

**Application of an Alternative Macroinvertebrate Sampling Method in  
the Chattooga River and Conasauga River Watersheds, Chattahoochee  
National Forest, GA**



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## Table of Contents

List of Tables.....	3
List of Figures .....	4
Introduction .....	5
Study Sites.....	5
Methods.....	6
Results .....	7
Discussion and Recommendations.....	7
Literature Cited .....	9
Appendix A: Comparison of Macroinvertebrate Metrics Between Years .....	17
Appendix B: Macroinvertebrate Species Counts and Metrics .....	36
Appendix C: Particle Size Distributions from Pebble Count Data.....	59

## List of Tables

Table 1. Number of macroinvertebrate sample sites per stream for streams sampled in the Chattooga River watershed.....	10
Table 2. Comparison of results for metrics used by the EPA to rank streams in the Chattooga River watershed.....	11
Table 3. Rankings for metric results from Table 2.....	11
Table 4. Final biological score and narrative ranking of streams in Chattooga River watershed, based on results and rankings in Tables 2 & 3. ....	11
Table 5. Comparison of metric results showing focusing on EPT metrics .....	12
Table 6. Pebble count and cobble embeddedness results for sites sampled in the Chattooga River watershed.....	13
Table 7. Pebble count and cobble embeddedness results for sites sampled in the Conasauga River watershed.....	13

### Appendix A:

Table A1. Macroinvertebrate metric results for Addie Branch.....	18
Table A2. Macroinvertebrate metric result rankings for Addie Branch.....	19
Table A3. Final biological score and narrative ranking of Addie Branch.....	20
Table A4. Macroinvertebrate metric results for Bailey Branch .....	21
Table A5. Macroinvertebrate metric result rankings for Bailey Branch .....	22
Table A6. Final biological score and narrative ranking of Bailey Branch .....	23
Table A7. Macroinvertebrate metric results for Martin-Finney Creek .....	24
Table A8. Macroinvertebrate metric result rankings for Martin-Finney Creek .....	25
Table A9. Final biological score and narrative ranking of Martin-Finney Creek .....	26
Table A10. Macroinvertebrate metric results for Reed Mill Branch.....	27
Table A11. Macroinvertebrate metric result rankings for Reed Mill Branch .....	28
Table A12. Final biological score and narrative ranking of Reed Mill Branch .....	29
Table A13. Macroinvertebrate metric results for Roach Mill Branch.....	30
Table A14. Macroinvertebrate metric result rankings for Roach Mill Branch .....	31
Table A15. Final biological score and narrative ranking of Roach Mill Branch .....	32
Table A16. Macroinvertebrate metric results for Rock Mountain Creek.....	33
Table A17. Macroinvertebrate metric result rankings for Rock Mountain Creek.....	34
Table A18. Final biological score and narrative ranking of Rock Mountain Creek.....	35

### Appendix B:

Table B1. Definitions of metrics used to interpret macroinvertebrate samples .....	37
Table B2. Macroinvertebrates collected from Addie Branch.....	38
Table B3. Macroinvertebrate metrics for samples collected from Addie Branch .....	40
Table B4. Macroinvertebrates collected from Bailey Branch .....	41
Table B5. Macroinvertebrate metrics for samples collected from Bailey Branch, .....	43
Table B6. Macroinvertebrates collected from Martin-Finney Creek .....	44
Table B7. Macroinvertebrate metrics for samples collected from Martin-Finney Creek.....	46
Table B8. Macroinvertebrates collected from Reed Mill Branch .....	47
Table B9. Macroinvertebrate metrics for samples collected from Reed Mill Branch.....	49
Table B10. Macroinvertebrates collected from Roach Mill Branch .....	50
Table B11. Macroinvertebrate metrics for samples collected from Roach Mill Branch.....	52
Table B12. Macroinvertebrates collected from Rock Mountain Creek, April 2001. ....	53
Table B13. Macroinvertebrate metrics for samples collected from Rock Mtn Creek.....	55
Table B14. Macroinvertebrates collected from rivers in the Conasauga River watershed .....	56
Table B15. Macroinvertebrate metrics for samples collected from Conasauga River watershed .....	58

### Appendix C:

Table C1. Substrate particle size class categories .....	60
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## List of Figures

Figure 1. Location of the Chattooga River and Conasauga River watersheds .....	14
Figure 2. Location of streams surveyed in the West Fork and Warwoman sub-watersheds .....	15
Figure 3. Location of streams surveyed in the Upper Conasauga River watershed .....	16

**Appendix A:** none

**Appendix B:** none

### **Appendix C:**

Figure C1. Frequency of substrate occurrence for Addie Branch .....	61
Figure C2. Frequency of substrate occurrence for Bailey Branch .....	62
Figure C3. Frequency of substrate occurrence for Martin-Finney Creek.....	63
Figure C4. Frequency of substrate occurrence for Reed Mill Creek.....	64
Figure C5. Frequency of substrate occurrence for Roach Mill Creek.....	65
Figure C6. Frequency of substrate occurrence for Rock Mountain Creek.....	66
Figure C7. Frequency of substrate occurrence for streams in the Conasauga River watershed.....	67

## **Introduction**

In 1999, the U. S. Environmental Protection Agency (EPA) completed a report assessing water quality conditions in the Chattooga River watershed (U. S. EPA 1999) in response to the settlement of the Georgia total maximum daily load (TMDL) lawsuit (Sierra Club v. Hakinson: CA 94-12501-1-CV-MHS). The EPA had collected macroinvertebrate, sediment, and channel condition data at sample stations within six designated sub-watersheds of the Chattooga River watershed to assess water quality. Results of the report were used to list streams that currently had, or were in danger of developing water quality problems. In 2000, at the request of the Chattahoochee-Oconee National Forest (CONF), the USFS Center for Aquatic Technology Transfer (CATT) further examined streams within two Chattooga River sub-watersheds by expanding upon the methodologies set forth in the 1999 EPA report (Whalen et al. 2002). Macroinvertebrate samples for both U. S. EPA (1999) and Whalen et al. (2002) were collected using a modified version of the Rapid Bioassessment Protocol III (RPB III) similar to that described in Plafkin et al. (1989). This protocol calls for materials to be collected from five habitat types: 1) deep riffle, 2) shallow riffle, 3) pool bottoms, 4) leaf litter, and 5) LWD.

In 2001, CONF resource managers requested that CATT investigate alternative methods for sampling stream macroinvertebrates. Samples collected using the EPA methodology often contained large amounts of sand and debris, which made sample collection, storage, and analysis time consuming and difficult. In addition, we questioned whether consistently sampling from the same five habitat types would allow us to observe differences in the macroinvertebrate communities between streams. We collaborated with Dr. Reese Voshell (Aquatic Entomology, Virginia Tech) to develop an alternative macroinvertebrate sampling methodology for CONF. We collected macroinvertebrates from several streams that were sampled in both U. S. EPA (1999) and Whalen et al. (2002) to examine for differences between results and investigate the practicality of the methodology. We also applied the methodology to several streams within the Conasauga River watershed to further test the new methodology.

## **Study Sites**

The Chattooga River watershed is located in northeast Georgia, northwest South Carolina, and southwest North Carolina (Figure 1). The Warwoman Creek and West Fork sub-watersheds are located within Georgia and North Carolina. In April 2001 we surveyed three streams in the West Fork and four streams in the Warwoman sub-watersheds (Table 1, Figure 2). All of the streams had been previously sampled in 1997 (U. S. EPA 1999) and/or 2000 (Whalen et al. 2002) and were located within the Chattahoochee-Oconee National Forest, GA. The downstream end of each surveyed reach was typically at a Forest Service boundary, or at the furthest downstream point of the stream if it was entirely on CONF lands.

The Upper Conasauga River watershed is located in northwest Georgia and southwest Tennessee (Figure 1). We collected macroinvertebrate and sediment samples from a single site in each of

four streams, including one site on the mainstem of the Conasauga River (Figure 3). All sample sites were located within the boundaries of the Cohutta Wilderness Area, Chattahoochee-Oconee National Forest, GA, and corresponded to previously established air and water quality (AWQ) sample sites. The Bear Branch sample site was located approximately 300 m upstream of its confluence with Jacks River. The Beech Branch sample site was located approximately 300 m downstream of the Beech Bottom trail crossing. The Conasauga River mainstem sample site was located at the confluence with an unnamed tributary (on right side of stream, as oriented upstream) just upstream of the Chestnut Lead Trail crossing. The Hickory Creek sample site was located approximately 75 m upstream from its confluence with the Conasauga River.

### **Methods**

Macroinvertebrate samples taken in September 1997 (U. S. EPA 1999), and May-September 2000 (Whalen et al. 2002) were collected using the rapid bioassessment protocols detailed in the standard operating procedures of the EPA's Region 4 Science and Ecosystem Support Division (U. S. EPA 1999). The protocol was a modified version of the Rapid Bioassessment Protocol III (RBP III) similar to that described in Plafkin et al. (1989). It called for materials to be collected from five habitat types: 1) deep riffle, 2) shallow riffle, 3) pool bottoms, 4) leaf litter, and 5) LWD. A D-frame net was used to collect materials from each habitat type within a 100 m reach of stream. Habitat specific samples were then combined into a single sample for each 100 m reach. Samples were collected at one site per stream in 1997. Multiple samples per stream (at least one per kilometer) were collected in 2000.

Macroinvertebrate samples for the present survey were collected in April 2001 using a methodology developed in collaboration with Dr. Reese Voshell, Department of Entomology, Virginia Tech. A 100 m long sample site was randomly selected from within the first kilometer of each stream survey section and subsequent sample sites were located at least once per kilometer thereafter. Samples were collected every three meters within the 100 m sample site, for a total of 33 samples per site. We used a random numbers table to determine the location of the sample within the wetted channel (distance from right bank) for each of the 33 samples. All 33 samples collected within the 100 m reach were combined to form a single composite sample for each site.

Samples were collected by a two-person crew using a D-frame dipnet. One individual held the dipnet with the opening facing upstream and timed the second individual, who disturbed the substrate within a 0.3 m<sup>2</sup> area in front of the dipnet. If the substrate in front of the net was completely sand, it was agitated to a depth of 5-10 cm (finger length) for 5 seconds. We collected all other samples by disturbing the area in front of the net for 15 seconds; cobbles, boulders, woody debris, and large organic materials were lifted and thoroughly rubbed, and smaller substrates were agitated, taking care to sweep sample materials into the dipnet. We also collected pebble count and cobble embeddedness data using methods described in Whalen et al. (2002) to characterize the substrate composition of sample reaches.

Samples from 2000 and the present survey were analyzed under the supervision of Dr. Reese Voshell, Department of Entomology, Virginia Polytechnic Institute and State University. The lab subsampled 200 organisms from each sample and identified each organism to the lowest possible taxonomic level. The lab calculated 17 metrics for each sample and provided the results of the analysis in the form of a written report provided to the CATT. We used five of the 17 metrics for comparison with 1997 and 2000 results. Scoring criteria used to compare 1997 and 2000 results to present survey results are presented in U. S. EPA (1999).

## **Results**

The majority of the metrics were not consistently different between years, however percent EPT taxa was distinctly lower in 2001 than in the 1997 or 2000 samples (Tables 2 & 3). This was not reflected in the number of EPT taxa collected, which was generally higher in 2001. The difference between 2000 and 2001 could be accounted for by an increase in the number of non-EPT individuals and a simultaneous decrease in the number of EPT individuals (Table 5). In addition, the number of clinger taxa collected was consistently higher in 1997 than in 2000 or 2001. These results were reflected in lower rankings for percent EPT in 2001 and higher rankings for number of clinger taxa in 1997 and number of EPT taxa in 2001 (Table 3), using the ranking procedures described in U. S. EPA (1999). Overall biological scores and biological ratings in 2001 were lower for four streams compared to 1997, and were lower for one stream when compared to 2000 (Table 4).

Results for Conasauga River watershed are presented in Appendix B. A total of 17 metrics were calculated for the data. Ranking criteria, which were only developed for Chattooga watershed streams, were not applied to these data.

## **Discussion and Recommendations**

There were several confounding factors that made it difficult for us to determine whether differences in results between years were because of changes in methodology or factors such as difference in time of year samples were collected, intensity of sampling, or actual changes in stream conditions over time. Samples from 1997 were collected in September, whereas samples taken in 2000 were collected from May-September, and samples from 2001 were collected during April. Seasonal changes in the macroinvertebrate community made it difficult to compare data collected during different times of year. Samples should be collected during the same time period every year, and should be collected when the largest portion of the macroinvertebrate community is in a size range that can be captured and identified efficiently (Barbour et al. 1999, Gibson et al. 1996). In the mountains of northern Georgia this time period occurs during early spring (Dr. Reese Voshell, Department of Entomology, Virginia Tech, pers. comm.).

One sample site was used to rate entire streams in 1997, whereas the median scores from multiple sites were used in 2000 and 2001. Whalen et al. (2002) demonstrated that while overall stream rankings

may remain the same (based on U. S. EPA (1999) ranking criteria), using multiple sample sites could reveal within stream variability that was not possible to observed using a single sample site.

Finally, given that we compared data collected over a period of four years, the observed decreases in overall scores may reflect chronic stream degradation. However, this scenario seemed unlikely given the low amount of management activity on the CONF over the past several years. CONF has been unable to harvest timber and has been working to improve and close forest roads since the initiation of the TMDL lawsuits (Charlene Neihardt, pers. comm.).

The new macroinvertebrate collection methodology presented here was practical and repeatable. Although we took 33 samples per reach (combined into one composite sample per reach for analysis), the amount of extraneous material (sand, woody debris, detritus) that we collected was much less than that using the EPA bioassessment protocol used in 1997 and 2000. This made transport, storage, and analysis of samples much more efficient. We provided stringent guidelines for the amount of area to be sampled and time spent collecting samples, which minimized potential sampling biases.

In addition, our random sampling technique allowed us to sample habitats in proportion to their presence in the stream. During the 1997 and 2000 surveys crews followed a slightly modified version of the established EPA RBP III protocol (Plafkin 1989), which directed them to collect from the same amount of material from the same habitat types in every stream reach, even if the habitat types were poorly represented in the reach. The EPA modified RBP macroinvertebrate sampling protocols in 1999 (the modified RBP method was not used to collect any samples reported here), instructing crews to estimate the proportion of each habitat type present in each reach and to distribute sampling effort appropriately (Barbour et al. 1999). However, observer bias could still allow for disproportionate sampling of habitat types within the reach.

Pebble count data (Appendix C) was collected in the same reaches from which macroinvertebrate samples were taken in an effort to describe the physical habitat contained within the reach. We could more fully describe the habitat conditions in the sample reaches by dividing the reach into habitat units and characterizing variables such as surface area, maximum and average depth, wetted width, bankful channel width, dominant and subdominant substrate, and LWD. The crew members could easily record these variables while collecting the macroinvertebrate samples by slightly modifying methods outlined in the 'Habitat' section of Whalen et al. (2002).

Research projects currently underway at the University of Georgia and Virginia Tech should help to provide further direction to the macroinvertebrate sampling programs in the CONF. Until the results of these studies are presented and incorporated into the sampling strategy, we recommend using the methodology and improvements described here to collect macroinvertebrate samples on the CONF.

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Table 1. Number of macroinvertebrate sample sites per stream for streams sampled in the Chattooga River watershed; from U. S. EPA (1999) (year 1997 streams), Whalen et al. (2002) (year 2000 streams), and present survey (year 2001 streams).

Sub-watershed	Stream	1997	2000	2001
Warwoman	Martin-Finney Creek	1	11	4
	Rock Mountain Creek	1	11	3
	Roach Mill Branch	1	2	3
	Warwoman Creek	1	2	0
West Fork	Addie Branch	1	7	4
	Bailey Branch	0	4	2
	Law Ground Creek	1	4	0
	Reed Mill Creek	1	5	3

Table 2. Comparison of results for metrics used by the EPA to rank streams in the Chattooga River watershed. Scores presented here represent the median score of several sites on each stream for 2000 (Whalen et al. 2002) and 2001 (present survey). One site per stream was used in 1997 (U. S. EPA 1999). Individual site scores are located in Appendix B.

	# EPT Taxa			% EPT Taxa			% 2 Dominant Taxa			NCBI			# Clinger Taxa		
	1997	2000	2001	1997	2000	2001	1997	2000	2001	1997	2000	2001	1997	2000	2001
Addie Br.	16	18	20	73.60	61.54	27.42	25.28	49.25	30.85	4.30	3.06	2.85	20	9	12
Bailey Br.	na	13	23	na	42.19	25.98	na	50.95	39.95	na	4.09	3.71	na	5	10
Martin-Finney Cr.	14	16	20	37.09	69.19	29.85	19.25	42.78	36.52	4.30	2.82	3.15	15	7	12
Reed Mill Br.	16	12	15	76.97	63.91	42.50	39.89	35.16	24.87	3.34	2.92	2.87	16	8	8
Roach Mill Br.	15	16	19	67.70	37.18	25.39	49.07	28.43	35.47	4.37	4.24	3.30	13	9	11
Rock Mt. Cr.	14	12	17	37.09	46.53	22.11	19.25	43.17	39.47	4.30	3.33	3.71	15	5	10

Table 3. Rankings for metric results from Table 2. Ranking criteria are presented in U. S. EPA (1999).

	# EPT Taxa			% EPT Taxa			% 2 Dominant Taxa			NCBI			# Clinger Taxa		
	1997	2000	2001	1997	2000	2001	1997	2000	2001	1997	2000	2001	1997	2000	2001
	(0-6)	(0-6)	(0-6)	(0-6)	(0-6)	(0-6)	(0-6)	(0-6)	(0-6)	(0-6)	(0-6)	(0-6)	(0-6)	(0-6)	(0-6)
Addie Br.	4	6	6	6	4	2	4	2	4	4	6	6	6	2	2
Bailey Br.		3	6		2	1		2	2		6	6		0	2
Martin-Finney Cr.	4	4	6	2	4	2	4	2	2	4	6	6	4	2	2
Reed Mill Br.	4	2	4	6	4	2	2	2	4	6	6	6	4	2	2
Roach Mill Br.	4	5	6	4	1	0	2	3	2	4	5	6	2	2	2
Rock Mt. Cr.	4	2	4	2	2	0	4	2	2	4	6	6	4	0	2

Table 4. Final biological score and narrative ranking of streams in Chattooga River watershed, based on results and rankings in Tables 2 & 3.

	Final Score			Ranking		
	1997	2000	2001	1997	2000	2001
Addie Br.	24	20	19	Very Good	Good	Good
Bailey Br.		13	17		Fair	Fair
Martin-Finney Cr.	18	18	17	Good	Good	Fair
Reed Mill Br.	22	16	16	Good	Fair	Fair
Roach Mill Br.	16	16	16	Fair	Fair	Fair
Rock Mt. Cr.	18	12	16	Good	Fair	Fair

Table 5. Comparison of metric results between Whalen et al. (2002) (year 2000 data) and present survey (year 2001 data), focusing on EPT metric results. Year 2000 data were collected using EPA methodologies described in U. S. EPA (1999), whereas year 2001 data were collected using the methodology described in the present report. Results are the median score for individual sites on each stream. Individual site scores are located in Appendix B.

Stream	<u>Total # Individuals</u>		<u>Total # of Taxa</u>		<u># EPT Taxa</u>		<u>% EPT Taxa</u>		<u># EPT Individuals</u>		<u># non-EPT Individuals</u>	
	2000	2001	2000	2001	2000	2001	2000	2001	2000	2001	2000	2001
Addie Branch	195	198	28	31	18	20	61.54	27.42	120	55	75	144
Bailey Branch	165	194	23	35	13	23	42.19	25.98	70	50	95	144
Martin-Finney	152	184	27	32	16	20	69.00	29.85	94	55	58	129
Reed Mill	171	200	24	24	12	15	63.91	42.50	110	85	61	115
Roach Mill Branch	145	193	30	34	16	17	37.00	25.39	51	49	94	144
Rock Mountain	154	190	23	29	12	17	47.00	22.11	67	42	87	148

Table 6. Pebble count and cobble embeddedness results for sites sampled in the Chattooga River watershed in April 2001. Pebble size frequency distribution figures can be found in Appendix C.

	Site	D50 (mm)	D33 (mm)	D84 (mm)	%<=2mm	cobble embeddedness (%)
Addie Branch	1	15	7	378	19	38
	2	52	6	4096	30	51
	3	4096	287	4096	8	21
	4	313	183	4096	7	20
Bailey Branch	1	7	2	49	45	67
	2	16	4	100	31	37
Martin Finney	1	130	36	4096	23	32
	2	105	5	800	33	50
	3	24	9	168	24	69
	4	35	2	432	37	61
Reed Mill	1	110	19	4096	22	38
	2	10	2	110	41	72
	3	4	2	42	48	77
Roach Mill	1	90	13	4096	27	57
	2	95	7	4096	30	60
	3	12	2	4096	41	56
Rock Mountain	1	120	22	4096	21	47
	2	54	7	4096	28	64
	3	19	4	4096	32	51

Table7. Pebble count and cobble embeddedness results for sites sampled in the Conasauga River watershed in April 2001. Pebble size frequency distribution figures can be found in Appendix C.

	Site	D50 (mm)	D33 (mm)	D84 (mm)	%<=2mm	cobble embeddedness (%)
Bear Branch	Con06 AWQ	596	73.2	4096	15	n/a
Beech Branch	Con10 AWQ	67	31	188	8	12
Conasauga River	Con01 AWQ	115	61	4096	3	32
Hickory Creek	Con05 AWQ	370	159	4096	7	23

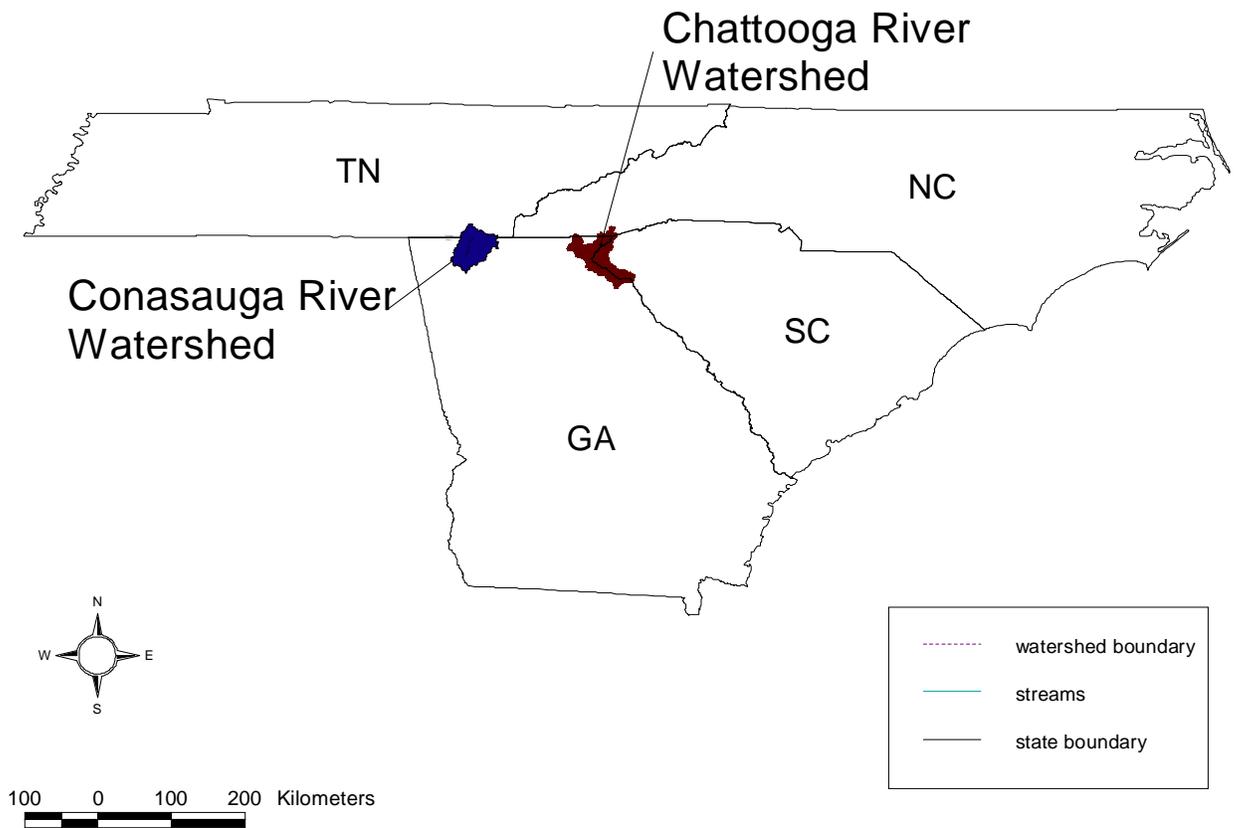


Figure 1. Location of the Chattooga River and Conasauga River watersheds in Tennessee, North Carolina, South Carolina, and Georgia. All streams surveyed for the present report were located in the Chattahoochee-Oconee National Forest, Georgia.

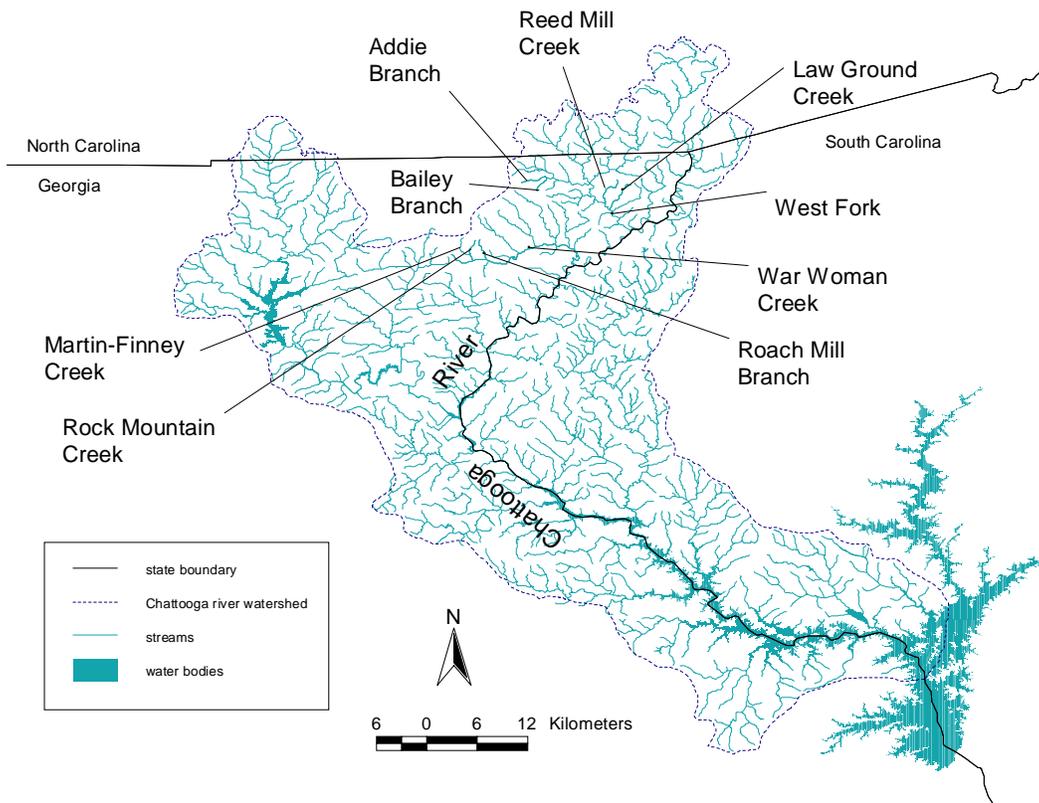


Figure 2. Location of streams surveyed in the West Fork and Warwoman sub-watersheds in 1997, 2000, and 2001. All surveys were performed on the Chattahoochee-Oconee National Forest, Georgia.

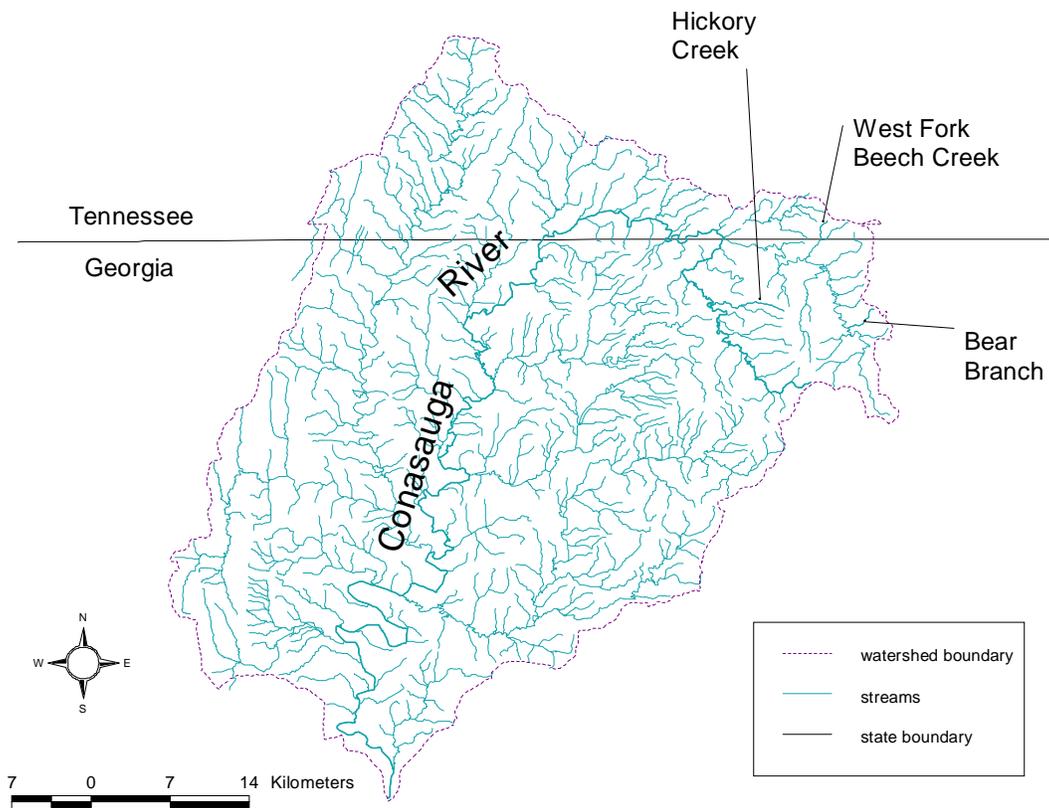


Figure 3. Location of streams surveyed in the Upper Conasauga River watershed during April 2001. All surveys were performed within the boundaries of the Cohutta Wilderness Area, Chattahoochee-Oconee National Forest, Georgia.

## **Appendix A: Comparison of Macroinvertebrate Metrics Between Years**

Table A1. Macroinvertebrate metric results for Addie Branch. Sample sites are arranged by year, and within year from furthest downstream to furthest upstream site. Scores from 1997 are from U. S. EPA (1999), scores from 2000 are from Whalen et al. (2002), and scores from 2001 are from the present survey. Raw data and full metric results for 2001 can be found in Appendix B.

Sample Site	# EPT Taxa			% EPT Taxa			% 2 Dominant Taxa			NCBI			# Clinger Taxa		
	1997	2000	2001	1997	2000	2001	1997	2000	2001	1997	2000	2001	1997	2000	2001
	#	#	#	%	%	%	%	%	%				#	#	#
R-1	16			73.60			25.28			4.30			20		
RFS02R01		18			47.47			48.48			3.68			9	
RFS02R02		18			77.60			52.08			1.80			8	
RFS02S03		22			55.67			40.21			3.28			11	
RFS02R04		19			61.54			33.85			3.06			10	
RFS02R06		18			54.77			49.25			3.06			7	
RFS02S05		18			82.49			62.21			2.03			10	
RFS02S07		13			80.98			71.20			1.87			7	
Addie 01			19			19.25			31.02			2.68			12
Addie 02			22			28.04			30.69			2.84			11
Addie 03			21			38.58			28.93			2.86			14
Addie 04			15			26.79			42.58			3.53			8
Total Mean	16	18	19	73.60	65.79	28.17	25.28	51.04	33.31	4.30	2.68	2.98	20	9	11
Total Median	16	18	20	73.60	61.54	27.42	25.28	49.25	30.85	4.30	3.06	2.85	20	9	12

Table A2. Macroinvertebrate metric result rankings for Addie Branch. Ranking criteria can be found in U. S. EPA (1999). Sample sites are arranged by year, and within year from furthest downstream to furthest upstream site. Rankings from 1997 are from U. S. EPA (1999), rankings from 2000 are from Whalen et al. (2002), and rankings from 2001 are from the present survey. Raw data and full metric results for 2001 can be found in Appendix B.

Sample Site	# EPT Taxa			% EPT Taxa			% 2 Dominant Taxa			NCBI			# Clinger Taxa		
	1997 rank (0-6)	2000 rank (0-6)	2001 rank (0-6)												
R-1	4			6			4			4			6		
RFS02R01		6			2			2			6			2	
RFS02R02		6			6			2			6			2	
RFS02S03		6			4			2			6			2	
RFS02R04		6			4			2			6			2	
RFS02R06		6			4			2			6			2	
RFS02S05		6			6			0			6			2	
RFS02S07		4			6			0			6			2	
Addie 01			6			0			4			6			2
Addie 02			6			2			4			6			2
Addie 03			6			2			4			6			4
Addie 04			4			2			2			6			2
Total Median	4	6	6	6	4	2	4	2	4	4	6	6	6	2	2

Table A3. Final biological score and narrative ranking of Addie Branch, based on results in Tables A1 & A2.

Sample Site	Final Score			Ranking		
	1997	2000	2001	1997	2000	2001
R-1	24			Very Good		
RFS02R01		18			Good	
RFS02R02		22			Good	
RFS02S03		20			Good	
RFS02R04		20			Good	
RFS02R06		20			Good	
RFS02S05		20			Good	
RFS02S07		18			Good	
Addie 01			18			Good
Addie 02			20			Good
Addie 03			22			Good
Addie 04			16			Fair
Total Median	24	20	19	Very Good	Good	Good

Table A4. Macroinvertebrate metric results for Bailey Branch. Sample sites are arranged by year, and within year from furthest downstream to furthest upstream site. Scores from 1997 are from U. S. EPA (1999), scores from 2000 are from Whalen et al. (2002), and scores from 2001 are from the present survey. Raw data and full metric results for 2001 can be found in Appendix B.

Sample Site	# EPT Taxa			% EPT Taxa			% 2 Dominant Taxa			NCBI			# Clinger Taxa		
	1997*	2000	2001	1997*	2000	2001	1997*	2000	2001	1997*	2000	2001	1997*	2000	2001
	#	#	#	%	%	%	%	%	%				#	#	#
RFS03S01		9			37.66			53.25			4.05			3	
RFS03R02		14			49.19			48.65			4.13			4	
RFS03R03		14			44.38			48.13			3.84			6	
RFS03S04		11			40.00			63.53			4.19			5	
Baily 01			25			23.15			47.29			4.16			10
Baily 02			20			28.80			32.61			3.25			10
Total Mean		12	23		42.81	25.98		53.39	39.95		4.05	3.71		5	10
Total Median		13	23		42.19	25.98		50.95	39.95		4.09	3.71		5	10

\*no data were reported for Bailey Branch in 1997

Table A5. Macroinvertebrate metric result rankings for Bailey Branch. Ranking criteria can be found in U. S. EPA (1999). Sample sites are arranged by year, and within year from furthest downstream to furthest upstream site. Rankings from 1997 are from U. S. EPA (1999), rankings from 2000 are from Whalen et al. (2002), and rankings from 2001 are from the present survey. Raw data and full metric results for 2001 can be found in Appendix B.

Sample Site	# EPT Taxa			% EPT Taxa			% 2 Dominant Taxa			NCBI			# Clinger Taxa		
	1997*	2000	2001	1997*	2000	2001	1997*	2000	2001	1997*	2000	2001	1997*	2000	2001
	rank	rank	rank	rank	rank	rank	rank	rank	rank	rank	rank	rank	rank	rank	rank
	(0-6)	(0-6)	(0-6)	(0-6)	(0-6)	(0-6)	(0-6)	(0-6)	(0-6)	(0-6)	(0-6)	(0-6)	(0-6)	(0-6)	(0-6)
RFS03S01		2			2			2			6			0	
RFS03R02		4			2			2			6			0	
RFS03R03		4			2			2			6			0	
RFS03S04		2			2			0			4			0	
Baily 01			6			0			2			6			2
Baily 02			6			2			2			6			2
Total Median		3	6		2	1		2	2		6	6		0	2

\*no data were reported for Bailey Branch in 1997

Table A6. Final biological score and narrative ranking of Bailey Branch, based on results in Tables A4 & A5.

Sample Site	Final Score			Ranking		
	1997*	2000	2001	1997*	2000	2001
RFS03S01		12			Fair	
RFS03R02		14			Fair	
RFS03R03		14			Fair	
RFS03S04		8			Poor	
Baily 01			16			Fair
Baily 02			18			Good
Total Median		13	17		Fair	Fair

\*no data were reported for Bailey Branch in 1997

Table A7. Macroinvertebrate metric results for Martin-Finney Creek. Sample sites are arranged by year, and within year from furthest downstream to furthest upstream site. Scores from 1997 are from U. S. EPA (1999), scores from 2000 are from Whalen et al. (2002), and scores from 2001 are from the present survey. Raw data and full metric results for 2001 can be found in Appendix B.

Sample Site	# EPT Taxa			% EPT Taxa			% 2 Dominant Taxa			NCBI			# Clinger Taxa		
	1997	2000	2001	1997	2000	2001	1997	2000	2001	1997	2000	2001	1997	2000	2001
	#	#	#	%	%	%	%	%	%				#	#	#
WW03	14			37.09			19.25			4.30			15		
WWFS03S01		16			72.22			42.86			2.82			8	
WWFS03S02		2			100.00			100			1.96			1	
WWFS03S03		14			61.84			30.92			3.04			11	
WWFS03R04		11			69.19			52.53			2.43			4	
WWFS03R05		10			57.32			53.66			2.86			2	
WWFS03S05		15			56.10			37.8			2.9			7	
WWFS03S06		17			50.31			38.65			3.38			7	
WWFS03S07		16			48.41			37.58			3.79			6	
WWFS03T08		19			70.16			40.84			2.46			10	
WWFS03S09		16			75.40			42.78			2.34			7	
WWFS03T10		16			75.17			51.68			2.31			8	
Finney 01			21			28.81			38.98			3.01			13
Martin 01			16			31.35			34.05			3.57			11
Finney 03			19			20.00			41.36			2.49			12
Finney 04			20			30.89			27.75			3.29			10
Total Mean	14	14	19	37.09	66.92	27.76	19.25	48.12	35.54	4.30	2.75	3.09	15	7	12
Total Median	14	16	20	37.09	69.19	29.85	19.25	42.78	36.52	4.30	2.82	3.15	15	7	12

Table A8. Macroinvertebrate metric result rankings for Martin-Finney Creek. Ranking criteria can be found in U. S. EPA (1999). Sample sites are arranged by year, and within year from furthest downstream to furthest upstream site. Rankings from 1997 are from U. S. EPA (1999), rankings from 2000 are from Whalen et al. (2002), and rankings from 2001 are from the present survey. Raw data and full metric results for 2001 can be found in Appendix B.

Sample Site	# EPT Taxa			% EPT Taxa			% 2 Dominant Taxa			NCBI			# Clinger Taxa		
	1997 rank (0-6)	2000 rank (0-6)	2001 rank (0-6)												
WW03	4			2			4			4			4		
WWFS03S01		4			6			2			6			2	
WWFS03S02		0			6			0			6			0	
WWFS03S03		4			4			4			6			2	
WWFS03R04		4			4			2			6			0	
WWFS03R05		2			4			2			6			0	
WWFS03S05		4			4			2			6			2	
WWFS03S06		4			2			2			6			2	
WWFS03S07		4			2			2			6			0	
WWFS03T08		6			4			2			6			2	
WWFS03S09		4			6			2			6			2	
WWFS03T10		4			6			2			6			2	
Finney 01			6			2			2			6			2
Martin 01			2			2			2			6			2
Finney 03			6			0			2			6			2
Finney 04			6			2			4			6			2
Total Median	4	4	6	2	4	2	4	2	2	4	6	6	4	2	2

Table A9. Final biological score and narrative ranking of Martin-Finney Creek based on results in Tables A7 & A8.

Sample Site	Final Score			Ranking		
	1997	2000	2001	1997	2000	2001
WW03	18			Good		
WWFS03S01		20			Good	
WWFS03S02		12			Fair	
WWFS03S03		20			Good	
WWFS03R04		16			Fair	
WWFS03R05		14			Fair	
WWFS03S05		18			Good	
WWFS03S06		16			Fair	
WWFS03S07		14			Fair	
WWFS03T08		20			Good	
WWFS03S09		20			Good	
WWFS03T10		20			Good	
Finney 01			18			Good
Martin 01			14			Fair
Finney 03			16			Fair
Finney 04			20			Good
Total Median	18	18	17	Good	Good	Fair

Table A10. Macroinvertebrate metric results for Reed Mill Branch. Sample sites are arranged by year, and within year from furthest downstream to furthest upstream site. Scores from 1997 are from U. S. EPA (1999), scores from 2000 are from Whalen et al. (2002), and scores from 2001 are from the present survey. Raw data and full metric results for 2001 can be found in Appendix B.

Sample Site	# EPT Taxa			% EPT Taxa			% 2 Dominant Taxa			NCBI			# Clinger Taxa		
	1997	2000	2001	1997	2000	2001	1997	2000	2001	1997	2000	2001	1997	2000	2001
	#	#	#	%	%	%	%	%	%				#	#	#
WF10	16			76.97			39.89			3.34			16		
WFFS10S01		14			68.82			32.35			2.92			11	
WFFS10S02		15			62.86			28.00			2.70			12	
WFFS10S03		11			76.37			35.16			2.50			6	
WFFS10R04		12			58.76			38.98			3.40			8	
WFFS10R05		11			63.91			37.87			3.25			6	
Reed 01			15			42.50			34.00			2.42			9
Reed 02			18			47.62			24.87			2.88			8
Reed 03			13			27.51			24.87			2.87			5
Total Mean	16	13	15	76.97	66.14	39.21	39.89	34.47	27.91	3.34	2.95	2.72	16	8.6	7
Total Median	16	12	15	76.97	63.91	42.50	39.89	35.16	24.87	3.34	2.92	2.87	16	8	8

Table A11. Macroinvertebrate metric result rankings for Reed Mill Branch. Ranking criteria can be found in U. S. EPA (1999). Sample sites are arranged by year, and within year from furthest downstream to furthest upstream site. Rankings from 1997 are from U. S. EPA (1999), rankings from 2000 are from Whalen et al. (2002), and rankings from 2001 are from the present survey. Raw data and full metric results for 2001 can be found in Appendix B.

Sample Site	# EPT Taxa			% EPT Taxa			% 2 Dominant Taxa			NCBI			# Clinger Taxa		
	1997 rank (0-6)	2000 rank (0-6)	2001 rank (0-6)												
WF10	4			6			2			6			4		
WFFS10S01		4			4			2			6			2	
WFFS10S02		4			4			4			6			2	
WFFS10S03		2			6			2			6			0	
WFFS10R04		2			4			2			6			2	
WFFS10R05		2			4			2			6			0	
Reed 01			4			2			2			6			2
Reed 02			6			2			4			6			2
Reed 03			4			2			4			6			0
Total Median	4	2	4	6	4	2	2	2	4	6	6	6	4	2	2

Table A12. Final biological score and narrative ranking of Reed Mill Branch, based on results in Tables A10 & A11.

Sample Site	Final Score			Ranking		
	1997	2000	2001	1997	2000	2001
WF10	22			Good		
WFFS10S01		18			Good	
WFFS10S02		20			Good	
WFFS10S03		16			Fair	
WFFS10R04		16			Fair	
WFFS10R05		14			Fair	
Reed 01			16			Fair
Reed 02			20			Good
Reed 03			16			Fair
Total Median	22	16	16	Good	Fair	Fair

Table A13. Macroinvertebrate metric results for Roach Mill Branch. Sample sites are arranged by year, and within year from furthest downstream to furthest upstream site. Scores from 1997 are from U. S. EPA (1999), scores from 2000 are from Whalen et al. (2002), and scores from 2001 are from the present survey. Raw data and full metric results for 2001 can be found in Appendix B.

Sample Site	# EPT Taxa			% EPT Taxa			% 2 Dominant Taxa			NCBI			# Clinger Taxa		
	1997	2000	2001	1997	2000	2001	1997	2000	2001	1997	2000	2001	1997	2000	2001
	#	#	#	%	%	%	%	%	%				#	#	#
WW04	15			67.70			49.07			4.37			13		
WWFS04S01		18			50.41			31.71			3.61			10	
WWFS04S02		14			23.95			25.15			4.86			8	
Roach 01			20			25.39			34.20			3.30			11
Roach 02			15			15.08			57.79			4.38			8
Roach 03			19			34.48			35.47			3.24			13
Total Mean	15	16	18	67.70	37.18	24.98	49.07	28.43	42.48	4.37	4.24	3.64	13	9	11
Total Median	15	16	19	67.70	37.18	25.39	49.07	28.43	35.47	4.37	4.24	3.30	13	9	11

Table A14. Macroinvertebrate metric result rankings for Roach Mill Branch. Ranking criteria can be found in U. S. EPA (1999). Sample sites are arranged by year, and within year from furthest downstream to furthest upstream site. Rankings from 1997 are from U. S. EPA (1999), rankings from 2000 are from Whalen et al. (2002), and rankings from 2001 are from the present survey. Raw data and full metric results for 2001 can be found in Appendix B.

Sample Site	# EPT Taxa			% EPT Taxa			% 2 Dominant Taxa			NCBI			# Clinger Taxa		
	1997 rank (0-6)	2000 rank (0-6)	2001 rank (0-6)												
WW04	4			4			2			4			2		
WWFS04S01		6			2			2			6			2	
WWFS04S02		4			0			4			4			2	
Roach 01			6			0			2			6			2
Roach 02			4			0			0			4			2
Roach 03			6			2			2			6			2
Total Median	4	5	6	4	1	0	2	3	2	4	5	6	2	2	2

Table A15. Final biological score and narrative ranking of Roach Mill Branch, based on results in Tables A13 & A14.

Sample Site	Final Score			Ranking		
	1997	2000	2001	1997	2000	2001
WW04	16			Fair		
WWFS04S01		18			Good	
WWFS04S02		14			Fair	
Roach 01			16			Fair
Roach 02			10			Poor
Roach 03			18			Good
Total Median	16	16	16	Fair	Fair	Fair

Table A16. Macroinvertebrate metric results for Rock Mountain Creek. Sample sites are arranged by year, and within year from furthest downstream to furthest upstream site. Scores from 1997 are from U. S. EPA (1999), scores from 2000 are from Whalen et al. (2002), and scores from 2001 are from the present survey. Raw data and full metric results for 2001 can be found in Appendix B.

Sample Site	# EPT Taxa			% EPT Taxa			% 2 Dominant Taxa			NCBI			# Clinger Taxa		
	1997	2000	2001	1997	2000	2001	1997	2000	2001	1997	2000	2001	1997	2000	2001
	#	#	#	%	%	%	%	%	%				#	#	#
WW03	14			37.09			19.25			4.30			15		
WWFS12R01		17		72.65				29.06			2.62			7	
WWFS12R02		12		46.53				28.47			3.27			7	
WWFS12S03		15		59.39				37.58			3.19			8	
WWFS12R04		15		53.72				23.94			2.84			9	
WWFS12R05		15		46.98				39.60			3.33			5	
WWFS12S06		10		26.83				48.78			4.49			5	
WWFS12R07		7		46.59				52.27			3.23			1	
WWFS12R08		12		32.90				49.68			4.42			3	
WWFS12S09		10		23.24				58.45			4.62			5	
WWFS12R10		12		23.87				60.65			4.26			5	
WWFS12R11		11		37.41				43.17			4.11			2	
Rock 01			17			33.16			35.29			3.70			10
Rock 02			20			22.11			39.47			3.71			11
Rock 03			13			12.11			67.37			4.80			8
Total Mean	14	12	17	37.09	42.74	22.46	19.25	42.88	47.38	4.30	3.67	4.07	15	5	10
Total Median	14	12	17	37.09	46.53	22.11	19.25	43.17	39.47	4.30	3.33	3.71	15	5	10

Table A17. Macroinvertebrate metric result rankings for Rock Mountain Creek. Ranking criteria can be found in U. S. EPA (1999). Sample sites are arranged by year, and within year from furthest downstream to furthest upstream site. Rankings from 1997 are from U. S. EPA (1999), rankings from 2000 are from Whalen et al. (2002), and rankings from 2001 are from the present survey. Raw data and full metric results for 2001 can be found in Appendix B.

Sample Site	# EPT Taxa			% EPT Taxa			% 2 Dominant Taxa			NCBI			# Clinger Taxa		
	1997	2000	2001	1997	2000	2001	1997	2000	2001	1997	2000	2001	1997	2000	2001
	rank	rank	rank	rank	rank	rank	rank	rank	rank	rank	rank	rank	rank	rank	rank
	(0-6)	(0-6)	(0-6)	(0-6)	(0-6)	(0-6)	(0-6)	(0-6)	(0-6)	(0-6)	(0-6)	(0-6)	(0-6)	(0-6)	(0-6)
WW03	4			2			4			4			4		
WWFS12R01		4			6			4			6			2	
WWFS12R02		2			2			4			6			2	
WWFS12S03		4			4			2			6			2	
WWFS12R04		4			4			4			6			2	
WWFS12R05		4			2			2			6			0	
WWFS12S06		2			2			2			4			0	
WWFS12R07		2			2			2			6			0	
WWFS12R08		2			2			2			4			0	
WWFS12S09		2			0			0			4			0	
WWFS12R10		2			0			0			4			0	
WWFS12R11		2			2			2			6			0	
Rock 01			4			2			2			6			2
Rock 02			6			0			2			6			2
Rock 03			4			0			0			4			2
Total Median	4	2	4	2	2	0	4	2	2	4	6	6	4	0	2

Table A18. Final biological score and narrative ranking of Rock Mountain Creek based on results in Tables A16 & A17.

Sample Site	Final Score			Ranking		
	1997	2000	2001	1997	2000	2001
WW03	18			Good		
WWFS12R01		22			Good	
WWFS12R02		16			Fair	
WWFS12S03		18			Good	
WWFS12R04		20			Good	
WWFS12R05		14			Fair	
WWFS12S06		10			Poor	
WWFS12R07		12			Fair	
WWFS12R08		10			Poor	
WWFS12S09		6			Poor	
WWFS12R10		6			Poor	
WWFS12R11		12			Fair	
Rock 01			16			Fair
Rock 02			16			Fair
Rock 03			10			Poor
Total Median	18	12	16	Good	Fair	Fair

## **Appendix B: Macroinvertebrate Species Counts and Metrics**

Table B1. Definitions of metrics used to interpret macroinvertebrate sample results (adapted from Barbour et al. (1999)).

Metric	Definition
Total Number of Individuals	Count of total number of macroinvertebrates in sample; richness measure; generally decreases due to perturbation
Number of Taxa	Count of total number of different genera captured; richness measure; generally decreases due to perturbation
Number of EPT Taxa	Total number of Ephemeroptera, Plecoptera, and Tricoptera taxa collected; richness measure; generally decreases due to perturbation
Number of Clinger Taxa	Total number of taxa with 'clinger' habit (i.e. having fixed retreats or adaptations for attaching to surfaces in flowing water); habit measure; generally decreases due to perturbation
Percent Clingers	Percent of taxa with 'clinger' habit (i.e. having fixed retreats or adaptations for attaching to surfaces in flowing water); habit measure; generally decreases due to perturbation
Percent 1 Dominant Taxa	Number of individuals in the taxa with the greatest number of individuals divided by the total number of individuals; tolerance measure; generally increases due to perturbation
Percent 2 Dominant Taxa	Number of individuals in the two taxa with the greatest number of individuals divided by the total number of individuals; tolerance measure; generally increases due to perturbation
Percent Tolerant Organisms	Percent of individuals considered to be tolerant to various perturbations (here, rated >5 on scale from 0-10); tolerance measure; generally increases due to perturbation
Intolerant Taxa	Total number of genera considered to be sensitive to perturbation; tolerance measure; generally decreases due to perturbation
Percent Diptera	Number of 'true fly' individuals divided by total number of individuals; composition measure; generally increases due to perturbation
Percent Chironomidae	Total number of Chironomids divided by total number of individuals; composition measure; generally increases due to perturbation
Percent EPT	Total number of Ephemeroptera, Plecoptera, and Tricoptera divided by total number of individuals; composition measure; generally decreases due to perturbation
North Carolina Biotic Index	Index that evaluates biological health of stream based on macroinvertebrate community; rating based on scale from 0 to 10 with 0 representing the best water quality and 10 representing the worst
Percent Collectors	Total number of individuals that collect or gather fine particulate matter divided by total number of individuals; functional feeding group measure; variable response to perturbation
Percent Filterers	Total number of individuals that filter fine particulate matter divided by total number of individuals; functional feeding group measure; generally variable response to perturbation
Percent Scrapers	Total number of individuals that graze upon periphyton divided by total number of individuals; functional feeding group measure; variable response to perturbation
Percent Shredders	Total number of individuals that shred coarse particulate matter divided by total number of individuals; functional feeding group measure; variable response to perturbation
Percent Predators	Total number of individuals that feed on other organisms divided by total number of individuals; functional feeding group measure; variable response to perturbation

Table B2. Macroinvertebrates collected from Addie Branch, April 2001.

<b>TAXON</b>	<b>Addie01</b>	<b>Addie02</b>	<b>Addie03</b>	<b>Addie04</b>
OLIGOCHAETA	4			1
Isopoda				
ASELLIDAE				
CAMBARIDAE		1	2	1
Pteronarcys	1	1		
Tallaperla	7	10	6	4
Amphinemura		3	10	6
PERLIDAE				
Agnetina				
Acroneuria			3	3
Eccoptura xanthenes				
PERLODIDAE				
Yugus	1	2	1	
Isoperla	1	3	11	1
CHLOROPERLIDAE				
Sweltsa		1		
Suwallia			1	
Leuctra	4	8	18	20
Ephemera	24	8		
Ephemerella	16	33	20	10
Eurylophella		1		
Ameletus	3	8	11	
LEPTOPHLEBIIDAE		5		
Paraleptophlebia	13		4	14
Habrophlebia vibrans				
Baetis (complex)				5
Stenonema	3		2	12
Epeorus	5	10	13	2
Cinygmula subaequalis				
Leucrocuta				
Isonychia				
Lanthus	3	1		1
Cordulegaster	5		1	1
Gerris				
Corydalus cornutus				
Nigronia fasciatus				
HYDROPSYCHIDAE		1		
Hydropsyche		3		
Cheumatopsyche				
Diplectrona modesta	8	10	7	5
Parapsyche	3	1	3	
Arctopsyche		1		
Agapetus				
Glossosoma				
Rhyacophila	4	5	7	5

<b>TAXON</b>	<b>Addie01</b>	<b>Addie02</b>	<b>Addie03</b>	<b>Addie04</b>
Phylocentropus				
Dolophilodes distinctus	2	1	1	8
Wormaldia				
Lype diversa			1	
Triaenodes				
Micrasema	2		1	
Lepidostoma		2		3
Neophylax			2	
Pycnopsyche	1	1	3	1
Cyrnellus				
Polycentropus				
Psilotreta	1			
Fattigia pele	1		1	
Psephenus herricki				5
Ectopria			3	
Stenelmis				
Optioservus	15	7	8	9
Promoresia	9			
Oulimnius latiusculus			1	
Anchytarsus				
Blepharicera				
Protoplasa fitchii				
TIPULIDAE				
Tipula				1
Antocha	1	2		
Dicranota		1		
Hexatoma	8	5	5	3
Pilaria	1			
Molophilus				
Ormosia				
Erioptera	1	3		
Dixa		1		
Simulium			2	
Prosimulium	1	13	12	14
CHIRONOMIDAE	34	25	37	69
CERATOPOGONIDAE	3	12		4
Tabanidae				
EMPIDIDAE				
Atherix	2			1
SPHAERIIDAE				
Corbicula				

Table B3. Macroinvertebrate metrics for samples collected from Addie Branch, April 2001.

	Addie01	Addie02	Addie03	Addie04
Total Number of Individuals (N)	187	189	197	209
Number of Taxa	32	33	30	27
Number of EPT Taxa (EPT Taxa)	19	22	21	15
Number of Clinger Taxa (Clinger Taxa)	12	11	14	8
Percent Clingers	28.34	30.16	34.01	28.71
Percent 1 Dominant Taxon	18.18	17.46	18.78	33.01
Percent 2 Dominant Taxa	31.02	30.69	28.93	42.58
Percent Tolerant Organisms	21.93	21.69	19.80	35.41
Intolerant Taxa	29	29	28	24
Percent Diptera	27.27	32.80	28.43	44.02
Percent Chironomidae	18.18	13.23	18.78	33.01
Percent EPT (%EPT)	19.25	28.04	38.58	26.79
North Carolina Biotic Index (NCBI)	2.68	2.84	2.86	3.53
Percent Collectors	52.41	46.56	37.56	48.33
Percent Filterers	7.49	15.87	12.69	12.92
Percent Scrapers	16.58	7.94	14.21	12.44
Percent Shredders	8.56	13.23	19.80	16.75
Percent Predators	14.97	15.87	14.72	9.09

Table B4. Macroinvertebrates collected from Bailey Branch, April 2001.

<b>TAXON</b>	<b>Bailey 01</b>	<b>Bailey02</b>
OLIGOCHAETA		3
Isopoda		
ASELLIDAE		
CAMBARIDAE		1
Pteronarcys		
Tallaperla	4	1
Amphinemura	2	3
PERLIDAE	1	
Agnetina		
Acroneuria		1
Eccoptura xanthenes	1	1
PERLODIDAE	2	
Yugus		2
Isoperla		1
CHLOROPERLIDAE	2	
Sweltsa	3	1
Suwallia		
Leuctra	8	18
Ephemera	2	1
Ephemerella	5	11
Eurylophella	2	
Ameletus	3	4
LEPTOPHLEBIIDAE		
Paraleptophlebia	6	4
Habrophlebia vibrans	3	
Baetis (complex)	3	
Stenonema	4	9
Epeorus	1	1
Cinygmula subaequalis		
Leucrocuta		
Isonychia		
Lanthus	4	10
Cordulegaster	5	1
Gerris		
Corydalus cornutus		
Nigronia fasciatus		
HYDROPSYCHIDAE		
Hydropsyche	1	
Cheumatopsyche	1	
Diplectrona modesta	7	7
Parapsyche		
Arctopsyche		
Agapetus		
Glossosoma		
Rhyacophila	7	10

<b>TAXON</b>	<b>Bailey 01</b>	<b>Bailey02</b>
Phylocentropus		3
Dolophilodes distinctus		3
Wormaldia		
Lype diversa		
Triaenodes		
Micrasema		
Lepidostoma	1	
Neophylax		
Pycnopsyche	2	1
Cyrnellus	1	
Polycentropus	4	
Psilotreta		1
Fattigia pele		
Psephenus herricki		
Ectopria		2
Stenelmis		
Optioservus	1	10
Promoresia		
Oulimnius latiusculus		
Anchytarsus		
Blepharicera		
Protoplasa fitchii		
TIPULIDAE		
Tipula		
Antocha		
Dicranota	1	
Hexatoma	16	2
Pilaria		17
Molophilus	1	
Ormosia		
Erioptera		
Dixa		1
Simulium		1
Prosimulum	11	7
CHIRONOMIDAE	80	42
CERATOPOGONIDAE	8	1
Tabanidae		
EMPIDIDAE		
Atherix		2
SPHAERIIDAE		1
Corbicula		

Table B5. Macroinvertebrate metrics for samples collected from Bailey Branch, April 2001.

	Bailey01	Bailey02
Total Number of Individuals (N)	203	184
Number of Taxa	34	35
Number of EPT Taxa (EPT Taxa)	25	20
Number of Clinger Taxa (Clinger Taxa)	10	10
Percent Clingers	17.73	24.46
Percent 1 Dominant Taxon	39.41	22.83
Percent 2 Dominant Taxa	47.29	32.61
Percent Tolerant Organisms	44.83	27.72
Intolerant Taxa	29	29
Percent Diptera	57.64	39.67
Percent Chironomidae	39.41	22.83
Percent EPT (%EPT)	23.15	28.80
North Carolina Biotic Index (NCBI)	4.16	3.25
Percent Collectors	50.74	34.24
Percent Filterers	10.34	11.96
Percent Scrapers	3.94	14.13
Percent Shredders	8.37	12.50
Percent Predators	26.60	26.63

Table B6. Macroinvertebrates collected from Martin-Finney Creek, April 2001.

<b>TAXON</b>	<b>Mfinney01</b>	<b>Mfinney02</b>	<b>Mfinney03</b>	<b>Mfinney04</b>
OLIGOCHAETA	4	1	4	6
Isopoda				
ASELLIDAE				
CAMBARIDAE				1
Pteronarcys	6	5	7	
Tallaperla	5	2		4
Amphinemura	8	18	3	9
PERLIDAE		1	2	
Agnetina			1	
Acroneuria	1	5	2	1
Eccoptura xanthenes				1
PERLODIDAE	2			
Yugus	2	1		5
Isoperla	3	4	2	
CHLOROPERLIDAE				
Sweltsa				1
Suwallia				
Leuctra		11	2	14
Ephemera			4	
Ephemerella	43	13	78	22
Eurylophella				
Ameletus		1	4	
LEPTOPHLEBIIDAE			4	
Paraleptophlebia	1		5	12
Habrophlebia vibrans				
Baetis (complex)		4		4
Stenonema	11	14	3	4
Epeorus	19	7	13	7
Cinygmula subaequalis				
Leucrocuta			4	
Isonychia	1			
Lanthus	1		1	2
Cordulegaster	1		1	2
Gerris				
Corydalus cornutus				
Nigronia fasciatus				
HYDROPSYCHIDAE		1		
Hydropsyche	2			
Cheumatopsyche	2			
Diplectrona modesta	2		9	14
Parapsyche			1	
Arctopsyche				
Agapetus				
Glossosoma	1			
Rhyacophila	12	6	12	

<b>TAXON</b>	<b>Mfinney01</b>	<b>Mfinney02</b>	<b>Mfinney03</b>	<b>Mfinney04</b>
Phylocentropus				
Dolophilodes distinctus	1	4		2
Wormaldia				
Lype diversa	1			1
Triaenodes				
Micrasema				
Lepidostoma				1
Neophylax				1
Pycnopsyche	2			2
Cyrnellus				
Polycentropus	1		3	1
Psilotreta				
Fattigia pele				2
Psephenus herricki				
Ectopria		1		
Stenelmis			1	
Optioservus	7	2	10	6
Promoresia	6		3	
Oulimnius latiusculus			2	
Anchytarsus	1	2		
Blepharicera				
Protoplasa fitchii			2	
TIPULIDAE		2	13	
Tipula	2	1		5
Antocha				
Dicranota		3		
Hexatoma			7	16
Pilaria				
Molophilus				
Ormosia		1		
Erioptera				2
Dixa			1	
Simulium		14		
Prosimulum		10	2	7
CHIRONOMIDAE	26	45	10	31
CERATOPOGONIDAE	2	3	2	2
Tabanidae				
EMPIDIDAE				1
Atherix	1	3	2	2
SPHAERIIDAE				
Corbicula				

Table B7. Macroinvertebrate metrics for samples collected from Martin-Finney Creek, April 2001.

	Mfinney01	Mfinney02	Mfinney03	Mfinney04
Total Number of Individuals (N)	177	185	220	191
Number of Taxa	31	29	34	33
Number of EPT Taxa (EPT Taxa)	21	16	19	20
Number of Clinger Taxa (Clinger Taxa)	13	11	12	10
Percent Clingers	31.07	32.43	25.00	24.61
Percent 1 Dominant Taxon	24.29	24.32	35.45	16.23
Percent 2 Dominant Taxa	38.98	34.05	41.36	27.75
Percent Tolerant Organisms	20.34	34.59	8.18	20.94
Intolerant Taxa	26	24	30	29
Percent Diptera	17.51	44.32	17.73	34.55
Percent Chironomidae	14.69	24.32	4.55	16.23
Percent EPT (%EPT)	28.81	31.35	20.00	30.89
North Carolina Biotic Index (NCBI)	3.01	3.57	2.49	3.29
Percent Collectors	52.54	38.38	55.00	43.98
Percent Filterers	4.52	15.68	5.45	12.04
Percent Scrapers	14.69	9.73	12.27	6.28
Percent Shredders	13.56	22.16	11.36	19.37
Percent Predators	14.69	14.05	15.91	17.80

Table B8. Macroinvertebrates collected from Reed Mill Branch, April 2001.

<b>TAXON</b>	<b>Reed01</b>	<b>Reed02</b>	<b>Reed03</b>
OLIGOCHAETA	2		
Isopoda			
ASELLIDAE			
CAMBARIDAE			
Pteronarcys	21	5	
Tallaperla	4	11	
Amphinemura	14	17	7
PERLIDAE			
Agnetina			
Acroneuria	8	5	2
Eccoptura xanthenes			
PERLODIDAE			4
Yugus	6		
Isoperla		9	
CHLOROPERLIDAE			
Sweltsa		1	
Suwallia			
Leuctra	2	11	11
Ephemera	1	2	25
Ephemerella	19	14	22
Eurylophella	1	1	
Ameletus			
LEPTOPHLEBIIDAE			4
Paraleptophlebia		6	
Habrophlebia vibrans			
Baetis (complex)	2	1	
Stenonema	10	12	15
Epeorus	42	4	
Cinygmula subaequalis			
Leucrocuta			
Isonychia			
Lanthus		5	2
Cordulegaster			5
Gerris			
Corydalus cornutus		1	
Nigronia fasciatus			
HYDROPSYCHIDAE			
Hydropsyche			
Cheumatopsyche			
Diplectrona modesta	26	15	12
Parapsyche			
Arctopsyche			
Agapetus			
Glossosoma			
Rhyacophila	2	2	9

<b>TAXON</b>	<b>Reed01</b>	<b>Reed02</b>	<b>Reed03</b>
Phylocentropus			
Dolophilodes distinctus		1	1
Wormaldia			
Lype diversa			
Triaenodes			
Micrasema			
Lepidostoma	2		
Neophylax			
Pycnopsyche		13	3
Cyrnellus			
Polycentropus			
Psilotreta			
Fattigia pele			3
Psephenus herricki	1		
Ectopria			
Stenelmis			
Optioservus	11	8	15
Promoresia	1		
Oulimnius latiusculus			
Anchytarsus	2	2	
Blepharicera			
Protoplasa fitchii			
TIPULIDAE			3
Tipula			9
Antocha			
Dicranota			
Hexatoma		5	
Pilaria			
Molophilus			
Ormosia			
Erioptera			
Dixa			
Simulium		1	2
Prosimulum	1		
CHIRONOMIDAE	18	30	21
CERATOPOGONIDAE		3	4
Tabanidae			1
EMPIDIDAE			
Atherix	4	4	5
SPHAERIIDAE			
Corbicula			4

Table B9. Macroinvertebrate metrics for samples collected from Reed Mill Branch, April 2001.

	Reed01	Reed02	Reed03
Total Number of Individuals (N)	200	189	189
Number of Taxa	23	27	24
Number of EPT Taxa (EPT Taxa)	15	18	13
Number of Clinger Taxa (Clinger Taxa)	9	8	5
Percent Clingers	48.00	23.28	23.81
Percent 1 Dominant Taxon	21.00	15.87	13.23
Percent 2 Dominant Taxa	34.00	24.87	24.87
Percent Tolerant Organisms	10.00	17.99	16.93
Intolerant Taxa	21	24	19
Percent Diptera	11.50	22.75	23.81
Percent Chironomidae	9.00	15.87	11.11
Percent EPT (%EPT)	42.50	47.62	27.51
North Carolina Biotic Index (NCBI)	2.42	2.88	2.87
Percent Collectors	42.50	30.69	38.10
Percent Filterers	13.50	8.99	10.05
Percent Scrapers	11.50	10.58	15.87
Percent Shredders	22.50	31.22	19.05
Percent Predators	10.00	18.52	16.93

Table B10. Macroinvertebrates collected from Roach Mill Branch, April 2001.

<b>TAXON</b>	<b>Roach01</b>	<b>Roach02</b>	<b>Roach03</b>
OLIGOCHAETA	5	1	5
Isopoda			
ASELLIDAE			
CAMBARIDAE			2
Pteronarcys	4		
Tallaperla	2	5	15
Amphinemura	3	2	4
PERLIDAE			
Agnetina			
Acroneuria	3	2	3
Eccoptura xanthenes			
PERLODIDAE			
Yugus	6		1
Isoperla		2	
CHLOROPERLIDAE			
Sweltsa	1		4
Suwallia			
Leuctra	1	6	9
Ephemera	13	1	
Ephemerella	17	15	10
Eurylophella	1		
Ameletus		4	
LEPTOPHLEBIIDAE			
Paraleptophlebia	8	5	18
Habrophlebia vibrans			
Baetis (complex)	3		
Stenonema	8	3	5
Epeorus			1
Cinygmula subaequalis			
Leucrocuta			
Isonychia			
Lanthus	1	4	3
Cordulegaster	1	1	
Gerris		2	
Corydalus cornutus			
Nigronia fasciatus			
HYDROPSYCHIDAE			
Hydropsyche			
Cheumatopsyche			
Diplectrona modesta	10	7	19
Parapsyche	2	1	1
Arctopsyche	5		2
Agapetus	1		
Glossosoma			
Rhyacophila	6	3	4

<b>TAXON</b>	<b>Roach01</b>	<b>Roach02</b>	<b>Roach03</b>
Phylocentropus			
Dolophilodes distinctus		1	4
Wormaldia			
Lype diversa			
Triaenodes			
Micrasema			1
Lepidostoma	3		1
Neophylax			1
Pycnopsyche	2		1
Cyrnellus			
Polycentropus			
Psilotreta			
Fattigia pele		1	
Psephenus herricki	1		
Ectopria		1	
Stenelmis			
Optioservus	4	3	2
Promoresia	4		1
Oulimnius latiusculus			
Anchytarsus	1		1
Blepharicera			
Protoplasa fitchii			
TIPULIDAE	4	1	6
Tipula			
Antocha			
Dicranota			
Hexatoma	10	2	10
Pilaria		6	
Molophilus			
Ormosia			
Erioptera		1	
Dixa	2	3	2
Simulium			3
Prosimulum	1	4	3
CHIRONOMIDAE	49	100	53
CERATOPOGONIDAE	9	11	4
Tabanidae			
EMPIDIDAE			1
Atherix	2	1	3
SPHAERIIDAE			
Corbicula			

Table B11. Macroinvertebrate metrics for samples collected from Roach Mill Branch, April 2001.

	Roach01	Roach02	Roach03
Total Number of Individuals (N)	193	199	203
Number of Taxa	34	30	34
Number of EPT Taxa (EPT Taxa)	20	15	19
Number of Clinger Taxa (Clinger Taxa)	11	8	13
Percent Clingers	20.73	12.06	21.67
Percent 1 Dominant Taxon	25.39	50.25	26.11
Percent 2 Dominant Taxa	34.20	57.79	35.47
Percent Tolerant Organisms	32.64	57.29	32.51
Intolerant Taxa	31	26	29
Percent Diptera	39.90	64.82	41.87
Percent Chironomidae	25.39	50.25	26.11
Percent EPT (%EPT)	25.39	15.08	34.48
North Carolina Biotic Index (NCBI)	3.30	4.38	3.24
Percent Collectors	50.78	63.32	43.84
Percent Filterers	9.33	6.53	15.76
Percent Scrapers	9.33	5.53	4.43
Percent Shredders	10.36	7.54	18.72
Percent Predators	20.21	17.09	16.26

Table B12. Macroinvertebrates collected from Rock Mountain Creek, April 2001.

<b>TAXON</b>	<b>Rock01</b>	<b>Rock02</b>	<b>Rock03</b>
OLIGOCHAETA	9	2	2
Isopoda			
ASELLIDAE			
CAMBARIDAE	1		
Pteronarcys	6		
Tallaperla	9	5	1
Amphinemura	16	6	
PERLIDAE		1	1
Agnetina			
Acroneuria	1		
Eccoptura xanthenes			
PERLODIDAE			
Yugus			
Isoperla	8	4	1
CHLOROPERLIDAE			
Sweltsa			
Suwallia			
Leuctra	3	4	8
Ephemera	1	1	
Ephemerella	12	18	9
Eurylophella		2	
Ameletus	1	5	1
LEPTOPHLEBIIDAE		8	
Paraleptophlebia	6		4
Habrophlebia vibrans			
Baetis (complex)	1		
Stenonema	4		4
Epeorus	15	9	1
Cinygmula subaequalis			
Leucrocuta		1	
Isonychia			
Lanthus	1		
Cordulegaster		1	
Gerris			
Corydalus cornutus			
Nigronia fasciatus			
HYDROPSYCHIDAE			
Hydropsyche			
Cheumatopsyche			
Diplectrona modesta	12	3	
Parapsyche	3	1	
Arctopsyche			
Agapetus			
Glossosoma			
Rhyacophila		5	1

<b>TAXON</b>	<b>Rock01</b>	<b>Rock02</b>	<b>Rock03</b>
Phylocentropus			
Dolophilodes distinctus	3	2	4
Wormaldia			
Lype diversa			
Triaenodes			
Micrasema			
Lepidostoma		5	
Neophylax			2
Pycnopsyche	1	4	5
Cyrnellus			
Polycentropus		1	
Psilotreta		1	
Fattigia pele			
Psephenus herricki			
Ectopria		1	
Stenelmis			
Optioservus	1	4	1
Promoresia			
Oulimnius latiusculus			
Anchytarsus	1		
Blepharicera			
Protoplasa fitchii			
TIPULIDAE	2		
Tipula	2		
Antocha			
Dicranota			
Hexatoma	3	21	24
Pilaria			
Molophilus			
Ormosia			
Erioptera			
Dixa		2	
Simulium			1
Prosimulum	2	2	1
CHIRONOMIDAE	50	54	104
CERATOPOGONIDAE	11	17	15
Tabanidae			
EMPIDIDAE			
Atherix	2		
SPHAERIIDAE			
Corbicula			

Table B13. Macroinvertebrate metrics for samples collected from Rock Mountain Creek, April 2001.

	Rock01	Rock02	Rock03
Total Number of Individuals (N)	187	190	190
Number of Taxa	29	29	20
Number of EPT Taxa (EPT Taxa)	17	20	13
Number of Clinger Taxa (Clinger Taxa)	10	11	8
Percent Clingers	22.99	15.79	7.89
Percent 1 Dominant Taxon	26.74	28.42	54.74
Percent 2 Dominant Taxa	35.29	39.47	67.37
Percent Tolerant Organisms	37.43	38.42	64.21
Intolerant Taxa	26	26	16
Percent Diptera	38.50	50.53	76.32
Percent Chironomidae	26.74	28.42	54.74
Percent EPT (%EPT)	33.16	22.11	12.11
North Carolina Biotic Index (NCBI)	3.70	3.71	4.80
Percent Collectors	50.27	50.53	63.16
Percent Filterers	10.70	4.21	3.16
Percent Scrapers	3.21	6.32	4.21
Percent Shredders	21.39	12.63	7.37
Percent Predators	13.90	26.32	22.11

Table B14. Macroinvertebrates collected from rivers in the Conasauga River watershed, April 2001.

<b>TAXON</b>	Bear Branch CON06AWQ	Beech Branch CON10AWQ	Conasauga River CON01AWQ	Hickory Creek CON05AWQ
OLIGOCHAETA	6		5	
Isopoda	1			
ASELLIDAE				9
CAMBARIDAE				
Pteronarcys	2	7	1	1
Tallaperla			7	1
Amphinemura	5		11	26
PERLIDAE	1		1	
Agnetina				
Acroneuria	1			
Eccoptura xanthenes				
PERLODIDAE	1			2
Yugus				
Isoperla	1		1	2
CHLOROPERLIDAE	1			
Sweltsa	1	8		10
Suwallia		2	2	
Leuctra	18	4	4	11
Ephemera		1	15	
Ephemerella	36	32	19	52
Eurylophella		5		4
Ameletus	3	2		11
LEPTOPHLEBIIDAE	1			2
Paraleptophlebia	1	13	2	
Habrophlebia vibrans				
Baetis (complex)	1	7	1	
Stenonema	3	4	5	29
Epeorus	23	1	3	8
Cinygmula subaequalis	27			
Leucrocuta	1			
Isonychia				
Lanthus		1	5	
Cordulegaster	2			
Gerris				
Corydalus cornutus		1		
Nigronia fasciatus			1	
HYDROPSYCHIDAE				
Hydropsyche				1
Cheumatopsyche				
Diplectrona modesta	5		5	
Parapsyche				
Arctopsyche				
Agapetus	1			
Glossosoma				

<b>TAXON</b>	Bear Branch CON06AWQ	Beech Branch CON10AWQ	Conasauga River CON01AWQ	Hickory Creek CON05AWQ
Rhyacophila	6	1	5	3
Phylocentropus			1	
Dolophilodes distinctus				1
Wormaldia	1			
Lype diversa				
Triaenodes			1	
Micrasema				
Lepidostoma		2		
Neophylax	2	1		
Pycnopsyche			1	
Cymnellus				
Polycentropus		1		
Psilotreta	1		1	
Fattigia pele			1	
Psephenus herricki		1		
Ectopria			1	
Stenelmis				
Optioservus			1	1
Promoresia	2		3	
Oulimnius latiusculus	4		2	
Anchytarsus		11		
Blepharicera	1	1		
Protoplasmata fitchii				
TIPULIDAE	2			1
Tipula				1
Antocha				
Dicranota			2	
Hexatoma		2	5	1
Pilaria				
Molophilus				
Ormosia				
Erioptera				
Dixa				
Simulium	3	11	12	4
Prosimulum	22	15	2	6
CHIRONOMIDAE	33	77	99	14
CERATOPOGONIDAE	2		2	1
Tabanidae				
EMPIDIDAE				
Atherix	1	1		1
SPHAERIIDAE				
Corbicula				

Table B15. Macroinvertebrate metrics for samples collected from Conasauga River watershed streams, April 2001.

	Bear Branch CON06AWQ	Beech Branch CON10AWQ	Conasauga River CON01AWQ	Hickory Creek CON05AWQ
Total Number of Individuals (N)	222	212	227	203
Number of Taxa	36	26	33	26
Number of EPT Taxa (EPT Taxa)	24	16	20	16
Number of Clinger Taxa (Clinger Taxa)	16	11	11	8
Percent Clingers	45.05	25.94	15.86	30.05
Percent 1 Dominant Taxon	16.22	36.32	43.61	25.62
Percent 2 Dominant Taxa	31.08	51.42	51.98	39.90
Percent Tolerant Organisms	20.27	41.51	52.42	14.29
Intolerant Taxa	31	24	28	21
Percent Diptera	28.83	50.47	53.74	14.29
Percent Chironomidae	14.86	36.32	43.61	6.90
Percent EPT (%EPT)	21.17	12.26	18.50	28.57
North Carolina Biotic Index (NCBI)	2.66	3.76	4.00	3.02
Percent Collectors	45.95	64.15	63.44	43.84
Percent Filterers	13.96	12.26	8.81	5.91
Percent Scrapers	20.27	4.25	5.73	20.20
Percent Shredders	12.16	11.32	11.45	20.20
Percent Predators	7.66	8.02	10.57	9.85

## **Appendix C: Particle Size Distributions from Pebble Count Data**

Table C1. Substrate particle size class categories (adapted from U. S. EPA (1999)).

Size Class Name	Size Class (mm)
Clay	<0.002
Silt	0.002-0.05
Sand	0.05-2.00
Small Gravel	2-16
Large Gravel	16-64
Small Cobble	64-128
Large Cobble	128-256
Small Boulder	256-512
Medium Boulder	512-1024
Large Boulder	1024-2084
Bedrock	2084-4096

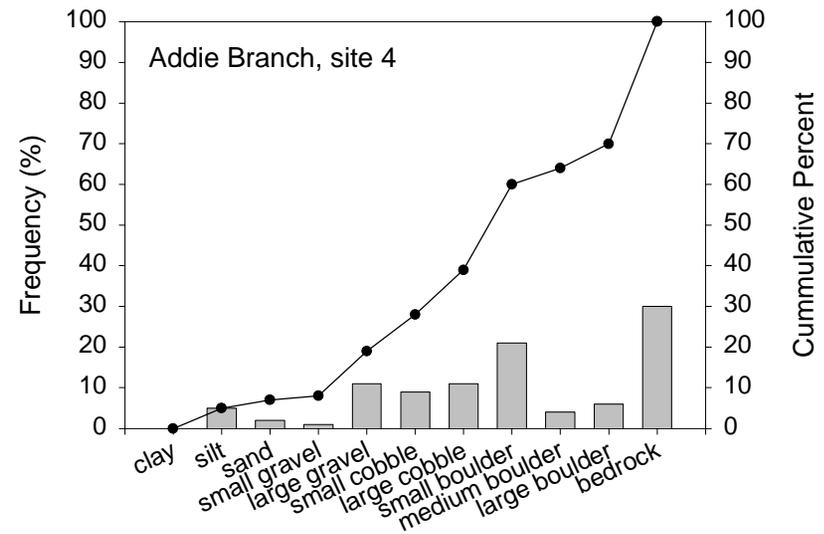
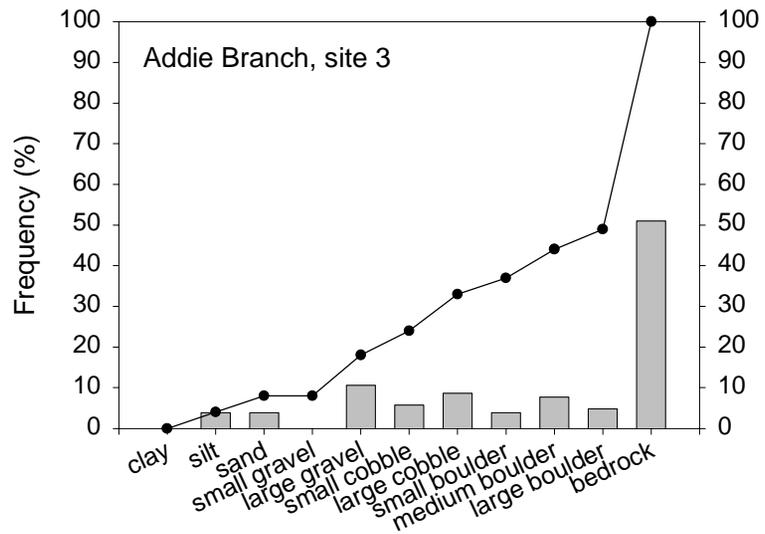
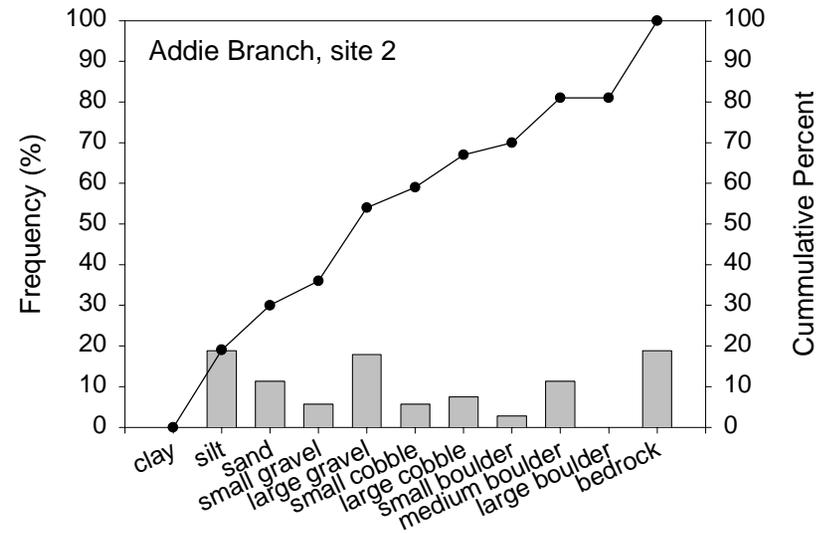
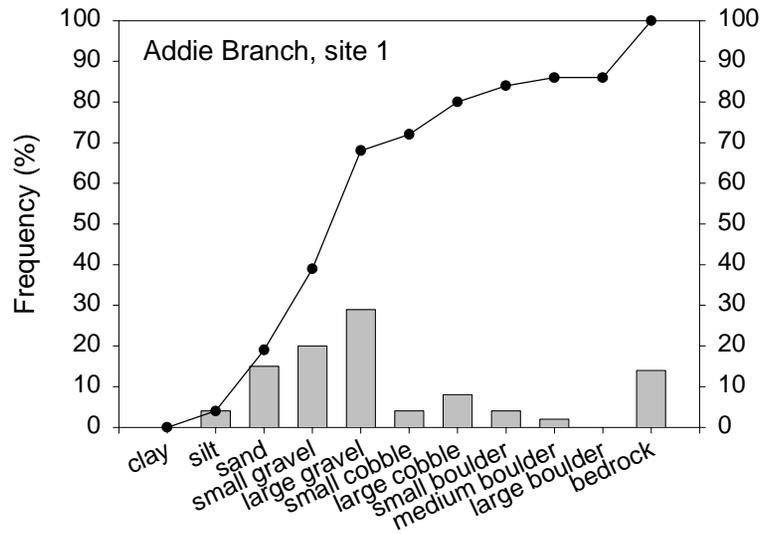


Figure C1. Frequency (percent) of substrate occurrence for pebble counts performed in riffles at four sites in Addie Branch, April 2001. See Table C1 for category size classes.

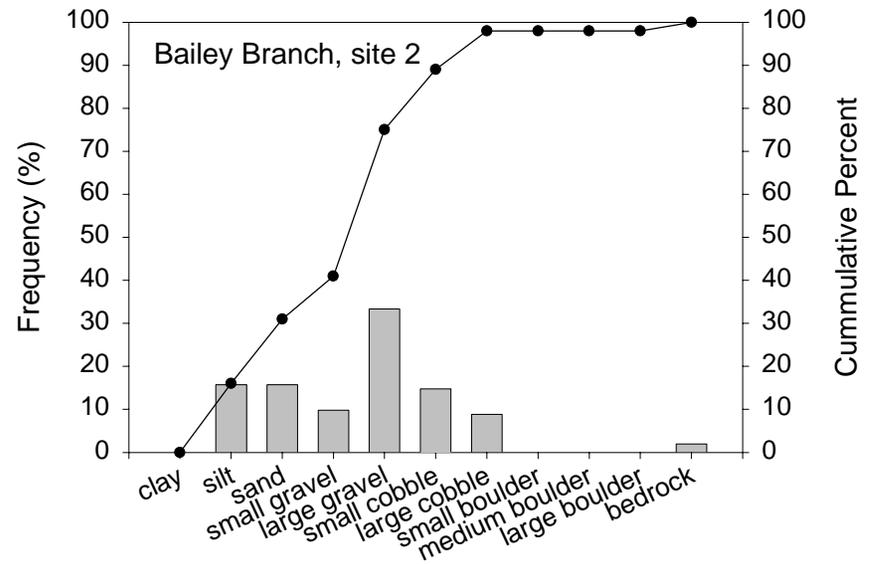
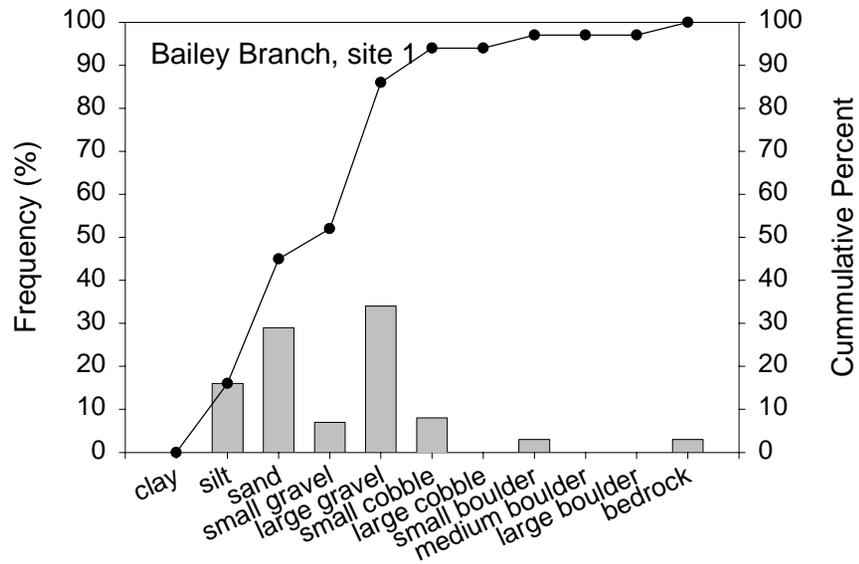


Figure C2. Frequency (percent) of substrate occurrence for pebble counts performed in riffles at two sites in Bailey Branch, April 2001. See Table C1 for category size classes.

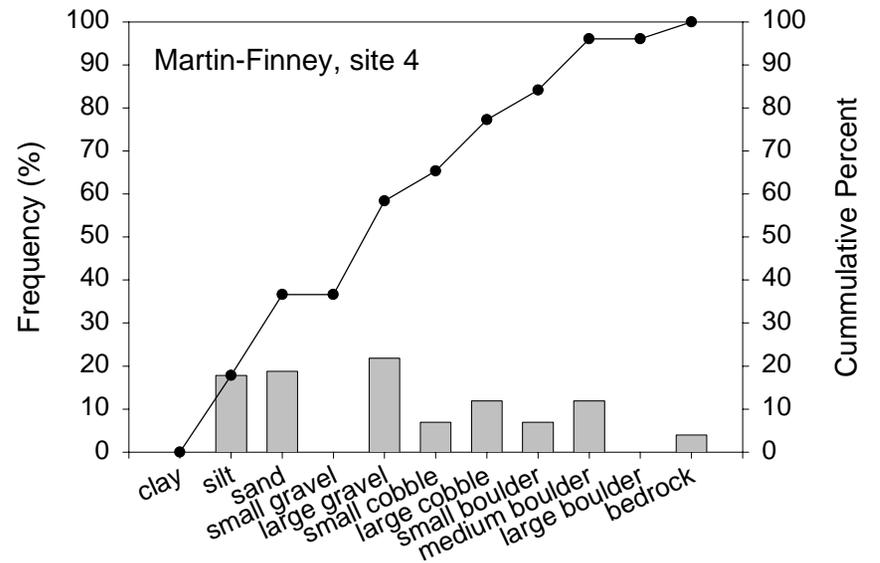
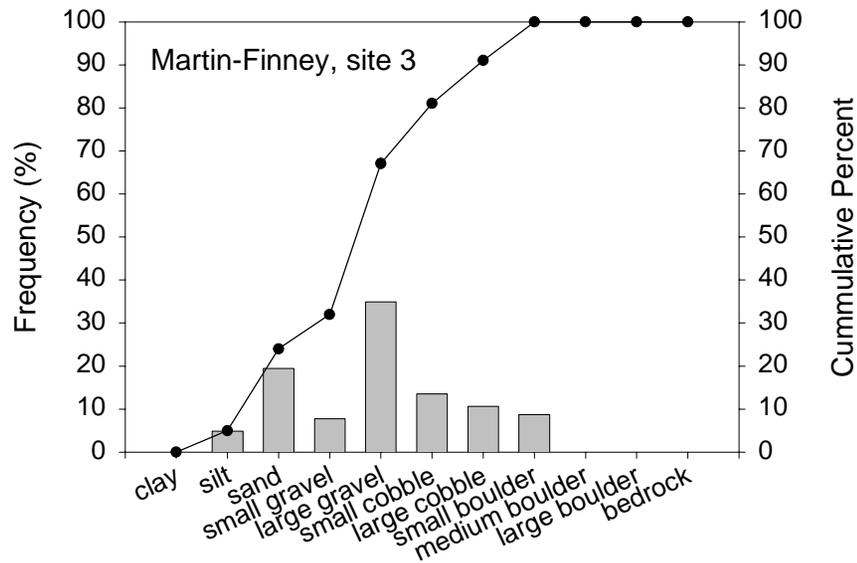
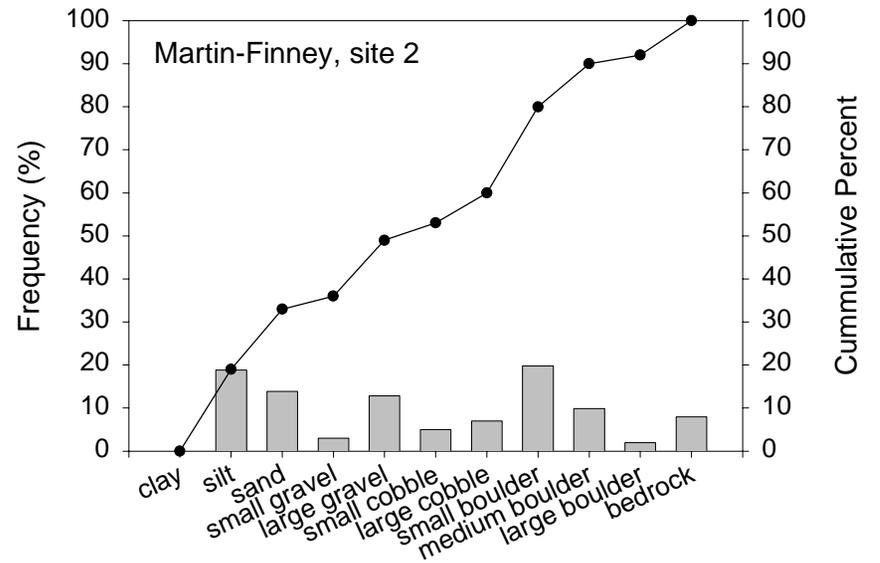
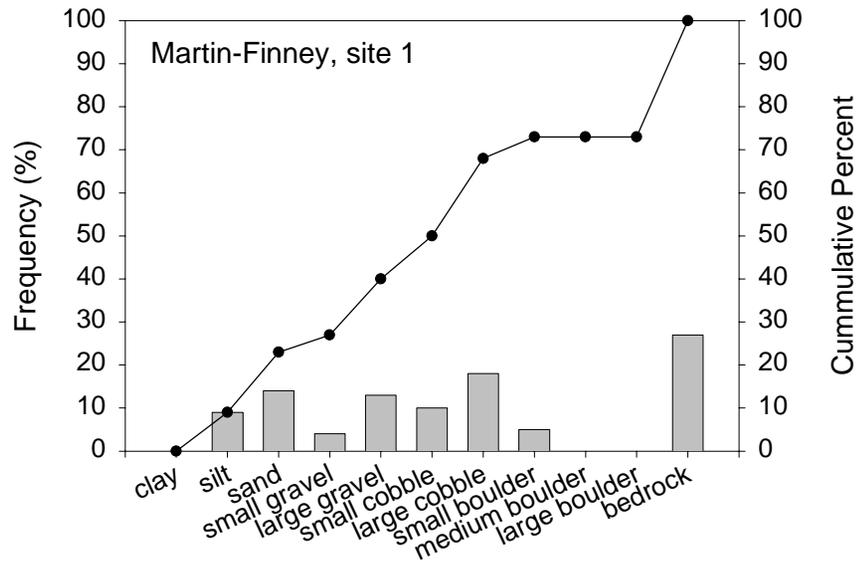


Figure C3. Frequency (percent) of substrate occurrence for pebble counts performed in riffles at four sites in Martin-Finney Creek, April 2001. See Table C1 for category size classes.

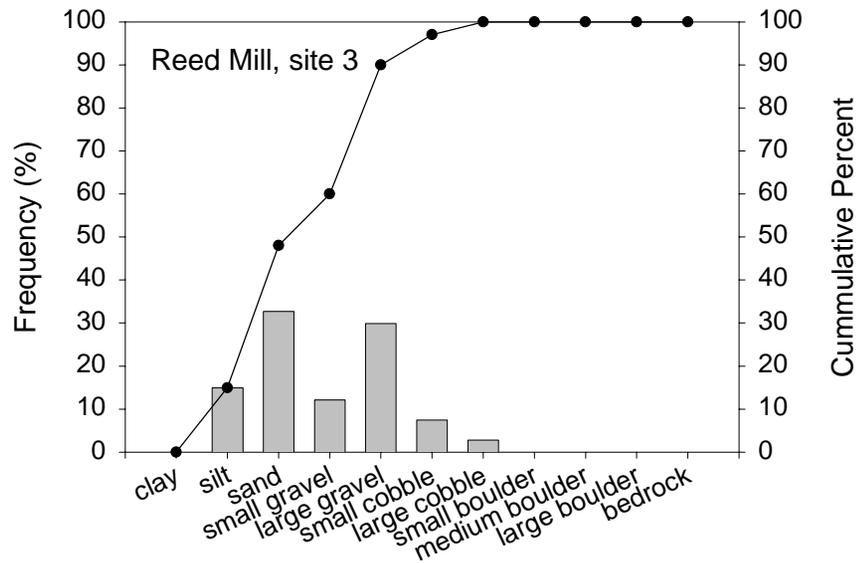
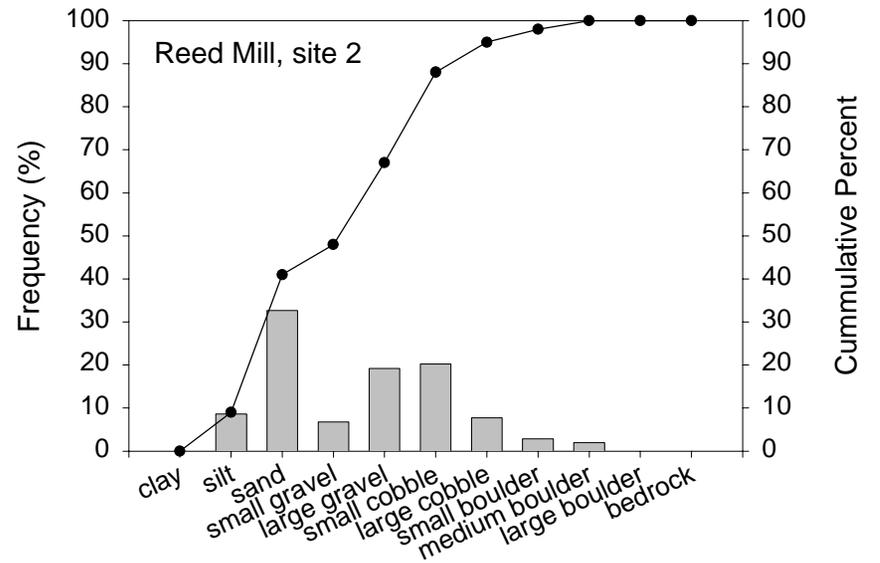
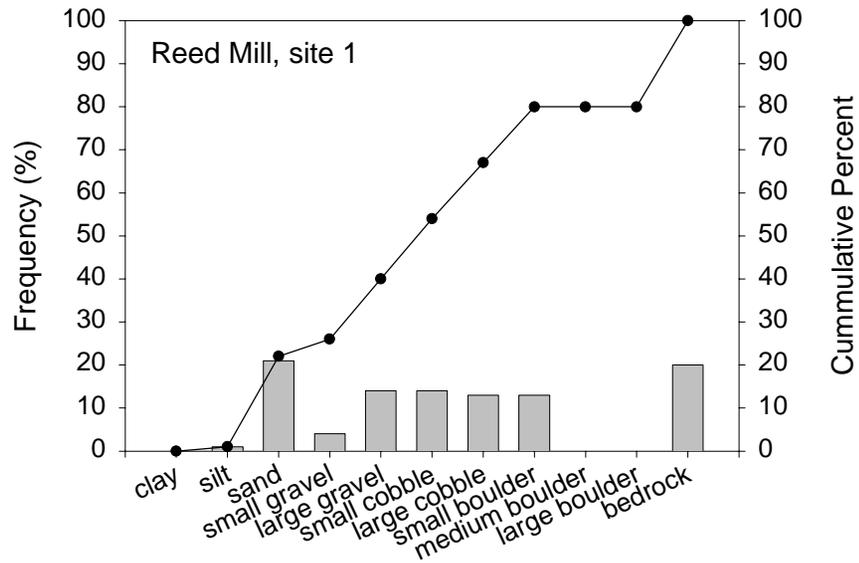


Figure C4. Frequency (percent) of substrate occurrence for pebble counts performed in riffles at three sites in Reed Mill Creek, April 2001. See Table C1 for category size classes.

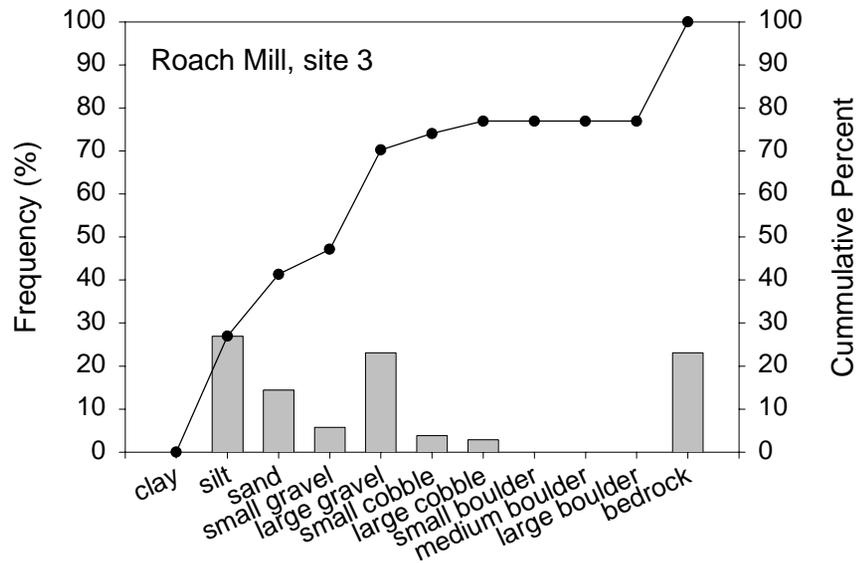
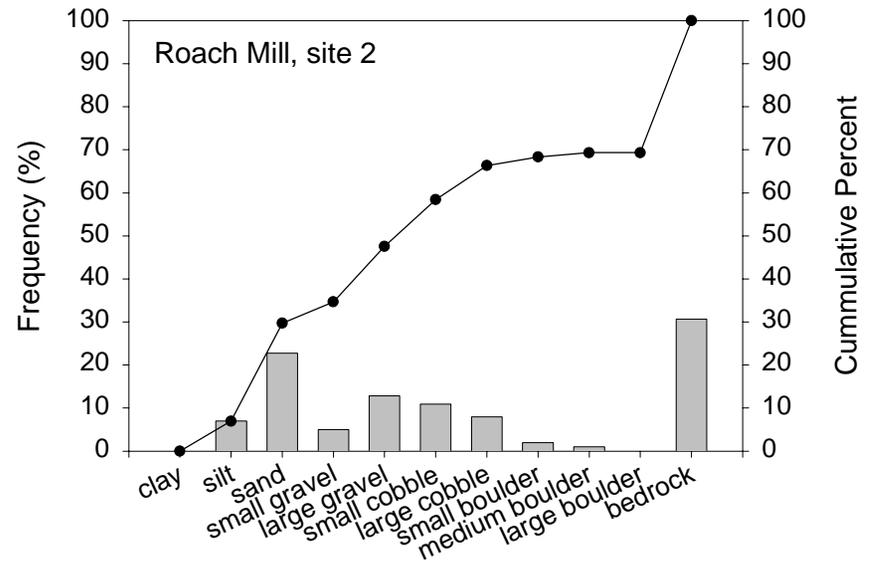
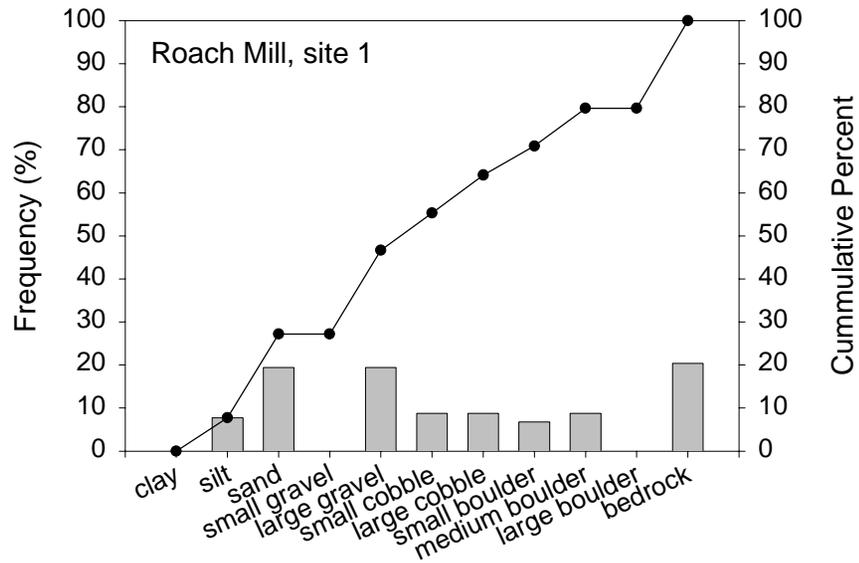


Figure C5. Frequency (percent) of substrate occurrence for pebble counts performed in riffles at three sites in Roach Mill Creek, April 2001. See Table C1 for category size classes.

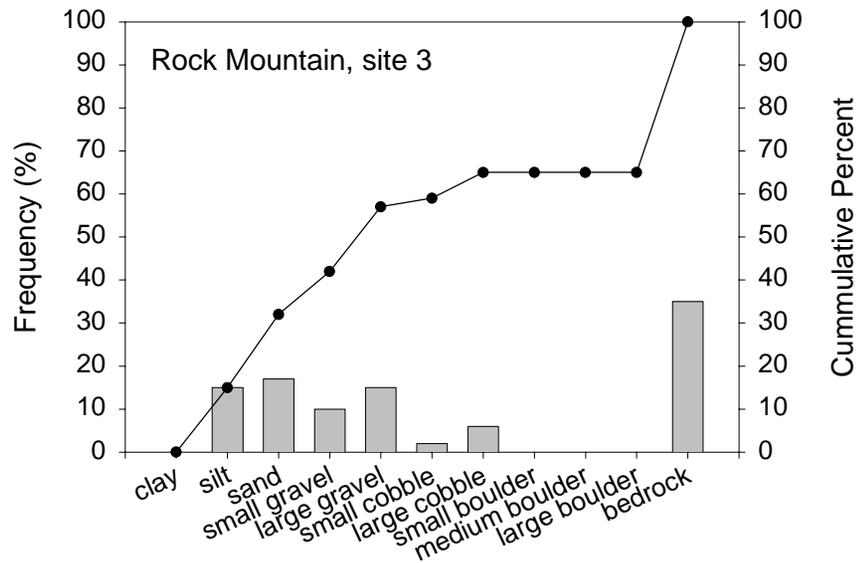
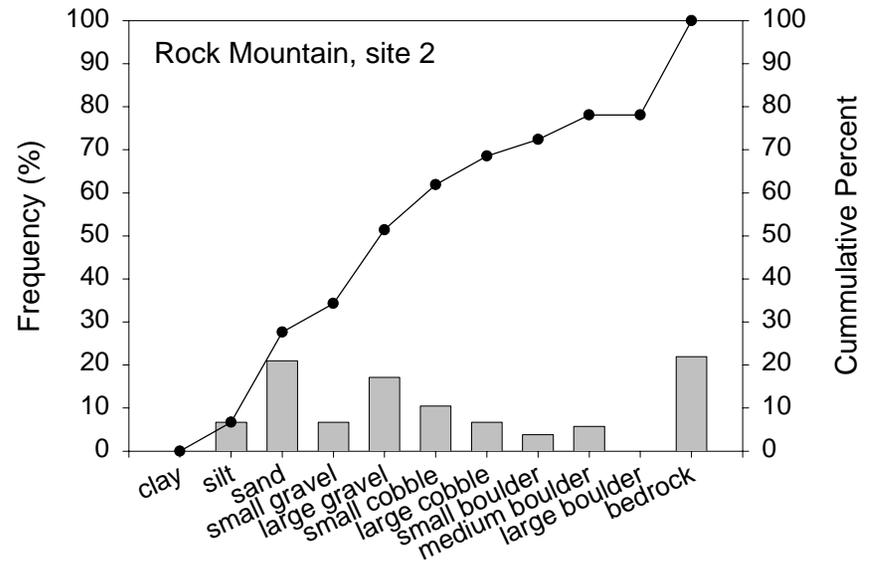
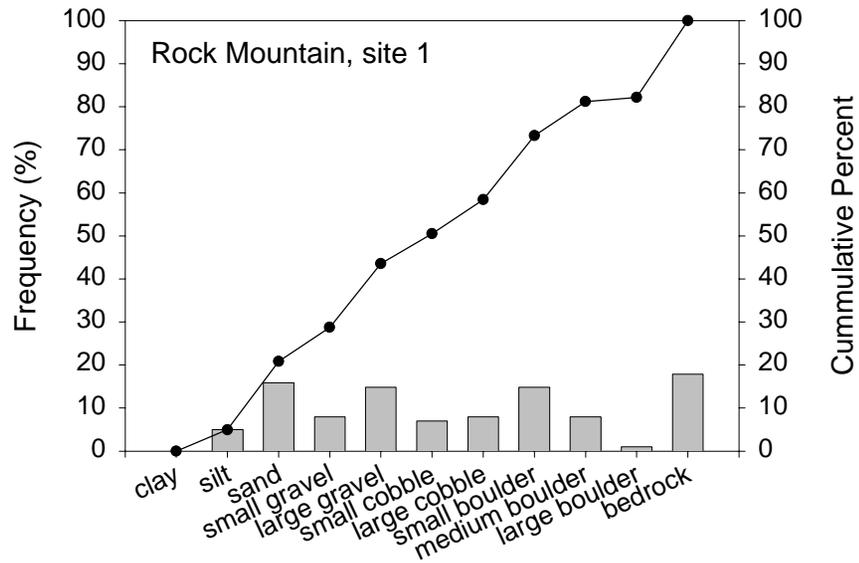


Figure C6. Frequency (percent) of substrate occurrence for pebble counts performed in riffles at three sites in Rock Mountain Creek, April 2001. See Table C1 for category size classes.

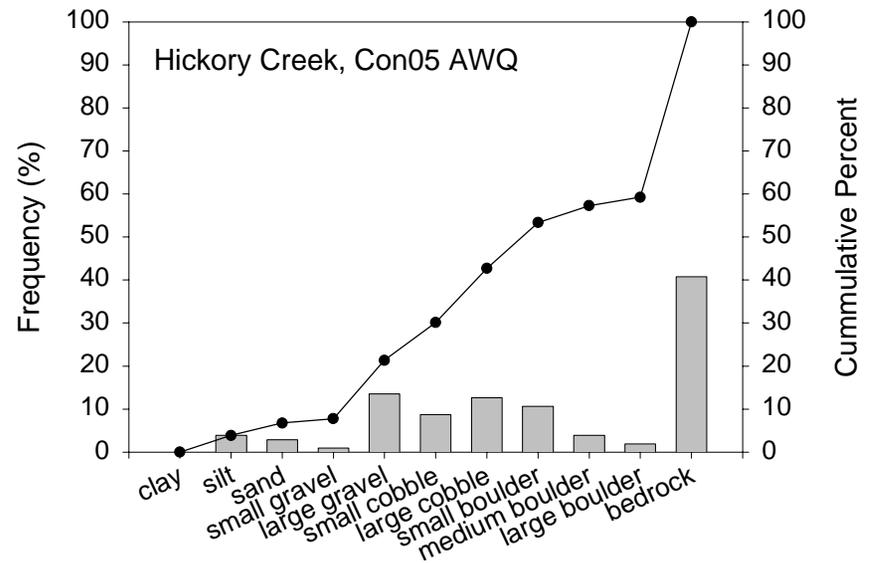
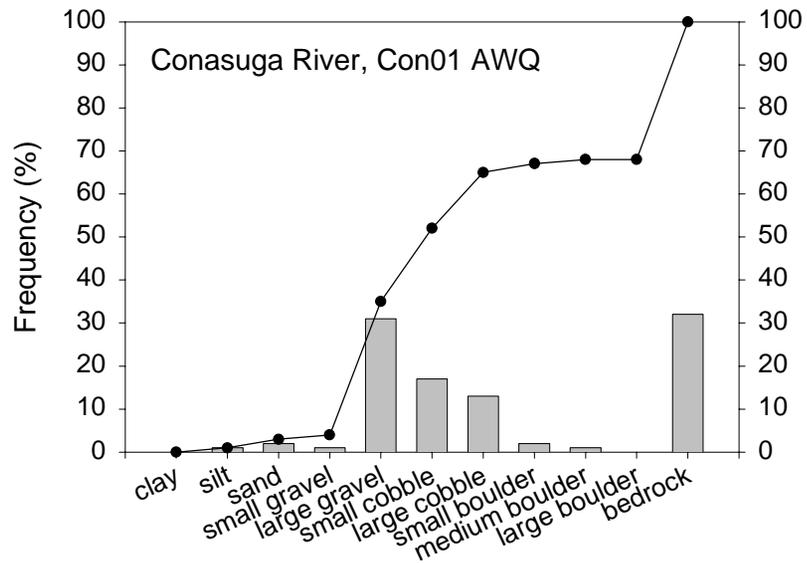
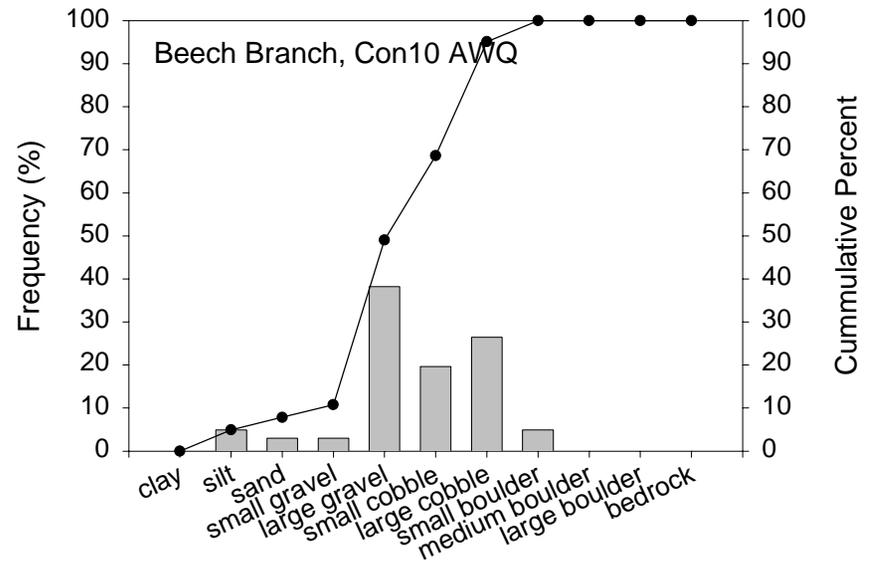
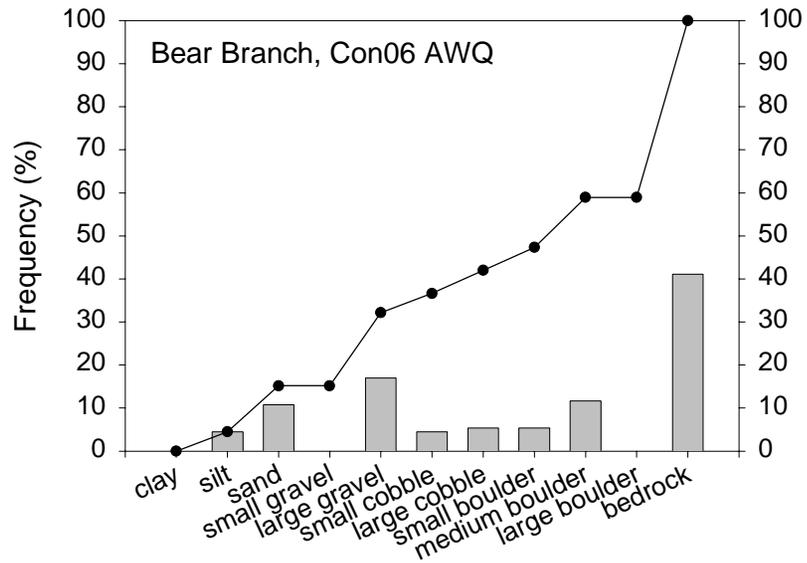


Figure C7. Frequency (percent) of substrate occurrence for pebble counts performed in riffles for four streams in the Conasuga River watershed, April 2001. See Table C1 for category size classes.