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Prepared in cooperation with the Alabama Clean Water Partnership

Assessment of Aquatic Macroinvertebrate Communities in the Autauga Creek Watershed, Autauga County, Alabama, 2009

Open-File Report 2011–1027

U.S. Department of the Interior
U.S. Geological Survey

Cover photograph: View of Bridge Creek sampling reach, Autauga County, Alabama, June 2009.

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KEN SALAZAR, Secretary

U.S. Geological Survey
Marcia K. McNutt, Director

U.S. Geological Survey, Reston, Virginia: 2011

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Conversion Factors

Multiply	By	To obtain
inch (in.)	25.4	millimeter (mm)
foot (ft)	0.3048	meter (m)
gallon (gal)	3.785	liter (L)
square mile (mi^2)	2.590	square kilometer (km^2)
square foot (ft^2)	0.0929	square meter (m^2)

Temperature is given in degrees Celsius (°C), which can be converted to degrees Fahrenheit (°F) by the following equation: °F = 1.8 (°C)+ 32

Assessment of Aquatic Macroinvertebrate Communities in the Autauga Creek Watershed, Autauga County, Alabama, 2009

By Will S. Mooty and Amy C. Gill

Abstract

Only four families within the Ephemeroptera, Plecoptera, Trichoptera orders were found during a 1999 survey of aquatic macroinvertebrates in Autauga Creek, Autauga County, Alabama, by the Alabama Department of Environmental Management. The low number of taxa of Ephemeroptera, Plecoptera, and Trichoptera families indicated that the aquatic macroinvertebrate community was in poor condition, and the creek was placed on the Alabama Department of Environmental Management 303(d) list.

The U.S. Geological Survey conducted a study in 2009 to provide data for the Alabama Department of Environmental Management and other water management agencies to re-evaluate aquatic macroinvertebrate communities in Autauga Creek to see if they meet Alabama Department of Environmental Management water-quality criteria. Aquatic macroinvertebrate communities were evaluated at three sites in the Autauga Creek watershed. Macroinvertebrates were sampled at two sites on Autauga Creek and one on Bridge Creek, the largest tributary to Autauga Creek. Water-quality field parameters were assessed at 11 sites.

During the 2009 sampling, 12 families within the orders of Ephemeroptera, Plecoptera, and Trichoptera were found at the Alabama Department of Environmental Management's assessment site whereas only four were found in 1999. The upstream site on Autauga Creek had higher numbers of taxa than either the Bridge Creek site or the lower site on Autauga Creek, which is the Alabama Department of Environmental Management's assessment site. Chironomid richness was noticeably higher at the two Autauga Creek sites than at the Bridge Creek site.

Introduction

The Autauga Creek watershed drains approximately 121 square miles in Autauga and Chilton Counties, lies primarily within the Fall Line Hills Level IV ecoregion (Griffith and others, 2001), and is a tributary to the Alabama River. Land use in the watershed is mainly forested, mixed with urban, pasture, and cropland (Alabama Department of Environmental Management, 2008b). Autauga Creek is historically significant in Prattville, Alabama, because city founder Daniel Pratt developed industrial facilities in 1835 on the creek and used the creek as a source of power for cotton mills. Though the creek no longer powers the mills, it remains a vital part of Prattville for its aesthetic appeal to the downtown landscape.

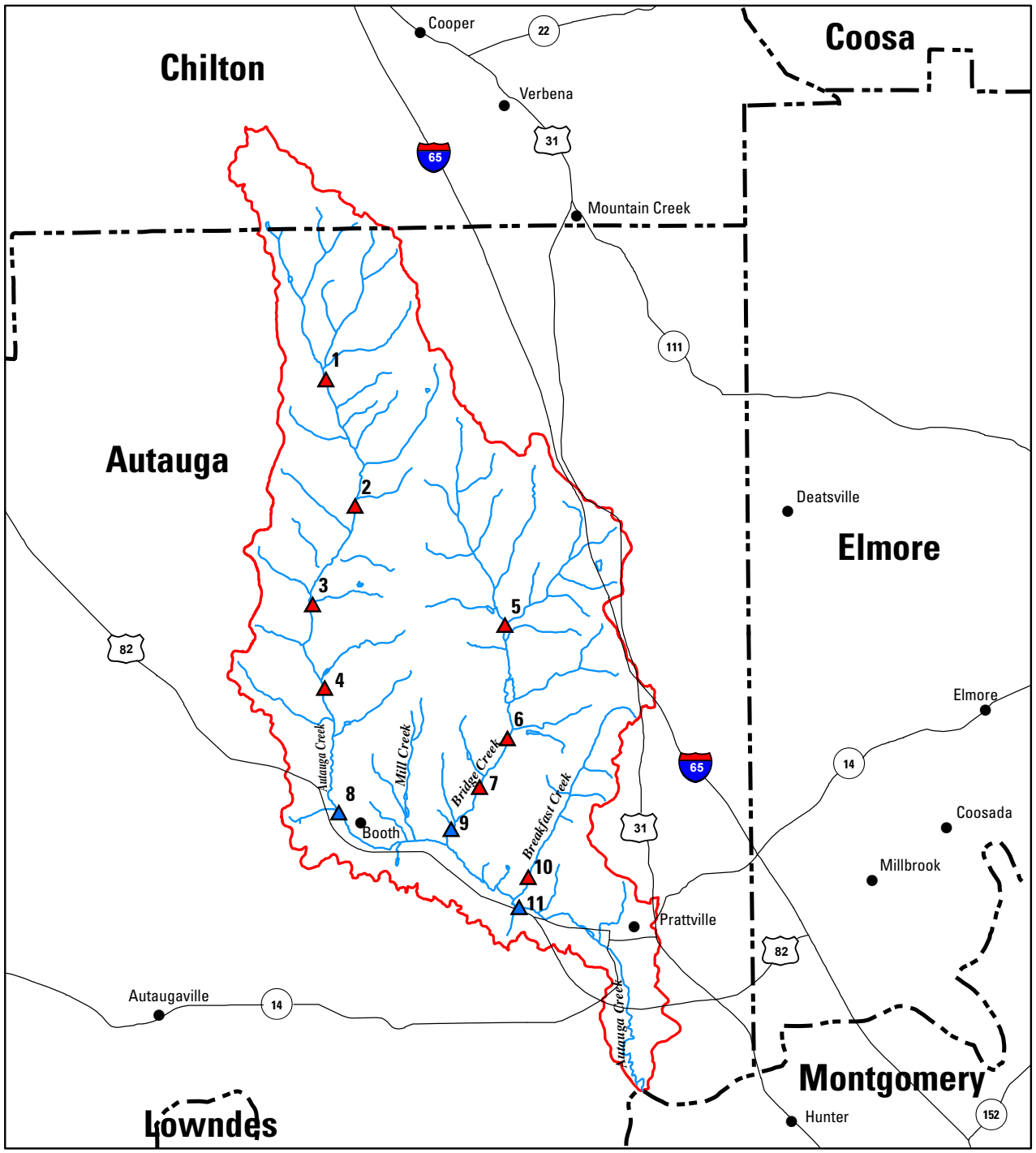
The Alabama Department of Environmental Management (ADEM) uses aquatic macroinvertebrate community health as one component of their water-quality standards (Alabama Department of Environmental Management, 2009). Some species of macroinvertebrates are less tolerant of pollution and stream degradation than others. By knowing which species are associated with less degraded or more degraded streams, water-quality managers can use the macroinvertebrate community makeup as one component to determine stream health.

In 1999, ADEM conducted a survey of aquatic macroinvertebrates in Autauga Creek, and only four Ephemeroptera, Plecoptera, and Trichoptera (EPT) families were found. The low number of EPT taxa (Alabama Department of Environmental Management, 2000) indicated that the aquatic macroinvertebrate community was in poor condition, and the creek was placed on ADEM's 303(d) list (Alabama Department of Environmental Management, 2006, 2008c).

Purpose and Scope

The purpose of this study was to provide data for ADEM and other water management agencies to re-evaluate aquatic macroinvertebrate communities in Autauga Creek to see if they meet ADEM criteria (Alabama Department of Environmental Management, 2009). If the communities meet ADEM criteria, the creek could be removed from the 303(d) list which would allow more uses of Autauga Creek in future development in the Prattville, Alabama, area.

In cooperation with the Alabama Clean Water Partnership, the U.S. Geological Survey sampled aquatic macroinvertebrate communities at three sites and assessed water-quality field parameters at 11 sites in the Autauga Creek watershed (fig. 1). Macroinvertebrates were sampled at two sites on Autauga Creek and one on Bridge Creek, the largest tributary to Autauga Creek. The sites were selected to determine if inflow from Bridge Creek is affecting aquatic macroinvertebrate communities. Data from all three sites can help city and county officials plan any necessary remediation.

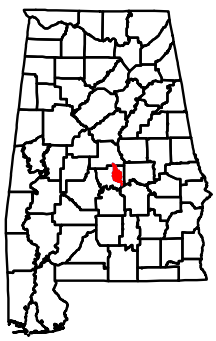


Base from U.S. Geological Survey digital data 1:100,000
Hydrography from U.S. Bureau of the Census digital data 1:100,000

0 3 6 MILES
0 4 8 KILOMETERS

EXPLANATION

- Autauga Creek basin boundary
- Water-quality measurement sites (see tables 1 and 2 for site information)
- Macroinvertebrate and water-quality sampling locations



LOCATION OF AUTAUGA CREEK BASIN IN AUTAUGA COUNTY, ALABAMA

Figure 1. Location of sampling sites in the Autauga Creek watershed, Autauga County, Alabama, 2009.

Methods

Water-quality field parameters were measured with a multi-parameter sonde at 11 sites in the Autauga Creek watershed (fig. 1, table 1). Parameters measured were water temperature, dissolved oxygen, specific conductance, pH, and turbidity (table 2). The sites were measured during base-flow conditions and during a period of storm runoff.

Sampling techniques for macroinvertebrates followed methods established in ADEM SOP #6000 (2008a) with the exception of riffle habitat which was modified from U.S. Geological Survey (USGS) protocols (Moulton and others, 2002) and the use of a "D"-frame net described in Barbour and others (1999). ADEM protocol states that samples should be collected from late April through early July, and all samples for this effort were collected in June, within the prescribed timeframe. Samples from each of the six habitats were collected, composited, and processed at each of the sampling sites using the procedures and methods described below.

Riffle Habitat

A kick net 0.5 meter (m) wide with a 500-micrometer (µm) mesh opening was positioned upright and securely on the streambed while a 0.25-square-meter (m^2) area upstream was physically disturbed. Five 0.25-m^2 riffle samples were collected at each of the three macroinvertebrate sampling sites. The five samples reflect the variability in the riffle habitat (collected from areas of fast current velocity and from slower velocity areas, including both shady and sunny areas). The samples were washed and composited in a large bucket sieve. Large debris was rinsed, visually inspected, and removed. Samples were placed in 500-milliliter (mL) plastic jars and preserved with 100 percent ethyl alcohol in preparation for shipment to the laboratory.

CPOM (Coarse Particulate Organic Matter) Habitat

A variety of CPOM (coarse particulate organic matter) sources were collected, where available, from at least three different areas for each of the three macroinvertebrate sampling sites. Sample sources included leaf packs caught on woody debris and rocks, and roots extending out into the stream. The samples were collected from shore and backwater areas. Enough material was collected to fill approximately one-half of a number 30 sieve bucket. Recently deposited or fully decomposed leaf litter was not collected.

Rock/Log Habitat

A total of about six rocks, logs, and sticks were washed into a large bucket sieve partially filled with water for the collection of attached fauna. The surfaces of the rocks, logs, and sticks were vigorously brushed or scrubbed to dislodge attached fauna. Any decaying logs, especially logs with loose bark, were picked apart and rinsed. Larger rocks and logs were visually inspected for attached invertebrates and hand-picked with forceps to ensure that as many as possible of the remaining organisms had been retrieved.

Table 1. Sampling sites in the Autauga Creek watershed, Autauga County, Alabama, 2009.

[wq, water quality]

Site number (see fig. 1)	Name	USGS station number	Latitude	Longitude	Sample type
1	Autauga Creek at County Road 20 near White City, AL	02420268	32°39'16"	86°35'08"	wq field parameters
2	Autauga Creek at County Road 42 near White City, AL	02420270	32°36'37"	86°34'24"	wq field parameters
3	Autauga Creek at County Road 40 near Old Kingston, AL	02420275	32°34'35"	86°35'29"	wq field parameters
4	Autauga Creek at County Road 63 near Booth, AL	02420280	32°32'50"	86°35'10"	wq field parameters
5	Bridge Creek at County Road 40 near Pine Level, AL	02420320	32°34'07"	86°30'44"	wq field parameters
6	Bridge Creek at County Road 59 near Pine Level, AL	02420330	32°31'45"	86°30'40"	wq field parameters
7	Bridge Creek at County Road 57 near Prattville, AL	02420340	32°30'45"	86°31'22"	wq field parameters
8	Autauga Creek at County Road 10 near Booth, AL	02420290	32°32'13"	86°34'50"	macroinvertebrates, wq field parameters
9	Bridge Creek at County Road 10 near Prattville, AL	02420345	32°29'52"	86°32'04"	macroinvertebrates, wq field parameters
10	Breakfast Creek at County Road 57 near Prattville, AL	02420355	32°28'51"	86°30'12"	wq field parameters
11	Autauga Creek adjacent to U.S. Hwy. 82 near Prattville, AL	02420400	32°28'14"	86°30'25"	macroinvertebrates, wq field parameters

Table 2. Water-quality field parameters measured in the Autauga Creek watershed, Autauga County, Alabama, 2009.

[°C, degrees Celsius; mg/L, milligrams per liter; µS/cm, microsiemens per centimeter; FNU, formazin nephelometric units; ----, no data]

Site number (see fig. 1)	Date	Temperature (°C)	Dissolved oxygen (mg/L)	Specific conductance (µS/cm at 25 °C)	pH (standard units)	Turbidity (FNU)	Flow condition
1	06/23/2009	25.6	6.9	23	5.8	49	Base[1]
	12/15/2009	14.0	9.1	19	5.8	----	High[2]
2	06/23/2009	24.1	7.6	25	6.1	4.3	Base
	12/15/2009	13.8	8.8	17	5.5	----	High
3	06/23/2009	24.5	7.0	26	6.1	8.5	Base
	12/15/2009	13.8	8.9	17	5.4	----	High
4	06/23/2009	24.7	7.4	24	6.2	5.3	Base
	12/15/2009	13.7	8.9	17	5.4	----	High
5	12/15/2009	14.2	9.2	17	5.8	----	High
6	06/23/2009	29.6	6.4	23	6.2	12	Base
	12/15/2009	13.5	9.3	17	5.9	----	High
7	06/23/2009	27.6	7.3	23	6.4	13	Base
	12/15/2009	13.2	9.3	17	5.8	----	High
8	06/23/2009	24.9	7.8	24	5.9	5.4	Base
	12/15/2009	13.2	9.1	17	5.4	----	High
9	06/23/2009	27.8	7.1	22	6.3	12	Base
	12/15/2009	13.0	9.3	17	5.8	----	High
10	06/23/2009	26.1	7.7	24	6.3	19	Base
	12/15/2009	14.9	9.6	24	6.2	----	High
11	06/23/2009	26.1	7.4	23	6.8	11.0	Base
	12/15/2009	15.1	6.9	59	6.2	----	High

[1] Base flow is sustained flow of a stream in the absence of direct runoff. It includes natural and human-induced streamflows. Natural base flow is largely controlled by groundwater discharge.

[2] High flow is flow in a stream during periods of stormwater runoff.

Root/Bank Habitat

Three different areas (each about 1 m in length) of cut bank with exposed roots were sampled at each site for collection of attached organisms. The sampled areas reflect the variability in root/bank habitat by differing current flow regimes and location on bank. Using a "D"-frame net 0.3 m in width and 0.3 m in height with a 500-µm mesh opening, the root/bank was physically disturbed and swept in an upstream motion. The captured material was rinsed in the net to remove fine silt. Large pieces of plant material were rinsed and visually inspected to remove attached organisms.

Macrophyte Bed Habitat

Three, 1-m² areas on macrophyte beds at each of the three macroinvertebrate sampling sites were physically disturbed and sampled using a sweeping motion with a "D"-frame net previously described. The captured material was rinsed in the net to remove fine silt. Large pieces of material were rinsed and visually inspected to remove attached organisms.

Sand/Bottom Habitat

If sand substrate was present at a macroinvertebrate sampling site, three areas were sampled at the site for macroinvertebrates. The areas sampled were 1 m long and of differing flow regimes. Samples were collected using a "D"-frame net previously described that was shuffled along the bottom of the creek with a shaky, scooping action approximately 2 to 3 centimeters (cm) below the surface of the sand.

Sample material for the habitat was composited in a 5-gallon bucket. Streamwater was added to the sample material, and the resulting slurry was stirred until large particles were in suspension. The water portion was decanted into a bucket sieve. The elutriation process was repeated at least three times. Material remaining in the bucket was inspected for heavier invertebrates, such as clams or mussels, which were added to the material in the sieve.

Sample Preservation

All samples were preserved separately with 100 percent denatured ethanol. Prior to shipping the samples to the laboratory, the ethanol was decanted to avoid the risk of shipping hazardous chemicals. Immediately upon receipt of samples at the laboratory, they were re-immersed in ethanol.

Sample Processing

All macroinvertebrate samples were processed by EcoAnalysts, Inc., of Moscow, ID, to a 200-organism subsample using a 300-µm sieve. All organisms were identified to the lowest practical level of taxonomic identification (table 3). Samples were rinsed and placed in a gridded tray. Random grids of material were sorted through until the target count was reached. The sorted material was placed in one jar marked "SORTED." The remaining material was replaced into the original sample jar(s) and marked "UNSORTED." The quality-control technician then redistributed the SORTED material into an appropriately-sized gridded tray, and at least 20 percent of the sorted material was checked for missed organisms. If at least 90 percent of the organisms present in the sorted material were picked during the original sorting (table 4; %Efficacy 1 ≥ 90), the sample passed the quality-control check, and the sample was ready for taxonomy. If less than 90 percent of the organisms were picked from the sorted material during the original sort, then the sample failed, and the sorted material was returned to the original sorter to be checked again (table 4; %Efficacy 2). The material was checked a second time for missed organisms. These steps were repeated until 90 percent of the organisms were removed from the subsample (table 4; %Efficacy 3). Results of the sorting efficacy are summarized in table 4.

EcoAnalysts, Inc., also used taxonomic identifications and enumerations to calculate a suite of metrics commonly used to assess benthic invertebrate community health. All of the metrics provided by EcoAnalysts, Inc., are included in this report, but some may be more applicable to the Autauga Creek watershed than others (table 5). Summaries of abundance and richness metrics are provided in charts as well as in table 5. General information on methods for metrics calculations can be found in Alabama Department of Environmental Management (2000) and Barbour and others (1999). A brief description of the specific metrics included in this report and references for their calculation methods follows.

Abundance measures are counts of organisms. The total number of organisms in the sample is calculated from the subsample abundance and reported as corrected abundance. EPT abundance is the total number of EPT organisms in the sample.

Dominance measures are commonly used to evaluate the even distribution of abundance among the taxa present in a sample. In table 5, the three most abundant taxa are listed along with their abundance. The percentages of total sample abundance contained in the most dominant taxon alone, the top two most dominant taxa, and the top three most dominant taxa are also presented.

Richness measures describe the numbers of distinct taxa present. Species richness is the number of species present in the sample. EPT richness is the number of distinct taxa within the EPT orders. Other richnesses presented in table 5 include each of the EPT orders individually, chironomidae (midges), oligochaeta (worms), and all organisms that are neither chironomids nor oligochaetes.

Percentages of individual sample abundance were calculated for orders and families of invertebrates detected at the Autauga Creek sites (community composition) and for functional groups (functional group composition). Invertebrates are placed into functional groups based on the common mode of feeding and type of food source. Functional groups are described in greater detail in Merritt and Cummins (1996). Richnesses for the various functional groups are also reported in table 5.

Diversity and evenness measures calculated by EcoAnalysts, Inc., included the Shannon-Wiener diversity index, Margalef's richness, Pielou's J′, and Simpson's heterogeneity. The Shannon-Wiener diversity index uses species abundance data to produce a score indicating the diversity of a biologic community (Rosenberg and Resh, 1993; Alabama Department of Environmental Management, 1996; Merritt and Cummins, 1996). Margalef's richness is an index based on richness and abundance (Margalef, 1958; Cuffney, 2003). Simpson's heterogeneity and Pielou's J′ are measures of the evenness of the community, or the level of distribution of abundance among the taxa (Washington, 1984; Rosenberg and Resh, 1993; Cuffney, 2003; EcoAnalysts, Inc., written commun., 2009).

Biotic indices are typically used to identify effects on the community from pollutants. The biotic indices included in table 5 should be used with caution because they were calculated with tolerance values developed for the western United States. The Hilsenhoff Biotic Index (HBI) was developed to assess the effects of organic pollution on macroinvertebrate communities. Tolerance values are assigned to each taxon, and then a weighted average tolerance value is calculated for each sample. Tolerance values used by EcoAnalysts, Inc., were those assigned to USEPA Region 10. The Metals Tolerance Index (MTI) is calculated in a similar manner but assesses community tolerance to metals contamination. The Fine Sediment Biotic Index (FSBI) was developed to evaluate the effects of fine sediment on macroinvertebrate communities in the western United States. FSBI tolerance values are assigned to each taxon, and the final score is the sum of tolerance values for the taxa present in the sample. Table 5 also includes average and weighted average FSBI tolerance values. The Temperature Preference Metric (TPM) was developed to evaluate summer temperatures in streams in Idaho (Hilsenhoff, 1987; Bukantis, 1998; Relyea, 2000; Brandt, 2001; EcoAnalysts, Inc., written commun., 2009).

Additional metrics that can be used to calculate a benthic index of biological integrity (B-IBI; Barbour and others, 1999) are included in table 5. These include long-lived taxa (require

Table 3. List of aquatic macroinvertebrates collected from the Autauga Creek watershed, June 23–25, 2009.

[Habitat type abbreviations: LOG/R, log/rock; ROOT/B, root/bank; MACRO, macrophytes; CPOM, coarse particulate organic matter; sp., undetermined species; L/R, large or rare specimens. Data are NOT adjusted for subsampling and INCLUDE Large/Rare specimens. Shading indicates detections. Site names are listed in table 1]

Site (see fig. 1)	8	8	8	8	8	8	9	9	9	9	9	11	11	11	11	11
Date	6/23/2009	6/23/2009	6/23/2009	6/23/2009	6/23/2009	6/23/2009	6/24/2009	6/24/2009	6/24/2009	6/24/2009	6/24/2009	6/25/2009	6/25/2009	6/25/2009	6/25/2009	6/25/2009
Habitat	SAND	LOG/R	ROOT/B	RIFFLE	MACRO	CPOM	SAND	LOG/R	ROOT/B	RIFFLE	CPOM	SAND	LOG/R	ROOT/B	RIFFLE	CPOM
Percent Subsampled	100.00	50.00	58.48	20.83	100.00	31.25	100.00	50.00	100.00	100.00	25.58	100.00	31.25	100.00	12.50	100.00
Ephemeroptera																
Acerpenna pygmaea	0	1	0	4	15	0	0	0	0	0	0	0	0	0	1	0
Attenella attenuata	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0
Baetidae	0	0	3	0	0	0	0	0	0	0	0	0	1	0	0	0
Caenis sp.	0	0	8	1	1	1	1	0	3	0	0	1	0	0	0	0
Heptagenia sp.	0	3	0	0	0	0	0	1	0	0	0	0	0	2	0	0
Heptageniidae	0	0	1	0	0	0	0	0	0	0	0	1	1	0	1	0
Isonychia sp.	0	2	0	1	0	0	0	0	8	40	0	0	1	2	15	0
Leptophlebiidae	0	0	3	0	1	0	0	0	1	0	0	0	0	0	0	0
Maccaffertium exiguum	0	0	0	0	0	0	0	0	0	2	0	0	1	0	0	0
Maccaffertium sp.	0	7	0	16	9	0	1	5	6	14	0	0	3	6	12	0
Paracloeodes sp.	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0
Plauditus sp.	0	3	0	1	10	0	0	0	0	2	0	0	0	0	2	0
Pseudocloeon dardanum	0	0	0	0	17	0	0	0	21	0	0	0	0	8	0	0
Pseudocloeon sp.	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0
Tricorythodes sp.	0	2	0	3	2	0	0	0	0	0	0	0	0	0	0	0
Odonata																
Aeshnidae	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0
Basiaeschna janata	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0
Boyeria vinosa	0	0	1	0	0	0	0	0	0	0	0	0	0	1	0	0
Calopterygidae	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0
Calopteryx sp.	0	0	12	0	0	1	0	0	3	0	0	0	0	11	0	0
Coenagrionidae	0	0	3	0	0	0	0	0	3	0	0	0	0	0	0	0
Didymops transversa	0	0	3	0	0	0	0	0	0	0	0	0	0	0	0	0
Gomphidae	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0
Macromia illinoiensis	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0
Progomphus sp.	2	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0
Stylurus sp.	1	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0
Plecoptera																
Acroneuria abnormis	0	2	0	5	0	0	0	0	0	2	0	0	2	0	5	0
Nemouridae	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Neoperla sp.	0	0	0	0	0	4	0	0	0	0	2	0	0	0	0	0
Perlesta sp.	0	4	0	2	6	0	0	0	2	5	0	0	0	0	0	0
Coleoptera																
Anchytarsus bicolor	0	0	0	0	0	0	0	0	0	0	0	0	0	0	8	0
Ancyronyx variegatus	0	3	0	0	2	0	0	1	1	0	0	1	0	0	0	0
Copelatus sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0
Gyretes sp.	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0
Hydrophilidae	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0
Macronychus glabratus	0	2	0	9	2	0	0	0	0	0	0	0	2	1	0	2
Stenelmis sp.	0	16	1	38	3	3	0	15	3	6	1	1	10	0	25	0
Megaloptera																
Corydalus cornutus	0	0	0	1	0	0	0	0	0	0	0	0	0	0	2	0
Sialis sp.	0	0	0	0	0	0	0	0	0	5	1	0	0	0	0	0

Table 3. List of aquatic macroinvertebrates collected from the Autauga Creek watershed, June 23–25, 2009.—Continued

[Habitat type abbreviations: LOG/R, log/rock; ROOT/B, root/bank; MACRO, macrophytes; CPOM, coarse particulate organic matter; sp., undetermined species; L/R, large or rare specimens. Data are NOT adjusted for subsampling and INCLUDE Large/Rare specimens. Shading indicates detections. Site names are listed in table 1]

Site (see fig. 1)	8	8	8	8	8	8	9	9	9	9	9	11	11	11	11	11
Date	6/23/2009	6/23/2009	6/23/2009	6/23/2009	6/23/2009	6/23/2009	6/24/2009	6/24/2009	6/24/2009	6/24/2009	6/24/2009	6/25/2009	6/25/2009	6/25/2009	6/25/2009	6/25/2009
Habitat	SAND	LOG/R	ROOT/B	RIFFLE	MACRO	CPOM	SAND	LOG/R	ROOT/B	RIFFLE	CPOM	SAND	LOG/R	ROOT/B	RIFFLE	CPOM
Percent Subsampled	100.00	50.00	58.48	20.83	100.00	31.25	100.00	50.00	100.00	100.00	25.58	100.00	31.25	100.00	12.50	100.00
Diptera-Chironomidae																
Ablabesmyia (Karelia) sp.	0	0	6	0	0	7	0	0	0	0	6	0	0	0	0	0
Ablabesmyia mallochi	0	0	21	0	0	25	0	0	0	0	5	1	0	0	0	0
Ablabesmyia sp.	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Brillia sp.	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0
Bryophaenocladius sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0
Chernovskiia sp.	0	0	0	0	0	0	0	0	0	0	0	7	0	0	0	0
Chironomini	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0
Cladotanytarsus sp.	0	5	0	0	0	0	0	2	0	0	0	0	0	0	0	0
Corynoneura sp.	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0
Cricotopus bicinctus gr.	0	3	1	0	0	0	0	0	0	0	0	0	0	0	0	0
Cricotopus sp.	0	5	0	0	0	0	0	6	0	0	0	0	3	0	0	0
Cryptochironomus sp.	0	1	1	1	0	1	1	0	0	0	7	9	0	0	0	0
Demicryptochironomus sp.	0	0	0	1	0	0	0	0	0	0	0	1	0	0	0	0
Djalmabatista sp.	0	0	0	0	0	0	8	0	0	0	0	4	0	0	0	0
Eukiefferiella devonica gr.	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Labrundinia sp.	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0
Lauterborniella agrayloides	0	0	9	0	1	7	0	0	0	0	0	0	0	0	0	0
Microtendipes pedellus gr.	0	0	4	0	1	2	0	0	0	0	2	0	0	0	0	0
Nanocladius sp.	0	0	0	1	0	0	0	0	0	0	0	0	1	0	1	0
Nilotanypus fimbriatus	0	0	0	0	0	0	0	2	0	0	0	0	1	0	0	0
Nilotanypus sp.	0	1	1	0	0	0	0	0	0	0	0	0	0	1	0	0
Nilothauma sp.	0	0	1	2	0	0	0	2	0	0	0	0	1	0	2	0
Orthocladiinae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0
Orthocladius Complex	0	0	0	0	1	0	0	0	0	0	0	0	3	0	0	0
Parachaetocladius sp.	0	0	0	1	0	0	0	0	0	0	0	1	0	0	5	0
Paracladopelma sp.	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Parametriocnemus sp.	0	0	1	4	0	0	0	2	0	0	0	0	1	1	0	0
Paratanytarsus sp.	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0
Phaenopsectra sp.	0	0	1	0	1	2	0	0	0	0	0	0	0	0	0	0
Polypedilum aviceps	0	1	1	0	2	0	0	0	0	0	0	0	0	0	0	0
Polypedilum fallax gr.	0	0	0	1	0	1	0	0	0	0	0	0	0	0	0	0
Polypedilum flavum	0	0	0	0	0	0	0	0	0	2	2	1	5	0	3	0
Polypedilum halterale gr.	0	0	1	0	0	0	0	0	0	0	1	15	0	0	1	0
Polypedilum illinoense gr.	0	3	4	2	5	20	0	3	5	0	0	0	0	3	0	0
Polypedilum ontario	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0
Polypedilum scalaenum gr.	0	3	3	9	0	0	0	0	2	0	4	9	0	0	0	1
Pseudochironomus sp.	0	3	1	0	0	0	0	1	0	3	0	0	1	0	4	0
Rheocricotopus sp.	0	0	0	1	0	0	0	0	0	0	0	0	3	1	1	0
Rheotanytarsus exiguus gr.	0	9	0	8	6	0	0	1	0	1	0	0	6	0	3	0
Rheotanytarsus pellucidus gr.	0	0	0	4	2	0	0	2	1	0	0	0	2	0	1	0
Robackia demeijerei	1	0	0	0	0	0	2	0	0	0	0	11	0	0	0	1
Saetheria sp.	0	0	0	0	0	0	4	0	0	0	0	0	0	0	0	0

Table 3. List of aquatic macroinvertebrates collected from the Autauga Creek watershed, June 23–25, 2009.—Continued

[Habitat type abbreviations: LOG/R, log/rock; ROOT/B, root/bank; MACRO, macrophytes; CPOM, coarse particulate organic matter; sp., undetermined species; L/R, large or rare specimens. Data are NOT adjusted for subsampling and INCLUDE Large/Rare specimens. Shading indicates detections. Site names are listed in table 1]

Site (see fig. 1)	8	8	8	8	8	8	9	9	9	9	9	11	11	11	11	11
Date	6/23/2009	6/23/2009	6/23/2009	6/23/2009	6/23/2009	6/23/2009	6/24/2009	6/24/2009	6/24/2009	6/24/2009	6/24/2009	6/25/2009	6/25/2009	6/25/2009	6/25/2009	6/25/2009
Habitat	SAND	LOG/R	ROOT/B	RIFFLE	MACRO	CPOM	SAND	LOG/R	ROOT/B	RIFFLE	CPOM	SAND	LOG/R	ROOT/B	RIFFLE	CPOM
Percent Subsampled	100.00	50.00	58.48	20.83	100.00	31.25	100.00	50.00	100.00	100.00	25.58	100.00	31.25	100.00	12.50	100.00
Diptera-Chironomidae—Continued																
Stempellina sp.	0	0	5	0	0	0	0	0	2	0	0	0	0	1	2	0
Stempellinella sp.	0	0	1	0	2	1	0	0	0	0	0	0	0	0	0	0
Stenochironomus sp.	0	1	1	10	1	6	0	0	1	1	0	1	0	0	1	0
Stictochironomus sp.	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0
Tanytarsus sp.	0	2	10	4	8	5	0	15	3	0	3	0	3	1	2	0
Thienemanniella sp.	0	0	0	0	1	0	0	0	0	0	1	0	3	0	0	0
Thienemannimyia gr. sp.	0	8	4	2	2	0	0	2	0	0	0	0	0	0	4	0
Tribelos jucundum	2	0	23	0	0	39	0	0	0	1	94	0	0	0	0	0
Tribelos sp.	0	0	40	0	0	72	0	0	0	0	77	1	0	0	0	0
Tvetenia discoloripes gr.	0	5	1	0	5	0	0	11	6	6	1	0	33	5	8	1
Xylotopus par	0	0	0	2	0	1	0	0	2	1	0	0	0	0	0	0
Diptera																
Atrichopogon sp.	0	0	0	0	0	0	0	0	0	3	0	0	0	0	0	0
Bezzia/Palpomyia sp.	0	0	0	0	1	3	0	0	0	0	0	0	0	0	0	0
Ceratopogoninae	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0
Hemerodromia sp.	0	3	0	1	0	3	0	3	0	0	2	1	12	0	8	0
Hexatoma sp.	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0
Neoplasta sp.	0	0	0	0	0	0	0	0	0	0	0	0	2	0	1	0
Probezzia sp.	2	0	0	0	0	0	0	0	0	0	2	5	0	0	0	0
Simuliidae	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0
Simulium sp.	0	1	1	1	30	0	0	7	1	15	0	0	0	0	3	0
Tabanidae	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0
Trichoptera																
Anisocentropus sp.	0	0	3	0	0	8	0	0	0	0	0	0	0	0	0	0
Brachycentrus nigrosoma	0	0	2	3	5	0	0	0	4	0	0	1	0	1	9	0
Brachycentrus numerosus	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0
Calamoceratidae	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0
Cheumatopsyche sp.	0	3	0	21	2	0	1	14	2	23	0	1	8	1	45	2
Chimarra sp.	0	4	0	10	1	0	0	0	0	1	0	0	2	0	11 (L/R)	0
Heteroplectron americanum	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0
Hydropsyche sp.	0	60	2	13	3	0	0	69	1	10	0	0	62	0	18	0
Hydroptila sp.	0	10	2	1	5	0	0	5	1	4	1	0	28	3	12	1
Hydroptilidae	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0
Macrostemum sp.	0	11	0	2	0	0	0	11	0	2	0	0	7	0	0	0
Mayatrichia sp.	0	5	2	4	10	0	0	6	5	2	0	0	6	0	1	1
Micrasema sp.	0	0	1	0	1	0	0	2	0	1	0	0	3	0	1	0
Nectopsyche sp.	0	1	1	0	2	2	1	0	3	0	0	0	0	2	1	0
Neotrichia sp.	0	1	4	2	5	0	0	0	0	0	0	0	0	0	0	0
Neureclipsis sp.	0	1	1	0	0	0	0	0	2	0	0	0	0	1	0	0
Oecetis sp.	0	3	0	1	0	0	0	3	0	0	0	0	1	1	5	0
Oxyethira sp.	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0
Polycentropodidae	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0
Triaenodes sp.	0	0	0	0	0	0	0	0	3	0	0	0	0	3	0	0

Table 3. List of aquatic macroinvertebrates collected from the Autauga Creek watershed, June 23–25, 2009.—Continued

[Habitat type abbreviations: LOG/R, log/rock; ROOT/B, root/bank; MACRO, macrophytes; CPOM, coarse particulate organic matter; sp., undetermined species; L/R, large or rare specimens. Data are NOT adjusted for subsampling and INCLUDE Large/Rare specimens. Shading indicates detections. Site names are listed in table 1]

Site (see fig. 1)	8	8	8	8	8	8	9	9	9	9	9	11	11	11	11	11
Date	6/23/2009	6/23/2009	6/23/2009	6/23/2009	6/23/2009	6/23/2009	6/24/2009	6/24/2009	6/24/2009	6/24/2009	6/24/2009	6/25/2009	6/25/2009	6/25/2009	6/25/2009	6/25/2009
Habitat	SAND	LOG/R	ROOT/B	RIFFLE	MACRO	CPOM	SAND	LOG/R	ROOT/B	RIFFLE	CPOM	SAND	LOG/R	ROOT/B	RIFFLE	CPOM
Percent Subsampled	100.00	50.00	58.48	20.83	100.00	31.25	100.00	50.00	100.00	100.00	25.58	100.00	31.25	100.00	12.50	100.00
Bivalvia																
Sphaeriidae	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0
Annelida																
Enchytraeidae	0	1	0	0	1	0	0	0	0	0	0	0	0	0	1	0
Haemonais waldvogeli	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0
Lumbriculidae	0	0	0	3	0	0	0	0	0	0	1	0	0	0	0	0
Nais behningi	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0
Nais sp.	0	0	0	2	0	0	0	1	0	0	0	0	0	0	0	0
Pristina sp.	0	0	0	0	0	0	0	2	0	0	2	0	0	0	0	0
Slavina appendiculata	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0
Spirosperma ferox	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0
Tubificidae with cap setae	0	0	0	5	0	0	0	0	0	0	0	0	0	0	0	0
Tubificidae without cap setae	0	0	1	1	0	0	0	0	0	0	1	1	0	0	1	0
Acari																
Acari	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0
Atractides sp.	0	5	0	0	1	0	0	0	0	0	0	0	0	0	0	0
Hygrobates sp.	0	0	0	3	2	0	0	11	0	1	0	3	7	0	2	0
Lebertia sp.	0	1	0	2	0	0	0	1	0	1	0	0	0	0	5	0
Mideopsis sp.	0	0	1	1	0	1	0	0	0	0	0	0	0	0	0	0
Neumania sp.	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0
Oribatei	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0
Protzia sp.	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0
Sperchon sp.	0	2	0	0	1	0	0	0	0	0	0	0	2	0	0	0
Sperchonopsis sp.	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	0
Torrenticola sp.	0	0	1	0	0	0	0	2	0	0	0	0	0	0	0	0
Crustacea																
Cambaridae	0	0	1	0	0	0	0	0	0	0	0	0	0	0	1 (L/R)	0
Crangonyx sp.	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0
Other organisms																
Prostoma sp.	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0
Turbellaria	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0
Totals																
	9	**210**	**214**	**216**	**179**	**219**	**20**	**210**	**100**	**154**	**220**	**82**	**229**	**58**	**240**	**9**

Table 4. Sort report for samples collected at sampling sites in the Autauga Creek watershed, Alabama, June 23–25, 2009.

[CPOM, coarse particulate organic matter; L, liter; QC, quality control; %, percent; N/A, not applicable]

EcoAnalysts Sample ID	Site/habitat (see table 1)	Collection date	Sort date	Primary matrix	Pre-rinse volume (L)	Post-rinse volume (L)	QC date	%Efficacy 1	%Efficacy 2	%Efficacy 3
5352.1-1	8 Sand	06/23/09	09/16/09	Bugs	0.001	0.001	09/17/09	100.00	N/A	N/A
5352.1-2	8 Log/rock	06/23/09	09/16/09	Coarse organic	0.10	0.05	09/17/09	96.41	N/A	N/A
5352.1-3	8 Root/bank	06/23/09	09/17/09	Coarse organic	0.20	0.15	09/17/09	97.79	N/A	N/A
5352.1-4	8 Riffle	06/23/09	09/16/09	Coarse organic	0.35	0.33	09/17/09	96.51	N/A	N/A
5352.1-5	8 Macrophytes	06/23/09	09/17/09	Coarse organic	0.10	0.09	09/17/09	95.70	N/A	N/A
5352.1-6	8 CPOM	06/23/09	09/17/09	Coarse organic	0.90	0.85	09/17/09	93.80	N/A	N/A
5352.1-7	9 Sand	06/24/09	09/17/09	Fine organic	0.05	0.05	09/17/09	100.00	N/A	N/A
5352.1-8	9 Log/rock	06/24/09	09/17/09	Coarse organic	0.05	0.05	09/17/09	98.21	N/A	N/A
5352.1-9	9 Root/bank	06/24/09	09/17/09	Fine organic	0.08	0.08	09/17/09	83.51	82.14	100.00
5352.1-10	9 Riffle	06/24/09	09/18/09	Coarse organic	0.14	0.05	09/19/09	58.62	90.63	N/A
5352.1-11	9 CPOM	06/24/09	09/17/09	Coarse organic	1.10	1.10	09/21/09	95.82	N/A	N/A
5352.1-12	11 Sand	06/25/09	09/17/09	Coarse organic	0.05	0.05	09/19/09	95.40	N/A	N/A
5352.1-13	11 Log/rock	06/25/09	09/17/09	Filamentous algae	0.10	0.10	09/20/09	100.00	N/A	N/A
5352.1-14	11 Root/bank	06/25/09	09/17/09	Coarse organic	0.02	0.02	09/19/09	93.44	N/A	N/A
5352.1-15	11 Riffle	06/25/09	09/18/09	Coarse organic	0.40	0.35	09/19/09	92.09	N/A	N/A
5352.1-16	11 CPOM	06/25/09	09/18/09	Fine organic	0.02	0.02	09/20/09	77.78	100.00	N/A

more than 1 year for life cycle) richness, clinger (organisms adapted to streams with high velocity and a smooth substrate) richness, percentage of abundance that is clingers, intolerant taxa richness, percentage of total individuals that are tolerant, percentage of total taxa that are tolerant, coleopteran (beetle) richness (EcoAnalysts, Inc., written commun., August 2009).

Water-Quality Field Parameter Measurements

Two series of measurements of water-quality field parameters were made at 11 sites in the watershed during 2009. Measurements were made with a multiparameter sonde that measured temperature, dissolved oxygen, specific conductance, pH, and turbidity.

The first series of measurements were made on June 23 during base-flow conditions. Temperatures in Autauga Creek ranged from a high of 27.6 degrees Celsius (°C) at site 4 to a low of 24.1 °C at site 2 (fig. 1; table 2). Temperatures on Bridge Creek ranged from a high of 29.6 °C at site 6 to a low of 27.6 °C at site 7. The one site on Breakfast Creek had a temperature of 26.0 °C. There appeared to be no trends in the temperature data. The variations in the readings were mostly the result of the amount of tree canopy over the creek near each measurement site.

The second series of measurements were made on December 15 during high flow after a period of rainfall. Temperatures in Autauga Creek ranged from 13.2 °C to 14.0 °C. The higher streamflow caused more consistent readings through the watershed than during base-flow conditions. Temperatures in Bridge Creek ranged from 13.0 °C to 14.2 °C. The temperature in Breakfast Creek was 14.9 °C.

Dissolved oxygen levels in the watershed were all within normal ranges. Readings in the watershed during the base-flow measurements ranged from 6.4 to 7.7 milligrams per liter (mg/L). High-flow measurements ranged from 8.8 to 9.6 mg/L.

Measurements of specific conductance were consistent throughout the watershed ranging only from 22 to 26 microsiemens per centimeter (µS/cm) at all of the sites during base flow and 17 to 19 µS/cm during high flow. These low readings indicate low dissolved solids in the streams.

Measurements of pH in the watershed ranged from 5.8 to 6.8 during base flow and 5.4 to 6.2 during high flow. There appeared to be no trends in the readings from the upper end of the basin to the lower end. Readings during high-flow conditions were slightly lower than base-flow conditions. These pH levels indicate slightly acidic to neutral water conditions.

Turbidity was only measured during base flow. Readings ranged from 49.1 to 4.26 formazin nephelometric units (FNU) on Autauga Creek and 12.2 to 12.8 FNU on Bridge Creek. Breakfast Creek measured 19.2 FNU. The readings do not appear to follow any pattern along the creeks. The highest value, 49.1 FNU at site 1, was on the uppermost site on Autauga Creek, but silt was possibly stirred up during the measurement. The lowest reading, 4.26 FNU at site 2, occurred on the very next site downstream. Otherwise, values ranged from 4.43 to 19.2 FNU in the rest of the watershed.

Table 5. Metrics for aquatic macroinvertebrates collected from Autauga Creek watershed, June 23–25, 2009.

[CPOM, coarse particulate organic matter; HBI, Hilsenhoff Biotic Index; MTI, Metals Tolerance Index; FSBI, Fine Sediment Biotic Index; TPM, Temperature Preference Metric; %, percent; N/A, not applicable; B-IBI, benthic index of biological integrity. Data ARE adjusted for subsampling and DO NOT include Large/Rare specimens]

Water body	Autauga Creek	Autauga Creek	Autauga Creek	Autauga Creek	Autauga Creek	Autauga Creek	Bridge Creek	Bridge Creek	Bridge Creek	Bridge Creek	Bridge Creek	Autauga Creek	Autauga Creek	Autauga Creek	Autauga Creek	Autauga Creek
Site (see fig. 1)	8	8	8	8	8	8	9	9	9	9	9	11	11	11	11	11
Date	06-23-2009	06-23-2009	06-23-2009	06-23-2009	06-23-2009	06-23-2009	06-24-2009	06-24-2009	06-24-2009	06-24-2009	06-24-2009	06-25-2009	06-25-2009	06-25-2009	06-25-2009	06-25-2009
Habitat	SAND	LOG/ ROCK	ROOT/ BANK	RIFFLE	MACRO-PHYTE	CPOM	SAND	LOG/ ROCK	ROOT/ BANK	RIFFLE	CPOM	SAND	LOG/ ROCK	ROOT/ BANK	RIFFLE	CPOM
Percent subsampled	100.00	50.00	58.48	20.83	100.00	31.25	100.00	50.00	100.00	100.00	25.58	100.00	31.25	100.00	12.50	100.00
Abundance measures																
Corrected abundance	9.00	420.00	365.94	1036.80	179.00	700.80	20.00	420.00	100.00	154.00	860.20	82.00	732.80	58.00	1824.00	9.00
EPT abundance	0.00	248.00	61.56	432.00	96.00	51.20	4.00	232.00	63.00	108.00	15.64	7.00	403.20	31.00	1032.00	4.00
Dominance measures																
Dominant taxon	*Tribelos jucundum*	*Hydropsyche* sp.	*Tribelos* sp.	*Stenelmis* sp.	*Simulium* sp.	*Tribelos* sp.	*Djalmabatista* sp.	*Hydropsyche* sp.	*Pseudocloeon dardanum*	*Isonychia* sp.	*Tribelos jucundum*	*Polypedilum halterale* gr.	*Hydropsyche* sp.	*Calopteryx* sp.	*Cheumatopsyche* sp.	*Macronychus glabratus*
Dominant abundance	2.00	120.00	68.40	182.40	30.00	230.40	8.00	138.00	21.00	40.00	367.54	15.00	198.40	11.00	360.00	2.00
2nd Dominant taxon	*Progomphus* sp.	*Stenelmis* sp.	*Tribelos jucundum*	*Cheumatopsyche* sp.	*PseudocloeonTribelos dardanum*	*jucundum*	*Saetheria* sp.	*Stenelmis* sp.	*Isonychia* sp.	*Cheumatopsyche* sp.	*Tribelos* sp.	*Robackia demeijerei*	T*vetenia discoloripes* gr.	*Pseudocloeon dardanum*	*Stenelmis* sp.	*Cheumatopsyche* sp.
2nd Dominant abundance	2.00	32.00	39.33	100.80	17.00	124.80	4.00	30.00	8.00	23.00	301.07	11.00	105.60	8.00	200.00	2.00
3rd Dominant taxon	*Probezzia* sp.	*Macrostemum* sp.	*Ablabesmyia mallochi*	*Maccaffertium* sp.	*Acerpenna pygmaea*	*Ablabesmyia mallochi*	*Robackia demeijerei*	*Tanytarsus* sp.	*Maccaffertium* sp.	*Simulium* sp.	*Cryptochironomus* sp.	*Cryptochironomus* sp.	*Hydroptila* sp.	*Maccaffertium* sp.	*Hydropsyche* sp.	*Hydroptila* sp.
3rd Dominant abundance	2.00	22.00	35.91	76.80	15.00	80.00	2.00	30.00	6.00	15.00	27.37	9.00	89.60	6.00	144.00	1.00
% Dominant taxon	22.22	28.57	18.69	17.59	16.76	32.88	40.00	32.86	21.00	25.97	42.73	18.29	27.07	18.97	19.74	22.22
% 2 Dominant taxa	44.44	36.19	29.44	27.31	26.26	50.68	60.00	40.00	29.00	40.91	77.73	31.71	41.48	32.76	30.70	44.44
% 3 Dominant taxa	66.67	41.43	39.25	34.72	34.64	62.10	70.00	47.14	35.00	50.65	80.91	42.68	53.71	43.10	38.60	55.56
Richness measures																
Species richness	6.00	44.00	57.00	50.00	42.00	27.00	9.00	32.00	31.00	26.00	25.00	27.00	36.00	23.00	44.00	7.00
EPT richness	0.00	19.00	15.00	17.00	18.00	5.00	4.00	9.00	15.00	13.00	3.00	7.00	14.00	12.00	15.00	3.00
Ephemeroptera richness	0.00	6.00	5.00	6.00	7.00	1.00	2.00	2.00	5.00	4.00	0.00	4.00	5.00	4.00	5.00	0.00
Plecoptera richness	0.00	3.00	0.00	2.00	1.00	1.00	0.00	0.00	1.00	2.00	1.00	0.00	1.00	0.00	1.00	0.00
Trichoptera richness	0.00	10.00	10.00	9.00	10.00	3.00	2.00	7.00	9.00	7.00	2.00	3.00	8.00	8.00	9.00	3.00

Table 5. Metrics for aquatic macroinvertebrates collected from Autauga Creek watershed, June 23–25, 2009.—Continued

[CPOM, coarse particulate organic matter; HBI, Hilsenhoff Biotic Index; MTI, Metals Tolerance Index; FSBI, Fine Sediment Biotic Index; TPM, Temperature Preference Metric; %, percent; N/A, not applicable; B-IBI, benthic index of biological integrity. Data ARE adjusted for subsampling and DO NOT include Large/Rare specimens]

Water body	Autauga Creek	Autauga Creek	Autauga Creek	Autauga Creek	Autauga Creek	Autauga Creek	Bridge Creek	Bridge Creek	Bridge Creek	Bridge Creek	Bridge Creek	Autauga Creek	Autauga Creek	Autauga Creek	Autauga Creek	Autauga Creek
Site (see fig. 1)	8	8	8	8	8	8	9	9	9	9	9	11	11	11	11	11
Date	06-23-2009	06-23-2009	06-23-2009	06-23-2009	06-23-2009	06-23-2009	06-24-2009	06-24-2009	06-24-2009	06-24-2009	06-24-2009	06-25-2009	06-25-2009	06-25-2009	06-25-2009	06-25-2009
Habitat	SAND	LOG/ ROCK	ROOT/ BANK	RIFFLE	MACRO-PHYTE	CPOM	SAND	LOG/ ROCK	ROOT/ BANK	RIFFLE	CPOM	SAND	LOG/ ROCK	ROOT/ BANK	RIFFLE	CPOM
Percent subsampled	100.00	50.00	58.48	20.83	100.00	31.25	100.00	50.00	100.00	100.00	25.58	100.00	31.25	100.00	12.50	100.00
Richness measures—Continued																
Chironomidae richness	3.00	16.00	25.00	16.00	14.00	16.00	4.00	13.00	8.00	7.00	12.00	13.00	14.00	7.00	17.00	3.00
Oligochaeta richness	0.00	1.00	1.00	5.00	1.00	0.00	0.00	2.00	2.00	0.00	4.00	1.00	0.00	0.00	2.00	0.00
Non-Chiro. Non-Olig. richness	3.00	27.00	31.00	29.00	27.00	11.00	5.00	17.00	21.00	19.00	9.00	13.00	22.00	16.00	25.00	4.00
Community composition																
% Ephemeroptera	0.00	8.57	7.48	12.04	30.73	0.46	10.00	2.86	39.00	37.66	0.00	4.88	3.06	31.03	13.60	0.00
% Plecoptera	0.00	3.33	0.00	3.24	3.35	1.83	0.00	0.00	2.00	4.55	0.91	0.00	0.87	0.00	2.19	0.00
% Trichoptera	0.00	47.14	9.35	26.39	19.55	5.02	10.00	52.38	22.00	27.92	0.91	3.66	51.09	22.41	40.79	44.44
% EPT	0.00	59.05	16.82	41.67	53.63	7.31	20.00	55.24	63.00	70.13	1.82	8.54	55.02	53.45	56.58	44.44
% Coleoptera	0.00	10.00	0.47	22.22	3.91	1.83	0.00	7.62	4.00	3.90	0.45	2.44	5.24	1.72	14.91	22.22
% Diptera	66.67	26.67	68.69	26.39	38.55	89.95	75.00	28.57	23.00	21.43	94.09	82.93	35.37	22.41	23.25	33.33
% Oligochaeta	0.00	0.48	0.47	5.56	0.56	0.00	0.00	1.43	3.00	0.00	2.27	1.22	0.00	0.00	0.88	0.00
% Baetidae	0.00	1.90	1.40	2.31	23.46	0.00	0.00	0.00	21.00	1.30	0.00	2.44	0.44	13.79	1.32	0.00
% Brachycentridae	0.00	0.00	1.40	1.39	3.35	0.00	0.00	0.95	4.00	0.65	0.00	1.22	1.31	3.45	4.82	0.00
% Chironomidae	44.44	24.76	66.82	24.54	21.23	87.21	75.00	23.81	22.00	9.74	92.27	75.61	28.82	22.41	17.98	33.33
% Ephemerellidae	0.00	0.00	0.47	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
% Hydropsychidae	0.00	35.24	0.93	16.67	2.79	0.00	5.00	44.76	3.00	22.73	0.00	1.22	33.62	1.72	27.63	22.22
% Odonata	33.33	0.00	9.35	0.00	1.12	0.46	5.00	0.00	7.00	0.00	0.45	1.22	0.00	22.41	0.00	0.00
% Perlidae	0.00	2.86	0.00	3.24	3.35	1.83	0.00	0.00	2.00	4.55	0.91	0.00	0.87	0.00	2.19	0.00
% Simuliidae	0.00	0.48	0.47	0.46	16.76	0.00	0.00	3.33	1.00	9.74	0.00	0.00	0.44	0.00	1.32	0.00
Functional group composition																
% Filterers	0.00	44.29	9.35	29.63	30.17	3.20	5.00	56.67	18.00	59.74	2.27	1.22	40.17	10.34	38.60	22.22
% Gatherers	33.33	11.90	42.99	19.44	23.46	54.79	25.00	10.95	17.00	10.39	80.91	9.76	20.52	13.79	13.16	11.11
% Predators	44.44	14.76	24.77	10.19	8.38	17.81	50.00	11.90	9.00	9.09	9.55	28.05	12.23	24.14	14.91	0.00
% Scrapers	0.00	14.76	2.34	26.85	12.85	2.28	5.00	12.86	14.00	15.58	0.45	3.66	9.17	13.79	17.11	11.11
% Shredders	0.00	9.05	5.14	9.72	6.70	10.96	5.00	5.24	13.00	1.95	2.73	12.20	5.68	15.52	2.19	33.33
% Piercer-Herbivores	0.00	5.24	2.80	1.39	5.59	0.46	0.00	2.38	2.00	2.60	0.45	0.00	12.23	5.17	5.26	11.11

Table 5. Metrics for aquatic macroinvertebrates collected from Autauga Creek watershed, June 23–25, 2009.—Continued

[CPOM, coarse particulate organic matter; HBI, Hilsenhoff Biotic Index; MTI, Metals Tolerance Index; FSBI, Fine Sediment Biotic Index; TPM, Temperature Preference Metric; %, percent; N/A, not applicable; B-IBI, benthic index of biological integrity. Data ARE adjusted for subsampling and DO NOT include Large/Rare specimens]

Water body	Autauga Creek	Autauga Creek	Autauga Creek	Autauga Creek	Autauga Creek	Autauga Creek	Bridge Creek	Bridge Creek	Bridge Creek	Bridge Creek	Bridge Creek	Autauga Creek	Autauga Creek	Autauga Creek	Autauga Creek	Autauga Creek
Site (see fig. 1)	8	8	8	8	8	8	9	9	9	9	9	11	11	11	11	11
Date	06-23-2009	06-23-2009	06-23-2009	06-23-2009	06-23-2009	06-23-2009	06-24-2009	06-24-2009	06-24-2009	06-24-2009	06-24-2009	06-25-2009	06-25-2009	06-25-2009	06-25-2009	06-25-2009
Habitat	SAND	LOG/ ROCK	ROOT/ BANK	RIFFLE	MACRO-PHYTE	CPOM	SAND	LOG/ ROCK	ROOT/ BANK	RIFFLE	CPOM	SAND	LOG/ ROCK	ROOT/ BANK	RIFFLE	CPOM
Percent subsampled	100.00	50.00	58.48	20.83	100.00	31.25	100.00	50.00	100.00	100.00	25.58	100.00	31.25	100.00	12.50	100.00
Functional group composition—Continued																
% Unclassified	22.22	0.00	8.88	1.39	10.06	7.31	10.00	0.00	23.00	0.65	0.91	43.90	0.00	15.52	4.82	11.11
Filterer Richness	0.00	9.00	6.00	9.00	9.00	2.00	1.00	7.00	7.00	7.00	2.00	1.00	9.00	5.00	8.00	1.00
Gatherer Richness	2.00	10.00	16.00	17.00	12.00	6.00	2.00	9.00	8.00	6.00	8.00	8.00	9.00	4.00	13.00	1.00
Predator Richness	2.00	11.00	15.00	12.00	7.00	8.00	3.00	8.00	4.00	5.00	8.00	6.00	8.00	4.00	10.00	0.00
Scraper Richness	0.00	4.00	4.00	3.00	4.00	2.00	1.00	4.00	3.00	4.00	1.00	3.00	5.00	2.00	4.00	1.00
Shredder Richness	0.00	8.00	6.00	4.00	5.00	4.00	1.00	3.00	4.00	2.00	2.00	2.00	4.00	4.00	3.00	2.00
Piercer-Herbivore Richness	0.00	2.00	2.00	2.00	2.00	1.00	0.00	1.00	2.00	1.00	1.00	0.00	1.00	1.00	1.00	1.00
Unclassified	2.00	0.00	6.00	2.00	2.00	3.00	1.00	0.00	2.00	1.00	2.00	6.00	0.00	2.00	4.00	1.00
Diversity/evenness measures																
Shannon-Weaver H' (log 10)	0.75	1.33	1.43	1.42	1.39	1.00	0.79	1.16	1.32	1.12	0.74	1.19	1.18	1.20	1.34	0.82
Shannon-Weaver H' (log 2)	2.50	4.40	4.74	4.73	4.61	3.34	2.62	3.85	4.39	3.72	2.46	3.95	3.92	3.97	4.45	2.73
Shannon-Weaver H' (log e)	1.74	3.05	3.29	3.28	3.19	2.31	1.82	2.67	3.04	2.58	1.71	2.74	2.72	2.75	3.08	1.89
Margalef's Richness	2.28	7.12	9.49	7.06	7.90	3.97	2.67	5.13	6.51	4.96	3.55	5.90	5.31	5.42	5.73	2.73
Pielou's J'	0.97	0.81	0.81	0.84	0.85	0.70	0.83	0.77	0.89	0.79	0.53	0.83	0.76	0.88	0.81	0.97
Simpson's Heterogeneity	0.92	0.90	0.93	0.94	0.94	0.83	0.82	0.87	0.93	0.89	0.69	0.92	0.88	0.93	0.92	0.94
Biotic indices																
% Indiv. with HBI Value	66.67	94.29	85.05	92.13	70.39	87.67	60.00	92.86	73.00	94.81	95.91	54.88	94.76	81.03	85.53	100.00
Hilsenhoff Biotic Index	3.83	5.12	5.58	5.06	5.03	5.53	4.25	5.13	4.90	3.91	5.26	5.91	5.12	4.89	4.74	5.22
% Indiv. with MTI Value	0.00	64.29	25.23	46.76	40.22	9.13	20.00	75.71	29.00	47.40	8.64	17.07	75.55	31.03	61.84	44.44
Metals Tolerance Index	N/A	4.31	2.96	3.73	4.06	3.60	3.75	4.47	3.28	4.55	3.63	3.93	4.39	3.33	4.12	4.50

Table 5. Metrics for aquatic macroinvertebrates collected from Autauga Creek watershed, June 23–25, 2009.—Continued

[CPOM, coarse particulate organic matter; HBI, Hilsenhoff Biotic Index; MTI, Metals Tolerance Index; FSBI, Fine Sediment Biotic Index; TPM, Temperature Preference Metric; %, percent; N/A, not applicable; B-IBI, benthic index of biological integrity. Data ARE adjusted for subsampling and DO NOT include Large/Rare specimens]

Water body	Autauga Creek	Autauga Creek	Autauga Creek	Autauga Creek	Autauga Creek	Autauga Creek	Bridge Creek	Bridge Creek	Bridge Creek	Bridge Creek	Bridge Creek	Autauga Creek	Autauga Creek	Autauga Creek	Autauga Creek	Autauga Creek
Site (see fig. 1)	8	8	8	8	8	8	9	9	9	9	9	11	11	11	11	11
Date	06-23-2009	06-23-2009	06-23-2009	06-23-2009	06-23-2009	06-23-2009	06-24-2009	06-24-2009	06-24-2009	06-24-2009	06-24-2009	06-25-2009	06-25-2009	06-25-2009	06-25-2009	06-25-2009
Habitat	SAND	LOG/ ROCK	ROOT/ BANK	RIFFLE	MACRO-PHYTE	CPOM	SAND	LOG/ ROCK	ROOT/ BANK	RIFFLE	CPOM	SAND	LOG/ ROCK	ROOT/ BANK	RIFFLE	CPOM
Percent subsampled	100.00	50.00	58.48	20.83	100.00	31.25	100.00	50.00	100.00	100.00	25.58	100.00	31.25	100.00	12.50	100.00
Biotic indices—Continued																
% Indiv. with FSBI Value	0.00	39.05	3.27	19.44	24.02	1.37	5.00	48.10	5.00	37.66	1.82	2.44	49.34	10.34	38.16	33.33
Fine Sediment Biotic Index	N/A	26.00	24.00	27.00	23.00	5.00	2.00	26.00	15.00	20.00	11.00	7.00	21.00	9.00	24.00	7.00
FSBI—average	N/A	0.59	0.42	0.54	0.55	0.19	0.22	0.81	0.48	0.77	0.44	0.26	0.58	0.39	0.55	1.00
FSBI—weighted average	N/A	4.73	4.86	3.29	3.40	5.00	2.00	4.40	3.40	2.93	4.00	3.50	4.76	3.50	3.37	3.00
% Indiv. with TPM Value	0.00	53.33	15.89	36.11	43.02	13.24	5.00	60.95	20.00	39.61	5.45	15.85	56.33	17.24	44.74	44.44
Temp. Pref. Metric —average	N/A	1.02	0.77	0.80	1.21	0.78	0.11	1.25	0.61	0.85	0.64	0.37	1.56	0.61	0.75	0.71
TPM—weighted average	N/A	2.28	2.41	2.18	3.39	2.31	1.00	2.36	1.70	2.36	2.33	2.00	2.46	2.20	1.58	1.50
Karr B-IBI Metrics																
Long-lived taxa richness	0.00	1.00	5.00	2.00	2.00	2.00	0.00	2.00	2.00	3.00	2.00	1.00	2.00	2.00	4.00	0.00
Clinger richness	0.00	24.00	15.00	19.00	18.00	8.00	3.00	15.00	11.00	15.00	6.00	4.00	17.00	9.00	17.00	3.00
% Clingers	0.00	77.14	16.82	62.04	58.66	8.68	15.00	77.14	29.00	60.39	4.55	4.88	64.19	31.03	60.96	44.44
Intolerant taxa richness	1.00	4.00	4.00	4.00	3.00	0.00	1.00	1.00	2.00	3.00	2.00	1.00	3.00	2.00	4.00	0.00
% Tolerant individuals	0.00	1.01	1.93	1.47	0.79	0.00	0.00	1.54	4.11	0.00	0.61	2.22	0.14	2.13	0.45	0.00
% Tolerant taxa	0.00	11.36	8.77	18.00	2.38	7.41	11.11	9.38	3.23	0.00	24.00	18.52	2.78	4.35	6.82	0.00
Coleoptera richness	0.00	3.00	1.00	3.00	3.00	2.00	0.00	2.00	2.00	1.00	1.00	2.00	2.00	1.00	3.00	1.00

Results of Macroinvertebrate Sample Analyses

Aquatic macroinvertebrate samples were collected at three sites in the Autauga Creek watershed on June 23–25, 2009. During reconnaissance of the watershed prior to sampling, Bridge Creek, the largest tributary to Autauga Creek, was visibly more turbid than Autauga Creek above their confluence. Sites were selected so that any effects of the higher turbidity or related water-quality parameters on the aquatic macroinvertebrate community could be observed. One of the macroinvertebrate sampling sites was at the ADEM basin assessment site AUC-2 adjacent to U.S. Hwy. 82 (site 11), below the confluence of the two creeks. The second (site 8) was on Autauga Creek above the confluence with Bridge Creek on County Road 10, and the third (site 9) was on Bridge Creek at County Road 10 (fig. 1; table 1).

Taxa identifications and enumerations for these samples are listed in table 3, and the calculated metrics are listed in table 5. Of particular note in the results is that at ADEM assessment site AUC-2 (site 11), 12 families of EPTs were found whereas only 4 were found during the 1999 sampling. Table 4 is the quality-control report from the taxonomy laboratory.

Total, EPT, and chironomid abundance, or the numbers of individuals, were highest in the riffle and log/rock habitats (fig. 2). Site 11 had the highest abundance. Sand habitat showed low abundance primarily due to low variability in the habitat and limited places for macroinvertebrates to attach and live. Log/rock, root/bank, and riffle habitats are generally more diverse with varying substrates and objects on which macroinvertebrates can attach. CPOM also can provide good habitat for macroinvertebrates but, as was the case at site 11, it is not always available to a large degree.

Richness, the number of taxa, was consistently higher at site 8 than sites 9 and 11 except in sand (fig. 3). Log/rock, root/bank, and riffle habitats had higher numbers of taxa due to the variability of the substrates in these habitats.

The riffle habitat is generally considered to be the richest in macroinvertebrate diversity, although in this study, log/rock and root/bank habitats were very similar to riffle habitat in terms of richness. EPT richness at sites 8, 9, and 11 in the riffle habitat was fairly similar, ranging from 13 to 17 taxa (fig. 4). Total and chironomid richnesses, however, were noticeably higher at sites 8 and 11 on Autauga Creek than at site 9 on Bridge Creek.

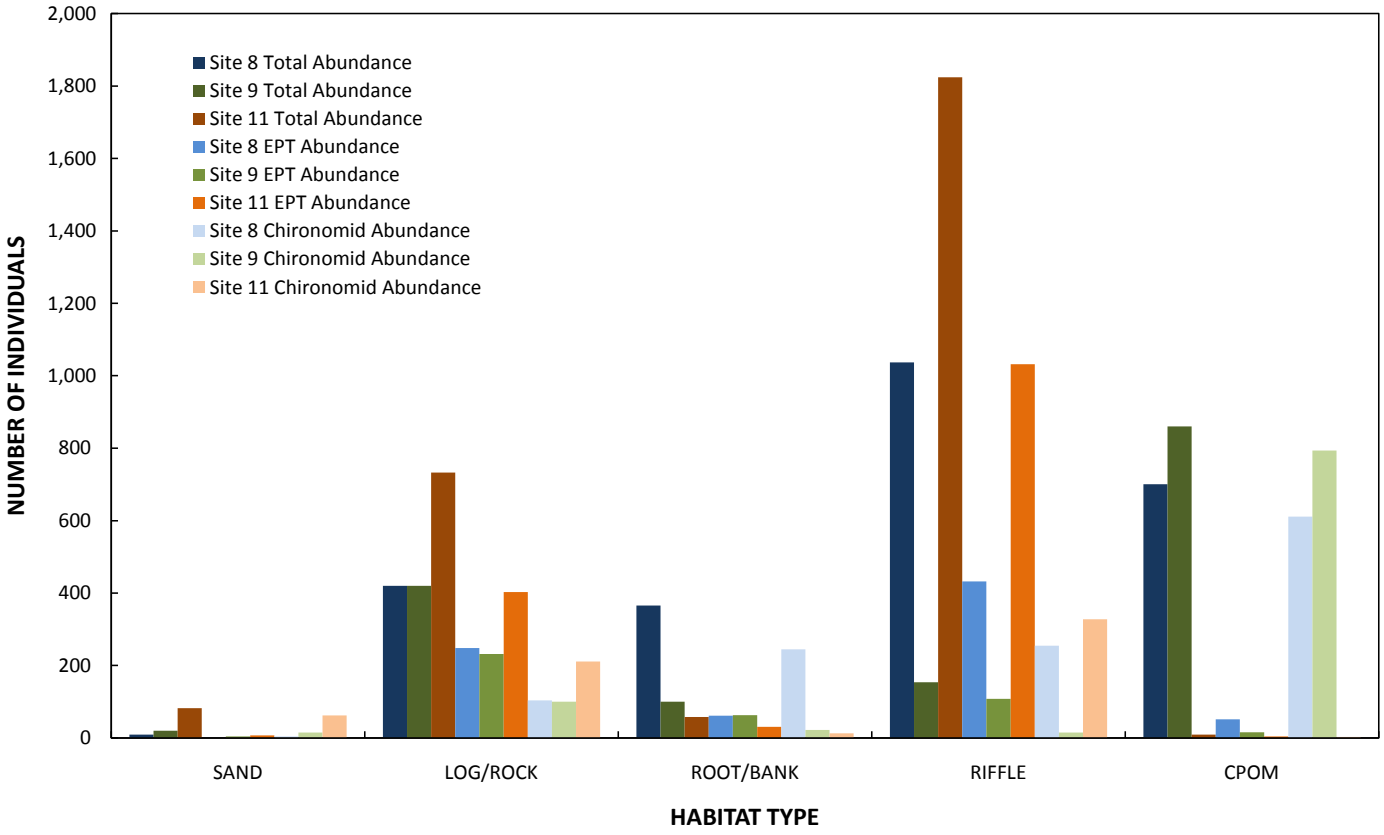


Figure 2. Total, EPT, and chironomid abundance at selected sites in the Autauga Creek watershed, Autauga County, Alabama, June 2009. [EPT, Ephemeroptera, Plecoptera, Trichoptera; CPOM, coarse particulate organic matter]

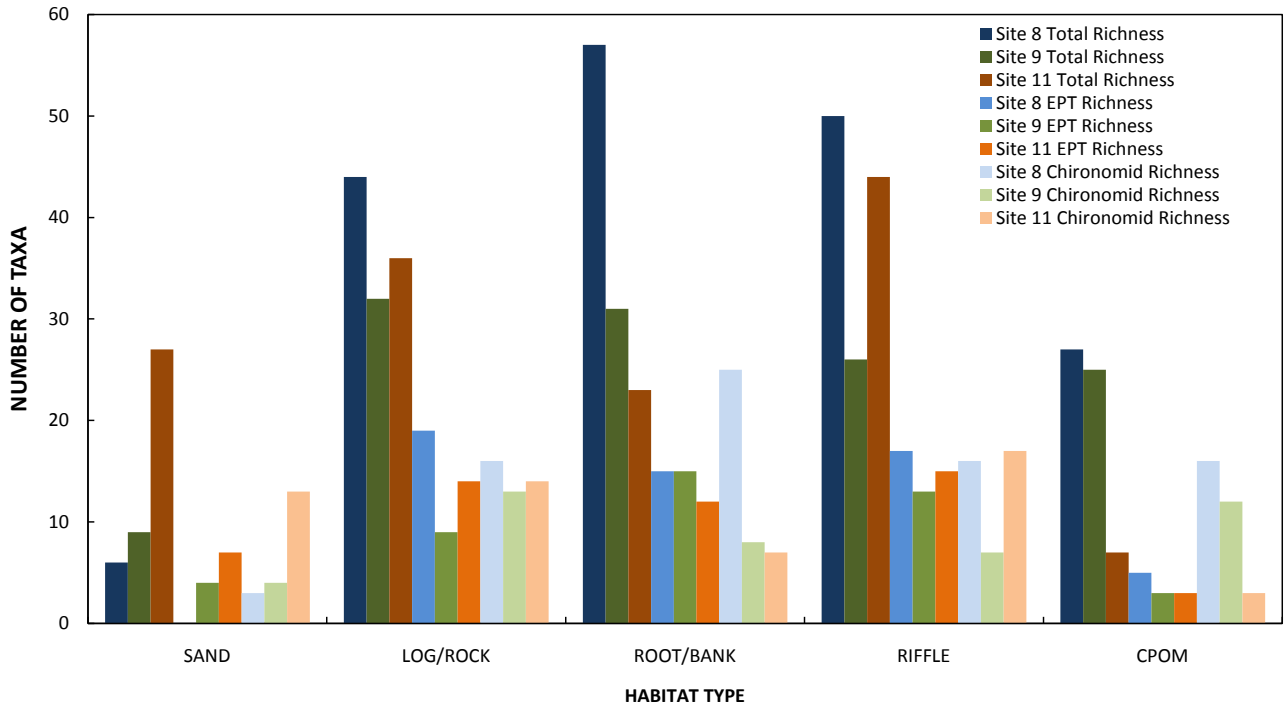


Figure 3. Total, EPT, and chironomid richness at selected sites in the Autauga Creek watershed, Autauga County, Alabama, June 2009. [EPT, Ephemeroptera, Plecoptera, Trichoptera; CPOM, coarse particulate organic matter]

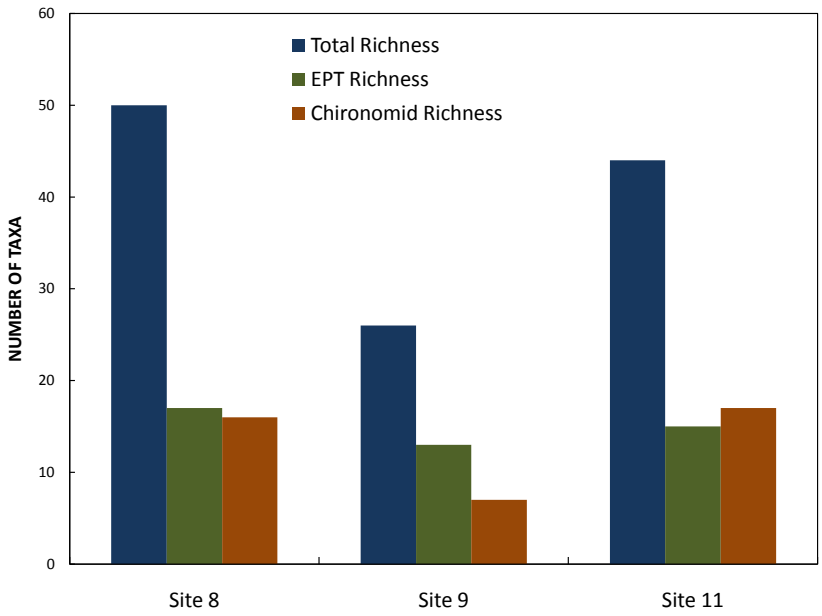


Figure 4. Total, EPT, and chironomid richness in riffle habitat at selected sites in the Autauga Creek watershed, Autauga County, Alabama, June 2009. [EPT, Ephemeroptera, Plecoptera, Trichoptera]

Summary

The purpose of this study was to provide data for the Alabama Department of Environmental Management (ADEM) and other water-management agencies to re-evaluate aquatic macroinvertebrate communities in Autauga Creek to see if they meet ADEM water-quality criteria. ADEM collected aquatic macroinvertebrate samples from Autauga Creek in 1999 and found only four families within the orders of Ephemeroptera, Plecoptera, and Trichoptera at the assessment site. The low EPT richness caused the creek to be included in the 2006 303(d) list, which may limit future use of the creek.

The U.S. Geological Survey collected aquatic macroinvertebrate samples from three sites in the Autauga Creek watershed on June 23–25, 2009. One site was at the 1999 ADEM assessment site on Autauga Creek below the confluence with Bridge Creek (site 11). The second site was on Autauga Creek above the confluence with Bridge Creek (site 8), and the third was on Bridge Creek (site 9), which is the largest tributary to Autauga Creek. The highest numbers of taxa and individuals of aquatic macroinvertebrates were found at site 11 on Autauga Creek. Twelve families within the orders of Ephemeroptera, Plecoptera, and Trichoptera were found at the site.

Water-quality field parameters of temperature, dissolved oxygen, specific conductance, pH, and turbidity were measured at 11 sites in the watershed during base flow on June 23, 2009, and during high flow on December 15, 2009. No trends were apparent in any of the water-quality field measurements from the upper end of the watershed to the lower end. Measurements of all parameters were within normal ranges for streams in this area.

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