Missouri Department of Natural Resources

Biological Assessment Study

Lower North Fork of the Spring River
Barton and Jasper Counties

2004

Prepared for:

Missouri Department of Natural Resources
Division of Environmental Quality
Water Protection Program
Water Pollution Control Branch

Prepared by:

Missouri Department of Natural Resources
Field Services Division
Environmental Services Program
Water Quality Monitoring Section

Table of Contents

TABLES

Page

FIGURES

ATTACHMENTS

Appendix A	Missouri Department of Natural Resources Bioassessment Study Plan Lower North Fork of the Spring River, Barton and Jasper Counties August 26, 2004
Appendix B	Statistical Analyses (One-Way ANOVA and Tukey Multiple Comparison Test for Parametric Data and Kruskal-Wallis ANOVA on Ranks and Dunn's Multiple Comparison Test for Non-parametric Data) Comparing Biological Metrics Between Sampling Stations
Appendix C	Lower North Fork of the Spring River Bioassessment Study Macroinvertebrate Bench Sheets

1.0 Introduction

At the request of the Missouri Department of Natural Resources (**MDNR**), Water Protection Program (**WPP**), Water Pollution Branch (**WPB**), the Environmental Services Program (**ESP**), Water Quality Monitoring Section (**WQMS**) conducted a macroinvertebrate bioassessment of the North Fork of the Spring River in Barton and Jasper counties. A 24-mile segment of the North Fork of the Spring River that flows from Lamar to the approximate confluence of Dry Fork Creek located southeast of Jasper was assessed. This segment is the lower portion of a 51.5 mile segment on the 2002 303(d) list for elevated levels of sediment.

1.1 Study Area/Justification

North Fork of the Spring River originates in western Dade County near the town of Golden City and is located within the Ozark/Elk/Spring Ecological Drainage Unit (EDU). North Fork of the Spring River is listed in the Missouri Water Quality Standards (MDNR 2000) as a class "C" stream for its first 51.5 miles and continuing as a class "P" stream for 14.5 miles to its confluence with the Spring River in Jasper County. Designated uses for North Fork of the Spring River are "warm water aquatic life protection, human health/fish consumption and livestock and wildlife watering." The first 51.5 miles of the North Fork of the Spring River have been placed on the 2002 303(d) list for elevated levels of sediment.

The North Fork of the Spring River is a tributary of the Spring River system in southwestern Missouri that flows through a geological transitional region that has features of both the Ozark and Plains ecoregions. The stream system is characterized by long pools with short, rocky, and gravelly riffles and the geology in the watershed contains beds of shale, sandstone, and limestone (Pflieger, 1989). Since the study reach has some sections that are transitional in nature, some sections that are plains-like, and there are no transition or plains biological criteria reference streams in the Ozark/Elk/Spring EDU, leafpacks, a type of artificial substrate was used to assess the stream. To determine impairment of the North Fork of the Spring River, leafpacks were deployed at 5 test stations on the North Fork of the Spring River and at two control stations in the Osage River and the Arkansas River drainages. The two control stations are Flat Rock Creek, a tributary of the Neosho River, located in Neosho County, Kansas and Little Drywood Creek, a Plains/Osage EDU biological criteria reference stream located in Vernon County, Missouri. The Kansas Department of Health and Environment recommended Flat Rock Creek as a control stream based on water quality data even though it is on the Kansas 303(d) list for copper. No macroinvertebrate sampling had been conducted on Flat Rock Creek, which could determine if this stream is of reference quality.

In 2004, a study plan was submitted to the MDNR, WPB (Appendix A). The ESP, WQMS was responsible for the proposed bioassessment study on the North Fork of the Spring River that included the following purpose, objectives, tasks, and null hypotheses.

1.2 Purpose

The purpose of the study is to determine if the North Fork of the Spring River macroinvertebrate community is impaired. If North Fork of the Spring River is impaired, a second objective is to determine if sediment deposition or something else is causing impairment.

1.3 Objectives

1) Determine if the macroinvertebrate community and water quality in North Fork of the Spring River is impaired compared to control streams in the Osage River and the Arkansas River drainages.

2) Assess the habitat quality of the North Fork of the Spring River.

1.4 Tasks

1) Conduct a bioassessment of the macroinvertebrate community at five test stations on the North Fork of the Spring River and at two control stations in the Osage River and the Arkansas River drainages during fall 2004.

2) Conduct a water quality assessment at the sampling stations to determine potential water quality impacts.

3) Conduct a habitat assessment at the sampling stations to ensure comparability of aquatic habitats.

1.5 Null Hypotheses

1) The macroinvertebrate community found in leafpacks will not differ significantly (P = 0.05) between longitudinally separate reaches of the North Fork of the Spring River.

2) The macroinvertebrate community found in leafpacks in the North Fork of the Spring River will not differ significantly (P = 0.05) from similar sized control reaches on Flat Rock Creek and Little Drywood Creek.

2.0 Methods

Carl Wakefield and Brian Nodine of the Missouri Department of Natural Resources, Field Services Division, Environmental Services Program, Water Quality Monitoring Section conducted this study.

2.1 Study Timing

Leafpacks were deployed and water quality samples were collected from August 30 to September 1, 2004. Stream habitat assessments were conducted and water quality field measurements (pH, conductivity, D.O., and water temperature) were collected from September 20 to September 22, 2004. Leafpacks were retrieved and water quality field measurements were collected from October 4 to 6, 2004.

2.2 Station Descriptions

Figure 1 shows the location for the test stations on North Fork of the Spring River and Table 1 provides legal descriptions and descriptive information for the test and control stations.

Table 1
Station Number, Legal Location, and Descriptive Information for the Lower North Fork of the Spring River Bioassessment Study

Station Number	Section, Township, Range	Description	County
North Fork Spring River #1	SE ¼ sec. 29, T. 30 N., R. 31 W.	Test-Redbud Road crossing	Jasper
North Fork Spring River #2	SW ¼ sec. 11, T. 30 N., R. 31 W.	Test-SW 100th road crossing	Barton
North Fork Spring River #3	SW ¼ sec. 26, T. 31 N., R. 31 W.	Test-Highway 126 road crossing	Barton
North Fork Spring River #4	SE ¼ sec. 1, T. 31 N., R. 31 W.	Test-SE 30th road crossing	Barton
North Fork Spring River #5	SW ¼ sec. 25, T. 32 N., R. 31 W.	Test-upstream of Lamar WWTF	Barton
Little Drywood Creek #1	SE ¼ sec. 30, T. 35 N., R. 31 W.	Control-near unnamed county road crossing	Vernon
Flat Rock Creek #2	SE ¼ sec. 7, T. 29 S., R. 21 E.	Control-110th road crossing	Neosho, Kansas

2.2.1 Ecological Drainage Unit

An EDU is a region in which biological communities and habitat conditions can be expected to be similar. A map of the Ozark/Elk/Spring EDU is also included in Figure 1. All test stations are within this EDU. Table 2 compares the land cover percentages from the Ozark/Elk/Spring EDU and 14-digit Hydrologic Units (**HU**), which contain the North Fork of the Spring River test stations and the control station on Little Drywood Creek, a biocriteria reference stream reach in the Osage/Plains EDU. Land cover data were derived from Thematic Mapper satellite data from 1991 to 1993 and interpreted by the Missouri Resource Assessment Partnership (**MoRAP**). Land cover data derived from USEPA BASINS Version 3.0 for the control station on Flat Rock Creek in Neosho County, Kansas was not included in Table #2 because it combined crops and grassland into one category (USGS 1994). Land cover data from USEPA Basins Version 3.0 estimated that crops and grassland made up 95 percent of the watershed and forest made up 4 percent. Grassland was the dominant land use of the North Fork of the Spring River watershed, Ozark/Elk/Spring EDU, and Little Drywood Creek (Table 2). Forest cover was much lower at the North Fork of the Spring River test stations than the Ozark/Elk/Spring EDU and the control station on Little Drywood Creek, but higher than Flat Rock Creek.

Figure 1: Map of the Lower North Fork of the Spring River and Sampling Stations

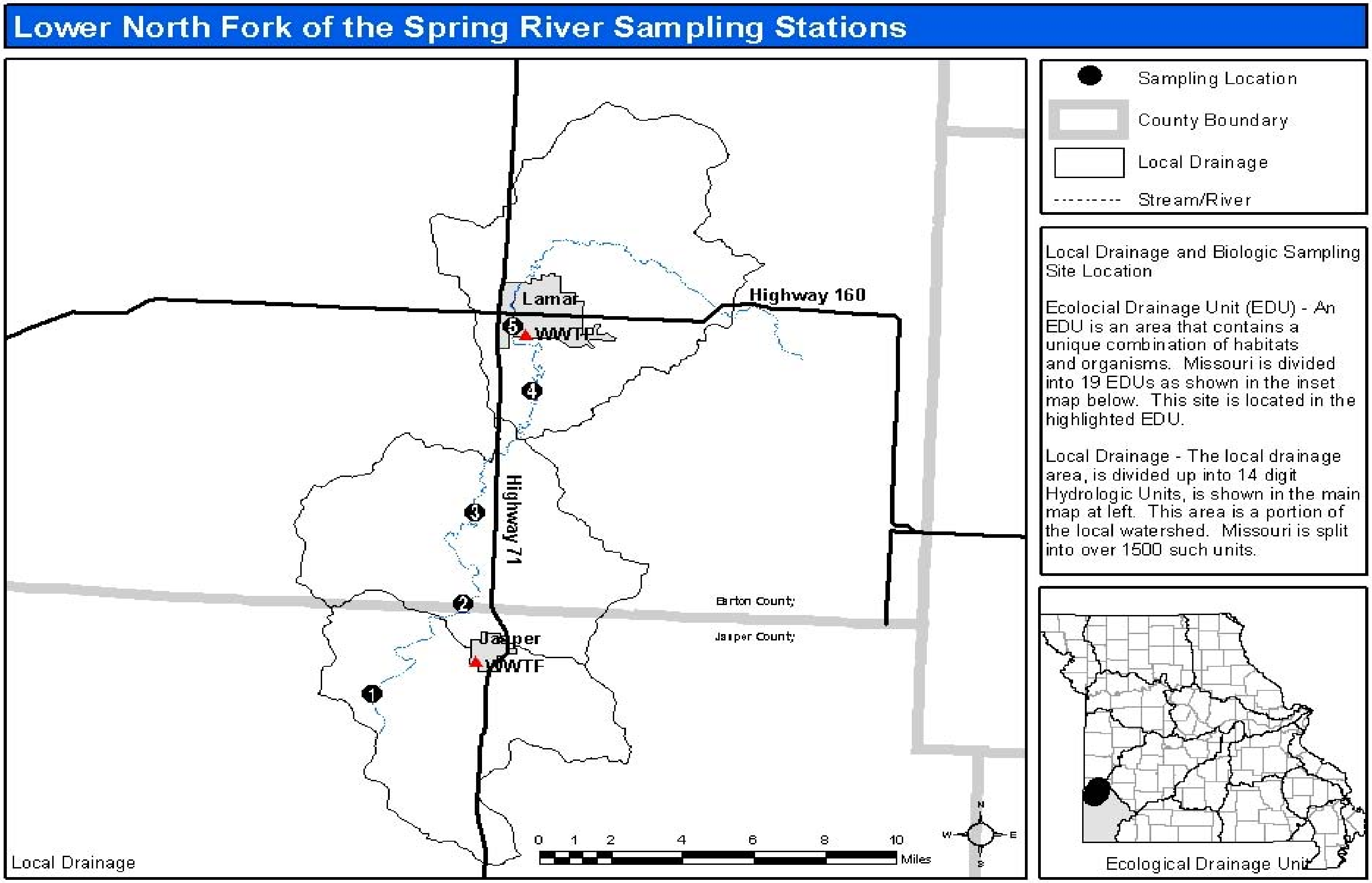


Table 2
Percent Land Cover

Land Cover	14-digit Hydrological Unit (HU)	Urban	Crops	Grassland	Forest	Swamp
Ozark/Elk/Spring EDU	Multiple Hydrological Units	0.7	5.5	67.2	25.4	0
North Fork Spring River #1	11070207080003	1.1	14.5	74.0	9.1	0
North Fork Spring River #2	11070207070004	0	24.6	64.8	9.8	0
North Fork Spring River #3	11070207070004	0	24.6	64.8	9.8	0
North Fork Spring River #4	11070207060004	1.9	21.4	63.2	10.9	0
North Fork Spring River #5	11070207060004	1.9	21.4	63.2	10.9	0
Little Drywood Creek #1	10290104060002	0.2	16.2	62.4	20.0	0

2.3 Habitat Assessment

A standardized assessment procedure was followed as described for Glide/Pool Habitat in the Stream Habitat Assessment Project Procedure (**SHAPP**) (2003a). The habitat assessment was conducted on all stations from September 20 to 22, 2004.

2.4 Biological Assessment

Biological assessments consisted of macroinvertebrate collection and physicochemical sampling.

2.4.1 Macroinvertebrate Collection and Analysis

Macroinvertebrates were quantitatively sampled by deploying 9 replicate leafpacks at each sample station. Leafpacks were placed in the stream at 3 separate locations (3 leafpacks per location) spread throughout the sample reach on inside bends of pools with stream flows less than 0.5 cubic feet per second (cfs). Leafpacks were retrieved after approximately five weeks of deployment.

Leafpacks were constructed of 30 X 21 cm pieces of polymesh netting containing a total of 10 leaves of eastern cottonwood (*Populus deltoides*) and American sycamore (*Platunus occidentalis*). Since American sycamore was more common in the riparian zone of the sample reaches of this study, approximately 70% of leaves placed in the leafpacks were of this species. Leaves were collected, air-dried, pre-weighed to 7 g (+/- 1 g), and stored in zip-lock bags until they were ready for use. Leafpacks were constructed by placing leaves on top of half of the polymesh netting while the other half was folded over on top of the leaves. The polymesh netting was tied together with nylon cord around the loose edges to enclose the leaves. The leafpacks were stored in zip-lock bags until deployment.

A set of 3 leafpacks were deployed in the stream by inserting a piece of rebar in the stream bottom near the bank edge and inserting another piece of rebar in the stream bottom downstream and about 10 to 15 feet from the bank. A piece of 3/16-inch diameter nylon rope was then attached around a tree near the bank, if available, then attached to the piece of rebar near the bank, and finally attached to the other piece of rebar located in the stream. The nylon rope was adjusted on the rebar so that it was at or near the water surface and was as tight as possible. The three leafpacks were spaced evenly along the nylon rope and deployed about a foot below the water surface by attaching a piece of #24 braided nylon twine to the leafpack and to the nylon rope at the water surface. A snap-on clip was attached to the bottom of the leafpack to weight it down so that it would hang vertically and be less susceptible to current.

At retrieval the leafpacks were removed from the stream by holding a kick net under the leafpack while cutting them loose from their place of attachment. The leafpacks were then placed in a plastic wash pan, the nylon cord was cut away from the polymesh netting, and the leaves were pulled from the netting and placed in a sample jar. A scrub brush and deionized (DI) water were used to clean debris from the polymesh netting and the material was rinsed into the sample jar with the leaves. The entire sample was preserved with 10% formalin. All macroinvertebrates were removed from leafpack samples at the Environmental Services Program biology lab with a dissecting microscope at 10X magnification. Specimens were preserved in glass vials containing 80% ethanol. All specimens were identified to taxonomic levels described in Standard Operating Procedure MDNR-WQMS-209, Taxonomic Levels for Macroinvertebrate Identifications.

Four standard metrics: Taxa Richness (**TR**), Ephemeroptera, Plecoptera, Trichoptera Taxa (**EPTT**), Biotic Index (**BI**), and the Shannon Diversity Index (**SDI**) were calculated for each replicate leafpack. Additional metrics, such as Percent EPT Relative Abundance, Percent Dominant (5) taxa, and Percent Clingers were also employed to discern differences in taxa between test and control stations.

Macroinvertebrate data collected at each sampling station were analyzed in two ways. First, a longitudinal comparison between the five sample reaches of the North Fork of the Spring River was made. Secondly, the data from the North Fork of the Spring River was compared to data collected from the control stations. Macroinvertebrate biological metric data that met the assumptions of parametric tests were analyzed using the one way analysis of variance (ANOVA) and Tukey's multiple comparison tests. Biological metric data that violated the assumptions of parametric tests were analyzed using the Kruskal-Wallis ANOVA and Dunn's multiple comparison tests.

2.4.2 Physicochemical Collection and Analysis

Results are shown from physicochemical collections and analyses during the study (Tables 6 and 7). Physicochemical samples collected during the study were: pH, temperature, conductivity, dissolved oxygen, discharge, turbidity, hardness, ammonia-N, nitrate/nitrite-N, Total Kjeldahl Nitrogen (TKN), chloride, and total phosphorus. Temperature, pH, conductivity, dissolved oxygen, and discharge measurements were conducted in the field.

All samples were collected per MDNR-FSS-001, Required/Recommended Containers, Volumes, Preservatives, Holding Times, and Special Sampling Considerations (MDNR 2003e). Samples were kept on ice until they were delivered to the ESP laboratory. The WQMS measured turbidity in the WQMS biology laboratory and all other samples were delivered to the ESP Chemical Analysis Section (CAS) for analyses.

Results of water quality analyses were compared to Water Quality Standards (MDNR 2000). The study reach of North Fork of the Spring River is classified as a class "C" stream with designated use of general warm-water fishery (GWWF). Waters designated as GWWF "allow the maintenance of a wide variety of warm-water biota, including naturally reproducing recreationally important fish species". Standards for aquatic life protection for GWWF in the Water Quality Standards are based on the rate of exposure (chronic and acute) for various pollutants.

2.4.3 Discharge

Stream flow was measured using a Marsh-McBirney Flow Meter at each station and discharge was calculated as cubic feet per second (cfs). Methodology was in accordance with Standard Operating Procedure MDNR-WQMS 113, Flow Measurement in Open Channels (MDNR 2003d).

2.5 Data Analysis

The physicochemical data were examined by parameter to identify stations that had elevated levels that were outliers or above Missouri Water Quality Standards (MDNR 2000). Sampling stations that had elevated levels of certain variables were then discussed with possible influences being identified.

2.6 Quality Control

Quality control was used as stated in the various MDNR Project Procedures and Standard Operating Procedures. A random number of processed macroinvertebrate collections were rechecked for missed specimens.

3.0 Results and Analysis

Three areas of interest were used to assess the Lower North Fork of the Spring River. These were the stream habitat assessment, biological assessment, and physicochemical water analysis.

3.1 Habitat Assessment

Table 3 provides habitat assessment scores for North Fork of the Spring River test stations and the control stations on Little Drywood Creek and Flat Rock Creek. Data was collected from September 20 to 22, 2004 with Carl Wakefield and Brian Nodine performing the scoring. According to the SHAPP guidance, for a study site to support a similar biological community, the total score of the study site should be 75 to 100 percent similar to the total score of a reference or control station. Based on this assumption and the stream habitat assessment scores, all of the test stations should have biological communities that are comparable to the control stations.

Some habitat category scores in the SHAPP, such as epifaunal substrate, sediment deposition, stream bank stability, stream bank vegetation protection, and riparian zone at the test and control stations scored in the poor or marginal scoring categories (Table 4). These results indicated that benthic sediment deposition could be a problem at some of the sampling stations. All of the test and control stations scored in the marginal or poor category for epifaunal substrate and channel sinuosity. Bank vegetation cover also scored in the marginal or poor category for at least one bank at all of the test and control stations. Sediment deposition scored in the marginal or poor category at Test Stations #3 through #5 and control station Little Drywood Creek #1, but not at Test Stations #1 and #2 and control station Flat Rock Creek #2. An average of at least 60 percent of the stream bottom was covered with fine sediment at Test Stations #3 and #5 and control station Little Drywood Creek #1. Bank stability scored in the marginal or poor category for at least one bank at North Fork of the Spring River #2 and #3 test stations and Flat Rock Creek #2 control station, but not at the other sampling stations. The riparian zone scored in the marginal or poor category for at least one bank at Test Stations #1, #3, #4, and at both control stations.

Table 3
Habitat Assessment Scores for Control and Test Stations
September 20-22, 2004

Transitional Reference Stream/Station	Habitat Score	Test Streams/Stations	Habitat Score	% of Reference
Little Drywood Creek #1	112	North Fork Spring River #1	118	103
Flat Rock Creek #2	118	North Fork Spring River #2	128	111
		North Fork Spring River #3	113	98
		North Fork Spring River #4	114	99
		North Fork Spring River #5	116	101

Table 4
Predominant Category Habitat Values Estimated from Stream Habitat Assessments for the North Fork of the Spring River (NFSR) Test Stations and Control Stations on Little Drywood Creek (LDW) and Flat Rock Creek (FRC). Mean values are listed in parentheses for habitat parameters in which a mean value was calculated. Habitat parameter categories ranged from I to IV with category I = optimal, category II = suboptimal, category III = marginal, and category IV = poor.

	NFSR #1	NFSR #2	NFSR #3	NFSR #4	NFSR #5	LDW #1	FRC #2
Stream Habitat Parameters							
Epifaunal Substrate/Available Cover	III (16.5)	III (13.0)	III (16.6)	IV (9.1)	III (14.2)	IV (5.6)	IV (5.9)
Pool Substrate Characterization	I	I	I	III	I	II	I
Pool Variability	III	I	I	II	III	III	I
Sediment Deposition	I (19.0)	II (22.5)	III (60.8)	III (65.8)	III (69.5)	III (68.3)	II (33.6)
Channel Flow Status	II	II	II	II	II	II	II
Channel Alteration	I	I	I	I	I	I	I
Channel Sinuosity	I	III	III	IV	IV	III	IV
Bank Stability – Left Bank	II	IV	I	I	II	I	I
Bank Stability – Right Bank	I	I	IV	I	I	I	IV
Vegetative Protection – Left Bank	IV (23.5)	IV (19.3)	IV (29.5)	III (54.0)	IV (22.8)	III (61.3)	III (66.5)
Vegetative Protection – Right Bank	IV (33.5)	IV (29.0)	IV (17.0)	IV (38.2)	III (51.5)	III (58.5)	IV (41.5)
Riparian Zone Width – Left Bank	III	I	I	I	I	IV	I
Riparian Zone Width – Right Bank	III	I	IV	III	I	I	IV

3.2 Biological Assessment

Biological metrics were calculated and analyzed to determine if the test stations on the North Fork of the Spring River were impaired. Metric data that met the assumptions of parametric tests was analyzed using a one-way analysis of variance (ANOVA) and Tukey multiple comparison tests. Data that violated the assumptions of parametric tests was analyzed using the non-parametric Kruskal-Wallis ANOVA on Ranks and Dunn's multiple comparison tests.

3.2.1 Standard Metrics

Standard metrics are the four primary metrics (TR, EPTT, BI, and SDI) used to calculated the Stream Condition Index (SCI) in the Semi-quantitative Macroinvertebrate Stream Bioassessment Project Procedure (MDNR 2003b).

3.2.1.1 Taxa Richness (TR)

Mean TR ranged from 16.7 at North Fork of the Spring River #5 (NFSR #5) to 28.9 at North Fork of the Spring River #1 (NFSR #1) (Table 5 and Figure 2). Taxa richness at North Fork of the Spring River #1 (NFSR #1) was significantly higher than Flat Rock Creek #2 (FRC #2) and Test Stations #2, #3, and #5 on the North Fork of the Spring River (One-Way ANOVA, $P < 0.001$; Tukey Multiple Comparison Test, $P < 0.05$). Taxa richness at Little Drywood Creek #1 (LDW #1) and North Fork of the Spring River #4 (NFSR #4) was also significantly higher than at North Fork of the Spring River #5 (NFSR #5).

3.2.1.2 EPT Taxa (EPTT)

Mean EPT taxa ranged from 3.8 at NFSR #5 to 8.0 at NFSR #1 (Table 5 and Figure 3). EPT taxa were significantly higher at NFSR #1 than at the other sampling stations. Additionally, EPT taxa at FRC #2 were significantly higher than at NFSR #5 (One-Way ANOVA, $P < 0.001$; Tukey Multiple Comparison Test, $P < 0.05$).

3.2.1.3 Biotic Index (BI)

Mean BI ranged from 6.7 at LDW #1 to 7.7 at NFSR #4 (Table 5 and Figure 4).
Biotic Index was significantly lower at LDW #1 than at NFSR Test Stations #2 through #4 (Kruskal-Wallis One-Way ANOVA, $P < 0.001$; Dunn's Multiple Comparison Test, $P < 0.05$). Biotic Index was also significantly lower at NFSR #1 and FRC #2 than at NFSR #4.

3.2.1.4 Shannon Diversity Index (SDI)

Mean SDI ranged from 1.9 at NFSR #2 to 2.6 at NFSR #1 (Table 5 and Figure 5). Shannon Diversity Index was significantly higher at NFSR #1 than at NFSR Test Stations #2, #3, and #5 (Kruskal-Wallis One-Way ANOVA, $P < 0.001$; Dunn's Multiple Comparison Test, $P < 0.05$). Shannon Diversity Index was also significantly higher at FRC #2 than at NFSR Test Station #3.

Figure 2
Taxa Richness (Mean ± SD) for North Fork of the Spring River (NFSR) Test Stations and Control Stations on Little Drywood Creek (LDW) and Flat Rock Creek (FRC).
Fall 2004

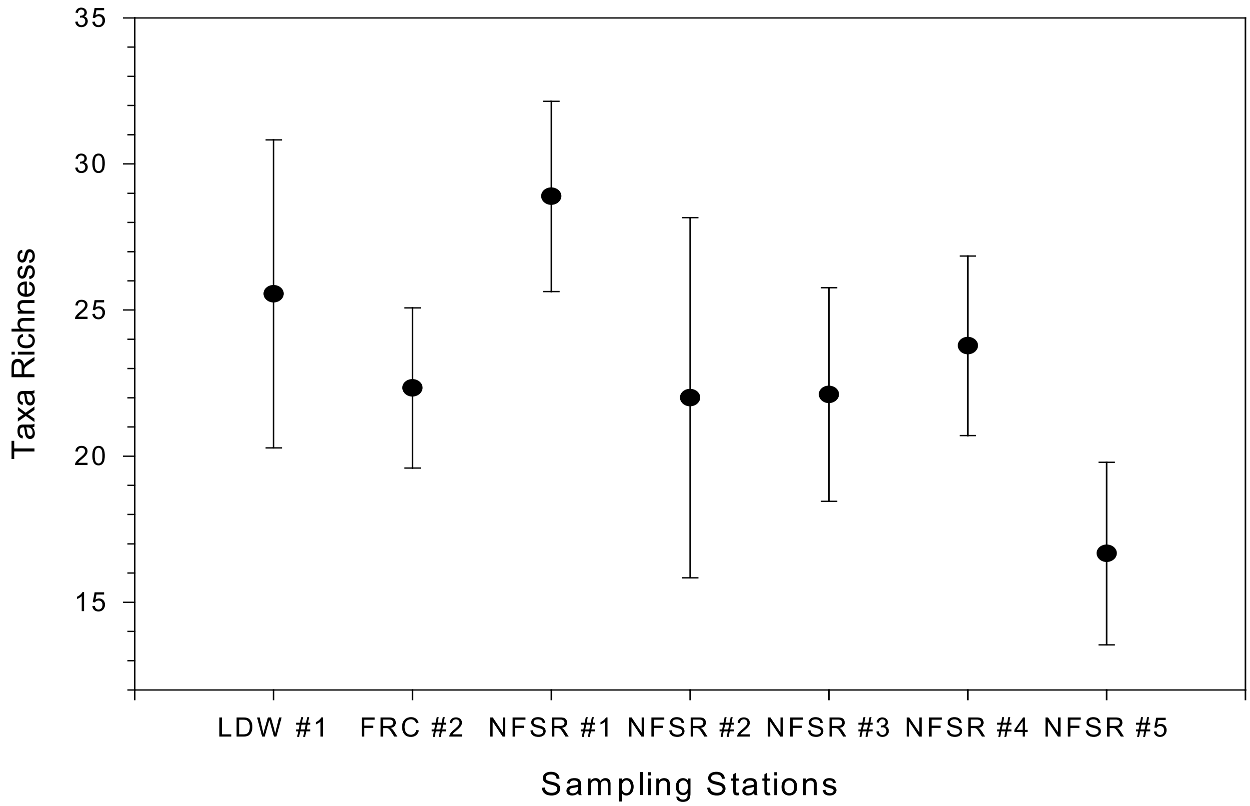


Figure 3
EPT Taxa (Mean ± SD) for North Fork of the Spring River (NFSR) Test Stations and Control Stations on Little Drywood Creek (LDW) and Flat Rock Creek (FRC).
Fall 2004

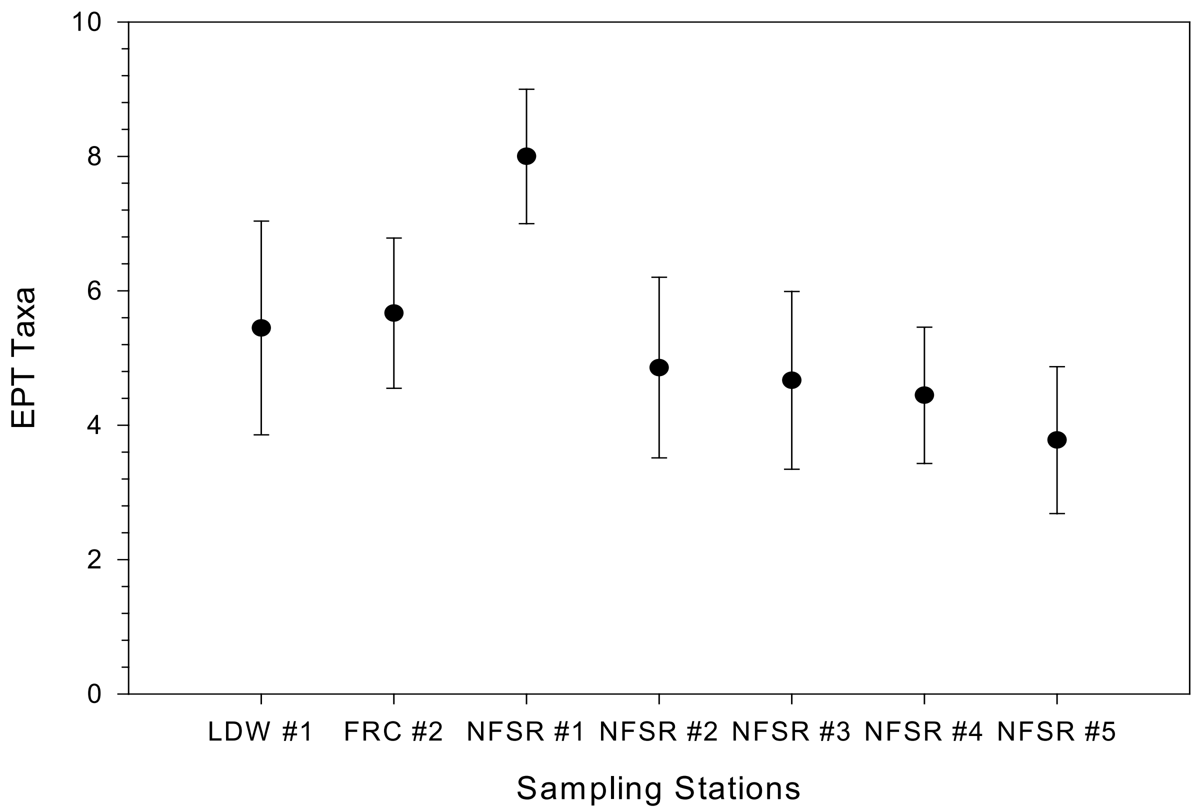


Figure 4
Biotic Index (Mean ± SD) for North Fork of the Spring River (NFSR) Test Stations and Control Stations on Little Drywood Creek (LDW) and Flat Rock Creek (FRC).
Fall 2004

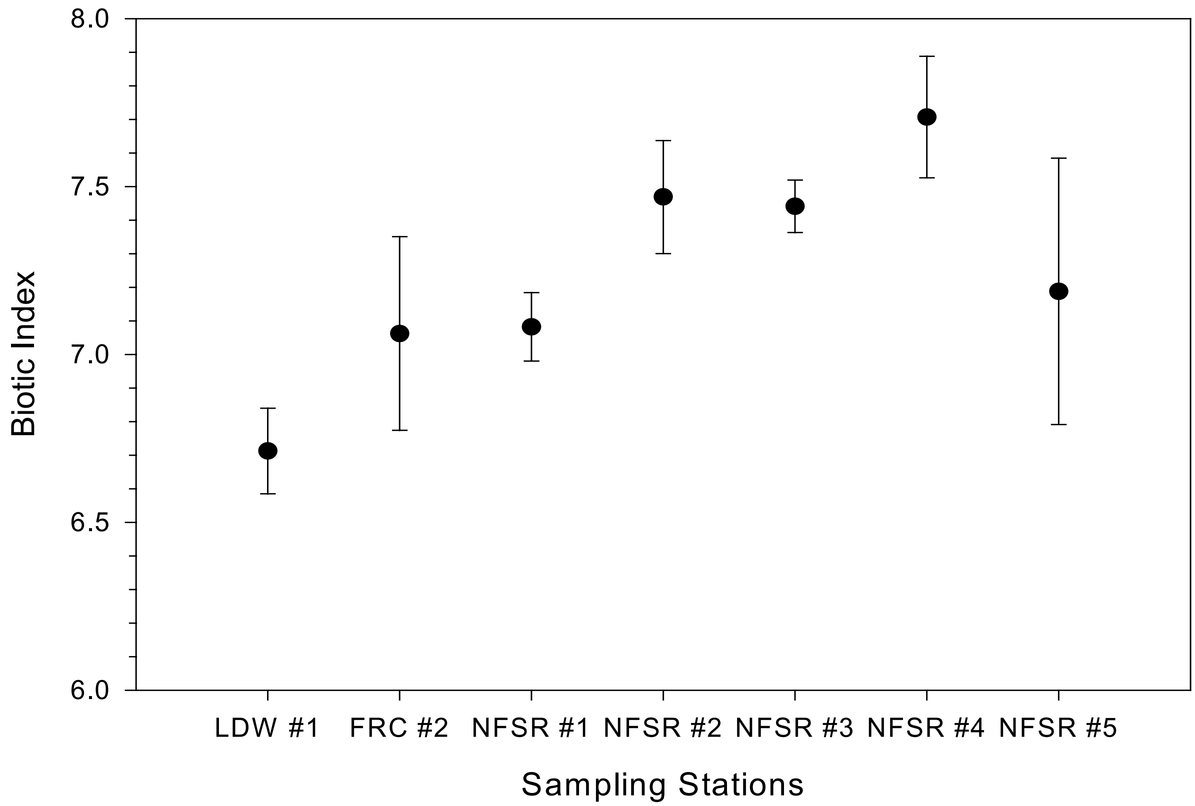
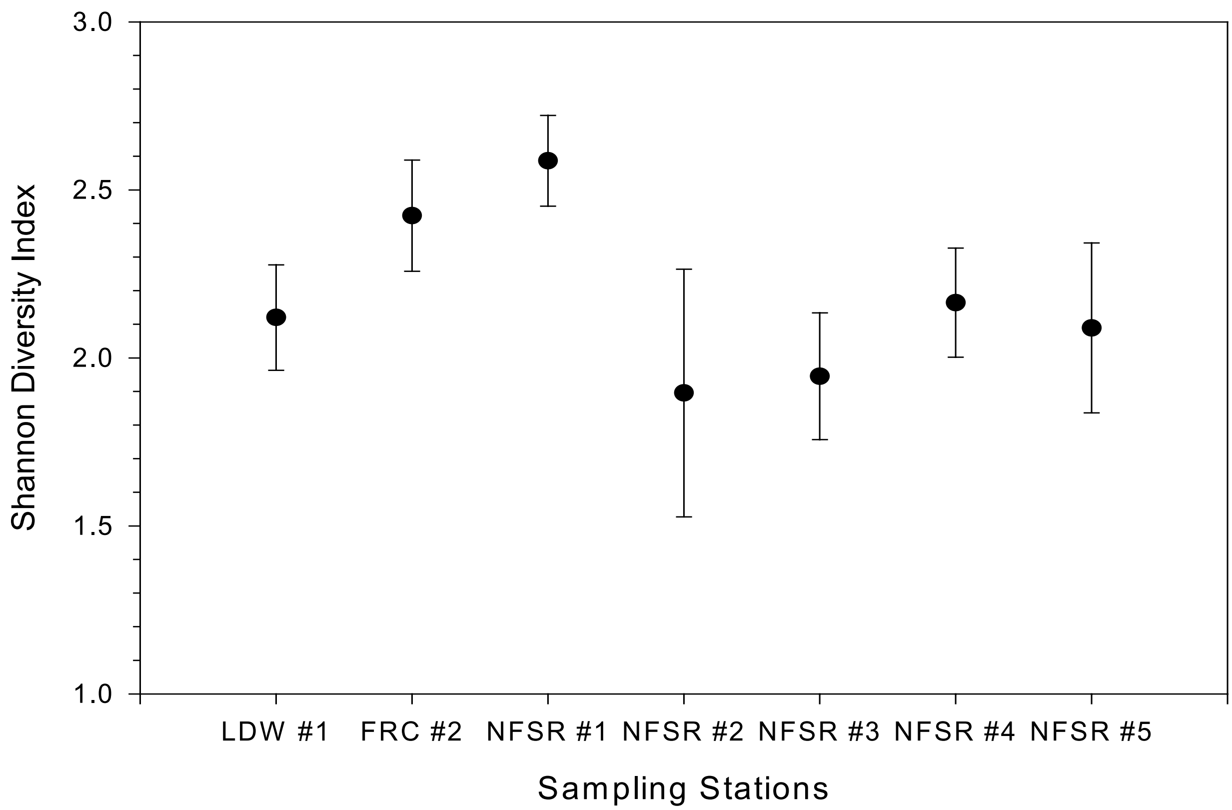


Figure 5
Shannon Diversity Index (Mean ± SD) for North Fork of the Spring River (NFSR) Test Stations and Control Stations on Little Drywood Creek (LDW) and Flat Rock Creek (FRC).
Fall 2004



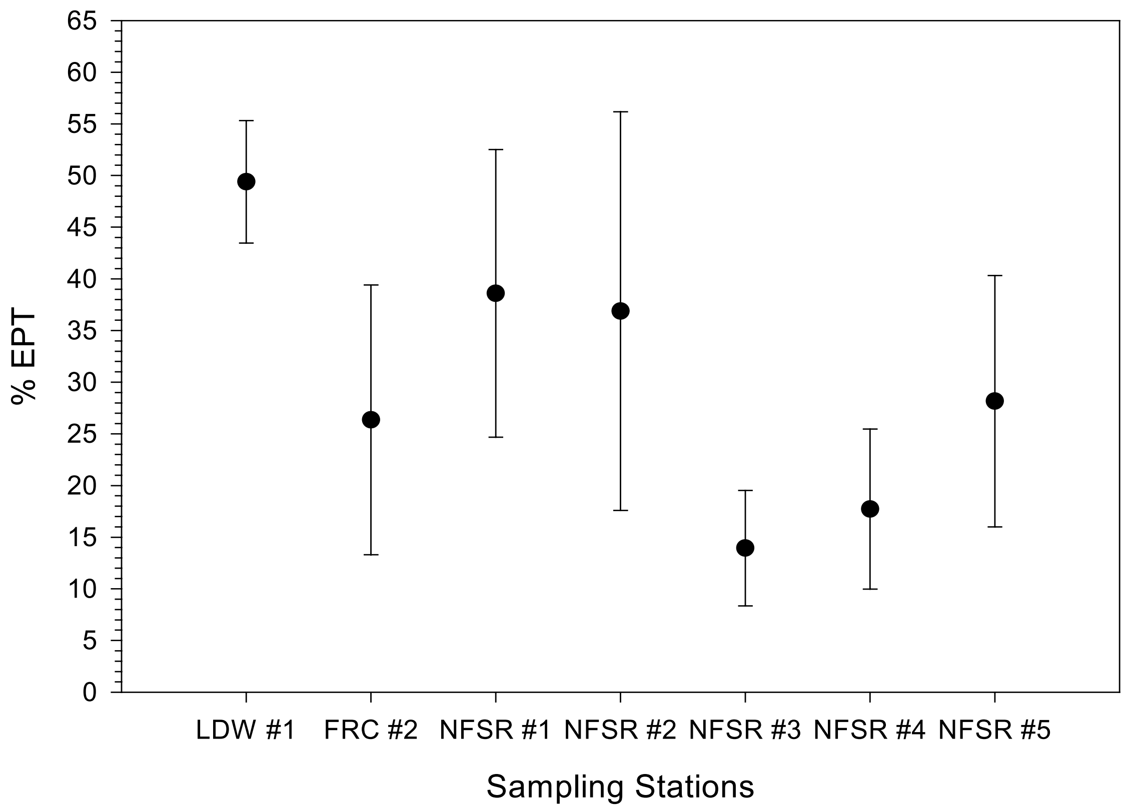
3.2.2. Secondary Metrics

In addition to standard metrics, secondary metrics were used to help determine impairment on NFSR test stations. The secondary metrics used in this study include percent EPT relative abundance, percent dominant (5) taxa, and percent clingers. These metrics have either been proposed as secondary metrics for the Semi-quantitative Macroinvertebrate Stream Bioassessment Project Procedure (MDNR 2003b) or are currently being used by other agencies, such as the Kentucky Department of Environmental Protection's Macroinvertebrate Bioassessment Index (Kentucky Division of Water 2003).

3.2.2.1 Percent EPT Relative Abundance

Mean percent EPT relative abundance ranged from 13.9 at NFSR #3 to 49.4 at LDW #1 (Table 5 and Figure 6). Percent EPT taxa at LDW #1 were significantly higher than NFSR #3 through #5 and control station FRC #2 (One-Way ANOVA, $P < 0.001$; Tukey Multiple Comparison Test, $P < 0.05$). NFSR #1 and #2 were also significantly higher than NFSR #3 and NFSR #4. This metric was dominated by the mayfly taxa *Stenacron* at all sampling stations.

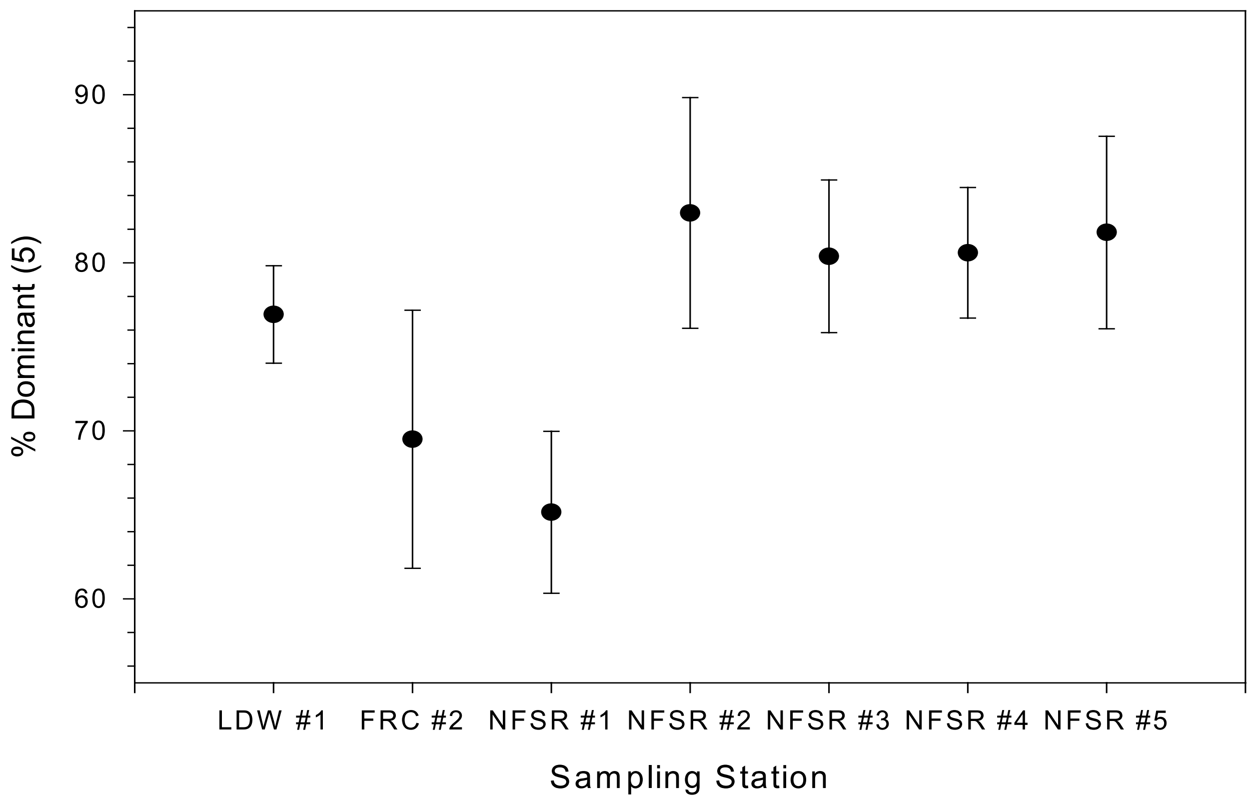
Figure 6
Percent EPT Relative Abundance (Mean ± SD) for North Fork of the Spring River (NFSR) Test Stations and Control Stations on Little Drywood Creek (LDW) and Flat Rock Creek (FRC).
Fall 2004



3.2.2.2 Percent Dominant (5) Taxa

This metric measures the proportion of a macroinvertebrate sample that is made up of the five most abundant taxa and is expected to increase with increasing water quality impairment. Mean percent dominant (5) taxa ranged from 65.2 at NFSR #1 to 83.0 at NFSR #2 (Table 5 and Figure 7). NFSR #1 was significantly lower than all other sampling stations except FRC #2 (One-Way ANOVA, $P < 0.001$; Tukey Multiple Comparison Test, $P < 0.05$). FRC #2 was also significantly lower than NFSR Test Stations #2 through #5.

Figure 7
Percent Dominant (5) Taxa (Mean ± SD) for North Fork of the Spring River (NFSR) Test Stations and Control Stations on Little Drywood Creek (LDW) and Flat Rock Creek (FRC). Fall 2004



3.2.2.3 Percent Clingers

This metric measures the proportion of macroinvertebrates that cling to hard, silt-free substrates and metric values should decrease with increasing amounts of fine sediment covering the stream bottom. Mean percent clingers ranged from 14.5 at NFSR #3 to 43.3 at NFSR #2 (Table 5 and Figure 8). Percent clingers at LDW #1 and NFSR #2 were significantly higher than the FRC #2 control station and NFSR Test Stations #3 and #4 (One-Way ANOVA, $P < 0.001$; Tukey Multiple Comparison Test, $P < 0.05$). Percent clingers at NFSR #1 were also significantly higher than at NFSR #3.

Figure 8
Percent Clingers (Mean ± SD) for North Fork of the Spring River (NFSR) Test Stations and Control Stations on Little Drywood Creek (LDW) and Flat Rock Creek (FRC).
Fall 2004

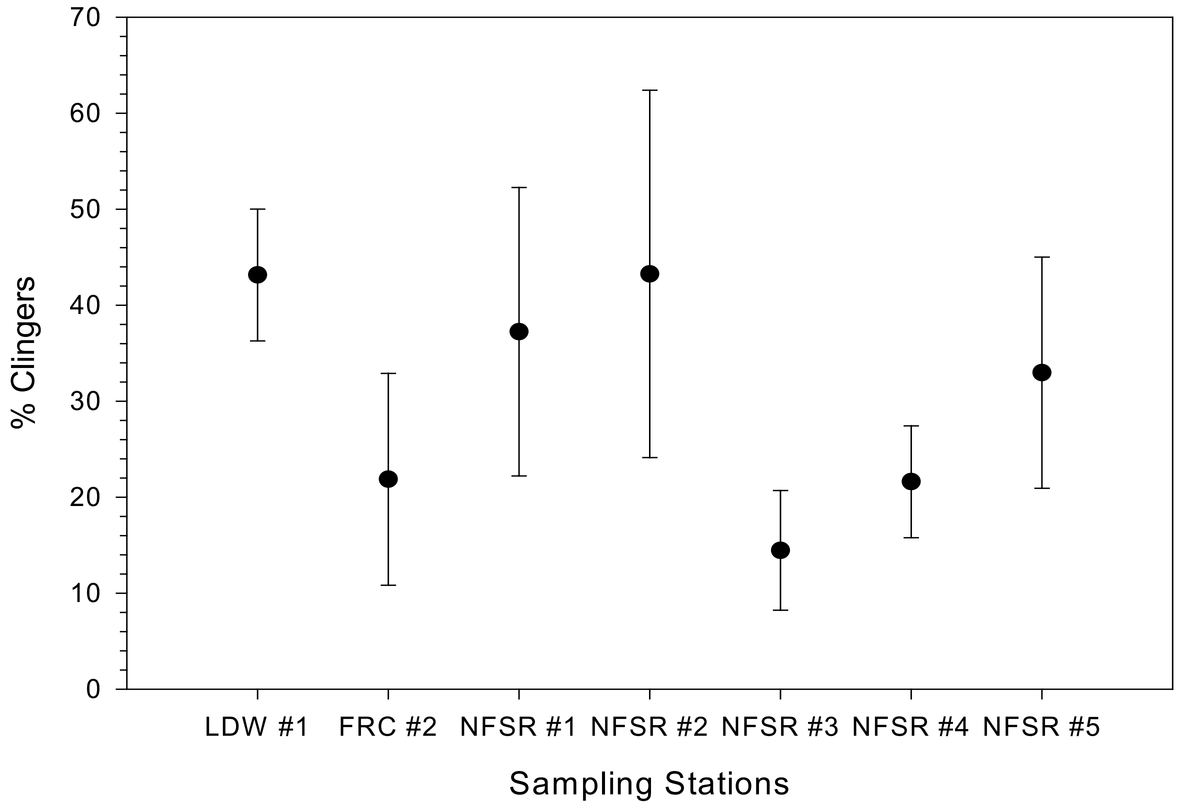


Table 5
Standard and Secondary Biological Metric Values (Mean ± SD) Calculated for North Fork of the Spring River (NFSR) Test Stations and Control Stations on Little Drywood Creek (LDW) and Flat Rock Creek (FRC)

	NFSR #1	NFSR #2	NFSR #3	NFSR #4	NFSR #5	LDW #1	FRC #2
Standard Metrics							
Taxa Richness	28.9 ± 3.3	22.0 ± 6.2	22.1 ± 3.7	23.8 ± 3.1	16.7 ± 3.1	25.6 ± 5.3	22.3 ± 2.7
EPT Taxa	8.0 ± 1.0	4.9 ± 1.4	4.7 ± 1.3	4.4 ± 1.0	3.8 ± 1.1	5.4 ± 1.6	5.7 ± 1.1
Biotic Index	7.1 ± 0.1	7.5 ± 0.2	7.4 ± 0.1	7.7 ± 0.2	7.2 ± 0.4	6.7 ± 0.1	7.1 ± 0.3
Shannon Diversity Index	2.6 ± 0.1	1.9 ± 0.4	2.0 ± 0.2	2.2 ± 0.2	2.1 ± 0.3	2.1 ± 0.2	2.4 ± 0.2
Secondary Metrics							
% EPT	38.6 ± 13.9	36.9 ± 19.3	13.9 ± 5.6	17.7 ± 7.7	28.2 ± 12.2	49.4 ± 5.9	26.4 ± 13.1
% Dominant (5 taxa)	65.2 ± 4.8	83.0 ± 6.9	80.4 ± 4.5	80.6 ± 3.9	81.8 ± 5.7	76.9 ± 2.9	69.5 ± 7.7
% Clingers	37.2 ± 15.0	43.3 ± 19.1	14.5 ± 6.2	21.6 ± 5.8	33.0 ± 12.0	43.1 ± 6.9	21.9 ± 11.0

3.2.3 Macroinvertebrate Percent and Community Composition

Percent composition for the five dominant macroinvertebrate families and Functional Feeding Groups were determined for each sampling station and are presented in Table 6. *Stenacron*, the most abundant EPT taxa, was more abundant at LDW #1 and much higher than at FRC #2, NFSR #3, and NFSR #4. *Hyalella azteca*, a tolerant amphipod with a biotic index of 7.9, was very abundant at NFSR #4, but was low in numbers at the other sampling stations. *Dicrotendipes* was the most abundant chironomid taxa found at NFSR #2 through #5, but it was much lower at NFSR #1 and the two control stations. *Ablabesmyia, Glyptotendipes, Phaenopsectra, Stenochironomus, Tanytarsus, Thienemannimyia* group, and *Tribelos* were chironomid taxa that were common at some of the sampling stations. *Glyptotendipes* was the second most abundant chironomid at NFSR #4 and was also abundant at NFSR #2 and FRC #2. *Tribelos* was the second most abundant chironomid taxa at NFSR #3 through #5 and at FRC #2. *Tanytarsus* (biotic index of 6.7) was more abundant at NFSR #1 and FRC #2 than the other sampling stations. *Stenochironmus* was the second most abundant taxa at LDW #1 and much more abundant than the other sampling stations.

The analysis of the relative abundance of Functional Feeding Groups showed that collector-filters were lower and scrapers were higher at LDW #1 than the other sampling stations (Table 6). Mean collector-filter values ranged from 9.0 at LDW #1 to 60.2 at NFSR #3 and mean scraper values ranged from 9.7 at NFSR #3 to 46.4 at LDW #1. *Dicrotendipes* was the most abundant collector-filter taxa and *Stenacron* was the most abundant scraper taxa. Shredders were much more abundant at LDW #1 than the other sampling stations except NFSR #4. Mean shredder values ranged from 5.3 at NFSR #3 and NFSR #5 to 20.4 at LDW #1. The tolerant *Glyptotendipes* made up most of the shredders at NFSR #4 while the less tolerant *Stenochironomus* made up most of the shredders at LDW #1. Predators were more abundant at FRC #2, NFSR #1, and LDW #1 than the other sampling stations. Mean predator values ranged from 4.4 at NFSR #2 to 16.7 at FRC #2. Tanypod chironomids like *Thienemannimyia* Group and *Ablabesmyia* made up a large portion of predators found at each sampling station.

3.2.4 Physicochemical Water

Physicochemical results are arranged to demonstrate trends of certain variables that may identify impact sources to the North Fork of the Spring River. Results can be found in Tables 7 and 8 for results of samples and field measurements collected during leafpack deployment, stream habitat assessment, and leafpack retrieval. Results for discharge, ammonia-N, nitrate + nitrite-N, TKN, total phosphorus, and dissolved oxygen are described in this section.

3.2.4.1 Discharge

Discharge during leafpack deployment at the North Fork of the Spring River test stations ranged from 1.45 cfs at NFSR #5 to 6.10 cfs at NFSR #1 (Table 7). Discharge was 1.76 cfs at LDW #1 control station and 0.02 cfs at FRC #2 control station. Based on field observations, discharge was much lower during later stream visits when stream habitat assessments were conducted and during leafpack retrieval, even though discharge was not measured.

Table 6

Dominant Taxa and Functional Feeding Group Values (Mean ± SD) for North Fork of the Spring River (NFSR) Test Stations and Control Stations on Little Drywood Creek (LDW) and Flat Rock Creek (FRC). Values in bold are the five most dominant taxa for each sampling station.

	NFSR #1	NFSR #2	NFSR #3	NFSR #4	NFSR #5	LDW #1	FRC #2
Percent Dominant Macroinvertebrate Taxa							
Stenacron	**21.1 ± 9.4**	**32.3 ± 19.5**	**8.1 ± 4.5**	**15.1 ± 7.1**	**22.3 ± 11.1**	**39.9 ± 6.6**	**8.8 ± 7.1**
Tanytarsus	**15.0 ± 10.0**	**5.8 ± 1.2**	**7.9 ± 2.1**	3.0 ± 2.0	3.7 ± 2.6	1.7 ± 1.3	**19.9 ± 10.7**
Dicrotendipes	**9.5 ± 3.6**	**27.8 ± 20.5**	**48.4 ± 6.7**	**21.0 ± 9.0**	**26.7 ± 15.6**	**6.3 ± 2.8**	5.8 ± 2.5
Thienemannimyia Group	**6.0 ± 2.5**	0.4 ± 0.3	2.0 ± 1.4	1.7 ± 1.2	2.4 ± 2.1	**5.5 ± 2.7**	6.4 ± 5.8
Ablabesmyia	**5.0 ± 1.3**	1.6 ± 1.2	**4.5 ± 1.0**	1.5 ± 1.3	2.7 ± 1.1	3.0 ± 1.5	2.6 ± 2.3
Glyptotendipes	0.6 ± 0.5	**9.5 ± 3.1**	2.7 ± 1.6	**15.9 ± 4.8**	2.6 ± 1.8	0.6 ± 0.9	**9.9 ± 3.8**
Paratanytarsus	3.0 ± 3.4	**6.6 ± 0.8**	2.4 ± 1.4	2.6 ± 1.9	**3.8 ± 1.8**	1.2 ± 0.8	0.3 ± 0.5
Tribelos	3.0 ± 3.3	0.5 ± 0.6	**9.7 ± 3.4**	**7.1 ± 7.1**	**12.3 ± 9.8**	1.4 ± 0.9	**11.8 ± 9.9**
Hyalella azteca	2.9 ± 3.3	0.4 ± 0.7	0.1 ± 0.2	**18.6 ± 12.6**	0.3 ± 0.5	0.5 ± 0.7	0.1 ± 0.3
Phaenopsectra	1.0 ± 1.2	1.7 ± 0.8	1.3 ± 0.6	0.4 ± 0.4	**6.0 ±4.3**	3.6 ± 1.9	1.8 ± 3.5
Stenochironomus	1.2 ± 1.1	1.3 ± 1.8	0.8 ± 0.5	0.1 ± 0.2	0.5 ±1.3	**18.9 ± 3.0**	1.8 ± 1.7
Leptophlebiidae	0.4 ± 0.4	0.4 ± 0.5	0.1 ± 0.2	0.2 ± 0.2	1.7 ± 1.9	**4.4 ± 2.4**	2.7 ± 4.0
Cyrnellus fraternus	4.0 ± 3.3	2.3 ± 3.2	2.6 ± 2.2	0.8 ± 1.0	0.1 ± 0.3	0.2 ± 0.5	**7.8 ± 8.2**
Percent Functional Feeding Groups							
Collector-Filters	30.9 ± 11.2	36.9 ± 21.9	60.2 ± 3.8	27.9 ± 8.2	34.2 ± 14.7	9.0 ± 4.1	36.0 ± 10.3
Collector-Gathers	18.1 ± 4.5	10.5 ± 3.0	16.3 ± 3.2	34.0 ± 10.8	23.3 ± 10.0	13.2 ± 3.4	19.4 ± 7.8
Scrapers	29.5 ± 12.2	36.4 ± 20.9	9.7 ± 4.4	16.1 ± 6.8	30.7 ± 13.9	46.4 ± 5.8	17.4 ± 10.9
Shredders	6.9 ± 4.0	11.5 ± 3.2	5.3 ± 1.6	17.2 ± 5.3	5.3 ± 3.4	20.4 ± 4.0	12.1 ± 4.7
Predators	14.2 ± 3.8	4.4 ± 2.3	8.4 ± 2.1	4.8 ± 2.5	6.3 ± 3.7	10.4 ± 3.7	16.7 ± 6.7

3.2.4.2 Nutrients

Ammonia-N, TKN, and total phosphorous were elevated at NFSR #4 Test Station. Nitrate + nitrite was also slightly elevated at NFSR #1 through #3.

3.2.4.2.1 Ammonia-N

Ammonia-N was 4.22 mg/L (5.06 mg/L when converted to total ammonia) at NFSR #4 Test Station (Table 7). This value was higher than the chronic value (1.6 mg/L) for total ammonia in the Water Quality Standards for the General Warm Water Fishery (GWWF) classification (MDNR 2000). Ammonia-N values at the other sample stations were well below Water Quality Standards.

3.2.4.2.2 Nitrate + Nitrite-N

Nitrate + nitrite-N ranged from 0.04 mg/L at Flat Rock Creek #2 to 0.80 mg/L at NFSR #1 (Table 7). Nitrate + nitrite-N values at NFSR #1 through #3 were slightly elevated compared to the other sampling stations and normal reference conditions for nitrate + nitrite-N, although there are no water quality standards for nitrate + nitrite-N in the Missouri Water Quality Standards (MDNR 2000) for the protection of aquatic life designation.

3.2.4.2.3 TKN

TKN was 5.90 mg/L at NFSR #4 and 1.54 mg/L at NFSR #3, which was much higher than values at other sampling stations and normal reference conditions for TKN (Table 7). TKN ranged from 0.62 mg/L to 0.97 mg/L at the other sampling stations.

3.2.4.2.4 Total Phosphorus

Total phosphorus had a slightly elevated value of 0.88 mg/L at NFSR #4 (Table 7). This value was higher than other sample stations and normal reference conditions for total phosphorus, although there are no water quality standards for total phosphorus in the Missouri Water Quality Standards (MDNR 2000). Total phosphorus ranged from 0.06 mg/L to 0.14 mg/L at the other sample stations.

3.2.4.3 Dissolved Oxygen

Dissolved oxygen was consistently low at all of the test stations of North Fork of the Spring River #4 during leafpack deployment and when stream habitat assessments were conducted in mid September (Tables 7 and 8). Dissolved oxygen was slightly above or below 5.0 mg/L, the minimum value allowed in the Missouri Water Quality Standards (MDNR 2000) for the protection of aquatic life designation, at the North Fork of the Spring River test stations during these time periods. Dissolved oxygen was above 5.0 mg/L during leafpack retrieval except at NFSR #2 and NFSR #3 (Table 7). Lower stream water temperature during this time period may have increased dissolved oxygen at most of the sampling stations.

Table 7
Physicochemical Variables for the North Fork of the Spring River Study Collected from August 30, 2004 to September 1, 2004
During Leafpack Deployment
Units mg/L unless otherwise noted.

Variable-Station	N. Fk. Spring River #1, Test	N. Fk. Spring River #2, Test	N. Fk. Spring River #3, Test	N. Fk. Spring River #4, Test	N. Fk. Spring River #5, Test	Little Drywood Creek #1, Control	Flat Rock Creek #2, Control
Sample Number	04-11067	04-11066	04-11065	04-11064	04-11063	04-11068	04-11070
Sample Date	08/31/2004	08/31/2004	08/31/2005	08/30/2004	08/30/2004	09/01/2004	09/01/2004
Sample Time	1115	1415	1605	1510	1310	1640	1315
pH (Units)	7.62	7.66	7.50	7.34	7.70	7.62	8.00
Temperature (C^0)	22.5	24.0	24.0	24.0	23.5	23.5	27.5
Conductivity (uS)	363	335	339	445	268	325	352
Dissolved O_2	**4.95**	**4.91**	**3.74**	**3.38**	5.11	5.69	8.04
Discharge (cfs)	6.10	4.70	3.60	3.11	1.45	1.76	0.02
Turbidity (NTUs)	10.7	22.3	11.7	14.2	15.3	30.6	9.20
Ammonia-N	0.13	0.03	0.41	**4.22**	0.03	0.03	0.03
Nitrate/Nitrite-N	0.80	0.62	0.75	0.14	0.14	0.07	0.04
TKN	0.91	0.97	1.54	**5.90**	0.81	0.63	0.62
Chloride	25.6	21.5	23.9	31.4	17.7	9.63	10.1
Total Phosphorus	0.11	0.13	0.14	**0.88**	0.13	0.06	0.08

Table 8
Physicochemical Field Measurements for the North Fork of the Spring River Study Collected During (a) Stream Habitat Assessments (September 20-22, 2004) and at (b) Leafpack Retrieval (October 4-6, 2004)
Units mg/L unless otherwise noted.

Variable-Station	N. Fk. Spring River #1, Test	N. Fk. Spring River #2, Test	N. Fk. Spring River #3, Test	N. Fk. Spring River #4, Test	N. Fk. Spring River #5, Test	Little Drywood Creek #1, Control	Flat Rock Creek #2, Control
(a) Field Measurements Collected During Stream Habitat Assessments							
Sample Date	09/22/2004	09/22/2004	09/21/2004	09/20/2004	09/20/2204	09/20/2004	09/21/2004
Sample Time	0955	1135	1635	1625	1430	1200	1320
pH (Units)	7.51	7.44	7.75	7.80	7.60	7.36	8.30
Conductivity (uS)	376	382	348	389	285	348	328
Dissolved O_2	5.25	5.05	**3.41**	5.07	**4.65**	**2.54**	8.40
Temperature (C^0)	19.0	21.0	21.8	22.4	24.0	19.0	21.5
(b) Field Measurements Collected During Leafpack Retrieval							
Sample Date	10/05/2004	10/06/2004	10/04/2004	10/04/2004	10/04/2004	10/06/2004	10/05/2004
Sample Time	1555	1005	1655	1430	1315	12.1235	1205
pH (Units)	8.30	7.41	7.51	7.74	7.70	7.47	7.84
Conductivity (uS)	414	474	362	515	290	383	354
Dissolved O_2	12.40	**4.15**	**4.62**	5.87	7.62	5.48	5.65
Temperature (C^0)	18.9	14.3	15.5	16.3	17.8	13.0	14.0

4.0 Discussion

The discussion describes possible effects of stream habitat, land use, ecoregion, and physicochemical conditions on the biological metric scores and the macroinvertebrate community composition.

4.1 Habitat Assessment

Total stream habitat assessment scores suggest that the test stations on NFSR should be comparable to the control stations on LDW and FRC in their ability to support a similar quality macroinvertebrate community (Table 3). However, some habitat categories of the SHAPP such as epifaunal substrate/available cover, sediment deposition, channel sinuosity, and bank vegetation protection scored either in the marginal or poor category at some of the NFSR test stations and at the control stations (Table 4). The low scores for epifaunal substrate and sediment deposition scores, especially at NFSR stations #3 through #5 and LDW #1, indicated that greater than 60 percent of the stream bottom is covered by fine sediment and good epifaunal substrate was low in abundance. Sediment deposition was much lower at NFSR #1, NFSR #2, and FRC #2 even though epifaunal substrate was still very low at FRC #2. Personal observations during sampling also indicated fine sediment depth on the stream bottom was much higher at NFSR #3 and NFSR #4 than the other sampling stations. At Test Station #2, the NFSR begins to enter into the Ozark highlands ecoregion from the central irregular plains ecoregion (Chapman et al., 2002; Figure 9) with the NFSR changing from a glide/pool stream to a riffle/pool stream, possibly accounting for some of the differences in epifaunal substrate and sediment deposition. Both LDW and FRC are located in the central irregular plains ecoregion, but FRC has physical characteristics (rock outcroppings and coarse substrate) more like NFSR #1 and #2 than the other NFSR test stations and LDW #1 control station. The change in physical habitat at the lower stations on the NFSR may have been one of the primary factors leading to higher metric values at NFSR #1, with some of the metrics like taxa richness, EPT taxa, and SDI having higher values than at the control stations.

4.2 Possible Effects of Land Use on Sedimentation

Row crops make up a much larger percentage and forest cover make up a much smaller percentage of the land use at the NFSR test stations than the entire Ozark/Elk/Spring EDU (Table 2). Row crops, except NFSR #1, also made up a higher percentage and forest cover made up a lower percentage of land use compared to LDW #1, a control station located within the biological criteria reference reach and located in the Osage/Plains EDU. The percentage of grasslands in the lower NFSR watershed was similar, except NFSR #1, to the entire Ozark/Elk/Spring EDU and the LDW #1 sampling station. The higher percentage of row crops and lower percentage of forest cover at NFSR sampling stations suggests increased runoff and altered stream hydrology, resulting in increased sheet and bank erosion. Increased runoff also has the potential to carry more contaminants, such as fertilizer and pesticides from farm fields, leading to water quality problems and effects to the biotic community.

4.3 Transitional Nature of North Fork of the Spring River

North Fork of the Spring River is a transitional stream that flows through both the Ozark Highlands and Central Irregular Plains ecoregions (Figure 9). The upper section near Golden City and the lower section starting near the Jasper County line has physical characteristics of both Ozark and plains streams with short riffles and very long pools with some woody debris. The section of stream starting near Lamar and ending near the Barton/Jasper County line has physical characteristics like plains streams in the Osage/Plains EDU with woody debris and fine sediment being abundant at some stream reaches.

Most of the sampling stations for the Upper North Fork of the Spring River bioassessment study (MDNR 2004) were located in or near the Ozark Highlands ecoregion. These stations scored poorly with SCI scores ranging from 10 to 14 against biological criteria calculated from two transitional reference streams (Horse and Cedar Creeks in the Ozark/Osage EDU). The exception was Station #1 with an SCI score of 18 during the fall sampling season. Macroinvertebrate taxa with high biotic index values and tolerant of low dissolved oxygen levels (such as Oligochaeta, *Chironomus*, *Chaoborus,* and *Physella*) were more abundant in NFSR than in Cedar Creek and Horse Creek, especially during the fall sampling season. EPT taxa during both sampling seasons were also generally higher at the two transitional reference streams than the test stations on NFSR.

Leafpack NFSR Stations #3 through #5 were located in the Central Irregular Plains ecoregion while Stations #1 and #2 were located in the Ozark Highlands ecoregion for the Lower North Fork of the Spring River bioassessment study. Stations #3 through #5 had physical characteristics of streams found in the plains. Station #2 was located near the border between the Central Irregular Plains and Ozark Highlands ecoregions and had characteristics of both ecoregions with long stagnant pools containing woody debris in part of the stream reach and riffle/runs present near rock outcroppings in another segment of the stream reach. Station #1 was more Ozark-like with rock outcroppings, well-defined riffles, and coarse substrate found in both the riffle/run areas and pools.

The section of the NFSR that flows through the Ozark Highlands ecoregion is located in the Springfield Plateau sub-ecoregion. The Springfield Plateau is an area of moderate topography that has soils that are rocky and contain Mississippian-age limestone. This area has numerous karst features that often allow connections between groundwater and surface flow. Streams located in the Ozark Highlands ecoregion normally have higher base flows than streams located in the Central Irregular Plains ecoregion because of the connection with groundwater. The section of the NFSR that flows through the Central Irregular Plains ecoregion is located in the Cherokee Plains sub-ecoregion. This area is relatively flat in topography and has poorly drained soils made up of clay. There is little or no groundwater connection because of the clay soils, which cause base flow to be much lower for streams in the Cherokee Plains sub-ecoregion compared to streams in the Springfield Plateau sub-ecoregion.

4.4 Macroinvertebrate Community Composition and Evaluation of Biological Metrics

Macroinvertebrate taxa with high biotic index values were common at all NFSR sampling stations, but the most tolerant taxa like *Dicrotendipes*, *Glyptotendipes*, and *Hyalella azteca* were less abundant at NFSR #1 and the two control stations. *Dicrotendipes*, a chironomid tolerant of low dissolved oxygen and sediment, was very abundant from NFSR Test Stations #2 through #5, with much lower abundance at NFSR Test Station #1, LDW #1, and FRC #2. Members of the genus *Dicrotendipes* usually inhabit sediments or Aufwuchs in standing or minimally flowing water and have a biotic index value of 7.9 (Wiederholm, 1983). Studies have found that two common species, *Dicrotendipes neomodestus* and *Dicrotendipes nervosus,* were common in areas of high organic pollution and low dissolved oxygen levels (Simpson and Bode, 1980). *Stenacron*, a tolerant EPT taxa (biotic index of 7.1), was the most abundant EPT taxa at all sampling stations, but was much lower in abundance at NFSR #3, NFSR #4, and FRC#2. *Tribelos*, which has a biotic index of 6.6 and has been documented to occur in littoral sediments of lakes and occurs in a wide range of ecological conditions in streams (Simpson and Bode, 1980; Wiederholm, 1983), was abundant at NFSR Test Stations #3 through #5 and FRC #2. *Glyptotendipes* was found in high abundance at NFSR #2 and NFSR #4. The genus has a biotic index of 8.5, generally occurs in detritus rich sediments of slow flowing rivers, and becomes abundant in areas of organic pollution (Simpson and Bode, 1980; Wiederholm, 1983). *Hyalella azteca*, a tolerant amphipod, was very abundant at NFSR #4 but very low in abundance at the other sampling stations. *Tanytarsus*, a filter feeding Tanytarsini chironomid with a biotic index of 6.7, and *Cyrnellus fraternus*, a filtering polycentropid caddisfly with a biotic index of 7.4, were much more abundant at NFSR #1 and FRC #2. The tribe Tanytarsini is considered to be the most sensitive group of chironomids to pollution and is currently being used as a biological metric in the state of Ohio (DeShon, 1995). *Stenochironmus* was the second most abundant taxa at LDW #1 and much more abundant than the other sampling stations. *Stenochironmus* are considered obligate miners of living and dead vegetation, including woody debris (Wiederholm, 1983).

There was no significant difference for 5 of the 7 biological metrics between the control stations, LDW #1 and FRC #2 (Figures 2 through 8 and Appendix B). Two metrics, percent EPT relative abundance and percent clingers, showed a significant difference between the control stations. The significant difference for these two metrics was mainly driven by the much higher abundance of the mayfly taxa *Stenacron* at LDW #1. These results indicated that FRC #2 was comparable to LDW #1 for most of the metrics. The results at NFSR Test Stations #4 and #5 showed that 4 of 7 metrics were significantly different compared to the results at either LDW #1 or FRC #2. Taxa richness (TR) and percent EPT relative abundance were significantly different from LDW #1 and EPTT and percent dominant (5) taxa were significantly different from FRC #2 at NFSR #5. At NFSR #4, BI was significantly different compared to both control stations, percent EPT relative abundance and percent clingers were significantly different compared to LDW #1, and percent dominant (5) taxa was significantly different compared to FRC #2. The results at NFSR #3 showed that 5 of 7 metrics were significantly different compared to either LDW #1 or FRC #2. Biotic index (BI), percent EPT relative abundance, and percent clingers were significantly different compared to LDW #1 and SDI and percent dominant (5) taxa were significantly different compared to FRC #2 at NFSR #3. At NFSR #2, 2 of 7 metrics were significantly different compared to either LDW #1 or FRC #2. Biotic index (BI) was significantly different from LDW #1 and percent dominant (5) taxa was significantly different from FRC #2 at NFSR #2. The results at NFSR #1 showed that 3 of 7 metrics had significantly higher values compared to either LDW #1 or FRC #2. The results at the NFSR test stations indicate impairment at Stations #3 through #5 since at least 4 of 7 metrics were significantly different compared to either LDW #1 or FRC #2. Test Station #2 showed some impairment, but the metric results indicate that the NFSR was beginning to show improvement compared to the upstream stations, with only 2 of 7 metrics significantly different from the control stations.

There was no indication of impairment at NFSR #1 since it had significantly higher values for 3 metrics and was not significantly different for the other 4 metrics compared to the control stations.

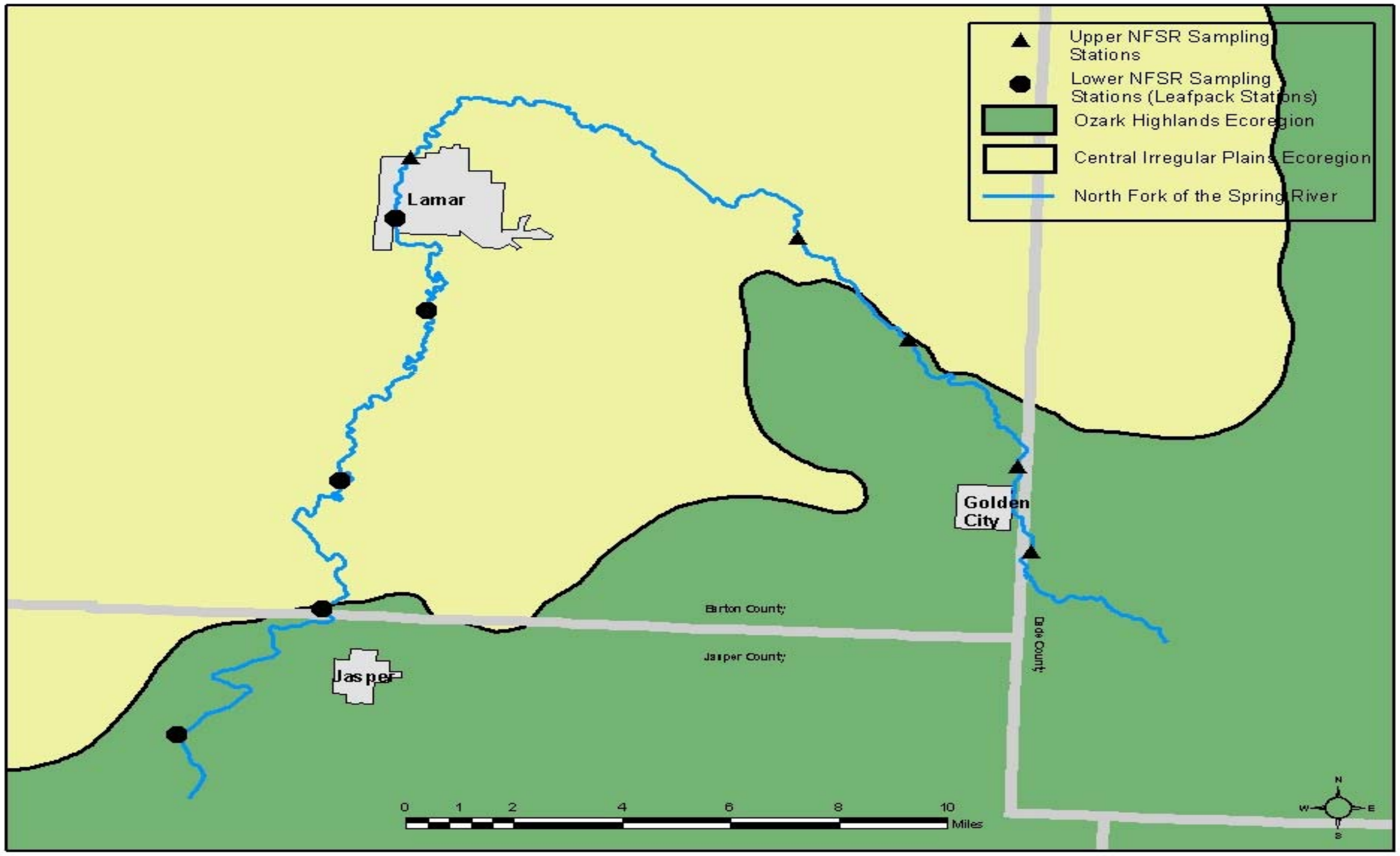
The results of BI, percent EPT relative abundance, and percent clingers metric values indicated that fine sediment could be impacting the macroinvertebrate community. Percent clingers measure the proportion of taxa that require hard substrate and should decrease with increasing fine sediment on the stream bottom. EPT taxa usually makes up a large percentage of clingers in a macroinvertebrate sample and a higher percentage of EPT taxa could indicate lower amounts of fine sediment. Biotic index values are based on tolerance of taxa to organic pollution and not for sediment, but many of the dominant taxa with high biotic index values, like *Dicrotendipes* and *Glyptotendipes,* are also tolerant to sediment according to previous studies (Simpson and Bode, 1980; Wiederholm, 1983).

4.5 Water Quality and Water Quantity Impacts

North Fork of the Spring River #4, located about 3.5 miles downstream of the Lamar WWTF, had elevated levels of ammonia-N, nitrate + nitrite-N, TKN, and total phosphorus (Table 7). The ammonia-N value of 4.22 mg/L was a chronic violation of the water quality standards. Water quality was probably impacting the macroinvertebrate community at this station since the biotic index was the highest and the macroinvertebrate community had high abundance of tolerant taxa like *Hyalella azteca*, *Dicrotendipes,* and *Glyptotendipes*. Other metrics like EPT taxa, percent EPT taxa, percent dominant (5) taxa, and percent clingers also performed poorly at NFSR #4.

Low stream discharge and low dissolved oxygen may have impacted the macroinvertebrate community at the NFSR test stations (Tables 7 and 8). Stream discharge during leafpack deployment ranged from 1.45 cfs at NFSR #5 to 6.10 cfs at NFSR #1. Visual estimates of stream discharge during the time period that the stream habitat assessments and leafpack retrieval were conducted indicated that discharge had decreased since leafpack deployment. In the Missouri Department of Natural Resources Water Quality Standards, the North Fork of the Spring River is listed as a class “C” stream. The low flow conditions and high water temperatures during this study were two probable causes of the low dissolved oxygen that were present at all test stations. Dissolved oxygen was slightly above or below 5.0 mg/L, the water quality standard for dissolved oxygen, at all of the NFSR test stations during leafpack deployment and during the time period that the stream habitat assessments were conducted. Dissolved oxygen was extremely low at Test Station #3 (3.74 mg/L) and Test Station #4 (3.38 mg/L) during leafpack deployment. At the time leafpacks were retrieved and processed, during the first week in October, dissolved oxygen levels were higher than 5.0 mg/L, except at NFSR #2 and #3. The higher dissolved oxygen levels during this time period were probably caused by lower water temperatures since stream discharge was estimated to be lower at leafpack retrieval than at leafpack deployment. The low values for many of the biological metrics and the high abundance of tolerant taxa like *Dicrotendipes* were probably caused by a combination of low dissolved oxygen, higher levels of fine sediment covering the stream bottom, nutrient enrichment from the Lamar WWTF, and non-point sources caused by surface runoff.

Figure 9.
Level III Ecoregion Map Showing Sampling Stations for the Upper North Fork of the Spring River Bioassessment Study Using Biological Criteria Protocols and the Lower North Fork of the Spring River Study Using Leafpacks.



5.0 Conclusions

Lower biological metric values for at least 4 metrics at Test Stations #3 through #5 and for two metrics at Test Station #2 indicate the macroinvertebrate community was impaired at these stations (Table 5). None of the biological metrics indicated impairment at Test Station #1. The first null hypothesis that all of the test stations would have a similar macroinvertebrate community was rejected since Station #1 had better biological metric values than the other test stations. The second null hypothesis that NFSR test stations would not differ from the two control stream stations was rejected. The results of this study, except at Test Station #1, and the results from the Upper North Fork of the Spring River Bioassessment Study in the Fall 2003 sampling season, except at Test Station #1, indicated that the macroinvertebrate community was impaired for the 303(d) listed stream reach.

The overall habitat scores indicated that the macroinvertebrate community should be fully supporting compared to control stations (Table 3). But there was evidence that fine sediment was a possible cause of impairment from Lamar to the Barton/Jasper County line based on some of the habitat parameters like epifaunal substrate and sediment deposition from the stream habitat assessment protocol and field observations made while sampling (Table 4). The physical characteristics of Test Stations #3 through #5 were prairie-like while Test Stations #1 and #2 were transitional in nature with characteristics of both prairie and Ozark streams.

The land use in the NFSR watershed generally had a higher percentage of land in row crops and a lower percentage in forest cover than the sampling station on Little Drywood Creek (Table 2). The high percentage of agriculture production in the NFSR watershed could lead to surface runoff problems during large precipitation events. Water quality data showed that ammonia-N, TKN, and total phosphorus were elevated at Test Station #4 and most likely originating from the Lamar WWTF. All of the test stations had low dissolved oxygen levels that were near or below 5.0 mg/L during leafpack deployment and during the time period in which stream habitat assessments were performed. A variety of impacts that include low dissolved oxygen levels, nutrient enrichment at Station #4, and possible elevated levels of benthic fine sediment were most likely causing the high abundance of tolerant taxa like *Dicrotendipes*, *Glyptotendipes*, and *Hyalella azteca* at test stations.

6.0 Recommendations

1. Recommend that the Missouri Department of Conservation, Resource Assessment and Monitoring (RAM) program staff conduct a fish community study on the North Fork of the Spring River watershed. Use the fish Index of Biotic Integrity (IBI) and/or other metrics to determine if the fish community indicates impairment similar to the macroinvertebrate community.

2. Conduct a sediment deposition and/or suspended sediment study on North Fork of the Spring River, Little Drywood Creek, Horse Creek, and Cedar Creek watersheds to determine if sedimentation is a problem in the North Fork of the Spring River watershed. This would involve collecting macroinvertebrates from four habitats (CS, NF, RM, SG) in the North Fork of the Spring River and estimating benthic sediment deposition and/or suspended sediment in the water column.

3. Conduct a water quality study on the entire watershed to determine the impacts of surface runoff on North Fork of the Spring River and its tributaries. This could determine if nutrients or other water quality parameters are elevated after major rainfall events.

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Submitted by: ____

Carl Wakefield
Environmental Specialist III
Environmental Services Program
Water Quality Monitoring Section

Date: ____

Approved by: ____

Connie Giesing
Interim Director
Environmental Services Program

CG:cwt

c: Cindy Davies, Interim Regional Director, SWRO
John Ford, QAPP Project Manager, WPCP

Appendix A

Missouri Department of Natural Resources
Bioassessment Study Plan
Lower North Fork of the Spring River
Dade and Barton Counties
August 26, 2004

Missouri Department of Natural Resources
Bioassessment Study Proposal
Lower North Fork Spring River, Barton and Jasper Counties
August 26, 2004

Objectives

This study will assess the aquatic macroinvertebrate community in the North Fork Spring River from Lamar, Missouri to the approximate confluence of Dry Fork Creek located southeast of Jasper, Missouri. The North Fork Spring River within the study area is classified by the State of Missouri Water Quality Standards as a class "C" stream and this section has been placed on the 2002 303d list for sediment. The stream originates in Barton and Dade counties near Golden City and flows through a predominately rural area in the Ozark/Elk/Spring Ecological Drainage Unit (EDU). The North Fork Spring River watershed drains a landscape that is transitional in nature between Ozark and Plains ecological regions and in the past has been classified as a distinctly different aquatic faunal area than other drainage's in Ozark/Elk Spring EDU (Pflieger, 1989). The lower North Fork Spring River study segment is a low gradient prairie stream with steep banks, long pools, and few riffles. Since the stream study segment is uniquely prairie-like and within an EDU that has predominantly riffle/pool stream types, it will not be compared to streams from the Ozark/Elk/Spring biocriteria database. Instead, leafpacks will be used to quantitatively compare the North Fork Spring River against 2 Plains control streams. Due to the unique location and transitional nature of the study reach of North Fork Spring River, comparisons will be made with control streams from the Osage River and the Arkansas River drainages. Two control stations will be placed on Flat Rock Creek, a tributary of the Neosho River, located in Neosho County, Kansas and one control station will be located within the reference reach of Little Drywood Creek (Plains/Osage EDU) in Vernon County, Missouri. The objectives of this study are to determine: 1) whether the aquatic macroinvertebrate community is being impacted by excessive amounts of sediment and 2) whether the aquatic macroinvertebrate community of North Fork Spring River is impaired in comparison to the control stations.

Null Hypotheses

1) The macroinvertebrate community found in leafpacks will not differ significantly ($P = 0.05$) between longitudinally separate reaches of North Fork Spring River.

2) The macroinvertebrate community found in leafpacks in the North Fork Spring River will not differ significantly ($P = 0.05$) from similar sized control reaches on Flat Rock Creek and Little Drywood Creek.

Background

The North Fork Spring River is a tributary of the Spring River system in southwestern Missouri that flows through a transitional area that has features of both the Ozark and plains ecoregions. It is characterized by long pools with short, rocky and gravelly riffles and the geology of the watershed contains beds of shale, sandstone and limestone (Pflieger, 1989). The goals of the study are to determine if the biological community of this stream is being impaired by excessive amounts of sediment since this section of stream has been placed on 2002 303d list.

Study Design

General: Five North Fork Spring River stations will be surveyed. The general locations are as follows: 1) upstream of 19th street in Lamar (SW1/4, Sec. 25, T32N, R31W); 2) upstream of SE 30th road (SE1/4, Sec. 1, T31N, R31W; 3) upstream of highway 126 (SW1/4, Sec. 26, T31N, R31W; 4) downstream of SW 100th road (NW1/4, Sec. 14, T30N, R31W); and 5) downstream of Redbud road (NE1/4, Sec. 32, T30N, R31W). Three control stations on Flat Rock Creek in Neosho County, Kansas and Little Drywood Creek in Vernon County, Missouri will also be surveyed. The general locations are as follows: 1) Flat Rock Creek located downstream of highway 47 (NW1/4, Sec. 19, T29S, R21E); 2) Flat Rock Creek located upstream of highway 110th road (SE1/4, Sec. 7, T29S, R21E); and 3) Little Drywood Creek upstream of a unnamed county road (SE1/4, Sec. 30, T35N, R31W). Data from the control stations will be used to assess the test stations on the North Fork Spring River. A longitudinal comparison of the North Fork Spring River sampling sites will also be made to try to determine if there are differences in macroinvertebrate community between test stations.

Each station will consist of a length approximately 20 times the average stream width as outlined in the Semi-quantitative Macroinvertebrate Stream Bioassessment Project Procedure (SMSBPP). To assess comparability between sampling stations, stream discharge, habitat assessment and water chemistry will be determined during the macroinvertebrate surveys. Sampling will be conducted in fall of 2004 (September 1 through October 1) and the spring of 2004 (March 1 through April 1).

Biological Sampling Methods: Macroinvertebrates will be quantitatively sampled by deploying 9 replicate leafpacks at each sample station. Leafpacks will be placed in the stream at three separate locations (3 leafpacks per location) spread throughout the sample station on inside bends of pools with stream flows less than 0.5 cubic feet per second (cfs). Leafpacks will be deployed at each of the sample stations around September 1, 2004 and March 1, 2005. The leafpacks will be collected from the stream stations about a month after the respective deployment.

Leafpacks are constructed of 30 X 21 cm pieces of polymesh netting containing a total of 10 leaves of eastern cottonwood (*Populus deltoides*) and American sycamore (*Platunus occidentalis*). Since American sycamore is more common in the riparian zone of the sample reaches of this study, approximately 70% of leaves placed in the leafpacks will be of this species. Leaves will be collected, air-dried, pre-weighed to 7 g (+/- 1 g), and stored in zip-lock bags until ready for use. Leafpacks will be constructed by placing leaves on top of half of the polymesh netting while the other half is folded over on top of leaves. The polymesh netting will be tied together with nylon cord around the loose edges to enclosed leaves. The leafpacks will then be stored in zip-lock bags until deployment.

A set of 3 leafpacks will be deployed in the stream by inserting a piece of rebar in the stream bottom near the bank's edge and inserting another piece of rebar in the stream bottom downstream and about 10 to 15 feet from the bank. A piece of 3/16 inch diameter nylon rope will then be attached around a tree near the bank, if available, then attached to the piece of rebar near the bank, and finally attached to the other piece of rebar located in the stream. The nylon rope will be adjusted on the rebar so that it is at or near the water's surface and is as tight as possible. The three leafpacks will be spaced evenly along the nylon rope and deployed about a foot below the water's surface by attaching a piece #24 braided nylon twine to the leafpack and to the nylon rope that is at the water's surface. A snap-on clip will be clipped on the bottom of the leafpack to weight the leafpack down so that it will not float to the surface of the water. This procedure will be done at three locations spread throughout the sample reach of each sample station.

At retrieval the leafpacks will be removed from the stream by holding a kick net under the leafpack while cutting them loose from their place of attachment. They will then be placed in a plastic wash pan, the nylon cord will be cut away from the polymesh netting, and the leaves will be pulled from the netting and placed in a sample jar. A scrub brush and deionized (DI) water will be used to clean debris from the polymesh netting and the material will be rinsed into the sample jar with the leaves. The entire sample will be preserved with 10% formalin. Macroinvertebrates will be removed from leafpack samples at the Environmental Services Program biology lab with a dissecting microscope at 10X magnification. Specimens will be preserved in glass vials containing 80% ethanol. All specimens will be identified to taxonomic levels described in Standard Operating Procedure MDNR-WQMS-209 (Taxonomic Levels for Macroinvertebrate Identifications).

Habitat Sampling Methods: Stream discharge will be measured at each sampling station with a Marsh-McBirney flow meter according to MDNR-WQMS-113. Stream habitat assessments will also be conducted within each study area according to the guidelines of the Stream Habitat Assessment Project Procedure.

Water Quality Sampling Methods: Water samples from all sampling stations will be analyzed at the ESP laboratory chloride, TKN, ammonia nitrogen, nitrite plus nitrate nitrogen, total phosphorus, and turbidity. Field analyses will include pH, conductivity, temperature and dissolved oxygen.

Laboratory Methods: All macroinvertebrate samples will be processed and identified according to the guidelines of MDNR-WQMS-209. Turbidity samples will be analyzed at the MDNR biological laboratory.

Data Analyses: Four standard metrics: Taxa Richness (TR); Ephemeroptera, Plecoptera, Trichoptera Taxa (EPTT), Biotic Index (BI), and the Shannon Diversity Index (SI) will be calculated for each replicate leafpack. Additional metrics, such as Percent EPT, Percent Chironomidae, EPT/Chironomidae ratio, Percent Scrapers, and Scraper/Collector-Filter ratio may be employed to discern differences in taxa between test and control stations.

Macroinvertebrate data will be analyzed in two ways using one way analysis of variance (ANOVA) for each biological metric. First, a longitudinal comparison between the five sample reaches of the North Fork Spring River will be made. Secondly, the data from the North Fork Spring River will be compared to data collected from the control stations.

Data Reporting: Results of the study will be summarized and interpreted in report format.

Quality Control: As stated in the various MDNR Project Procedures and Standard Operating Procedures.

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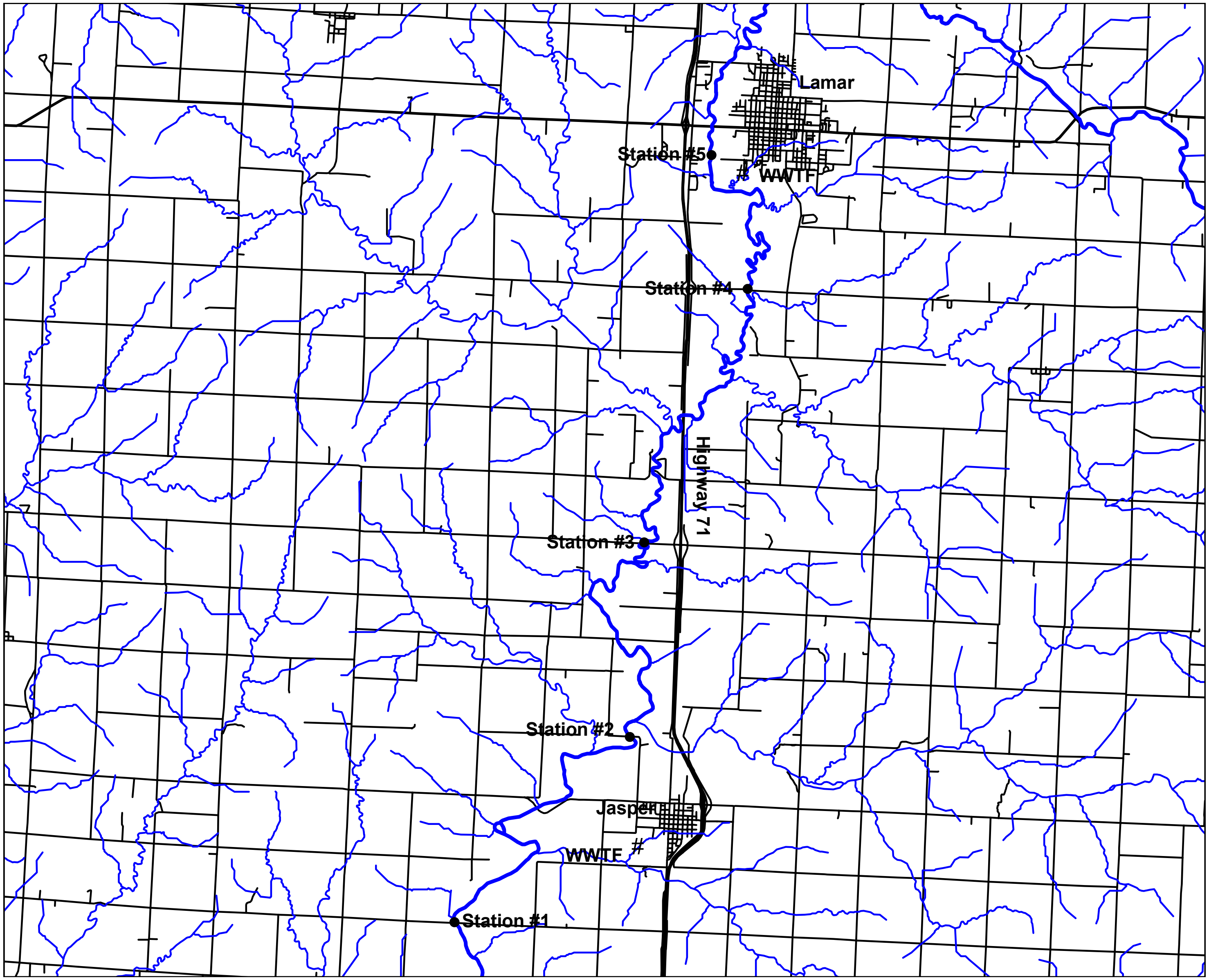
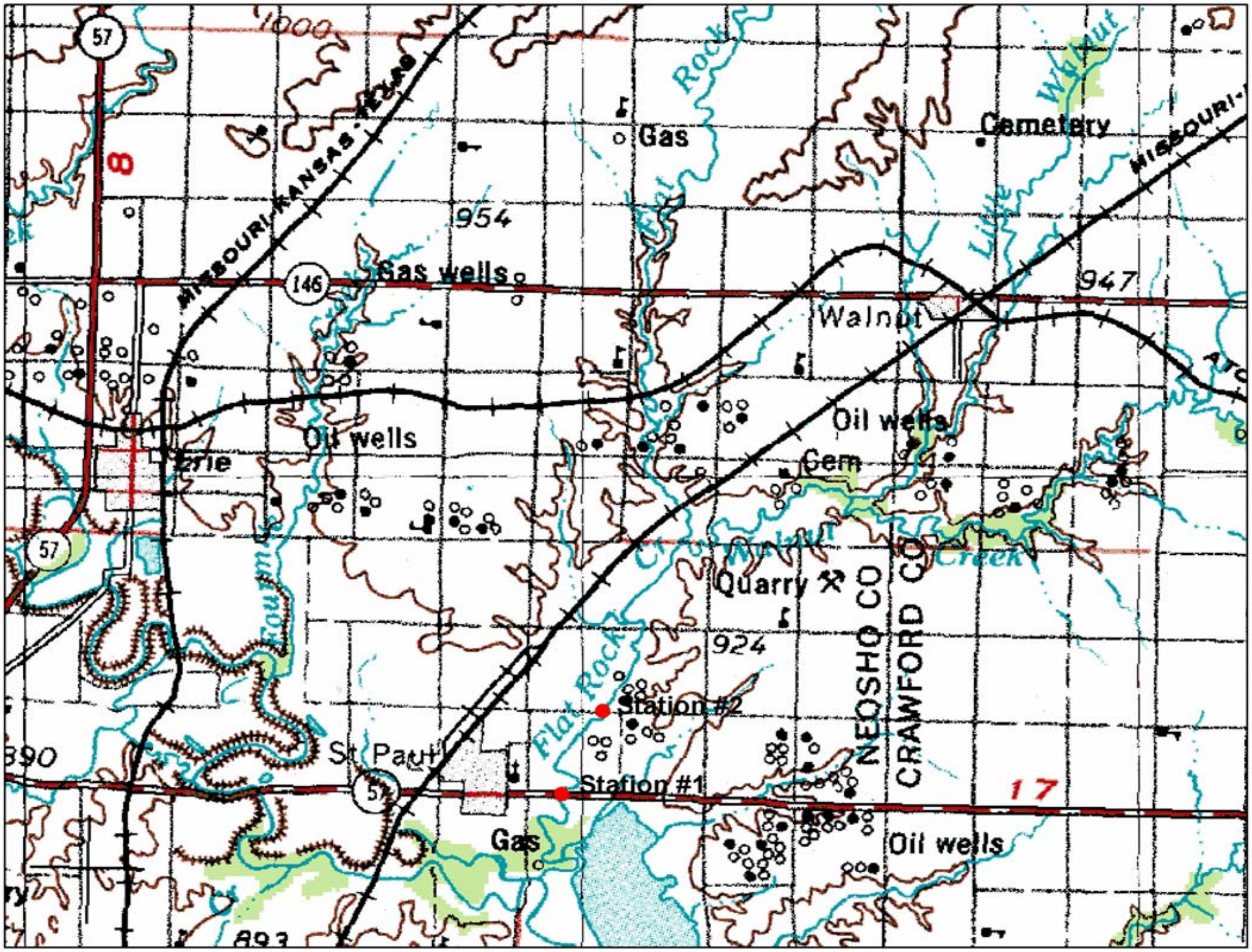
Attachments:

Maps of all sampling stations in this study

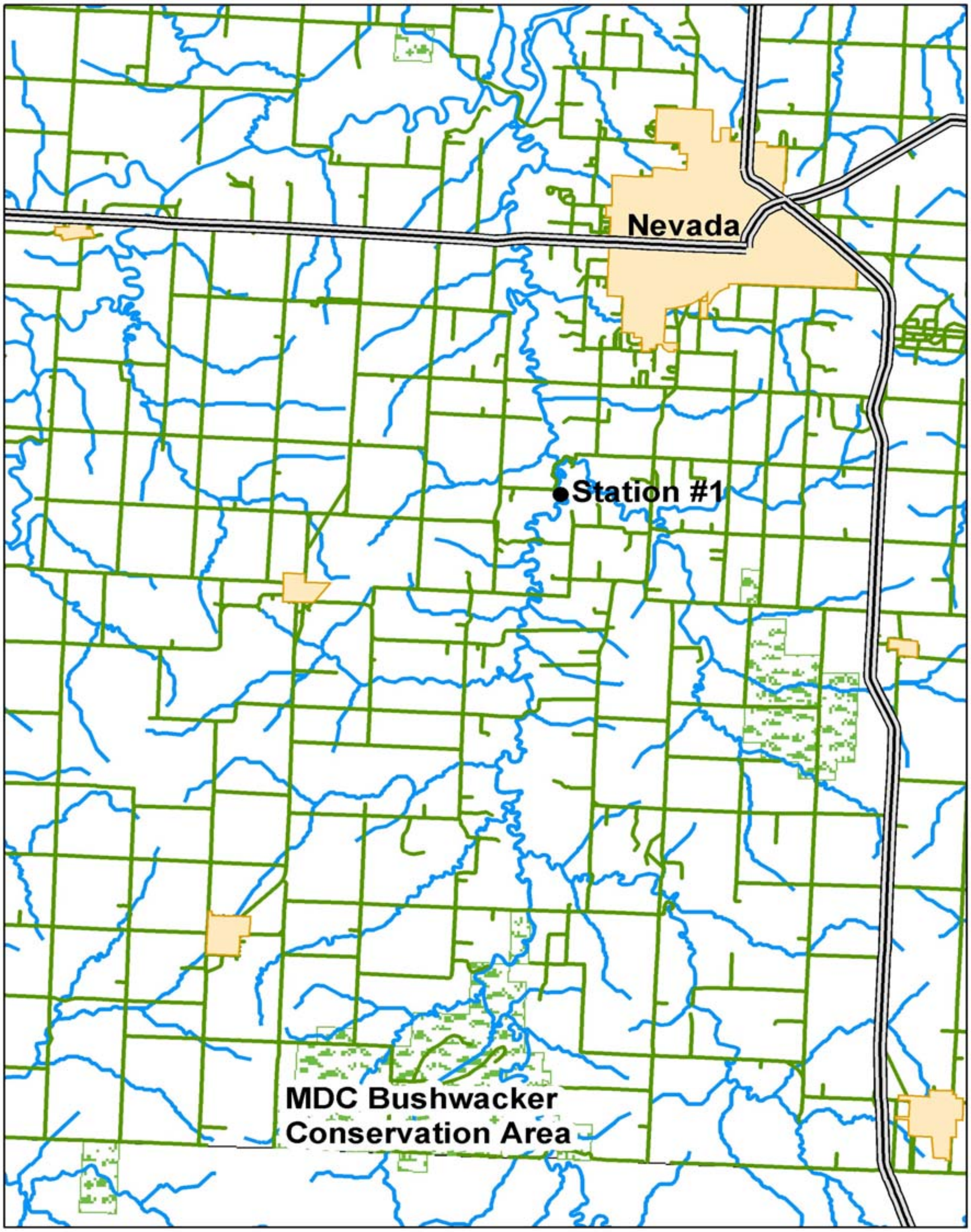
Lower North Fork of the Spring River Bioassessment Test Stations



Flat Rock Creek Bioassessment Control Stations



Little Drywood Creek Control Station



Appendix B

Statistical Analyses (One-Way ANOVA and Tukey Multiple Comparison Test for Parametric Data and Kruskal-Wallis ANOVA on Ranks and Dunn's Multiple Comparison Test for Non-parametric Data Comparing Biological Metrics Between Sampling Stations.

One Way Analysis of Variance Wednesday, August 17, 2005, 07:59:19

Data source: One Way Analysis of Variance comparing taxa richness (TR) between the North Fork of the Spring River (NFSR) test stations and control stations on Little Drywood Creek (LDW) and Flat Rock Creek (FRC)

Normality Test: Passed (P > 0.200)

Equal Variance Test: Passed (P = 0.188)

Group Name	N	Missing	Mean	Std Dev	SEM
NFSR #5	9	0	16.667	3.122	1.041
NFSR #4	9	0	23.778	3.073	1.024
NFSR #3	9	0	22.111	3.655	1.218
NFSR #2	7	0	22.000	6.164	2.330
NFSR #1	9	0	28.889	3.257	1.086
FRC #2	9	0	22.333	2.739	0.913
LDW #1	9	0	25.556	5.270	1.757

Source of Variation	DF	SS	MS	F	P
Between Groups	6	755.035	125.839	7.943	<0.001
Residual	54	855.556	15.844		
Total	60	1610.590			

The differences in the mean values among the treatment groups are greater than would be expected by chance; there is a statistically significant difference (P = <0.001).

Power of performed test with alpha = 0.050: 0.999

All Pairwise Multiple Comparison Procedures (Tukey Test):

Comparisons for factor: **Station**

Comparison	Diff of Means	p	q	P	P<0.050
NFSR #1 vs. NFSR #5	12.222	7	9.212	<0.001	Yes
NFSR #1 vs. NFSR #2	6.889	7	4.857	0.019	Yes
NFSR #1 vs. NFSR #3	6.778	7	5.108	0.011	Yes
NFSR #1 vs. FRC #2	6.556	7	4.941	0.016	Yes
NFSR #1 vs. NFSR #4	5.111	7	3.852	0.112	No
NFSR #1 vs. LDW #1	3.333	7	2.512	0.569	Do Not Test
LDW #1 vs. NFSR #5	8.889	7	6.699	<0.001	Yes
LDW #1 vs. NFSR #2	3.556	7	2.507	0.572	No
LDW #1 vs. NFSR #3	3.444	7	2.596	0.531	Do Not Test
LDW #1 vs. FRC #2	3.222	7	2.429	0.608	Do Not Test
LDW #1 vs. NFSR #4	1.778	7	1.340	0.963	Do Not Test
NFSR #4 vs. NFSR #5	7.111	7	5.360	0.007	Yes

NFSR #4 vs. NFSR #2	1.778	7	1.253	0.973	Do Not Test
NFSR #4 vs. NFSR #3	1.667	7	1.256	0.973	Do Not Test
NFSR #4 vs. FRC #2	1.444	7	1.089	0.987	Do Not Test
FRC #2 vs. NFSR #5	5.667	7	4.271	0.056	No
FRC #2 vs. NFSR #2	0.333	7	0.235	1.000	Do Not Test
FRC #2 vs. NFSR #3	0.222	7	0.167	1.000	Do Not Test
NFSR #3 vs. NFSR #5	5.444	7	4.103	0.074	Do Not Test
NFSR #3 vs. NFSR #2	0.111	7	0.0783	1.000	Do Not Test
NFSR #2 vs. NFSR #5	5.333	7	3.760	0.129	Do Not Test

A result of "Do Not Test" occurs for a comparison when no significant difference is found between two means that enclose that comparison. For example, if you had four means sorted in order, and found no difference between means 4 vs. 2, then you would not test 4 vs. 3 and 3 vs. 2, but still test 4 vs. 1 and 3 vs. 1 (4 vs. 3 and 3 vs. 2 are enclosed by 4 vs. 2: 4 3 2 1). Note that not testing the enclosed means is a procedural rule, and a result of Do Not Test should be treated as if there is no significant difference between the means, even though one may appear to exist.

One Way Analysis of Variance Wednesday, August 17, 2005, 08:03:48

Data source: One Way Analysis of Variance comparing EPT Taxa (EPTT) between the North Fork of the Spring River (NFSR) test stations and control stations on Little Drywood Creek (LDW) and Flat Rock Creek (FRC)

Normality Test: Passed (P = 0.124)

Equal Variance Test: Passed (P = 0.105)

Group Name	**N**	**Missing**	**Mean**	**Std Dev**	**SEM**
NFSR #5	9	0	3.778	1.093	0.364
NFSR #4	9	0	4.444	1.014	0.338
NFSR #3	9	0	4.667	1.323	0.441
NFSR #2	7	0	4.857	1.345	0.508
NFSR #1	9	0	8.000	1.000	0.333
FRC #2	9	0	5.667	1.118	0.373
LDW #1	9	0	5.444	1.590	0.530

Source of Variation	**DF**	**SS**	**MS**	**F**	**P**
Between Groups	6	99.405	16.568	11.065	<0.001
Residual	54	80.857	1.497		
Total	60	180.262			

The differences in the mean values among the treatment groups are greater than would be expected by chance; there is a statistically significant difference (P = <0.001).

Power of performed test with alpha = 0.050: 1.000

All Pairwise Multiple Comparison Procedures (Tukey Test):

Comparisons for factor: **Station**

Comparison	**Diff of Means**	**p**	**q**	**P**	**P<0.050**
NFSR #1 vs. NFSR #5	4.222	7	10.351	<0.001	Yes
NFSR #1 vs. NFSR #4	3.556	7	8.717	<0.001	Yes
NFSR #1 vs. NFSR #3	3.333	7	8.172	<0.001	Yes
NFSR #1 vs. NFSR #2	3.143	7	7.208	<0.001	Yes
NFSR #1 vs. LDW #1	2.556	7	6.265	<0.001	Yes
NFSR #1 vs. FRC #2	2.333	7	5.721	0.003	Yes
FRC #2 vs. NFSR #5	1.889	7	4.631	0.029	Yes
FRC #2 vs. NFSR #4	1.222	7	2.996	0.357	No
FRC #2 vs. NFSR #3	1.000	7	2.452	0.597	Do Not Test
FRC #2 vs. NFSR #2	0.810	7	1.856	0.843	Do Not Test
FRC #2 vs. LDW #1	0.222	7	0.545	1.000	Do Not Test
LDW #1 vs. NFSR #5	1.667	7	4.086	0.077	No

LDW #1 vs. NFSR #4	1.000	7	2.452	0.597	Do Not Test
LDW #1 vs. NFSR #3	0.778	7	1.907	0.826	Do Not Test
LDW #1 vs. NFSR #2	0.587	7	1.347	0.962	Do Not Test
NFSR #2 vs. NFSR #5	1.079	7	2.475	0.586	Do Not Test
NFSR #2 vs. NFSR #4	0.413	7	0.946	0.994	Do Not Test
NFSR #2 vs. NFSR #3	0.190	7	0.437	1.000	Do Not Test
NFSR #3 vs. NFSR #5	0.889	7	2.179	0.719	Do Not Test
NFSR #3 vs. NFSR #4	0.222	7	0.545	1.000	Do Not Test
NFSR #4 vs. NFSR #5	0.667	7	1.634	0.907	Do Not Test

A result of "Do Not Test" occurs for a comparison when no significant difference is found between two means that enclose that comparison. For example, if you had four means sorted in order, and found no difference between means 4 vs. 2, then you would not test 4 vs. 3 and 3 vs. 2, but still test 4 vs. 1 and 3 vs. 1 (4 vs. 3 and 3 vs. 2 are enclosed by 4 vs. 2: 4 3 2 1). Note that not testing the enclosed means is a procedural rule, and a result of Do Not Test should be treated as if there is no significant difference between the means, even though one may appear to exist.

Kruskal-Wallis One Way Analysis of Variance on Ranks Wednesday, August 17, 2005, 08:08:15

Data source: Kruskal-Wallis One Way Analysis of Variance on Ranks comparing biotic index (BI) between the North Fork of the Spring River (NFSR) test stations and control stations on Little Drywood Creek (LDW) and Flat Rock Creek (FRC)

Normality Test: Passed (P = 0.052)

Equal Variance Test: Failed (P = 0.010)

Group	**N**	**Missing**	**Median**	**25%**	**75%**
NFSR #5	9	0	7.140	6.845	7.450
NFSR #4	9	0	7.680	7.575	7.850
NFSR #3	9	0	7.400	7.380	7.508
NFSR #2	7	0	7.460	7.353	7.475
NFSR #1	9	0	7.080	7.035	7.150
FRC #2	9	0	7.150	6.838	7.262
LDW #1	9	0	6.700	6.637	6.785

H = 43.416 with 6 degrees of freedom. (P = <0.001)

The differences in the median values among the treatment groups are greater than would be expected by chance; there is a statistically significant difference (P = <0.001)

To isolate the group or groups that differ from the others use a multiple comparison procedure.

All Pairwise Multiple Comparison Procedures (Dunn's Method)

Comparison	**Diff of Ranks**	**Q**	**P<0.01**
NFSR #4 vs LDW #1	46.556	5.563	Yes
NFSR #4 vs NFSR #1	32.500	3.883	Yes
NFSR #4 vs FRC #2	31.611	3.777	Yes
NFSR #4 vs NFSR #5	25.944	3.100	No
NFSR #4 vs NFSR #2	10.857	1.214	Do Not Test
NFSR #4 vs NFSR #3	10.833	1.294	Do Not Test
NFSR #3 vs LDW #1	35.722	4.268	Yes
NFSR #3 vs NFSR #1	21.667	2.589	No
NFSR #3 vs FRC #2	20.778	2.483	Do Not Test
NFSR #3 vs NFSR #5	15.111	1.806	Do Not Test
NFSR #3 vs NFSR #2	0.0238	0.00266	Do Not Test
NFSR #2 vs LDW #1	35.698	3.990	Yes
NFSR #2 vs NFSR #1	21.643	2.419	Do Not Test
NFSR #2 vs FRC #2	20.754	2.320	Do Not Test
NFSR #2 vs NFSR #5	15.087	1.686	Do Not Test

NFSR #5 vs LDW #1	20.611	2.463	No
NFSR #5 vs NFSR #1	6.556	0.783	Do Not Test
NFSR #5 vs FRC #2	5.667	0.677	Do Not Test
FRC #2 vs LDW #1	14.944	1.786	Do Not Test
FRC #2 vs NFSR #1	0.889	0.106	Do Not Test
NFSR #1 vs LDW #1	14.056	1.680	Do Not Test

Note: The multiple comparisons on ranks do not include an adjustment for ties.

Kruskal-Wallis One Way Analysis of Variance on Ranks Wednesday, August 17, 2005, 08:12:11

Data source: Kruskal-Wallis One Way Analysis of Variance on Ranks comparing Shannon Diversity Index (SDI) between the North Fork of the Spring River (NFSR) test stations and control stations on Little Drywood Creek (LDW) and Flat Rock Creek (FRC)

Normality Test: Passed (P = 0.125)

Equal Variance Test: Failed (P = 0.009)

Group N	Missing	Median	25%	75%
NFSR #59	0	2.070	1.877	2.328
NFSR #49	0	2.170	2.010	2.317
NFSR #39	0	1.940	1.828	2.090
NFSR #27	0	1.910	1.688	2.172
NFSR #19	0	2.580	2.538	2.683
FRC #2 9	0	2.470	2.320	2.518
LDW #1 9	0	2.140	2.095	2.195

H = 34.873 with 6 degrees of freedom. (P = <0.001)

The differences in the median values among the treatment groups are greater than would be expected by chance; there is a statistically significant difference (P = <0.001)

To isolate the group or groups that differ from the others use a multiple comparison procedure.

All Pairwise Multiple Comparison Procedures (Dunn's Method):

Comparison	Diff of Ranks	Q	P<0.01
NFSR #1 vs NFSR #3	38.667	4.620	Yes
NFSR #1 vs NFSR #2	37.738	4.218	Yes
NFSR #1 vs NFSR #5	30.556	3.651	Yes
NFSR #1 vs LDW #1	27.778	3.319	No
NFSR #1 vs NFSR #4	25.056	2.994	Do Not Test
NFSR #1 vs FRC #2	9.000	1.075	Do Not Test
FRC #2 vs NFSR #3	29.667	3.545	Yes
FRC #2 vs NFSR #2	28.738	3.212	No
FRC #2 vs NFSR #5	21.556	2.576	Do Not Test
FRC #2 vs LDW #1	18.778	2.244	Do Not Test
FRC #2 vs NFSR #4	16.056	1.918	Do Not Test
NFSR #4 vs NFSR #3	13.611	1.626	No
NFSR #4 vs NFSR #2	12.683	1.418	Do Not Test
NFSR #4 vs NFSR #5	5.500	0.657	Do Not Test
NFSR #4 vs LDW #1	2.722	0.325	Do Not Test

LDW #1 vs NFSR #3	10.889	1.301	Do Not Test
LDW #1 vs NFSR #2	9.960	1.113	Do Not Test
LDW #1 vs NFSR #5	2.778	0.332	Do Not Test
NFSR #5 vs NFSR #3	8.111	0.969	Do Not Test
NFSR #5 vs NFSR #2	7.183	0.803	Do Not Test
NFSR #2 vs NFSR #3	0.929	0.104	Do Not Test

Note: The multiple comparisons on ranks do not include an adjustment for ties.

One Way Analysis of Variance Wednesday, August 17, 2005, 08:03:48

Data source: One Way Analysis of Variance comparing EPT Taxa (EPTT) between the North Fork of the Spring River (NFSR) test stations and control stations on Little Drywood Creek (LDW) and Flat Rock Creek (FRC)

Normality Test: Passed (P = 0.124)

Equal Variance Test: Passed (P = 0.105)

Group Name	N	Missing	Mean	Std Dev	SEM
NFSR #5	9	0	3.778	1.093	0.364
NFSR #4	9	0	4.444	1.014	0.338
NFSR #3	9	0	4.667	1.323	0.441
NFSR #2	7	0	4.857	1.345	0.508
NFSR #1	9	0	8.000	1.000	0.333
FRC #2	9	0	5.667	1.118	0.373
LDW #1	9	0	5.444	1.590	0.530

Source of Variation	DF	SS	MS	F	P
Between Groups	6	99.405	16.568	11.065	<0.001
Residual	54	80.857	1.497		
Total	60	180.262			

The differences in the mean values among the treatment groups are greater than would be expected by chance; there is a statistically significant difference (P = <0.001).

Power of performed test with alpha = 0.050: 1.000

All Pairwise Multiple Comparison Procedures (Tukey Test):

Comparisons for factor: **Station**

Comparison	Diff of Means	p	q	P	P<0.050
NFSR #1 vs. NFSR #5	4.222	7	10.351	<0.001	Yes
NFSR #1 vs. NFSR #4	3.556	7	8.717	<0.001	Yes
NFSR #1 vs. NFSR #3	3.333	7	8.172	<0.001	Yes
NFSR #1 vs. NFSR #2	3.143	7	7.208	<0.001	Yes
NFSR #1 vs. LDW #1	2.556	7	6.265	<0.001	Yes
NFSR #1 vs. FRC #2	2.333	7	5.721	0.003	Yes
FRC #2 vs. NFSR #5	1.889	7	4.631	0.029	Yes
FRC #2 vs. NFSR #4	1.222	7	2.996	0.357	No
FRC #2 vs. NFSR #3	1.000	7	2.452	0.597	Do Not Test
FRC #2 vs. NFSR #2	0.810	7	1.856	0.843	Do Not Test
FRC #2 vs. LDW #1	0.222	7	0.545	1.000	Do Not Test
LDW #1 vs. NFSR #5	1.667	7	4.086	0.077	No

LDW #1 vs. NFSR #4	1.000	7	2.452	0.597	Do Not Test
LDW #1 vs. NFSR #3	0.778	7	1.907	0.826	Do Not Test
LDW #1 vs. NFSR #2	0.587	7	1.347	0.962	Do Not Test
NFSR #2 vs. NFSR #5	1.079	7	2.475	0.586	Do Not Test
NFSR #2 vs. NFSR #4	0.413	7	0.946	0.994	Do Not Test
NFSR #2 vs. NFSR #3	0.190	7	0.437	1.000	Do Not Test
NFSR #3 vs. NFSR #5	0.889	7	2.179	0.719	Do Not Test
NFSR #3 vs. NFSR #4	0.222	7	0.545	1.000	Do Not Test
NFSR #4 vs. NFSR #5	0.667	7	1.634	0.907	Do Not Test

A result of "Do Not Test" occurs for a comparison when no significant difference is found between two means that enclose that comparison. For example, if you had four means sorted in order, and found no difference between means 4 vs. 2, then you would not test 4 vs. 3 and 3 vs. 2, but still test 4 vs. 1 and 3 vs. 1 (4 vs. 3 and 3 vs. 2 are enclosed by 4 vs. 2: 4 3 2 1). Note that not testing the enclosed means is a procedural rule, and a result of Do Not Test should be treated as if there is no significant difference between the means, even though one may appear to exist.

One Way Analysis of Variance Wednesday, August 17, 2005, 08:17:07

Data source: One Way Analysis of Variance comparing percent dominant (5) taxa between the North Fork of the Spring River (NFSR) test stations and control stations on Little Drywood Creek (LDW) and Flat Rock Creek (FRC)
Normality Test: Passed (P > 0.200)

Equal Variance Test: Passed (P = 0.465)

Group Name	**N**	**Missing**	**Mean**	**Std Dev**	**SEM**
NFSR #5	9	0	81.803	5.730	1.910
NFSR #4	9	0	80.596	3.886	1.295
NFSR #3	9	0	80.381	4.546	1.515
NFSR #2	7	0	82.964	6.865	2.595
NFSR #1	9	0	65.151	4.818	1.606
FRC #2	9	0	69.497	7.680	2.560
LDW #1	9	0	76.927	2.899	0.966

Source of Variation	**DF**	**SS**	**MS**	**F**	**P**
Between Groups	6	2434.206	405.701	14.076	<0.001
Residual	54	1556.433	28.823		
Total	60	3990.640			

The differences in the mean values among the treatment groups are greater than would be expected by chance; there is a statistically significant difference (P = <0.001).

Power of performed test with alpha = 0.050: 1.000

All Pairwise Multiple Comparison Procedures (Tukey Test):

Comparisons for factor: **Station**

Comparison	**Diff of Means**	**p**	**q**	**P**	**P<0.050**
NFSR #2 vs. NFSR #1	17.813	7	9.311	<0.001	Yes
NFSR #2 vs. FRC #2	13.468	7	7.040	<0.001	Yes
NFSR #2 vs. LDW #1	6.038	7	3.156	0.296	No
NFSR #2 vs. NFSR #3	2.583	7	1.350	0.961	Do Not Test
NFSR #2 vs. NFSR #4	2.369	7	1.238	0.975	Do Not Test
NFSR #2 vs. NFSR #5	1.161	7	0.607	1.000	Do Not Test
NFSR #5 vs. NFSR #1	16.652	7	9.305	<0.001	Yes
NFSR #5 vs. FRC #2	12.307	7	6.877	<0.001	Yes
NFSR #5 vs. LDW #1	4.877	7	2.725	0.472	Do Not Test
NFSR #5 vs. NFSR #3	1.422	7	0.795	0.998	Do Not Test
NFSR #5 vs. NFSR #4	1.208	7	0.675	0.999	Do Not Test
NFSR #4 vs. NFSR #1	15.444	7	8.630	<0.001	Yes
NFSR #4 vs. FRC #2	11.099	7	6.202	0.001	Yes

NFSR #4 vs. LDW #1	3.669	7	2.050	0.772	Do Not Test
NFSR #4 vs. NFSR #3	0.214	7	0.120	1.000	Do Not Test
NFSR #3 vs. NFSR #1	15.230	7	8.510	<0.001	Yes
NFSR #3 vs. FRC #2	10.884	7	6.082	0.001	Yes
NFSR #3 vs. LDW #1	3.454	7	1.930	0.818	Do Not Test
LDW #1 vs. NFSR #1	11.776	7	6.580	<0.001	Yes
LDW #1 vs. FRC #2	7.430	7	4.152	0.068	No
FRC #2 vs. NFSR #1	4.346	7	2.428	0.608	No

A result of "Do Not Test" occurs for a comparison when no significant difference is found between two means that enclose that comparison. For example, if you had four means sorted in order, and found no difference between means 4 vs. 2, then you would not test 4 vs. 3 and 3 vs. 2, but still test 4 vs. 1 and 3 vs. 1 (4 vs. 3 and 3 vs. 2 are enclosed by 4 vs. 2: 4 3 2 1). Note that not testing the enclosed means is a procedural rule, and a result of Do Not Test should be treated as if there is no significant difference between the means, even though one may appear to exist.

One Way Analysis of Variance Wednesday, August 17, 2005, 08:20:10

Data source: One Way Analysis of Variance comparing percent clingers between the North Fork of the Spring River (NFSR) test stations and control stations on Little Drywood Creek (LDW) and Flat Rock Creek (FRC)

Normality Test: Passed (P = 0.157)

Equal Variance Test: Passed (P = 0.029)

Group Name	N	Missing	Mean	Std Dev	SEM
NFSR #5	9	0	32.970	12.037	4.012
NFSR #4	9	0	21.603	5.825	1.942
NFSR #3	9	0	14.459	6.230	2.077
NFSR #2	7	0	43.260	19.123	7.228
NFSR #1	9	0	37.239	15.021	5.007
FRC #2	9	0	21.862	11.034	3.678
LDW #1	9	0	43.144	6.871	2.290

Source of Variation	DF	SS	MS	F	P
Between Groups	6	6737.703	1122.951	8.551	<0.001
Residual	54	7091.800	131.330		
Total	60	13829.504			

The differences in the mean values among the treatment groups are greater than would be expected by chance; there is a statistically significant difference (P = <0.001).

Power of performed test with alpha = 0.050: 1.000

All Pairwise Multiple Comparison Procedures (Tukey Test):

Comparisons for factor: **Station**

Comparison	Diff of Means	p	q	P	P<0.050
NFSR #2 vs. NFSR #3	28.801	7	7.053	<0.001	Yes
NFSR #2 vs. NFSR #4	21.657	7	5.303	0.008	Yes
NFSR #2 vs. FRC #2	21.398	7	5.240	0.009	Yes
NFSR #2 vs. NFSR #5	10.290	7	2.520	0.566	No
NFSR #2 vs. NFSR #1	6.021	7	1.474	0.942	Do Not Test
NFSR #2 vs. LDW #1	0.116	7	0.0283	1.000	Do Not Test
LDW #1 vs. NFSR #3	28.686	7	7.509	<0.001	Yes
LDW #1 vs. NFSR #4	21.541	7	5.639	0.004	Yes
LDW #1 vs. FRC #2	21.282	7	5.571	0.004	Yes
LDW #1 vs. NFSR #5	10.174	7	2.663	0.500	Do Not Test
LDW #1 vs. NFSR #1	5.906	7	1.546	0.928	Do Not Test
NFSR #1 vs. NFSR #3	22.780	7	5.963	0.002	Yes

NFSR #1 vs. NFSR #4	15.636	7	4.093	0.076	No
NFSR #1 vs. FRC #2	15.377	7	4.025	0.085	Do Not Test
NFSR #1 vs. NFSR #5	4.269	7	1.118	0.985	Do Not Test
NFSR #5 vs. NFSR #3	18.511	7	4.846	0.019	Yes
NFSR #5 vs. NFSR #4	11.367	7	2.976	0.365	Do Not Test
NFSR #5 vs. FRC #2	11.108	7	2.908	0.393	Do Not Test
FRC #2 vs. NFSR #3	7.403	7	1.938	0.815	No
FRC #2 vs. NFSR #4	0.259	7	0.0678	1.000	Do Not Test
NFSR #4 vs. NFSR #3	7.144	7	1.870	0.838	Do Not Test

A result of "Do Not Test" occurs for a comparison when no significant difference is found between two means that enclose that comparison. For example, if you had four means sorted in order, and found no difference between means 4 vs. 2, then you would not test 4 vs. 3 and 3 vs. 2, but still test 4 vs. 1 and 3 vs. 1 (4 vs. 3 and 3 vs. 2 are enclosed by 4 vs. 2: 4 3 2 1). Note that not testing the enclosed means is a procedural rule, and a result of Do Not Test should be treated as if there is no significant difference between the means, even though one may appear to exist.

Appendix C

Lower North Fork of the Spring River Bioassessment Study Macroinvertebrate Bench Sheets

Aquid Invertebrate Database Bench Sheet Report
North Fk Spring R [0449226], Station #5a, Sample Date: 10/4/2004 12:00:00 PM

ORDER: TAXA	LP
DIPTERA	
Ablabesmyia	2
Dicrotendipes	86
Glyptotendipes	12
Kiefferulus	25
Paratanytarsus	4
Phaenopsectra	7
Rheotanytarsus	1
Tanytarsus	4
Tribelos	25
EPHEMEROPTERA	
Caenis latipennis	7
Stenacron	12
TRICHOPTERA	
Cheumatopsyche	1
TUBIFICIDA	
Tubificidae	1

Aquid Invertebrate Database Bench Sheet Report
North Fk Spring R [0449227], Station #5b, Sample Date: 10/4/2004 12:00:00 PM

ORDER: TAXA	LP
"HYDRACARINA"	
Acarina	2
COLEOPTERA	
Lutrochus	1
DIPTERA	
Ablabesmyia	1
Anopheles	1
Dicrotendipes	32
Glyptotendipes	3
Kiefferulus	6
Paratanytarsus	4
Procladius	1
Rheotanytarsus	3
Tanytarsus	3
Tribelos	2
EPHEMEROPTERA	
Caenis latipennis	4
Stenacron	2
ISOPODA	
Lirceus	2
LIMNOPHILA	
Ancylidae	3
TRICHOPTERA	
Cheumatopsyche	1

LP = Leafpack

Aquid Invertebrate Database Bench Sheet Report
North Fk Spring R [0449228], Station #5c, Sample Date: 10/4/2004 12:00:00 PM

ORDER: TAXA	**LP**
DIPTERA	
Ablabesmyia	4
Dicrotendipes	21
Glyptotendipes	2
Kiefferulus	4
Parachironomus	1
Paratanytarsus	6
Phaenopsectra	15
Polypedilum fallax grp	2
Thienemannimyia grp.	1
Tribelos	35
EPHEMEROPTERA	
Caenis latipennis	1
Leptophlebiidae	1
Stenacron	43
Stenonema femoratum	1

Aquid Invertebrate Database Bench Sheet Report
North Fk Spring R [0449229], Station #5d, Sample Date: 10/4/2004 12:00:00 PM

ORDER: TAXA	**LP**
"HYDRACARINA"	
Acarina	1
AMPHIPODA	
Hyalella azteca	1
DIPTERA	
Ablabesmyia	4
Chironomus	1
Dicrotendipes	23
Glyptotendipes	1
Kiefferulus	1
Parachironomus	1
Paratanytarsus	1
Phaenopsectra	7
Polypedilum fallax grp	2
Rheotanytarsus	10
Tanytarsus	6
Thienemannimyia grp.	5
Tribelos	43
EPHEMEROPTERA	
Caenis latipennis	3
Leptophlebiidae	5
Stenacron	30
Stenonema femoratum	4
MEGALOPTERA	
Sialis	1
ODONATA	
Argia	2
TRICHOPTERA	
Cyrnellus fraternus	1

LP = Leafpack

Aquid Invertebrate Database Bench Sheet Report
North Fk Spring R [0449230], Station #5e, Sample Date: 10/4/2004 12:00:00 PM

ORDER: TAXA	LP
DIPTERA	
Ablabesmyia	4
Cricotopus/Orthocladius	3
Dicrotendipes	8
Glyptotendipes	2
Kiefferulus	1
Paratanytarsus	6
Phaenopsectra	8
Rheotanytarsus	7
Tanytarsus	3
Thienemannimyia grp.	6
Tribelos	6
EPHEMEROPTERA	
Caenis latipennis	1
Leptophlebiidae	5
Stenacron	34
Stenonema femoratum	4
LIMNOPHILA	
Ancylidae	1
ODONATA	
Argia	1
TRICHOPTERA	
Psychomyia	1

Aquid Invertebrate Database Bench Sheet Report
North Fk Spring R [0449231], Station #5f, Sample Date: 10/4/2004 12:00:00 PM

ORDER: TAXA	LP
AMPHIPODA	
Hyalella azteca	1
DIPTERA	
Ablabesmyia	2
Cricotopus/Orthocladius	1
Dicrotendipes	5
Glyptotendipes	1
Labrundinia	1
Paratanytarsus	4
Phaenopsectra	2
Polypedilum fallax grp	5
Rheotanytarsus	4
Stenochironomus	3
Tanytarsus	7
Thienemannimyia grp.	4
Tribelos	2
EPHEMEROPTERA	
Leptophlebiidae	3
Stenacron	23
Stenonema femoratum	4
ODONATA	
Argia	1
Enallagma	1

LP = Leafpack

Aquid Invertebrate Database Bench Sheet Report
North Fk Spring R [0449232], Station #5g, Sample Date: 10/4/2004 12:00:00 PM

ORDER: TAXA	**LP**
AMPHIPODA	
Hyalella azteca	1
DIPTERA	
Ablabesmyia	2
Cricotopus bicinctus	1
Dicrotendipes	36
Glyptotendipes	3
Paratanytarsus	4
Phaenopsectra	3
Rheotanytarsus	1
Stempellinella	1
Tanytarsus	5
Thienemannimyia grp.	2
EPHEMEROPTERA	
Caenis latipennis	2
Leptophlebiidae	1
Stenacron	28
Stenonema femoratum	3

Aquid Invertebrate Database Bench Sheet Report
North Fk Spring R [0449233], Station #5h, Sample Date: 10/4/2004 12:00:00 PM

ORDER: TAXA	**LP**
DIPTERA	
Ablabesmyia	6
Cricotopus/Orthocladius	1
Dicrotendipes	43
Glyptotendipes	2
Paratanytarsus	3
Phaenopsectra	17
Polypedilum fallax grp	1
Rheotanytarsus	5
Tanytarsus	3
Thienemannimyia grp.	3
Tribelos	11
EPHEMEROPTERA	
Caenis latipennis	1
Stenacron	30

LP = Leafpack

Aquid Invertebrate Database Bench Sheet Report
North Fk Spring R [0449234], Station #5i, Sample Date: 10/4/2004 12:00:00 PM

ORDER: TAXA	LP
DIPTERA	
Ablabesmyia	5
Dicrotendipes	62
Glyptotendipes	5
Kiefferulus	1
Microtendipes	1
Paratanytarsus	7
Phaenopsectra	14
Polypedilum fallax grp	7
Rheotanytarsus	2
Stenochironomus	1
Tanytarsus	5
Thienemannimyia grp.	4
Tribelos	35
EPHEMEROPTERA	
Caenis latipennis	1
Leptophlebiidae	2
Stenacron	44
Stenonema femoratum	2
ODONATA	
Argia	1
TRICHOPTERA	
Cyrnellus fraternus	1

LP = Leafpack

Aquid Invertebrate Database Bench Sheet Report
North Fk Spring R [0449235], Station #4a, Sample Date: 10/4/2004 1:55:00 PM

ORDER: TAXA	**LP**
AMPHIPODA	
Hyalella azteca	70
COLEOPTERA	
Scirtes	1
DIPTERA	
Ablabesmyia	8
Chironomus	1
Cricotopus bicinctus	5
Cricotopus/Orthocladius	2
Dicrotendipes	49
Glyptotendipes	47
Kiefferulus	2
Nanocladius	1
Paratanytarsus	2
Phaenopsectra	2
Polypedilum illinoense grp	1
Rheotanytarsus	23
Stenochironomus	1
Tanytarsus	22
Thienemannimyia grp.	10
Tribelos	23
EPHEMEROPTERA	
Caenis latipennis	3
Callibaetis	3
Stenacron	38
ODONATA	
Argia	3
TRICHOPTERA	
Cyrnellus fraternus	1
TUBIFICIDA	
Tubificidae	1

LP = Leafpack

Aquid Invertebrate Database Bench Sheet Report
North Fk Spring R [0449236], Station #4b, Sample Date: 10/4/2004 1:55:00 PM

ORDER: TAXA	**LP**
AMPHIPODA	
Hyalella azteca	100
DIPTERA	
Ablabesmyia	6
Cricotopus bicinctus	2
Cricotopus/Orthocladius	8
Dicrotendipes	59
Glyptotendipes	55
Kiefferulus	2
Nanocladius	4
Parachironomus	1
Paratanytarsus	4
Polypedilum illinoense grp	1
Polypedilum scalaenum grp	1
Rheotanytarsus	19
Stenochironomus	2
Tanytarsus	15
Thienemannimyia grp.	10
Tribelos	7
EPHEMEROPTERA	
Caenis latipennis	1
Callibaetis	1
Stenacron	19
LIMNOPHILA	
Physella	2
ODONATA	
Argia	2

LP = Leafpack

Aquid Invertebrate Database Bench Sheet Report
North Fk Spring R [0449237], Station #4c, Sample Date: 10/4/2004 1:55:00 PM

ORDER: TAXA	LP
AMPHIPODA	
Hyalella azteca	80
COLEOPTERA	
Dineutus	1
Scirtes	1
DIPTERA	
Ablabesmyia	3
Chironomus	2
Cricotopus bicinctus	1
Cricotopus/Orthocladius	2
Dicrotendipes	99
Glyptotendipes	103
Kiefferulus	6
Parachironomus	2
Paratanytarsus	16
Phaenopsectra	4
Polypedilum illinoense grp	2
Rheotanytarsus	13
Tanytarsus	9
Thienemannimyia grp.	5
Tribelos	2
EPHEMEROPTERA	
Caenis latipennis	2
Callibaetis	3
Leptophlebiidae	1
Stenacron	28
Stenonema femoratum	3
LIMNOPHILA	
Physella	2
ODONATA	
Argia	1
TRICHOPTERA	
Cyrnellus fraternus	3
TRICLADIDA	
Planariidae	1

LP = Leafpack

Aquid Invertebrate Database Bench Sheet Report
North Fk Spring R [0449238], Station #4d, Sample Date: 10/4/2004 1:55:00 PM

ORDER: TAXA	LP
AMPHIPODA	
Hyalella azteca	39
COLEOPTERA	
Dubiraphia	1
DIPTERA	
Ablabesmyia	3
Cricotopus bicinctus	1
Cricotopus/Orthocladius	1
Dicrotendipes	146
Glyptotendipes	74
Kiefferulus	17
Parachironomus	1
Paratanytarsus	14
Procladius	1
Rheotanytarsus	8
Tanypus	1
Tanytarsus	3
Thienemannimyia grp.	1
Tribelos	9
EPHEMEROPTERA	
Caenis latipennis	3
Callibaetis	3
Stenacron	94
LIMNOPHILA	
Physella	1
ODONATA	
Argia	1
RHYNCHOBDELLIDA	
Glossiphoniidae	1
TRICHOPTERA	
Cyrnellus fraternus	1
TUBIFICIDA	
Tubificidae	1

LP = Leafpack

Aquid Invertebrate Database Bench Sheet Report
North Fk Spring R [0449239], Station #4e, Sample Date: 10/4/2004 1:55:00 PM

ORDER: TAXA	**LP**
AMPHIPODA	
Hyalella azteca	259
DIPTERA	
Ablabesmyia	3
Dicrotendipes	76
Glyptotendipes	98
Kiefferulus	11
Parachironomus	1
Paratanytarsus	37
Phaenopsectra	2
Polypedilum illinoense grp	1
Rheotanytarsus	10
Stenochironomus	1
Tanytarsus	5
Thienemanniella	1
Thienemannimyia grp.	2
Tribelos	15
EPHEMEROPTERA	
Caenis latipennis	3
Callibaetis	3
Leptophlebiidae	3
Stenacron	49
Stenonema femoratum	3
ISOPODA	
Lirceus	1
LIMNOPHILA	
Menetus	4
Physella	1
ODONATA	
Argia	3
Enallagma	1
Epicordulia	1
RHYNCHOBDELLIDA	
Glossiphoniidae	2
TRICHOPTERA	
Cyrnellus fraternus	1
TRICLADIDA	
Planariidae	12

LP = Leafpack

Aquid Invertebrate Database Bench Sheet Report
North Fk Spring R [0449240], Station #4f, Sample Date: 10/4/2004 1:55:00 PM

ORDER: TAXA	**LP**
AMPHIPODA	
Hyalella azteca	14
DIPTERA	
Ablabesmyia	4
Anopheles	1
Chironomus	1
Dicrotendipes	157
Glyptotendipes	79
Kiefferulus	37
Paratanytarsus	17
Rheotanytarsus	4
Tanytarsus	11
Thienemannimyia grp.	2
Tribelos	15
EPHEMEROPTERA	
Caenis latipennis	10
Callibaetis	2
Leptophlebiidae	1
Stenacron	62
Stenonema femoratum	1
HEMIPTERA	
Neoplea	1
LIMNOPHILA	
Ancylidae	2
Menetus	1
Physella	2
ODONATA	
Argia	1
RHYNCHOBDELLIDA	
Glossiphoniidae	2

LP = Leafpack

Aquid Invertebrate Database Bench Sheet Report
North Fk Spring R [0449241], Station #4g, Sample Date: 10/4/2004 1:55:00 PM

ORDER: TAXA	**LP**
AMPHIPODA	
Hyalella azteca	11
DIPTERA	
Ablabesmyia	10
Anopheles	1
Dicrotendipes	39
Glyptotendipes	23
Kiefferulus	5
Nanocladius	1
Parachironomus	1
Paratanytarsus	2
Phaenopsectra	1
Polypedilum illinoense grp	1
Procladius	1
Rheotanytarsus	5
Tanytarsus	10
Thienemannimyia grp.	4
Tribelos	47
EPHEMEROPTERA	
Caenis latipennis	2
Callibaetis	2
Stenacron	48
LIMNOPHILA	
Physella	1
ODONATA	
Argia	1
Enallagma	2
TRICHOPTERA	
Cyrnellus fraternus	4

LP = Leafpack

Aquid Invertebrate Database Bench Sheet Report
North Fk Spring R [0449242], Station #4h, Sample Date: 10/4/2004 1:55:00 PM

ORDER: TAXA	**LP**
AMPHIPODA	
Hyalella azteca	46
COLEOPTERA	
Berosus	5
DIPTERA	
Ablabesmyia	2
Dicrotendipes	38
Glyptotendipes	30
Kiefferulus	10
Parachironomus	2
Paratanytarsus	3
Phaenopsectra	1
Rheotanytarsus	7
Tanytarsus	7
Thienemannimyia grp.	8
Tribelos	22
EPHEMEROPTERA	
Caenis latipennis	3
Leptophlebiidae	1
Stenacron	58
ODONATA	
Argia	1
TRICHOPTERA	
Cyrnellus fraternus	3

LP = Leafpack

Aquid Invertebrate Database Bench Sheet Report
North Fk Spring R [0449243], Station #4i, Sample Date: 10/4/2004 1:55:00 PM

ORDER: TAXA	**LP**
"HYDRACARINA"	
Acarina	1
AMPHIPODA	
Hyalella azteca	51
DIPTERA	
Ablabesmyia	3
Chironomus	1
Culex	1
Dicrotendipes	44
Glyptotendipes	35
Kiefferulus	21
Parachironomus	2
Paratanytarsus	6
Phaenopsectra	3
Polypedilum illinoense grp	3
Procladius	2
Rheotanytarsus	2
Tanytarsus	5
Thienemannimyia grp.	6
Tribelos	50
EPHEMEROPTERA	
Caenis latipennis	3
Callibaetis	2
Stenacron	68
LIMNOPHILA	
Physella	1
ODONATA	
Argia	2
Epicordulia	1
TRICHOPTERA	
Cyrnellus fraternus	9

LP = Leafpack

Aquid Invertebrate Database Bench Sheet Report
North Fk Spring R [0449244], Station #3a, Sample Date: 10/4/2004 3:45:00 PM

ORDER: TAXA	**LP**
"HYDRACARINA"	
Acarina	1
DIPTERA	
Ablabesmyia	25
Cricotopus bicinctus	1
Dicrotendipes	272
Glyptotendipes	7
Nanocladius	1
Paratanytarsus	1
Phaenopsectra	9
Polypedilum fallax grp	12
Polypedilum scalaenum grp	5
Procladius	3
Rheotanytarsus	4
Stenochironomus	3
Tanytarsus	24
Thienemannimyia grp.	8
Tribelos	59
EPHEMEROPTERA	
Caenis latipennis	23
Stenacron	30
LIMNOPHILA	
Physella	1
ODONATA	
Argia	6
TRICHOPTERA	
Cyrnellus fraternus	6

LP = Leafpack

Aquid Invertebrate Database Bench Sheet Report
North Fk Spring R [0449245], Station #3b, Sample Date: 10/4/2004 3:45:00 PM

ORDER: TAXA	**LP**
"HYDRACARINA"	
Acarina	1
DIPTERA	
Ablabesmyia	14
Corynoneura	2
Cricotopus bicinctus	4
Cricotopus/Orthocladius	1
Dicrotendipes	163
Glyptotendipes	6
Labrundinia	1
Nanocladius	1
Paratanytarsus	6
Phaenopsectra	6
Polypedilum fallax grp	5
Polypedilum scalaenum grp	4
Rheotanytarsus	11
Stenochironomus	2
Tanytarsus	44
Thienemannimyia grp.	19
Tribelos	24
EPHEMEROPTERA	
Caenis latipennis	17
Callibaetis	2
Stenacron	24
LIMNOPHILA	
Ancylidae	1
Physella	3
ODONATA	
Argia	7
TRICHOPTERA	
Cyrnellus fraternus	7
Hydroptila	1

LP = Leafpack

Aquid Invertebrate Database Bench Sheet Report
North Fk Spring R [0449246], Station #3c, Sample Date: 10/4/2004 3:45:00 PM

ORDER: TAXA	LP
"HYDRACARINA"	
Acarina	1
AMPHIPODA	
Hyalella azteca	1
DIPTERA	
Ablabesmyia	19
Chironomus	2
Corynoneura	1
Cricotopus/Orthocladius	2
Dicrotendipes	302
Glyptotendipes	8
Kiefferulus	2
Labrundinia	1
Paratanytarsus	7
Phaenopsectra	2
Polypedilum fallax grp	1
Polypedilum illinoense grp	1
Polypedilum scalaenum grp	2
Rheotanytarsus	1
Stenochironomus	4
Tanytarsus	30
Thienemannimyia grp.	4
Tribelos	44
EPHEMEROPTERA	
Caenis latipennis	13
Callibaetis	1
Stenacron	29
Stenonema femoratum	1
ODONATA	
Argia	4
TRICHOPTERA	
Cyrnellus fraternus	2

LP = Leafpack

Aquid Invertebrate Database Bench Sheet Report
North Fk Spring R [0449247], Station #3d, Sample Date: 10/4/2004 3:45:00 PM

ORDER: TAXA	**LP**
DIPTERA	
Ablabesmyia	14
Chironomus	1
Cricotopus bicinctus	1
Dicrotendipes	211
Glyptotendipes	20
Paratanytarsus	14
Phaenopsectra	3
Polypedilum scalaenum grp	2
Rheotanytarsus	5
Stenochironomus	3
Tanytarsus	35
Thienemannimyia grp.	8
Tribelos	49
EPHEMEROPTERA	
Caenis latipennis	12
Callibaetis	1
Stenacron	26
ODONATA	
Argia	5
TRICHOPTERA	
Cyrnellus fraternus	7

LP = Leafpack

Aquid Invertebrate Database Bench Sheet Report
North Fk Spring R [0449248], Station #3e, Sample Date: 10/4/2004 3:45:00 PM

ORDER: TAXA	**LP**
AMPHIPODA	
Hyalella azteca	2
COLEOPTERA	
Scirtes	2
DIPTERA	
Ablabesmyia	26
Cricotopus/Orthocladius	1
Dicrotendipes	218
Glyptotendipes	10
Nanocladius	5
Paratanytarsus	18
Phaenopsectra	4
Polypedilum fallax grp	5
Polypedilum illinoense grp	2
Polypedilum scalaenum grp	4
Stenochironomus	8
Tanytarsus	41
Thienemannimyia grp.	16
Tribelos	39
EPHEMEROPTERA	
Caenis latipennis	10
Callibaetis	1
Leptophlebiidae	2
Stenacron	28
Stenonema femoratum	1
HEMIPTERA	
Neoplea	1
LIMNOPHILA	
Menetus	2
ODONATA	
Argia	9
RHYNCHOBDELLIDA	
Glossiphoniidae	1
TRICHOPTERA	
Cyrnellus fraternus	6

LP = Leafpack

Aquid Invertebrate Database Bench Sheet Report
North Fk Spring R [0449249], Station #3f, Sample Date: 10/4/2004 3:45:00 PM

ORDER: TAXA	**LP**
AMPHIPODA	
Hyalella azteca	1
DIPTERA	
Ablabesmyia	14
Dicrotendipes	229
Glyptotendipes	26
Labrundinia	1
Nanocladius	4
Paratanytarsus	17
Phaenopsectra	8
Polypedilum fallax grp	3
Polypedilum illinoense grp	1
Procladius	1
Rheotanytarsus	4
Stenochironomus	2
Tanytarsus	38
Thienemannimyia grp.	3
Tribelos	28
EPHEMEROPTERA	
Acerpenna	1
Caenis latipennis	8
Callibaetis	6
Leptophlebiidae	1
Stenacron	52
Stenonema femoratum	1
ODONATA	
Argia	7
TRICHOPTERA	
Cyrnellus fraternus	6

LP = Leafpack

Aquid Invertebrate Database Bench Sheet Report
North Fk Spring R [0449250], Station #3g, Sample Date: 10/4/2004 3:45:00 PM

ORDER: TAXA	LP
DIPTERA	
Ablabesmyia	23
Cricotopus/Orthocladius	2
Dicrotendipes	187
Glyptotendipes	7
Nanocladius	1
Paratanytarsus	8
Phaenopsectra	4
Polypedilum scalaenum grp	1
Procladius	3
Rheotanytarsus	4
Stenochironomus	1
Tanytarsus	29
Thienemanniella	1
Thienemannimyia grp.	4
Tribelos	55
EPHEMEROPTERA	
Caenis latipennis	8
Callibaetis	1
Leptophlebiidae	1
Stenacron	56
ODONATA	
Argia	7
TRICHOPTERA	
Cyrnellus fraternus	17

LP = Leafpack

Aquid Invertebrate Database Bench Sheet Report
North Fk Spring R [0449251], Station #3h, Sample Date: 10/4/2004 3:45:00 PM

ORDER: TAXA	**LP**
DIPTERA	
Ablabesmyia	14
Cladotanytarsus	1
Cricotopus bicinctus	1
Dicrotendipes	100
Glyptotendipes	4
Paratanytarsus	4
Phaenopsectra	4
Rheotanytarsus	10
Stenochironomus	4
Tanytarsus	16
Thienemannimyia grp.	4
Tribelos	14
EPHEMEROPTERA	
Caenis latipennis	9
Stenacron	38
ODONATA	
Argia	4
TRICHOPTERA	
Cyrnellus fraternus	14

LP = Leafpack

Aquid Invertebrate Database Bench Sheet Report
North Fk Spring R [0449252], Station #3i, Sample Date: 10/4/2004 3:45:00 PM

ORDER: TAXA	**LP**
DIPTERA	
Ablabesmyia	19
Chironomus	1
Cricotopus/Orthocladius	1
Dicrotendipes	165
Glyptotendipes	13
Kiefferulus	1
Paratanytarsus	16
Phaenopsectra	8
Polypedilum fallax grp	6
Polypedilum scalaenum grp	3
Rheotanytarsus	10
Stenochironomus	2
Tanytarsus	38
Thienemannimyia grp.	8
Tribelos	60
EPHEMEROPTERA	
Caenis latipennis	9
Callibaetis	1
Stenacron	6
LIMNOPHILA	
Ancylidae	1
ODONATA	
Argia	9
TRICHOPTERA	
Cyrnellus fraternus	15

LP = Leafpack

Aquid Invertebrate Database Bench Sheet Report

North Fk Spring R [0449255], Station #2c, Sample Date: 10/6/2004 8:45:00 AM

ORDER: TAXA	**LP**
DIPTERA	
Cricotopus bicinctus	2
Cricotopus/Orthocladius	1
Dicrotendipes	191
Glyptotendipes	37
Kiefferulus	2
Parachironomus	2
Paratanytarsus	14
Phaenopsectra	4
Rheotanytarsus	9
Stenochironomus	1
Tanytarsus	13
EPHEMEROPTERA	
Caenis latipennis	2
Leptophlebiidae	1
Stenacron	6
TRICHOPTERA	
Cyrnellus fraternus	2

LP = Leafpack

Aquid Invertebrate Database Bench Sheet Report
North Fk Spring R [0449256], Station #2d, Sample Date: 10/6/2004 8:45:00 AM

ORDER: TAXA	**LP**
AMPHIPODA	
Hyalella azteca	4
DIPTERA	
Ablabesmyia	4
Corynoneura	1
Dicrotendipes	16
Glyptotendipes	29
Kiefferulus	1
Parachironomus	10
Parakiefferiella	1
Paratanytarsus	14
Phaenopsectra	2
Polypedilum fallax grp	1
Rheotanytarsus	1
Tanytarsus	11
EPHEMEROPTERA	
Caenis latipennis	1
Callibaetis	1
Stenacron	128
LIMNOPHILA	
Menetus	1
ODONATA	
Argia	1

LP = Leafpack

Aquid Invertebrate Database Bench Sheet Report
North Fk Spring R [0449257], Station #2e, Sample Date: 10/6/2004 8:45:00 AM

ORDER: TAXA	**LP**
AMPHIPODA	
Hyalella azteca	3
DIPTERA	
Ablabesmyia	5
Dicrotendipes	57
Glyptotendipes	36
Parachironomus	7
Parakiefferiella	1
Paratanytarsus	22
Phaenopsectra	5
Polypedilum illinoense grp	1
Rheotanytarsus	1
Stenochironomus	1
Tanytarsus	24
Thienemannimyia grp.	1
Tribelos	4
EPHEMEROPTERA	
Callibaetis	2
Stenacron	128
Stenonema femoratum	4
LIMNOPHILA	
Ancylidae	3
TRICHOPTERA	
Cyrnellus fraternus	3

LP = Leafpack

Aquid Invertebrate Database Bench Sheet Report
North Fk Spring R [0449258], Station #2f, Sample Date: 10/6/2004 8:45:00 AM

ORDER: TAXA	LP
"HYDRACARINA"	
Acarina	1
COLEOPTERA	
Scirtes	1
DIPTERA	
Ablabesmyia	6
Dicrotendipes	19
Glyptotendipes	24
Kiefferulus	2
Paratanytarsus	19
Phaenopsectra	4
Rheotanytarsus	1
Tanytarsus	14
Thienemannimyia grp.	2
Tribelos	1
EPHEMEROPTERA	
Callibaetis	2
Leptophlebiidae	1
Stenacron	145
Stenonema femoratum	5
HEMIPTERA	
Corixidae	1
LIMNOPHILA	
Ancylidae	11
Menetus	6
ODONATA	
Argia	1
TRICHOPTERA	
Cyrnellus fraternus	3
TRICLADIDA	
Planariidae	3

LP = Leafpack

Aquid Invertebrate Database Bench Sheet Report
North Fk Spring R [0449259], Station #2g, Sample Date: 10/6/2004 8:45:00 AM

ORDER: TAXA	LP
"HYDRACARINA"	
Acarina	2
COLEOPTERA	
Dubiraphia	1
Scirtes	1
DIPTERA	
Ablabesmyia	12
Cladotanytarsus	1
Corynoneura	1
Cricotopus bicinctus	1
Cricotopus/Orthocladius	3
Dicrotendipes	107
Glyptotendipes	27
Kiefferulus	1
Microtendipes	3
Parachironomus	2
Paratanytarsus	23
Phaenopsectra	3
Pseudochironomus	1
Rheotanytarsus	2
Stelechomyia	1
Stenochironomus	16
Tanytarsus	23
Thienemannimyia grp.	1
Tribelos	4
EPHEMEROPTERA	
Caenis latipennis	1
Callibaetis	1
Leptophlebiidae	5
Stenacron	57
Stenonema femoratum	3
HEMIPTERA	
Corixidae	3
LIMNOPHILA	
Menetus	1
ODONATA	
Argia	2
Enallagma	1
TRICHOPTERA	
Cyrnellus fraternus	4
Hydroptila	2
TRICLADIDA	
Planariidae	10

LP = Leafpack

Aquid Invertebrate Database Bench Sheet Report
North Fk Spring R [0449260], Station #2h, Sample Date: 10/6/2004 8:45:00 AM

ORDER: TAXA	**LP**
"HYDRACARINA"	
Acarina	1
DIPTERA	
Ablabesmyia	2
Corynoneura	1
Dicrotendipes	67
Forcipomyiinae	1
Glyptotendipes	19
Labrundinia	1
Parachironomus	4
Paratanytarsus	17
Phaenopsectra	6
Polypedilum illinoense grp	2
Procladius	1
Rheotanytarsus	1
Stenochironomus	6
Tanytarsus	14
Thienemanniella	1
Thienemannimyia grp.	2
EPHEMEROPTERA	
Caenis latipennis	1
Leptophlebiidae	1
Stenacron	62
Stenonema femoratum	6
HEMIPTERA	
Rheumatobates	1
ODONATA	
Argia	5
TRICHOPTERA	
Cyrnellus fraternus	6
TRICLADIDA	
Planariidae	9

LP = Leafpack

Aquid Invertebrate Database Bench Sheet Report
North Fk Spring R [0449261], Station #2i, Sample Date: 10/6/2004 8:45:00 AM

ORDER: TAXA	**LP**
"HYDRACARINA"	
Acarina	1
DIPTERA	
Ablabesmyia	3
Cricotopus/Orthocladius	1
Dicrotendipes	99
Glyptotendipes	12
Parachironomus	1
Paratanytarsus	19
Phaenopsectra	9
Polypedilum fallax grp	1
Rheotanytarsus	2
Stenochironomus	2
Tanytarsus	16
Thienemannimyia grp.	1
Tribelos	1
EPHEMEROPTERA	
Caenis latipennis	1
Leptophlebiidae	1
Stenacron	84
Stenonema femoratum	2
ODONATA	
Argia	2
TRICHOPTERA	
Cyrnellus fraternus	27
Hydroptila	2

LP = Leafpack

Aquid Invertebrate Database Bench Sheet Report
North Fk Spring R [0449262], Station #1a, Sample Date: 10/5/2004 3:15:00 PM

ORDER: TAXA	**LP**
"HYDRACARINA"	
Acarina	3
ARHYNCHOBDELLIDA	
Erpobdellidae	1
COLEOPTERA	
Berosus	1
Dubiraphia	1
DIPTERA	
Ablabesmyia	11
Corynoneura	4
Cricotopus bicinctus	6
Cricotopus/Orthocladius	1
Dicrotendipes	36
Glyptotendipes	2
Labrundinia	2
Microtendipes	1
Nanocladius	19
Parachironomus	7
Paratanytarsus	8
Polypedilum fallax grp	1
Polypedilum illinoense grp	9
Polypedilum scalaenum grp	12
Rheotanytarsus	19
Stenochironomus	1
Tanytarsus	90
Thienemanniella	1
Thienemannimyia grp.	29
Tribelos	2
EPHEMEROPTERA	
Caenis latipennis	11
Callibaetis	1
Stenacron	48
Stenonema femoratum	3
TRICHOPTERA	
Cyrnellus fraternus	21
Hydroptila	11
Oecetis	4

LP = Leafpack

Aquid Invertebrate Database Bench Sheet Report
North Fk Spring R [0449263], Station #1b, Sample Date: 10/5/2004 3:15:00 PM

ORDER: TAXA	**LP**
"HYDRACARINA"	
Acarina	1
AMPHIPODA	
Hyalella azteca	6
DIPTERA	
Ablabesmyia	18
Corynoneura	1
Cricotopus/Orthocladius	1
Dicrotendipes	17
Glyptotendipes	3
Nanocladius	7
Parachironomus	5
Paratanytarsus	5
Phaenopsectra	1
Polypedilum fallax grp	1
Polypedilum illinoense grp	5
Polypedilum scalaenum grp	3
Rheotanytarsus	14
Stenochironomus	1
Tanytarsus	88
Thienemanniella	2
Thienemannimyia grp.	16
Tribelos	3
EPHEMEROPTERA	
Caenis latipennis	3
Leptophlebiidae	2
Stenacron	44
Stenonema femoratum	5
ODONATA	
Argia	2
Enallagma	1
TRICHOPTERA	
Cernotina	1
Cyrnellus fraternus	12
Hydroptila	21
Nectopsyche	1
Oecetis	1

LP = Leafpack

Aquid Invertebrate Database Bench Sheet Report
North Fk Spring R [0449264], Station #1c, Sample Date: 10/5/2004 3:15:00 PM

ORDER: TAXA	**LP**
AMPHIPODA	
Hyalella azteca	17
COLEOPTERA	
Dubiraphia	1
DIPTERA	
Ablabesmyia	20
Anopheles	1
Corynoneura	4
Dicrotendipes	50
Glyptotendipes	5
Labrundinia	2
Nanocladius	26
Parachironomus	8
Parakiefferiella	1
Paratanytarsus	7
Phaenopsectra	2
Polypedilum convictum grp	2
Polypedilum illinoense grp	3
Polypedilum scalaenum grp	4
Rheotanytarsus	1
Stenochironomus	2
Tanytarsus	92
Thienemanniella	5
Thienemannimyia grp.	32
Tribelos	4
EPHEMEROPTERA	
Caenis latipennis	12
Callibaetis	1
Leptophlebiidae	2
Stenacron	20
Stenonema femoratum	3
ODONATA	
Argia	2
Enallagma	2
TRICHOPTERA	
Cyrnellus fraternus	3
Hydroptila	2
TRICLADIDA	
Planariidae	2

LP = Leafpack

Aquid Invertebrate Database Bench Sheet Report
North Fk Spring R [0449265], Station #1d, Sample Date: 10/5/2004 3:15:00 PM

ORDER: TAXA	**LP**
"HYDRACARINA"	
Acarina	5
AMPHIPODA	
Hyalella azteca	2
DIPTERA	
Ablabesmyia	8
Cladotanytarsus	1
Corynoneura	1
Cricotopus/Orthocladius	2
Dicrotendipes	18
Glyptotendipes	1
Microtendipes	2
Nanocladius	1
Paratanytarsus	32
Phaenopsectra	6
Procladius	2
Stenochironomus	5
Tanytarsus	8
Thienemanniella	1
Thienemannimyia grp.	13
Tribelos	5
EPHEMEROPTERA	
Caenis latipennis	5
Callibaetis	1
Leptophlebiidae	2
Stenacron	68
Stenonema femoratum	3
Tricorythodes	1
HEMIPTERA	
Corixidae	3
ODONATA	
Argia	3
Enallagma	3
RHYNCHOBDELLIDA	
Glossiphoniidae	1
TRICHOPTERA	
Cernotina	1
Cyrnellus fraternus	32
Hydroptila	43

LP = Leafpack

Aquid Invertebrate Database Bench Sheet Report
North Fk Spring R [0449266], Station #1e, Sample Date: 10/5/2004 3:15:00 PM

ORDER: TAXA	LP
"HYDRACARINA"	
Acarina	1
AMPHIPODA	
Hyalella azteca	12
COLEOPTERA	
Dineutus	1
DIPTERA	
Ablabesmyia	7
Dicrotendipes	11
Forcipomyiinae	1
Nanocladius	1
Parakiefferiella	1
Paratanytarsus	4
Polypedilum illinoense grp	1
Polypedilum scalaenum grp	1
Rheotanytarsus	5
Stenochironomus	2
Tanytarsus	14
Thienemannimyia grp.	10
Tribelos	1
EPHEMEROPTERA	
Caenis latipennis	6
Callibaetis	4
Leptophlebiidae	1
Stenacron	33
Stenonema femoratum	12
LIMNOPHILA	
Ancylidae	2
Menetus	1
ODONATA	
Enallagma	1
TRICHOPTERA	
Cyrnellus fraternus	8
Hydroptila	1
Nectopsyche	3
Oecetis	2

LP = Leafpack

Aquid Invertebrate Database Bench Sheet Report
North Fk Spring R [0449267], Station #1f, Sample Date: 10/5/2004 3:15:00 PM

ORDER: TAXA	**LP**
"HYDRACARINA"	
Acarina	1
AMPHIPODA	
Hyalella azteca	18
DIPTERA	
Ablabesmyia	13
Dicrotendipes	14
Glyptotendipes	1
Labrundinia	2
Polypedilum scalaenum grp	2
Rheotanytarsus	8
Stenochironomus	1
Tanytarsus	12
Thienemannimyia grp.	21
Tribelos	2
EPHEMEROPTERA	
Caenis latipennis	6
Callibaetis	4
Choroterpes	1
Leptophlebiidae	2
Stenacron	86
Stenonema femoratum	15
HEMIPTERA	
Corixidae	1
LIMNOPHILA	
Ancylidae	2
ODONATA	
Argia	4
TRICHOPTERA	
Cyrnellus fraternus	8
TRICLADIDA	
Planariidae	2

LP = Leafpack

Aquid Invertebrate Database Bench Sheet Report
North Fk Spring R [0449268], Station #1g, Sample Date: 10/5/2004 3:15:00 PM

ORDER: TAXA	LP
"HYDRACARINA"	
Acarina	1
AMPHIPODA	
Hyalella azteca	2
DIPTERA	
Ablabesmyia	20
Corynoneura	1
Dicrotendipes	55
Glyptotendipes	4
Labrundinia	2
Microtendipes	1
Nanocladius	7
Paratanytarsus	4
Phaenopsectra	2
Polypedilum	1
Polypedilum fallax grp	2
Polypedilum scalaenum grp	28
Rheotanytarsus	1
Stenochironomus	2
Tanytarsus	41
Thienemanniella	3
Thienemannimyia grp.	16
Tribelos	22
EPHEMEROPTERA	
Caenis latipennis	35
Callibaetis	5
Stenacron	92
Stenonema femoratum	8
ODONATA	
Argia	1
TRICHOPTERA	
Cernotina	1
Cyrnellus fraternus	6
Hydroptila	4
Nectopsyche	1
Orthotrichia	7

LP = Leafpack

Aquid Invertebrate Database Bench Sheet Report
North Fk Spring R [0449269], Station #1h, Sample Date: 10/5/2004 3:15:00 PM

ORDER: TAXA	**LP**
AMPHIPODA	
Hyalella azteca	3
DIPTERA	
Ablabesmyia	11
Corynoneura	1
Cricotopus/Orthocladius	1
Dicrotendipes	29
Glyptotendipes	2
Labrundinia	2
Nanocladius	4
Paratanytarsus	10
Phaenopsectra	4
Polypedilum	2
Polypedilum fallax grp	1
Polypedilum illinoense grp	2
Polypedilum scalaenum grp	11
Rheotanytarsus	1
Stenochironomus	5
Tanytarsus	36
Thienemanniella	3
Thienemannimyia grp.	9
Tribelos	11
EPHEMEROPTERA	
Caenis latipennis	15
Stenacron	41
Stenonema femoratum	9
ODONATA	
Argia	1
Enallagma	2
Nasiaeschna pentacantha	1
TRICHOPTERA	
Cyrnellus fraternus	5
Hydroptila	3
Oecetis	1
Orthotrichia	1

LP = Leafpack

Aquid Invertebrate Database Bench Sheet Report
North Fk Spring R [0449270], Station #1i, Sample Date: 10/5/2004 3:15:00 PM

ORDER: TAXA	LP
"HYDRACARINA"	
Acarina	1
DIPTERA	
Ablabesmyia	11
Dicrotendipes	13
Microtendipes	1
Nanocladius	1
Paratanytarsus	2
Phaenopsectra	6
Polypedilum	1
Polypedilum fallax grp	2
Polypedilum illinoense grp	2
Polypedilum scalaenum grp	12
Stenochironomus	6
Tanytarsus	14
Thienemannimyia grp.	4
Tribelos	17
EPHEMEROPTERA	
Caenis latipennis	10
Callibaetis	2
Procloeon	1
Stenacron	47
Stenonema femoratum	9
LIMNOPHILA	
Ancylidae	1
TRICHOPTERA	
Cyrnellus fraternus	2
Hydroptila	1
Oecetis	1

LP = Leafpack

Aquid Invertebrate Database Bench Sheet Report
Flat Rock Ck [0449280], Station #2a, Sample Date: 10/5/2004 11:45:00 AM

ORDER: TAXA	**LP**
"HYDRACARINA"	
Acarina	1
DIPTERA	
Ablabesmyia	4
Dicrotendipes	4
Glyptotendipes	11
Kiefferulus	1
Microtendipes	1
Parachironomus	2
Paratanytarsus	1
Stenochironomus	3
Tanytarsus	13
Thienemannimyia grp.	2
Tribelos	5
EPHEMEROPTERA	
Callibaetis	1
Leptophlebiidae	1
Stenacron	9
Stenonema femoratum	7
HEMIPTERA	
Corixidae	3
LIMNOPHILA	
Ancylidae	2
Menetus	4
TRICLADIDA	
Planariidae	1

LP = Leafpack

Aquid Invertebrate Database Bench Sheet Report
Flat Rock Ck [0449281], Station #2b, Sample Date: 10/5/2004 11:45:00 AM

ORDER: TAXA	LP
"HYDRACARINA"	
Acarina	2
DIPTERA	
Ablabesmyia	2
Corynoneura	2
Dicrotendipes	8
Glyptotendipes	20
Kiefferulus	1
Nanocladius	1
Parachironomus	6
Phaenopsectra	19
Polypedilum illinoense grp	1
Stenochironomus	4
Tanytarsus	42
Thienemannimyia grp.	2
Tribelos	31
EPHEMEROPTERA	
Caenis latipennis	3
Callibaetis	2
Heptageniidae	1
Stenacron	1
Stenonema femoratum	2
HEMIPTERA	
Corixidae	2
LIMNOPHILA	
Ancylidae	6
Menetus	6
ODONATA	
Argia	2
TRICHOPTERA	
Cyrnellus fraternus	6
TUBIFICIDA	
Branchiura sowerbyi	1

LP = Leafpack

Aquid Invertebrate Database Bench Sheet Report
Flat Rock Ck [0449282], Station #2c, Sample Date: 10/5/2004 11:45:00 AM

ORDER: TAXA	**LP**
COLEOPTERA	
Hydroporus	1
DIPTERA	
Ablabesmyia	2
Corynoneura	1
Dicrotendipes	11
Glyptotendipes	21
Kiefferulus	1
Labrundinia	1
Microtendipes	1
Parachironomus	3
Parakiefferiella	1
Paratanytarsus	1
Phaenopsectra	1
Stenochironomus	2
Tanytarsus	53
Tribelos	15
EPHEMEROPTERA	
Caenis latipennis	4
Callibaetis	1
Stenacron	4
Stenonema femoratum	3
HEMIPTERA	
Corixidae	4
ODONATA	
Argia	2
Enallagma	1
TRICHOPTERA	
Cyrnellus fraternus	6
VENEROIDEA	
Sphaeriidae	1

LP = Leafpack

Aquid Invertebrate Database Bench Sheet Report
Flat Rock Ck [0449283], Station #2d, Sample Date: 10/5/2004 11:45:00 AM

ORDER: TAXA	**LP**
DIPTERA	
Ablabesmyia	1
Anopheles	1
Dicrotendipes	3
Glyptotendipes	10
Labrundinia	1
Nanocladius	1
Parachironomus	1
Parakiefferiella	1
Polypedilum fallax grp	1
Tanytarsus	24
Thienemannimyia grp.	9
Tribelos	2
EPHEMEROPTERA	
Caenis latipennis	1
Heptageniidae	2
Leptophlebiidae	13
Stenacron	26
Stenonema femoratum	13
ODONATA	
Argia	2
Enallagma	4
TRICHOPTERA	
Cyrnellus fraternus	5
Oecetis	1
TRICLADIDA	
Planariidae	1

LP = Leafpack

Aquid Invertebrate Database Bench Sheet Report
Flat Rock Ck [0449284], Station #2e, Sample Date: 10/5/2004 11:45:00 AM

ORDER: TAXA	**LP**
"HYDRACARINA"	
Acarina	1
AMPHIPODA	
Hyalella azteca	1
DIPTERA	
Dicrotendipes	14
Glyptotendipes	4
Parachironomus	3
Phaenopsectra	2
Tanytarsus	59
Thienemannimyia grp.	26
Tribelos	1
EPHEMEROPTERA	
Caenis latipennis	1
Leptophlebiidae	14
Stenacron	15
Stenonema femoratum	17
LIMNOPHILA	
Ancylidae	1
ODONATA	
Argia	6
TRICHOPTERA	
Cyrnellus fraternus	3
Hydroptila	1

LP = Leafpack

Aquid Invertebrate Database Bench Sheet Report
Flat Rock Ck [0449285], Station #2f, Sample Date: 10/5/2004 11:45:00 AM

ORDER: TAXA	**LP**
AMPHIPODA	
Hyalella azteca	2
DIPTERA	
Ablabesmyia	1
Dicrotendipes	19
Glyptotendipes	21
Kiefferulus	1
Labrundinia	1
Nanocladius	2
Nilothauma	5
Parachironomus	4
Paratanytarsus	3
Phaenopsectra	5
Stenochironomus	10
Tanytarsus	54
Thienemanniella	3
Thienemannimyia grp.	47
Tribelos	3
EPHEMEROPTERA	
Caenis latipennis	1
Leptophlebiidae	8
Stenacron	51
Stenonema femoratum	17
HEMIPTERA	
Corixidae	1
ODONATA	
Argia	11
Enallagma	2
TRICHOPTERA	
Cyrnellus fraternus	12
Oecetis	5
TRICLADIDA	
Planariidae	4

LP = Leafpack

Aquid Invertebrate Database Bench Sheet Report
Flat Rock Ck [0449286], Station #2g, Sample Date: 10/5/2004 11:45:00 AM

ORDER: TAXA	**LP**
COLEOPTERA	
Scirtes	1
DIPTERA	
Ablabesmyia	7
Chaoborus	1
Cladotanytarsus	1
Cryptochironomus	1
Dicrotendipes	16
Glyptotendipes	18
Nilothauma	1
Parachironomus	10
Parakiefferiella	1
Phaenopsectra	1
Polypedilum illinoense grp	1
Polypedilum scalaenum grp	1
Stenochironomus	1
Tanytarsus	18
Thienemannimyia grp.	10
Tribelos	39
EPHEMEROPTERA	
Caenis latipennis	2
Callibaetis	3
Stenacron	1
HEMIPTERA	
Trichocorixa	2
ODONATA	
Argia	13
TRICHOPTERA	
Cyrnellus fraternus	16

LP = Leafpack

Aquid Invertebrate Database Bench Sheet Report
Flat Rock Ck [0449287], Station #2h, Sample Date: 10/5/2004 11:45:00 AM

ORDER: TAXA	**LP**
DIPTERA	
Ablabesmyia	10
Dicrotendipes	9
Glyptotendipes	17
Kiefferulus	2
Microtendipes	1
Parachironomus	4
Parakiefferiella	1
Procladius	1
Stenochironomus	1
Tanytarsus	14
Thienemannimyia grp.	7
Tribelos	31
EPHEMEROPTERA	
Caenis latipennis	1
Callibaetis	2
Leptophlebiidae	1
Stenacron	13
Stenonema femoratum	2
HEMIPTERA	
Corixidae	3
LIMNOPHILA	
Physella	1
ODONATA	
Argia	9
TRICHOPTERA	
Cyrnellus fraternus	36
Hydroptila	1
TRICLADIDA	
Planariidae	1

LP = Leafpack

Aquid Invertebrate Database Bench Sheet Report
Flat Rock Ck [0449288], Station #2i, Sample Date: 10/5/2004 11:45:00 AM

ORDER: TAXA	LP
DECAPODA	
Palaemonetes kadiakensis	1
DIPTERA	
Ablabesmyia	5
Cryptochironomus	1
Dicrotendipes	3
Glyptotendipes	12
Kiefferulus	3
Nilotanypus	1
Phaenopsectra	1
Stenochironomus	5
Tanytarsus	10
Thienemannimyia grp.	6
Tribelos	32
EPHEMEROPTERA	
Caenis latipennis	1
Callibaetis	2
Leptophlebiidae	1
Stenacron	10
Stenonema femoratum	1
LIMNOPHILA	
Menetus	1
Physella	1
ODONATA	
Argia	1
TRICHOPTERA	
Cyrnellus fraternus	27

LP = Leafpack

Aquid Invertebrate Database Bench Sheet Report
Little Drywood Ck [0449289], Station #1a, Sample Date: 10/6/2004 11:30:00 AM

ORDER: TAXA	**LP**
"HYDRACARINA"	
Acarina	4
AMPHIPODA	
Hyalella azteca	2
DIPTERA	
Ablabesmyia	6
Axarus	1
Chaoborus	1
Chironomus	2
Cladotanytarsus	4
Dicrotendipes	14
Kiefferulus	2
Paratanytarsus	1
Phaenopsectra	6
Polypedilum fallax grp	2
Procladius	5
Rheotanytarsus	2
Stenochironomus	67
Tanytarsus	3
Thienemannimyia grp.	11
Tribelos	3
EPHEMEROPTERA	
Caenis latipennis	12
Leptophlebiidae	5
Stenacron	123
HEMIPTERA	
Corixidae	1
LIMNOPHILA	
Ancylidae	8
Ferrissia	3
Menetus	2
Physella	4
ODONATA	
Argia	3
TRICHOPTERA	
Cyrnellus fraternus	4

LP = Leafpack

Aquid Invertebrate Database Bench Sheet Report
Little Drywood Ck [0449290], Station #1b, Sample Date: 10/6/2004 11:30:00 AM

ORDER: TAXA	**LP**
"HYDRACARINA"	
Acarina	7
AMPHIPODA	
Hyalella azteca	1
DIPTERA	
Ablabesmyia	14
Cladotanytarsus	1
Corynoneura	2
Cryptochironomus	1
Dicrotendipes	16
Glyptotendipes	2
Paratanytarsus	1
Phaenopsectra	1
Procladius	7
Rheotanytarsus	1
Stenochironomus	63
Tanytarsus	7
Thienemannimyia grp.	21
Tribelos	4
EPHEMEROPTERA	
Caenis latipennis	20
Hexagenia	1
Leptophlebiidae	3
Procloeon	1
Stenacron	138
Stenonema femoratum	4
LIMNOPHILA	
Ancylidae	2
Ferrissia	1
Menetus	1
Physella	1
ODONATA	
Argia	1
TRICHOPTERA	
Hydroptila	1
Oecetis	5
TUBIFICIDA	
Tubificidae	3

LP = Leafpack

Aquid Invertebrate Database Bench Sheet Report
Little Drywood Ck [0449291], Station #1c, Sample Date: 10/6/2004 11:30:00 AM

ORDER: TAXA	LP
"HYDRACARINA"	
Acarina	2
AMPHIPODA	
Hyalella azteca	3
ARHYNCHOBDELLIDA	
Erpobdellidae	1
DIPTERA	
Ablabesmyia	15
Corynoneura	1
Dicrotendipes	21
Glyptotendipes	1
Microtendipes	1
Parakiefferiella	1
Paratanytarsus	3
Phaenopsectra	18
Polypedilum fallax grp	2
Polypedilum scalaenum grp	1
Procladius	2
Rheotanytarsus	3
Stenochironomus	80
Tanytarsus	3
Thienemannimyia grp.	37
Tribelos	11
EPHEMEROPTERA	
Caenis latipennis	7
Leptophlebiidae	13
Stenacron	190
Stenonema femoratum	2
ISOPODA	
Lirceus	5
LIMNOPHILA	
Ancylidae	7
Ferrissia	5
Menetus	1
Physella	3
ODONATA	
Argia	3
TRICHOPTERA	
Cyrnellus fraternus	1
Hydroptila	1
TRICLADIDA	
Planariidae	1
VENEROIDEA	
Sphaeriidae	1

LP = Leafpack

Aquid Invertebrate Database Bench Sheet Report
Little Drywood Ck [0449292], Station #1d, Sample Date: 10/6/2004 11:30:00 AM

ORDER: TAXA	**LP**
"HYDRACARINA"	
Acarina	1
AMPHIPODA	
Hyalella azteca	1
COLEOPTERA	
Dubiraphia	1
DIPTERA	
Ablabesmyia	11
Dicrotendipes	16
Labrundinia	1
Nanocladius	6
Nilothauma	1
Paratanytarsus	9
Phaenopsectra	5
Rheotanytarsus	3
Stenochironomus	60
Tanytarsus	6
Thienemanniella	1
Thienemannimyia grp.	15
EPHEMEROPTERA	
Baetidae	1
Caenis latipennis	5
Leptophlebiidae	19
Stenacron	198
Stenonema femoratum	2
LIMNOPHILA	
Ancylidae	2
ODONATA	
Argia	1
TRICHOPTERA	
Cyrnellus fraternus	2
Hydroptila	1

LP = Leafpack

Aquid Invertebrate Database Bench Sheet Report
Little Drywood Ck [0449293], Station #1e, Sample Date: 10/6/2004 11:30:00 AM

ORDER: TAXA	**LP**
"HYDRACARINA"	
Acarina	1
AMPHIPODA	
Hyalella azteca	7
DIPTERA	
Ablabesmyia	4
Dicrotendipes	25
Glyptotendipes	1
Microtendipes	1
Nanocladius	2
Parachironomus	1
Parakiefferiella	1
Paratanytarsus	5
Phaenopsectra	13
Polypedilum fallax grp	1
Polypedilum scalaenum grp	1
Stenochironomus	58
Tanytarsus	3
Thienemanniella	1
Thienemannimyia grp.	8
Tribelos	1
EPHEMEROPTERA	
Caenis latipennis	6
Leptophlebiidae	21
Procloeon	2
Stenacron	114
Stenonema femoratum	7
ISOPODA	
Lirceus	2
LIMNOPHILA	
Ancylidae	6
Ferrissia	1
Physella	2
ODONATA	
Argia	4
TRICHOPTERA	
Hydroptila	1
TRICLADIDA	
Planariidae	8
TUBIFICIDA	
Tubificidae	1

LP = Leafpack

Aquid Invertebrate Database Bench Sheet Report
Little Drywood Ck [0449294], Station #1f, Sample Date: 10/6/2004 11:30:00 AM

ORDER: TAXA	**LP**
AMPHIPODA	
Hyalella azteca	1
DIPTERA	
Ablabesmyia	12
Dicrotendipes	15
Microtendipes	1
Nanocladius	1
Parachironomus	1
Paratanytarsus	4
Phaenopsectra	13
Polypedilum fallax grp	1
Rheotanytarsus	1
Stenochironomus	52
Tanytarsus	8
Thienemannimyia grp.	11
Tribelos	6
EPHEMEROPTERA	
Acerpenna	2
Caenis latipennis	5
Leptophlebiidae	18
Stenacron	103
Stenonema femoratum	4
ISOPODA	
Lirceus	1
LIMNOPHILA	
Ancylidae	1
Ferrissia	1
ODONATA	
Argia	3
TRICHOPTERA	
Hydroptila	1

LP = Leafpack

Aquid Invertebrate Database Bench Sheet Report
Little Drywood Ck [0449295], Station #1g, Sample Date: 10/6/2004 11:30:00 AM

ORDER: TAXA	**LP**
COLEOPTERA	
Hydroporus	1
Scirtes	1
DIPTERA	
Ablabesmyia	1
Dicrotendipes	9
Glyptotendipes	4
Paratanytarsus	1
Phaenopsectra	8
Polypedilum fallax grp	3
Rheotanytarsus	2
Stenochironomus	30
Tanytarsus	2
Thienemannimyia grp.	8
Tribelos	3
EPHEMEROPTERA	
Caenis latipennis	13
Leptophlebiidae	11
Stenacron	47
LIMNOPHILA	
Ancylidae	1
TRICHOPTERA	
Cernotina	1

LP = Leafpack

Aquid Invertebrate Database Bench Sheet Report
Little Drywood Ck [0449296], Station #1h, Sample Date: 10/6/2004 11:30:00 AM

ORDER: TAXA	**LP**
"HYDRACARINA"	
Acarina	2
COLEOPTERA	
Paracymus	1
DIPTERA	
Ablabesmyia	4
Corynoneura	1
Dicrotendipes	7
Glyptotendipes	2
Paratanytarsus	3
Phaenopsectra	6
Polypedilum fallax grp	2
Procladius	1
Stenochironomus	30
Thienemannimyia grp.	5
Tribelos	1
EPHEMEROPTERA	
Leptophlebiidae	6
Stenacron	53
Stenonema femoratum	2
ISOPODA	
Lirceus	3
LIMNOPHILA	
Ancylidae	1
ODONATA	
Argia	1

LP = Leafpack

Aquid Invertebrate Database Bench Sheet Report
Little Drywood Ck [0449297], Station #1i, Sample Date: 10/6/2004 11:30:00 AM

ORDER: TAXA	**LP**
AMPHIPODA	
Hyalella azteca	1
DIPTERA	
Ablabesmyia	15
Dicrotendipes	39
Glyptotendipes	1
Labrundinia	1
Microtendipes	1
Nanocladius	2
Parachironomus	1
Parakiefferiella	2
Paratanytarsus	2
Phaenopsectra	16
Polypedilum scalaenum grp	2
Rheotanytarsus	5
Stenochironomus	39
Tanytarsus	13
Thienemannimyia grp.	33
Tribelos	7
EPHEMEROPTERA	
Caenis latipennis	10
Leptophlebiidae	10
Stenacron	94
Stenonema femoratum	2
TRICHOPTERA	
Hydroptila	1
TRICLADIDA	
Planariidae	1

LP = Leafpack