT taxa richness rating and the biotic index differ by one bioclassification, the EPT abundance value is used to determine the final site rating.

The expected EPT taxa richness values are lower in small high-quality mountain streams (< 4 m wide or with a drainage area < 3.5 mi²). For these small mountain streams, an adjustment to the EPT taxa richness values is made prior to applying taxa richness criteria.

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

Criteria have been developed to assign bioclassifications ranging from Poor to Excellent to each benthic sample. These bioclassifications primarily reflect the influence of chemical pollutants. The major physical pollutant, sediment, is not assessed as well by a taxa richness analysis.

Appendix B2.

Benthic macroinvertebrate data collected in the Savannah River basin, 1984 - 1999.
Current basinwide monitoring sites have the Map No. bolded.

Subbasin/ Stream	Location	County	Map No. ¹	Index No.	Date	S/ EPT S	NCBI EPT BI	Bio Class ¹
01								
Chattooga R	SR 1107	Jackson	B-1	3	01/88	96/48	3.65/3.00	E
Chattooga R	USFS Rd	Jackson	B-2	3	07/99	107/57	3.35/2.85	E
					07/94	97/47	4.03/2.84	E
					08/90	93/44	3.49/2.52	E
					08/88	115/50	4.04/2.41	E
					01/88	84/45	3.21/2.58	E
(North) Fowler Cr	off SR 1107	Jackson	B-3	3-1-(2)	06/99	98/50	3.87/2.87	E
					01/88	-/34	-/3.21	G
Norton Mill Cr	SR 1107	Jackson	B-4	3-3	06/99	71/44	3.70/3.03	E
					01/88	-/19	-/2.96	G-F
Scotsman Cr	USFS Rd	Jackson	B-5	3-7	06/99	-/47	-/1.92	E
					01/88	-/42	-/2.17	E
(South) Fowler Cr	SR 1100	Jackson	B-6	3-8	01/88	64/37	3.40/2.49	G
E Fk Chattooga R	NC 107	Jackson	B-7	3-10	01/88	-/31	-/2.17	G
Overflow Cr (NC/SC line)	USFS Rd	Macon	B-8	3-10-2	07/91	68/42	2.51/2.09	E
					07/89	78/44	2.96/2.22	E
					01/88	-/43	-/2.19	E
W Fk Overflow Cr	USFS Rd	Macon	B-9	3-10-2-2	01/88	68/46	2.50/1.96	E
UT W Fk Overflow Cr	USFS Rd	Macon	B-10	3-10-2-2	01/88	-/35	-/1.82	E ³
Clear Cr	SR 1618	Macon	B-11	3-10-2-3	01/88	-/34	-/3.60	G
Big Cr (above Little Cr)	Off SR 1608	Macon	B-12	3-10-3	01/88	-/38	-/2.30	E
					08/87	102/47	3.21/2.15	E
Big Cr	SR 1608	Macon	B-13	3-10-3	07/99	-/45	-/1.99	E
					07/94	-/45	-/2.13	E
					08/87	99/49	3.22/2.27	E
02								
Indian Cr	US 64	Transylvania	B-1	4-5-(3)	07/99	-/34	-/2.24	G
					07/94	-/31	-/2.14	G
Bearwallow Cr (midsection)	USFS Rd	Transylvania	B-2	4-7-(1)	09/89	-/25	-/2.02	G-F
Bearwallow Cr (near mouth)	USFS Rd	Transylvania	B-3	4-7-(2)	05/91	-/44	-/1.67	E
					06/88	93/45	3.43/2.61	E
Trays Island Cr	Off US 64	Jackson	B-4	4-13-5-(1)	12/91	-/31	-/1.48	E ³
Horsepasture R (near Union)	NC 281	Transylvania	B-5	4-13-(12.5)	07/99	76/43	3.95/3.25	E
					07/94	91/37	4.34/3.05	G
					07/89	53/24	4.82/3.37	G-F
					08/87	78/28	4.75/3.36	G
					07/86	91/36	4.53/3.08	G
					08/85	53/16	5.42/3.86	F
					08/84	61/25	4.47/3.37	G-F
Whitewater R	NC 281	Transylvania	B-6	4-14-(1.5)	07/99	-/48	-/2.23	E
					07/94	-/47	-/2.05	E
Thompson R	NC 281	Transylvania	B-7	4-14-6	09/89	84/43	3.19/2.20	E
					02/88	68/41	3.03/1.88	E
Thompson R (below hatchery)	NC 281	Transylvania	B-8	4-14-6	09/89	74/29	5.57/3.60	G-F
					02/88	79/38	4.70/2.83	G-F
Thompson R (NC/SC state line)		Transylvania	B-9	4-14-6	02/88	85/41	3.33/2.01	G
UT Thompson R	NC 281	Transylvania	B-10	4-14-6	02/88	-/31	-/1.95	G

¹Map number in bold face is a basin assessment site.²E = Excellent, G = Good, G-F = Good-Fair, and F = Fair.³Small stream criteria