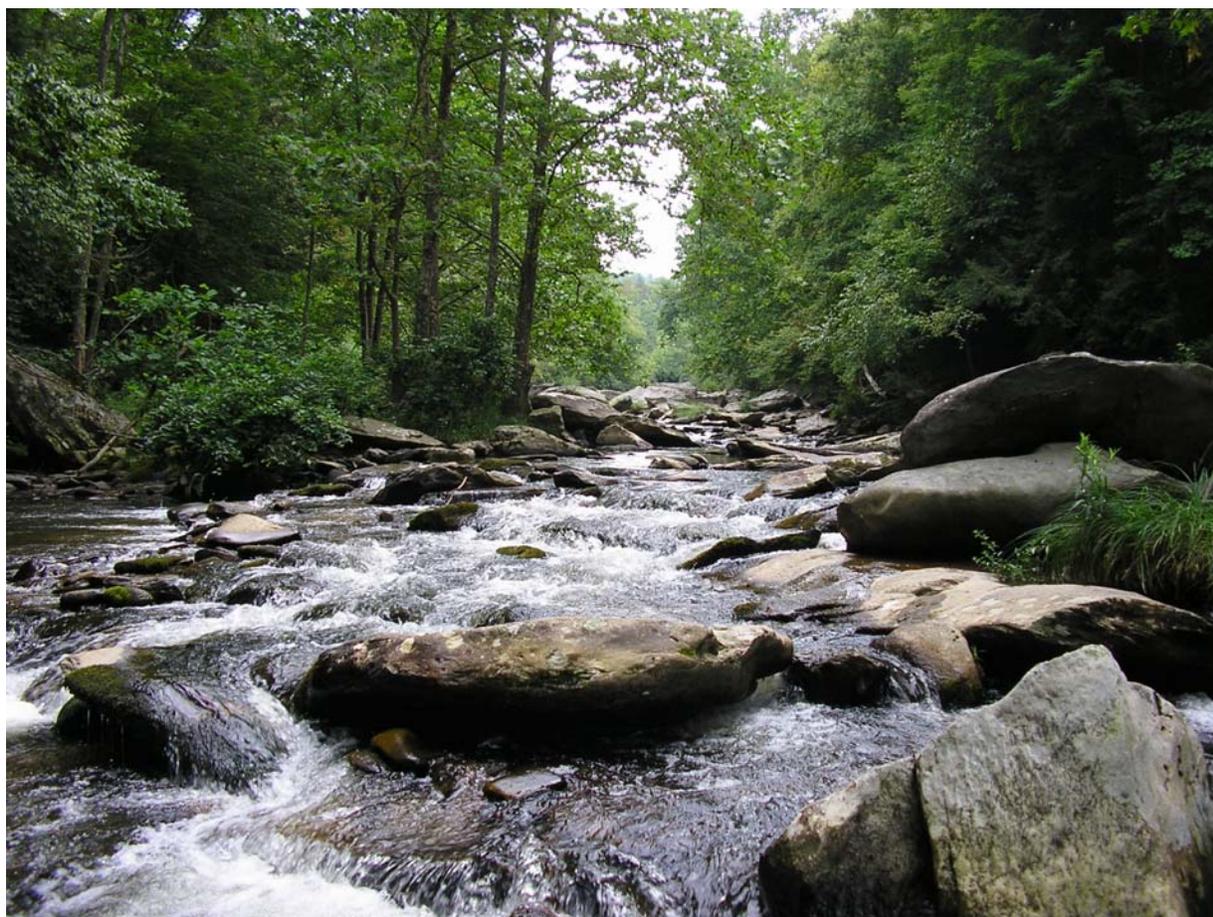


BASINWIDE ASSESSMENT REPORT WATAUGA RIVER BASIN



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

March 2009



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INTRODUCTION TO PROGRAM METHODS

The Division of Water Quality 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. The Watauga River basin has been sampled by the Environmental Sciences Section (ESS) four times for basinwide monitoring: 1994, 1999, 2004, and 2008.

The ESS 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 program 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 Watauga River basin include benthic macroinvertebrates, fish community, ambient monitoring, and aquatic toxicity monitoring for the period 2004-2008. Details of biological sampling methods (including habitat evaluation) and rating criteria can be found in the appendices of this report. Technical terms are defined in the Glossary.

This document is structured with physical, geographical, and biological data discussions presented in hydrologic units (HUCs). General water quality conditions are given in an upstream to downstream format. Lakes data, ambient chemistry data and aquatic toxicity data, with summaries, are presented in separate reports.

BASIN DESCRIPTION

The Watauga River Basin is located south of the New River Basin and north of the French Broad River Basin in both Avery and Watauga counties (Figure 1). This basin contains western portions of Boone and the municipalities of Banner Elk, Beech Mountain, Elk Park, Seven Devils and Sugar Mountain. It is the second smallest river basin (205 mi²) in the state incorporating approximately 270 miles of streams and rivers. This basin is located in the Blue Ridge ecoregion, which extends from southern Pennsylvania to northern Georgia. The Watauga basin includes the Elk and Watauga Rivers, which are headwater tributaries of the Holston River in Tennessee. The Holston River connects with the Tennessee River and eventually these waters flow to the Mississippi River and the Gulf of Mexico.

Topographically, the basin varies, encompassing narrow ridges to rolling plateaus and lower valleys to mountainous areas with high peaks. The forested slopes, high gradient cool streams, and rough terrain occur mainly on metamorphic rocks with smaller areas of igneous and sedimentary geology (Griffith *et al* 2002). Major tributaries include Boone, Laurel, and Hoskin Forks, Beaverdam, Beech, Cove, Meatcamp, Fall, and Greenbriar Creeks (Figure 2).

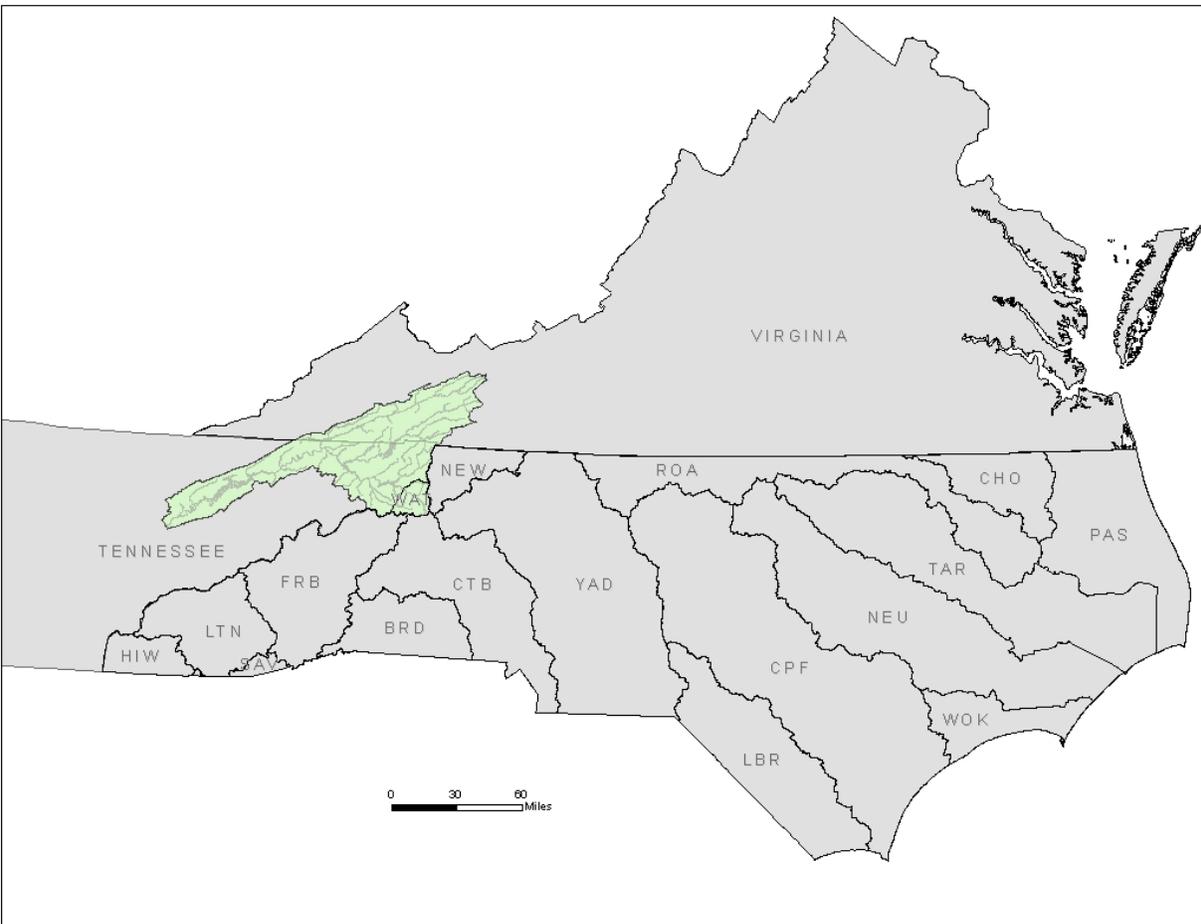


Figure 1. Geographic Relationships of the Watauga River Basin in North Carolina.

WATAUGA RIVER HUC 06010103 – WATAUGA RIVER HEADWATERS

Description

The Hydrologic Unit (HUC) 06010103 is the only eight-digit HUC within the Watauga River basin. It is located in the northwestern portion of North Carolina. This HUC contains the Watauga River headwaters and its tributaries. The headwaters of the Watauga River originate in Avery and Watauga counties. This watershed contains several small municipalities and western portions of Boone. The Watauga River HUC is divided ecologically between three Level IV ecoregions including Southern Crystalline Ridges and Mountains, Southern Metasedimentary Mountains, and High Mountains. Most of the land use in this HUC consists of a mixture of residential and commercial development, agriculture, and expansive forest land within Pisgah National Forest.

Upper portions of the Watauga River and many of its associated tributaries are known to support good quality trout fisheries. Boone and Laurel Forks were classified by NCDWQ as Outstanding Resource Waters (ORW) in 1993. From source to US 321, the Watauga River is classified as an ORW and from US 321 to the North Carolina/Tennessee border the river is designated a High Quality Water (HQW). Currently, the Watauga River and Boone Fork are designated as Natural Heritage Significant Aquatic Habitats by the North Carolina Natural Heritage Program (NCNHP) due to excellent benthic bioclassifications and the rare benthic macroinvertebrates found in these catchments.

Parts of the basin are developing rapidly with additions of homes and recreational areas, such as golf courses and other tourist attractions. Much of this development is focused near riverine corridors, potentially affecting water quality through numerous point source dischargers and nonpoint source runoff. Most of the basin's population is located in and around the Boone area, but the other nearby municipalities are also experiencing growth. There are currently 30 NPDES permitted dischargers; up from 28 in 2004. The two largest facilities are the Valley Creek (0.9 MGD to Valley Creek) and Sugar Mountain (1.0 MGD to Flattop Creek) wastewater treatment plants. The Sugar Mountain and Beech Mountain (0.4 MGD to Pond Creek) facilities are required by permit to monitor their effluent's toxicity.

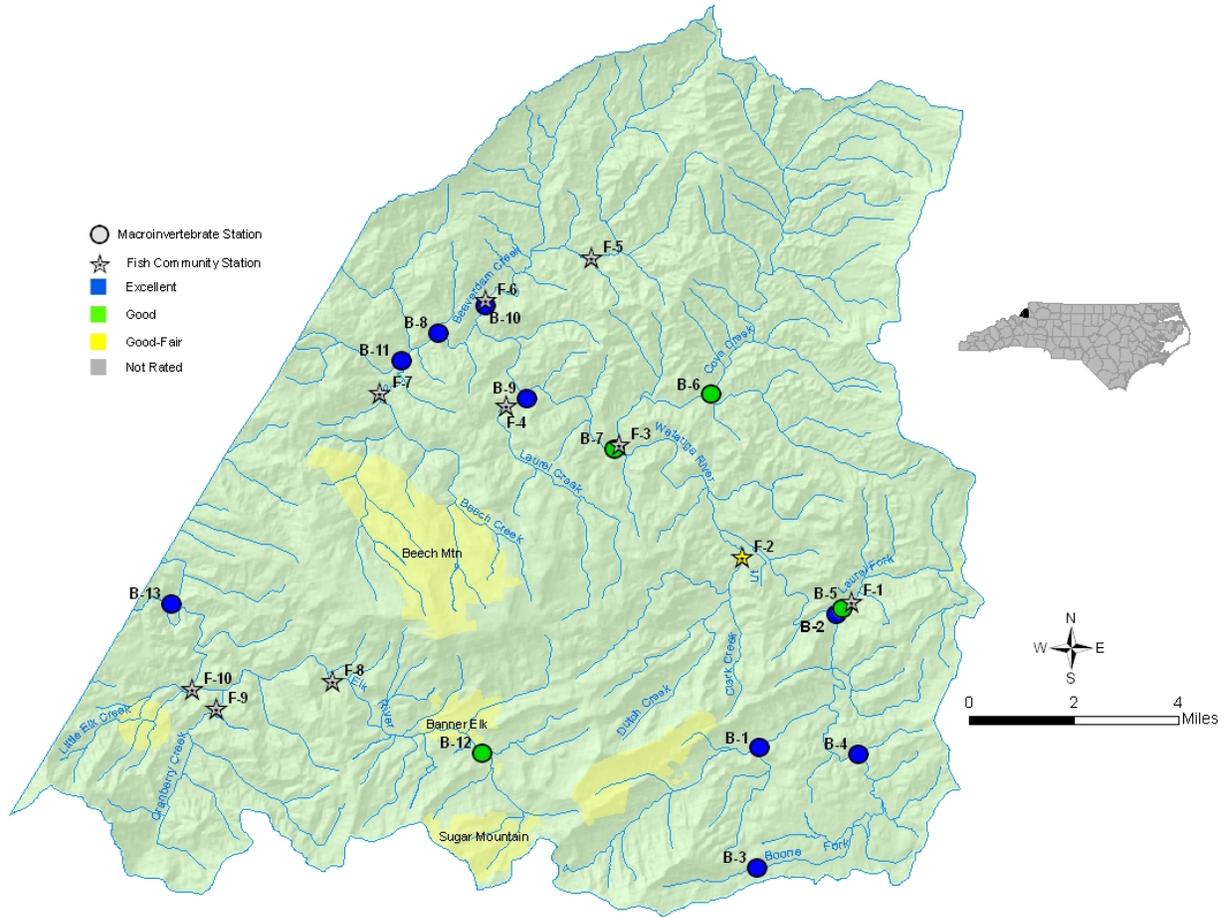


Figure 2. Sampling sites in the Watauga River basin (HUC 06010103). Monitoring sites are listed in Table 1.

Table WAT01. Waterbodies monitored in HUC 06010103 in the Watauga River basin for basinwide assessment, 2004 and 2008.

Map # ¹	Waterbody	County	Location	2004	2008
B-1	Watauga R	Watauga	SR 1580	Good	Excellent
B-2	Watauga R	Watauga	NC 105	Excellent	Excellent
B-3	Boone Fk	Watauga	SR 1561	Excellent	Excellent
B-4	Boone Fk	Watauga	Off SR 1558	Excellent	Excellent
B-5	Laurel Fk	Watauga	SR 1111	Good-Fair	Good
B-6	Cove Cr	Watauga	SR 1149	Good	Good
B-7	Watauga R	Watauga	SR 1121	Excellent	Good
B-8	Watauga R	Watauga	SR 1200	Excellent	Excellent
B-9	Laurel Cr	Watauga	Off SR 1123	Good	Excellent
B-10	Beaverdam Cr	Watauga	SR1202	Good	Excellent
B-11	Beech Cr	Watauga	US 321	Excellent	Excellent
B-12	Elk R	Avery	off NC 184	Good-Fair	Good
B-13	Elk R	Avery	SR 1305	Good	Excellent
F-1	Laurel Fk	Watauga	SR 1111	Good-Fair	Not Rated
F-2	Dutch Cr	Watauga	SR 1112/NC 194	Good-Fair	Good-Fair
F-3	Cove Cr	Watauga	SR 1149/off SR 1121	Good-Fair	Not Rated
F-4	Laurel Creek	Watauga	SR 1123	Not Rated	Not Rated
F-5	Beaverdam Cr	Watauga	SR 1211	---	Not Rated
F-6	Beaverdam Cr	Watauga	SR 1202	Poor	Not Rated
F-7	Beech Cr	Avery	SR 1312	Not Rated	Not Rated
F-8	Elk R	Avery	SR 1326	Not Rated	Not Rated
F-9	Cranberry Cr	Avery	NC 194	Not Rated	Not Rated
F-10	Little Elk Cr	Avery	Off SR 1305	---	Not Rated

¹B = benthic macroinvertebrate monitoring sites; F = fish community monitoring sites.

Overview of Water Quality

The Watauga River Basin (HUC 06010103) includes the Watauga and Elk Rivers and their tributaries. Overall, water quality within this HUC remains good with benthic bioclassifications at Good or Excellent (Table 1). There are no waters within this HUC listed on the 2007 303d Impaired Waters List for impaired biological integrity. Main water quality concerns within this basin have been attributed to nonpoint source runoff including inputs of nutrients and/or sediments. Residential, recreational, and agricultural activities within this HUC should be monitored due to the potential for water quality degradation through nonpoint runoff and multiple small point source dischargers.

Benthos Assessment

Six sites in the basin appear to have improved in 2008 from 2004 ratings based on the benthic sampling regime. The upper segment of the Watauga River at SR 1580 near Foscoe improved from a Good rating in 2004 to Excellent in 2008. Laurel Fork improved from Good-Fair to Good and Laurel Creek at SR 1123 improved from Good to Excellent. The NC 184 Elk River site increased from Good-Fair to Good and the SR 1305 site increased from Good to Excellent. It was noted that EPT taxa richness values substantially increased at both main stem Elk River sites in Avery County. The Elk River site at SR 1305 had the highest EPT taxa richness (53) of any site in this HUC. This was the highest EPT taxa richness ever recorded at SR 1305 since summer sampling began in 1994. Beaverdam Creek received an Excellent benthic bioclassification for the first time since sampling began in 1994 exhibiting a substantial increase in EPT taxa richness in 2008.

The two mainstem Elk River sites were the only portion of this HUC that showed a decline in water quality in 2004. The Elk River off NC 184 near Banner Elk declined from a Good rating in 1999 (Appendix B-1) to a Good-Fair rating in 2004 and the Elk River at SR 1305 declined from Excellent in 1999 to Good in 2004. Declining bioclassifications at both Elk River sites in 2004 indicated water quality concerns in the watershed. However, both Elk River sites exhibited improved bioclassifications in 2008. The Elk River off NC-184 improved from Good-Fair to Good and the site at SR 1305 improved from Good to Excellent. Increased EPT taxa richness and higher bioclassifications at both sites in 2008 may suggest decreased non point source pollution in the Elk River catchments. However, prolonged extreme drought conditions within the Watauga HUC (Appendix G-1) may have contributed to increased EPT taxa richness. Less overall precipitation should lead to less runoff potentially leading to this outcome.

The entire Watauga River was classified as High Quality Waters in 1990, and Boone Fork and its tributaries were classified as Outstanding Resource Waters in 1993. Benthos sites on Boone Fork have maintained bioclassifications of Excellent since 2004. Despite some absent macroinvertebrate taxa in 2008 compared to 2004, benthic invertebrate communities at these sites appear reasonably stable. Based on macrobenthos, both Beech and Cove Creek sites have obtained bioclassifications of Excellent and Good since 1999 respectively (Appendix B-1).

The Watauga River at SR 1121 near Sugar Grove was the only benthos sampling location that exhibited a bioclassification decline from Excellent in 2004 to Good in 2008. Despite the high EPT taxa richness at the SR 1121 site, mostly tolerant to facultative EPT taxa were observed. The 2008 sample produced the second highest chironomid taxa richness recorded from this location. This site has been extensively sampled in the past and regularly is classified as Good (10 out of 12 samples) suggesting quite stable water quality.

The primary water quality problem in this basin is nonpoint source runoff, including inputs of sediment and nutrients. Sites that were sampled in this basin have roads that run parallel to the stream, leading to narrow riparian zones with frequent breaks. Many of the catchments in the Watauga River basin are intensively farmed, especially the Cove Creek and Laurel Creek watersheds. Based upon the macroinvertebrate data, reduced nonpoint source runoff due to drought conditions may be leading to higher bioclassifications (Good or Excellent ratings) on some stream and river segments within this HUC (Table WAT01.1). This may be reflected by samples collected from Watauga River, Laurel Fork, Laurel Creek, Beaverdam Creek., and Elk River sites.

Fish Assessment

Ten fish sites were sampled in the Watauga River basin in June of 2008. No fish community assessments had been performed by DWQ in any of these streams prior to 2004. The most commonly collected species were Central Stonerollers and Western Blacknose Dace. One of these two species was numerically dominant at 8 of the 10 sites. Historically, Central Stonerollers are the most abundant and widely distributed fish within this basin (Appendix F-5). Brown trout were the most abundant at two of the sites.

One of the 10 stream sites in the Watauga River basin were evaluated using the North Carolina Index of Biotic Integrity (NCIBI) (Appendix F-3). Six of the sites were not rated because "Trout stream" specific criteria and metrics have not yet been developed. Three other sites were not rated including two sites at Beaverdam Creek and one at Cove Creek. These sites were not rated due to potential drought and/or trout recruitment effects observed. Beaverdam Creek at SR 1202 and Cove Creek at SR 1121 will be resampled in 2009 to establish NCIBI scores if possible.

Dutch Creek at SR 1112 received an NCIBI score of 44 in 2008 resulting in a Good-Fair rating. This stream reach received a Good-Fair bioclassification both in 2004 and 2008. Despite some degradation, it continues to exhibit a well balanced fish community made up of both intolerant and tolerant taxa adapted to mixed temperature regimes. Central stonerollers represented 52% of the collected sample at the Dutch Creek site potentially indicating excess nutrient input from nonpoint sources.

Monitoring should continue at the Beaverdam Creek sites due to extreme drought throughout this watershed (Appendix G-1) and its proximity to agricultural land use. Further analyses should focus on differences found between fish and benthic bioclassifications within this stream. The Poor fish bioclassification received in 2004 may have resulted from an atypical, high gradient sampled stream reach or the extent of adjacent agricultural land use just upstream. This stream will be listed for Impaired Biological Integrity due to agricultural activities on the 2008 303d list. Several Beaverdam Creek sites will be resampled in March of 2009 for fish/benthic comparability studies. This should help determine its status on future 303d lists.

Habitat characteristics and examples of high and moderate quality habitat sites in the basin are presented in Appendix F-6. The Not Rated fish community sites in the basin were mostly trout streams found with habitats of moderate to high quality (scores ranging from 76 to 94). Despite moderate to high quality habitats existing throughout fish and benthic sampling sites, 2008 fish and benthic data continue to suggest nonpoint source runoff is potentially the most important stressor within this watershed.

River and Stream Assessment

Site specific summaries of the 13 benthic macroinvertebrate and 10 fish community basinwide sampling events may be found at this link: [06010103](#).

Special Studies

Greenbriar Creek Stormwater BMPs:

Greenbriar Creek was sampled for the first time in 2008 following observations of excess silt entering the stream reach downstream from development activities. The NCDWQ Asheville Regional Office was contacted regarding these observations and has since required remediation and stormwater BMP compliance at this location. This stream reach received a Good rating when sampled in 2008; however, the sample was collected soon after development activities were initiated. Greenbriar Creek will be sampled again in the summer of 2009 and a report summarizing water quality results will follow.

Random Ambient Monitoring System (RAMS):

Cold Prong (upstream of Price Lake, Watauga County)

As part of a new component of the North Carolina Division of Water Quality's (NCDWQ) Ambient Monitoring Network, the Random Ambient Monitoring System (RAMS) is a probabilistic monitoring initiative where sampling locations are randomly located on freshwater streams throughout the state. As part of this sampling strategy, a benthic macroinvertebrate sample was taken at Cold Prong. The site characteristics included a natural and highly sinuous channel with frequent and well-developed riffles and pools as well as a good variety of substrates and instream habitats. The total habitat score was 91. There were no previous benthic samples at this location and the July 9, 2007 Qual-4 sample resulted in 54 total taxa, 29 EPT taxa, and a Not Impaired bioclassification.

Small Streams Biocriteria Development Study:

Fall Creek (near confluence with Elk River off SR 1305, Avery County) NI
George Branch (SR 1310, Watauga County) NR
George Gap Branch (SR 1213, Watauga County) NI
Stone Mountain Creek (SR 1201, Watauga County) NI
Upper Laurel Fork (SR 1114, Watauga County) NI
UT Stone Mountain Branch (SR 1206, Watauga County) NI

Current NCDWQ Standard Operating Procedures (SOPs) prohibit the assignment of bioclassifications to perennial streams with drainage areas less than 3 square miles. The only exception to this pertains to High Quality Waters (HQW) of the mountain ecoregion which can receive one of the five tiered hierarchal bioclassifications (i.e., Poor, Fair, Good-Fair, Good, or Excellent). Current NCDWQ SOPs limit the designation of perennial streams with drainage areas less than 3 square miles (which are not HQW mountain streams) as either Not Rated (NR) or Not Impaired (NI). In order to expand the amount of small streams in North Carolina that are eligible to receive one of the five-tiered bioclassifications, approximately 120 sites in 25 counties and 8 river basins have been selected as probable reference streams, impacted, and intermediate disturbance sites. As part of this study, the five sites listed above were sampled in the Watauga River basin during the first week of May, 2007. George Branch received a Not Rated bioclassification while the remaining four sites received Not Impaired designations. Draft small stream bioclassification thresholds are expected spring, 2009.

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GLOSSARY

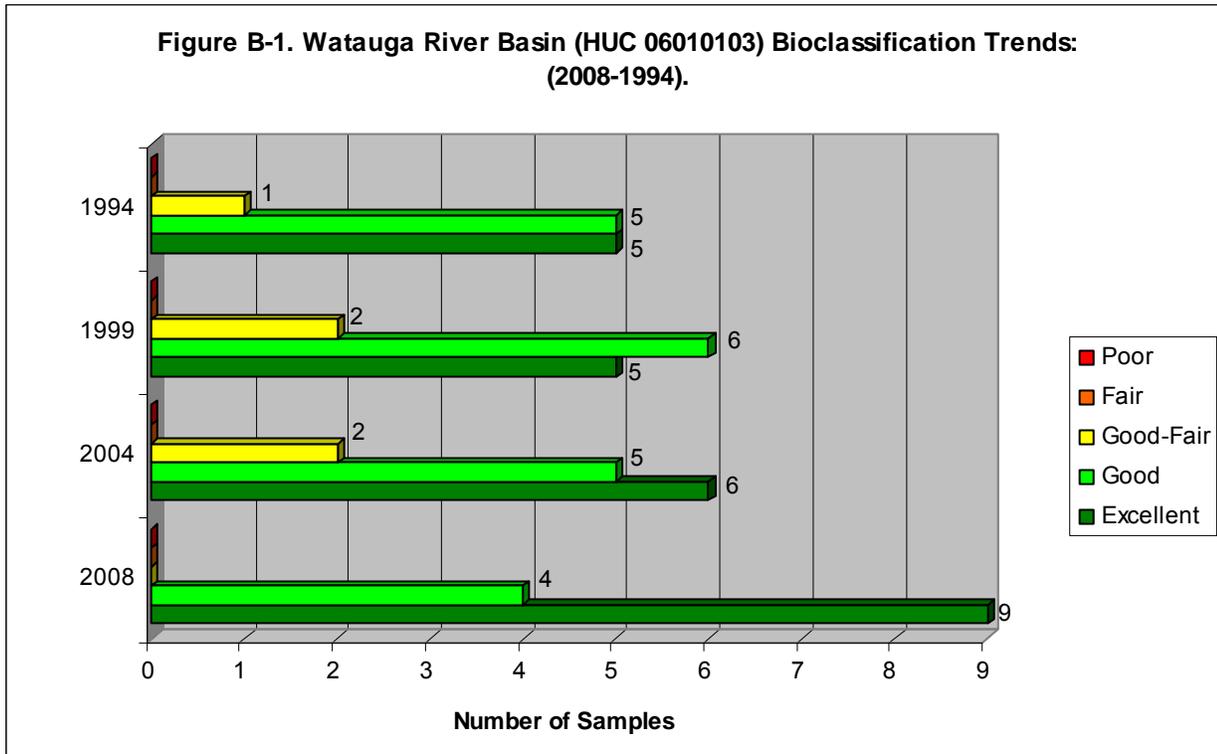
7Q10	A value which represents the lowest average flow for a seven day period that will recur on a ten year frequency. This value is applicable at any point on a stream. 7Q10 flow (in cfs) is used to allocate the discharge of toxic substances to streams.
Bioclass	Criteria have been developed to assign 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 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 $\mu\text{mhos/cm}$ at 25 °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, and soil type. Examples include Southern Outer Piedmont, Carolina Flatwoods, 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. Waters which are rated as 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.
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 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. Summary of benthic macroinvertebrate data, sampling methods and criteria.

Overall Watauga River Basin Summary:

For 2008, 13 long-term benthic macroinvertebrate samples were sampled in the Watauga River Basin as part of the Basinwide Assessment program. Graphical representations of bioclassification trends from 2008-1994 among these long-term basinwide benthos sites for the entire Watauga River basin (Figure B-1) can be found below. As can be seen from this data, the 2008 benthic macroinvertebrate community bioclassifications have generally improved from 1994, 1999, and 2004 levels. Indeed, the 2008 sampling period produced more Excellent bioclassifications (nine) than previously recorded for basinwide sampling in the Watauga River Basin (previous high was six in 2004). In general, most of the primary sources of pollution in this basin take the form of non-point impacts. The improvements seen in the benthic macroinvertebrate communities among most Watauga River basin sites for 2008 support this conclusion. During drought conditions, less runoff from nonpoint sources is introduced from land into waterbodies and this typically results in the development of a more diverse and less pollution tolerant benthic macroinvertebrate community. This appears to have been the case among benthic macroinvertebrate basin sites in the Watauga River basin in 2008. The only exception to this trend was found at the Watauga River (SR 1121) which declined from Excellent in 2004 to Good in 2008.



Numerous rare invertebrate taxa were collected in the Watauga River basin in 2004-2008.
 These data are presented below in Table 1.

Table 1. Selected Rare Taxa Collected in the Watauga River Basin (Rare Taxa Defined as <32 Observations: Equivalent to 0.5% of Approximately 6,300 NCDWQ Benthic Collections).

Taxon	North Carolina Natural Heritage Designated as Significantly Rare?	Date	Collection Location(s)
Mayflies			
<i>Drunella longicornis</i>	YES	8/1/2008	Boone Fork (SR 1561)
<i>Serratella spiculosa</i>	YES	8/17/2004	Beech Creek (US 321)
Stoneflies			
<i>Isoperla nr bilineata</i>	NO	12/2/2004	Watauga River (SR 1121)
<i>Isoperla lata</i>	YES	12/2/2004	Cove Creek (SR 1149)
Caddisflies			
<i>Ceraclea flava</i>	NO	8/18/2004	Boone Fork (SR 1558)
<i>Ceratopsyche walkeri</i>	YES	8/17/2004	Beech Creek (US 321)
<i>Goera fuscula</i>	NO	7/9/2007	Cold Prong (Price Lake Loop)
<i>Matrioptila jeanae</i>	YES	7/29/2008	Watauga River (SR 1121, SR 1200)
Crustaceans			
<i>Cambarus robustus</i>	NO	5/15/2007	Cove Creek (Off SR 1121)
<i>Cambarus robustus</i>	NO	5/15/2007	George Branch (SR 1310)
<i>Cambarus robustus</i>	NO	8/16/2004	Elk River (SR 1305)
Gastropods			
<i>Fossaria sp</i>	NO	7/28/2008	Watauga River (NC 105)

SAMPLING METHODS

Standard Qualitative (Full Scale) Method

Benthic macroinvertebrates can be collected from wadeable, freshwater, flowing waters using three 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).

EPT Method

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 (NCDENR 2006). 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, and 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

Bioclassification criteria for standard qualitative samples in the mountain ecoregion are given below and in Table 2 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 taxa richness scores to produce a final bioclassification (Table 4.). Criteria bioclassifications for the EPT sample method is based on the total number of these taxa present in the sample and bioclassification thresholds for this method are presented in Table 3.

EPT abundance and Total taxa richness calculations also are used to help examine between-site differences in water quality.

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.

Table 2. Mountain Criteria for Standard Qualitative (Full Scale) Samples.

Score	Biotic Index Values	EPT Values
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—7.0	12-13
1.4	7.01-7.05	10-11
1	>7.05	0-9

Table 3. EPT Taxa Richness Criteria for Mountain (EPT) samples.

Score	EPT Values
Excellent	>35
Good	28-35
Good-Fair	19-27
Fair	11-18
Poor	0-10

Table 4. Benthic macroinvertebrate data collected from Watauga River Basin, 1988-2008. Basinwide sites sampled in 2008 are in bold font.

HUC/Waterbody	Location	County	Index No.	Date	ST	EPT	BI	EPT BI	BioClass
HUC 06010103									
Watauga R	SR 1339	Avery	8-(1)	7/27/88	---	38	---	1.70	Excellent
				8/13/85	61	33	3.22	2.02	Excellent
Watauga R	SR 1594	Watauga	8-(1)	8/16/04	---	43	---	2.53	Excellent
				03/90	---	40	---	1.89	Good
				7/27/88	83	44	3.21	2.39	Excellent
				8/13/85	67	34	3.24	2.52	Excellent
Watauga R	SR 1580	Watauga	8-(1)	7/28/08	---	36	---	3.10	Excellent
				8/18/04	---	32	---	3.33	Good
				7/13/99	---	25	---	3.83	Good-Fair
				8/9/94	---	38	---	3.16	Excellent
				7/27/88	---	37	---	3.04	Excellent
Watauga R	NC 105	Watauga	8-(1)	7/28/08	110	50	4.06	3.18	Excellent
				8/18/04	106	55	4.07	3.27	Excellent
				7/14/99	88	42	3.83	3.24	Excellent
				8/8/94	73	40	3.82	3.13	Excellent
				3/5/90	---	40	---	1.90	Good
Boone Fk	SR 1561	Watauga	8-7	8/1/08	---	39	---	2.05	Excellent
				8/18/04	75	46	3.03	1.83	Excellent
				7/13/99	72	39	2.59	1.61	Excellent
				8/8/94	58	36	2.33	1.72	Good
Boone Fk	SR 1558	Watauga	8-7	7/31/08	---	44	---	2.64	Excellent
				8/18/04	---	39	---	3.30	Excellent
				7/12/99	---	32	---	2.65	Good
				8/8/94	---	31	---	2.48	Good
Laurel Fk	SR 1552	Watauga	8-10	8/18/04	58	34	2.88	2.37	Not Impaired
Laurel Fk	SR 1111	Watauga	8-10	7/28/08	---	35	---	3.18	Good
				8/18/04	---	26	---	2.91	Good-Fair
				7/13/99	---	27	---	3.06	Good-Fair
				9/8/94	---	24	---	3.09	Good-Fair
				3/5/90	---	31	---	2.71	Good
Cove Cr	NC 321	Watauga	8-15	7/13/99	---	32	---	3.75	Good
				8/9/94	---	30	---	3.54	Good
Cove Cr	SR 1149	Watauga	8-15	7/29/08	---	34	---	4.46	Good
				12/1/04	---	27	---	3.15	Good-Fair
				8/17/04	---	34	---	3.64	Good
Watauga R	SR1121	Watauga	8-(16)	7/29/08	122	49	4.90	4.16	Good
				12/02/04	74	39	4.00	3.09	Good
				8/17/04	100	47	4.55	3.67	Excellent
				7/15/99	81	38	4.22	3.36	Good
				8/9/94	87	42	4.22	3.48	Good
Watauga R	SR 1200	Watauga	8-(16)	7/29/08	105	49	4.27	3.56	Excellent
				8/17/04	110	45	4.45	3.18	Excellent
				7/15/99	94	50	3.98	3.36	Excellent
				8/9/94	97	46	3.66	2.79	Excellent
				7/28/88	86	38	4.65	3.03	Good
Laurel Cr	SR 1123	Watauga	8-17	7/29/08	---	43	---	2.47	Excellent
				8/17/04	---	35	---	2.34	Good
				7/15/99	---	31	---	2.45	Good
Beaverdam Cr	SR 1202	Watauga	8-19	6/16/08	---	44	---	2.98	Excellent

Table 4 (continued).

HUC/Waterbody	Location	County	Index No.	Date	ST	EPT	BI	EPT BI	BioClass
HUC 06010103									
				8/17/04	---	30	---	2.57	Good
				7/13/99	---	37	---	3.02	Good
				8/9/94	---	32	---	2.45	Good
Beech Cr	US 321	Watauga	8-20	7/29/08	---	52	---	2.98	Excellent
				8/17/04	---	41	---	2.01	Excellent
				7/15/99	---	38	---	2.41	Excellent
				8/11/08	94	46	3.12	2.43	Excellent
Elk R	SR 1326	Avery	8-22-(3)	8/10/94	76	33	3.83	3.02	Good
Elk R	NC 184	Avery	8-22-(3)	7/30/08	99	34	5.02	3.92	Good
				8/16/04	71	24	5.39	4.09	Good-Fair
				7/14/99	102	44	4.33	3.50	Excellent
				8/10/94	77	33	4.61	4.16	Good
Elk R	SR 1305	Avery	8-22-(14.5)	7/30/08	110	53	4.42	3.46	Excellent
				8/16/04	103	43	4.30	3.16	Good
				7/14/99	88	44	3.86	3.09	Excellent
				8/10/94	---	36	---	2.95	Excellent

Appendix F-1. Fish community sampling methods and criteria.

Sampling Methods

Fish community assessments were performed adhering to all methods in the existing standard operating procedures (NCDENR 2006). The fish in the delineated reach were then collected using two backpack electrofishing units and two persons netting the stunned fish. A seine was also used where there were substantial riffles. In 2008 Biological Assessment Unit Staff were assisted by a summer intern 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. These fish have been deposited as voucher specimens with the North Carolina State Museum of Natural Sciences in Raleigh.

NCIBI (North Carolina Index of Biotic Integrity) Analysis, Evaluation, and Scoring Criteria

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 factors that influence aquatic faunal communities (water quality, energy source, habitat quality, flow regime, and biotic interactions). While change within 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.

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 been revised (NCDENR 2006). 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. In 2001, the bioclassifications and criteria were recalibrated against regional reference site data (Biological Assessment Unit Memorandum F-20010922) (Tables 1 – 4). To qualify as a reference site, the site had to satisfy all seven criteria in the order listed in Table 1. 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. In the Watauga River basin two sites qualified as reference sites: Laurel Creek at SR 1123 and Boone Fork off SR 1558, Watauga County. Laurel Creek was assessed again in 2008, Boone Fork was not.

Table 1. Reference site selection hierarchy -- a watershed-based approach for 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 ($\sim \leq 0.01$ MGD), the dischargers are more than one mile upstream
3 -- Percent urbanization	$< 10\%$ of the watershed is urban or residential areas
4 -- Percent forested	$\geq 70\%$ 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	Mountain streams -- width of the riparian zone along both banks is $\geq 6\text{m}$
Exception 1	If the site satisfied Criteria 1 - 6, except one of the two riparian widths was less than one unit optimal, 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 $\geq 60\%$ (rather than $\geq 70\%$), then the site still qualified as a reference site. [Note: in the New River Basin this last exception is $\geq 50\%$.]

Criteria and ratings are applicable only to wadeable streams in the Watauga River basin. Metrics and ratings are the same as those for the French Broad, Hiwassee, Little Tennessee, and New River basins and should not be applied to non-wadeable streams nor to small, wadeable Southern Appalachian type trout streams in each of these basins. Physical attributes of Southern Appalachian type trout streams may include, but are not limited to, gradient (often high-gradient), certain visual aspects of the stream and riparian zones (e.g., *Rhododendron*-, *Leucothoe*-, and *Tsuga*-lined), presence of boulder and rock outcrop plunge pools, overall faunal characteristics (naturally low fish diversity), low specific conductance (often less than $25\mu\text{S}/\text{cm}$), temperature (often less than 20°C), clarity (gin-clear), elevation (which will vary from basin to basin and within a basin), and stream order (1^{st} – 3^{rd}). These streams are currently not rated.

Table 2. Metrics and scoring criteria for the NCIBI for wadeable streams in the French Broad, Hiwassee, Little Tennessee, New, and Watauga River basins with watersheds ranging between 3.1 and 161 mi².

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		
	<u>French Broad & Little Tennessee River Basins</u>	<u>New River, Pigeon River, Watauga¹, & Hiwassee River Basins</u>	
	≥ 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		
	<u>All basins, except Pigeon River Basin</u>	<u>Pigeon River Basin</u>	
	≥ 8 species	≥ 6 species	5
	6 or 7 species	4 or 5 species	3
	≤ 5 species	≤ 3	1
6	No. of intolerant species		
	<u>All basins, except New River Basin</u>	<u>New River Basin</u>	
	≥ 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	

¹Tentative for the Watauga River basin; also includes *Cottus bairdi* (Mottled Sculpin) and *Noturus insignis* (Margined Madtom). The Watauga River Basin and the Toxaway River (Savannah River Basin) are the only river basins in North Carolina where these three benthic, insectivorous groups (darters, Mottled Sculpin, and Margined Madtom) are sympatric.

Table 3. Tolerance ratings and adult trophic guild assignments for fish in the Watauga River basin. Species collected in 2008 are highlighted in blue. Common and scientific names follow Nelson, *et al.* (2004).

Family/Species	Common Name	Tolerance Rating	Trophic Guild of Adults
Cyprinidae	Carps And Minnows		
<i>Campostoma anomalum</i>	Central Stoneroller	Intermediate	Herbivore
<i>Clinostomus funduloides</i>	Rosyside Dace	Intermediate	Insectivore
<i>Cyprinella galactura</i>	Whitetail Shiner	Intermediate	Insectivore
<i>Cyprinus carpio</i>	Common Carp	Tolerant	Omnivore
<i>Luxilus coccogenis</i>	Warpaint Shiner	Intermediate	Insectivore
<i>Nocomis micropogon</i>	River Chub	Intermediate	Omnivore
<i>Notemigonus crysoleucas</i>	Golden Shiner	Tolerant	Omnivore
<i>Notropis leuciodus</i>	Tennessee Shiner	Intermediate	Insectivore
<i>N. photogenis</i>	Silver Shiner	Intolerant	Insectivore
<i>Phoxinus oreas</i>	Mountain Redbelly Dace	Intermediate	Herbivore
<i>Pimephales notatus</i>	Bluntnose Minnow	Tolerant	Omnivore
<i>Rhinichthys obtusus</i>	Western Blacknose Dace	Intermediate	Insectivore
<i>R. cataractae</i>	Longnose Dace	Intermediate	Insectivore
<i>Semotilus atromaculatus</i>	Creek Chub	Tolerant	Insectivore
Catostomidae	Suckers		
<i>Catostomus commersonii</i>	White Sucker	Tolerant	Omnivore
<i>Hypentelium nigricans</i>	Northern Hogsucker	Intermediate	Insectivore
<i>Moxostoma duquesnei</i>	Black Redhorse	Intermediate	Insectivore
Ictaluridae	North American Catfishes		
<i>Noturus insignis</i>	Margined Madtom	Intermediate	Insectivore
Salmonidae	Trouts And Salmons		
<i>Oncorhynchus mykiss</i>	Rainbow Trout	Intolerant	Insectivore
<i>Salmo trutta</i>	Brown Trout	Intermediate	Piscivore
<i>Salvelinus fontinalis</i>	Brook Trout	Intolerant	Insectivore
Cottidae	Sculpins		
<i>Cottus bairdii</i>	Mottled Sculpin	Intermediate	Insectivore
Centrarchidae	Sunfishes		
<i>Ambloplites rupestris</i>	Rock Bass	Intolerant	Piscivore
<i>Lepomis auritus</i>	Redbreast Sunfish	Tolerant	Insectivore
<i>L. cyanellus</i>	Green Sunfish	Tolerant	Insectivore
<i>L. macrochirus</i>	Bluegill	Intermediate	Insectivore
<i>Micropterus dolomieu</i>	Smallmouth Bass	Intolerant	Piscivore
<i>M. salmoides</i>	Largemouth Bass	Intermediate	Piscivore
Percidae	Perches		
<i>Etheostoma chlorbranchium</i>	Greenfin Darter	Intolerant	Insectivore
<i>Percina aurantiaca</i>	Tangerine Darter	Intolerant	Insectivore

Table 4. 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

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. Heavy, acute infections can be fatal, especially to small fish. However, 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).

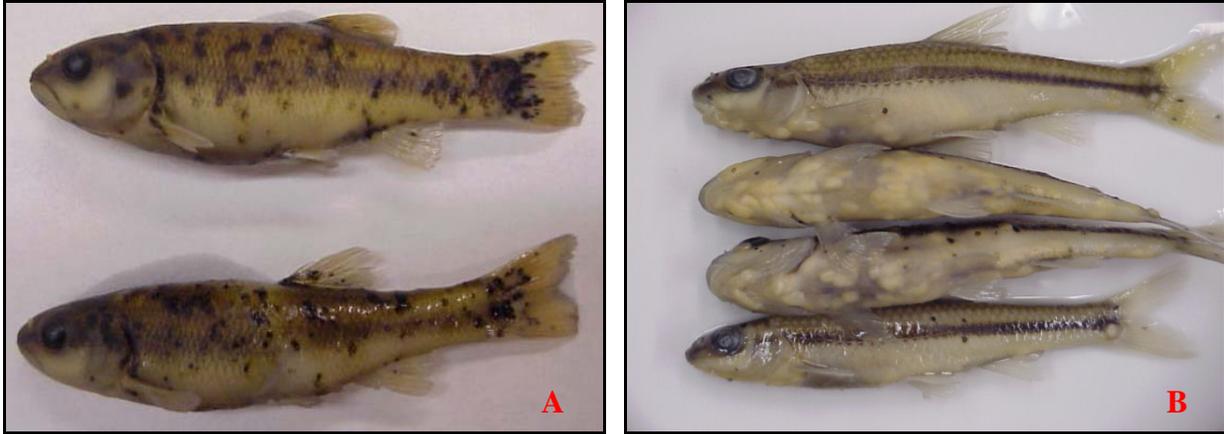


Figure 1. Heavy infestation of blackspot disease in creek chub (A) and yellow grub in bigeye chub (B).

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.

Appendix F-2. A summary of fish community assessment data for 2008.

Monitoring efforts in 2008 may be summarized as:

- Due to the persistence and impacts from the drought in the Cape Fear River basin, basinwide monitoring efforts for the Watauga River basin were shifted from 2009 to 2008, one year ahead of schedule.
- Ten fish community samples were collected as part of the Watauga River basinwide monitoring cycle; samples were last collected during the 2004 basinwide assessment. None of the sites sampled were on the impaired streams (§303d) list (NCDENR 2007).
- All sites scheduled to be sampled in 2008 were sampled, except for Baird Creek; Baird Creek at SR 1117/NC 194 was not sampled because it was too small.
- Eight of the 10 sites were last sampled in 2004 (Appendix F-3). Two new sites were assessed: Little Elk Creek below the Town of Elk Park and Beaverdam Creek above the community of Bethel.
- The drainage areas of the assessed watersheds ranged from 4.4 to 34.9 square miles (Appendix F-4).
- The most widely distributed species were the Central Stoneroller, Northern Hogsucker, and Brown Trout collected at all 10 sites (Appendix F-5). The most abundant species was the Central Stoneroller, constituting slightly more than one-third of all the fish collected.
- Only one of the 10 sites were evaluated and rated using the North Carolina Index of Biotic Integrity (NCIBI) (Appendices F-1, F-3, and F-4). Dutch Creek was rated Good-Fair, the same rating it received in 2004. Sites not rated included a least impacted reference site (Laurel Creek); Cove Creek and the two sites on Beaverdam Creek each draining agricultural areas, and two sites, Beech Creek and Elk River, that have altered fish communities.
- The instream and riparian habitat assessment scores ranged from 70 to 96 (Appendix F-6). Habitat degradation across the basin was most pronounced in the narrowness of the riparian zones and the lack of a canopy. The lowest score at Cove Creek was attributable to long-term poor landuse practices and nonpoint source sedimentation.
- No dissolved oxygen concentrations were less than the respective water quality standard for Class C, C;Tr, or B;Tr waters (e.g., 5 mg/L for Class C and 6 mg/L for trout waters) (Appendix F-7).
- Specific conductance ranged from 39 μ S/cm at Laurel Creek, a regional reference site, to 140 μ S/cm at Laurel Fork (Appendix F-7). Elevated readings were attributable to urbanized and industrial watersheds, effluent from NPDES permitted dischargers, and agricultural landuse practices.
- All pH measurements met the water quality standard (6 s.u.-9 s.u.), except at Cranberry Creek which was 5.9 s.u. which was measured early in the morning (Appendix F-7).
- The basin has been experiencing a drought for 22 months ranging from Abnormally Dry to Exceptional (Appendix G-1). Since January 2000, the basin has been in a Moderate, Severe, Extreme, or Exceptional drought more than 40 percent of the time. Normal conditions have prevailed slightly less than 45 percent of the time.

**Appendix F-3. Fish community data collected from the Watauga River Basin, 2004 and 2008.
Current basinwide sites are in bold font.**

Waterbody	Station	County	Index No.	Date	NCIBI Score	NCIBI Rating
Watauga R	off SR 1557	Watauga	8-(1)	05/06/04	44	Good-Fair
Boone Fk	off SR 1558	Watauga	8-7	05/06/04	50	Good
Laurel Fk	SR 1111	Watauga	8-10	06/16/08	---	Not Rated
				05/05/04	---	Not Rated
Dutch Cr	SR 1112/NC 194	Watauga	8-12-(1.5)	06/16/08	44	Good-Fair
				05/05/04	46	Good-Fair
Cove Cr	off SR 1121	Watauga	8-15	06/17/08	---	Not Rated
Cove Cr	SR 1149	Watauga	8-15	12/02/04	---	Not Rated ¹
				05/05/04	40	Good-Fair
Laurel Cr	SR 1123	Watauga	8-17	06/17/08	---	Not Rated
				05/04/04	---	Not Rated
Beaverdam Cr	SR 1211	Watauga	8-19	06/17/08	---	Not Rated
Beaverdam Cr	SR 1202	Watauga	8-19	06/18/08	---	Not Rated
				05/04/04	26	Poor
Beech Cr	off SR 1312	Avery	8-20	06/18/08	---	Not Rated
				05/04/04	---	Not Rated
Elk R	SR 1326	Avery	8-22-(14.5)	06/19/08	---	Not Rated
				05/03/04	---	Not Rated
Cranberry Cr	NC 194	Avery	8-22-16	06/19/08	---	Not Rated
				05/03/04	---	Not Rated
Little Elk Cr	off SR 1305	Avery	8-22-17	06/18/08	---	Not Rated

post 2004 hurricane impact assessments.

Appendix F-4. Fish community metric values from 10 wadeable streams in the Watauga River basinwide monitoring program, 2008¹.

Waterbody	Location	County	d. a. (mi²)	Date	No. Species	No. Fish	No. Sp. DSM	No. Sp. RST	No. Sp. Cyprinids	No. Intol. Sp.	% Tolerant	% Omni. +Herb.	% Insect.	% MA
Laurel Fk	SR 1111	Watauga	7.0	06/16/08	11	231	0	2	5	1	10	35	46	73
Dutch Cr	SR 1112/NC 194	Watauga	10.6	04/16/08	21	1175	2	5	9	5	3	75	21	86
Cove Cr	off SR 1121	Watauga	34.9	06/17/08	13	1143	1	3	5	2	4	49	46	92
Laurel Cr	SR 1123	Watauga	7.0	06/17/08	5	290	0	1	3	0	1	26	70	80
Beaverdam Cr	SR 1211	Watauga	11.7	06/17/08	10	869	0	4	4	3	17	41	55	80
Beaverdam Cr	SR 1202	Watauga	20.3	06/18/08	9	566	0	3	5	2	9	42	51	67
Beech Cr	off SR 1312	Avery	15.0	06/18/08	7	332	0	2	3	1	18	14	58	86
Elk R	SR 1326	Avery	18.7	06/19/08	8	906	0	2	2	1	4	71	24	88
Cranberry Cr	NC 194	Avery	9.8	06/19/08	6	134	0	2	2	1	3	4	57	67
Little Elk Cr	off SR 1305	Avery	4.4	06/18/08	8	482	1	2	2	1	2	5	90	100

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

Appendix F-5. Fish distributional records for the Watauga River basin.

Based upon Menhinick (1991), NC DWQ’s data, and data from other researchers, 30 species have been collected from the Watauga River Basin (Table 3 in Appendix F-1); the fewest species of any basin in the state, due in part to its small watershed of only 205 square miles. The species assemblage includes 14 species of minnows, 5 species of sunfish and bass, and 3 species each of suckers and trouts. There are no endemic species. None of the species has been afforded special protection status by the U. S. Department of the Interior, the NC Wildlife Resources Commission, or the NC Natural Heritage Program under the NC State Endangered Species Act (G.S. 113-331 to 113-337) (LeGrand *et al.* 2008; Menhinick and Braswell 1997). The Green Sunfish, *Lepomis cyanellus*, is reported for the first time from the basin based on 2008 collections. This species was collected from Beaverdam, Cove, and Dutch creeks; all tributaries to the Watauga River. There were no other new distributional records obtained in 2008.

Nine of the 30 species (30 percent of the total basin fauna) are nonindigenous (exotic) and were introduced either as sportfish, forage fish, baitfish, or for reasons unknown (<http://www.esb.enr.state.nc.us/Native%20and%20Introduced%20Freshwater%20Fish%20in%20North%20Carolina.2-1.htm>). They include Rosyside Dace, Common Carp, Golden Shiner, Mountain Redbelly Dace, Margined Madtom, Rainbow Trout, Brown Trout, Redbreast Sunfish, and Green Sunfish. In 2008, 7 of the 23 species collected were nonindigenous species. Of the 10 streams sampled in 2008, each stream had at least one, sometimes as many as seven, nonindigenous species present. They constituted from 20% to 43% of the total number of species collected at a site and from 1.6% to 68% of the total number of fish collected at a site.

In 2008, 23 of the 30 species were collected. Species not collected included those with preferences for larger streams and rivers (Silver Shiner and Tangerine Darter), more lentic than lotic preferences in this basin (Common Carp, Golden Shiner, and Largemouth Bass) and some of the more uncommon basin species such as Bluntnose Minnow and Longnose Dace. Other summaries of the data are found in Table 1.

Table 1. Fish community summaries for the Watauga River basin, 2008.

Summary	Species
Most widely distributed species (collected at all sites)	Central Stoneroller, Northern Hogsucker, and Brown Trout
Less widely distributed species (collected from a single site)	Mountain Redbelly Dace, Mottled Sculpin, Bluegill, and Greenfin Darter
Most abundant species (constituting slightly more than one-third of all the fish collected)	Central Stoneroller
Rare species (less than 10 specimens collected)	Rosyside Dace, Brook Trout, and Bluegill.

Appendix F-6. Habitat evaluations and stream and riparian habitats 10 basinwide fish community sites in the Watauga River basin, 2008.

Habitat Assessments

A method and scoring system has been developed to evaluate the physical habitats of a stream (NCDENR 2006). The narrative descriptions of eight habitat characteristics, including channel modification, amount of instream habitat, type of bottom substrate, pool variety, riffle frequency, bank stability, light penetration, and riparian zone width, are converted into numerical scores. The total habitat score ranges between 1 and 100. Higher numbers suggest better habitat quality, but criteria have not been developed to assign ratings. Scores greater than 65 generally represent moderate to high quality habitat sites, whereas scores less than 65 generally represent low to poor quality habitat sites (DWQ unpublished data).

Although all of the sites sampled in 2008 had overall moderate to high quality habitats (score ≥ 65), there were substantial differences among the 10 sites (Tables 1 and 2). The highest quality habitats were found at Beaverdam Creek (SR 1202) and at Laurel Fork; the lowest at Cove Creek and Beaverdam Creek (at SR 1211). At the lower scoring sites, generally the substrate was 40 percent to 80 percent embedded, pools infrequent and minimal shading and buffers provided by the narrow riparian zones.

Table 2. Rankings of 10 waterbodies in Watauga River basin according to the total habitat scores, 2008.

Waterbody	Location	County	Level IV Ecoregion	Score
Beaverdam Cr	SR 1202	Watauga	Southern Crystalline Ridges & Mountains	96
Laurel Fk	SR 1111	Watauga	Southern Crystalline Ridges & Mountains	94
Beech Cr	off SR 1312	Avery	Southern Crystalline Ridges & Mountains	93
Laurel Cr	SR 1123	Watauga	Southern Crystalline Ridges & Mountains	93
Elk River	SR 1326	Avery	Southern Crystalline Ridges & Mountains	90
Little Elk Cr	off SR 1305	Avery	Southern Crystalline Ridges & Mountains	86
Cranberry Cr	NC 194	Avery	Southern Crystalline Ridges & Mountains	76
Dutch Cr	SR 1112/NC 194	Watauga	Southern Crystalline Ridges & Mountains	76
Beaverdam Cr	SR 1211	Watauga	Southern Crystalline Ridges & Mountains	71
Cove Cr	off SR 1121	Watauga	Southern Crystalline Ridges & Mountains	70

Characteristics of moderate to high quality habitats are (Figure 1:

- instream habitats composed of rocks, sticks, leafpacks, snags, logs, undercut banks and root mats;
- a substrate of 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.

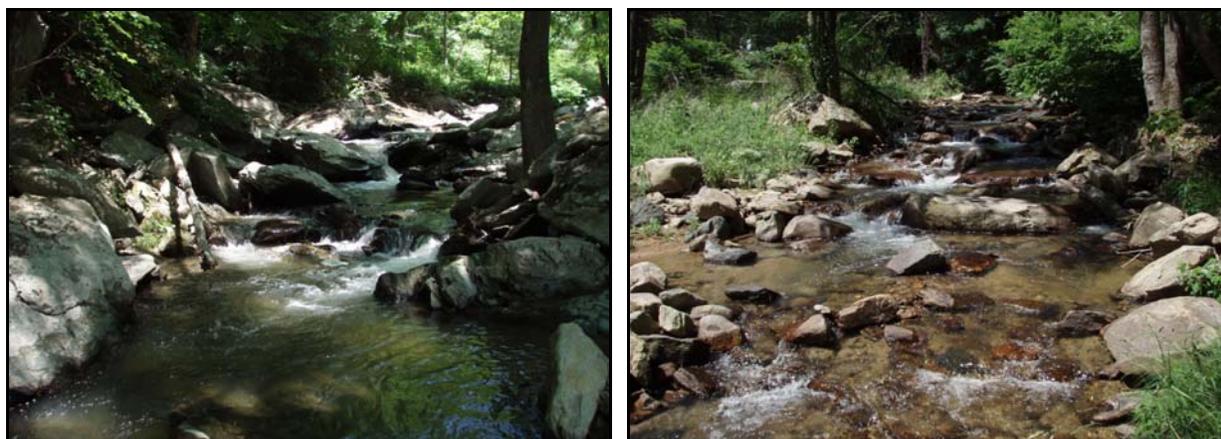


Figure 1 High quality instream habitats, plunge pools, riffles, and stable banks at Laurel Fork at SR 1111 (left) and Laurel Creek at SR 1123 (right), Watauga County.

Table 1. Habitat evaluations at 10 basinwide fish community sites in the Watauga River basin, 2008. Red bold denotes less than optimal habitat conditions.

Waterbody	Location	County	Channel	Instream				Bank	Bank	Shade	Riparian	Riparian	Total Score
				Habitat	Substrate	Pools	Riffles	Stability-L	Stability-R		Zone-L	Zone-R	
Laurel Fk	SR 1111	Watauga	5	20	14	10	16	7	7	7	5	3	94
Dutch Cr	SR 1112/NC 194	Watauga	5	19	8	6	15	6	6	7	2	2	76
Cove Cr	off SR 1121	Watauga	5	18	8	10	14	5	5	1	2	2	70
Laurel Cr	SR 1123	Watauga	5	20	15	10	16	6	6	7	4	4	93
Beaverdam Cr	SR 1211	Watauga	5	18	8	6	10	6	4	7	5	2	71
Beaverdam Cr	SR 1202	Watauga	5	20	12	10	16	7	7	10	4	5	96
Beech Cr	off SR 1312	Avery	5	20	15	8	16	7	6	7	5	4	93
Elk River	SR 1326	Avery	5	20	12	10	16	6	6	5	5	5	90
Cranberry Cr	NC 194	Avery	5	17	8	6	16	6	5	7	4	2	76
Little Elk Cr	off SR 1305	Avery	5	19	15	6	16	6	7	7	3	2	86
Maximum possible scores			5	20	15	10	16	7	7	10	5	5	100

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

- an embedded substrate of primarily gravel and cobble;
- short and narrow riffles; and
- a deeply entrenched channel with vertical, sparsely vegetated banks offering minimal shading and often with livestock having access to the stream.



Figure 2 Narrow riparian zones and a lack of canopy at Cove Creek off SR 1121 (left) and Beaverdam Creek at SR 1211 (right), Watauga County.

Appendix F-7. Water quality at 10 fish community sites in the Watauga River basin, 2008.

Water quality data (temperature, specific conductance, dissolved oxygen, and pH) were collected at every site during fish community assessments in 2008 (Table 1). The magnitude of the water temperatures were a function of time of day and canopy cover. No dissolved oxygen concentrations were less than the respective water quality standard for Class C, Class C;Tr, or Class B;Tr waters (e.g., 5 mg/L for Class C and 6 mg/L for trout waters). Dissolved oxygen saturation levels at all sites were approximately 90 percent. Conductivity (specific conductance) ranged from 39 μ S/cm at Laurel Creek, a regional reference site, to 140 μ S/cm at Laurel Fork which has an urbanized and industrial watershed and receives effluent from two NPDES permitted dischargers (NC0038041 and NC0061425) (Table 1 and Figure 1). The elevated readings at Cove and Little Elk creeks were a function of its agricultural watershed and receiving effluent from a NPDES permitted discharger (NC0079561), respectively. All pH measurements met the water quality standard (6-9 s.u.), except at Cranberry Creek which was 5.9 s.u. when it was measured early in the morning.

Table 1. Water quality measurements at 10 fish community sites in the Watauga River basin, 2008. Red bold denotes less than the water quality standard.

Waterbody	Location	County	Date	Temperature (°C)	Specific Conductance (μS/cm)	Dissolved Oxygen (mg/L)	Saturation (%)	pH (s.u.)
Laurel Fk	SR 1111	Watauga	06/16/08	18.5	140	8.2	88	7.1
Dutch Cr	SR 1112/NC 194	Watauga	06/16/08	23.1	54	7.5	88	6.5
Cove Cr	off SR 1121	Watauga	06/17/08	19.4	125	8.0	87	7.0
Laurel Cr	SR 1123	Watauga	06/17/08	18.2	39	8.7	92	6.3
Beaverdam Cr	SR 1211	Watauga	06/17/08	23.5	75	7.7	91	6.9
Beaverdam Cr	SR 1202	Watauga	06/18/08	15.3	77	8.8	88	6.4
Beech Cr	off SR 1312	Avery	06/18/08	15.3	61	9.1	91	6.0
Elk River	SR 1326	Avery	06/19/08	15.1	97	9.3	92	6.9
Cranberry Cr	NC 194	Avery	06/19/08	12.8	81	9.2	87	5.9
Little Elk Cr	off SR 1305	Avery	06/18/08	17.7	111	8.4	88	6.9

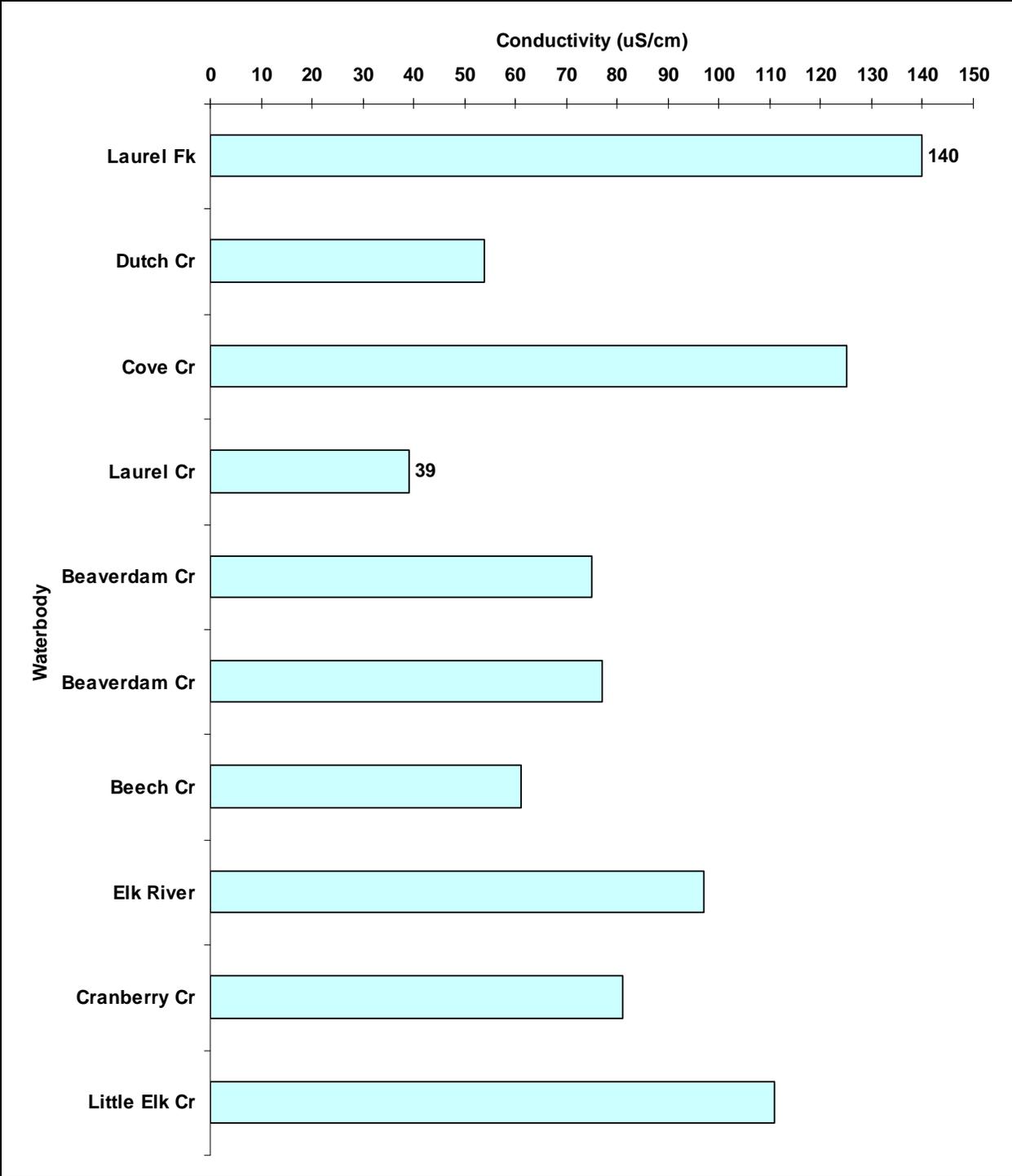


Figure 1. Specific conductance at 10 fish community sites in the Watauga River basin, 2008.

Appendix F-8. Fish community references.

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Appendix G-1. Flow measurement and flow conditions in the Watauga River near Sugar Grove.

Useful web links for drought and flow-related data may be found in Table 1. Between February 2007 and December 2008 the basin experienced drought-like conditions. Area-weighted averages for the HUC 06010103 from January 04, 2000 to December 09, 2008 have ranged from Abnormally Dry to Exceptional (Figure 1). Since January 2000, the basin has been in a Moderate, Severe, Extreme, or Exceptional drought more than 40 percent of the time; normal conditions have prevailed slightly less than 45 percent of the time.

Table 1. Drought and flow-related web sites.

Source	Web Address
National Weather Service Forecasts Office, Raleigh, NC	http://www.meas.ncsu.edu/nws/www/cases/
NC Division of Water Resources, Drought Monitoring	http://www.ncwater.org/Drought_Monitoring/
NC Drought Management Advisory Council	http://www.ncdrought.org/archive/index.php
USGS (real-time streamflow data for North Carolina)	http://waterdata.usgs.gov/nc/nwis/current?type=flow

Between January 01 and September 30, 2008, the lowest daily mean flow at the only USGS gauge site in the basin, the Watauga River near Sugar Grove, was 15 cfs on August 23 and 24, 2008; the greatest daily mean flow was 2,180 cfs on March 4th (Figure 2). The lowest daily mean flow on record for this site is 8.1 cfs recorded on September 13, 2002 (Weaver 2005). During fish community sampling from in mid-June (June 16-19, 2008), flows were approximately 50 percent to 70 percent of the historical median daily flows (Figure 2). The last time fish community assessments were conducted in the basin was in early May 2004 and daily flows were approximately 80 to 85 percent of the historic median flows (Figure 3). During benthic macroinvertebrate sampling from July through August 2008 flows were well above median flow from early to mid July and then declined until late August.

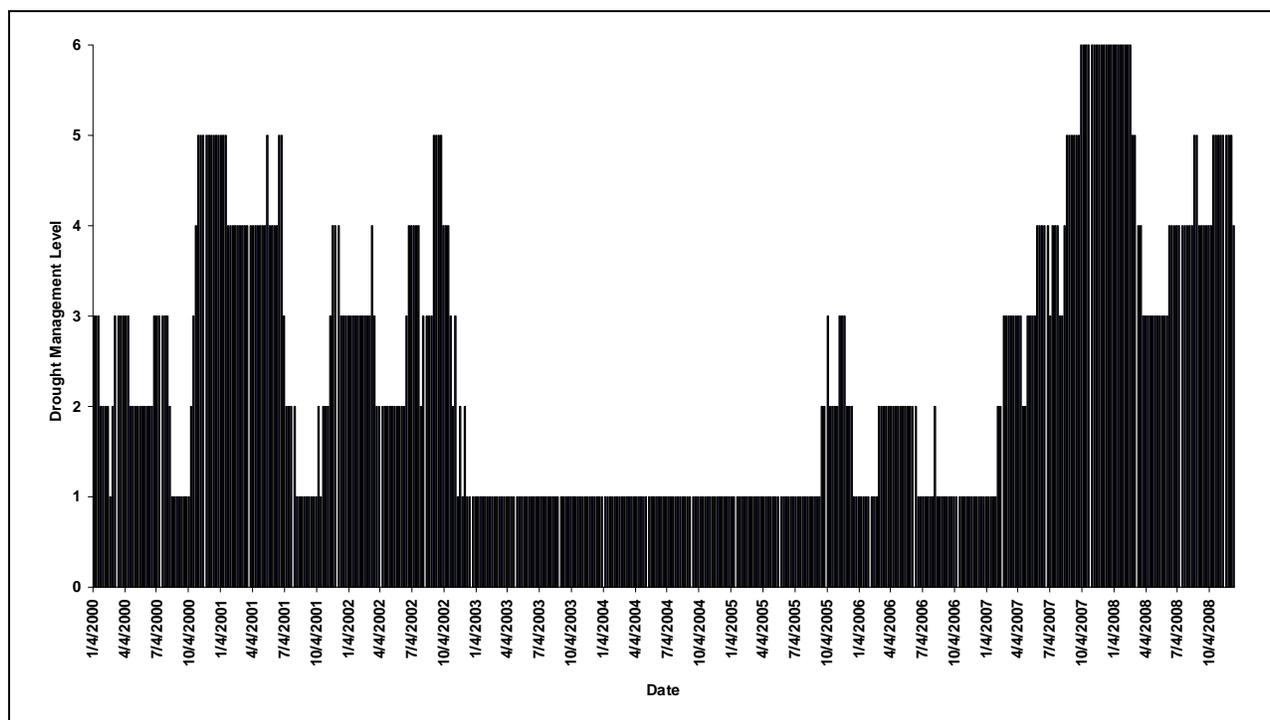


Figure 1. Drought monitor history (area weighted average) for HUC 06010103 in North Carolina and Tennessee, January 04, 2000 – December 12, 2008. Drought Management Level 1 = Normal, 2 = Abnormally Dry, 3 = Moderate, 4 = Severe, 5 =

Extreme, and 6 = Exceptional. Data modified from

http://www.ncwater.org/Drought_Monitoring/dmhistory/?type=HUC8&id=06010103.

During the past 10 years, the basin has experienced prolonged droughts, e.g., 1998-2002 and 2007-2008, and exceptionally high flows resulting from the remnants of hurricanes (Figure 2). During a three week period in September 2004, the tropical storm remnants of three hurricanes (Frances, Ivan, and Jeanne) lead to wide-spread flooding throughout the central and northern mountains of western North Carolina in the Catawba, French Broad, New, and Watauga River basins. Rainfall estimates for the combined three storms totaled more than 20 - 30 inches in certain watersheds. Runoff from the storms produced flash-floods throughout the region with peak flows in excess of 10,000 cfs (approximately 500 times median flows) in upper tributary streams, peaks flows in some tributary rivers exceeded 50,000 cfs. In the Watauga River basin, the peak flow during Hurricane Frances (September 7-9, 2004) was 17,000 cfs which had an approximate recurrence interval of 10 to 25 years. During Hurricane Ivan (September 17 & 18, 2004) the peak flow was 23,000 cfs which had an approximate recurrence interval of once every 50 years. The daily mean flows for these three storms were 8,970, 8,730, and 1,000 cfs, respectively.

Changes in the benthic macroinvertebrate community are often used to help assess between-year changes in water quality. However, some between-year changes in the communities may be due partly to changes in flow. High flows magnify the potential effects of nonpoint source runoff and in areas of high imperviousness, this can lead to scour, substrate instability, and reduced periphyton. Low flows may accentuate the effect of point source dischargers by providing less dilution of wastes. Whether a change is flow-related is decided on a site-by-site basis, looking at:

- Flow. The daily flow patterns over a six to twelve month period prior to the collections are examined using the most comparable records from USGS gaging stations. Areas primarily affected by nonpoint source runoff are expected to have a decline in water quality after high flow, but may improve during low flow. The exception to this rule is the smaller headwater streams, which may cease flowing during extreme droughts. Streams affected primarily by point source dischargers may improve after high flow (with dilution of the effluent) and decline after low flows. These changes, however, occasionally produce a between-year change of only one bioclassification.
- Changes throughout the subbasin, especially at reference sites. Flow-related changes usually affect a whole group of sites, not just single sites.
- Changes in species composition. Real changes in water quality are usually reflected in a significant change in the composition of the invertebrate community.

Consequently, all between-year changes in the biological communities are considered in light of flow conditions. Daily flow information is obtained from the closest available USGS monitoring site and compared to the long-term median flows. High flow is defined by BUA Staff as a median flow greater than 140 percent of the long-term median for that time period, usually July or August. Low flow is defined as a median flow less than 60 percent of the long-term median, while normal flow is 60 percent to 140 percent of the median. Although broad scale regional patterns are often observed, there may be large geographical variation within the state and large variation within a single summer period.

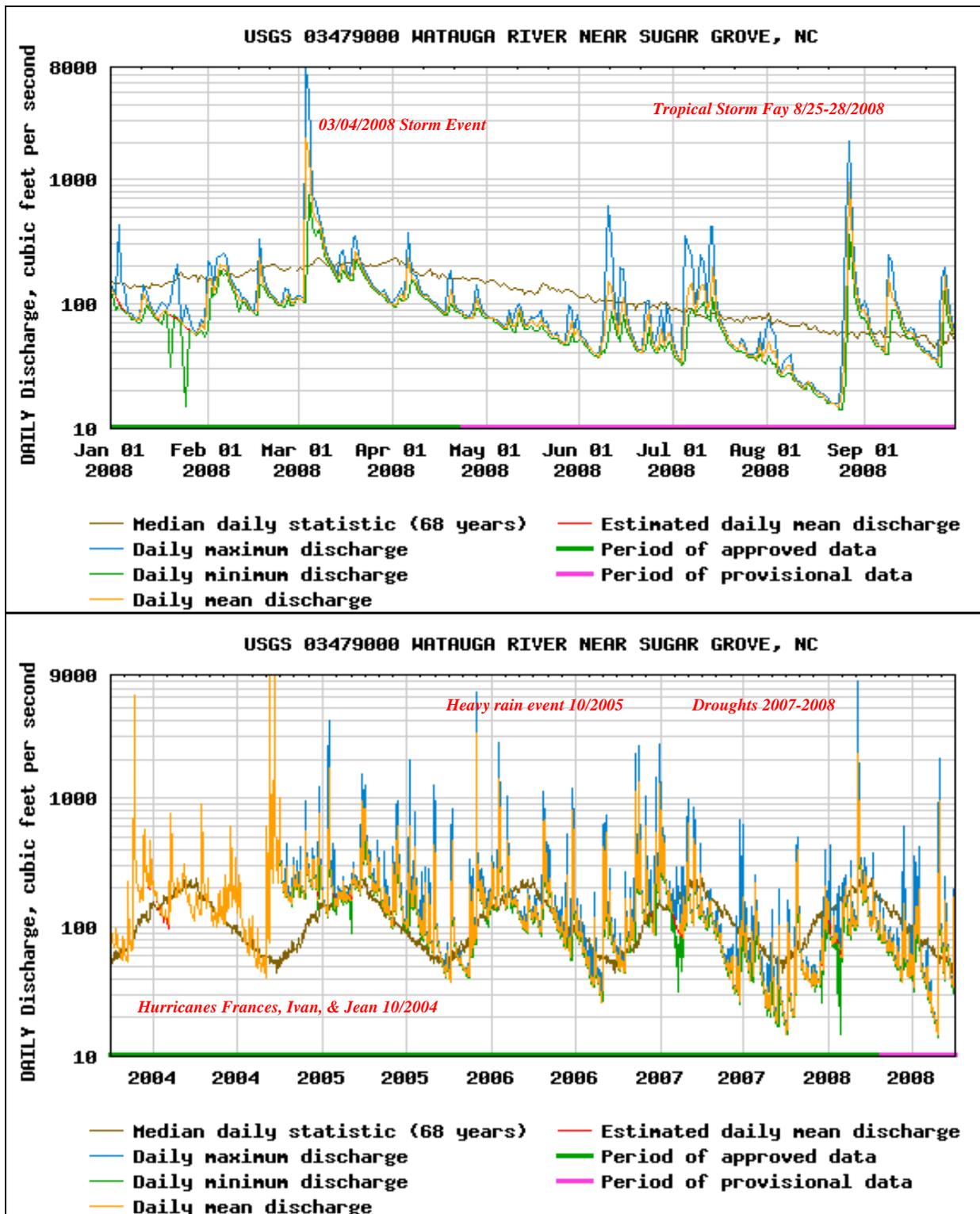


Figure 2. Flows in the Watauga River near Sugar Grove, January 01, 2008 – September 30, 2008 (top) and September 30, 2003 to September 30, 2008 (bottom).

Appendix S-1. Fish and benthos site summaries for basinwide sites collected in the Watauga River basin for the 2008 cycle.

BENTHIC MACROINVERTEBRATE SAMPLE

Waterbody	Location	Station ID	Date	Bioclassification
WATAUGA R	SR 1580	LB14	07/28/08	Excellent

County	Subbasin	8 digit HUC	Latitude	Longitude	AU Number	Level IV Ecoregion
WATAUGA	1	6010103	36.15638889	-81.77027778	8-(1)	Southern Metasedimentary Mountains

Stream Classification	Drainage Area (mi2)	Elevation (ft)	Stream Width (m)	Stream Depth (m)
B; Tr, HQW	10.9	2,996	8	0.4

Visible Landuse (%)	Forested/Wetland	Urban	Agriculture	Other (describe)
	70	30	0	

Upstream NPDES Dischargers (>1MGD or <1MGD and within 1 mile)	NPDES Number	Volume (MGD)
Water Quality SERV	NC0050610001	0.076
Mill Ridge	NC0030473001	0.052

Water Quality Parameters

Temperature (°C)	24.3
Dissolved Oxygen (mg/L)	7.6
Specific Conductance (µS/cm)	83
pH (s.u.)	7.5

Water Clarity	Clear
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Habitat Assessment Scores (max)

Channel Modification (5)	4
Instream Habitat (20)	14
Bottom Substrate (15)	14
Pool Variety (10)	5
Riffle Habitat (16)	15
Left Bank Stability (7)	5
Right Bank Stability (7)	6
Light Penetration (10)	7
Left Riparian Score (5)	1
Right Riparian Score (5)	4
Total Habitat Score (100)	75

Site Photograph



Substrate	Boulder, cobble, gravel, sand, silt and bedrock.
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Sample Date	Sample ID	ST	EPT	BI	EPT BI	Bioclassification
07/28/08	10478	36	36	3.10	3.10	Excellent
08/18/04	9517	32	32	3.33	3.33	Good
07/13/99	7889	25	25	3.83	3.83	Good-Fair
08/09/94	6608	38	38	3.16	3.16	Excellent
07/27/88	4638	37	37	3.04	3.04	Excellent

Taxonomic Analysis

The 2008 sample represented a significant improvement from the 1999 and 2004 samples and included two new mayfly records for this site (*Pseudocloeon propinquum* and *Ephemerella invaria* GR) as well as a highly intolerant caddisfly taxon (*Ceratopsyche slossonae*). Based on EPT taxa richness and EPTBI it would appear that this location has rebounded to levels measured in 1998 and 1994.

Data Analysis

There are five small dischargers located upstream of this station including two facilities (Mill Ridge and Water Quality SERV) which are located within approximately 2,000 feet of the sampling area. However, as was noted after the 1999 assessment, nonpoint source runoff was identified as the strongest influence on this community. Analysis of the long-term ambient water chemistry data on the Watauga River (Shulls Mill) between 1994 and 1999 indicated no relationship between flow and conductivity suggesting that point sources have limited influence here. This conclusion is supported by the 2008 data which was taken during one of the most severe long-term droughts on record. This reduction in non-point pollution as a result of the drought is reflected in the improvement in bioclassification as well as the increase in EPT taxa richness, a decrease in the EPTBI, and the highest EPT abundance value ever recorded from this site. However, treatment upgrades completed in 2006 to the Water Quality SERV facility may have contributed to improved conditions here.

BENTHIC MACROINVERTEBRATE SAMPLE

Waterbody	Location	Station ID	Date	Bioclassification
WATAUGA R	NC 105	LB18	07/28/08	Excellent

County	Subbasin	8 digit HUC	Latitude	Longitude	AU Number	Level IV Ecoregion
WATAUGA	1	6010103	36.19404	-81.74528	8-(1)	Southern Metasedimentary Mountains

Stream Classification	Drainage Area (mi2)	Elevation (ft)	Stream Width (m)	Stream Depth (m)
B; Tr, HQW	0	2,755	12	0.5

Visible Landuse (%)	Forested/Wetland	Urban	Agriculture	Other (describe)
	60	30	0	

Upstream NPDES Dischargers (>1MGD or <1MGD and within 1 mile)	NPDES Number	Volume (MGD)
NONE	N/A	N/A

Water Quality Parameters

Temperature (°C)	23.4
Dissolved Oxygen (mg/L)	7.6
Specific Conductance (µS/cm)	60
pH (s.u.)	7.5

Water Clarity	Clear
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Habitat Assessment Scores (max)

Channel Modification (5)	5
Instream Habitat (20)	15
Bottom Substrate (15)	13
Pool Variety (10)	10
Riffle Habitat (16)	15
Left Bank Stability (7)	7
Right Bank Stability (7)	7
Light Penetration (10)	7
Left Riparian Score (5)	3
Right Riparian Score (5)	3
Total Habitat Score (100)	85

Site Photograph



Substrate	Boulder, cobble, bedrock, gravel, sand and a trace of silt.
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Sample Date	Sample ID	ST	EPT	BI	EPT BI	Bioclassification
07/28/08	10477	110	50	4.06	3.18	Excellent
08/18/04	9520	106	55	4.07	3.27	Excellent
07/14/99	7899	88	42	3.83	3.24	Excellent
08/08/94	6604	73	40	3.82	3.13	Excellent
03/05/90	5202	40	40	1.90	1.90	Good

Taxonomic Analysis

The last two summer Full-Scale samples resulted in the addition of mayfly and caddisfly taxa not previously collected from comparable (Full-Scale) samples in 1994 and 1999 and included the mayfly *Baetis tricaudatus*, and the caddisflies *Oecetis nocturna*, *Trianaodes ignitus* and *Neophylax consimilis*. Other taxa collected in 2004 and 2008 but absent from 1994 and 1999 included several Elmidae beetle taxa (i.e., *Dubiraphia* sp., *Macronychus glabratus*, and *Optioservus ovalis*) as well as the chironomids *Cryptochironomus* sp., *Diamesa* sp., and *Paratendipes* sp. These taxa in part accounted for the slightly elevated BI in 2004 and 2008 relative to 1994 and 1999.

Data Analysis

There are eight small dischargers located upstream of this station, including one approximately 1.4 river miles upstream (Carolina WTR Serv., NC0032123001, MGD=0.1400) and one other about 2.6 river miles upstream (Hebron Colony, NC0032191001, MGD=0.0040). Specific conductance was moderately higher in 2008 (60 µS/cm) versus levels measured in 1999 (45 µS/cm) and 2004 (48 µS/cm) suggesting that drought induced low flows are slightly elevating effluent concentrations from the upstream facilities here. This conclusion is supported by the fact that in wetter years 1991-1999 (Watauga River near Sugar Grove, mean discharge was 194 c.f.s.) relative to the drier years of 2000-2008 (mean discharge was 154 c.f.s.) the overall BI was lower in the 1994 and 1999 samples relative to the 2004 and 2008 collections despite an increase in EPT taxa richness in 2004 and 2008. Given the fact that the bioclassification has remained unchanged despite variations in stream discharge and small shifts in the invertebrate community suggests that water quality is generally stable at this location.

BENTHIC MACROINVERTEBRATE SAMPLE

Waterbody	Location	Station ID	Date	Bioclassification
BOONE FK	SR 1561	LB4	08/01/08	Excellent

County	Subbasin	8 digit HUC	Latitude	Longitude	AU Number	Level IV Ecoregion
WATAUGA	1	6010103	36.12305556	-81.77	7-Aug	Southern Metasedimentary Mountains

Stream Classification	Drainage Area (mi2)	Elevation (ft)	Stream Width (m)	Stream Depth (m)
C; Tr, ORW	1.4	3,616	6	0.4

Visible Landuse (%)	Forested/Wetland	Urban	Agriculture	Other (describe)
	100	0	0	

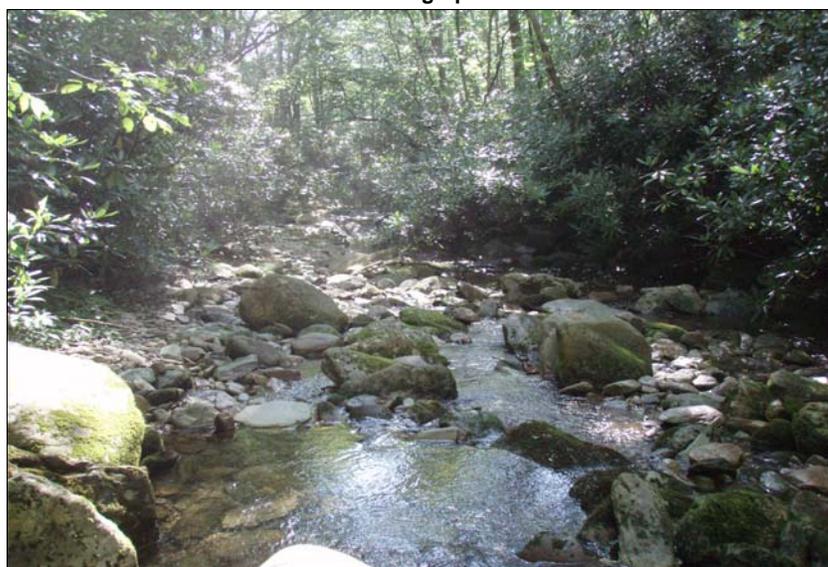
Upstream NPDES Dischargers (>1MGD or <1MGD and within 1 mile)	NPDES Number	Volume (MGD)
NONE	N/A	N/A

Water Quality Parameters

Temperature (°C)	17.3
Dissolved Oxygen (mg/L)	7.7
Specific Conductance (µS/cm)	17
pH (s.u.)	5.6

Water Clarity	Clear
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Site Photograph



Habitat Assessment Scores (max)

Channel Modification (5)	5
Instream Habitat (20)	16
Bottom Substrate (15)	15
Pool Variety (10)	10
Riffle Habitat (16)	15
Left Bank Stability (7)	6
Right Bank Stability (7)	6
Light Penetration (10)	9
Left Riparian Score (5)	5
Right Riparian Score (5)	5
Total Habitat Score (100)	92

Substrate	Boulder, cobble, bedrock, gravel, sand and a trace of silt.
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Sample Date	Sample ID	ST	EPT	BI	EPT BI	Bioclassification
08/01/08	10520	39	39	2.05	2.05	Excellent
08/18/04	9518	75	46	3.03	1.83	Excellent
07/13/99	7892	72	39	2.59	1.61	Excellent
08/08/94	6607	58	36	2.33	1.72	Good

Taxonomic Analysis

Previous samples at this location were Full-Scale collections. Given the very sparse root and bank habitat and the completely forested watershed, an EPT sample was used in 2008. Despite this reduction in sampling effort, the EPT taxa richness was very comparable to the 1994 and 1999 samples and was close to the 2004 sample. Overall, the invertebrate community appears quite stable at this location as there were 20 EPT taxa common among all samples. However, there were some taxa collected from the 1994, 1999, and 2004 samples that were not observed in 2008. These taxa included the mayflies *Acentrella* sp., *Epeorus pleuralis*, *Maccaffertium pudicum*, and the caddisfly *Neophylax mitchelli*. It is unclear why these taxa were absent in 2008 but it may be related to reduced flows, reduced pH, or a combination of these factors. Indeed, many species of mayfly have been shown to be sensitive to low pH values and their absence in 2008 may be related to the low pH.

Data Analysis

There are no NPDES dischargers upstream of this station and with the exception of a small portion of the Blue Ridge Parkway, this watershed is completely forested. Not surprisingly, specific conductance was very low in 2008 (17 µS/cm) and was consistent with levels measured in 1999 (12 µS/cm) and 2004 (18 µS/cm). However, the pH in 2008 (5.6) was significantly less than that measured in 1999 (6.7) and in 2004 (7.1). This sharp decline in pH may account for the slightly elevated EPTBI noted in 2008. It is unclear why the pH was so much lower in 2008 relative to previous collections.

BENTHIC MACROINVERTEBRATE SAMPLE

Waterbody	Location	Station ID	Date	Bioclassification
BOONE FK	SR 1558	LB3	07/31/08	Excellent

County	Subbasin	8 digit HUC	Latitude	Longitude	AU Number	Level IV Ecoregion
WATAUGA	1	6010103	36.15527778	-81.73666667	7-Aug	Southern Metasedimentary Mountains

Stream Classification	Drainage Area (mi2)	Elevation (ft)	Stream Width (m)	Stream Depth (m)
C; Tr, ORW	9.8	3,185	11	0.4

Visible Landuse (%)	Forested/Wetland	Urban	Agriculture	Other (describe)
	100	0	0	

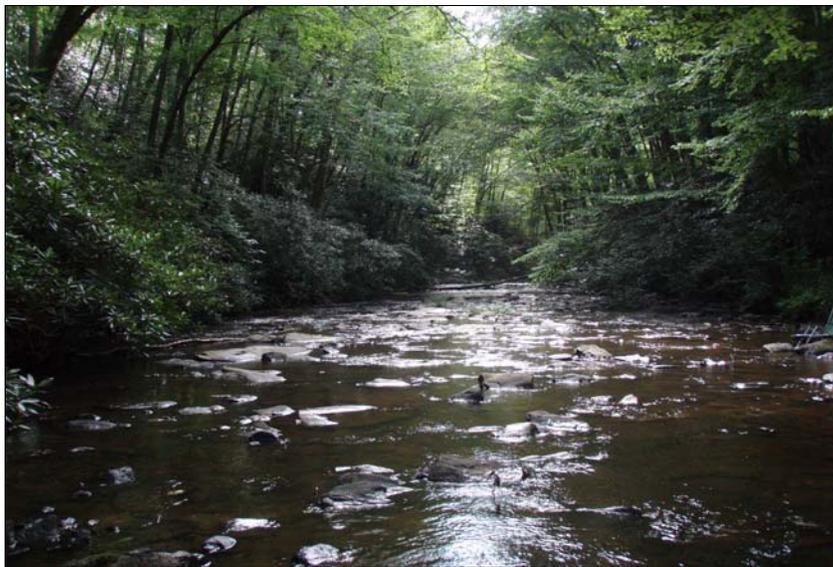
Upstream NPDES Dischargers (>1MGD or <1MGD and within 1 mile)	NPDES Number	Volume (MGD)
NONE	N/A	N/A

Water Quality Parameters

Temperature (°C)	21.2
Dissolved Oxygen (mg/L)	7.3
Specific Conductance (µS/cm)	29
pH (s.u.)	6.2

Water Clarity	Clear
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Site Photograph



Habitat Assessment Scores (max)

Channel Modification (5)	5
Instream Habitat (20)	17
Bottom Substrate (15)	15
Pool Variety (10)	9
Riffle Habitat (16)	16
Left Bank Stability (7)	6
Right Bank Stability (7)	7
Light Penetration (10)	10
Left Riparian Score (5)	4
Right Riparian Score (5)	5
Total Habitat Score (100)	94

Substrate	Boulder, cobble, gravel, sand and bedrock.
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Sample Date	Sample ID	ST	EPT	BI	EPT BI	Bioclassification
07/31/08	10519	44	44	2.64	2.64	Excellent
08/18/04	9519	39	39	3.30	3.30	Excellent
07/12/99	7891	32	32	2.65	2.65	Good
08/08/94	6606	31	31	2.48	2.48	Good

Taxonomic Analysis

The 2008 sample produced the highest EPT taxa richness value measured to date at this location. Numerous EPT taxa were collected in 2008 that were not previously observed here and included the mayflies *Ephemerella catawba*, *Ephemerella invaria* GR, *Serratella deficiens*, *Serratella serrata*, the stonefly *Malirekus hastatus*, and the caddisflies *Ceratopsyche alhedra*, *Lype diversa*, *Rhyacophila carolina* and *R. torva*. In addition to the higher EPT taxa richness, the 2008 sample also resulted in the highest EPT abundance yet measured here, while the EPTBI remained comparable to previous collections.

Data Analysis

There are no NPDES facilities upstream of this location although this segment of Boone Fork is located approximately 2.1 stream miles below Price Lake and is only about 1,700 feet below a much smaller impoundment. Landuse in this watershed is mostly forest with some light residential use concentrated near Julian Price Memorial Park and the US 221 corridor. Given the lack of point source dischargers, and the presence of some non-point sources, the reduction in runoff due to drought is a probable explanation for the improved EPT taxa richness and EPT abundance measured in 2008.

BENTHIC MACROINVERTEBRATE SAMPLE

Waterbody	Location	Station ID	Date	Bioclassification
LAUREL FK	SR 1111	LB10	07/28/08	Good

County	Subbasin	8 digit HUC	Latitude	Longitude	AU Number	Level IV Ecoregion
WATAUGA	1	6010103	36.19583333	-81.74333333	10-Aug	Southern Crystalline Ridges and Mountains

Stream Classification	Drainage Area (mi2)	Elevation (ft)	Stream Width (m)	Stream Depth (m)
C; Tr	7.5	2,763	6	0.4

Visible Landuse (%)	Forested/Wetland	Urban	Agriculture	Other (describe)
	40	60	0	

Upstream NPDES Dischargers (>1MGD or <1MGD and within 1 mile)	NPDES Number	Volume (MGD)
Discovery Vacation Club	NC0061425001	0.03

Water Quality Parameters

Temperature (°C)	18.9
Dissolved Oxygen (mg/L)	8.17
Specific Conductance (µS/cm)	145
pH (s.u.)	7.1

Water Clarity	Clear
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Habitat Assessment Scores (max)

Channel Modification (5)	4
Instream Habitat (20)	15
Bottom Substrate (15)	13
Pool Variety (10)	10
Riffle Habitat (16)	14
Left Bank Stability (7)	7
Right Bank Stability (7)	6
Light Penetration (10)	7
Left Riparian Score (5)	3
Right Riparian Score (5)	2
Total Habitat Score (100)	81

Site Photograph



Substrate	Bedrock, boulder, cobble, gravel, sand and a trace of silt.
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Sample Date	Sample ID	ST	EPT	BI	EPT BI	Bioclassification
07/28/08	10522	35	35	3.18	3.18	Good
08/18/04	9521	26	26	2.91	2.91	Good-Fair
07/13/99	7893	27	27	3.06	3.06	Good-Fair
09/08/94	6605	24	24	3.09	3.09	Good-Fair
03/05/90	5186	31	31	2.71	2.71	Good

Taxonomic Analysis

The 2008 EPT sample resulted in both the highest EPT taxa richness value and EPT abundance (200) yet to be measured at this location. Several intolerant caddisfly taxa were collected here for this first time in 2008 and included *Pycnopsyche gentilis*, *Nyctiophylax celta*, *Rhyacophila torva*, and *Neophylax mitchelli*.

Data Analysis

Although there are two small NPDES dischargers above this location (Discovery Vacation Club: NC0061425001, MGD=0.03, located approximately 4,000 feet upstream and PSI Properties/Laurel Sea: NC0038041001, MGD=0.0145, located approximately 2.1 miles upstream) this site appears to be influenced most strongly by the extensive non-point pollution associated with the City of Boone, the NC 105 corridor, and the nearby quarry. This conclusion is supported by the fact that despite the low flows associated with drought, the effluent from the upstream dischargers does not seem to be adversely affecting the invertebrate community as the 2008 sample resulted in the highest EPT diversity and EPT abundance ever measured here while the specific conductance was also the highest in 2008 (145 µS/cm) relative to 2004 (135 µS/cm) and 1999 (80 µS/cm). Indeed, the 2008 EPT abundance (200) is an extremely large increase from levels measured in 1990 (109), 1994 (94), 1999 (110), and 2004 (128). The reduction in runoff and subsequent non-point pollution likely explains the improved community metrics measured in 2008. However, PSI Properties is planning on a substantial plant expansion so additional monitoring at this location will be critical.

FISH COMMUNITY SAMPLE

Waterbody	Location	Date	Station ID	Bioclassification
LAUREL FK	SR 1111	06/16/08	LF8	Not Rated

County	Subbasin	8 digit HUC	Latitude	Longitude	AU Number	Level IV Ecoregion
WATAUGA	1	06010103	36.197778	-81.740278	8-10	Southern Crystalline Ridges & Mountains

Stream Classification	Drainage Area (mi2)	Elevation (ft)	Stream Width (m)	Average Depth (m)	Reference Site
C;Tr	7	2892	5	0.5	No

Visible Landuse (%)	Forested/Wetland	Urban	Agriculture	Other (describe)
	95	5	0	0

Upstream NPDES Dischargers (>1MGD or <1MGD and within 1 mile)	NPDES Number	Volume (MGD)
Willow Valley Resort WWTP, 100% domestic, ~0.4 miles upstream	NC0061425	0.03

Water Quality Parameters

Temperature (°C)	18.5
Dissolved Oxygen (mg/L)	8.2
Specific Conductance (µS/cm)	140
pH (s.u.)	7.1

Water Clarity	Clear
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Habitat Assessment Scores (max)

Channel Modification (5)	5
Instream Habitat (20)	20
Bottom Substrate (15)	14
Pool Variety (10)	10
Riffle Habitat (16)	16
Left Bank Stability (7)	7
Right Bank Stability (7)	7
Light Penetration (10)	7
Left Riparian Score (5)	5
Right Riparian Score (5)	3
Total Habitat Score (100)	94

Site Photograph



Substrate	bedrock, boulder, cobble, gravel.
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Sample Date	Sample ID	Species Total	NCIBI	Bioclassification
06/16/08	2008-61	11	--	Not Rated
01/00/00	2004-40	10	--	Not Rated

Most Abundant Species	Central Stoneroller.
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Exotic Species	Redbreast Sunfish, Rainbow Trout, Brown Trout, Rosyside Dace.
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Species Change Since Last Cycle	Gains -- Rosyside Dace, Black Redhorse. Losses -- Brook Trout.
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Data Analysis

Watershed -- a tributary to the Watauga River that drains the western side of Boone in central Watauga County. **Habitats** -- high quality instream habitats consisting of high gradient plunge pools, riffles, and chutes; good riparian habitats including stable Hemlock and Rhododendron lined banks; elevated conductivity for a mountain stream. **2008** -- an even mix of cold and cool water fish species was collected, with more than twice as many individuals captured than in 2004 (n=231 vs.108), with increased abundances for most species. **2004-2008** -- twelve fish species are known from this site, including five minnow species, three sucker species, and all three trout species (two of which are intolerant to pollution); a slightly higher conductivity (140 µS/cm vs. 109 µS/cm in 2004) may be encouraging the recruitment of Central Stonerollers (herbivorous fish that often proliferate with additional nutrients); however, the fish community trophic structure has become more balanced since the last basinwide cycle; although this high gradient trout stream is Not Rated, there appears to be no substantial water quality issues in this catchment.

FISH COMMUNITY SAMPLE

Waterbody	Location	Date	Station ID	Bioclassification
DUTCH CR	SR 1112/NC 194	06/16/08	LF7	Good-Fair

County	Subbasin	8 digit HUC	Latitude	Longitude	AU Number	Level IV Ecoregion
WATAUGA	1	06010103	36.209167	-81.778333	8-12-(1.5)	Southern Crystalline Ridges & Mountains

Stream Classification	Drainage Area (mi2)	Elevation (ft)	Stream Width (m)	Average Depth (m)	Reference Site
C;Tr	10.6	2693	7	0.4	No

Visible Landuse (%)	Forested/Wetland	Rural Residential	Agriculture	Other (describe)
	70	25	0	5

Upstream NPDES Dischargers (>1MGD or <1MGD and within 1 mile)	NPDES Number	Volume (MGD)
None	---	---

Water Quality Parameters

Temperature (°C)	23.1
Dissolved Oxygen (mg/L)	7.5
Specific Conductance (µS/cm)	54
pH (s.u.)	6.5

Water Clarity	Clear
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Habitat Assessment Scores (max)

Channel Modification (5)	5
Instream Habitat (20)	19
Bottom Substrate (15)	8
Pool Variety (10)	6
Riffle Habitat (16)	15
Left Bank Stability (7)	6
Right Bank Stability (7)	6
Light Penetration (10)	7
Left Riparian Score (5)	2
Right Riparian Score (5)	2
Total Habitat Score (100)	76

Site Photograph



Substrate	cobble, gravel, sand, boulder.
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Sample Date	Sample ID	Species Total	NCIBI	Bioclassification
06/16/08	2008-62	21	44	Good-Fair
05/05/04	2004-39	19	46	Good-Fair

Most Abundant Species

Central Stoneroller.

Exotic Species

Redbreast Sunfish, Green Sunfish, Mountain Redbelly Dace, Rosyside Dace, Margined Madtom, Rainbow Trout, Brown Trout.

Species Change Since Last Cycle

Gains -- Green Sunfish, Brook Trout.

Data Analysis

Watershed -- drains part of southwest Watauga County, just north of Seven Devils. **Habitats** -- riffles, runs, side snag pools, and boulder pools; stable banks, but thin riparian zones on both sides of the stream. **2008** -- very diverse and abundant fish community (n=1175) with all previously collected species present, including five that are considered to be intolerant to pollution (Rock Bass, Smallmouth Bass, Greenfin Darter, Rainbow Trout, and Brook Trout); however, Central Stoneroller (an herbivorous minnow that is indicative of nutrient inputs) represented 52% of the collected sample (n=609 vs.383 in 2004). **2004-2008** -- There are 21 fish species of mixed temperature regimes that are known from this watershed, including three species of sucker, four species of sunfish, nine species of minnow, one catfish species, one darter species, and all three trout species. In spite of its thin riparian zones, and moderately embedded substrates, this stream continues to support a robust yet altered fish population.

BENTHIC MACROINVERTEBRATE SAMPLE

Waterbody	Location	Station ID	Date	Bioclassification
COVE CR	SR 1149	LB5	07/29/08	Good

County	Subbasin	8 digit HUC	Latitude	Longitude	AU Number	Level IV Ecoregion
WATAUGA	1	6010103	36.25416667	-81.79027778	15-Aug	Southern Crystalline Ridges and Mountains

Stream Classification	Drainage Area (mi2)	Elevation (ft)	Stream Width (m)	Stream Depth (m)
C	32.5	2,661	6	0.4

Visible Landuse (%)	Forested/Wetland	Urban	Agriculture	Other (describe)
	30	10	60	

Upstream NPDES Dischargers (>1MGD or <1MGD and within 1 mile)	NPDES Number	Volume (MGD)
Old Cove Creek School	NC0067008	0.01

Water Quality Parameters

Temperature (°C)	20.4
Dissolved Oxygen (mg/L)	7.7
Specific Conductance (µS/cm)	125
pH (s.u.)	7.2

Water Clarity	Clear
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Habitat Assessment Scores (max)

Channel Modification (5)	4
Instream Habitat (20)	14
Bottom Substrate (15)	12
Pool Variety (10)	3
Riffle Habitat (16)	14
Left Bank Stability (7)	4
Right Bank Stability (7)	4
Light Penetration (10)	2
Left Riparian Score (5)	1
Right Riparian Score (5)	2
Total Habitat Score (100)	60

Site Photograph



Substrate	Gravel, cobble, sand, silt and a trace of bedrock and boulder.
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Sample Date	Sample ID	ST	EPT	BI	EPT BI	Bioclassification
07/29/08	10479	34	34	4.46	4.46	Good
12/01/04	9534	27	27	3.15	3.15	Good-Fair
08/17/04	9516	34	34	3.64	3.64	Good

Taxonomic Analysis

Comparing the two summer samples (2004 and 2008) it is evident that the EPT community structure at this location is generally stable. EPT taxa richness was identical between the summer sampling events and numerous taxa were common between these two collections. However, several intolerant EPT present from the 2004 summer sample were absent from the 2008 July collection and included the mayflies *Epeorus vitreus*, *Paraleptophlebia sp.*, and the caddisflies *Glossosoma sp.*, *Dolophilodes sp.*, and *Rhyacophila fuscula*. Of particular interest, *Epeorus vitreus* and *Dolophilodes sp.* were all abundant in August 2004, while *Glossosoma sp.* was common. All of these taxa were completely absent in late July 2008. Conversely, the 2008 sample produced new records of more facultative taxa including the mayfly *Pseudocloeon propinquum* and the caddisflies *Hydroptila sp.* and *Oecetis persimilis*. The decline in EPT taxa richness at this location observed from the December EPT sample was the result of seasonality effects and not due to changes in water quality.

Data Analysis

The mountain region of North Carolina has experienced unprecedented long-term drought conditions. This station is approximately 1.2 miles downstream of a small discharger. The large increase in the EPTBI from the summer 2004 collection to the sample taken this July is due to both the absence of several intolerant taxa present in 2004 as well as the addition of several new facultative taxa in 2008. These shifts in taxa distributions are likely the result of an increase in the instream waste concentration as a result of drought induced low flows. This conclusion is supported by the slightly elevated specific conductance observed in 2008 (125 µS/cm) versus that measured in the summer of 2004 (116 µS/cm) as well as the winter of 2004 (91 µS/cm).

FISH COMMUNITY SAMPLE

Waterbody	Location	Date	Station ID	Bioclassification
COVE CR	off SR 1121	06/17/08	LF 11	Not Rated

County	Subbasin	8 digit HUC	Latitude	Longitude	AU Number	Level IV Ecoregion
WATAUGA	1	06010103	36.23945	-81.8214	8-15	Southern Crystalline Ridges & Mountains

Stream Classification	Drainage Area (mi2)	Elevation (ft)	Stream Width (m)	Average Depth (m)	Reference Site
C	34.9	2691	8	0.3	No

Visible Landuse (%)	Forested/Wetland	Rural Residential	Agriculture	Other (describe)
	60	5	35	0

Upstream NPDES Dischargers (>1MGD or <1MGD and within 1 mile)	NPDES Number	Volume (MGD)
None	---	---

Water Quality Parameters

Temperature (°C)	19.4
Dissolved Oxygen (mg/L)	8.0
Specific Conductance (µS/cm)	125
pH (s.u.)	7.0

Water Clarity	Clear
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Habitat Assessment Scores (max)

Channel Modification (5)	5
Instream Habitat (20)	18
Bottom Substrate (15)	8
Pool Variety (10)	10
Riffle Habitat (16)	14
Left Bank Stability (7)	5
Right Bank Stability (7)	5
Light Penetration (10)	1
Left Riparian Score (5)	2
Right Riparian Score (5)	2
Total Habitat Score (100)	70

Site Photograph



Substrate	gravel, cobble, boulder.
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Sample Date	Sample ID	Species Total	NCIBI	Bioclassification
06/17/08	2008-63	13	38	Not Rated
12/2/2004*	2004-142	11	--	Not Rated
05/05/04	2004-38	13	40	Good-Fair

Most Abundant Species	Central Stoneroller.	Exotic Species	Redbreast Sunfish, Green Sunfish, Margined Madtom, Brown Trout.
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Species Change Since Last Cycle	Gains -- Redbreast Sunfish, Green Sunfish, Smallmouth Bass, Black Redhorse. Losses -- Rainbow Trout, Creek Chub.
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Data Analysis

Watershed -- drains most of the north-eastern quadrant of the Watauga River basin; this site was moved approximately one mile downstream from the previous basinwide site (at SR 1149) to a location immediately above the Watauga River confluence, corresponding to DWQ's Random Ambient Water Quality Monitoring site. **Habitats** -- riffle runs with side pools, and a completely open canopy; severely entrenched; other than a lack of swift chutes, the instream habitats are similar to the upstream location. **2008** -- more than twice the number of fish at this new location (n=1143), but the trophic structure is similar; the effects of agricultural runoff and full sun exposure is highlighted by the elevated number of herbivorous Central Stonerollers (n=500), and possibly the lack of darter species; new Watauga County record for Green Sunfish (n=10); some recruiting from the mainstem Watauga River could also be occurring; this site was Not Rated pending additional 2009 monitoring. **2004-2008** -- this watershed is supporting a fairly diverse fish community of mixed temperature designations (cold, cool, and warm), and continues to be impacted by agricultural practices in the watershed.

* Post hurricane study (BAU Memorandum F-20040405)

BENTHIC MACROINVERTEBRATE SAMPLE

Waterbody	Location	Station ID	Date	Bioclassification
WATAUGA R	SR 1121	LB12	07/29/08	Good

County	Subbasin	8 digit HUC	Latitude	Longitude	AU Number	Level IV Ecoregion
WATAUGA	1	6010103	36.23833333	-81.82277778	8-(1)	Southern Crystalline Ridges and Mountains

Stream Classification	Drainage Area (mi2)	Elevation (ft)	Stream Width (m)	Stream Depth (m)
B; Tr, HQW	92	2,615	22	0.5

Visible Landuse (%)	Forested/Wetland	Urban	Agriculture	Other (describe)
	30	10	30	30 (christmas tree farms)

Upstream NPDES Dischargers (>1MGD or <1MGD and within 1 mile)	NPDES Number	Volume (MGD)
NONE	N/A	N/A

Water Quality Parameters

Temperature (°C)	24
Dissolved Oxygen (mg/L)	8.5
Specific Conductance (µS/cm)	101
pH (s.u.)	8

Water Clarity	Clear
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Habitat Assessment Scores (max)

Channel Modification (5)	4
Instream Habitat (20)	15
Bottom Substrate (15)	12
Pool Variety (10)	3
Riffle Habitat (16)	10
Left Bank Stability (7)	5
Right Bank Stability (7)	5
Light Penetration (10)	2
Left Riparian Score (5)	2
Right Riparian Score (5)	0
Total Habitat Score (100)	58

Site Photograph



Substrate	Cobble, gravel, boulder, sand and silt.
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Sample Date	Sample ID	ST	EPT	BI	EPT BI	Bioclassification
07/29/08	10480	122	49	4.90	4.16	Good
12/02/04	9535	74	39	4.00	3.09	Good
08/17/04	9515	100	47	4.55	3.67	Excellent
07/15/99	7901	81	38	4.22	3.36	Good
08/09/94	6609	87	42	4.22	3.48	Good

Taxonomic Analysis

Although the 2008 sample resulted in the highest EPT taxa richness value recorded here, this increase was largely comprised of facultative taxa which increased the EPTBI to its highest level. In addition, numerous previously collected intolerant EPT taxa were absent in 2008 and included the mayflies *Drunella allegheniensis*, *Epeorus vitreus*, *Stenacron pallidum*, the stoneflies *Sweltsa sp.*, *Leuctra sp.*, *Tallaperla sp.*, and the caddisfly *Goera sp.* In addition, the 2008 sample produced the second highest chironomid taxa richness value (27) which contributed to the elevated biotic index. Including the 2008 collection, this location has been sampled 12 times resulting in 10 Good bioclassifications and two Excellent ratings indicating an overall stable water quality regime. However, the absence of the highly intolerant taxa in 2008 may suggest a shift to a slightly more tolerant community and may be related to effluent concentration due to drought induced low flows.

Data Analysis

Landuse in this watershed is a mix of row crop agriculture, pasture, rural residences, and forest. In addition, there are eight very small dischargers (none exceeding 0.14 MGD) located throughout this catchment although the closest one to this location is over 11 river miles upstream. Given the small sizes and large distances of the dischargers from this sampling point, it would be expected that the extreme drought would likely not adversely affect the community here, and that the reduced non-point pollution should result in a decreased EPTBI and BI. The fact that these metrics increased, and that many pollution intolerant taxa were absent in 2008 but collected in previous samples, may indicate that the dischargers are exerting a slightly more significant influence here than are the non-point sources and that drought is exacerbating this impact.

BENTHIC MACROINVERTEBRATE SAMPLE

Waterbody	Location	Station ID	Date	Bioclassification
WATAUGA R	SR 1200	LB11	07/29/08	Excellent

County	Subbasin	8 digit HUC	Latitude	Longitude	AU Number	Level IV Ecoregion
WATAUGA	1	6010103	36.26916667	-81.88444444	8-(16)	Southern Crystalline Ridges and Mountains

Stream Classification	Drainage Area (mi2)	Elevation (ft)	Stream Width (m)	Stream Depth (m)
B; HQW	128	2,462	30	0.6

Visible Landuse (%)	Forested/Wetland	Urban	Agriculture	Other (describe)
	100	0	0	

Upstream NPDES Dischargers (>1MGD or <1MGD and within 1 mile)	NPDES Number	Volume (MGD)
NONE	N/A	N/A

Water Quality Parameters

Temperature (°C)	26.3
Dissolved Oxygen (mg/L)	8.3
Specific Conductance (µS/cm)	84
pH (s.u.)	8.3

Water Clarity	Clear
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Site Photograph



Habitat Assessment Scores (max)

Channel Modification (5)	4
Instream Habitat (20)	15
Bottom Substrate (15)	13
Pool Variety (10)	10
Riffle Habitat (16)	15
Left Bank Stability (7)	7
Right Bank Stability (7)	7
Light Penetration (10)	2
Left Riparian Score (5)	5
Right Riparian Score (5)	4
Total Habitat Score (100)	82

Substrate	Boulder, cobble, bedrock, gravel, sand and a trace of silt.
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Sample Date	Sample ID	ST	EPT	BI	EPT BI	Bioclassification
07/29/08	10481	105	49	4.27	3.56	Excellent
08/17/04	9524	110	45	4.45	3.18	Excellent
07/15/99	7904	94	50	3.98	3.36	Excellent
08/09/94	6611	97	46	3.66	2.79	Excellent
07/28/88	4642	86	38	4.65	3.03	Good

Taxonomic Analysis

The overall invertebrate community has been stable at this location since 1994 with Excellent bioclassifications recorded on four consecutive samples. Indeed there were 19 common EPT taxa collected from this location at each of the five previous collections. Nevertheless, the 2008 sample did result in several new EPT records for this location and included the mayflies *Heterocloeon anoka*, *Procloeon sp.*, *Paraleptophlebia sp.*, and the caddisflies *Matrioptila jeanae*, *Hydroptila sp.*, *Trienodes ignitus*, and *Psychomyia flavida*.

Data Analysis

Most of the landuse in this catchment is a combination of forest, pasture, and a few scattered rural residences. Although there are some small dischargers far upstream of this station, none of them are closer than approximately 19 river miles and none of them exceed a permitted flow of 0.14 MGD. As a result, it would appear that this site is more strongly influenced by non point pollution. If the dischargers were exerting the stronger influence, it would be likely that the benthic macroinvertebrate metrics would exhibit deleterious effects from an increased instream waste concentration due to the unprecedented drought and associated low flow conditions. However, this does not appear to be the case as both the EPT taxa richness improved from levels seen 1988, 1994, and 2004, while the BI improved from levels measured in 1988 and 2004. Indeed, the EPT abundance measured in 2008 was the highest ever recorded from this location (256). Overall, water quality appears stable at this location.

BENTHIC MACROINVERTEBRATE SAMPLE

Waterbody	Location	Station ID	Date	Bioclassification
LAUREL CR	SR 1123	LB8	07/29/08	Excellent

County	Subbasin	8 digit HUC	Latitude	Longitude	AU Number	Level IV Ecoregion
WATAUGA	1	6010103	36.25166667	-81.85333333	17-Aug	Southern Crystalline Ridges and Mountains

Stream Classification	Drainage Area (mi2)	Elevation (ft)	Stream Width (m)	Stream Depth (m)
C; Tr	7.3	2,647	5	0.3

Visible Landuse (%)	Forested/Wetland	Urban	Agriculture	Other (describe)
	90	10	0	

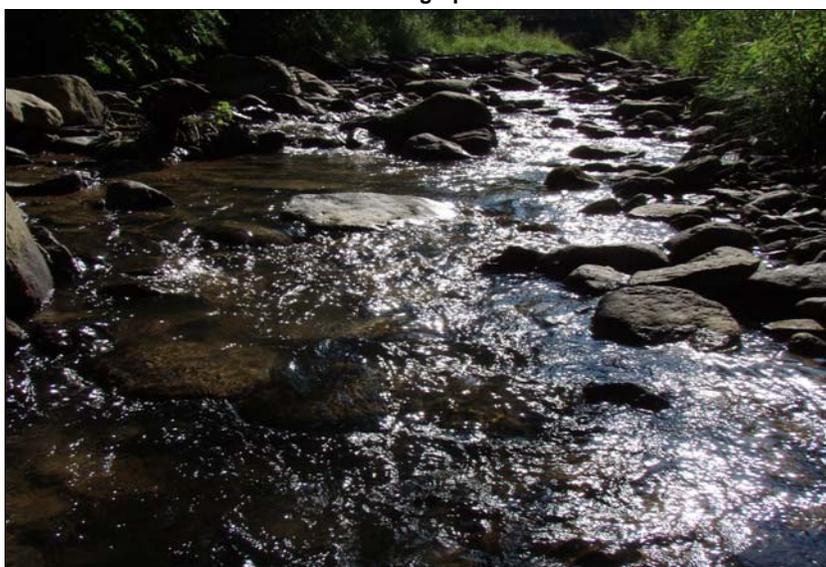
Upstream NPDES Dischargers (>1MGD or <1MGD and within 1 mile)	NPDES Number	Volume (MGD)
NONE	N/A	N/A

Water Quality Parameters

Temperature (°C)	23.3
Dissolved Oxygen (mg/L)	6.7
Specific Conductance (µS/cm)	46
pH (s.u.)	7

Water Clarity	Clear
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Site Photograph



Habitat Assessment Scores (max)

Channel Modification (5)	4
Instream Habitat (20)	14
Bottom Substrate (15)	13
Pool Variety (10)	5
Riffle Habitat (16)	16
Left Bank Stability (7)	5
Right Bank Stability (7)	7
Light Penetration (10)	8
Left Riparian Score (5)	1
Right Riparian Score (5)	4
Total Habitat Score (100)	77

Substrate	Boulder, cobble, gravel, sand and silt.
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Sample Date	Sample ID	ST	EPT	BI	EPT BI	Bioclassification
07/29/08	10483	43	43	2.47	2.47	Excellent
08/17/04	9514	35	35	2.34	2.34	Good
07/15/99	7902	31	31	2.45	2.45	Good

Taxonomic Analysis

The 2008 sample resulted in the highest EPT taxa richness yet measured at this location and there was an addition of eight EPT taxa not previously collected. These taxa included the mayfly *Baetis intercalaris*, and the caddisflies *Ceratopsyche bifida*, *Ceratopsyche morosa*, *Pycnopsyche sp.*, *Nyctiophylax celta*, *Nectopsyche exquisita*, and *Neophylax oligius*. In addition, the 2008 sample also represented the highest EPT abundance recorded for this location (199) and was up from 153 (1999) and 181 (2004).

Data Analysis

Landuse in this catchment is mostly forest with some scattered rural residences. There are no NPDES facilities in this watershed. The large increase in EPT taxa richness and EPT abundance measured in 2008 is likely the result of a sharp reduction in overland runoff and non-point pollution as a result of the drought.

FISH COMMUNITY SAMPLE

Waterbody	Location	Date	Station ID	Bioclassification
LAUREL CR	SR 1123	06/17/08	LF6	Not Rated

County	Subbasin	8 digit HUC	Latitude	Longitude	AU Number	Level IV Ecoregion
WATAUGA	1	06010103	36.249238	-81.860212	8-17	Southern Crystalline Ridges & Mountains

Stream Classification	Drainage Area (mi2)	Elevation (ft)	Stream Width (m)	Average Depth (m)	Reference Site
C;Tr	7	2801	6	0.3	Yes

Visible Landuse (%)	Forested/Wetland	Rural Residential	Agriculture	Other (describe)
	95	5	0	0

Upstream NPDES Dischargers (>1MGD or <1MGD and within 1 mile)	NPDES Number	Volume (MGD)
None	---	---

Water Quality Parameters

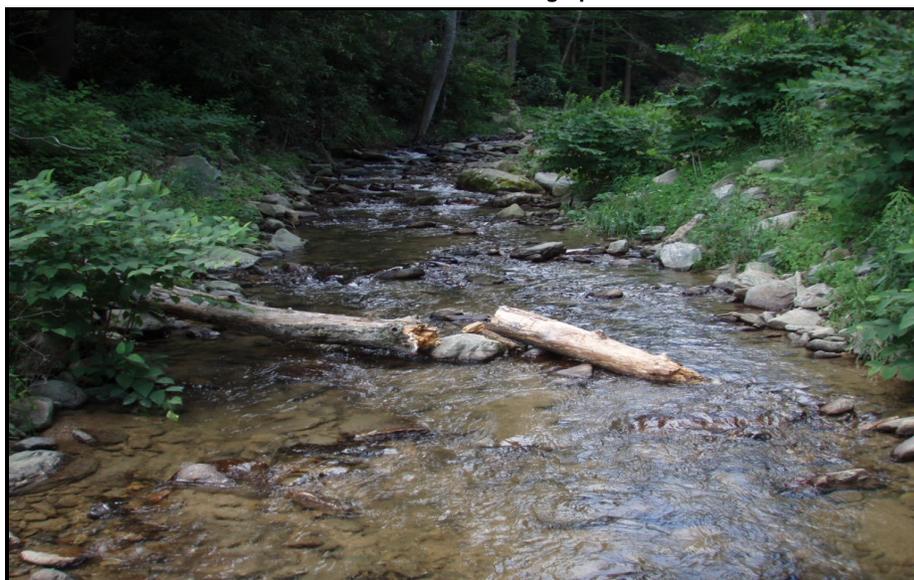
Temperature (°C)	18.2
Dissolved Oxygen (mg/L)	8.7
Specific Conductance (µS/cm)	39
pH (s.u.)	6.3

Water Clarity	Clear
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Habitat Assessment Scores (max)

Channel Modification (5)	5
Instream Habitat (20)	20
Bottom Substrate (15)	15
Pool Variety (10)	10
Riffle Habitat (16)	16
Left Bank Stability (7)	6
Right Bank Stability (7)	6
Light Penetration (10)	7
Left Riparian Score (5)	4
Right Riparian Score (5)	4
Total Habitat Score (100)	93

Site Photograph



Substrate	cobble, boulder, gravel.
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Sample Date	Sample ID	Species Total	NCIBI	Bioclassification
06/17/08	2008-64	5	--	Not Rated
05/04/04	2004-37	4	--	Not Rated

Most Abundant Species	Western Blacknose Dace.	Exotic Species	Brown Trout.
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Species Change Since Last Cycle	Gains -- Creek Chub.
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Data Analysis

Watershed -- a forested tributary to the Watauga River; drains the area immediately to the east of Beech Mountain in west-central Watauga County.
Habitats -- excellent instream habitat qualities; high gradient riffles and plunge pools of various sizes; good riparian widths, stable banks and good stream canopy that offers abundant shade to the stream. **2008** -- low diversity and abundance of the fish community, which is typical of high gradient mountain streams; however, almost three times the total abundance as in the previous sample (n=290 vs.103), largely due to rising populations of Western Blacknose Dace (representing 67% of the total catch) and Central Stonerollers (26% of the sample). **2004-2008** -- this high gradient mountain stream continues to support a low diversity fish community of cold and cool water species, and although Not Rated, appears healthy with no obvious water quality issues.

FISH COMMUNITY SAMPLE

Waterbody	Location	Date	Station ID	Bioclassification
BEAVERDAM CR	SR 1211	06/17/08	LF 12	Not Rated

County	Subbasin	8 digit HUC	Latitude	Longitude	AU Number	Level IV Ecoregion
WATAUGA	1	06010103	36.291286	-81.83277	8-19	Southern Crystalline Ridges & Mountains

Stream Classification	Drainage Area (mi2)	Elevation (ft)	Stream Width (m)	Average Depth (m)	Reference Site
C;Tr	11.7	2798	4.5	0.4	No

Visible Landuse (%)	Forested/Wetland	Rural Residential	Agriculture	Other (describe)
	60	5	35	0

Upstream NPDES Dischargers (>1MGD or <1MGD and within 1 mile)	NPDES Number	Volume (MGD)
None	---	---

Water Quality Parameters

Temperature (°C)	23.5
Dissolved Oxygen (mg/L)	7.7
Specific Conductance (µS/cm)	75
pH (s.u.)	6.9

Water Clarity	Clear
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Habitat Assessment Scores (max)

Channel Modification (5)	5
Instream Habitat (20)	18
Bottom Substrate (15)	8
Pool Variety (10)	6
Riffle Habitat (16)	10
Left Bank Stability (7)	6
Right Bank Stability (7)	4
Light Penetration (10)	7
Left Riparian Score (5)	5
Right Riparian Score (5)	2
Total Habitat Score (100)	71

Site Photograph



Substrate	gravel, cobble, bedrock, boulder, sand.
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Sample Date	Sample ID	Species Total	NCIBI	Bioclassification
06/17/08	2008-65	10	38	Not Rated

Most Abundant Species	Western Blacknose Dace.	Exotic Species	Green Sunfish, Rainbow Trout, Brown Trout.
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Species Change Since Last Cycle	N/A
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New basinwide site. **Watershed** -- a tributary to the Watauga River that receives the Little Beaverdam Creek and Forest Grove Creek catchments in the north-central tip of Watauga County; site location is about 3.25 miles above the SR 1202 fish community site. **Habitats** -- riffle runs with some shallow bedrock plunge pools; canopy is limited to the left bank only, with full sun on the right side; although the upstream watershed is largely forested, substrates are highly embedded from agricultural sedimentation in this mid section of the creek; livestock have full access along the right bank in this reach of the stream. **2008** -- moderately diverse fish community, mixed primarily with cold and cool water species, including one sucker species, two sunfish species, four minnow species, and all three species of trout (two of which are considered intolerant to pollution), but no benthic dwellers such as Sculpin or darters; many Central Stoneroller present (n=205, 24%) and River Chub (n=149, 17%); new record for Green Sunfish in the Watauga River basin; overall, this stream is supporting a fairly rich community of fish, but suffers from incomplete riparian corridors and agricultural sedimentation.

BENTHIC MACROINVERTEBRATE SAMPLE

Waterbody	Location	Station ID	Date	Bioclassification
BEAVERDAM CR	SR 1202	LB1	06/16/08	Excellent

County	Subbasin	8 digit HUC	Latitude	Longitude	AU Number	Level IV Ecoregion
WATAUGA	1	06010103	36.277222	-81.868611	8-19	Southern Crystalline Ridges and Mountains

Stream Classification	Drainage Area (mi2)	Elevation (ft)	Stream Width (m)	Stream Depth (m)
C; Tr	20.5	2631	5	0.4

Visible Landuse (%)	Forested/Wetland	Urban	Agriculture	Other (describe)
	90	10	0	

Upstream NPDES Dischargers (>1MGD or <1MGD and within 1 mile)	NPDES Number	Volume (MGD)
NONE	N/A	N/A

Water Quality Parameters

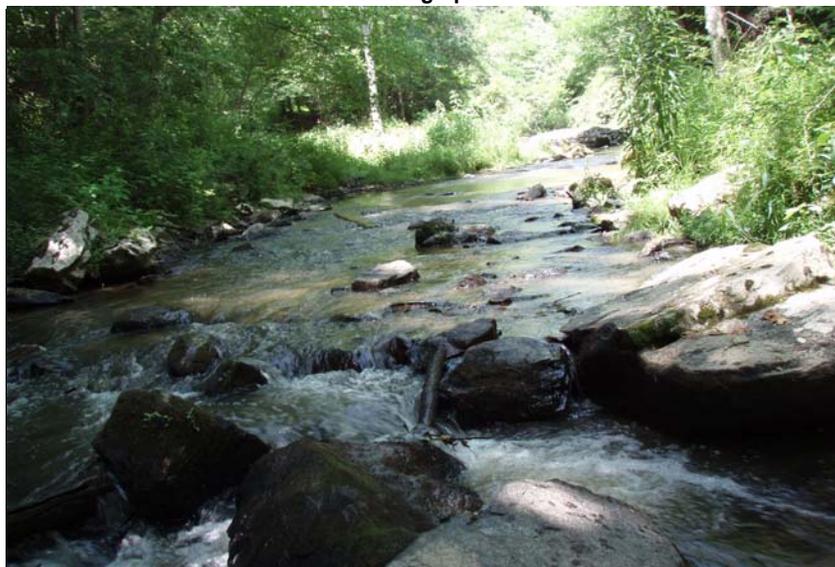
Temperature (°C)	23.7
Dissolved Oxygen (mg/L)	7.6
Specific Conductance (µS/cm)	72
pH (s.u.)	7.0

Water Clarity	slightly turbid
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Habitat Assessment Scores (max)

Channel Modification (5)	4
Instream Habitat (20)	16
Bottom Substrate (15)	12
Pool Variety (10)	9
Riffle Habitat (16)	14
Left Bank Stability (7)	7
Right Bank Stability (7)	6
Light Penetration (10)	9
Left Riparian Score (5)	3
Right Riparian Score (5)	5
Total Habitat Score (100)	85

Site Photograph



Substrate	Bedrock, boulder, rubble, gravel, and sand with a trace of silt.
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Sample Date	Sample ID	ST	EPT	BI	EPT BI	Bioclassification
06/16/08	10456	44	44	2.98	2.98	Excellent
08/17/04	9523	30	30	2.57	2.57	Good
07/13/99	7896	37	37	3.02	3.02	Good
08/09/94	6612	32	32	2.45	2.45	Good

Taxonomic Analysis

The 2008 sample resulted in the first Excellent bioclassification recorded from this location since monitoring commenced in 1994. In addition, the 2008 sample produced seven additional EPT taxa not previously recorded at this station and included the mayflies *Acentrella femorella*, *Proclaoen spp.*, *Eurylophella aestiva*, *E. minimella*, *Ephemera spp.*, *Epeorus dispar*, *Rhithrogena spp.*, as well as the caddisflies *Ceratopsyche morosa*, *C. slossonae*, *Dipterotrana modesta*, *Nectopsyche exquisita*, *Oecetis persimilis*, and *Trienodes ignitus*.

Data Analysis

Although Bethel Elementary (NC0066991001, MGD=0.0065) is approximately 2.9 miles upstream from this location, the 2008 data suggests that non-point pollution is the primary influence on the benthic macroinvertebrate community at this station. This conclusion is supported by the fact that despite the low flows associated with drought, the effluent from the small upstream discharger does not seem to be adversely affecting the invertebrate community as the 2008 sample not only resulted in the highest EPT diversity and EPT abundance (223 in 2008, next highest value was 156 in 1999) ever measured here, but the specific conductance was essentially identical from 2008 (72) to 2004 (69).

FISH COMMUNITY SAMPLE

Waterbody	Location	Date	Station ID	Bioclassification
BEAVERDAM CR	SR 1202	06/18/08	LF5	Not Rated

County	Subbasin	8 digit HUC	Latitude	Longitude	AU Number	Level IV Ecoregion
WATAUGA	1	06010103	36.278611	-81.868333	8-19	Southern Crystalline Ridges & Mountains

Stream Classification	Drainage Area (mi2)	Elevation (ft)	Stream Width (m)	Average Depth (m)	Reference Site
C;Tr	20.3	2700	6	0.5	No

Visible Landuse (%)	Forested/Wetland	Urban	Agriculture	Other (describe)
	100	0	0	0

Upstream NPDES Dischargers (>1MGD or <1MGD and within 1 mile)	NPDES Number	Volume (MGD)
None	---	---

Water Quality Parameters

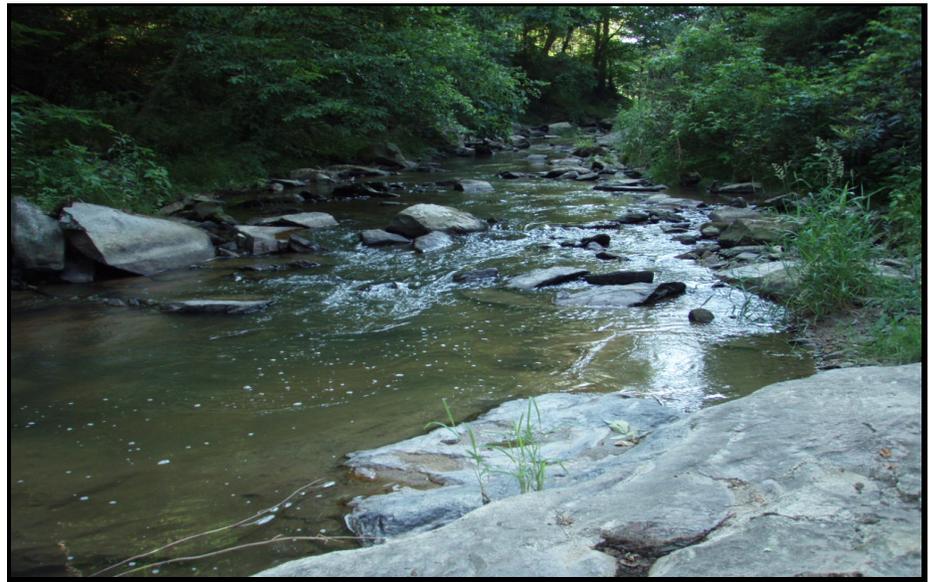
Temperature (°C)	15.3
Dissolved Oxygen (mg/L)	8.8
Specific Conductance (µS/cm)	77
pH (s.u.)	6.4

Water Clarity	Clear
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Habitat Assessment Scores (max)

Channel Modification (5)	5
Instream Habitat (20)	20
Bottom Substrate (15)	12
Pool Variety (10)	10
Riffle Habitat (16)	16
Left Bank Stability (7)	7
Right Bank Stability (7)	7
Light Penetration (10)	10
Left Riparian Score (5)	4
Right Riparian Score (5)	5
Total Habitat Score (100)	96

Site Photograph



Substrate	boulder, bedrock, cobble, sand, gravel, silt.
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Sample Date	Sample ID	Species Total	NCIBI	Bioclassification
06/18/08	2008-66	9	36	Not Rated
05/04/04	2004-36	8	26	Poor

Most Abundant Species	Western Blacknose Dace.
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Exotic Species	Rainbow Trout, Brown Trout.
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Species Change Since Last Cycle	Gains -- Brown Trout
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Data Analysis

Watershed -- a tributary to the Watauga River that drains the agricultural areas of Leander and Bethel, as well as the northern tip of Watauga County; this location is approximately 3.25 miles below the SR 1211 fish community site and exhibits forested habitat types unlike the farmed areas just upstream.

Habitats -- excellent quality riparian and instream habitats consisting of high gradient runs with plunge pools and cobble riffles; highest habitat score for the basin in 2008. **2008** -- a moderately diverse mix of primarily cold and cool water fish species, but no benthic dwelling darters, sculpin or madtoms collected.

2004-2008 -- with the exception of one Brown Trout captured in 2008, the same species were collected during these two basinwide cycles, including two intolerants (Rock Bass, and Rainbow Trout); however, higher abundances and a more balanced trophic structure was observed in 2008; although this site exhibits excellent quality habitats, the watershed continues to be influenced by agriculture; this site was Not Rated pending additional monitoring in the spring of 2009.

FISH COMMUNITY SAMPLE

Waterbody	Location	Date	Station ID	Bioclassification
BEECH CR	off SR 1312	06/18/08	LF4	Not Rated

County	Subbasin	8 digit HUC	Latitude	Longitude	AU Number	Level IV Ecoregion
AVERY	1	06010103	36.251948	-81.903565	8-20	Southern Crystalline Ridges & Mountains

Stream Classification	Drainage Area (mi2)	Elevation (ft)	Stream Width (m)	Average Depth (m)	Reference Site
C;Tr	15	2720	6	0.3	No

Visible Landuse (%)	Forested/Wetland	Urban	Agriculture	Other (describe)
	100	0	0	0

Upstream NPDES Dischargers (>1MGD or <1MGD and within 1 mile)	NPDES Number	Volume (MGD)
None	---	---

Water Quality Parameters

Temperature (°C)	15.3
Dissolved Oxygen (mg/L)	9.1
Specific Conductance (µS/cm)	61
pH (s.u.)	6.0

Water Clarity	Clear
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Habitat Assessment Scores (max)

Channel Modification (5)	5
Instream Habitat (20)	20
Bottom Substrate (15)	15
Pool Variety (10)	8
Riffle Habitat (16)	16
Left Bank Stability (7)	7
Right Bank Stability (7)	6
Light Penetration (10)	7
Left Riparian Score (5)	5
Right Riparian Score (5)	4
Total Habitat Score (100)	93

Site Photograph



Substrate	cobble, boulder.
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Sample Date	Sample ID	Species Total	NCIBI	Bioclassification
06/18/08	2008-67	7	--	Not Rated
05/04/04	2004-35	8	--	Not Rated

Most Abundant Species	Brown Trout.
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Exotic Species	Redbreast Sunfish, Rainbow Trout, Brown Trout.
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Species Change Since Last Cycle	Losses -- Longnose Dace.
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Data Analysis

Watershed -- located along the western edge of Watauga County and the northern tip of Avery County, draining the community of Beech Mountain; there are three minor (<1MGD) Beech Mountain NPDES facilities located three or more miles above this site. **Habitats** -- high quality instream habitats consisting of riffles, runs and a few side pools; less auto salvage debris in the stream than in 2004; a berm has been built above the right bank along the salvage yard property; good riparian coverages with full canopy and stable banks. **2008** -- a moderately diverse fish community for this high gradient trout stream with a majority of cold water species, but also abundant Redbreast Sunfish (warmwater species, n=59), and three times the number of Brown Trout as in 2004 (n=95 vs. 29). **2004-2008** -- a total of eight species have been collected at this site, including two species of trout (one of which is intolerant to pollution), and three minnow species, but no benthic inhabiting species such as sculpin.

BENTHIC MACROINVERTEBRATE SAMPLE

Waterbody	Location	Station ID	Date	Bioclassification
BEECH CR	US 321	LB2	07/29/08	Excellent

County	Subbasin	8 digit HUC	Latitude	Longitude	AU Number	Level IV Ecoregion
WATAUGA	1	6010103	36.26111111	-81.89666667	20-Aug	Southern Crystalline Ridges and Mountains

Stream Classification	Drainage Area (mi2)	Elevation (ft)	Stream Width (m)	Stream Depth (m)
C; Tr	20.2	2,519	6	0.5

Visible Landuse (%)	Forested/Wetland	Urban	Agriculture	Other (describe)
	90	10	0	

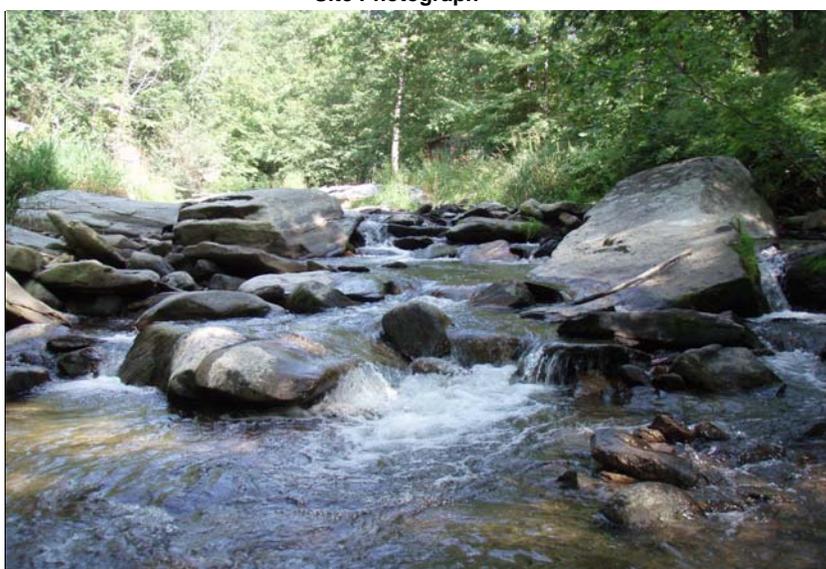
Upstream NPDES Dischargers (>1MGD or <1MGD and within 1 mile)	NPDES Number	Volume (MGD)
NONE	N/A	N/A

Water Quality Parameters

Temperature (°C)	21.8
Dissolved Oxygen (mg/L)	7.5
Specific Conductance (µS/cm)	82
pH (s.u.)	6.9

Water Clarity	Clear
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Site Photograph



Habitat Assessment Scores (max)

Channel Modification (5)	5
Instream Habitat (20)	15
Bottom Substrate (15)	14
Pool Variety (10)	10
Riffle Habitat (16)	15
Left Bank Stability (7)	5
Right Bank Stability (7)	7
Light Penetration (10)	7
Left Riparian Score (5)	2
Right Riparian Score (5)	2
Total Habitat Score (100)	82

Substrate	Boulder, cobble, gravel, sand and bedrock.
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Sample Date	Sample ID	ST	EPT	BI	EPT BI	Bioclassification
07/29/08	10482	52	52	2.98	2.98	Excellent
08/17/04	9513	41	41	2.01	2.01	Excellent
07/15/99	7903	38	38	2.41	2.41	Excellent
08/11/94	6641	94	46	3.12	2.43	Excellent

Taxonomic Analysis

The bioclassification has been identical here at every collection. However, there has been some fluctuation in the EPTBI and EPT taxa richness among the last three EPT samples (1999, 2004, and 2008). Numerous EPT taxa were collected here for the first time in 2008 and included the mayflies *Drunella allegheniensis*, *Maccaffertium ithaca*, *Stenacron carolina*, and the caddisflies *Hydroptila sp.*, *Leucotrichia pictipes*, *Lype diversa*, *Psychomyia flavida*, *Rhyacophila carolina*, and *R. ledra*.

Data Analysis

Although there are no dischargers on Beech Creek, there is one small NPDES facility (Town of Beech Mountain, NC0069761001, MGD 0.4) located approximately six miles upstream on a small tributary (Pond Creek). Although the drought has been severe statewide, it has been at its most acute in the mountain region. While the EPT taxa richness increased in 2008, several of these new taxa are pollution facultative species (e.g., *Hydroptila sp.*, *Leucotrichia pictipes*, and *Lype diversa*) and their presence in part accounts for the elevated EPTBI. This shift to a slightly more facultative community as measured by the EPTBI may be the result of marginally higher concentrations of instream waste from the small upstream discharger due to the reduced drought flows. However, the specific conductance data was only slightly elevated in 2008 (82 µS/cm) relative to the 2004 measurement (79 µS/cm).

BENTHIC MACROINVERTEBRATE SAMPLE

Waterbody	Location	Station ID	Date	Bioclassification
ELK R	NC 184	LB7	07/30/08	Good

County	Subbasin	8 digit HUC	Latitude	Longitude	AU Number	Level IV Ecoregion
AVERY	1	6010103	36.15277778	-81.86527778	8-22-(3)	Southern Metasedimentary Mountains

Stream Classification	Drainage Area (mi2)	Elevation (ft)	Stream Width (m)	Stream Depth (m)
C; Tr	7.4	3,658	4	0.3

Visible Landuse (%)	Forested/Wetland	Urban	Agriculture	Other (describe)
	10	50	40	

Upstream NPDES Dischargers (>1MGD or <1MGD and within 1 mile)	NPDES Number	Volume (MGD)
NONE	N/A	N/A

Water Quality Parameters

Temperature (°C)	19.2
Dissolved Oxygen (mg/L)	8.2
Specific Conductance (µS/cm)	105
pH (s.u.)	7.3

Water Clarity	Clear
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Site Photograph



Habitat Assessment Scores (max)

Channel Modification (5)	4
Instream Habitat (20)	12
Bottom Substrate (15)	10
Pool Variety (10)	3
Riffle Habitat (16)	14
Left Bank Stability (7)	4
Right Bank Stability (7)	5
Light Penetration (10)	1
Left Riparian Score (5)	1
Right Riparian Score (5)	3
Total Habitat Score (100)	57

Substrate	Gravel, sand, cobble, boulder and silt.
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Sample Date	Sample ID	ST	EPT	BI	EPT BI	Bioclassification
07/30/08	10484	99	34	5.02	3.92	Good
08/16/04	9511	71	24	5.39	4.09	Good-Fair
07/14/99	7897	102	44	4.33	3.50	Excellent
08/10/94	6639	77	33	4.61	4.16	Good

Taxonomic Analysis

The 2008 sample improved substantially from the 2004 sample, was comparable to the 1994 sample, but did not match the community metrics measured in 1999. EPT taxa present in 2008, 1999, and 1994 but absent in 2004 included the mayflies *Pseudocloeon frondale*, *Ephemera sp.*, *Leucrocota sp.*, *Maccaffertium pudicum*, *Isonychia sp.* the stoneflies *Leuctra sp.* and *Acroneuria abnormis*, and the caddisflies *Cheumatopsyche sp.*, and *Hydropsyche betteni*. The absence of these taxa (many of which require flow) in 2004 suggests low flow conditions. However, based on average annual flow data garnered from the only USGS gauge in the basin (Watauga River, near Sugar Grove), flows were actually higher in 2003 and 2004 relative to flows measured in 2007 and 2008, 1998 and 1999, as well as 1993 and 1994. This suggests that the increased flows in 2003 and 2004 resulted in more non-point pollution impacts thereby suppressing the EPT community. This finding is consistent with the landuse in this catchment which includes numerous non-point sources.

Data Analysis

There are no permitted dischargers upstream of this location and landuse is a mix of commercial and residential associated with Banner Elk and the NC 184 corridor. This watershed also includes lesser areas of forest and pasture. Given the largely suburban composition of this watershed, coupled with lower flows and higher bioclassifications seen in 1994, 1999, and 2008 (versus the higher flows and declining bioclassification measured in 2004) strongly suggests that non-point pollution is the primary influence upstream of this location.

FISH COMMUNITY SAMPLE

Waterbody	Location	Date	Station ID	Bioclassification
ELK R	SR 1326	06/19/08	LF3	Not Rated

County	Subbasin	8 digit HUC	Latitude	Longitude	AU Number	Level IV Ecoregion
AVERY	1	06010103	36.171438	-81.917373	8-22-(14.5)	Southern Crystalline Ridges & Mountains

Stream Classification	Drainage Area (mi2)	Elevation (ft)	Stream Width (m)	Average Depth (m)	Reference Site
B;Tr	18.7	3327	12	0.5	No

Visible Landuse (%)	Forested/Wetland	Rural Residential	Agriculture	Other (describe)
	85	2	13	0

Upstream NPDES Dischargers (>1MGD or <1MGD and within 1 mile)	NPDES Number	Volume (MGD)
None	---	---

Water Quality Parameters

Temperature (°C)	15.1
Dissolved Oxygen (mg/L)	9.3
Specific Conductance (µS/cm)	97
pH (s.u.)	6.9

Water Clarity	Clear
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Habitat Assessment Scores (max)

Channel Modification (5)	5
Instream Habitat (20)	20
Bottom Substrate (15)	12
Pool Variety (10)	10
Riffle Habitat (16)	16
Left Bank Stability (7)	6
Right Bank Stability (7)	6
Light Penetration (10)	5
Left Riparian Score (5)	5
Right Riparian Score (5)	5
Total Habitat Score (100)	90

Site Photograph



Substrate	cobble, sand, boulder.
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Sample Date	Sample ID	Species Total	NCIBI	Bioclassification
06/19/08	2008-70	8	--	Not Rated
05/03/04	2004-34	11	--	Not Rated

Most Abundant Species	Central Stoneroller.
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Exotic Species	Redbreast Sunfish, Rainbow Trout, Brown Trout
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Species Change Since Last Cycle	Gains -- none. Losses -- Rock Bass, Rosyside Dace, Creek Chub.
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Data Analysis

Watershed -- Flows east into Tennessee and drains the north-western edge of Avery County, including the towns of Banner Elk and Sugar Mountain; there are three minor NPDES facilities above this site (minimum of 1.6 miles upstream) servicing Banner Elk and Sugar Mountain. **Habitats** -- high quality instream habitats consisting of cobble riffles, runs, large boulder pools, and a few slower flowing side channel braids; mostly sunlit due to the width of the river and its flood plain; good riparian widths and stable banks. **2008** -- a moderately diverse mix of cold, cool, and warm water species with a majority representation of Central Stonerollers (68% of the sample, n=614). **2004-2008** -- a total of eleven species are known from this watershed, including two species of sucker, three species of sunfish, four species of minnow, two species of trout (one is considered intolerant to pollution), but no darters, sculpin or madtoms; a slightly higher conductivity and the upsurge of herbivorous Central Stonerollers since 2004 is perhaps an indication of increased nutrient inputs to the river.

BENTHIC MACROINVERTEBRATE SAMPLE

Waterbody	Location	Station ID	Date	Bioclassification
ELK R	SR 1305	LB6	07/30/08	Excellent

County	Subbasin	8 digit HUC	Latitude	Longitude	AU Number	Level IV Ecoregion
AVERY	1	6010103	36.19166667	-81.97305556	8-22-(14.5)	Southern Crystalline Ridges and Mountains

Stream Classification	Drainage Area (mi2)	Elevation (ft)	Stream Width (m)	Stream Depth (m)
B; Tr	48	2,756	12	0.4

Visible Landuse (%)	Forested/Wetland	Urban	Agriculture	Other (describe)
	90	0	10	0

Upstream NPDES Dischargers (>1MGD or <1MGD and within 1 mile)	NPDES Number	Volume (MGD)
NONE	N/A	N/A

Water Quality Parameters

Temperature (°C)	25.3
Dissolved Oxygen (mg/L)	8.5
Specific Conductance (µS/cm)	97
pH (s.u.)	8.4

Water Clarity	Clear
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Site Photograph



Habitat Assessment Scores (max)

Channel Modification (5)	4
Instream Habitat (20)	16
Bottom Substrate (15)	13
Pool Variety (10)	5
Riffle Habitat (16)	14
Left Bank Stability (7)	7
Right Bank Stability (7)	5
Light Penetration (10)	3
Left Riparian Score (5)	5
Right Riparian Score (5)	3
Total Habitat Score (100)	75

Substrate	Cobble, boulder, gravel, sand, silt and bedrock.
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Sample Date	Sample ID	ST	EPT	BI	EPT BI	Bioclassification
07/30/08	10486	110	53	4.42	3.46	Excellent
08/16/04	9510	103	43	4.30	3.16	Good
07/14/99	7898	88	44	3.86	3.09	Excellent
08/10/94	6613	36	36	2.95	2.95	Excellent

Taxonomic Analysis

The 2008 Full-Scale sample produced nine more EPT taxa than the previous high for this metric measured in 1999. These included many facultative EPT taxa such as the mayflies *Pseudocloeon propinquum*, *Maccaffertium modestum*, and the caddisflies *Hydroptila sp.*, *Leucotrichia pictipes*, *Nectopsyche exqusita*, *Oecetis persimilis*, *Triadenotes ignitus*, and *T. perna/helo*. The addition of these taxa in part resulted in an increase in the BI and EPTBI in 2008. Moreover, there were many intolerant EPT taxa not previously collected here and included the mayflies *Ephemera sp.*, *Anthopotamus distinctus*, the stoneflies *Suwallia sp.*, *Tallaperla sp.*, and the caddisflies *Hydropsyche scalaris*, *Hydatophylax argus*, *Rhyacophila formosa*, and *Neophylax consimilis*. The 2008 sample also resulted in the highest EPT abundance yet to be measured at this location.

Data Analysis

This station was moved about three-fourths of a mile downstream from the previous sampling location as access was extremely favorable. This segment of the Elk River is just over 10 river miles downstream of two small NPDES facilities (Banner Elk, NC0032115001; MGD=0.6, and Elk River Utilities, Inc., NC0058378001; MGD=0.08). As would be expected, during drought conditions and reduced river discharge, the effluent from the upstream facilities appears to be more concentrated than in previous years as specific conductance was 97 (µS/cm) in 2008 but only 83 (µS/cm) in 2004, and 55 (µS/cm) in 1999. Despite this, it would appear that non-point pollution exerts the strongest overall influence on the invertebrate community and the large improvement in EPT taxa richness and abundance is likely due to reduced non-point pollution.

FISH COMMUNITY SAMPLE

Waterbody	Location	Date	Station ID	Bioclassification
CRANBERRY CR	NC 194	06/19/08	LF2	Not Rated

County	Subbasin	8 digit HUC	Latitude	Longitude	AU Number	Level IV Ecoregion
AVERY	1	06010103	36.162919	-81.956664	8-22-16	Southern Crystalline Ridges & Mountains

Stream Classification	Drainage Area (mi2)	Elevation (ft)	Stream Width (m)	Average Depth (m)	Reference Site
C;Tr	9.8	3001	5	0.4	No

Visible Landuse (%)	Forested/Wetland	Rural Residential	Agriculture	Other (describe)
	80	20	0	0

Upstream NPDES Dischargers (>1MGD or <1MGD and within 1 mile)	NPDES Number	Volume (MGD)
None	---	---

Water Quality Parameters

Temperature (°C)	12.8
Dissolved Oxygen (mg/L)	9.2
Specific Conductance (µS/cm)	81
pH (s.u.)	5.9

Water Clarity	Clear
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Habitat Assessment Scores (max)

Channel Modification (5)	5
Instream Habitat (20)	17
Bottom Substrate (15)	8
Pool Variety (10)	6
Riffle Habitat (16)	16
Left Bank Stability (7)	6
Right Bank Stability (7)	5
Light Penetration (10)	7
Left Riparian Score (5)	4
Right Riparian Score (5)	2
Total Habitat Score (100)	76

Site Photograph



Substrate	cobble, sand, gravel.
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Sample Date	Sample ID	Species Total	NCIBI	Bioclassification
06/19/08	2008-69	6	--	Not Rated
05/03/04	2004-33	6	--	Not Rated

Most Abundant Species	Brown Trout.	Exotic Species	Rainbow Trout, Brown Trout.
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Species Change Since Last Cycle	N/A
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Data Analysis

Watershed -- a tributary to the Elk River that drains part of rural north-central Avery County. **Habitats** -- riffle runs with side snag pools, and one large pool; left bank with good riparian coverage and bank stability; the right bank in this reach is mowed with minor sloughing of sediments, and offers no shade to the stream; moderate to high substrate embeddedness. **2008** -- a moderate to low diversity trout stream with a majority of cold water fish species, but no benthic inhabitants, such as darters or sculpin. **2004-2008** -- the same six species have been collected from this site on two occasions including two species of trout (one of which is considered intolerant to pollution), two species of sucker, and two minnow species; the NCIBI metrics are identical between the 2004 and 2008 samples, indicating that little has changed in this watershed since the last basinwide cycle.

FISH COMMUNITY SAMPLE

Waterbody	Location	Date	Station ID	Bioclassification
LITTLE ELK CR	off SR 1305	06/18/08	LF13	Not Rated

County	Subbasin	8 digit HUC	Latitude	Longitude	AU Number	Level IV Ecoregion
AVERY	1	06010103	36.168145	-81.965099	8-22-17	Southern Crystalline Ridges and Mountains

Stream Classification	Drainage Area (mi2)	Elevation (ft)	Stream Width (m)	Average Depth (m)	Reference Site
C;Tr	4.4	2909	3	0.2	No

Visible Landuse (%)	Forested/Wetland	Rural Residential	Agriculture	Other (describe)
	90	10	0	0

Upstream NPDES Dischargers (>1MGD or <1MGD and within 1 mile)	NPDES Number	Volume (MGD)
Town of Elk Park WWTP (~0.6 mile upstream)	NC0079561	0.1

Water Quality Parameters

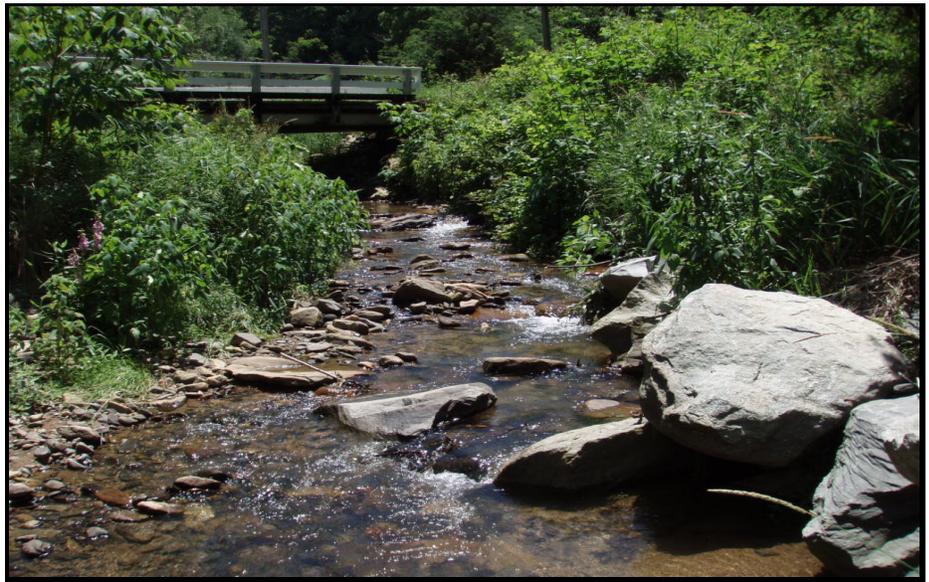
Temperature (°C)	17.7
Dissolved Oxygen (mg/L)	8.4
Specific Conductance (µS/cm)	111
pH (s.u.)	6.9

Water Clarity	Clear
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Habitat Assessment Scores (max)

Channel Modification (5)	5
Instream Habitat (20)	19
Bottom Substrate (15)	15
Pool Variety (10)	6
Riffle Habitat (16)	16
Left Bank Stability (7)	6
Right Bank Stability (7)	7
Light Penetration (10)	7
Left Riparian Score (5)	3
Right Riparian Score (5)	2
Total Habitat Score (100)	86

Site Photograph



Substrate	cobble, boulder, gravel.
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Sample Date	Sample ID	Species Total	NCIBI	Bioclassification
06/18/08	2008-68	8	--	Not Rated

Most Abundant Species	Western Blacknose Dace.	Exotic Species	Redbreast Sunfish, Brown Trout.
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Species Change Since Last Cycle	N/A
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Data Analysis

New basinwide site. **Watershed** -- a small high gradient trout stream that drains north central Avery County, including the town of Elk Park; this site is located just above the stream's confluence with the Elk River. **Habitats** -- high quality instream habitats consisting of riffles, plunge pools and short runs; the lower half of the reach is sunlit, and the upper half was dark with a very dense canopy, good riparian, and stable banks. **2008** -- 72% (n=348) of the collected fish population was represented by Western Blacknose Dace, and about 17% (n=80) of the sample was Mottled Sculpin (both of these fish are designated as cold water species); one intolerant species was collected (Rock Bass); although Not Rated, this small, high gradient trout stream is supporting a moderately diverse fish community; however, it appears that the Elk Park WWTP is elevating the stream's conductivity.