Ecological and Biogeographical Influences on Stream Community Composition in Zoar Valley, New York

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April Marie Newman

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Signature:
April M. Newman, Student — 5-4-07 Date

Approvals:
Dr. Thomas P. Diggins, Thesis Advisor — 4 May 07 Date

Dr. Carl G. Johnston, Committee Member — 4 May 07 Date

Dr. John D. Usis, Committee Member — May 7, 2007 Date

Dr. Peter J. Kasvinsky, Dean of Graduate Studies — 5/7/07 Date

ABSTRACT. Biotic communities in low order streams are influenced by multiple factors that may reflect both ecological conditions within individual watersheds, and also biogeographic considerations such as spatial proximity among streams and organism dispersal abilities. Our aim was to assess benthic invertebrate community composition in 23 first – third order streams in Zoar Valley, NY, across a gradient in habitat quality, and to further explore the role of local biogeography. Replicate Surber samples were collected from each stream on three dates during April – September 2006. One hundred and thirty-seven taxa were collected, representing fifty-five families, dominated by juvenile insects. Additionally we quantified ecological variables such as stream order, watershed area, habitat quality indices, and land cover, and we generated a spatial distance matrix to quantify geographic separation among streams. Similarity/dissimilarity among stream communities was quantified by multivariate ordination of genus/species distributions by Non-metric Multi-dimensional Scaling. Dipterans (true flies) tended to be a cohesive group, and loaded towards lower-order streams, whereas taxa of Ephemeroptera (mayflies) and Plecoptera (stoneflies) were more variable in distribution across stream orders and watershed sizes. Separate ordination of the thirty-one encountered genera/species of Chironomidae suggested specificity towards individual streams. Regression of distances in ordination space on geographic distances was non-significant, indicating these streams represented individual geographic units, apparently with little overlap among them. Given the high degree of disturbance inherent in many small woodland streams, these quantitative studies of the high integrity stream systems surrounding Zoar Valley canyon should prove valuable to conservation and restoration strategies.

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I would like to first and foremost thank my thesis advisor Dr. Thomas P. Diggins. Dr. Diggins opened my eyes to the natural beauty that lies within Zoar Valley. Thanks to him and our field experiences, I have learned valuable information pertaining to woodland and riparian ecosystems that I would never have learned from a textbook. I would not be the "crazy bug lady" that I am if it were not for him. I would also like to thank my committee members, Dr. Carl Johnston and Dr. John Usis for all of their input into this research. Another person who was an important part of this research was Brian Jones. I would like to thank Brian for the additional hours and trips to Zoar Valley he took with me so it would be possible to collect that data and samples I needed. I would also like to thank all of the student workers in the Diggins laboratory especially Lydia Guevara for all of the chironomid slide mounting help. If it were not for them, it would have taken me at least another year to get through all of the samples. To my friends and family who have been there to see me through all of this and for supporting me in times of stress, thank you. Finally, I would like to thank Ashleigh Glass and Ashley Jasenec "the Ashley's" for keeping me entertained and as stress-free as possible.

TABLE OF CONTENTS

Ecological and Biogeographical Influences on Stream Community Composition in Zoar Valley, New York

April Newman

LIST OF TABLES

LIST OF FIGURES

LIST OF FIGURES

I. INTRODUCTION

> "People who experience for the first time the diversity of life in a stream are invariable moved to wider awareness of what is at stake in the protection of water quality…Few disciplines exist in which the study of nature can offer so much direct benefit toward the preservation of the very habitat being studied" (Mandaville 2002).

The majority of woodland stream ecosystems in the eastern United States are recovering from some degree of historical human disturbance. Because of this, it is importance to assess and gain an understanding of these multi-faceted ecosystems. One way of doing this is through evaluating the dynamics of community structure and organization, and how these riparian systems respond across multiple spatial and temporal scales

The diversity of life found in any stream can be a notable discovery. This is especially true in streams that have rarely been explored, specifically in terms of community composition. Because aquatic communities can integrate multiple facets of overall system quality, it is important to look at such streams in detail.

This thesis will study the community composition of 23 first – third order streams in Zoar Valley, New York. The primary objective of the study was to concurrently evaluate the possible environmental dynamics and biogeographical influences on stream aquatic community composition and structure.

Lotic Habitats

Freshwater environments can be divided into two basic types, lotic systems such as streams and rivers, and lentic systems including standing water such as lakes. The major distinction between these two types of environments is the relative residence times of water within them (Townsend 1980). Lotic systems include everything from seepage springs or trickling headwaters to the larger rivers that empty into lakes and oceans (McCafferty 1998). Due to natural aeration from the turbulence of the flowing waters, animal life in streams and rivers are most often readily provided with oxygen (McCafferty 1998).

The flow of water and its ability to form patterns of streams and their beds are the fundamental properties of their biotic habitats (Hynes 1970). Streams can be generally categorized on the basis of flow reliability. Perennial streams have measurable flow throughout the year, whereas intermittent streams have discontinuous flow and may even dry up for periods of time (McCafferty 1998). Streams can also be categorized by stream order, a classification that reflects progression in size from small tributaries to the largest of all rivers. For example, a stream which has no tributaries is considered first-order, while a second-order stream is the convergence of two fist-order streams. When two second-order streams join, the result is a third-order stream, etc. The world's largest rivers are classified as being 10 – 12 order.

Riparian zones are a vital component of the river's ecosystem. These are the interfaces between terrestrial and aquatic ecosystems (Gregory *et al.* 1991). In their undisturbed condition, riparian zones can be characterized by dominant vegetation types that are tolerant of, and adapted to, relatively high soil moisture content. Riparian zones contain some of the most diverse, dynamic, and complex of biophysical habitats (Naiman *et al.* 1993, Naiman *et al.* 1997). Because of this uniqueness, they serve as a template for understanding the organization, diversity, and dynamics of communities associated with fluvial ecosystems (Naiman *et al.* 1997).

The ecology of streams is particularly interesting due to the continuous and rapid throughput of water and other materials. In order to understand the distribution and abundance of species within a riparian ecosystem, a variety of dynamics must be examined. Such factors can generally be placed into three categories: 1) Factors associated with dispersal and/or behaviors of organisms, 2) Interspecific and intraspecific biotic factors such as predation and competition, and 3) Suitability of the abiotic environment including physical and chemical composition (Townsend 1980). Other factors that play a role in benthic community composition and abundance in riparian ecosystems include current speed, temperature, substratum, dissolved substances (i.e., oxygen, salinity, acidity, and hardness), liability to drought, food availability, shade, oviposition habits, and proximity of suitable habitats (Hynes 1970).

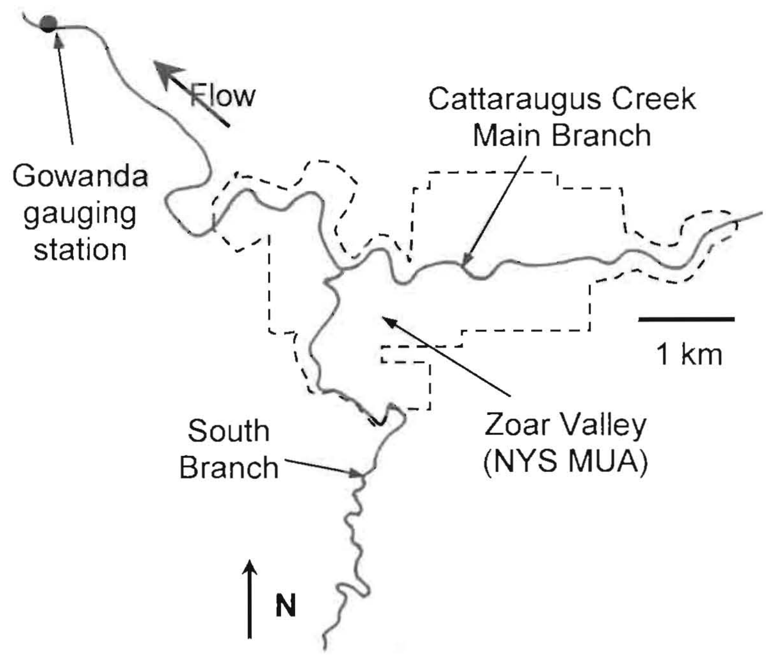
Environmental Influences on Stream Biotic Assemblages

Habitat availability is considered to be a critical template that shapes organisms' life-history strategies. Johnson *et al.* (2004) stated that the environmental characteristics of a specific stream were not random, but instead controlled by macroscale geomorphic patterns. Therefore, aquatic communities are considered to be structured by processes operating at multiple spatial scales (Johnson *et al.* 2004). However as suggested by Ormerod et al. (2000), few studies have concurrently assessed the importance of both regional and local factors on aquatic community structure. Recent work on broad-scale patterns in biotic diversity has primarily focused on how local habitat and environmental facors and historical processes have influenced the occurrence and persistence of species (Tonn 1990, Ricklefs and Schluter 1993, Poff 1997). However, it is logical to think that sites with similar habitats and/or environments might support similar biotic assemblages. But the distribution and abundance of species are not only influenced by environmental conditions, e.g. moisture, temperature regime, nutrient availability, and habitat structure (Brown *et al.* 1995), but also by biotic processes of competition, predation, dispersal, disturbance, and disease (Connell 1983). Therefore, it is reasonable to suggest that geographically proximal sites might also be more likely to support similar species assemblages than would sites that are farther apart (Legendre and Fortin 1989). Parris (2004) comments that as a consequence of spatial heterogeneity, there are three possible sources of variation in the composition of stream biotic assemblages: 1) pure environmental variation, 2) pure spatial variation, and 3) spatially-structured environmental variation (i.e. an interplay between both sources of variation).

Zoar Valley

The Zoar Valley Canyon, located in western New York (N 42°26', W 78°52'), is an 1185-ha state owned multi-use area. The depth of the main canyon ranges from 70 to 130 meters, which makes it the second deepest canyon system in New York State (Kershner 1994). The steep vertical walls of the canyon are cut by two branches of Cattaraugus Creek, the Main and the South branches. The Main Branch also forms the boundary between Erie and Cattaraugus Counties (Kershner 1994). (Fig.1)

Figure 1. Regional location of Zoar Valley, New York.


Flow
Cattaraugus Creek
Main Branch
Gowanda
gauging
station
1 km
Zoar Valley
(NYS MUA)
South
Branch
N


Lake Ontario
New York
State
(USA)
Lake Erie
100 km
Cattaraugus Creek

The Zoar Valley Canyon represents one of the premier riparian (i.e., a river and its surroundings) ecosystems in the Northeast, but only recently has quantitative ecological research been conducted here. As a consequence, the biota, in a sense, is still a mystery in a biologist's eyes. Previous and on-going studies here by YSU faculty and students have primarily focused upon Cattaraugus Creek itself and its canyon-bottom landforms, including trends in water quality (Basto-Salgado et al. 2005), riparian forest dynamics (Diggins and Kershner 2005, Pfeil et al. 2007), and fern biodiversity (Sinn and Chuey 2005).

This research that has focused primarily on the gorge leaves the entire upland portion of Zoar Valley basically unstudied. Numerous first – third order forest-covered streams can be found within this area above the canyon. These streams, which vary in origin, may be begin in the surrounding farmland and flow into second growth forest. From that point they may flow through a transition into old growth forest, then finally give way into precipitous cascades down into the canyon. Very little is known about the biota of these streams. What is known is that the land surrounding the streams has seen marked changes in terms of forest cover over the past century. An approximately 75-year record of aerial images (Fairchild Aerial Surveys 1929, USGS 1962, NYS Office of Technology 2002) reveals the various degrees of disturbance in the watersheds of these small streams. Such disturbances have ranged from minimal to near total. However, all watersheds have begun to renaturalize over the past few decades.

Goals and Objectives

This research compared stream community composition, i.e. benthic macroinvertebrates, to watershed characteristics of individual streams in the Zoar Valley study area. Three objectives were addressed during the course of this study: (1) to compare stream invertebrate community composition and structure from stream to stream, (2) to access the influence of watershed and/or habitat characteristics on community composition, and (3) to evaluate the role of local biogeography in patterns of community similarity/dissimilarity among streams.

By addressing these objectives, this thesis allowed us to quantitatively ask questions such as: What exact forces are shaping the community composition of these streams at an interface between high ecological integrity and landscape disturbance? Are watershed characteristics a bigger force on stream community composition versus the actual geographic/spatial distances between the streams? Are these streams essentially acting like aquatic islands in a sea of dry land, and will there be different patterns in community composition related to organism dispersal and colonization?

II. METHODS

Study Design

This research was designed to quantify the interplay between environmental/habitat quality and biogeographical dynamics in 23 first – third order streams above the Zoar Valley gorge. Stream biological community composition (i.e. benthic macroinvertebrates) and various watershed characteristics were quantified for each stream ecosystem. Identical sampling procedures in spring, summer, and fall 2006 were applied to all 23 streams. A complete watershed delineation of each stream was done with site-specific details pertaining to stream order as well as watershed land cover types, including mature forest, logged but not farmed land, and former farmland. Multivariate ordination analysis was employed to reveal patterns of similarity/dissimilarity in the distribution and abundance of macroinvertebrate taxa on the 23 streams. Given the complimentary objectives of assessing the influence of environmental and habitat characteristics and the influence of local biogeography on community composition, I chose to compare patterns in proximity of streams in ordination space to patterns in proximity of streams in geographical space (i.e. actual spatial distances). Such analyses have not been previously explored in a study of stream ecology.

Site Characterization

The study area contains three geographic subunits that were based on state-owned land, entrance assess, and parking availability. These areas were named southeast, southwest and north (Fig. 2). Sampling was conducted in these areas in first-, second-, and third-order streams. The southwest study site contains a total of seven streams that flow to the South Branch of the Zoar Valley Canyon (Fig. 3). The southeast (Fig. 4) and North (Fig.5) study zones contain ten and six streams respectively that flow into the Main Branch of Cattaraugus Creek from opposite sides of the canyon. Figure 6 shows the photographs of various feeder-brook streams within study area.

Figure 2. The three geographic subunits of study area above the Zoar Valley Canyon. The three study areas were named and indicated by boxes. Parking access for each area indicated by asterisks.

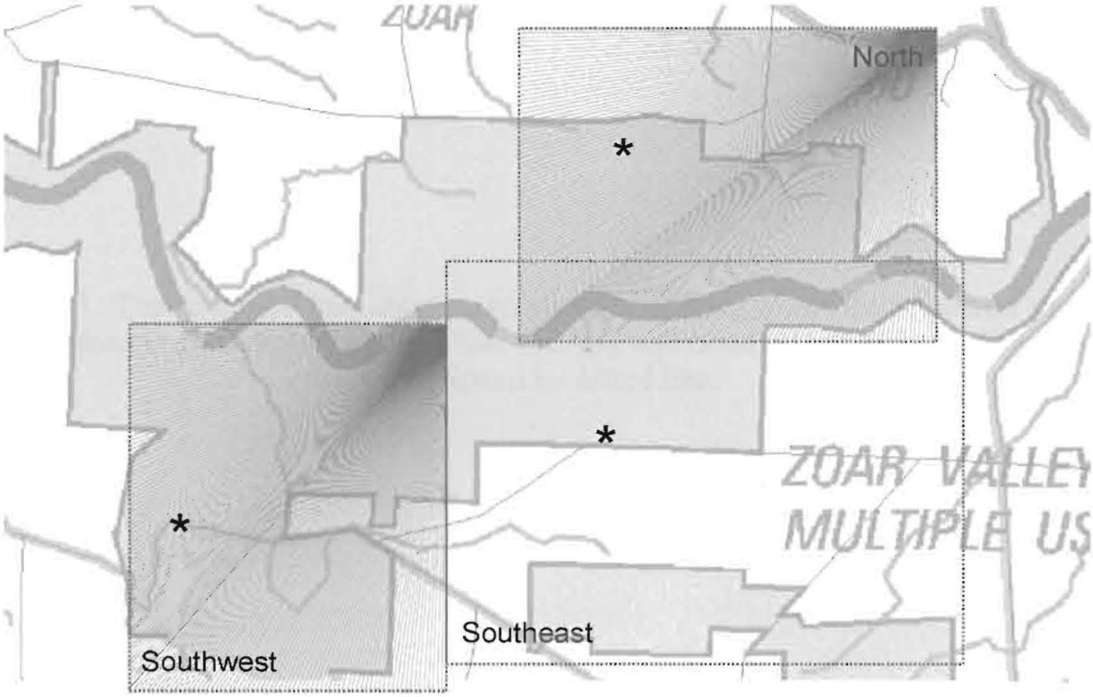

North
Southeast
Southwest
ZOAR VALLEY
MULTIPLE US

Figure 3. Topographical map showing locations of streams within the southwest study area. Streams are indicated by solid line whereas watershed size of individual streams are indicated by dotted line.


ERIE CO
CATTARAUGUS CO
CREEK
VALLEY
1
2
3
4
5
6
7
WICKHAM RD
ROAD
Gravel Pit
Gravel Pit
500 m

Figure 4. Topographical map showing locations of streams within the southeast study area. Streams are indicated by solid line whereas watershed size of individual streams are indicated by dotted line.

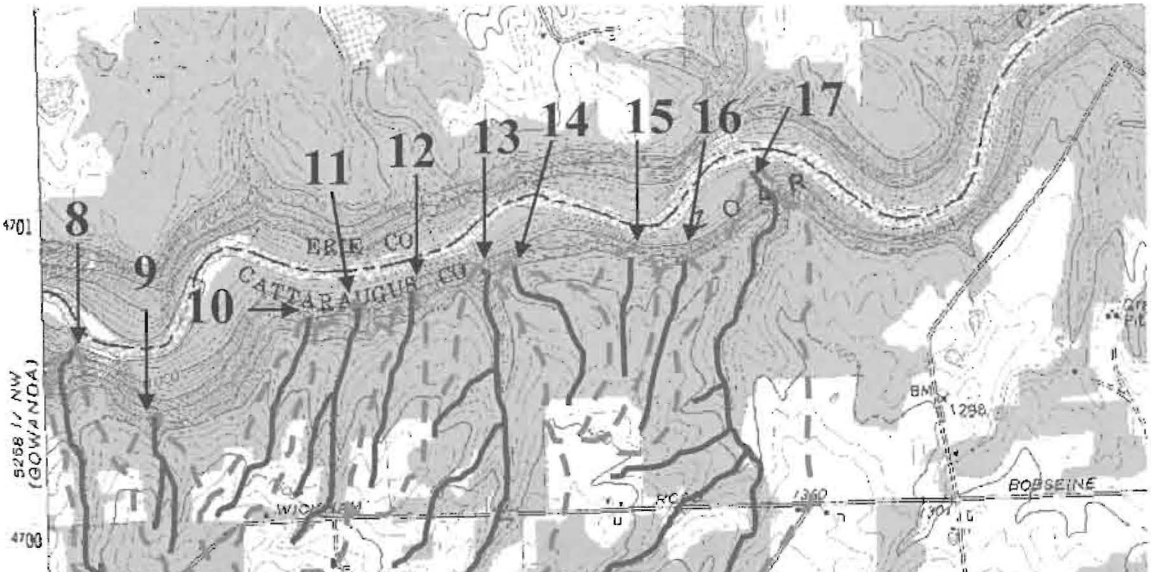

8
9
10
11
12
13
14
15
16
17
ERIE CO
CATTARAUGUS CO
WICKHAM
ROAD
BOPSEINE
FORTY
ROAD
BM 1298
BM 1667
4701
4700
4699
25'
(GOWANDA)
GOWANDA 5 MI.
500 m

Figure 5. Topographical map showing locations of streams within the north study area. Streams are indicated by solid line whereas watershed size of individual streams are indicated by dotted line.

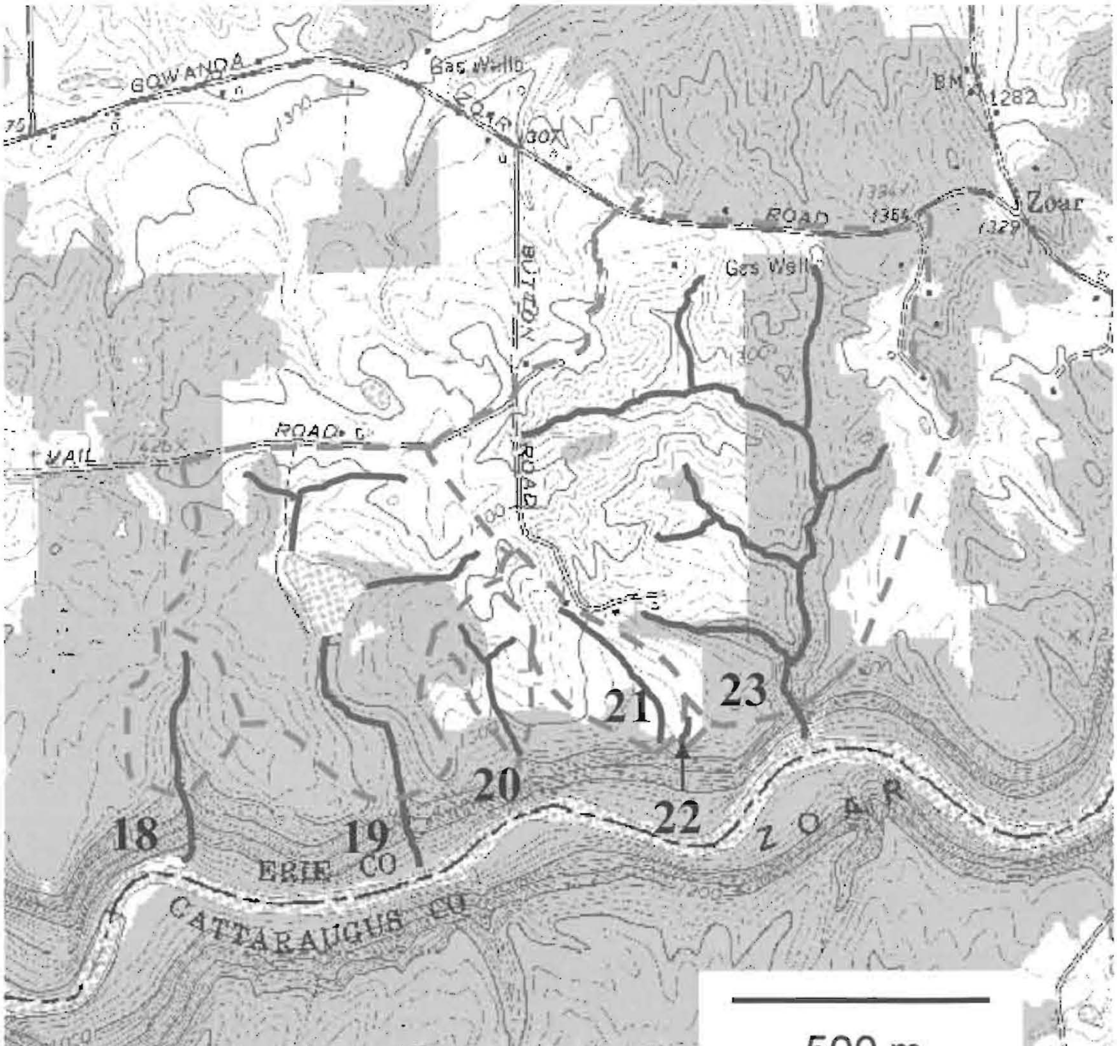

GOWANDA
ZOAR
ROAD
Gas Wells
Gas Well
BM
1282
Zoar
BUTTON ROAD
VAIL ROAD
ERIE CO
CATTARAUGUS CO
Z O A R
18
19
20
21
22
23
500 m

Figure 6. Photographs of various feeder-brook streams within study area.
1) Overlook of Zoar Valley canyon and Cattaraugus Creek, 2) Precipitous Cascade, 3) First-order stream, 4) Second-order stream, and 5) Third-order stream

1

2

3

4

5

Habitat Characterization

Watershed delineation was achieved by examination of USGS 1:24,000 quadrangle topographic maps, augmented by extensive ground-truthing of each stream on foot. A Global Positioning System (GPS) was used to determine sampling locations on each stream. The parameters quantified included quality of forest surrounding each stream (i.e. mature forest, logged but not farmed, logged and farmed), percent canopy cover around sampling sites, percent mature forest of streams, and finally stream order. Canopy cover was gauged directly using an optical densitometer and percent mature forest cover in watersheds was determined by examination of historical aerial photographs and topographical maps, and verified by onsite observations. All watershed and/or forested areas on maps were measured by planimetry.

Habitat conditions of streams were assessed using a Qualitative Habitat Evaluation Index (QHEI; OhioEPA 2002; An 2002). Parameters evaluated included substrate type, instream cover, sinuosity, channel morphology, riparian zone and bank erosion, pool/glide and riffle/run quality, and the gradient of each stream. The health of the habitats was evaluated by the sum of scores obtained from the parameters with a maximum score of 100 and a minimum of 0. The scores can be categorized as four levels, optimal (>90%; score: >98), sub-optimal (75-89%; score: 82-98), marginal support (60-74%; score: 66-81), and poor (<59%) based on the criteria of the Ohio EPA (2002) (An 2002). While QHEI scores provide a comparative measure of habitat quality, it must be mentioned that these scores are relatively biased for larger streams (they are often employed to assess sport fish habitat).

Benthic Community Sampling

In-stream fauna of benthic macroinvertebrates was sampled for each stream on three separate sample dates to ensure temporal representation of emerging insects. Sampling during 2006 was conducted in spring (April 29, and May 6 and 16), summer (July 3, 5, and 6), and fall (September 15, 23, and 24). Invertebrates were collected approximately 100 m upstream from the canyon edge. For streams in which this was not possible due to exposed bedrock containing steep water chutes, sampling was done at the first usable location closest to canyon edge. A 30 x 30-cm Surber sampler with a 500-μm mesh was used to collect three replicated benthic samples from riffle/cobble areas of each study stream on each date. The substratum was agitated for approximately two minutes for each replicate. The contents found within the net of the Surber were rinsed and preserved in 70% ethanol in the field (Doviak 2002). Invertebrate specimens were then visually sorted from preserved samples in the laboratory under illuminated 3x magnifiers. Macroinvertebrates were identified to family, genus, and possibly species at magnification of 7 x 40x according to Pennak (1953), Peckarsky et al. (1990), Merrit and Cummings (1996), USEPA (2006), NYS DEC (2006), Wiggins (1977), Simpson et al. (1980) and/or Wiederholm (1983), Harper and Hynes (1971). Invertebrate collections are presently being stored in 70% ethanol, so voucher specimens may be obtained for any of the identified taxa.

Chironomids were prepared and slide mounted as described by Diggins and Stewart (1993, 1998). Head capsules were separated from the body and digested using warm, 10% KOH for 2 – 5 minutes, after which they were permanently slide mounted in Canada balsam. Chironomid slides are also being stored as voucher specimens.

Statistical Analysis

Ordination of community composition was generated using Non-metric Multidimensional Scaling (NMDS) (SPSS 13.0, alscal algorithm). NMDS is increasingly utilized for indirect gradient analyses of species distributions because it is robust in the face of non-monotonic data distributions. (http://ordination.okstate.edu, 2007). This is opposed to statistically elegant Principle Components Analysis (PCA), which however can suffer some artifacts when used to ordinate species distributions. NMDS was used to identify patterns of similarity/dissimilarity of benthic community composition among streams. NMDS has previously been employed in studies of riparian ecosystems to examine patterns in community composition within benthic macroinvertebrate (Mykrä et al 2004), woody vegetation (Baker and Wiley 2004), and even diatom assemblages (Weilhoefer and Pan 2006), and thus has widely demonstrated utility as an analysis of species distributions.

Two separate analyses were run: 1) an ordination showing patterns including all taxa of macroinvertebrates, and 2) an ordination including only the very speciose Chironomidae. After these ordination plots were generated, Pearson correlation coefficients were calculated to compare original species abundances to NMDS dimension scores, to assess the influence of these abundances on the ordination axes. (These coefficients are the statistical equivalent of "loadings" that are generated by eigenvector-based analyses such as PCA.)

Distance matrices were constructed using ordination dimension scores from stream community composition, to quantify separation in ordination space between pairings of individual streams. Additional distance matrices were constructed to quantify separation in geographic space. Separate matrices of both types were constructed for all possible pairings of streams and for adjacent pairs of streams only. Sets of these matrices were generated both for all taxa and for Chironomidae only. Ordination distances were then compared to geographic distances by simple linear regression (SPSS 13.0, Zar 1998).

III. RESULTS

Characterization of Streams

Areas of the individual watersheds surrounding the 23 first – third order streams were quite variable ranging from 1.22 ha - 220.12 ha (Table 1). However only three watersheds exceeded 100 ha while eighteen watersheds were less than 25 ha. The three streams whose watersheds exceeded 100 ha were all categorized as third order streams. There was, however, an additional third order stream whose watershed area was much smaller, at 22.27 ha (Table 1).

All streams were essentially perennial, but flow in Stream #'s 5, 6, 20, 21, and 22 was substantially reduced on the summer sampling date in June 2006 to the point were standard Surber samples were difficult or actually impossible to collect.

QHEI scores were also variable, ranging from 46 – 84 (Table 1). The lowest score was obtained from the habitat surrounding Stream #2, a first-order stream, while the highest was from Stream #23, a third-order stream. The three habitats that were of the highest quality (i.e. QHEI scores ≥ 80) were from Stream #13, second-order, and Streams #1 and #23, both third-order streams (Table 1).

Also measured were percent canopy cover surrounding each sampling location and percent mature forest of individual watersheds (Table 1). Percent canopy cover ranged from 93% in Stream #17 to 68% in Stream #20. Percent of mature forest ranged from 100% in both watersheds of Streams # 5 & 6 to 7% in Stream #13 (Table 1).

Table 1. Watershed and habitat characteristics of study streams.

Stream Number	Order	Latitude	Longitude	Watershed Area (ha)	Canopy Cover %	Mature Forest %
1	3	42.4306	-78.8951	22.27	90	20
2	1	42.4314	-78.8951	4.92	83	20
3	2	42.4329	-78.8932	5.95	91	28
4	2	42.4339	-78.8927	7.25	84	36
5	1	42.4358	-78.8926	4.66	88	100
6	1	42.4368	-78.8927	5.95	86	100
7	3	42.4368	-78.8891	220.10	85	34
8	1	42.437	-78.8738	19.79	85	43
9	1	42.4369	-78.8701	10.15	77	58
10	1	42.4387	-78.8646	12.69	83	30
11	2	42.4386	-78.8627	21.32	89	10
12	1	42.4394	-78.8595	12.18	89	44
13	2	42.4391	-78.856	83.23	89	7
14	1	42.4409	-78.8546	11.67	91	69
15	1	42.441	-78.8506	10.66	82	91
16	1	42.4408	-78.8485	9.14	82	76
17	3	42.4401	-78.8466	115.20	93	26
18	2	42.4448	-78.8665	8.39	86	84
19	2	42.4445	-78.8596	54.66	77	41
20	2	42.4448	-78.8564	5.18	68	65
21	1	42.4451	-78.85	10.00	78	21
22	1	42.4455	-78.849	1.22	70	50
23	3	42.4465	-78.8467	108.65	80	12

Table 1 Cont. Watershed and habitat characteristics of study streams. Summary scores given for five major QHEI components (Scores do not total to entire QHEI because some miscellaneous components are not listed here).

		QHEI Components				
Stream Number	QHEI Score/100	Substrate/20	Instream Cover/20	Channel Morphology/20	Riparian Zone/10	Pool/ Current/12
1	82	20	15	19	8	6
2	46	3	11	13	7	4
3	77	18	16	17	8	5
4	71	18	12	16	8	5
5	52	8	11	15	7	4
6	59	11	10	15	8	4
7	78	16	14	19	9	7
8	71	19	11	15	7	6
9	76	19	14	17	7	6
10	59	17	6	15	8	4
11	73	20	11	16	8	7
12	68	19	11	16	8	4
13	80	20	11	19	8	8
14	62	16	12	15	7	3
15	56	13	11	13	7	4
16	57	17	5	15	7	4
17	78	20	11	19	8	8
18	75	20	16	17	7	4
19	79	20	18	17	8	4
20	62	17	9	15	7	2
21	50	11	8	13	6	1
22	51.5	17	5	13	6.5	1
23	84	20	16	19	8	7

Macroinvertebrate Diversity and Abundance

Trends in community composition of in-stream fauna were based on the identification of 137 taxa representing fifty-five families, dominated by juvenile insects (Appendix A-1, B-1, and C-1). From the 11 families in the order Diptera, thirty-one genera/species of the family Chironomidae were also collected (Appendix A-2, B-2, and C-2). List of averages of all collected taxa, in order of overall abundance in all 23 streams can be found in Table 2. The most abundant taxa, i.e. the upper quartile of all 137 taxa (n = 34), represented insect the orders Coleoptera, Diptera, Ephemeroptera, Odonata, Plecoptera, and Trichoptera (Table 3).

Macroinvertebrate Community

Three ordination graphs were generated deriving Dimensions 1 and 2 from the macroinvertebrate taxa of the streams. The first ordination (Fig. 7) included stream averages from all replicates for all taxa. This ordination, however, revealed a high amount of clustering, with only three major outlying streams and thus did not provide much useful information for the majority of our sites. Examination of raw data revealed that these outliers were a result of very high numbers in single replicates of the stonefly *Nemoura* in Streams #5 and #6, and the dipterans *Prosimulium* and *Simulium*, in Stream #7. Therefore, a second ordination graph was generated using all taxa, but omitting the four specific replicate x taxa data that generated the obvious outliers in Figure 7 (Fig. 8).

Table 2. List of averages of all collected taxa, in order of overall abundance in all 23 streams.

Order	Family	Subfamily	Tribe	Genus/species	Average
Plecoptera	Nemouridae			Amphinemua	17.50
Plecoptera	Leuctridae			Leuctra	12.81
Trichoptera	Hydropsychidae			Diplectrona	7.74
Ephemeroptera	Leptophlebiidae			Paraleptophlebia	6.83
Plecoptera	Nemouridae			Nemoura	6.52
Plecoptera	Chloroperlidae			Haploperla	6.13
Ephemeroptera	Heptageniidea			Epeorus (Iron)	5.71
Diptera	Chironomidae	Orthocladiinae		Parametriocnemus lundbecki	5.30
Plecoptera	Chloroperlidae			Suwallia	4.71
Ephemeroptera	Baetidae			Baetis	3.84
Tubificida	Oligocheatae				3.76
Ephemeroptera	Heptageniidea			Cingymula	3.56
Diptera	Ceratopogonidae			Probezzia	3.08
Plecoptera	Perlodidae			Isoperla	2.89
Trichoptera	Polycentropidae			Polycentropus	2.72
Diptera	Tipulidae	Limoniinae		Hexatoma	2.44
Ephemeroptera	Ameletidae			Ameletus	2.40
Trichoptera	Philopotamidae			Dolophilodes	2.30
Diptera	Tipulidae			Dicranota	2.27
Diptera	Simuliidae			Simulium	2.19
Trichoptera	Hydropsychidae			Hydropsyche	2.05
Diptera	Chironomidae	Tanypodinae		Thienemannimyia	1.96
Diptera	Chironomidae	Orthocladiinae		Eukiefferiella discoloripes	1.90
Diptera	Chironomidae	Chironominae	Tanytarsini	Tanytarsus guerlus	1.81
Diptera	Chironomidae	Orthocladiinae		Pseodorthocladius	1.65
Diptera	Tipulidae			Molophilus	1.51
Plecoptera	Peltoperlidae			Tallaperla	1.46
Odonata	Cordulegastridae			Cordulegaster	1.40
Ephemeroptera	Ephemerellidae			Serratella	1.35
Diptera	Chironomidae	Diamesinae		Diamesa	1.33
Diptera	Chironomidae	Orthocladiinae		Heterotrissocladius marcidus	1.33
Coleoptera	Elmidae			Oulimnius	1.33
Diptera	Simuliidae			Prosimulium	1.18
Coleoptera	Elmidae			Microcylleopus	1.14
Odonata	Gomphidae			Stylogomphus	1.13
Diptera	Tipulidae			Pseudolimnophila	1.09
Trichoptera	Lepidostomatidae			Lepidostoma	1.07
Plecoptera	Peltoperlidae			Peltoperla	0.99
Diptera	Tabanidae			Chrysops	0.93
Decapoda	Cambaridae				0.93
Ephemeroptera	Ephemerellidae			Ephemerella	0.85
Trichoptera	Glossosomatidae			Glossosoma	0.84
Diptera	Chironomidae	Chironominae	Chironominae	Polypedilum scalaenum	0.80
Plecoptera	Perlidae			Acroneuria	0.77
Trichoptera	Limnephilidae			Pycnopsyche	0.73
Diptera	Dixidae			Dixa	0.70
Collembola	Isotomidae				0.64

Table 2 Cont. List of averages of all collected taxa, in order of overall abundance in all 23 streams.

Order	Family	Subfamily	Tribe	Genus/species	Average
Plecoptera	Chloroperlidae			Sweltsa	0.61
Pelecypoda	Sphaeriidae				0.60
Coleoptera	Psephenidae			Ectopria	0.59
Diptera	Tipulidae			Ormosia	0.49
Coleoptera	Elmidae			Stenelmis	0.49
Hemiptera	Veliidae			Microvelia	0.48
Ephemeroptera	Ephemeridae			Pentagenia	0.43
Trichoptera	Limnephilidae			Hesperophylax	0.43
Plecoptera	Perlidae			Perlesta	0.43
Diptera	Chironomidae	Orthocladiinae		Eukiefferiella bavarica	0.43
Diptera	Tipulidae			Tipula	0.39
Plecoptera	Perlodidae			Remenus	0.35
Megaloptera	Corydalidae			Chauliodes	0.33
Ephemeroptera	Ephemeridae			Ephemera	0.27
Megaloptera	Sialidae			Sialis	0.26
Diptera	Chironomidae	Chironominae	Tanytarsini	Heterotanytarsus	0.26
Diptera	Chironomidae	Chironominae	Tanytarsini	Tanytarsus glabrescens	0.26
Coleoptera	Elmidae			Macronychus	0.24
Trichoptera	Beraeidae			Beraea	0.22
Megaloptera	Corydalidae			Nigronia	0.22
Diptera	Tipulidae			Limnophila	0.22
Trichoptera	Limnephilidae			Psychoglypha	0.17
Trichoptera	Limnephilidae			Pseudostenophylax	0.17
Diptera	Chironomidae	Chironominae	Chironominae	Polypedilum	0.17
Diptera	Chironomidae	Orthocladiinae		Paracheatocladius	0.17
Odonata	Gomphidae			Lanthus	0.17
Coleoptera	Hydrophilidae			Hydrobius	0.17
Tubificida	Lumberculus				0.15
Trichoptera	Goeridae			Goera	0.13
Diptera	Chironomidae	Orthocladiinae		Thienemanniella xena	0.13
Trichoptera	Phryganeidae			Ptilostomis	0.09
Hemiptera	Veliidae			Rhagovelia	0.09
Diptera	Chironomidae	Diamesinae		Symposiocladius	0.09
Diptera	Chironomidae	Orthocladiinae		Thienemanniella	0.09
Diptera	Empididae			Hemerodromia	0.09
Trichoptera	Uenoisae			Neophylax	0.07
Plecoptera	Peltoperlidae			Agentina	0.04
Diptera	Dolichopodidae			Rhaphium	0.04
Trichoptera	Hydropsychidae			Cheumatopsyche	0.04
Trichoptera	Hydropsychidae			Parapsyche	0.04
Trichoptera	Polycentropidae			Nyctiophylax	0.04
Hemiptera	Gerridae				0.04
Hydrachnidia	Limnesia				0.04
Lepidoptera	Pyralidae				0.04

Table 2 Cont. List of averages of all collected taxa, in order of overall abundance in all 23 streams.

Order	Family	Subfamily	Tribe	Genus/species	Average
Diptera	Chironomidae	Chironominae	Chironominae	Paratendipes	0.04
Diptera	Chironomidae	Chironominae	Chironominae	Polypedilum	0.04
Diptera	Chironomidae	Chironominae	Chironominae	Polypedilum fallax	0.04
Diptera	Chironomidae	Chironominae	Chironominae	Stenochironomus	0.04
Diptera	Chironomidae	Chironominae	Tanytarsini		0.04
Diptera	Chironomidae	Diamesinae		Prodiamesa	0.04
Diptera	Chironomidae	Diamesinae		Sympotthastia	0.04
Diptera	Chironomidae	Orthocladiinae		Brillia	0.04
Diptera	Chironomidae	Orthocladiinae		Epoicocladius	0.04
Diptera	Chironomidae	Orthocladiinae		Parakiefferiella	0.04
Diptera	Chironomidae	Tanypodinae		Larsia	0.04
Diptera	Pelecorhynchidae			Glutops	0.04
Diptera	Simuliidae			Twinnia	0.04
Trichoptera	Doliphopodidae			Raphium	0.04
Diptera	Psychodidae			Pericoma, Telmatoscopus	0.04
Diptera	Ptychopteridae			Ptychoptera	0.04
Odonata	Aeshnidae			Boyeria	0.04
Coleoptera	Elmidae			Ancyronyx	0.04
Coleoptera	Elmidae			Optioservus	0.04
Coleoptera	Dytiscidae			Rhantus	0.04
Coleoptera	Haliplidae			Halipus	0.04
Coleoptera	Hydrophilidae			Sperchopsis	0.04
Coleoptera	Histeridae				0.04
Polydesmida					0.04
Gastropoda	Bithyniidae			Bithynia tentaculata	0.04
Mesogastropoda	Hydrobiidae				0.04
Basommatophora	Planorbidae				0.04

Table 3. Average occurrences (organisms per replicate Surber sample) of the upper quartile (n = 34) of macroinvertebrates found within study streams.

	Order	Coleoptera	Diptera		
	Family	Elmidae	Chironomidae		
	Subfamily		Chironominae	Diamesinae	Orthocladiinae
	Tribe				
Stream	Genus	Oulimnius	Tanytarsus guerlus	Diamesa	Eukiefferiella discoloripes
1		0.00	1.50	0.00	1.00
2		0.00	2.50	0.00	0.00
3		1.00	1.40	1.00	2.00
4		1.00	1.40	0.00	3.80
5		1.00	2.00	0.00	9.50
6		1.00	3.67	0.00	10.00
7		0.00	1.00	1.00	4.00
8		0.00	1.00	4.50	2.00
9		0.00	1.75	3.00	0.00
10		0.00	2.20	1.50	1.00
11		0.00	1.60	13.00	1.00
12		2.50	2.00	1.00	1.00
13		0.00	2.50	1.00	1.00
14		3.50	1.60	0.00	1.00
15		9.00	2.00	1.00	1.00
16		0.00	1.20	0.00	0.00
17		6.00	2.67	1.00	0.00
18		0.00	1.00	1.67	2.00
19		0.00	2.67	1.00	0.00
20		2.00	2.75	0.00	1.50
21		1.00	1.00	0.00	1.00
22		1.50	2.00	0.00	1.00
23		1.00	0.00	0.00	0.00

Table 3 Cont. Average occurrences (organisms per replicate Surber sample) of the upper quartile (n = 34) of macroinvertebrates found within study streams.

	Order	Diptera		
	Family	Chironomidae		
	Subfamily	Orthocladiinae		
	Tribe			
Stream	Genus	Heterotrissocladius marcidus	Parametriocnemus lundbecki	Pseodorthocladius
1		0.00	1.50	1.00
2		3.00	5.14	1.33
3		2.00	6.29	2.00
4		1.00	4.50	2.33
5		2.50	13.67	1.00
6		2.50	6.67	3.50
7		0.00	1.00	1.00
8		1.00	3.29	1.00
9		2.00	3.43	0.00
10		2.00	9.33	0.00
11		0.00	4.50	0.00
12		1.00	6.43	1.50
13		1.00	3.83	0.00
14		1.00	6.63	1.50
15		1.00	3.25	4.00
16		3.00	6.14	2.75
17		1.00	2.17	4.00
18		0.00	1.83	1.50
19		1.67	8.86	2.00
20		1.00	8.80	1.50
21		3.00	8.75	6.00
22		0.00	2.00	0.00
23		1.00	4.00	0.00

Table 3 Cont. Average occurrences (organisms per replicate Surber sample) of the upper quartile (n = 34) of macroinvertebrates found within study streams.

	Order	Diptera			
	Family	Chironomidae	Ceratopogonidae	Simuliidae	
	Subfamily	Tanypodinae			
	Tribe				
Stream	Genus	Thienemannimyia	Probezzia	Prosimulium	Simulium
1		0.00	0.00	0.00	0.00
2		1.40	1.50	0.00	0.00
3		1.00	2.33	0.00	0.00
4		1.00	3.00	4.00	1.00
5		1.00	2.00	14.00	29.00
6		1.00	4.00	3.00	2.33
7		0.00	0.00	167.00	307.00
8		3.00	1.33	0.00	0.00
9		2.83	5.00	0.00	1.00
10		3.25	1.50	2.00	1.00
11		1.75	1.50	2.00	0.00
12		3.00	6.00	0.00	2.00
13		0.00	1.00	0.00	5.00
14		2.40	2.40	0.00	1.00
15		0.00	3.00	0.00	0.00
16		2.50	2.80	0.00	0.00
17		1.00	1.50	0.00	1.00
18		3.00	3.00	0.00	0.00
19		2.67	1.00	1.00	1.00
20		5.20	4.00	0.00	0.00
21		5.00	24.00	0.00	0.00
22		1.00	0.00	0.00	2.40
23		3.00	0.00	0.00	1.50

Table 3 Cont. Average occurrences (organisms per replicate Surber sample) of the upper quartile (n = 34) of macroinvertebrates found within study streams.

	Order	Diptera			Ephemeroptera	
	Family	Tipulidae			Ameletidae	Baetidae
	Subfamily					
	Tribe					
Stream	**Genus**	**Dicranota**	**Hexatoma**	**Molophilus**	**Ameletus**	**Baetis**
1		2.00	1.00	0.00	0.00	5.40
2		1.00	2.00	1.00	1.00	4.00
3		3.00	2.00	0.00	2.00	6.75
4		1.00	3.25	2.33	6.25	1.00
5		1.00	0.00	0.00	2.00	0.00
6		0.00	0.00	0.00	12.00	1.00
7		0.00	2.25	1.00	0.00	14.33
8		2.75	1.00	0.00	2.25	1.43
9		1.00	1.00	0.00	2.50	3.33
10		4.50	2.13	1.00	1.33	1.40
11		1.75	2.60	1.00	2.00	4.33
12		3.00	3.67	3.00	1.00	1.00
13		4.60	2.83	0.00	0.00	7.60
14		3.00	4.00	2.00	2.33	7.00
15		2.25	3.00	0.00	1.00	4.00
16		3.50	1.33	1.40	6.00	3.00
17		3.00	2.71	0.00	7.50	3.50
18		3.38	1.33	1.00	0.00	3.75
19		3.33	1.00	1.00	0.00	7.00
20		3.00	5.00	1.00	0.00	1.50
21		2.00	10.80	14.50	0.00	0.00
22		2.00	1.50	0.00	1.00	5.00
23		1.00	1.67	4.50	5.00	2.00

Table 3 Cont. Average occurrences (organisms per replicate Surber sample) of the upper quartile (n = 34) of macroinvertebrates found within study streams.

	Order	Ephermeroptera			
	Family	Ephemerellidae	Heptageniidea		Leptophlebiidae
	Subfamily				
	Tribe				
Stream	Genus	Serratella	Cingymula	Epeorus (Iron)	Paraleptophlebia
1		2.50	10.33	8.80	0.00
2		1.00	0.00	0.00	4.50
3		2.00	4.40	3.33	7.83
4		1.00	1.00	3.00	4.38
5		0.00	0.00	0.00	0.00
6		5.00	0.00	0.00	12.00
7		1.50	2.20	14.50	4.00
8		1.00	3.33	5.75	7.14
9		0.00	1.80	4.80	6.43
10		0.00	1.00	4.25	3.17
11		1.00	4.40	12.40	4.00
12		8.00	2.33	3.50	5.29
13		0.00	9.60	11.00	4.17
14		2.50	7.00	15.00	3.11
15		0.00	3.33	6.00	2.60
16		0.00	1.00	1.00	17.75
17		4.00	19.50	15.33	8.25
18		0.00	1.00	12.60	1.00
19		1.50	2.00	3.00	10.11
20		0.00	0.00	0.00	10.75
21		0.00	1.00	0.00	30.40
22		0.00	6.67	6.00	4.17
23		0.00	0.00	1.00	6.00

Table 3 Cont. Average occurrences (organisms per replicate Surber sample) of the upper quartile (n = 34) of macroinvertebrates found within study streams.

	Order	Odonata	Plecoptera		
	Family	Cordulegastridae	Chloroperlidae		Leuctridae
	Subfamily				
	Tribe				
Stream	**Genus**	**Cordulegaster**	**Haploperla**	**Suwallia**	**Leuctra**
1		0.00	2.00	2.00	6.33
2		3.33	0.00	1.00	29.25
3		1.00	2.00	3.75	40.71
4		1.00	14.00	11.75	4.80
5		0.00	0.00	4.00	2.00
6		0.00	1.50	13.00	7.00
7		1.00	5.00	3.00	4.33
8		1.00	15.00	2.00	17.13
9		1.00	4.00	2.00	25.57
10		2.33	2.20	2.50	11.75
11		4.00	7.00	2.75	14.43
12		2.00	4.00	18.25	15.00
13		0.00	25.00	1.00	14.50
14		1.67	9.75	8.00	14.33
15		2.50	8.00	3.00	8.50
16		1.00	0.00	2.00	6.86
17		1.00	26.67	1.33	2.67
18		1.00	8.00	10.80	8.50
19		2.00	0.00	9.00	23.57
20		2.20	0.00	1.00	14.00
21		3.25	0.00	0.00	5.60
22		1.00	6.67	6.00	9.00
23		0.00	0.00	0.00	8.67

Table 3 Cont. Average occurrences (organisms per replicate Surber sample) of the upper quartile (n = 34) of macroinvertebrates found within study streams.

	Order	Plecoptera			
	Family	Nemouridae		Perlodidae	Peltoperlidae
	Subfamily				
	Tribe				
Stream	**Genus**	**Amphinemura**	**Nemoura**	**Isoperla**	**Tallaperla**
1		10.75	0.00	1.67	0.00
2		13.40	6.40	0.00	0.00
3		14.60	1.67	2.83	2.33
4		25.00	33.00	4.60	4.67
5		2.00	106.50	0.00	0.00
6		29.33	158.00	0.00	0.00
7		8.75	4.67	1.00	0.00
8		29.40	4.60	3.00	1.75
9		5.25	4.67	2.25	1.00
10		17.00	5.50	3.00	2.00
11		45.25	0.00	3.60	2.00
12		45.67	2.67	4.33	2.67
13		3.25	1.67	3.25	1.00
14		27.67	2.00	5.17	1.00
15		16.00	2.67	7.00	0.00
16		10.33	42.71	2.00	0.00
17		10.33	2.00	5.00	1.00
18		7.80	4.00	2.14	3.33
19		19.00	2.00	4.00	0.00
20		14.33	4.00	3.60	2.67
21		18.00	8.25	6.33	1.00
22		12.80	0.00	1.67	7.00
23		16.50	4.25	0.00	0.00

Table 3 Cont. Average occurrences (organisms per replicate Surber sample) of the upper quartile (n = 34) of macroinvertebrates found within study streams.

	Order	Trichoptera			
	Family	Hydropsychidae		Philopotamidae	Polycentropidae
	Subfamily				
	Tribe				
Stream	Genus	Diplectrona	Hydropsyche	Dolophilodes	Polycentropus
1		2.50	2.00	1.00	0.00
2		1.50	1.00	1.00	0.00
3		11.43	1.50	3.25	2.75
4		1.00	0.00	8.00	4.50
5		0.00	1.00	0.00	2.50
6		0.00	0.00	0.00	10.00
7		4.00	2.33	1.00	2.50
8		10.86	1.00	1.00	1.00
9		5.00	0.00	0.00	1.00
10		2.00	0.00	2.33	1.00
11		7.50	0.00	5.50	1.25
12		32.40	0.00	2.50	2.50
13		2.33	13.25	4.50	1.00
14		14.56	2.00	5.40	2.20
15		7.83	0.00	2.00	1.00
16		3.20	2.00	1.00	2.50
17		4.67	1.00	1.00	1.33
18		5.00	0.00	1.00	3.00
19		19.50	9.60	7.33	12.00
20		15.00	2.50	1.00	1.50
21		20.67	4.00	2.00	1.00
22		6.13	2.86	2.00	6.50
23		1.00	1.00	0.00	1.50

Table 3 Cont. Average occurrences (organisms per replicate Surber sample) of the upper quartile (n = 34) of macroinvertebrates found within study streams.

	Order	Tubificida
	Family	Oligocheatae
	Subfamily	
	Tribe	
Stream	Genus	
1		1.00
2		3.14
3		1.67
4		1.25
5		11.00
6		2.67
7		1.00
8		1.00
9		1.00
10		1.00
11		1.00
12		7.50
13		1.00
14		3.20
15		10.50
16		7.33
17		1.00
18		5.33
19		2.33
20		9.00
21		11.67
22		1.00
23		1.00

Figure 7. Ordination plot including all identified taxa of benthic aquatic macroinvertebrates.

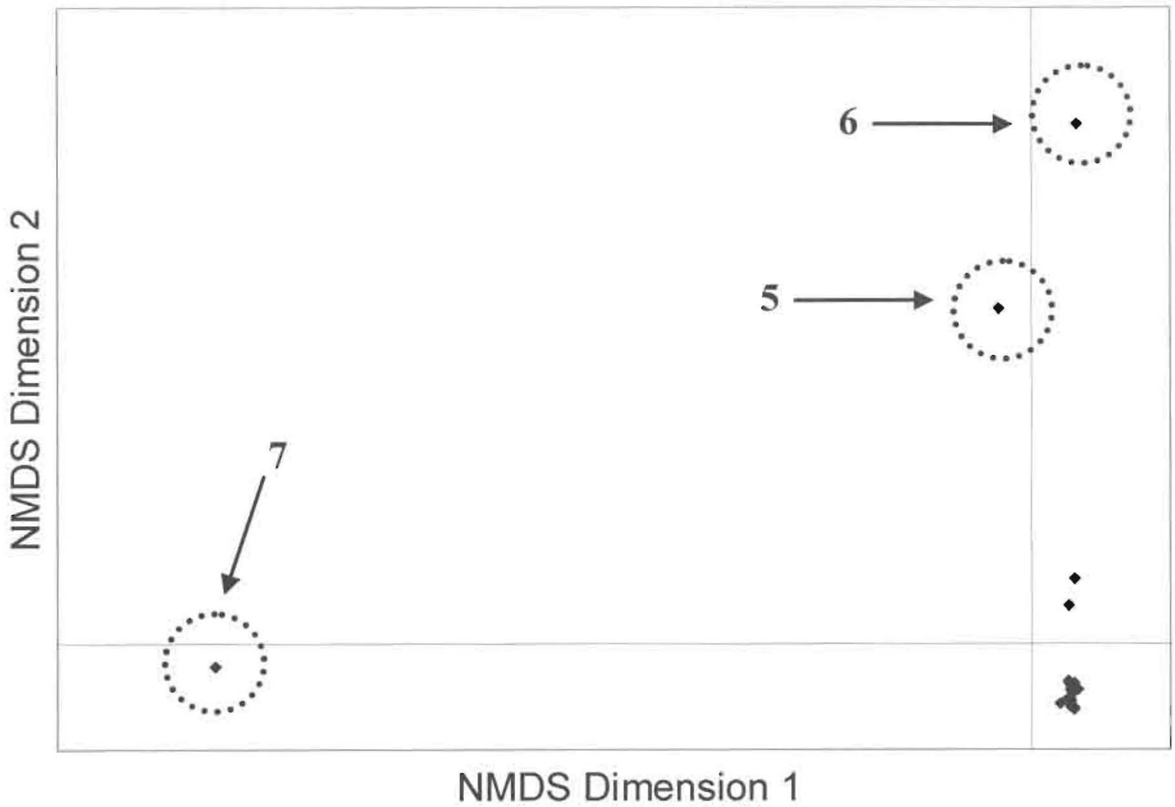

6
5
7
NMDS Dimension 2
NMDS Dimension 1

Figure 8. Ordination plot that includes all identified taxa (but omitting 4 outlying data – see text): 1) *Nemoura*, 2) *Prosimulium*, and 3) *Simulium*. Size of plot symbols indicates size of watersheds.

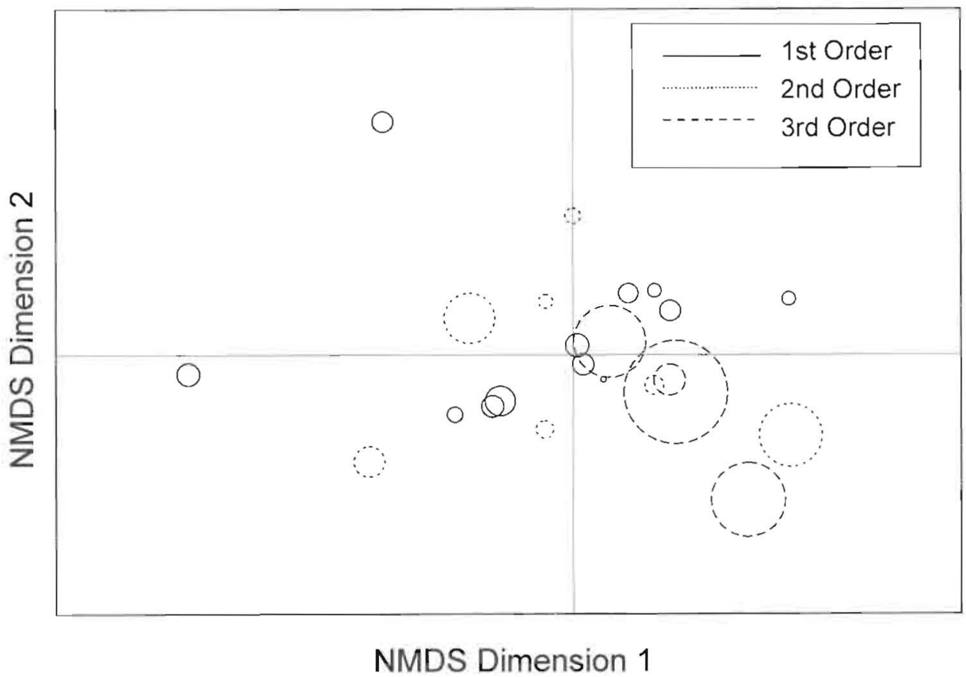
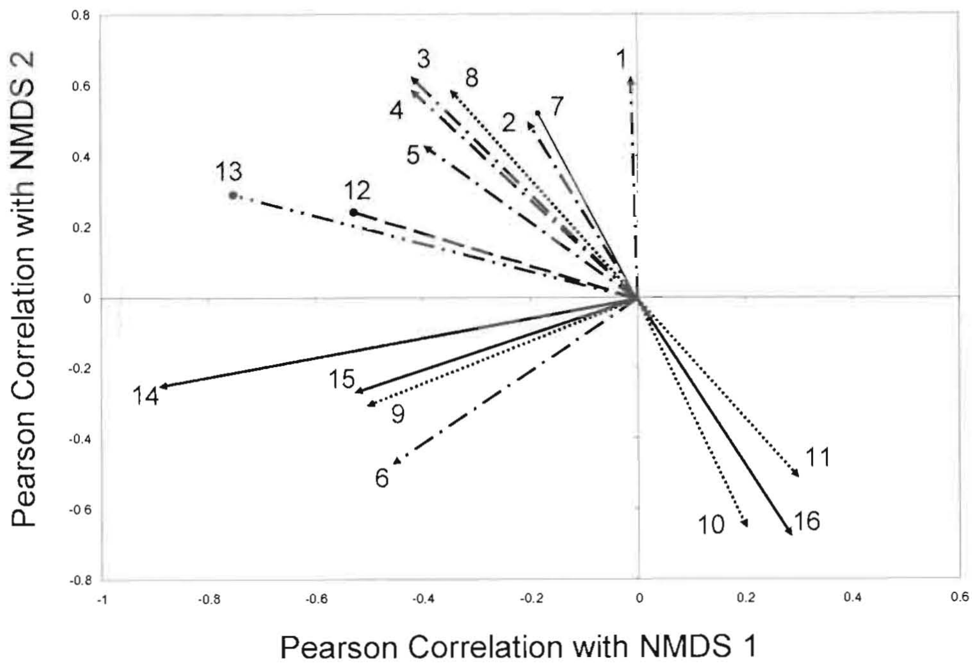
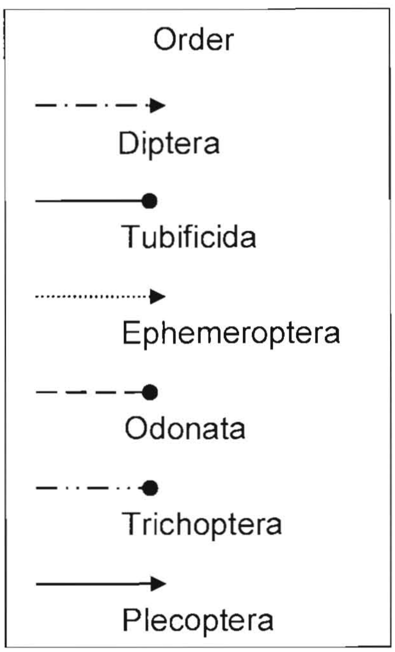

1st Order
2nd Order
3rd Order
NMDS Dimension 2
NMDS Dimension 1

Figure 9. “Loadings” for the all taxa ordination plot (omitting 4 outlying data – see text).





Diptera
1. Heterotrissocladius - Chironomidae
2. Parametriocnemus - Chironomidae
3. Probezzia - Ceratopogonidae
4. Molophilus - Tipulidae
5. Hexatoma - Tipulidae
6. Thienemannimyia - Chironomidae

Tubificida
7. Unidentified Tubificid

Ephemeroptera
8. Paraleptophlebia - Leptophlebidae
9. Seratella - Ephemereliidae
10. Epeorus (Iron) - Heptageniidae
11. Cingymula - Heptageniidae

Odonata
12. Cordulegaster - Cordulegastridae

Trichoptera
13. Diplectrona - Hydropsychidae

Plecoptera
14. Amphenimura - Nemouridae
15. Suwallia - Chloroperlidae
16. Haploperla - Chloroperlidae

This ordination of the streams revealed clustering (in the lower right quadrant of the graph) of third-order streams, as well as of streams with larger watershed areas. However, within this cluster, additional first- and second-order streams with noticeably smaller watershed areas could also be found. Pearson correlation of taxon abundance with dimension scores (i.e. "loadings") revealed taxa from six orders that were significantly correlated ($p < 0.05$) with either Dimension 1 or 2 or with both (Fig. 9). These taxa included six genera in the order Diptera, one unidentified Tubificid annelid worm, four genera of Ephemeroptera, one genus of Odonata, one genus of Trichoptera, and three genera of Plecoptera (Fig.9). Loading vectors for five of the six abundant dipterans shown were within 60° of each other in the upper left quadrant of the ordination plot. In contrast, two taxa of Ephemeroptera and one taxon of Plecoptera loaded strongly to the lower right quadrant, and thus were positively associated with larger streams.

To further investigate this apparent small stream/large stream axis demonstrated by these taxa, we reconstructed ordination plots using: 1) first order streams only (Fig. 10), and 2) second order streams only (Fig. 11). There were insufficient third order streams to conduct a reliable NMDS analysis alone (SPSS version 13.0). Within first order streams only (Fig. 10) related dipterans loaded closely together but were no longer a unified group (i.e. Chironomidae and Tipulidae diverged). Within second order streams only (Fig. 11), all taxa that suggested a directional axis in Figure 9 now showed no pattern whatsoever. Additionally, loadings of some of the dipterans had also become quite weak.

The third ordination plot that was generated included taxa only from the very speciose Chironomidae (Fig. 12). Ordination of the streams based solely on Chironomid composition revealed a high degree of clustering of all watershed sizes and stream orders, and did not appear to reveal any size or order based trend as did the ordination of all taxa. Pearson correlations revealed that taxa from three subfamilies (Orthocladiinae, Chironominae and Diamesinae) were significantly associated ($p < 0.05$) with either Dimension 1 or 2 or with both (Fig. 13). From those subfamilies, seven genera/species of Orthocladiinae, one genus/species of Chironomidae, and one genus/species of Diamesinae had the strongest correlation with the two dimensions (Fig. 13).

Spatial Proximity

Linear regression of ordination distances (i.e. similarity/dissimilarity of stream macroinvertebrate communities) between all possible pairings of streams, and between pairings only of adjacent streams, on geographic distances revealed a complete lack of significance (Figs. 14, 15, 16, & 17; Note R^2s ≤ 0.0315 and p-values from 0.309 to 0.715).

Figure 10. Ordination plot of first order streams only, with "loadings" of dipteran, plecopteran, and ephemeropteran taxa that were particularly informative in the ordination of all streams.

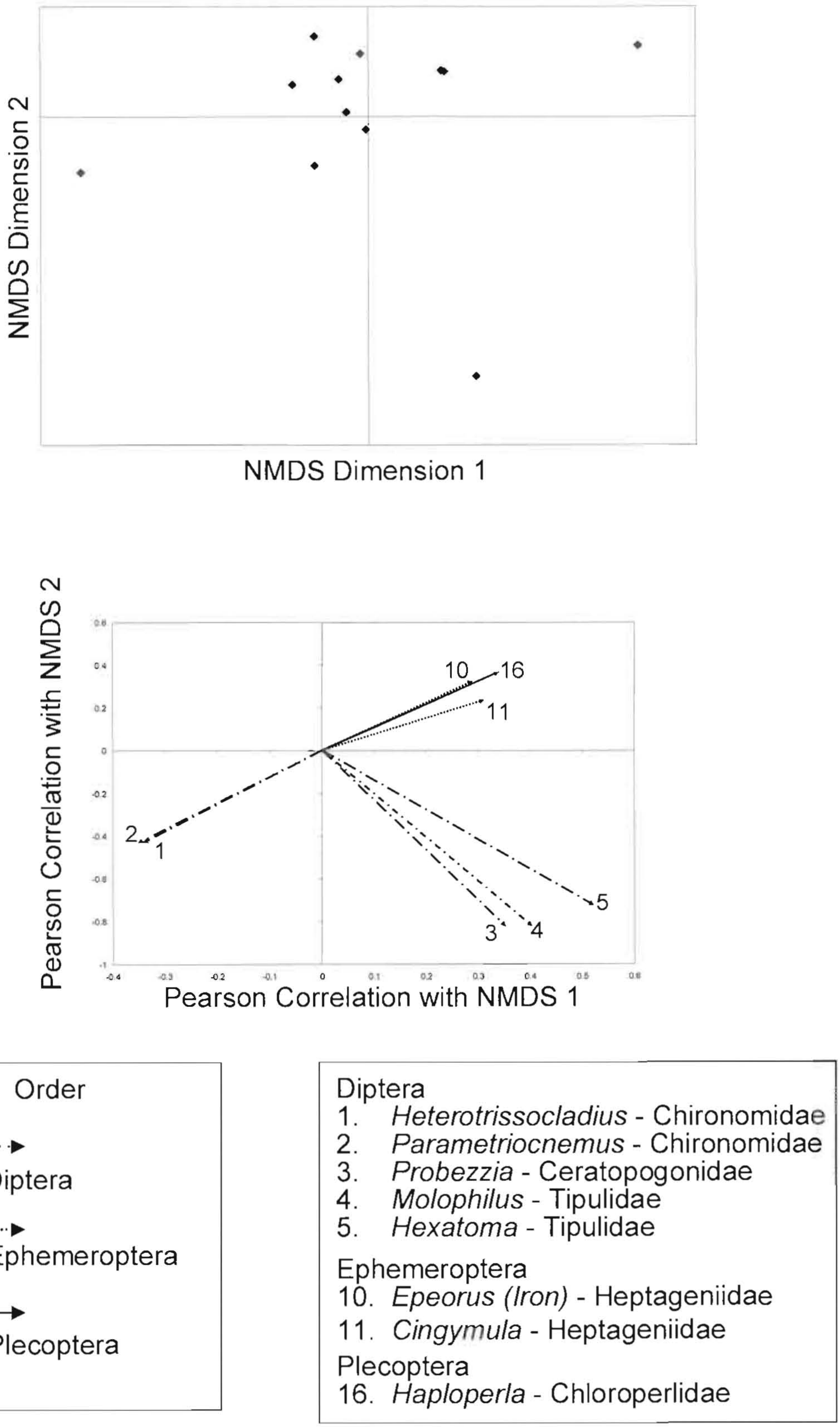
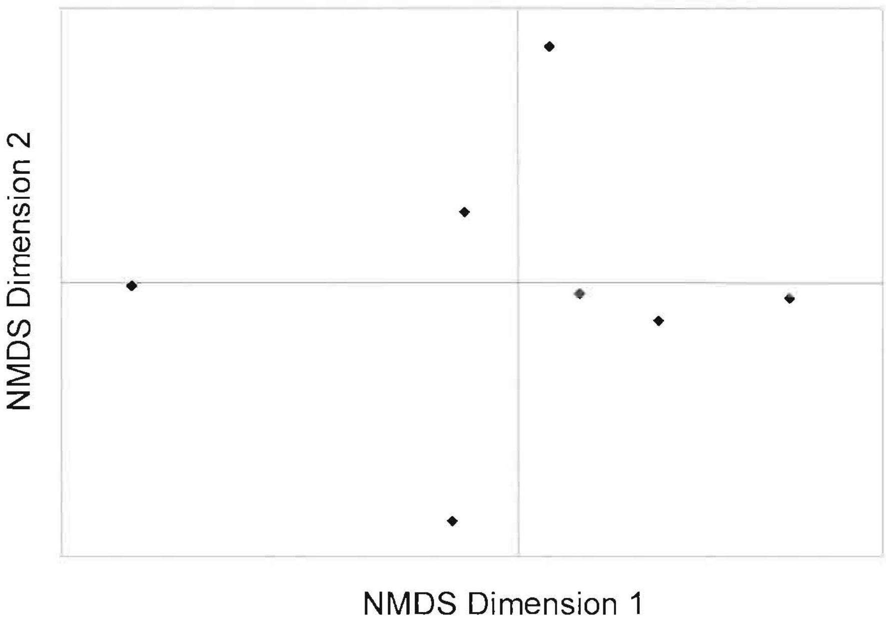
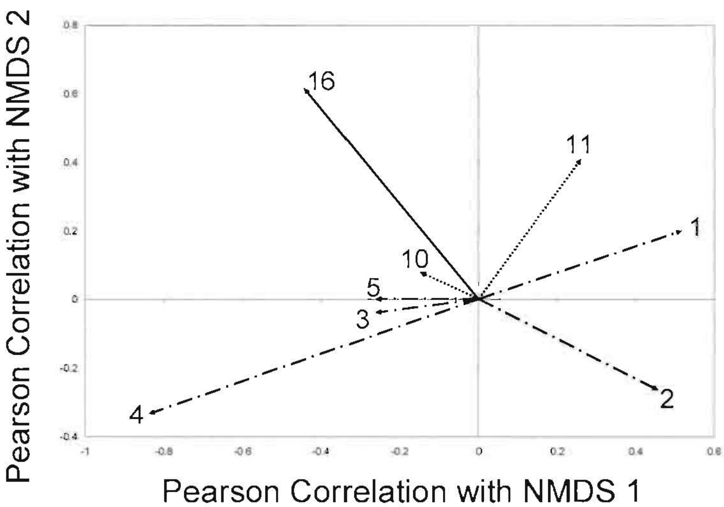
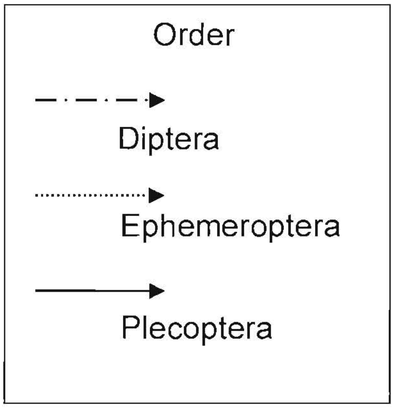

NMDS Dimension 2
NMDS Dimension 1
Pearson Correlation with NMDS 2
Pearson Correlation with NMDS 1
10
16
11
2
1
5
3
4
Order
Diptera
Ephemeroptera
Plecoptera
Diptera
1. Heterotrissocladius - Chironomidae
2. Parametriocnemus - Chironomidae
3. Probezzia - Ceratopogonidae
4. Molophilus - Tipulidae
5. Hexatoma - Tipulidae
Ephemeroptera
10. Epeorus (Iron) - Heptageniidae
11. Cingymula - Heptageniidae
Plecoptera
16. Haploperla - Chloroperlidae

Figure 11. Ordination plot of second order streams only, with "loadings" of dipteran, plecopteran, and ephemeropteran taxa that were particularly informative in the ordination of all streams.







Diptera
1. *Heterotrissocladius* - Chironomidae
2. *Parametriocnemus* - Chironomidae
3. *Probezzia* - Ceratopogonidae
4. *Molophilus* - Tipulidae
5. *Hexatoma* - Tipulidae

Ephemeroptera
10. *Epeorus (Iron)* - Heptageniidae
11. *Cingymula* - Heptageniidae

Plecoptera
16. *Haploperla* - Chloroperlidae

Figure 12. Ordination plot generated from Chironomidae genera only.
Size of plot symbols indicates size of watersheds.

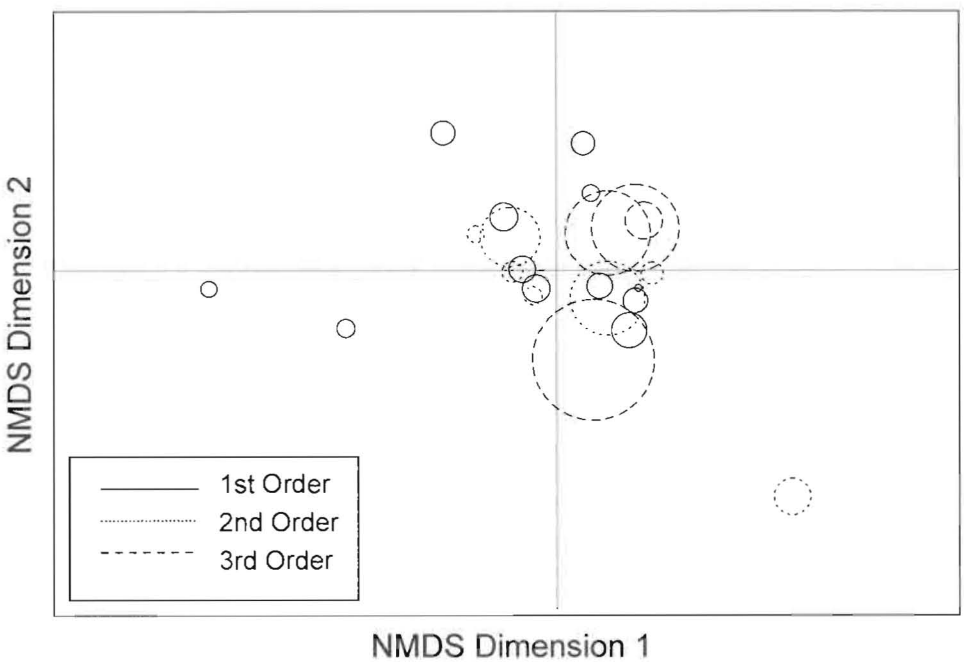
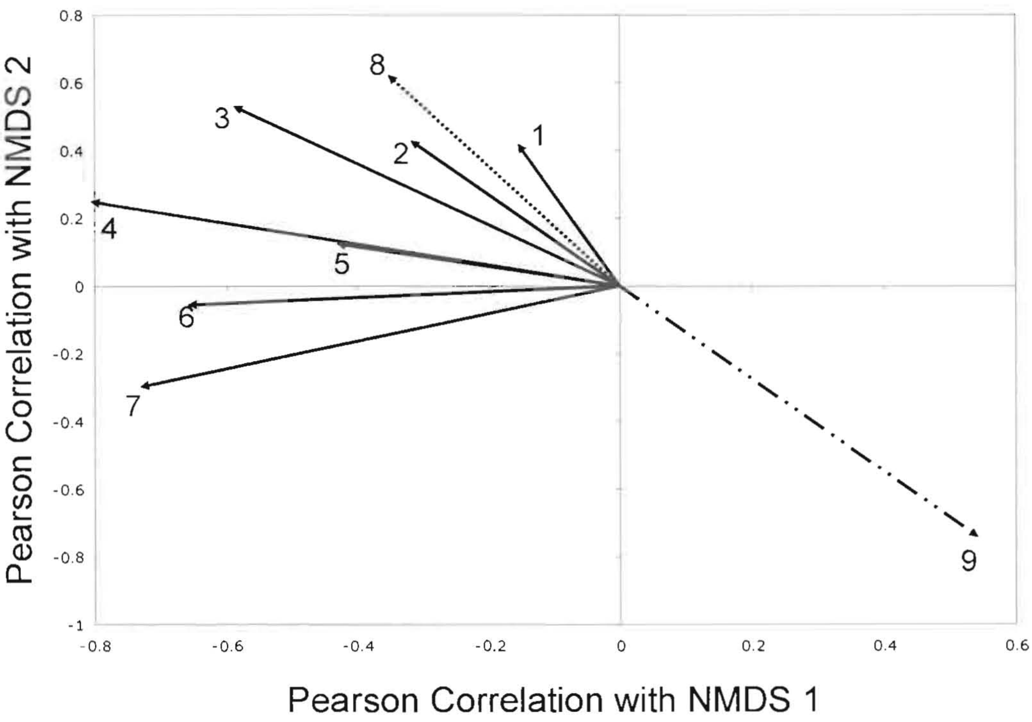
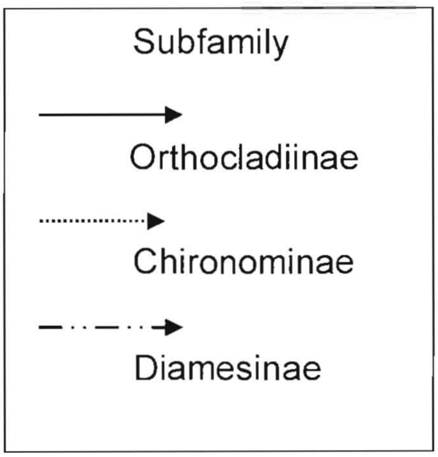

NMDS Dimension 2
NMDS Dimension 1
1st Order
2nd Order
3rd Order

Figure 13. "Loadings" for Chironomid genera only ordination plot.



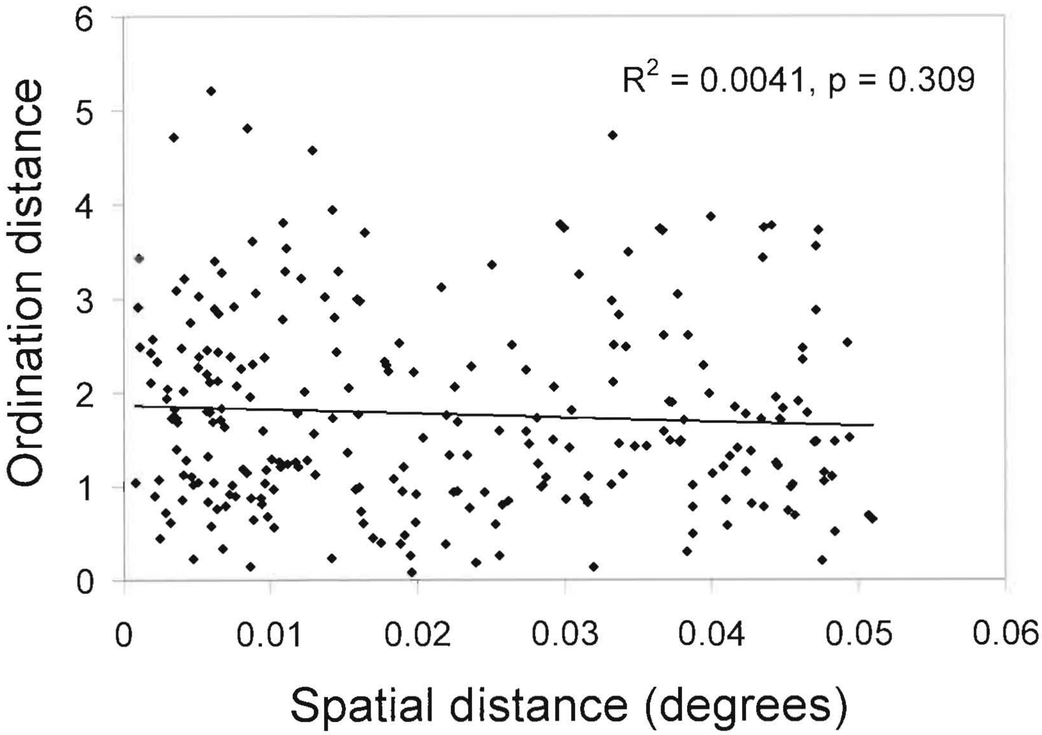


Orthocladiinae
1. *Thienemanniella* xena
2. *Pseudorthocladius*
3. *Heterotrissocladius marcidus*
4. *Parametriocnemus lundbecki*
5. *Symposiocladius*
6. *Parakiefferiella*
7. *Eukiefferiella discoloripes*

Chironominae
8. *Polypedilum scalaenum*

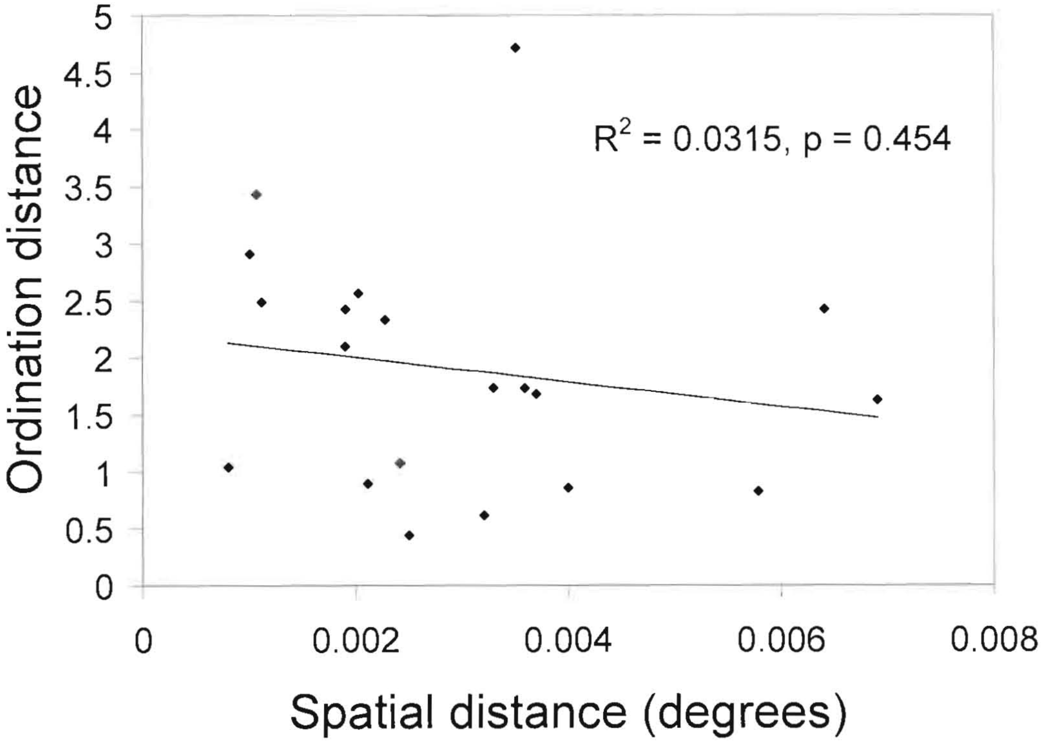
Diamesinae
9. *Diamesa*

Figure 14. Linear regression of all possible pairings of stream geographic/spatial distances to their actual ordination distances based upon all macroinvertebrate taxa



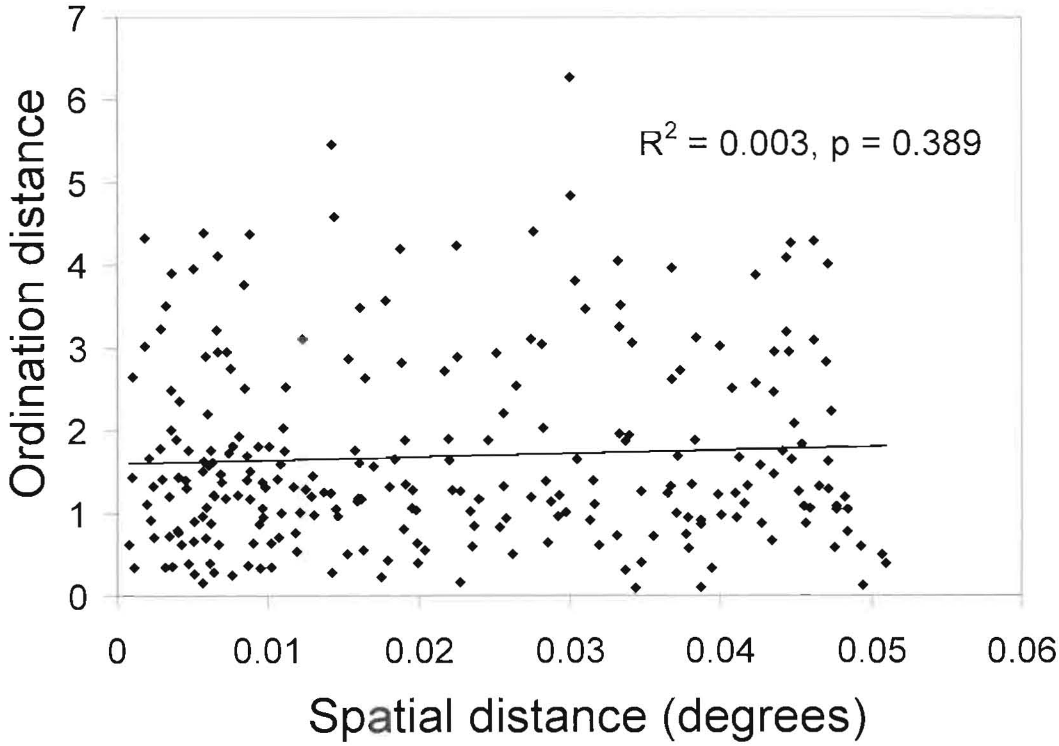
R^2 = 0.0041, p = 0.309
Ordination distance
0
1
2
3
4
5
6
0
0.01
0.02
0.03
0.04
0.05
0.06
Spatial distance (degrees)

Figure 15. Linear regression of spatial distance to ordination distance of adjacent only streams based upon all macroinvertebrate taxa.



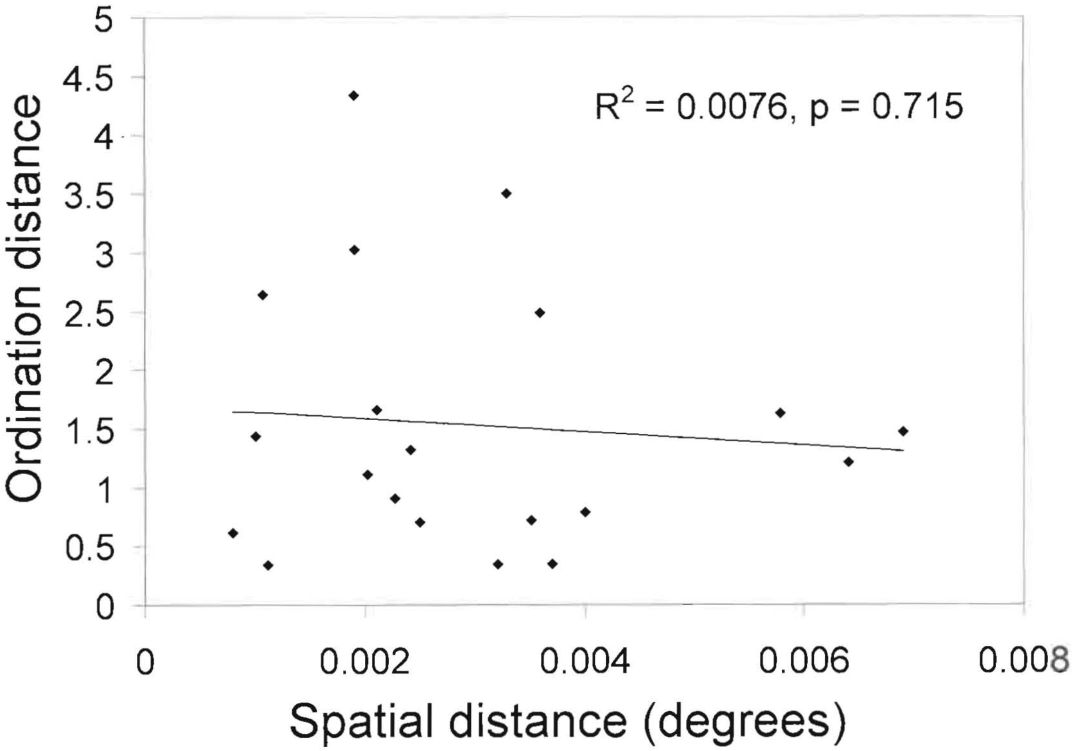
5
4.5
4
3.5
3
2.5
2
1.5
1
0.5
0
Ordination distance
R2 = 0.0315, p = 0.454
0
0.002
0.004
0.006
0.008
Spatial distance (degrees)

Figure 16. Linear regression of all possible pairings of stream geographic/spatial distances to their actual ordination distances based upon Chironomidae genera



Ordination distance
R^2 = 0.003, p = 0.389
Spatial distance (degrees)
0
1
2
3
4
5
6
7
0
0.01
0.02
0.03
0.04
0.05
0.06

Figure 17. Linear regression of spatial distance to ordination distance of adjacent only streams based upon Chironomidae genera.



R^2 = 0.0076, p = 0.715
Ordination distance
Spatial distance (degrees)
0
0.5
1
1.5
2
2.5
3
3.5
4
4.5
5
0
0.002
0.004
0.006
0.008

IV. DISCUSSION

Total Macroinvertebrate Community Composition

Results of this study suggested that there was some influence of watershed and/or habitat characteristics on stream community composition. The all-taxa ordination (however, omitting the 4 taxa x replicate data that produced the major outliers in Fig. 7) showed a clustering of all third-order streams, along with the largest second-order stream. This could be a reflection of these streams having larger watershed sizes and more complex stream morphology than the lower order streams. All the large streams in this study area displayed both exemplary in-stream and riparian development. The loose clustering of these largest and highest order streams in this study represented an inclusive pattern, as all such streams were in the same general region in ordination space. This pattern, however, was not *exclusive* because a number of first- and second-order streams having smaller watersheds were also found in the same region of ordination space.

Dovciak and Perry (2002) similarly observed a distinction in ordination space (Principal Components Analysis) between streams of differing physical habitat scores, although across a broader geographic region (southwest Minnesota) and a wider range of environmental quality than in the present study. Riva-Murray et al. (2002), in a study of large tributaries in the Hudson River Basin, NY, included benthic invertebrate assemblages and derived indices (e.g. EPT richness, Hilsenhoff Biotic Index) in a direct gradient Canonical Correspondence Analysis that also included watershed, environmental, and water quality variables. The objectives of the present study, however, focused on ecological and biogeographic patterns of community composition, and so included only species distributions, rather than the derived indices more often associated with assessments of environmental health in potentially stressed systems.

Taxa loadings for this ordination showed an obvious directional pattern among the dipterans. This suggests that the dominant dipterans were showing patterns of being a cohesive group in their contribution to community composition within these 23 streams. The dipterans also loaded in the opposite direction from the position of higher order streams in ordination space. Thus there was little association of dipterans with high order streams, suggesting they are more indicative of smaller streams. Average total abundances of all dipteran taxa were 45.2, 33.7, and 16.2 among first, second, and third order streams respectively, confirming the patterns suggested by ordination. It is reasonable to speculate that substrate type may play a role in the distribution of these insects. The substrate of higher order streams contained more boulders, cobbles, and gravel, while the lower order streams in which dipterans prevailed contained more silt/sand substrates.

In contrast, closely aligned loadings of three mayfly and stonefly taxa suggested association with the larger streams in our study. Although the dipterans were convincingly associated primarily with low order smaller streams, the Ephemeroptera and Plecoptera appeared to have a broader distribution, with various taxa associated both with larger or smaller streams. Interestingly the large stream/small stream axis suggested by the abundant taxa of Diptera and by some Ephemeroptera and Plecoptera weakened and ultimately broke down when looking at stream orders independently as opposed to all together. In Dovciak and Perry's (2002) PCA of stream macroinvertebrates several taxa of Ephemeroptera and Trichoptera likewise loaded strongly on ordination axes and reflected environmental gradients, although not dipteran taxa as in the present study.

Chironomid Community Composition

Ordination of chironomid genera revealed a very dense and complex clustering of all stream/watershed types near the origin of the graph, although some individual streams diverged. Compared to this ordination of chironomids only, ordination of all invertebrate taxa demonstrated more utility in distinguishing similarities/differences among stream types (i.e. stream order, size, etc.). Ordination of chironomids, however, showed an ability to discriminate certain individual streams from the whole group. In a study by Diggins (2000), chironomid larvae from the polluted Buffalo River, New York, yielded a similar discriminatory ability among sites, over a short stretch of river that had relatively constant water conditions and sediment physical characteristics.

The specific discriminatory utility of chironomids in the present Zoar Valley study was further evidenced by loadings of individual genera. For example, all Orthocladiinae loading vectors were within 70° of each other, toward the left side of the ordination graph, where three 1st order streams were located separately from the complex cluster near the origin. Also, and in a completely opposite direction in ordination space, a genus of the Diamesinae loaded into the lower right quadrant where another stream diverged from the cluster.

When comparing the separate ordination analyses conducted on all taxa and conducted on chironomids alone, it appeared that the analysis of all taxa was more useful in detecting patterns in community composition that may reflect watershed characteristics. However, it must be mentioned that, while these ordinations revealed trends, the gradient in stream characteristics was not that large. All 23 study streams are low order and have predominately forested watersheds. Also, in terms of QHEI scores, environmental quality was consistently free of degradation, and ranged from very high to moderate. In no circumstance was any stream classified as fair or poor. Even along such a subtle gradient, however, ordination analysis, especially in regard to "loading" vectors, was still highly informative.

Influence of Spatial Distance Among Streams

Somewhat surprisingly, this study failed to reveal any role of local biogeography in patterns of community similarity/dissimilarity among streams. There was absolutely no relationship between patterns in community similarity among streams and their geographic distances from one another. This suggests that despite close physical proximity of some streams (some adjacent streams were only tens of meters apart) they are biogeographically independent in terms of invertebrate community composition. This was not entirely expected because most invertebrate taxa possess dispersal terrestrial adult stages. The results presented here indicated that these small streams, although clearly located within a local ecological province, are acting very much as individualistic units. The present study did not specifically address lateral migration abilities of the resident insect taxa (or biological and environmental impediments to such dispersal) but investigating such questions could serve as the basis for valuable future research. Perhaps, in the case of these diverse and fascinating ecosystems in Zoar Valley, my suggestion that streams may act "like aquatic islands in a sea of dry land" could be effectively true.

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APPENDIX A-1

Occurrence of benthic macroinvertebrate taxa on spring sample date (April 29, May 6 and 16, 2006), reported as number of individuals per Surber sample.

Phylum / Class / Order / Family		Arthropoda / Insecta / Coleoptera / Dytiscidae	Elmidae						
Stream/Rep	Genus	Rhantus	Ancyronyx	Macronychus	Microcylleopus	Optioservus	Oulimnius	Stenelmis	Unknown
1.1									
1.2									
1.3									
2.1									
2.2									
2.3									
3.1									
3.2							1		
3.3									
4.1							1		
4.2									
4.3									
5.1							1		
6.1		1							
6.2									
6.3							1		
7.1						1			
7.2								4	
7.3								2	
8.1									
8.2									
8.3									
9.1									
9.2									
9.3									
10.1									
10.2									
10.3									
11.1									
11.2									
11.3									
12.1									
12.2							1		
12.3									
13.1									
13.2									
13.3									
14.1							2		
14.2							5		
14.3									
15.1							9		
15.2									
16.1									
16.2									
16.3									
17.1									
17.2									
17.3			1				6		
18.1									
18.2									
18.3									
19.1									
19.2									
19.3									
20.1							2		
20.2									
21.1							1		
22.1									
22.2									
22.3									
23.1							1		
23.2							2		
23.3									

Phylum / Class / Order / Family	Arthropoda / Insecta / Coleoptera / Haliplidae	Histeridae	Hydrophilidae			Psephenidae	Unknown
Stream/Rep — Genus	Halipus		Hydrobius	Sperchopsis	Unknown	Ectopria	
1.1							
1.2							
1.3							
2.1							
2.2							
2.3							
3.1							
3.2							
3.3							
4.1							
4.2							
4.3							
5.1							
6.1							
6.2							
6.3							
7.1							
7.2							
7.3							
8.1							
8.2							
8.3							
9.1							
9.2							
9.3							
10.1							
10.2							
10.3							
11.1							
11.2							
11.3					1		
12.1					1		
12.2						2	
12.3						1	
13.1					1		
13.2							
13.3							
14.1							
14.2							
14.3							
15.1						1	
15.2							
16.1				1			
16.2							
16.3							
17.1							
17.2							
17.3							
18.1							
18.2							
18.3							
19.1							
19.2							
19.3							
20.1							
20.2							
21.1							
22.1							
22.2							
22.3							
23.1							
23.2							
23.3							

	Phylum Class Order Family	Arthropoda Insecta Collembola Isotomidae	Diptera Chironomidae	Ceratopogonidae	Dixidac	Doliphopodidae
Stream/Rep	Genus		See Appedix A-2	Probezzia	Dixa	Raphium
1.1						
1.2					1	
1.3						
2.1						
2.2				1		
2.3						
3.1						
3.2						
3.3						
4.1						
4.2						
4.3						
5.1		2				
6.1				4		
6.2						
6.3		1				
7.1						
7.2						
7.3						
8.1		1				
8.2		1				
8.3						
9.1						
9.2						
9.3						
10.1						
10.2				2	1	
10.3						
11.1				2		
11.2				1		
11.3						

	Phylum Class Order Family	Arthropoda Insecta Collembola Isotomidae	Diptera Chironomidae	Ceratopogonidae	Dixidae	Doliphopodidae
Stream/Rep	Genus		See Appedix A-2	Probezzia	Dixa	Raphium
12.1					1	
12.2				2		
12.3				1		
13.1						
13.2						
13.3						
14.1						
14.2					1	
14.3				1		
15.1				5		
15.2		2				
16.1				3		
16.2		1				
16.3						
17.1						
17.2						
17.3				1		
18.1						
18.2						
18.3						
19.1						
19.2						
19.3				1		
20.1				2		
20.2				6		
21.1				41		
22.1						
22.2						
22.3						
23.1						
23.2						
23.3						

Phylum / Class / Order / Family	Arthropoda / Insecta / Diptera / Empididae	Pelecorhynchidae	Psychodidae	Ptychopteridae
Stream/Rep / **Genus**	Hemerodromia	Glutops	Pericoma, Telmatoscopus	Ptychoptera
1.1				
1.2				
1.3				
2.1				
2.2				
2.3				
3.1				
3.2				
3.3				
4.1				
4.2				
4.3				
5.1				
6.1				
6.2				
6.3				
7.1				
7.2				
7.3				
8.1				
8.2				
8.3				
9.1				
9.2				
9.3				
10.1				
10.2				
10.3				
11.1				
11.2				
11.3				
12.1				
12.2				
12.3				
13.1				
13.2				
13.3				
14.1				
14.2				
14.3				1
15.1				
15.2				
16.1			1	
16.2				
16.3				
17.1				
17.2				
17.3				
18.1				
18.2				
18.3				
19.1				
19.2				
19.3				
20.1				
20.2				
21.1		1		
22.1				
22.2				
22.3				
23.1				
23.2				
23.3				

	Phylum	Arthropoda							
	Class	Insecta							
	Order	Diptera							
	Family	Simuliidae			Tabanidae	Tipulidae			
Stream/Rep	Genus	Prosimulium	Simulium	Twinnia	Chrysops	Dicranota	Hexatoma	Limnophila	Molophilus
1.1						2			
1.2							1		
1.3									
2.1									
2.2									1
2.3									
3.1				1					
3.2							2		
3.3									
4.1		4							1
4.2									
4.3			1						
5.1		14	29						
6.1		3	2						
6.2			1						
6.3			4						
7.1		310					2		
7.2			613				2		
7.3		24							1
8.1					1	7	1		
8.2									
8.3						1			
9.1						1			
9.2									
9.3									
10.1			1		1		2		
10.2		2	1		5		4		
10.3							1		
11.1							1		
11.2		2				2	1		
11.3		2							

	Phylum	Arthropoda							
	Class	Insecta							
	Order	Diptera							
	Family	Simuliidae			Tabanidae	Tipulidae			
Stream/Rep	Genus	Prosimulium	Simulium	Twinnia	Chrysops	Dicranota	Hexatoma	Limnophila	Molophilus
12.1						3	1		
12.2			2			1	1		
12.3						1	2		
13.1			9			8	1		
13.2			5				1		
13.3			1						
14.1									
14.2			1			1	2		
14.3					1		1		2
15.1					1	2	5		
15.2					1	2	1		
16.1					2	2	1		1
16.2									
16.3									1
17.1							1		
17.2							4		
17.3			1				3		
18.1						1	2		
18.2						4	1		
18.3						8			
19.1									
19.2						3	1		1
19.3								1	
20.1							4	2	
20.2							4		1
21.1					2	3	8		11
22.1						1			
22.2			2				2	2	8
22.3			1				2		
23.1			2			1			
23.2							1		
23.3			1						

Phylum / Class / Order / Family	Arthropoda / Insecta / Diptera / Tipulidae				Ephemeroptera / Ameletidae	Baetidae	
Stream/Rep / **Genus**	Ormosia	Pseudolimnophila	Tipula	Unidentifiable	Ameletus	Baetis	Unidentifiable
1.1						10	
1.2						9	
1.3						2	1
2.1						4	
2.2							1
2.3					1		4
3.1					2	8	
3.2					2	17	
3.3						1	
4.1					4	1	
4.2					15		
4.3					5		
5.1					2		
6.1					15		
6.2					12		
6.3					9	1	
7.1						34	
7.2						37	
7.3						11	
8.1				1	6	2	
8.2					1	2	
8.3					1	1	
9.1					4	3	
9.2						5	
9.3					1	2	
10.1		3			2	2	
10.2	2	6			1	2	
10.3					1		
11.1						2	
11.2					1	9	
11.3		2			3	2	

Phylum / Class / Order / Family	Arthropoda / Insecta / Diptera / Tipulidae				Ephemeroptera / Ameletidae	Baetidae	
Stream/Rep / **Genus**	Ormosia	Pseudolimnophila	Tipula	Unidentifiable	Ameletus	Baetis	Unidentifiable
12.1						1	
12.2		3	1		1	1	1
12.3					1	13	
13.1						10	
13.2						11	
13.3						7	
14.1					3	8	
14.2					1	12	
14.3					3	1	
15.1		1			1	15	
15.2						2	
16.1				1	9	2	1
16.2	1			2	3		1
16.3						4	
17.1					10	7	
17.2						5	
17.3					5	6	
18.1						6	
18.2				2		4	
18.3						4	
19.1						2	
19.2						16	
19.3						9	
20.1		7	1			2	
20.2		3					
21.1	10	4					
22.1							
22.2					5	2	
22.3							
23.1					1	4	
23.2						9	
23.3					1	6	

Phylum / Class / Order / Family	Arthropoda / Insecta / Ephemeroptera / Ephemerellidae			Ephemeridae		Heptageniidea	
Stream/Rep — Genus	Ephemerella	Serratella	Unidentifiable	Ephemera	Pentagenia	Cingymula	Epeorus (Iron)
1.1		4				15	27
1.2		1				9	7
1.3						7	3
2.1							
2.2		1					
2.3							
3.1	1					3	6
3.2						9	2
3.3							
4.1		1	1				
4.2							2
4.3						1	6
5.1							
6.1							
6.2							
6.3		5					
7.1	1	1				2	27
7.2						2	25
7.3						3	5
8.1						7	5
8.2							1
8.3						2	15
9.1				1		2	6
9.2							6
9.3							3
10.1							3
10.2	1					1	6
10.3	1						6
11.1		1				1	4
11.2						5	33
11.3						14	17

Phylum / Class / Order / Family	Arthropoda / Insecta / Ephemeroptera / Ephemerellidae			Ephemeridae		Heptageniidea	
Stream/Rep — Genus	Ephemerella	Serratella	Unidentifiable	Ephemera	Pentagenia	Cingymula	Epeorus (Iron)
12.1							5
12.2						1	6
12.3	2					8	22
13.1						10	15
13.2						29	22
13.3						6	4
14.1		1				12	18
14.2	2	4				14	26
14.3							1
15.1	1					8	6
15.2						1	
16.1							
16.2							
16.3						1	1
17.1	5	3				32	6
17.2	4	2				20	13
17.3	4	7				25	27
18.1						1	33
18.2							13
18.3	1						9
19.1							
19.2	3					4	3
19.3						1	
20.1							
20.2	2						
21.1							
22.1							
22.2							1
22.3							
23.1						8	5
23.2						20	4
23.3						6	9

Phylum / Class / Order / Family	Arthropoda / Insecta / Ephemeroptera / Leptophlebiidae	Unidentifiable	Hemiptera / Gerridae	Veliidae	
Stream/Rep (Genus)	Paraleptophlebia		Unidentifiable	Microvelia	Rhagovelia
1.1		2			
1.2					
1.3					
2.1	2				
2.2	3				
2.3	3				
3.1					
3.2	4				
3.3					
4.1	4				
4.2	13				
4.3	4				
5.1					
6.1	15				
6.2	7				
6.3	14				
7.1					
7.2					
7.3					
8.1	18				
8.2					
8.3	13				
9.1	12				
9.2	1	1			
9.3					
10.1	3				
10.2	3				
10.3	4				
11.1	1				
11.2	8				
11.3	6				
12.1	6				
12.2	10				
12.3	2				
13.1	3				
13.2	4	1			
13.3					
14.1	3				
14.2	2				
14.3	4				
15.1	5				
15.2	2				
16.1	102				
16.2	31				
16.3	2				
17.1	1				
17.2	24				
17.3	21				
18.1	1				
18.2					
18.3	1				
19.1	2				
19.2	23				
19.3	32				
20.1	19				
20.2	17				
21.1	130				
22.1					
22.2	9				
22.3	8				
23.1	3				
23.2	4				
23.3	5				

Phylum	Arthropoda					
Class	Insecta					
Order	Hydrachnidia		Lepidoptera	Megaloptera		
Family	Limnesia	Unidentifiable	Pyralidae	Corydalidae		Sialidae
Stream/Rep Genus				Chauliodes	Nigronia	Sialis
1.1						
1.2						
1.3						
2.1						
2.2						
2.3						
3.1						
3.2						
3.3						
4.1						
4.2						
4.3						
5.1						
6.1	1					
6.2						
6.3						
7.1						
7.2						
7.3						
8.1						
8.2						
8.3				1		
9.1				1		
9.2						
9.3						
10.1						
10.2						
10.3						
11.1						
11.2						
11.3						
12.1						
12.2						
12.3				1		
13.1						
13.2						
13.3						
14.1						
14.2						
14.3						
15.1		2				
15.2			1			
16.1						
16.2						
16.3						
17.1						
17.2						
17.3						
18.1						
18.2						
18.3						
19.1						
19.2						
19.3						
20.1						
20.2						
21.1						
22.1						
22.2						
22.3						
23.1						
23.2						1
23.3						

Phylum	Arthropoda				
Class	Insecta				
Order	Odonoata				
Family	Aeshnidae	Cordulegastridae	Gomphidae		
Stream/Rep / Genus	Boyeria	Cordulegaster	Lanthus	Stylogomphus	Unidentifiable
1.1					
1.2					
1.3					
2.1					
2.2					
2.3					
3.1					
3.2		1			
3.3					
4.1					
4.2					
4.3					
5.1					
6.1					
6.2					
6.3					
7.1					
7.2				1	
7.3					
8.1					
8.2					
8.3					
9.1				1	
9.2					
9.3		1			
10.1		4			
10.2		2		1	
10.3		2			
11.1		4			
11.2				2	
11.3					
12.1		1		1	
12.2		1			
12.3					
13.1					
13.2					
13.3					
14.1		2			
14.2					
14.3		2			
15.1				4	
15.2					
16.1					
16.2					
16.3					
17.1					
17.2					
17.3		1			
18.1					
18.2		1			
18.3		1			
19.1					
19.2		2			
19.3					
20.1		2		2	
20.2		1	1		
21.1		6		1	
22.1					
22.2					
22.3					
23.1				1	
23.2					
23.3					

Stream/Rep	Phylum / Class / Order / Family — Genus	Arthropoda / Insecta / Plecoptera / Chloroperlidae — Haploperla	Suwallia	Sweltsa	Unidentifiable	Leuctridae — Leuctra	Nemouridae — Amphinemua	Nemoura
1.1			1	3		2	25	
1.2				5			3	
1.3			4				10	
2.1							5	
2.2				3		25	34	11
2.3							20	10
3.1			7				36	2
3.2			2			5	24	2
3.3							2	1
4.1						3	54	78
4.2						7	15	19
4.3				7		10	50	26
5.1						3	2	211
6.1						10	12	235
6.2		1					22	82
6.3		2	13			4	54	157
7.1		3					13	4
7.2		9					20	9
7.3		3					1	1
8.1		26				5	100	14
8.2						2	9	
8.3		4				21	36	1
9.1		4				5	9	5
9.2			1			6	8	
9.3							3	
10.1						5	13	4
10.2		1				3	47	8
10.3		3	4			10	35	9
11.1		8					17	
11.2		13	3			5	139	
11.3		5				2	20	

Stream/Rep	Phylum / Class / Order / Family — Genus	Arthropoda / Insecta / Plecoptera / Chloroperlidae — Haploperla	Suwallia	Sweltsa	Unidentifiable	Leuctridae — Leuctra	Nemouridae — Amphinemua	Nemoura
12.1		2				10	21	5
12.2		6				11	114	
12.3		28				6	82	5
13.1		44	1				4	1
13.2		28					7	2
13.3		3					1	
14.1		8				1	42	
14.2		25				7	84	1
14.3		5				7	25	
15.1		15					39	6
15.2		1				1	7	
16.1						10	22	262
16.2						1	1	13
16.3							8	3
17.1		26					4	
17.2		33	2			4	13	
17.3		21					14	
18.1						2	14	
18.2		8				5	6	
18.3		8				7	12	
19.1							4	
19.2						21	55	
19.3						21	16	
20.1						19	26	
20.2						16	7	
21.1						11	30	5
22.1								
22.2						22	32	14
22.3						1	1	1
23.1		10				9	19	
23.2		7				1	22	
23.3		3				12	21	

Phylum		Arthropoda							
Class		Insecta							
Order		Plecoptera							
Family		Perlidae	Perlodidae				Peltoperlidae		
Stream/Rep	Genus	Acroneuria	Perlesta	Isoperla	Remenus	Unidentifiable	Agentina	Peltoperla	Tallaperla
1.1				1					
1.2									
1.3					2				
2.1						6			
2.2					2				
2.3									
3.1					1				
3.2		1							
3.3									
4.1									
4.2				1					
4.3				2					
5.1									
6.1									
6.2									
6.3									
7.1		2		1			1		
7.2		2					1		
7.3									
8.1									1
8.2									
8.3									
9.1			1						
9.2									
9.3									
10.1									
10.2									
10.3									
11.1									
11.2		2			3				
11.3									

Phylum		Arthropoda							
Class		Insecta							
Order		Plecoptera							
Family		Perlidae	Perlodidae				Peltoperlidae		
Stream/Rep	Genus	Acroneuria	Perlesta	Isoperla	Remenus	Unidentifiable	Agentina	Peltoperla	Tallaperla
12.1				3					3
12.2				2					1
12.3		1		6					2
13.1				3					
13.2		1		1					
13.3									
14.1									
14.2				2					
14.3									
15.1				6					
15.2									
16.1				1					
16.2									
16.3									
17.1		2	3	2					
17.2									
17.3			2	11					
18.1				2					
18.2				2					
18.3				1					2
19.1									
19.2									
19.3		1							
20.1				5					6
20.2				1				1	1
21.1								1	1
22.1									
22.2									
22.3									
23.1			2						
23.2			2	2					
23.3		1	3	1					

Phylum Class Order Family	Arthropoda Insecta Plecoptera Unidentifiable	Tricoptera Beraeidae	Dolichopodidae	Glossosomatidae	Goeridae
Stream/Rep / **Genus**		Beraea	Rhaphium	Glossosoma	Goera
1.1					
1.2					
1.3					
2.1					
2.2					
2.3					
3.1					
3.2					
3.3					
4.1					
4.2				1	
4.3				1	
5.1					
6.1					
6.2				1	
6.3					
7.1				1	
7.2		1			
7.3					
8.1		2		3	
8.2				1	
8.3					
9.1					
9.2					
9.3					
10.1		2		1	
10.2					
10.3					
11.1					
11.2					
11.3					
12.1					
12.2				1	
12.3					
13.1	1				
13.2					
13.3	1				
14.1					
14.2				1	
14.3				1	
15.1				4	
15.2				1	
16.1				3	
16.2				1	
16.3					
17.1					
17.2					
17.3				1	
18.1					
18.2					
18.3					
19.1					
19.2				1	
19.3					
20.1					
20.2					
21.1					
22.1					
22.2				1	
22.3					
23.1					
23.2					
23.3			1	1	3

Phylum	Arthropoda					
Class	Insecta					
Order	Tricoptera					
Family	Hydropsychidae					Lepidostomatidae
Stream/Rep	Cheumatopsyche	Diplectrona	Hydropsyche	Parapsyche	Unknown	Lepidostoma
1.1		2				
1.2						
1.3		1				
2.1						
2.2						
2.3						
3.1		5				
3.2						
3.3						
4.1						
4.2						
4.3						
5.1						
6.1						
6.2						
6.3						
7.1		4				
7.2		8				
7.3						
8.1		13				
8.2						
8.3		6				
9.1						
9.2						
9.3						
10.1		2				
10.2						
10.3						
11.1						
11.2		7				
11.3		1				
12.1		7				1
12.2		1				
12.3		10				
13.1		2				
13.2		3	1			
13.3						
14.1		8				
14.2		15				
14.3		3				
15.1		10				
15.2						
16.1		1				
16.2						
16.3						
17.1						
17.2		6				
17.3		4	1			
18.1		5				
18.2						
18.3		2				
19.1			2			
19.2		16			1	
19.3		8				
20.1			1		1	
20.2	1					
21.1		4				
22.1						
22.2						
22.3						
23.1		8			1	
23.2		3				
23.3		4	1			

Stream/Rep	Phylum Class Order Family Genus	Arthropoda Insecta Tricoptera Limnephilidae Hesperophylax	Pseudostenophylax	Psychoglypha	Pycnopsyche	Philopotamidae Dolophilodes	Unidentifiable	Phryganeidae Ptilostomis
1.1								
1.2								
1.3								
2.1								
2.2								
2.3								
3.1						2		
3.2								
3.3								
4.1						8		
4.2								
4.3								
5.1								
6.1								
6.2								
6.3								
7.1								
7.2								
7.3								
8.1								
8.2								
8.3								
9.1								
9.2								
9.3								
10.1					2			
10.2								
10.3					1	2		
11.1								
11.2								
11.3					1			

Stream/Rep	Phylum Class Order Family Genus	Arthropoda Insecta Tricoptera Limnephilidae Hesperophylax	Pseudostenophylax	Psychoglypha	Pycnopsyche	Philopotamidae Dolophilodes	Unidentifiable	Phryganeidae Ptilostomis
12.1					1	2		
12.2						3		
12.3						3		
13.1						2		
13.2								
13.3					2			
14.1								
14.2						2		
14.3								1
15.1					1	3		
15.2					1			
16.1								
16.2					3			
16.3								
17.1					2			
17.2								
17.3					1			
18.1						1		
18.2								
18.3					1			
19.1								
19.2								
19.3								
20.1								
20.2								
21.1					1	2		
22.1								
22.2								
22.3								
23.1					1			
23.2					1	1		
23.3						3		

Stream/Rep	Phylum / Class / Order / Family / Genus	Arthropoda / Insecta / Tricoptera / Polycentropidae / Polycentropus	Nyctiophylax	Uenoisae / Neophylax	Unidentifiable	Crustacea / Decapoda / Cambaridae	Diplopoda / Polydesmida
1.1					1		
1.2					1		
1.3						1	
2.1							
2.2					1	1	
2.3							
3.1							
3.2							
3.3							
4.1							
4.2		2					
4.3		11				1	
5.1							
6.1							
6.2		4					
6.3		16					
7.1		3		1			
7.2		3		2			
7.3							
8.1						1	
8.2							
8.3		1					
9.1		1					
9.2						1	
9.3							
10.1		1					
10.2						1	
10.3		1					
11.1							
11.2		1					
11.3							

Stream/Rep	Phylum / Class / Order / Family / Genus	Arthropoda / Insecta / Tricoptera / Polycentropidae / Polycentropus	Nyctiophylax	Uenoisae / Neophylax	Unidentifiable	Crustacea / Decapoda / Cambaridae	Diplopoda / Polydesmida
12.1		2				3	
12.2		3				1	
12.3		1			2	3	
13.1		1					
13.2		1					
13.3							
14.1							
14.2		3					
14.3							
15.1							
15.2							
16.1						2	
16.2		1					
16.3							
17.1							
17.2		1				1	
17.3						1	
18.1		1				1	
18.2						1	1
18.3		3					
19.1							
19.2		5				1	
19.3		1					
20.1		2				1	
20.2							
21.1							
22.1							
22.2							
22.3		2					
23.1		2					
23.2							
23.3							

Stream/Rep	Phylum / Class / Order / Family / Genus	Mollusca / Gastropoda / Basommatophora / Planorbidae	Mesogastropoda / Bithyniidae / Bithynia tentaculata	Hydrobiidae	Pelecypoda / Sphaeriidae
1.1					
1.2					
1.3					
2.1					
2.2					
2.3					
3.1					
3.2					
3.3					
4.1					
4.2					
4.3					
5.1					
6.1					
6.2					
6.3					
7.1					
7.2					
7.3					
8.1					
8.2					
8.3					
9.1					
9.2					
9.3					
10.1					
10.2					
10.3					
11.1					
11.2					
11.3					

Stream/Rep	Phylum / Class / Order / Family / Genus	Mollusca / Gastropoda / Basommatophora / Planorbidae	Mesogastropoda / Bithyniidae / Bithynia tentaculata	Hydrobiidae	Pelecypoda / Sphaeriidae
12.1					
12.2					
12.3					
13.1					
13.2					
13.3					
14.1					
14.2					
14.3					1
15.1					
15.2					
16.1					2
16.2					1
16.3					
17.1				1	
17.2					
17.3					
18.1					
18.2					
18.3					
19.1					
19.2					
19.3					
20.1					
20.2					1
21.1					
22.1					
22.2					
22.3					
23.1					
23.2					
23.3					

Phylum Class Order Family	Tubificida	
Stream/Rep / Genus	Lumberculus	Oligocheatae
1.1		1
1.2		
1.3		
2.1		
2.2		3
2.3		2
3.1		
3.2		
3.3		
4.1		2
4.2		
4.3		
5.1		6
6.1		1
6.2		2
6.3		5
7.1		
7.2		1
7.3		
8.1		1
8.2		
8.3		
9.1		1
9.2		
9.3		
10.1		
10.2		
10.3		
11.1		1
11.2		1
11.3		

Phylum Class Order Family	Tubificida	
Stream/Rep / Genus	Lumberculus	Oligocheatae
12.1		
12.2		
12.3		
13.1	1	
13.2		
13.3		
14.1		
14.2		1
14.3		3
15.1		4
15.2		
16.1	1	32
16.2		1
16.3		
17.1		
17.2		
17.3		
18.1		
18.2		
18.3		1
19.1		
19.2	2	
19.3	1	
20.1		9
20.2		
21.1		6
22.1		
22.2		1
22.3		
23.1		
23.2		1
23.3		

APPENDIX A-2

Occurrence of Chironomid genera only on spring sample date (April 29, May 6 and 16, 2006), reported as number of individuals per Surber sample.

Order	Diptera						
Family	Chironomidae						
Subfamily	Chironominae						
Tribe	Chironominae					Unknown Chironomini 1	Unknown Chironomini 2
Stream/Rep / Genus	Paratendipes	Polypedilum	Polypedilum fallax	Polypedilum scalaenum	Stenochironomus		
1.1							
1.2							
1.3							
2.1							
2.2				4			
2.3				2			
3.1							
3.2							
3.3							
4.1							
4.2							
4.3							
5.1							
6.1				1			
6.2							
6.3							
7.1							
7.2							
7.3							
8.1							
8.2							
8.3							
9.1							
9.2							
9.3							
10.1							
10.2				2			
10.3							
11.1							
11.2							
11.3							

Order	Diptera						
Family	Chironomidae						
Subfamily	Chironominae						
Tribe	Chironominae					Unknown Chironomini 1	Unknown Chironomini 2
Stream/Rep / Genus	Paratendipes	Polypedilum	Polypedilum fallax	Polypedilum scalaenum	Stenochironomus		
12.1							
12.2							
12.3							
13.1							
13.2							
13.3							
14.1							
14.2							
14.3				1			
15.1							
15.2							
16.1				1			
16.2	1			1			
16.3							
17.1							
17.2							
17.3							
18.1							
18.2							
18.3							
19.1							
19.2				1			
19.3							
20.1				1			
20.2							
21.1				6		4	
22.1							
22.2				1			
22.3							
23.1							
23.2							
23.3							

Order	Diptera								
Family	Chironomidae								
Subfamily	Chironominae				Diamesinae			Orthocladiinae	
Tribe	Tanytarsini								
Stream/Rep Genus	Heterotanytarsus	Tanytarsus glabrescens	Tanytarsus guerlus	Unknown11	Diamesa	Prodiamesa	Sympotthastia	Brillia	Epoicocladius
1.1									
1.2			1						
1.3									
2.1									
2.2			2						
2.3		1							
3.1			1		1				
3.2			1						
3.3							1		
4.1			3						
4.2			1						
4.3		1	1						
5.1			2						
6.1			6						
6.2			1						
6.3			4						
7.1			1						
7.2			1		1				
7.3									
8.1	2	2			8				
8.2									
8.3									
9.1			2		1			1	1
9.2					1				
9.3									
10.1	4		1		1				
10.2			5						
10.3			2						
11.1			1						
11.2			2		22				
11.3			1						

Order	Diptera								
Family	Chironomidae								
Subfamily	Chironominae				Diamesinae			Orthocladiinae	
Tribe	Tanytarsini								
Stream/Rep Genus	Heterotanytarsus	Tanytarsus glabrescens	Tanytarsus guerlus	Unknown11	Diamesa	Prodiamesa	Sympotthastia	Brillia	Epoicocladius
12.1					1				
12.2			2						
12.3			3		1				
13.1			1		1				
13.2									
13.3									
14.1			2						
14.2			3						
14.3									
15.1			2		1				
15.2		1							
16.1			2						
16.2			1						
16.3			1						
17.1									
17.2									
17.3									
18.1					3				
18.2			1						
18.3					1				
19.1									
19.2			1						
19.3									
20.1		1	4						
20.2			5						
21.1			1						
22.1									
22.2									
22.3									
23.1									
23.2									
23.3			1						

Order / Family / Subfamily / Tribe	Diptera / Chironomidae / Orthocladiinae										
Stream/Rep — Genus	Eukiefferiella bavarica	Eukiefferiella discoloripes	Heterotrissocladius marcidus	Paracheatocladius	Parakiefferialla sp.	Parametriocnemus lundbecki	Pseodorthocladius	Symposiocladius	Thienemanniella (Xena)	Thienemanniella	Unknown
1.1		1		1		1	1				
1.2											
1.3											
2.1											
2.2			4	3		6	1				
2.3			3			5	1	1			
3.1		1				3					
3.2		4	2			3					
3.3		2									
4.1		13	1			10					
4.2		2									
4.3		2	1			4	2				
5.1		17	2		1	7		1			
6.1			4			4	5				
6.2		9				6					
6.3		11	1			10	2				
7.1		4				1	1				
7.2						1					1
7.3											
8.1	1	1	1			5					
8.2											
8.3		3				4					
9.1						8					
9.2											
9.3			1			1					
10.1			4			12					
10.2		1	2			18					
10.3			1			6					
11.1						3					
11.2						4					
11.3											
12.1		1				4					
12.2						14	1				
12.3		2	2			6	1				
13.1						12					
13.2		1				1					
13.3											
14.1						1	1				
14.2		1				6	2				
14.3						3					
15.1		1	1			4	7				
15.2						3	1				
16.1						14	4				
16.2						9	1				
16.3											
17.1						3					
17.2						1					
17.3											
18.1		4				1	2				
18.2		1				5	1				
18.3						1					
19.1											
19.2						7					
19.3							2				
20.1		2				10	1				
20.2		1				3	2				
21.1						3					
22.1											
22.2			1			4			1		
22.3											
23.1											
23.2						2					
23.3						3					

Order / Family / Subfamily / Tribe	Diptera / Chironomidae / Tanypodinae			Unidentifiable
Stream/Rep — Genus	Larsia	Thienemannimyia	Unidentifiable	
1.1				
1.2				
1.3				
2.1				
2.2		1		
2.3	1	1		
3.1				
3.2				
3.3				
4.1				
4.2				
4.3		1		
5.1				
6.1		1		
6.2				
6.3				
7.1				
7.2				
7.3				
8.1		4	1	
8.2				
8.3		1		
9.1		5		
9.2		1		
9.3		1		
10.1		6		
10.2				
10.3		1		
11.1				
11.2		2		
11.3		1		

Order / Family / Subfamily / Tribe	Diptera / Chironomidae / Tanypodinae			Unidentifiable
Stream/Rep — Genus	Larsia	Thienemannimyia	Unidentifiable	
12.1				
12.2		2		1
12.3		3		
13.1				4
13.2				
13.3				
14.1		1		
14.2		1		
14.3		8		
15.1				
15.2				1
16.1		1		2
16.2				
16.3				
17.1				2
17.2		1		
17.3		1		
18.1				2
18.2		3		1
18.3				20
19.1		2		
19.2				
19.3				
20.1		15		
20.2		6		
21.1		12		
22.1				
22.2		3		1
22.3				
23.1		1		
23.2				
23.3				

Appendix B-1

Occurrence of benthic macroinvertebrate taxa on summer sample date (July 3, 5, and 6, 2006), reported as number of individuals per Surber sample.

	Phylum	Arthropoda								
	Class	Insecta								
	Order	Coleoptera								
	Family	Dytiscidae	Elmidae							Haliplidae
Stream/Sample	Genus	Rhantus	Ancyronyx	Macronychus	Microcylleopus	Optioservus	Oulimnius	Stenelmis	Unknown	Halipus
1.1										
1.2										
1.3										
2.1										
2.2										
2.3										
3.1										
3.2									1	
3.3									1	
4.1										
4.2										
4.3										
5.1										
7.1										
7.2								7		
7.3				1				1		
8.1										
8.2										
8.3										
9.1								3		
9.2										
9.3					2					
10.1										
10.2										
10.3										
11.1										
11.2										
11.3										
12.1										
12.2										
12.3										

	Phylum	Arthropoda								
	Class	Insecta								
	Order	Coleoptera								
	Family	Dytiscidae	Elmidae							Haliplidae
Stream/Sample	Genus	Rhantus	Ancyronyx	Macronychus	Microcylleopus	Optioservus	Oulimnius	Stenelmis	Unknown	Halipus
13.1					1			1		
13.2					1			3		
13.3					2			4		
14.1										
14.2										
14.3					1					
15.1					1					
15.2										
15.3										
16.1					1					
16.2										
16.3										
17.1				1				1		
17.2										
17.3					5					
18.1										
18.2										
18.3										
19.1								1		
19.2										
19.3										
20.1										
21.1										
23.1					3					
23.2				2						
23.3				3	4					

Phylum	Arthropoda						
Class	Insecta						Collembola
Order	Coleoptera						
Family	Histeridae	Hydrophilidae			Psephenidae	Unknown	Isotomidae
Stream/Sample / Genus		Hydrobius	Sperchopsis	Unknown	Ectopria		
1.1							
1.2							
1.3							
2.1						1	
2.2							
2.3	1						
3.1							
3.2					1		
3.3							1
4.1							
4.2							
4.3							
5.1					1		
7.1							
7.2							
7.3							
8.1							
8.2							
8.3							
9.1							
9.2							1
9.3							
10.1							2
10.2				1			
10.3							1
11.1					1		
11.2							
11.3						1	
12.1							
12.2							
12.3							
13.1					1		
13.2							
13.3							
14.1							
14.2							
14.3							
15.1							
15.2							
15.3		2					
16.1							
16.2							
16.3		1					
17.1							1
17.2							
17.3							
18.1							
18.2							
18.3							
19.1							
19.2							
19.3							
20.1							
21.1							
23.1							
23.2					1		
23.3							

Phylum / Class / Order / Family	Arthropoda / Insecta / Diptera / Chironomidae	Ceratopogonidae	Dixidae	Doliphopodidae	Empididae
Stream/Sample — Genus	See Appedix B-2	Probezzia	Dixa	Raphium	Hemerodromia
1.1					
1.2					
1.3			1		
2.1		1			
2.2			2		1
2.3			2		1
3.1			3		
3.2		1			
3.3					
4.1					
4.2					
4.3					
5.1					
7.1					
7.2					
7.3					
8.1		1			
8.2					
8.3					
9.1			1		
9.2					
9.3					
10.1			1		
10.2					
10.3		1	1		
11.1					
11.2					
11.3					
12.1			2		
12.2		1			
12.3					

Phylum / Class / Order / Family	Arthropoda / Insecta / Diptera / Chironomidae	Ceratopogonidae	Dixidae	Doliphopodidae	Empididae
Stream/Sample — Genus	See Appedix B-2	Probezzia	Dixa	Raphium	Hemerodromia
13.1					
13.2					
13.3					
14.1					
14.2		1			
14.3					
15.1					
15.2			1		
15.3					
16.1			2		
16.2		1	1		1
16.3		2			
17.1			1		
17.2					
17.3		1			
18.1					
18.2					
18.3					
19.1					
19.2					
19.3					
20.1					
21.1		1			
23.1					
23.2					
23.3					

Phylum / Class / Order / Family	Arthropoda / Insecta / Diptera / Pelecorhynchidae	Psychodidae	Ptychopteridae	Simuliidae	
Stream/Sample — Genus	Glutops	Pericoma, Telmatoscopus	Ptychoptera	Prosimulium	Simulium
1.1					
1.2					
1.3					
2.1					
2.2					
2.3					
3.1					
3.2					
3.3					
4.1					
4.2					
4.3					
5.1					
7.1					
7.2					
7.3					
8.1					
8.2					
8.3					
9.1					
9.2					1
9.3					
10.1					
10.2					
10.3					
11.1					
11.2					
11.3					
12.1					
12.2					
12.3					
13.1					
13.2					
13.3					
14.1					
14.2					
14.3					
15.1					
15.2					
15.3					
16.1					
16.2					
16.3					
17.1					
17.2					
17.3					
18.1					
18.2					
18.3					
19.1					1
19.2					
19.3				1	
20.1					
21.1					
23.1					1
23.2					4
23.3					

Phylum	Arthropoda									
Class	Insecta									
Order	Diptera									
Family	Simuliidae	Tabanidae	Tipulidae							
Stream/Sample / **Genus**	Twinnia	Chrysops	Dicranota	Hexatoma	Limnophila	Molophilus	Ormosia	Pseudolimnophila	Tipula	Unidentifiable
1.1										
1.2										
1.3										
2.1		2		1						
2.2			1							
2.3			1							
3.1			5	2						
3.2										
3.3			1							
4.1				1						
4.2			1	6						
4.3				3						
5.1										
7.1										
7.2										
7.3										
8.1		1	2							
8.2										
8.3		2	1							
9.1			1	1				1	1	
9.2				1				1		
9.3										
10.1				1			2			3
10.2		1	5	4			5			
10.3		1	4	2					1	
11.1			2							
11.2			1							
11.3			2	1						
12.1										
12.2				1					1	
12.3			5	3				2		

Phylum	Arthropoda									
Class	Insecta									
Order	Diptera									
Family	Simuliidae	Tabanidae	Tipulidae							
Stream/Sample / **Genus**	Twinnia	Chrysops	Dicranota	Hexatoma	Limnophila	Molophilus	Ormosia	Pseudolimnophila	Tipula	Unidentifiable
13.1			6	9						
13.2			7	4						
13.3		1	1	1						
14.1			2	8					1	
14.2			6	5						
14.3			3	1						
15.1										
15.2			1	2						
15.3			4	3					1	
16.1										
16.2			6					1	1	
16.3		1	5							
17.1		1		2						
17.2										
17.3		2	3	2						
18.1										
18.2			3							
18.3			2							
19.1			5							
19.2			9					1		
19.3			1							
20.1			3	11						
21.1		1	1	2			2	2	1	
23.1				1						
23.2										
23.3			3							

Phylum	Arthropoda						
Class	Insecta						
Order	Ephemeroptera						
Family	Ameletidae	Baetidae		Ephemerellidae			Ephemeridae
Stream/Sample / Genus	Ameletus	Baetis	Unidentifiable	Ephemerella	Serratella	Unidentifiable	Ephemera
1.1							
1.2							
1.3							
2.1					1		
2.2							
2.3							
3.1							
3.2							
3.3							
4.1							
4.2							
4.3	1						
5.1							
7.1							
7.2							
7.3		2					
8.1	1	1					
8.2		2					1
8.3		1					1
9.1							
9.2							2
9.3							1
10.1		1					
10.2		1					
10.3		1					
11.1		2					
11.2							
11.3		10					
12.1							
12.2				1			
12.3							
13.1				1			
13.2		6					
13.3		4					
14.1				1			
14.2							
14.3							
15.1							
15.2		1					
15.3		1					
16.1							
16.2							
16.3							
17.1		1					
17.2							
17.3		1					1
18.1							
18.2							
18.3							
19.1			1				
19.2							
19.3		1					
20.1		1					
21.1							
23.1		1					
23.2			1				
23.3		1					

Phylum / Class / Order / Family	Arthropoda / Insecta / Ephemeroptera / Ephemeridae	Heptageniidea		Leptophlebiidae	Unidentifiable
Stream/Sample — Genus	Pentagenia	Cingymula	Epeorus (Iron)	Paraleptophlebia	
1.1			2		
1.2					
1.3			5		
2.1				5	
2.2				10	
2.3				4	
3.1				24	
3.2				5	
3.3			2	5	
4.1				1	
4.2				6	
4.3			1	4	
5.1					
7.1			1		
7.2				4	
7.3					
8.1				4	
8.2			2	1	
8.3				4	
9.1		1	2	9	
9.2		2	7	12	
9.3		3		4	
10.1				2	
10.2				1	
10.3			2	6	
11.1			2	2	
11.2				2	
11.3			6	7	
12.1			1	1	
12.2				6	
12.3			2	6	

Phylum / Class / Order / Family	Arthropoda / Insecta / Ephemeroptera / Ephemeridae	Heptageniidea		Leptophlebiidae	Unidentifiable
Stream/Sample — Genus	Pentagenia	Cingymula	Epeorus (Iron)	Paraleptophlebia	
13.1			3	1	
13.2		1		10	
13.3		2			
14.1				1	
14.2				3	
14.3		1		4	
15.1				2	
15.2		1		2	
15.3					
16.1				1	
16.2					
16.3				1	
17.1				1	
17.2				1	
17.3		1		1	
18.1		1		1	
18.2			6		
18.3			2	1	
19.1				6	
19.2				5	
19.3				3	
20.1				5	
21.1		1		15	
23.1		1			
23.2		3		2	
23.3					

Phylum / Class / Order / Family	Arthropoda / Insecta / Hemiptera / Gerridae	Veliidae		Hydrachnidia / Limnesia	Unidentifiable	Lepidoptera / Pyralidae
Stream/Sample / Genus	Unidentifiable	Microvelia	Rhagovelia			
1.1						
1.2						
1.3						
2.1						
2.2						
2.3						
3.1						
3.2						
3.3						
4.1						
4.2						
4.3						
5.1						
7.1						
7.2		1				
7.3		1				
8.1						
8.2						
8.3						
9.1						
9.2		1				
9.3						
10.1						
10.2						
10.3						
11.1						
11.2						
11.3					1	
12.1						
12.2		1				
12.3		1				
13.1		1				
13.2						
13.3						
14.1						
14.2						
14.3						
15.1						
15.2						
15.3						
16.1						
16.2						
16.3						
17.1	1	3				
17.2						
17.3			2			
18.1						
18.2						
18.3						
19.1						
19.2						
19.3						
20.1						
21.1						
23.1						
23.2						
23.3						

Phylum / Class / Order / Family	Arthropoda / Insecta / Megaloptera / Corydalidae		Sialidae	Odonata / Aeshnidae	Cordulegastridae
Stream/Sample / **Genus**	Chauliodes	Nigronia	Sialis	Boyeria	Cordulegaster
1.1					
1.2					
1.3					
2.1					3
2.2					
2.3					6
3.1					
3.2					1
3.3					1
4.1					
4.2					
4.3					
5.1					
7.1					
7.2					
7.3					1
8.1	2				1
8.2					
8.3					
9.1					
9.2			1		
9.3			1		
10.1					1
10.2					3
10.3					2
11.1					
11.2					
11.3		4			
12.1					
12.2					3
12.3					

Phylum / Class / Order / Family	Arthropoda / Insecta / Megaloptera / Corydalidae		Sialidae	Odonata / Aeshnidae	Cordulegastridae
Stream/Sample / **Genus**	Chauliodes	Nigronia	Sialis	Boyeria	Cordulegaster
13.1					
13.2	1		1		
13.3					
14.1					
14.2					
14.3					
15.1					2
15.2					
15.3					3
16.1					
16.2	1				1
16.3					1
17.1					
17.2					
17.3					
18.1					1
18.2					
18.3					1
19.1					
19.2					
19.3					
20.1					3
21.1					
23.1					
23.2					1
23.3					

Phylum / Class / Order / Family	Arthropoda / Insecta / Odonata / Gomphidae			Plecoptera / Chloroperlidae				Leuctridae
Stream/Sample **Genus**	Lanthus	Stylogomphus	Unidentifiable	Haploperla	Suwallia	Sweltsa	Unidentifiable	Leuctra
1.1					4			4
1.2					1			
1.3				2				13
2.1	1							14
2.2								3
2.3								75
3.1		6						177
3.2				2				35
3.3								45
4.1				9	3			
4.2				19				
4.3			1		34			2
5.1					6			
7.1								5
7.2					3			5
7.3								3
8.1								16
8.2					2			41
8.3								16
9.1								68
9.2	1							71
9.3		2						10
10.1				2				32
10.2				1				15
10.3				4				26
11.1				1				15
11.2								1
11.3		3		8				71
12.1								3
12.2					1			25
12.3	1				2			31
13.1								24
13.2								40
13.3								13
14.1								10
14.2				1				61
14.3								14
15.1		2						1
15.2		1						4
15.3		1						28
16.1								5
16.2		2						17
16.3								2
17.1								5
17.2								2
17.3		1			1			3
18.1					2			9
18.2							1	18
18.3					5			10
19.1								73
19.2								33
19.3								9
20.1		1						26
21.1								5
23.1								12
23.2								15
23.3								20

Phylum		Arthropoda								
Class		Insecta								
Order		Plecoptera								
Family		Nemouridae		Perlidae		Perlodidae			Peltoperlidae	
Stream/Sample	Genus	Amphinemura	Nemoura	Acroneuria	Perlesta	Isoperla	Remenus	Unidentifiable	Agentina	Peltoperla
1.1										
1.2										
1.3		5				3				
2.1		5								
2.2			1							
2.3		3	9							
3.1		10				1				
3.2						1				
3.3		1				2				
4.1		4								
4.2		2	9							
4.3						14				
5.1										
7.1						1				
7.2				2						
7.3		1						1		
8.1		1	2							
8.2		1	1							
8.3				1						
9.1						4		3		
9.2		1				2		8		
9.3						1				
10.1		2								
10.2		1				2				
10.3		4				4				
11.1						4				
11.2						1				
11.3		5				6				
12.1										
12.2						2				
12.3		2				5				
13.1				2		7				
13.2		1	2	11		2				
13.3				7						
14.1		9				11				
14.2		4				7				
14.3		2	1			4				
15.1										
15.2		2								
15.3			1							
16.1			3							
16.2			6							
16.3			11			1				
17.1						2				
17.2										
17.3					1					
18.1						1				1
18.2		6	4							7
18.3		1								1
19.1			2							1
19.2		1	2							
19.3				2						
20.1		10				2				
21.1		6								
23.1										
23.2		1		8						
23.3		1				2				

	Phylum Class Order Family	Arthropoda Insecta Plecoptera Peltoperlidae	Unidentifiable	Tricoptera Beraeidae	Dolichopodidae	Glossosomatidae
Stream/Sample	Genus	Tallaperla		Beraea	Rhaphium	Glossosoma
1.1						
1.2						
1.3						
2.1						
2.2						
2.3						
3.1		5				
3.2						
3.3		1				
4.1		4				
4.2		8				
4.3		2				
5.1			1			
7.1						
7.2						
7.3						
8.1		2				
8.2		2	2			
8.3		2				
9.1		1	1			
9.2						
9.3						
10.1		2				
10.2						
10.3		2				
11.1		1				
11.2						
11.3		4				
12.1		1				
12.2		1				
12.3		9				

	Phylum Class Order Family	Arthropoda Insecta Plecoptera Peltoperlidae	Unidentifiable	Tricoptera Beraeidae	Dolichopodidae	Glossosomatidae
Stream/Sample	Genus	Tallaperla		Beraea	Rhaphium	Glossosoma
13.1		1				
13.2						
13.3		1				
14.1						
14.2		1				
14.3						
15.1						
15.2						
15.3						
16.1						
16.2						
16.3						
17.1						
17.2		1				
17.3						
18.1		1				
18.2		7				
18.3						
19.1						
19.2						
19.3						
20.1						
21.1		1				
23.1		7				
23.2						
23.3						

Phylum / Class / Order / Family		Arthropoda / Insecta / Tricoptera / Goeridae	Hydropsychidae					Lepidostomatidae
Stream/Sample	Genus	Goera	Cheumatopsyche	Diplectrona	Hydropsyche	Parapsyche	Unknown	Lepidostoma
1.1				1				
1.2								
1.3				1				
2.1								
2.2								
2.3				1		1		
3.1				6				11
3.2				3				1
3.3				1				
4.1								
4.2								
4.3								
5.1								
7.1					1			
7.2					4			
7.3							1	
8.1				2				
8.2				3				
8.3				1				1
9.1				5				
9.2				2				1
9.3				1				
10.1								
10.2								1
10.3								1
11.1				1				
11.2				1				
11.3				11				1
12.1								
12.2								
12.3				3				3

Phylum / Class / Order / Family		Arthropoda / Insecta / Tricoptera / Goeridae	Hydropsychidae					Lepidostomatidae
Stream/Sample	Genus	Goera	Cheumatopsyche	Diplectrona	Hydropsyche	Parapsyche	Unknown	Lepidostoma
13.1				2	7			
13.2				2	37			
13.3					8			
14.1				10				1
14.2				6	1			1
14.3				3				1
15.1				3				2
15.2				3				6
15.3				13				3
16.1				4				5
16.2				2				
16.3								
17.1								1
17.2								1
17.3								
18.1				1				
18.2								
18.3				1				
19.1								
19.2								
19.3				8	4			1
20.1				8	2			1
21.1					4			
23.1				1	1			
23.2				2	1			
23.3				3	6			

Phylum / Class / Order / Family	Arthropoda / Insecta / Tricoptera / Limnephilidae				Philopotamidae		Phryganeidae
Stream/Sample — Genus	Hesperophylax	Pseudostenophylax	Psychoglypha	Pycnopsyche	Dolophilodes	Unidentifiable	Ptilostomis
1.1							
1.2							
1.3							
2.1							
2.2							
2.3					1		
3.1				1	4		
3.2					6		
3.3					1		
4.1				1			
4.2				1		1	
4.3							
5.1	10			1			
7.1							
7.2					1		
7.3							
8.1							
8.2			1				
8.3					1		
9.1							
9.2							
9.3							
10.1					3		
10.2				3	2		
10.3							
11.1				1	2		
11.2							
11.3					9		
12.1					2		
12.2							
12.3				1	3		
13.1				1	7		
13.2					7		
13.3					2		
14.1					11		
14.2					12		
14.3					1		
15.1			2				
15.2							
15.3					1		
16.1							
16.2							
16.3							
17.1							
17.2				1			
17.3				1	1		
18.1							
18.2							
18.3							
19.1					11		
19.2					1		
19.3					10		
20.1					1		
21.1							
23.1							
23.2							
23.3				1			

Phylum / Class / Order / Family	Arthropoda / Insecta / Tricoptera / Polycentropidae			Arthropoda / Insecta / Tricoptera / Uenoisae	Unidentifiable	Crustacea / Decapoda / Cambaridae	Diplopoda / Polydesmida
Stream/Sample	**Genus**	Polycentropus	Nyctiophylax	Neophylax			
1.1							
1.2							
1.3							
2.1							
2.2							
2.3							
3.1		2				1	
3.2							
3.3		1					
4.1						1	
4.2						1	
4.3		3				1	
5.1							
7.1		1					
7.2							
7.3							
8.1							
8.2					1		
8.3							
9.1		1			1	1	
9.2						1	
9.3						1	
10.1							
10.2							
10.3						2	
11.1						1	
11.2						1	
11.3		1					
12.1							
12.2							
12.3						5	
13.1						1	
13.2							
13.3						1	
14.1		1			2		
14.2						1	
14.3						1	
15.1						1	
15.2					1		
15.3		1					
16.1							
16.2						2	
16.3							
17.1		1				1	
17.2						1	
17.3						2	
18.1							
18.2						1	
18.3		2				1	
19.1		22				1	
19.2		13					
19.3							
20.1		1					
21.1		1					
23.1		6					
23.2		19					
23.3		2			1		

Stream/Sample	Phylum / Class / Order / Family / Genus	Mollusca / Gastropoda / Basommatophora / Planorbidae	Mesogastropoda / Bithyniidae / Bithynia tentaculata	Hydrobiidae	Pelecypoda / Sphaeriidae
1.1					
1.2					
1.3					
2.1					
2.2					
2.3					1
3.1					
3.2					
3.3					
4.1					
4.2					
4.3					
5.1					
7.1					
7.2					
7.3					
8.1					
8.2					
8.3					
9.1					
9.2					
9.3					
10.1					
10.2					
10.3					
11.1					
11.2					
11.3					
12.1					
12.2					
12.3					
13.1					
13.2					
13.3					
14.1					
14.2					
14.3					
15.1					
15.2					
15.3					
16.1					
16.2			1		8
16.3					
17.1					
17.2					
17.3					
18.1					
18.2					
18.3					
19.1					3
19.2					
19.3					
20.1					
21.1					
23.1					
23.2					
23.3					

	Phylum Class Order Family	Tubificida Lumberculus	Oligocheatae
Stream/Sample	Genus		
1.1			
1.2			
1.3			
2.1			5
2.2			1
2.3			7
3.1			3
3.2			
3.3			
4.1			
4.2			1
4.3			1
5.1			1
7.1			
7.2			
7.3			
8.1			1
8.2			
8.3			
9.1			
9.2			
9.3			
10.1			
10.2			
10.3			
11.1			
11.2			
11.3			1
12.1			
12.2			
12.3			

	Phylum Class Order Family	Tubificida Lumberculus	Oligocheatae
Stream/Sample	Genus		
13.1			1
13.2			
13.3			
14.1			5
14.2			
14.3			
15.1			
15.2			
15.3			1
16.1			
16.2			7
16.3			1
17.1			
17.2			
17.3			1
18.1			
18.2			
18.3			
19.1			4
19.2			
19.3			
20.1			
21.1			
23.1			
23.2			
23.3			

APPENDIX B-2

Occurrence of Chironomid genera on summer sample date (July 3, 5, and 6, 2006), reported as number of individuals per Surber sample.

Order	Diptera					
Family	Chironomidae					
Subfamily	Chironominae					
Tribe	Chironominae					Unknown Chironomini 1
Stream/Sample Genus	Paratendipes	Polypedilum	Polypedilum fallax	Polypedilum scalaenum	Stenochironomus	
1.1						
1.2						
1.3						
2.1						
2.2						
2.3						
3.1						
3.2			1			
3.3						
4.1						
4.2						
4.3						
5.1						
7.1						
7.2						
7.3						
8.1						
8.2						
8.3						
9.1						
9.2						
9.3						
10.1						
10.2						
10.3						
11.1						
11.2						
11.3						

Order	Diptera					
Family	Chironomidae					
Subfamily	Chironominae					
Tribe	Chironominae					Unknown Chironomini 1
Stream/Sample Genus	Paratendipes	Polypedilum	Polypedilum fallax	Polypedilum scalaenum	Stenochironomus	
12.1						
12.2						
12.3						
13.1						
13.2						
13.3						
14.1						
14.2						
14.3						
15.1						
15.2						
15.3						
16.1						
16.2						
16.3						
17.1			2			
17.2						
17.3						
18.1						
18.2						
18.3						
19.1		1				
19.2						
19.3						
20.1			1			
21.1			1			
23.1						
23.2	1					
23.3						

Stream/Sample	Order: Diptera Family: Chironomidae Subfamily: Chironominae Tribe: Unknown Chironomini 2 Genus:	Order: Diptera Family: Chironomidae Subfamily: Chironominae Tribe: Tanytarsini Genus: Heterotanytarsus	Tanytarsus glabrescens	Tanytarsus guerlus	Unknown11	Subfamily: Diamesinae Genus: Diamesa
1.1						
1.2						
1.3						
2.1			2			1
2.2						
2.3			5			
3.1			2		1	
3.2						
3.3			2			
4.1			1			
4.2						
4.3						
5.1						
7.1						
7.2						
7.3						
8.1						
8.2					1	
8.3						
9.1			1			
9.2			3		7	
9.3						
10.1			1			
10.2					2	
10.3			2			
11.1						
11.2			1			
11.3					4	
12.1						
12.2						
12.3					1	
13.1			4			
13.2			5			
13.3			3			
14.1						
14.2						
14.3						
15.1						
15.2						
15.3						
16.1			1			
16.2			1			
16.3						
17.1			4			
17.2						
17.3			2	1	1	
18.1						
18.2					1	
18.3						
19.1						
19.2						
19.3						
20.1			1			
21.1			1			
23.1			1			
23.2						
23.3						

Stream/Sample	Genus	Prodiamesa	Sympotthastia	Brillia	Epoicocladius	Eukiefferiella bavarica	Eukiefferiella discoloripes	Heterotrissocladius marcidus	Parachaetocladius	Parakiefferiella sp
Order		Diptera								
Family		Chironomidae								
Subfamily		Diamesinae	Orthocladiinae							
Tribe										
1.1										
1.2										
1.3										
2.1										16
2.2										2
2.3							2			4
3.1					1		2			20
3.2						1				1
3.3										10
4.1										
4.2										3
4.3						1				2
5.1										
7.1										1
7.2										
7.3										
8.1										2
8.2							1			2
8.3							1			1
9.1										1
9.2							3			4
9.3										
10.1						1				9
10.2										3
10.3							3			8
11.1										14
11.2										1
11.3					1	1				5

Stream/Sample	Genus	Prodiamesa	Sympotthastia	Brillia	Epoicocladius	Eukiefferiella bavarica	Eukiefferiella discoloripes	Heterotrissocladius marcidus	Parachaetocladius	Parakiefferiella sp.
Order		Diptera								
Family		Chironomidae								
Subfamily		Diamesinae	Orthocladiinae							
Tribe										
12.1										
12.2							1			4
12.3						1	1			4
13.1						1	1			4
13.2					2					2
13.3										3
14.1							1			25
14.2										
14.3										5
15.1										
15.2										1
15.3										5
16.1							1			3
16.2							5			4
16.3										7
17.1										1
17.2										1
17.3							1			5
18.1										
18.2						1				
18.3										
19.1							2			21
19.2										1
19.3										2
20.1							1			12
21.1							3			
23.1										1
23.2						1				2
23.3										2

Order / Family / Subfamily / Tribe		Diptera / Chironomidae / Orthocladiinae					
Stream/Sample	Genus	Parametriocnemus lundbecki	Pseodorthocladius	Symposiocladius	Thienemanniella (Xena)	Thienemanniella	Unknown
1.1							
1.2							
1.3							
2.1							
2.2							
2.3		2					
3.1							
3.2							
3.3							
4.1							
4.2							
4.3							
5.1							
7.1							
7.2							
7.3							
8.1							
8.2							
8.3							
9.1							
9.2							
9.3							
10.1					1		
10.2							
10.3							
11.1							
11.2							
11.3							

Order / Family / Subfamily / Tribe		Diptera / Chironomidae / Orthocladiinae					
Stream/Sample	Genus	Parametriocnemus lundbecki	Pseodorthocladius	Symposiocladius	Thienemanniella (Xena)	Thienemanniella	Unknown
12.1							
12.2							
12.3							
13.1							
13.2							
13.3							
14.1		2					
14.2							
14.3							
15.1							
15.2							
15.3							
16.1					1		
16.2		5					
16.3							
17.1							
17.2							
17.3							
18.1							
18.2							
18.3							
19.1							
19.2							
19.3							
20.1							
21.1				1			
23.1							
23.2							
23.3							

Order / Family / Subfamily / Tribe	Diptera / Chironomidae / Tanypodinae			Unidentifiable
Stream/Sample / **Genus**	Larsia	Thienemannimyia	Unidentifiable	
1.1				
1.2				
1.3				
2.1	1			
2.2				
2.3	3		1	
3.1				
3.2				
3.3	1			
4.1				
4.2				
4.3				
5.1				
7.1				
7.2				
7.3				
8.1	4			
8.2				
8.3				
9.1	3			
9.2	6			
9.3	1			
10.1				
10.2	3			
10.3	3		1	
11.1	2			
11.2				
11.3	2			
12.1			1	
12.2	5		1	
12.3			2	
13.1			1	
13.2				
13.3				
14.1				
14.2				
14.3	1			
15.1			1	
15.2				
15.3				
16.1			4	
16.2	4		2	
16.3			22	
17.1	1			
17.2	1			
17.3	1		2	
18.1				
18.2			1	
18.3				
19.1	2		2	
19.2	4			
19.3				
20.1	3		3	
21.1	6			
23.1				
23.2				
23.3				

APPENDIX C-1

Occurrence of benthic macroinvertebrate taxa on fall sample date (September 15, 23, and 24), reported as number of individuals per Surber sample.

Phylum	Arthropoda							
Class	Insecta							
Order	Coleoptera							
Family	Dytiscidae	Elmidae						
Stream/Sample Genus	Rhantus	Ancyronyx	Macronychus	Microcylleopus	Optioservus	Oulimnius	Stenelmis	Unknown
1.1								
1.2								
1.3								
2.1								
2.2								
2.3								
3.1								
3.2								
3.3								
4.1								
4.2						1		
4.3								
5.1								
5.2								
5.3								
7.2								
7.3				2				
8.1								
8.2								
8.3								
9.1								
9.2								
9.3								
10.1								
10.2								
10.3								
11.1								
11.2								
11.3								
12.1				1				
12.2								
12.3						4		
13.1								
13.2								
13.3				2				
14.1								
14.2			1					
14.3				1				
15.1				1				
15.2								
15.3								
16.1								
16.2								
16.3								
17.1								
17.3				4				
18.1								
18.2								
18.3								
19.1								
19.2								
19.3				1				
20.1								
20.2								
21.1				6				
21.2				16				
21.3				1				
22.1				2				
22.2				1				
22.3				3				
23.1				1		1		
23.2								
23.3								

Stream/Sample	Halipus		Hydrobius	Sperchopsis	Unknown	Ectopria
Phylum	Arthropoda					
Class	Insecta					
Order	Coleoptera					
Family	Haliplidae	Histeridae	Hydrophilidae			Psephenidae
1.1						
1.2						
1.3						
2.1						
2.2						1
2.3						
3.1	1					
3.2						1
3.3						
4.1			1			
4.2						
4.3						
5.1						
5.2						
5.3						
7.2						
7.3						
8.1						
8.2						
8.3						
9.1						
9.2						1
9.3						
10.1						
10.2						
10.3						
11.1						1
11.2						
11.3						
12.1						
12.2						
12.3						5

Stream/Sample	Halipus		Hydrobius	Sperchopsis	Unknown	Ectopria
Phylum	Arthropoda					
Class	Insecta					
Order	Coleoptera					
Family	Haliplidae	Histeridae	Hydrophilidae			Psephenidae
13.1						
13.2						
13.3						
14.1						1
14.2						
14.3						
15.1						
15.2						
15.3						
16.1						
16.2						
16.3						
17.1						
17.3						
18.1						
18.2						
18.3						
19.1						
19.2						
19.3						
20.1						1
20.2						1
21.1						
21.2						
21.3						
22.1						
22.2						
22.3						
23.1						
23.2						
23.3						

Phylum / Class / Order / Family	Arthropoda / Insecta / Coleoptera / Unknown	Collembola / Isotomidae	Diptera / Chironomidae	Ceratopogonidae	Dixidae
Stream/Sample / **Genus**			See Appendix C-2	Probezzia	Dixa
1.1					
1.2					
1.3					
2.1				1	
2.2				3	
2.3					
3.1				5	
3.2		1			
3.3				1	
4.1				5	
4.2				1	1
4.3					
5.1				2	
5.2				2	
5.3					
7.2					
7.3					
8.1				2	
8.2				1	
8.3					
9.1				5	
9.2				5	
9.3					
10.1				2	
10.2				1	
10.3					
11.1					
11.2					
11.3					
12.1					
12.2				9	
12.3		1		12	
13.1					
13.2				1	
13.3					
14.1				7	1
14.2				1	
14.3				2	
15.1		1		1	
15.2		1			
15.3		1			1
16.1				5	
16.2				3	
16.3					
17.1				1	
17.3				3	
18.1				3	
18.2					
18.3					
19.1					
19.2				1	
19.3					
20.1				6	
20.2				2	1
21.1		2		28	
21.2				45	
21.3				5	
22.1					
22.2					
22.3					
23.1		1			
23.2					
23.3					

Stream/Sample	Phylum / Class / Order / Family / Genus	Arthropoda / Insecta / Diptera / Dolíphopodidae / Raphium	Empididae / Hemerodromia	Pelecorhynchidae / Glutops	Psychodidae / Pericoma, Telmatoscopus
1.1					
1.2					
1.3					
2.1					
2.2					
2.3					
3.1					
3.2					
3.3					
4.1					
4.2					
4.3					
5.1		1			
5.2					
5.3					
7.2					
7.3					
8.1					
8.2					
8.3					
9.1					
9.2					
9.3					
10.1					
10.2					
10.3					
11.1					
11.2					
11.3					
12.1					
12.2					
12.3					

Stream/Sample	Phylum / Class / Order / Family / Genus	Arthropoda / Insecta / Diptera / Dolíphopodidae / Raphium	Empididae / Hemerodromia	Pelecorhynchidae / Glutops	Psychodidae / Pericoma, Telmatoscopus
13.1					
13.2					
13.3					
14.1					
14.2					
14.3					
15.1					
15.2					
15.3					
16.1					
16.2					
16.3					
17.1					
17.3					
18.1					
18.2					
18.3					
19.1					
19.2					
19.3					
20.1					
20.2					
21.1					
21.2					
21.3					
22.1					
22.2					
22.3					
23.1					
23.2					
23.3					

Phylum		Arthropoda						
Class		Insecta						
Order		Diptera						
Family		Ptychopteridae	Simuliidae			Tabanidae	Tipulidae	
Stream/Sample	Genus	Ptychoptera	Prosimulium	Simulium	Twinnia	Chrysops	Dicranota	Hexatoma
1.1								1
1.2								
1.3								
2.1								2
2.2								3
2.3							1	
3.1								3
3.2								1
3.3								
4.1								
4.2								3
4.3								
5.1							1	
5.2								
5.3								
7.2								2
7.3				1				3
8.1								
8.2								
8.3								
9.1								
9.2						2		
9.3								
10.1								
10.2								2
10.3								1
11.1								1
11.2								9
11.3								
12.1								
12.2								6
12.3								10
13.1							1	
13.2								1
13.3								
14.1								3
14.2								
14.3								8
15.1								4
15.2								
15.3								
16.1						1		1
16.2						6		
16.3							1	2
17.1								1
17.3						2		6
18.1							2	1
18.2							6	
18.3							1	
19.1				1			1	
19.2						1		
19.3							1	
20.1								1
20.2						2		5
21.1						4		21
21.2						9		18
21.3								5
22.1				4				3
22.2								
22.3								1
23.1								
23.2								1
23.3								

Phylum / Class / Order / Family	Arthropoda / Insecta / Diptera / Tipulidae						Ephemeroptera / Ameletidae
Stream/Sample — Genus	Limnophila	Molophilus	Ormosia	Pseudolimnophila	Tipula	Unidentifiable	Ameletus
1.1				1			
1.2							
1.3							
2.1							
2.2							
2.3							
3.1							
3.2							
3.3							
4.1		4		1			
4.2		2					
4.3							
5.1							
5.2							
5.3							
7.2							
7.3							
8.1				1			
8.2				2			
8.3							
9.1				3			
9.2							
9.3							
10.1		1	1	2			
10.2							
10.3							
11.1				1			
11.2		1					
11.3							
12.1							
12.2		3					
12.3							

Phylum / Class / Order / Family	Arthropoda / Insecta / Diptera / Tipulidae						Ephemeroptera / Ameletidae
Stream/Sample — Genus	Limnophila	Molophilus	Ormosia	Pseudolimnophila	Tipula	Unidentifiable	Ameletus
13.1							
13.2							
13.3							
14.1							
14.2							
14.3							
15.1							
15.2							
15.3					1		
16.1		2		2			
16.2		1		1			
16.3		2					
17.1							
17.3							
18.1		1					
18.2							
18.3							
19.1							
19.2							
19.3							
20.1					1		
20.2				3			
21.1		18	13	10			
21.2		25	9	2	1		
21.3		4	5				
22.1							
22.2							
22.3							
23.1		1			1		
23.2							
23.3							

Phylum		Arthropoda						
Class		Insecta						
Order		Ephemeroptera						
Family		Baetidae	Ephemerellidae			Ephemeridae		
Stream/Sample	Genus	Baetis	Unidentifiable	Ephemerella	Serratella	Unidentifiable	Ephemera	Pentagenia
1.1		5				2		
1.2		1						
1.3								
2.1								
2.2								
2.3								
3.1			1		2			
3.2								
3.3		1						
4.1		1						
4.2								
4.3								
5.1								
5.2								
5.3								
7.2		1						2
7.3		1			2			1
8.1					1			
8.2		1						
8.3								
9.1								7
9.2								
9.3								
10.1								
10.2								
10.3								
11.1					1			
11.2								
11.3		1						
12.1								
12.2								
12.3					8			

Phylum		Arthropoda						
Class		Insecta						
Order		Ephemeroptera						
Family		Baetidae	Ephemerellidae			Ephemeridae		
Stream/Sample	Genus	Baetis	Unidentifiable	Ephemerella	Serratella	Unidentifiable	Ephemera	Pentagenia
13.1								
13.2								1
13.3								2
14.1				1				
14.2								
14.3			1					
15.1		1					3	
15.2								
15.3								
16.1								
16.2						1		
16.3						1		
17.1								
17.3		1				1		
18.1		1						
18.2								
18.3								
19.1					2			
19.2			1		1			
19.3			1					
20.1								
20.2				4				
21.1				1				
21.2				1				
21.3				1				
22.1		9						
22.2								
22.3								
23.1								
23.2								
23.3								

	Phylum	Arthropoda				
	Class	Insecta				
	Order	Ephemeroptera				Hemiptera
	Family	Heptageniidea		Leptophlebiidae	Unidentifiable	Gerridae
Stream/Sample	Genus	Cingymula	Epeorus (Iron)	Paraleptophlebia		Unidentifiable
1.1						
1.2						
1.3						
2.1						
2.2						
2.3						
3.1		1				
3.2		2		1		
3.3		7		8		
4.1		1				
4.2				1		
4.3				2		
5.1						
5.2						
5.3						
7.2		1		5		
7.3		3		3		
8.1				7		
8.2		1		3		
8.3						
9.1				3		
9.2		1		4		
9.3						
10.1						
10.2						
10.3						
11.1						
11.2		1		3		
11.3		1		3		
12.1						
12.2		1		5		
12.3		5		3		
13.1				1		
13.2						
13.3				6		
14.1				5	1	
14.2				3		
14.3		1		3		
15.1				2		
15.2						
15.3						
16.1				1		
16.2				1		
16.3		1		3		
17.1				2		
17.3				15		
18.1						
18.2						
18.3						
19.1				10		
19.2				5		
19.3		1		5		
20.1						
20.2				2		
21.1				3		
21.2				3		
21.3				1		
22.1		2		9		
22.2						
22.3				2		
23.1						
23.2						
23.3				1		

Stream/Sample	Phylum: Arthropoda; Class: Insecta; Order: Hemiptera; Family: Veliidae; Genus: Microvelia	Rhagovelia	Hydrachnidia; Limnesia	Unidentifiable	Lepidoptera; Pyralidae
1.1					
1.2					
1.3					
2.1					
2.2					
2.3					
3.1					
3.2					
3.3					
4.1					
4.2					
4.3					
5.1					
5.2					
5.3					
7.2					
7.3					
8.1	3				
8.2					
8.3					
9.1					
9.2					
9.3					
10.1					
10.2					
10.3					
11.1					
11.2					
11.3					
12.1					
12.2					
12.3					

Stream/Sample	Phylum: Arthropoda; Class: Insecta; Order: Hemiptera; Family: Veliidae; Genus: Microvelia	Rhagovelia	Hydrachnidia; Limnesia	Unidentifiable	Lepidoptera; Pyralidae
13.1					
13.2					
13.3					
14.1					
14.2					
14.3					
15.1					
15.2					
15.3					
16.1					
16.2					
16.3					
17.1					
17.3					
18.1					
18.2					
18.3					
19.1					
19.2					
19.3					
20.1					
20.2					
21.1					
21.2	1				
21.3	1				
22.1					
22.2					
22.3					
23.1					
23.2					
23.3					

Phylum / Class / Order / Family	Arthropoda / Insecta / Megaloptera / Corydalidae		Sialidae	Odonoata / Aeshnidae	Cordulegastridae	Gomphidae
Stream/Sample / **Genus**	Chauliodes	Nigronia	Sialis	Boyeria	Cordulegaster	Lanthus
1.1						
1.2						
1.3						
2.1						
2.2					1	
2.3						
3.1				1		
3.2						
3.3						
4.1						
4.2					1	
4.3						
5.1						
5.2						
5.3						
7.2						
7.3						
8.1						
8.2			3			
8.3						
9.1					1	
9.2						
9.3						
10.1						
10.2						
10.3						
11.1						
11.2						
11.3						
12.1						
12.2					3	
12.3						
13.1						
13.2						
13.3						
14.1					1	
14.2						
14.3		1				
15.1						
15.2						
15.3						
16.1						
16.2					1	
16.3						
17.1						
17.3						
18.1						
18.2						
18.3						
19.1						
19.2						
19.3						
20.1					1	
20.2					4	
21.1	4				1	
21.2	2				3	
21.3					3	
22.1						
22.2						
22.3						
23.1						
23.2						
23.3						

Phylum / Class / Order / Family	Arthropoda / Insecta / Odonoata / Gomphidae		Plecoptera / Chloroperlidae				Leuctridae
Stream/Sample — Genus	Stylogomphus	Unidentifiable	Haploperla	Suwallia	Sweltsa	Unidentifiable	Leuctra
1.1				1			
1.2				1			
1.3							
2.1				1			
2.2							
2.3							
3.1				5			2
3.2							1
3.3				1			20
4.1							2
4.2				9			
4.3				1			
5.1				2			
5.2							1
5.3							
7.2				4			
7.3				2			
8.1				3			12
8.2							24
8.3				1			
9.1	1						5
9.2				3			14
9.3	1						
10.1							1
10.2	1						2
10.3				1			
11.1				3			
11.2				4			5
11.3				1			2
12.1	1						
12.2				20			
12.3	2			50			10
13.1							3
13.2				1			3
13.3							4
14.1				7			5
14.2				4			13
14.3				13			11
15.1	1			3			
15.2							
15.3							
16.1							
16.2				2			6
16.3							7
17.1	1						1
17.3				1			1
18.1				15			
18.2				26			
18.3				6			
19.1				9			
19.2							5
19.3							3
20.1	1						2
20.2	2			1			7
21.1							6
21.2	10						3
21.3							3
22.1				6			1
22.2							
22.3							2
23.1							
23.2							
23.3							3

Phylum / Class / Order / Family		Arthropoda / Insecta / Plecoptera / Nemouridae		Perlidae		Perlodidae		
Stream/Sample	Genus	Amphinemura	Nemoura	Acroneuria	Perlesta	Isoperla	Remenus	Unidentifiable
1.1						1		
1.2								
1.3								
2.1								
2.2			1					
2.3								
3.1						5		
3.2						4		
3.3					1	4		
4.1								
4.2						5		
4.3						1		
5.1								
5.2			2					
5.3								
7.2								
7.3				2				
8.1			5			1		
8.2						5		
8.3								
9.1								
9.2			8			2		
9.3			1					
10.1								
10.2			1					
10.3								
11.1								
11.2						3		
11.3						4		
12.1			1					
12.2						8		
12.3			2			6		
13.1								
13.2								
13.3								
14.1								
14.2			4		1	4		
14.3						3		
15.1						8		
15.2								
15.3			1					
16.1								
16.2								
16.3			1			4		
17.1								
17.3			2					
18.1						4		
18.2						4		
18.3						1		
19.1					1	3		
19.2					5			
19.3						5		
20.1						2		
20.2			4			8		
21.1			13			7		
21.2			11			5		
21.3			4			7		
22.1				2				
22.2				1	1			
22.3					1			
23.1			1					
23.2								
23.3			1					

Phylum	Arthropoda					
Class	Insecta					
Order	Plecoptera				Tricoptera	
Family	Peltoperlidae			Unidentifiable	Beraeidae	Dolichopodidae
Stream/Sample / **Genus**	Agentina	Peltoperla	Tallaperla		Beraea	Rhaphium
1.1						
1.2						
1.3						
2.1						
2.2						
2.3						
3.1			1			
3.2						
3.3						
4.1						
4.2		3				
4.3		2				
5.1						
5.2						
5.3						
7.2						
7.3						
8.1		3				
8.2						
8.3						
9.1						
9.2						
9.3						
10.1						
10.2						
10.3		1				
11.1						
11.2						
11.3			1			
12.1						
12.2		4	1			
12.3						
13.1						
13.2						
13.3						
14.1		1				
14.2						
14.3						
15.1		1				
15.2						
15.3						
16.1						
16.2						
16.3						
17.1						
17.3						
18.1		3				
18.2						
18.3						
19.1		1				
19.2						
19.3						
20.1			1			
20.2		1				
21.1		4				
21.2		10				
21.3		6				
22.1						
22.2						
22.3						
23.1						
23.2						
23.3						

Stream/Sample	Phylum / Class / Order / Family / Genus	Glossosoma	Goera	Cheumatopsyche	Diplectrona	Hydropsyche	Parapsyche	Unknown
	Phylum	Arthropoda						
	Class	Insecta						
	Order	Tricoptera						
	Family	Glossosomatidae	Goeridae	Hydropsychidae				
1.1					7	2		
1.2					3	2		
1.3								
2.1						1		
2.2								
2.3		1			2	1		
3.1					23			
3.2					13	2		
3.3					29	1		
4.1		1						
4.2					1			
4.3		2						
5.1								
5.2						1		
5.3								
7.2					3			
7.3					1	2		
8.1					8	1		
8.2					43			
8.3								
9.1					2			
9.2					18			
9.3					2			
10.1					1			
10.2		2			1			
10.3					4			
11.1					5			
11.2					31			
11.3					3			
12.1								
12.2					27			
12.3					124			
13.1					4			
13.2					1			
13.3								
14.1					22			
14.2					11			
14.3					53	3		
15.1					17			
15.2								
15.3					1			
16.1								
16.2					5	2		
16.3					4			
17.1								
17.3					4	1		
18.1					18			
18.2					3			
18.3					5			
19.1					53	12		
19.2		1			28	23		
19.3					4	7		
20.1					13	3		
20.2					24	4		
21.1					27			
21.2								
21.3		1			31			
22.1					26	7		
22.2					2	3		
22.3						1		
23.1					1	1		
23.2								
23.3						1		

Phylum	Arthropoda						
Class	Insecta						
Order	Tricoptera						
Family	Lepidostomatidae	Limnephilidae				Philopotamidae	
Stream/Sample / Genus	Lepidostoma	Hesperophylax	Pseudostenophylax	Psychoglypha	Pycnopsyche	Dolophilodes	Unidentifiable
1.1						1	
1.2							
1.3							
2.1							
2.2							
2.3							
3.1							
3.2							
3.3							
4.1							
4.2							
4.3							
5.1				1			
5.2			4				
5.3			2				
7.2							
7.3							
8.1							
8.2							
8.3							
9.1							
9.2							
9.3							
10.1							
10.2							
10.3							
11.1							
11.2							
11.3							
12.1							
12.2							
12.3							

Phylum	Arthropoda						
Class	Insecta						
Order	Tricoptera						
Family	Lepidostomatidae	Limnephilidae				Philopotamidae	
Stream/Sample / Genus	Lepidostoma	Hesperophylax	Pseudostenophylax	Psychoglypha	Pycnopsyche	Dolophilodes	Unidentifiable
13.1							
13.2							
13.3							
14.1							
14.2							
14.3						1	
15.1							
15.2							
15.3							
16.1							
16.2							
16.3						1	
17.1							
17.3						1	
18.1							
18.2							
18.3							
19.1							
19.2							
19.3							
20.1							
20.2			1				
21.1							
21.2							
21.3							
22.1							
22.2							
22.3							
23.1							
23.2							
23.3							

	Phylum	Arthropoda				
	Class	Insecta				
	Order	Tricoptera				
	Family	Phryganeidae	Polycentropidae		Uenoisae	Unidentifiable
Stream/Sample	Genus	Ptilostomis	Polycentropus	Nyctiophylax	Neophylax	
1.1						
1.2						
1.3						
2.1						
2.2						
2.3						
3.1			3			
3.2				1		
3.3			5			
4.1			1			
4.2			5			
4.3			5			
5.1			3			
5.2			2			
5.3						
7.2			3			
7.3						
8.1						
8.2						
8.3						
9.1						
9.2						
9.3						
10.1						
10.2						
10.3						
11.1			1			
11.2			2			
11.3						
12.1						
12.2			2			
12.3			3			

	Phylum	Arthropoda				
	Class	Insecta				
	Order	Tricoptera				
	Family	Phryganeidae	Polycentropidae		Uenoisae	Unidentifiable
Stream/Sample	Genus	Ptilostomis	Polycentropus	Nyctiophylax	Neophylax	
13.1			1			
13.2						
13.3						
14.1			3			
14.2		1	2			1
14.3			2			
15.1						
15.2						
15.3						
16.1						
16.2		1				
16.3			4			
17.1						
17.3			2			
18.1			5			
18.2			6			
18.3			1			
19.1			37			
19.2			5			
19.3			1			
20.1						
20.2						
21.1						
21.2						
21.3						
22.1			7			
22.2			3			
22.3						
23.1						
23.2						
23.3			1			

Phylum / Class / Order / Family	Arthropoda / Crustacea / Decapoda / Cambaridae	Diplopoda / Polydesmida	Mollusca / Gastropoda / Basommatophora / Planorbidae	Mesogastropoda / Bithyniidae
Stream/Sample — Genus				Bithynia tentaculata
1.1				
1.2				
1.3	1			
2.1	1			
2.2				
2.3				
3.1				
3.2				
3.3				
4.1				
4.2				
4.3				
5.1			1	
5.2				
5.3				
7.2	2			
7.3	1			
8.1	1			
8.2				
8.3				
9.1				
9.2	1			
9.3				
10.1				
10.2				
10.3				
11.1				
11.2				
11.3				
12.1				
12.2	1			
12.3	1			

Phylum / Class / Order / Family	Arthropoda / Crustacea / Decapoda / Cambaridae	Diplopoda / Polydesmida	Mollusca / Gastropoda / Basommatophora / Planorbidae	Mesogastropoda / Bithyniidae
Stream/Sample — Genus				Bithynia tentaculata
13.1				
13.2				
13.3				
14.1				
14.2				
14.3				
15.1				
15.2				
15.3				
16.1				
16.2				
16.3				
17.1				
17.3				
18.1				
18.2				
18.3	1			
19.1	1			
19.2				
19.3				
20.1				
20.2				
21.1				
21.2				
21.3				
22.1				
22.2				
22.3				
23.1				
23.2				
23.3				

Phylum / Class / Order / Family	Mollusca / Gastropoda / Mesogastropoda / Hydrobiidae	Pelecypoda / Sphaeriidae	Tubificida / Lumberculus	Oligocheatae
Stream/Sample / **Genus**				
1.1				
1.2				
1.3				
2.1				
2.2				1
2.3				3
3.1				1
3.2		1		1
3.3		1		
4.1				1
4.2		1		
4.3				
5.1				26
5.2				
5.3				
7.2				
7.3				
8.1				1
8.2				
8.3				
9.1				
9.2				
9.3				
10.1				
10.2				1
10.3				
11.1				
11.2				
11.3				
12.1				
12.2				8
12.3				7

Phylum / Class / Order / Family	Mollusca / Gastropoda / Mesogastropoda / Hydrobiidae	Pelecypoda / Sphaeriidae	Tubificida / Lumberculus	Oligocheatae
Stream/Sample / **Genus**				
13.1				1
13.2				
13.3				
14.1		1		5
14.2				2
14.3		1		
15.1		1		3
15.2				
15.3				34
16.1				2
16.2				1
16.3				
17.1				1
17.3				
18.1				14
18.2				
18.3				1
19.1				2
19.2				1
19.3				
20.1				
20.2				
21.1				16
21.2		1		13
21.3				
22.1				
22.2				
22.3				
23.1				
23.2				1
23.3				

APPENDIX C-2

Occurrence of Chironomid genera on fall sample date (September 15, 23, and 24, 2006), reported as number of individuals per Surber sample.

	Order	Diptera					
	Family	Chironomidae					
	Subfamily	Chironominae					
	Tribe	Chironominae					Unknown Chironomini 1
Stream/Sample	Genus	Paratendipes	Polypedilum	Polypedilum fallax	Polypedilum scalaenum	Stenochironomus	
1.1							
1.2							
1.3							
2.1							
2.2							
2.3							
3.1							
3.2							
3.3							
4.1							
4.2							
4.3							
5.1					1		
5.2							
5.3							
7.2							
7.3							
8.1						1	
8.2							
8.3							
9.1							
9.2							
9.3							
10.1							
10.2							
10.3							
11.1							
11.2							
11.3							
12.1							
12.2							
12.3							
13.1							
13.2							
13.3							
14.1							
14.2							
14.3							
15.1							
15.2							
15.3							
16.1							
16.2							
16.3							
17.1							
17.3					2		
18.1							
18.2							
18.3							
19.1							
19.2							
19.3							
20.1							
20.2							
21.1					6		
21.2					1		
21.3							
22.1							
22.2							
22.3							
23.1							
23.2							
23.3							

Order / Family / Subfamily / Tribe	Diptera / Chironomidae / Chironominae / Unknown Chironomini 2	Tanytarsini			Diamesinae			
Stream/Sample — Genus		Heterotanytarsus	Tanytarsus glabrescens	Tanytarsus guerlus	Unknown1 1	Diamesa	Prodiamesa	Sympotthastia
1.1				2				
1.2								
1.3								
2.1								
2.2								
2.3				1				
3.1				1				
3.2								
3.3	1							
4.1								
4.2				1				
4.3								
5.1								
5.2								
5.3								
7.2								
7.3								
8.1				1				
8.2								
8.3								
9.1				1				
9.2								
9.3								
10.1								
10.2								
10.3								
11.1								
11.2								
11.3				3				
12.1								
12.2						1		
12.3	1							
13.1				1				
13.2				1				
13.3								
14.1				1				
14.2				1				
14.3				1				
15.1								
15.2								
15.3								
16.1								
16.2								
16.3								
17.1								
17.3				2				
18.1				1				
18.2				1				
18.3								
19.1				2		1		
19.2				5				
19.3								
20.1								
20.2				1				
21.1								
21.2				1				
21.3				1				
22.1				5				
22.2								
22.3				1				
23.1								
23.2								
23.3								

Order / Family / Subfamily / Tribe	Diptera / Chironomidae / Orthocladiinae										
Stream/Sample / Genus	Brillia	Epoicocladius	Eukiefferiella bavarica	Eukiefferiella discoloripes	Heterotrissocladius marcidus	Paracheatocladius	Parakiefferialla sp.	Parametriocnemus lundbecki	Pseodorthocladius	Symposiocladius	Thienemanniella (Xena)
1.1								2			
1.2									1		
1.3											
2.1								2			
2.2											
2.3								1			
3.1								4			
3.2								3	2		
3.3											
4.1				1					2		
4.2					1			7	3		
4.3								1			
5.1				2	3			29	1		
5.2								5			
5.3											
7.2											
7.3											
8.1			1					8	1		
8.2								1			
8.3											
9.1								3			
9.2			1					6			
9.3								1			
10.1					1						
10.2											
10.3					1						
11.1								2			
11.2								5			
11.3								2			
12.1								1			
12.2								8			
12.3								10	2		

Order / Family / Subfamily / Tribe	Diptera / Chironomidae / Orthocladiinae										
Stream/Sample / Genus	Brillia	Epoicocladius	Eukiefferiella bavarica	Eukiefferiella discoloripes	Heterotrissocladius marcidus	Paracheatocladius	Parakiefferialla sp.	Parametriocnemus lundbecki	Pseodorthocladius	Symposiocladius	Thienemanniella (Xena)
13.1			1								
13.2											
13.3								1			
14.1								2	1		
14.2								3			
14.3								8			
15.1											
15.2											
15.3											
16.1								5			
16.2											
16.3								1	1		
17.1											
17.3					1			2	4		
18.1				2				1			
18.2								2			
18.3								1			
19.1			1		1			13			
19.2					2			12			
19.3								6			
20.1								3			
20.2			1		1			16			
21.1			2	1				10	1		
21.2			4					6	13		
21.3			1					16	4		3
22.1								3			
22.2											
22.3								1			
23.1								7			
23.2								1			
23.3											

Order / Family / Subfamily / Tribe	Diptera / Chironomidae / Orthocladiinae		Tanypodinae			Unidentifiable
Stream/Sample — Genus	Thienemanniella	Unknown	Larsia	Thienemannimyia	Unidentifiable	
1.1						
1.2						1
1.3						
2.1				1		
2.2						
2.3						
3.1						
3 2						
3.3						
4.1				1		
4.2						
4.3						
5.1				1		1
5.2						
5.3						
7.2						
7.3						
8.1						1
8.2						
8.3						
9.1						
9.2						
9.3						
10.1						
10.2						
10.3						
11.1						
11.2						
11.3						
12.1						
12.2						2
12.3				2		2
13.1						
13.2						
13.3						
14.1						
14.2						
14.3				1		
15.1						
15.2						
15.3						
16.1						
16.2						
16.3						
17.1						
17.3						
18.1						1
18.2						
18.3						
19.1						
19.2						
19.3						
20.1				1		
20.2				1		
21.1				1		
21.2				1		
21.3						
22.1						
22.2						
22.3						
23.1						
23.2						
23.3						