Missouri Department of Natural Resources

Biological Assessment Report

Peruque Creek
St. Charles & Warren Counties

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Prepared for:

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Water Protection and Soil Conservation Division
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1.0 Introduction

At the request of the Water Pollution Control Program (**WPCP**), the Environmental Services Program's (**ESP**) Water Quality Monitoring Section (**WQMS**) conducted a biological assessment of Peruque Creek, which flows through rural and suburban portions of Warren and St. Charles counties, Missouri. It was added to the Missouri proposed 303(d) list of impaired waters in 2002 for nonvolatile suspended solids from urban and rural nonpoint source pollution.

North Fork Cuivre River, a nearby drainage that flows through a mostly rural watershed, was used as a control site to compare with Peruque Creek. This comparison was to determine whether biological impairment could be differentiated between a rural stream setting and one under increasing pressure from development. Additionally, South River, a biological criteria reference stream, was re-sampled for comparison to both Peruque Creek and North Fork Cuivre River. Sampling was conducted on March 19-27, 2002 and on September 24-25, 2002 to provide data to the WPCP for use in evaluating and comparing the biological integrity of the two streams. Dave Michaelson and Cecilia Campbell of the Environmental Services Program, Air and Land Protection Division conducted the sampling.

On January 16, 2002 a study plan was submitted to the WPCP (Appendix A). A total of 10 null hypotheses were stated in this plan:

1) Macroinvertebrate assemblages will not differ between reaches of Peruque Creek where best management practices (**BMPs**) are in use in the watershed and reaches where poor management practices are used in the watershed;

2) Water chemistry will not differ between reaches of Peruque Creek where BMPs are in use in the watershed and reaches where poor management practices are used;

3) Fecal coliform concentrations will not differ between reaches of Peruque Creek where BMPs are in use in the watershed and reaches where poor management practices are used;

4) Benthic sediment percentage estimates will not differ between reaches of Peruque Creek where BMPs are in use in the watershed and reaches where poor management practices are used;

5) Measures of habitat quality will not differ between reaches of Peruque Creek where BMPs are in use in the watershed and reaches where poor management practices are used;

6) Macroinvertebrate assemblages will not differ between Peruque Creek and reference streams within the Plains/Mississippi Tributaries between Des Moines and Missouri Rivers Ecological Drainage Unit (**EDU**);

7) Water chemistry will not differ between Peruque Creek and reference streams within the Plains/Mississippi Tributaries between Des Moines and Missouri Rivers EDU;

8) Fecal coliform concentrations will not differ between Peruque Creek and reference streams within the Plains/Mississippi Tributaries between Des Moines and Missouri Rivers EDU;

9) Benthic sediment percentage estimates will not differ between Peruque Creek and reference streams within the Plains/Mississippi Tributaries between Des Moines and Missouri Rivers EDU;

10) Measures of habitat quality will not differ between Peruque Creek and reference streams within the Plains/Mississippi Tributaries between Des Moines and Missouri Rivers EDU.

2.0 Study Area

Peruque Creek originates in eastern Warren County, west of Wright City, flows east through St. Charles County and into Lake St. Louis. At the outfall of the reservoir, the creek resumes a northeasterly course and enters the Mississippi River near the town of Firma, Missouri. Although the Peruque Creek watershed is largely rural (dominated by pasture, forest, and cropland), a sizable urbanized portion also exists (see Table 1). The lowermost sample station of the stream reach assessed is in a reach classified "P" with beneficial use designations of "livestock and wildlife watering" and "warm water aquatic life protection, human health/fish consumption." Sample stations #2 through #5 fall in a reach of the stream designated class "C" with the same beneficial use designations listed above. The uppermost sample station is unclassified.

North Fork Cuivre River originates in west central Pike County, southwest of Bowling Green, and flows southeast through a watershed that is dominated by cropland (see Table 1). The North Fork Cuivre River sample stations are in a reach classified "C" with beneficial use designations of "livestock and wildlife watering" and "warm water aquatic life protection, human health/fish consumption." This stream was chosen as a control in the study due to several factors: its close proximity to the study stream within the same EDU; a watershed of comparable size; and a relative lack of urbanization in the watershed.

Peruque Creek and North Fork Cuivre River are located within the Plains/Mississippi Tributaries between the Des Moines and Missouri Rivers (**PMSD)** EDU. An EDU is a region in which biological communities and habitat conditions can be expected to be similar. Please see Appendix B for maps of the EDU and the 14-digit Hydrologic Units (**HU**), #07110009010001 and #07110008010003, that contain the sampling reaches for Peruque Creek and North Fork Cuivre River, respectively. See Table 1 for a comparison of land use for the 14-digit HUs. In addition to Peruque and North Fork Cuivre River,

land use for comparable biological criteria reference streams within the PMSD EDU have been included in Table 1 for comparison. Land cover data were derived from the Thematic Mapper satellite data from 1991-1993, and interpreted by the Missouri Resource Assessment Partnership (**MoRAP**).

Table 1
Percent Land Cover

	Urban	Crops	Grassland	Forest	Swamp
PMSD* EDU	1.1	43.5	35.9	17.1	0.2
Peruque Creek	11.8	25.5	33.1	26.2	0.0
North Fork Cuivre River	0.2	56.5	29.2	13.4	0.0
North River	0.0	30.0	45.8	10.2	0.4
South River	0.2	53.2	34.7	10.2	0.4
South Fabius River	0.2	37.9	45.2	15.6	0.1

*Plains/Mississippi Tributaries between the Des Moines and Missouri Rivers

3.0 Site Descriptions

With the exception of Station 6 and Station 5, which were in Warren County, all Peruque Creek macroinvertebrate sample stations were located in St. Charles County. North Fork Cuivre River sample sites were in Pike County. The average width and discharge measurements during both survey periods are given for each sampling station in Table 2 in the Data Results section.

Peruque Creek Station 1 (SW ¼ sec. 32, T. 47 N., R. 2 E.) was located downstream of the Duello Road bridge. Geographic coordinates at the upstream terminus of this station were Lat. 38.787287˚, Long. –90.827498˚.

Peruque Creek Station 2 (NE ¼ NE ¼ sec. 35, T. 47 N., R. 1 E.) was located upstream of the Wilmer Road bridge. Geographic coordinates at the downstream terminus of this station were Lat. 38.792738˚, Long. –90.872231˚.

Peruque Creek Station 3 (Sur. 149, T. 47 N., R. 1 E.) was located upstream from the Hepperman Road bridge. Geographic coordinates at the downstream terminus of this station were Lat. 38.792247˚, Long. –90.885220˚.

Peruque Creek Station 4 (W ½ sec. 30, T. 47 N., R 1 E.) was located upstream from the State Road T bridge. Geographic coordinates at the downstream terminus of this station were Lat. 38.804294˚, Long. –90.955551˚.

Peruque Creek Station 5 (SW ¼ SW ¼ sec. 23, T. 47 N., R. 1 W.) was located upstream from the South Stringtown Road bridge. Geographic coordinates at the midpoint of this station were Lat. 38.815637˚, Long. –90.997554˚.

Peruque Creek Station 6 (NW ¼ sec. 22, T. 47 N., R. 1 W.) was located at Ruge Memorial Park in Wright City, Missouri. Geographic coordinates at the midpoint of this station were Lat. 38.821845˚, Long. –91.202815˚.

North Fork Cuivre River 1 (W ½ sec. 13, T. 51 N., R. 3 W.) was located downstream of Pike County Road 325. Geographic coordinates at the upstream terminus of this station were Lat. 39.193592˚, Long. –91.202815˚.

North Fork Cuivre River 2 (E ½ sec. 33, T. 52 N., R. 3 W.) was located upstream of Highway 161. Geographic coordinates at the downstream terminus of this station were Lat. 39.234612˚, Long. –91.2466625˚.

Water quality samples were collected at three sites on Peruque Creek and two sites on North Fork Cuivre River for fecal coliform analysis. Fecal coliform counts are presented in Table 7 in the Data Results section.

Peruque Creek Fecal Coliform Site 1 (W ½ sec. 30, T. 47 N., R 1 E.) was located at the State Road T bridge, just upstream from the Foristell Wastewater Treatment Facility tributary. Geographic coordinates at the point of collection were Lat. 38.804400˚, Long. –90.959100˚.

Peruque Creek Fecal Coliform Site 2 (NE ¼ NE ¼ sec. 33, T. 47 N., R. 1 E.) was located at the Pointe Prairie Road bridge. Geographic coordinates at the point of collection were Lat. 38.794800˚, Long. –90.911000˚.

Peruque Creek Fecal Coliform Site 3 (Sur. 149, T. 47 N., R. 1 E.) was located at the Hepperman Road bridge. Geographic coordinates at the point of collection were Lat. 38.792250˚, Long. –90.885222˚.

North Fork Cuivre River Fecal Coliform Site 1 (W ½ sec. 13, T. 51 N., R. 3 W.) was located at the Highway 161 bridge. Geographic coordinates at the point of collection were Lat. 39.234611˚, Long. –91.246666˚.

North Fork Cuivre River Fecal Coliform Site 2 (W ½ sec. 13, T. 51 N., R. 3 W.) was located at the Pike County Road 325 bridge. Geographic coordinates at the point of collection were Lat. 38.193500˚, Long. –91.203000˚.

4.0 Methods

4.1 Macroinvertebrate Collection and Analyses

A standardized sample collection procedure was followed as described in the Semi-quantitative Macroinvertebrate Stream Bioassessment Project Procedure (**SMSBPP**) (MDNR 2001a). Three standard habitats-flowing water over coarse substrate, depositional substrate in non-flowing water, and rootmat at the stream edge-were

sampled at all locations. During the fall sample season, however, there was insufficient flowing water to provide a coarse substrate sample at Peruque Creek Station 6.

A standardized sample analysis procedure was followed as described in the SMSBPP. The following four metrics were used: 1) total taxa (TT); 2) total number of taxa in the orders Ephemeroptera, Plecoptera, and Trichoptera (EPTT); 3) biotic index (BI); and 4) Shannon diversity index (SDI). These metrics are combined to form the Stream Condition Index (**SCI**). Stream Condition Indices between 20-16 qualify as fully supporting, between 14-10 are partially supporting, and 8-4 are considered nonsupporting of aquatic life. The multi-habitat macroinvertebrate data are presented in Appendix C as laboratory bench sheets.

Additionally, macroinvertebrate data were analyzed in three specific ways. First, comparisons were made between Peruque Creek reaches where BMPs were being used and reaches where poor land practices were in place. Patterns were illustrated using XY line graphs with stream location (station number) on the X-axis and biological characteristics on the Y-axis. Secondly, Peruque Creek stations were compared to North Fork Cuivre River stations. Finally, data from Peruque Creek and North Fork Cuivre River were compared to biological criteria from reference streams within the same EDU and the same watershed size classification. Biocriteria data collected from fall 2002 and previous survey years constituted the basis of the comparison.

4.2 Physiochemical Data Collection and Analysis

During each survey period, *in situ* water quality measurements were collected at all stations. Field measurements included temperature (˚C), dissolved oxygen (mg/L), conductivity (µS/cm), and pH. Additionally, water samples were collected and analyzed by ESP's Chemical Analysis Section for turbidity (NTU), chloride, total phosphorus, ammonia-N, nitrate/nitrite-N, and total Kjeldahl nitrogen (**TKN**).

Stream velocity was measured at each station during each survey period using a Marsh-McBirney Flo-Mate Model 2000. Discharge was calculated per the methods in the Standard Operating Procedure MDNR-FSS-113, Flow Measurement in Open Channels (MDNR 2003).

Stream habitat characteristics for each sampling station were measured during the spring 2002 survey period using a standardized assessment analysis procedure as described for riffle/pool habitat in the Stream Habitat Assessment Project Procedure (MDNR 2000).

Physiochemical data were summarized and presented in tabular and graphic form for comparison among stations on Peruque Creek, and between Peruque Creek stations and those of North Fork Cuivre River and reference streams.

4.3 Benthic Sediment Percentage Estimation

Instream deposits of fine sediment [i.e., particle size less than approximately 2 mm (coarse sand)] were visually estimated for percent coverage per area at each macroinvertebrate sample station. To ensure sampling method uniformity, percent sediment coverage was estimated at the upper margins of pools and lower margins of riffle/run (coarse substrate) habitat. Depths of the sample areas did not exceed two (2.0) feet and water velocity was less than 0.5 feet per second (fps). A Marsh McBirney flow meter was used to ensure that water velocity of the sample area was within this range.

Three sediment estimation areas (grids) were placed within each macroinvertebrate sampling station (see Figure 1). Within each grid, six contiguous transects traversed the stream (see Figure 2). A tape measure was stretched from bank to bank at each grid. A 0.25 m^2 sample quadrat was placed directly on the substrate within each of the six transects. Placement of the quadrat within each transect was determined by using a random number that equated to one foot increments on the tape measure. The downstream edge of the quadrat was placed on the random foot increment. Two investigators estimated the percentage of the stream bottom covered by fine sediment within each quadrat. Estimates were accepted if the two observations were within a ten percent margin of error. If estimates diverged by more than ten percent, the investigators repeated the process until estimates were within an acceptable margin of error. An average of these two estimates was recorded and used for analysis.

Sediment deposition among sites was compared using Kruskal-Wallis one way analysis of variance on ranks. The mean percent sediment deposition at Peruque Creek stations was statistically compared to each other and to North Fork Cuivre River Station 1, which served as a control. All statistical interpretations were conducted using SigmaStat® (version 2.03, Jandel Scientific, San Rafael, California) software. An *a priori* p-value of <0.05 was selected to determine statistically significant differences among data sets.

4.4 Fecal Coliform Analysis

WQMS personnel collected water samples for fecal coliform analysis at three Peruque Creek locations and two North Fork Cuivre River locations. Samples were collected four times, at least two weeks apart, during the period from July 1 through September 4. Sample collection and analysis were conducted according to established MDNR

Figure 1: Sediment Estimation Grids within a Macroinvertebrate Sample Station

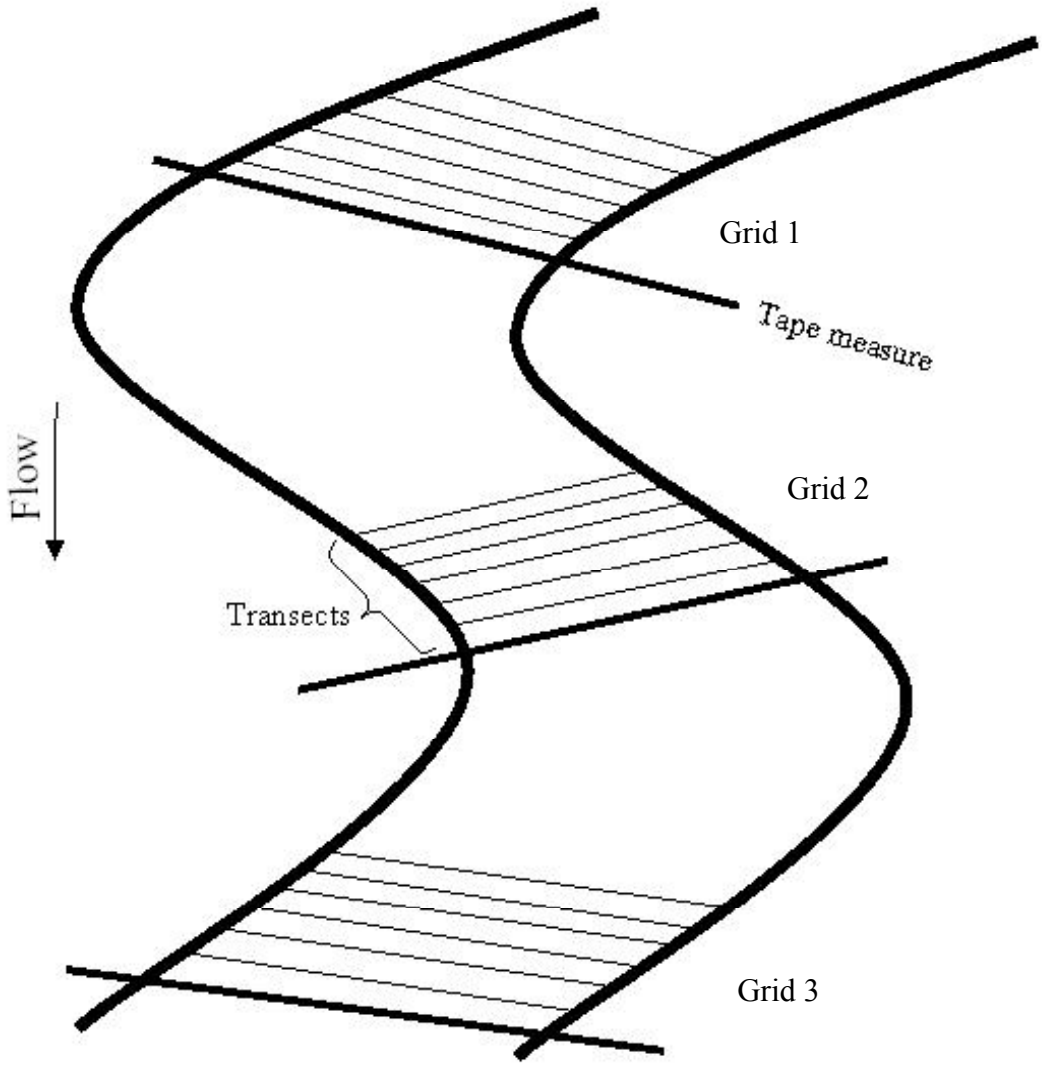
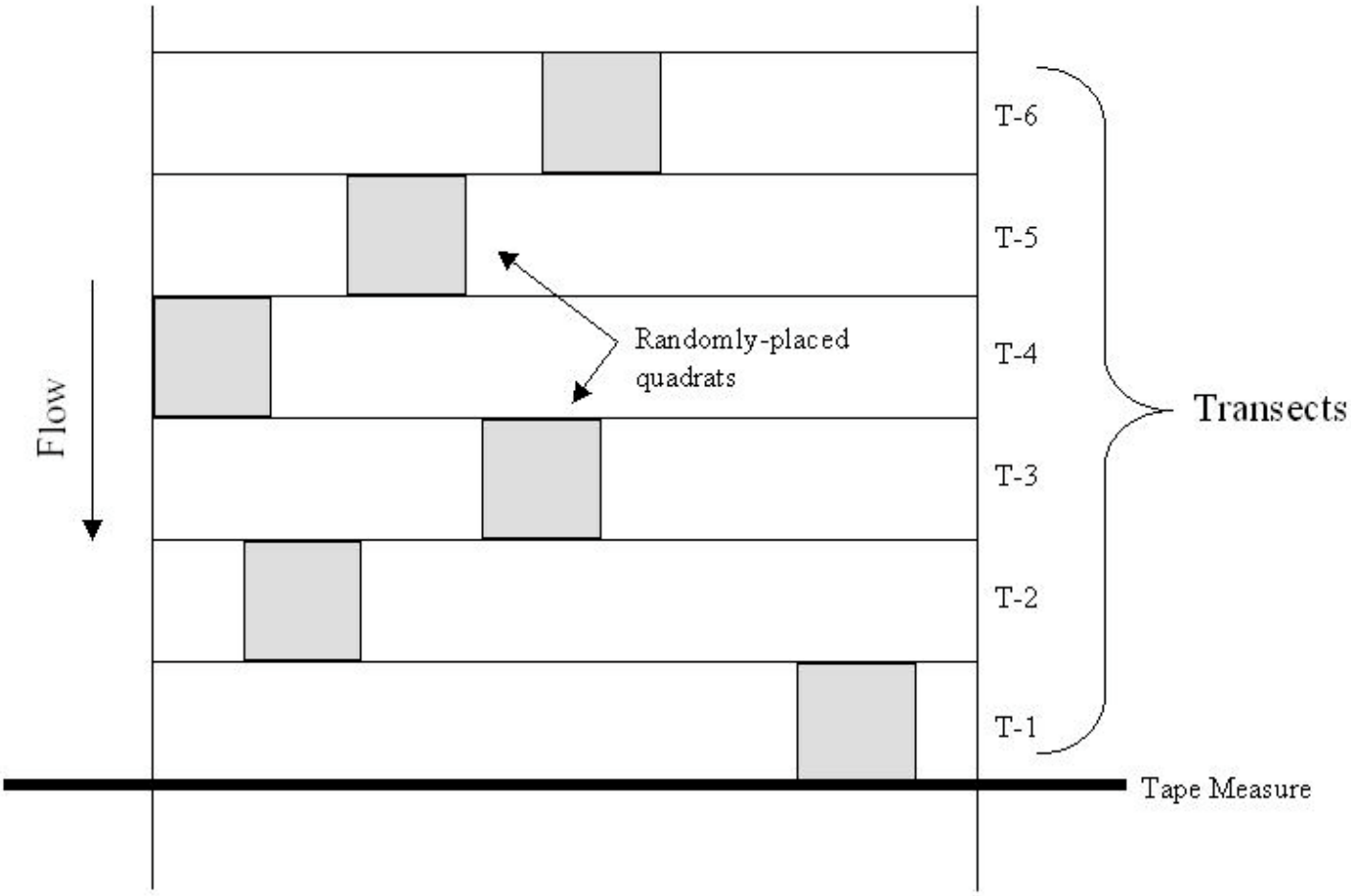


Figure 2: Sediment Sample Grid



protocols: MDNR-FSS-001, Required/Recommended Containers, Volumes, Preservatives, Holding Times, and Special Considerations (MDNR 2002a); MDNR-FSS-002, Field Sheet and Chain of Custody Record (MDNR 2001b); and MDNR-WQMS-108, Field Analysis of Fecal Coliform Bacteria (MDNR 2002b).

4.5 Quality Assurance/Quality Control (QA/QC)

QA/QC procedures were followed as described in the SMSBPP and in accordance with the Fiscal Year 2003 Quality Assurance Project Plans for "Wasteload Allocations and Other Special Studies" and "Biological Assessment."

5.0 Data Results

5.1 Physiochemical Data

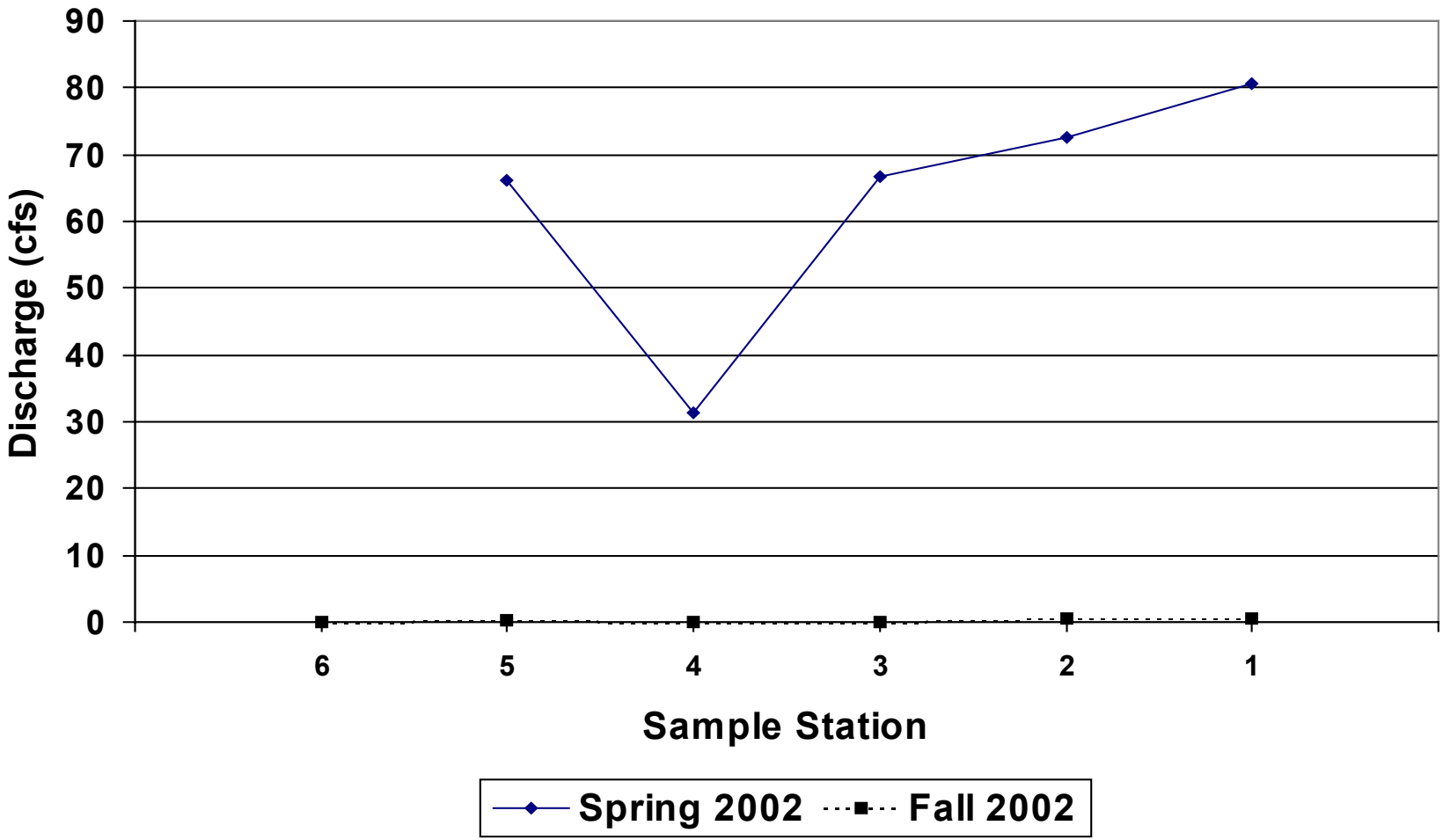
Physical characteristics of each Peruque Creek, North Fork Cuivre River, and South River station are presented in Table 2. Stream widths at Peruque Creek stations ranged from 8 to 24 feet with widths tending to increase while progressing downstream. Peruque Creek stream flow during the spring sample season generally increased in downstream stations with the exception of Station 4, which exhibited less than half the flow of either station upstream or downstream from it (see Figure 3). We are unable to explain this anomaly. Flow during the fall sample season was much reduced compared to spring flow rates in Peruque Creek. Upper stations had been nearly reduced to pools with very little water flowing across riffles. At Station 6, surface flow across riffles had ceased entirely.

Table 2
Physical Characteristics of the Stations

			Spring 2002	Fall 2002
Creek	Station	Avg. Width (ft.)	Flow (cfs)	Flow (cfs)
Peruque Cr.	1	24	80.7	1.02
	2	20	72.5	0.49
	3	23	66.6	0.06
	4	19	31.4	0.13
	5	11	66.2	0.26
	6	8	No data	0.0
NFCuivre River	1	75	54.0	1.69
	2	69	36.0	0.15
South River	1	No data	No data	0.50

In situ water quality measurements are summarized in Tables 3 (Spring 2002) and 4 (Fall 2002). Temperatures among sites varied seasonally, with mean temperatures at Peruque Creek stations higher in the fall (15.8˚C) than spring (4.2˚C). Water temperature at

Figure 3: Peruque Creek Discharge



Peruque Creek Stations 2 and 3 were much higher than at the remaining sites. Portions of Stations 2 and 3 were made up of extended reaches with shallow water and little or no tree canopy. The remaining four stations were mostly shaded. Mean water temperatures during fall 2002 at North Fork Cuivre River were considerably higher than at Peruque Creek. This difference can be attributed to the time of day at which the readings were taken (late afternoon) and to the fact that North Fork Cuivre River is wider than Peruque Creek and has more surface area exposed to sunlight.

Table 3
In situ Water Quality Measurements at all Stations (Spring 2002)

Creek/Station	Parameter				
	Temp. (˚C)	Diss. O_2 (mg/L)	Cond. (µS/cm)	pH	Turb. (NTU)
Peruque #1	3	13.9	262	7.5	42.6
Peruque #2	4	14.3	231	7.8	33.4
Peruque #3	4	13.8	260	7.9	42.1
Peruque #4	6	13.4	243	7.8	37.4
Peruque #5	4	13.3	209	7.7	280
Peruque #6	No data	No data	No data	No data	No data
NFCuivre R #1	4	12.7	383	7.9	28.2
NFCuivre R #2	4	13.9	372	8.1	32.3

Table 4
In situ Water Quality Measurements at all Stations (Fall 2002)

Creek/Station	Parameter				
	Temp. (˚C)	Diss. O_2 (mg/L)	Cond. (µS/cm)	pH	Turb. (NTU)
Peruque #1	15	6.2	411	7.3	21.4
Peruque #2	18.5	10.2	394	7.8	5.04
Peruque #3	20.5	7.16	421	7.7	25.5
Peruque #4	13	7.8	631	7.8	1.32
Peruque #5	14	9.95	1050	8.1	7.22
Peruque #6	14	2.56	527	7.6	41.6
NFCuivre R #1	22	8.35	534	7.7	20.6
NFCuivre R #2	22	8.58	543	7.8	9.93
South River #1	21.5	8.0	470	8.0	4.92

Turbidity levels varied widely among stations during fall 2002. During the spring, turbidity was generally higher and more consistent among sites. A notable exception occurred at Peruque Creek Station 5, downstream from the Wright City wastewater treatment facility, where turbidity was measured at 280 NTUs. This value was nearly seven times higher than the next highest reading during that season.

Conductivity and pH were consistent among sites and seasons with one exception. Conductivity at Peruque Creek Station 5 was 1050 µS/cm during the fall sampling season, almost double that of nearly every other sample location.

Nutrient concentrations as well as chloride concentrations are presented in Table 5 (Spring 2002) and Table 6 (Fall 2002). Ammonia as nitrogen was below the detection limit of 0.05 mg/L during both seasons for all stations at Peruque Creek and North Fork Cuivre River. This parameter was also below detectable limits for South River during the fall season. Nitrate/nitrite levels were generally higher in samples from spring 2002, with mean concentrations at North Fork Cuivre River being nearly triple those at Peruque Creek. Concentrations of TKN during the spring season among all Peruque Creek sites, however, were considerably higher than at North Fork Cuivre River. The lowest TKN reading at Peruque Creek was nearly five times higher than the highest concentration observed at North Fork Cuivre River. Other nutrient parameters varied mostly according to season, except at Peruque Creek Station 5. Concentrations of water chemistry parameters consistent with wastewater discharge (TKN, phosphorus, and chloride) were elevated at this site compared to other sites upstream and downstream.

Table 5
Nutrient Concentrations at all Stations (Spring 2002)

Creek/Station	Parameter				
	NH_3-N	NO_2/NO_3-N	TKN	Total Phos.	Chloride
Peruque #1	*	0.48	0.79	0.13	32.3
Peruque #2	*	0.46	0.78	0.12	22.6
Peruque #3	*	0.47	0.72	0.11	29.9
Peruque #4	*	0.58	0.59	0.14	18.5
Peruque #5	*	0.41	1.27	0.36	20.1
Peruque #6	No data	No data	No data	No data	No data
NFCuivre R #1	*	1.73	0.11	0.11	27
NFCuivre R #2	*	1.63	0.12	0.12	29.4

*below detectable limits

Table 6
Nutrient Concentrations at all Stations (Fall 2002)

Creek/Station	Parameter				
	NH_3-N	NO_2/NO_3-N	TKN	Total Phos.	Chloride
Peruque #1	*	0.13	0.31	0.07	20.9
Peruque #2	*	*	0.23	*	17
Peruque #3	*	*	0.29	0.06	18.6
Peruque #4	*	*	0.27	0.06	53.8
Peruque #5	*	0.49	1.59	1.11	134
Peruque #6	*	*	0.51	0.19	20.7
NFCuivre R #1	*	0.12	0.5	0.13	14.6
NFCuivre R #2	*	0.75	0.3	0.06	24.6
South River #1	*	0.39	*	0.07	29.3

*below detectable limits

5.2 Fecal Coliform Analysis

Fecal coliform bacteria concentration information for Peruque Creek and North Fork Cuivre River is presented in Table 7 (Summer 2002). During the July and September 2002 collection periods, Peruque Creek fecal coliform concentrations were higher at the Pointe Prairie Road monitoring site than the State Road T and Hepperman Road sites. The Pointe Prairie site is located downstream from wastewater treatment facilities (**WWTF**) for Foristell and Wright City. For the single sample collected in August, fecal coliform concentrations were lowest at Pointe Prairie among the three Peruque Creek sites, whereas an extremely high concentration of >6000 colony forming units/100 mL was observed at the State Road T collection site, downstream from the Wright City WWTF.

Table 7
Peruque Creek and North Fork Cuivre River Fecal Coliform Concentrations

Site Description	Collection Date	Discharge (cfs)	Fecal Coliform (cfu/100 mL)
Peruque Creek-State Road T	7-2-02	0.01[1]	30
Peruque Creek-State Road T	7-23-02	0.07[1]	50
Peruque Creek-State Road T	8-13-02	No flow[1]	>6000
Peruque Creek-State Road T	9-4-02	0.23[1]	90
Peruque Creek-Pointe Prairie Rd.	7-2-02	1.66[1]	300
Peruque Creek-Pointe Prairie Rd.	7-23-02	0.17[1]	105
Peruque Creek-Pointe Prairie Rd.	8-13-02	0.72[1]	50
Peruque Creek-Pointe Prairie Rd.	9-4-02	No flow[1]	210
Peruque Creek-Hepperman Rd.	7-2-02	0.58[1]	150
Peruque Creek-Hepperman Rd.	7-23-02	0.49[1]	90
Peruque Creek-Hepperman Rd.	8-13-02	No flow[1]	180
Peruque Creek-Hepperman Rd.	9-4-02	0.05[1]	95
North Fork Cuivre River-Highway 161	7-2-02	3.11	210
North Fork Cuivre River-Highway 161	7-23-02	3.94	440
North Fork Cuivre River-Highway 161	8-13-02	2.71	120
North Fork Cuivre River-Highway 161	9-4-02	1.86	100
North Fork Cuivre River-Co. Rd. 325	7-2-02	0.97	125
North Fork Cuivre River-Co. Rd. 325	7-23-02	4.04	440
North Fork Cuivre River-Co. Rd. 325	8-13-02	1.82	900
North Fork Cuivre River-Co. Rd. 325	8-13-02[2]	1.82	570
North Fork Cuivre River-Co. Rd. 325	9-4-02	0.23	520
North Fork Cuivre River-Co. Rd. 325	9-4-02[2]	0.23	370

[1]Discharge was measured the day prior to fecal coliform sampling.
[2]Duplicate sample.

At North Fork Cuivre River, fecal coliform concentrations were more consistent throughout the summer and were generally higher than the three stations on Peruque Creek. Samples collected in July were similar or slightly higher at Highway 161, the upstream station, when compared to the downstream station at County Road 325. Samples collected from County Road 325 in August and September, however, had substantially higher coliform concentrations than the upstream site.

5.3 Habitat Assessment

Habitat assessment scores were recorded for each sampling station. Results are presented in Table 8. According to the project procedure, for a study site to fully support a biological community, the total score from the physical habitat assessment should be 75% to 100% similar to the total score of the reference site. The mean habitat score for the two North Fork Cuivre River sites was 137.5; when the habitat scores for an additional reference stream were included, the average across all sites was 126. All Peruque Creek stations had habitat scores that exceeded or were within the aforementioned range of similarity. It was therefore inferred that the sites should support comparable biological communities.

Table 8
Reference Streams and Peruque Creek Habitat Assessment Scores

Reference Streams	Habitat Score	Peruque Creek	Habitat Score	% of Mean Ref.
NFCuivre R #1	138	Station #1	148	117%
NFCuivre R #2	137	Station #2	151	120%
North River #1	105	Station #3	138	110%
North River #2	125	Station #4	128	102%
		Station #5	153	121%
		Station #6	108	86%
Mean Ref. Stream Score	**126**			

5.4 Biological Assessment

5.4.1 Comparison of Peruque Creek BMP Sites versus non-BMP Sites

Of the six stations surveyed for macroinvertebrates, we judged four to have adjacent land uses consistent with best management practices (BMPs). The adjoining watersheds at the remaining two sites, Station 3 (Hepperman Road) and Station 4 (State Road T) were impacted by poor land use practices associated with property development at the time of the study. In spite of differences in land use practices among sites within the study reach, there was no direct impact observed with respect to the macroinvertebrate community. Total Taxa and EPT Taxa tended to increase progressing downstream in both spring and fall sample seasons regardless of adjacent land use (Figures 4 and 5). Other biological

Figure 4: Peruque Creek Total Taxa

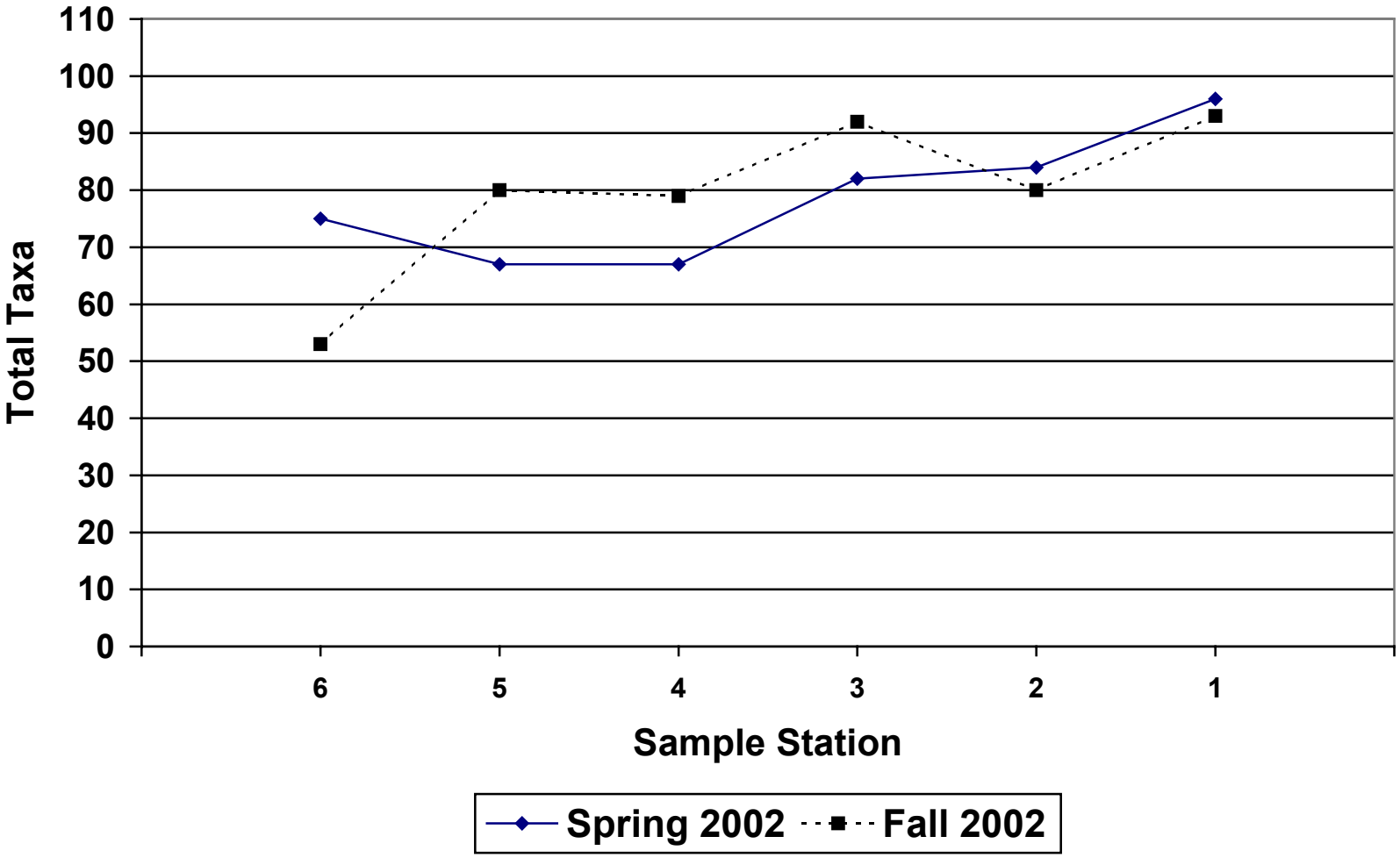
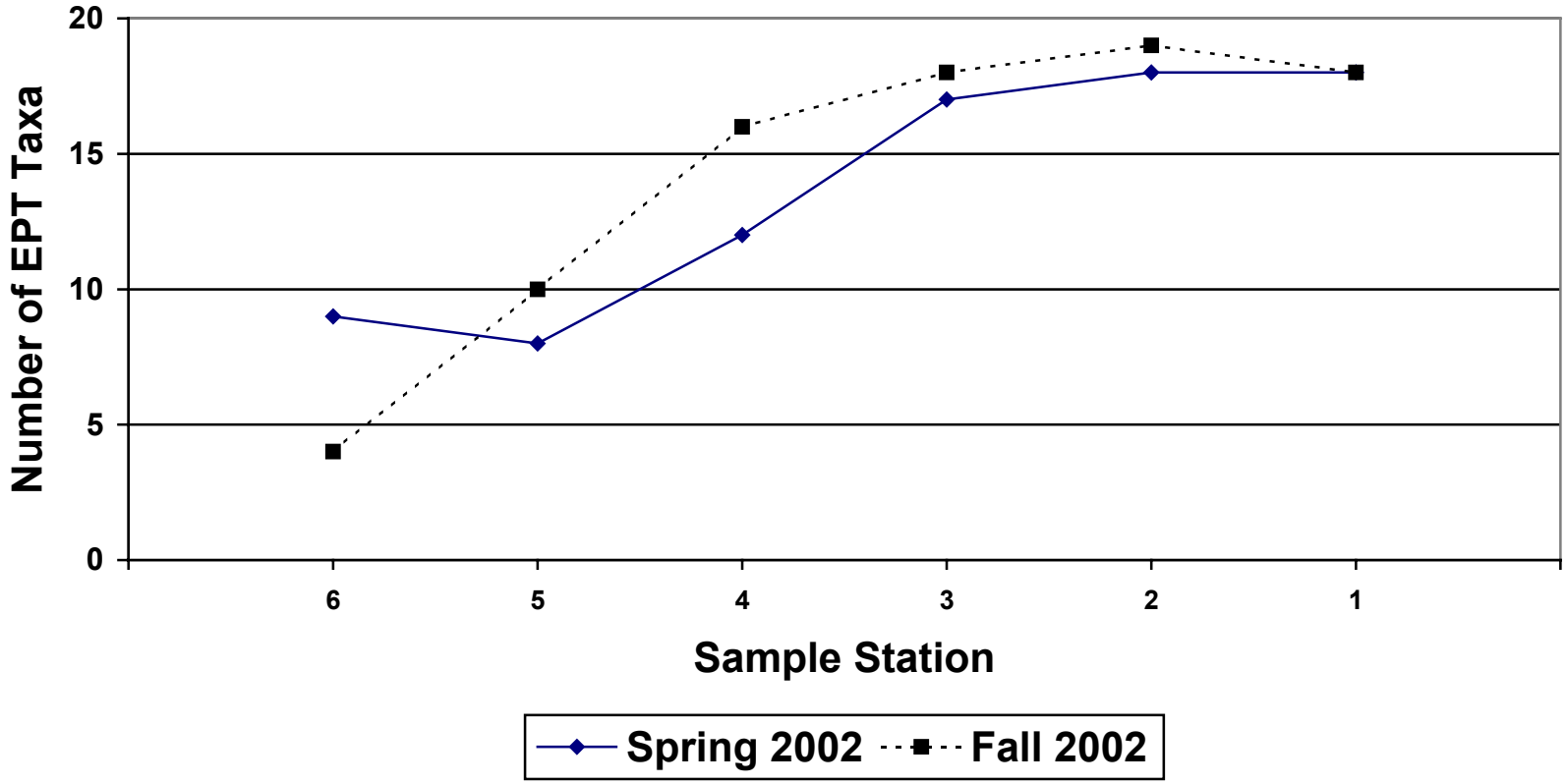


Figure 5: Peruque Creek EPT Taxa



indices and the SCI followed this trend during both sample seasons. Lowest numbers were observed in upstream stations, gradually increasing downstream (Tables 9 and 10).

Table 9
Peruque Creek Metric Values and Scores, Spring 2002 Season, Using Plains/Mississippi Tributaries between the Des Moines and Missouri Rivers EDU Biocriteria

Site #	TT	EPTT	BI	SDI	SCI	Support
#6 Value	75	9	8.01	2.66		
#6 Score	3	3	3	3	12	**Partial**
#5 Value	67	8	7.85	2.60		
#5 Score	3	3	3	3	12	**Partial**
#4 Value	67	12	8.19	2.19		
#4 Score	3	3	1	3	10	**Partial**
#3 Value	82	17	7.25	3.05		
#3 Score	5	3	3	3	14	**Partial**
#2 Value	84	18	6.81	3.30		
#2 Score	5	5	3	5	18	**Full**
#1 Value	96	18	7.07	3.37		
#1 Score	5	5	3	5	18	**Full**

Table 10
Peruque Creek Metric Values and Scores, Fall 2002 Season, Using Plains/Mississippi Tributaries between the Des Moines and Missouri Rivers EDU Biocriteria

Site #	TT	EPTT	BI	SDI	SCI	Support
#6 Value	53	4	7.77	3.10		
#6 Score	3	1	3	5	12	**Partial**
#5 Value	80	10	7.49	3.07		
#5 Score	5	3	3	5	16	**Full**
#4 Value	79	16	6.93	3.11		
#4 Score	5	3	3	5	16	**Full**
#3 Value	92	18	7.11	3.50		
#3 Score	5	3	3	5	16	**Full**
#2 Value	80	19	6.72	3.29		
#2 Score	5	5	3	5	18	**Full**
#1 Value	93	18	6.54	3.58		
#1 Score	5	3	3	5	16	**Full**

During the spring 2002 sample season, only the two downstream sample sites (Stations 1 and 2) were fully supporting, whereas the remainders were partially supporting. During the fall 2002 sample season, however, all but Station 6 achieved a fully supporting ranking. During fall sampling, Station 6 was nearly devoid of flow and the existing water was restricted to isolated pools.

5.4.2 Comparisons of Peruque Creek and North Fork Cuivre River versus Plains/Mississippi Tributaries between the Des Moines and Missouri Rivers EDU Biological Criteria

Metrics calculated for Peruque Creek and North Fork Cuivre River were compared to biological criteria from the PMSD EDU Biocriteria Reference Sites. These criteria are listed for the spring and fall sampling seasons in Tables 11 and 12, respectively. This comparison was made to assess the degree to which using biological criteria was applicable for Peruque Creek and North Fork Cuivre River. Most of the biocriteria reference streams are fourth and fifth order, whereas Peruque Creek and North Fork Cuivre River survey sites were second and third order. Larger streams may have more available habitat and higher numbers of macroinvertebrate taxa and diversity than smaller streams.

Table 11
Biological Criteria for Warm Water Reference Streams in the Plains/Mississippi Tributaries between the Des Moines and Missouri Rivers EDU Spring Season

	Score = 5	Score = 3	Score = 1
TT	>78	78-39	38-0
EPTT	>17	17-8	7-0
BI	<6.20	6.20-8.10	8.11-10
SI	>3.19	3.19-1.60	1.50-0

Table 12
Biological Criteria for Warm Water Reference Streams in the Plains/Mississippi Tributaries between the Des Moines and Missouri Rivers EDU Fall Season

	Score = 5	Score = 3	Score = 1
TT	>76	76-38	37-0
EPTT	>18	18-9	8-0
BI	<6.34	6.34-8.17	8.18-10
SI	>3.00	3.00-1.50	1.40-0

The four metrics calculated for the spring and fall sample seasons at Peruque Creek (Tables 9 and 10) and North Fork Cuivre River (Tables 13 and 14) were roughly comparable to the biological criteria reference metrics; however some seasonal differences were observed. During the spring season at the upper three stations of Peruque Creek, all four metric values were poorer than the reference metrics. With the exception of the Biotic Index metric, the scores of the downstream two stations exceeded

the reference metrics and were the only stations categorized as fully supporting for aquatic life. Each had Stream Condition Index scores of 18. During the spring season at North Fork Cuivre River, only the Total Taxa metric at the upstream station exceeded the reference metrics. Both North Fork Cuivre River sites were categorized as partially supporting for aquatic life.

Table 13
North Fork Cuivre River Metric Values and Scores, Spring 2002 Season, Using Plains/Mississippi Tributaries between the Des Moines and Missouri Rivers EDU Biocriteria

Site #	TT	EPTT	BI	SDI	SCI	Support
#2 Value	84	12	7.17	2.87		
#2 Score	5	3	3	3	14	**Partial**
#1 Value	73	13	6.69	2.83		
#1 Score	3	3	3	3	12	**Partial**

Table 14
North Fork Cuivre River Metric Values and Scores, Fall 2002 Season, Using Plains/Mississippi Tributaries between the Des Moines and Missouri Rivers EDU Biocriteria

Site #	TT	EPTT	BI	SDI	SCI	Support
#2 Value	72	13	7.33	3.11		
#2 Score	3	3	3	5	14	**Partial**
#1 Value	79	12	7.35	3.23		
#1 Score	5	3	3	5	16	**Full**

During the fall sample season, scores from all but the uppermost Peruque Creek site were sufficient to merit a fully supporting ranking. Relative to the other sites, Peruque Creek Station 6 was lacking in Total Taxa and EPT Taxa, dropping it to a partially supporting ranking. Metrics among North Fork Cuivre River sample sites during the fall season were similar, except that Total Taxa at the upstream site was slightly lower. This difference resulted in the upstream site receiving a partially supporting score, whereas the downstream site was categorized as fully supporting.

5.4.3 Macroinvertebrate Percent and Community Composition

The number of macroinvertebrate total taxa, EPT Taxa, and percent EPT for Peruque Creek and North Fork Cuivre River are presented in Tables 15 and 16. These tables also provide percent composition data for the five dominant macroinvertebrate families at each sample station. The percent of relative abundance data were averaged from the sum

Table 15 : Spring 2002 Peruque Creek and North Fork Cuivre River Macroinvertebrate Composition

	Peruque Creek Test Stations						North Fork Cuivre River Control Stations	
Variable-Station	6	5	4	3	2	1	2	1
Total Taxa	75	67	67	82	84	96	84	73
Number EPT Taxa	9	8	12	17	18	18	12	13
% Ephemeroptera	6.4	6.1	15.7	6.3	9.1	8.9	18.8	18.7
% Plecoptera	0.5	0.3	1.2	6.2	6.2	1.8	0.2	0.8
% Trichoptera	0.5	0.5	1.2	1.4	0.6	1.4	0.7	0.5
% Dominant Families								
Chironomidae	71.4	65.8	70.3	63.4	56.6	56.2	61.1	67.1
Tubificidae	7.9	8.1	2.8	-	-	4.6	9.6	2.5
Elmidae	5.9	11.0	-	-	6.3	8.1	3.4	6.0
Caenidae	4.3	5.0	15.3	4.8	-	3.4	15.2	12.9
Planorbidae	1.0	-	-	-	-	-	-	-
Enchytraeidae	1.0	-	1.3	-	-	-	-	-
Baetidae	1.0	-	-	-	3.7	-	-	3.4
Heptageniidae	1.0	-	-	-		-	2.8	-
Crangonyctidae	-	3.4	-	-	-	-	-	-
Hydrophilidae	-	-	1.5	-	-	-	-	-
Tipulidae	-	-	1.3	-	-	-	-	-
Ceratopogonidae	-	-	-	2.8	-	-	-	-
Lumbricidae	-	-	-	3.7	5.8	-	-	-
Perlodidae	-	-	-	3.3	-	-	-	-
Hyalellidae	-	-	-	-	4.1	3.9	-	-

Table 16 : Fall 2002 Peruque Creek and North Fork Cuivre River Macroinvertebrate Composition

	Peruque Creek Test Stations						North Fork Cuivre River Control Stations	
Variable-Station	6	5	4	3	2	1	2	1
Total Taxa	53	80	79	92	80	93	72	79
Number EPT Taxa	4	10	16	18	19	18	13	12
% Ephemeroptera	2.8	9.9	33.0	29.6	36.0	21.9	22.4	15.0
% Plecoptera	-	-	-	-	-	0.1	-	-
% Trichoptera	0.8	2.2	14.3	2.3	12.3	18.6	1.8	2.5
% Dominant Families								
Chironomidae	38.0	20.8	26.0	27.6	10.7	19.2	27.7	19.2
Elmidae	12.8	12.4	-	5.9	-	8.4	4.3	18.0
Planorbidae	10.5	6.8	-	-	-	-	-	-
Hyalellidae	9.4	-	8.7	8.4	10.9	-	-	-
Physidae	8.5	24.1	-	-	-	-	6.1	7.6
Heptageniidae	-	7.8	-	-	-	-	-	-
Caenidae	-	-	23.4	19.6	18.8	10.1	19.3	9.2
Hydropsychidae	-	-	7.1	-	7.0	8.1	-	-
Philopotamidae	-	-	5.6	-	-	8.4	-	-
Coenagrionidae	-	-	-	5.5	-	-	-	-
Tricorythidae	-	-	-	-	9.6	-	-	-
Baetidae	-	-	-	-	-	-	-	-
Ancylidae	-	-	-	-	-	-	17.3	-
Tubificidae	-	-	-	-	-	-	-	17.3

of the three macroinvertebrate habitats (coarse substrate, nonflow, and rootmat) sampled at each station. Spring 2002 macroinvertebrate samples from Peruque Creek Station 6, the uppermost sample station, contained 75 total taxa and 9 EPT Taxa (Table 15). Peruque Creek Station 1, the most downstream sample station, contained 96 total taxa and 18 EPT Taxa. Midge larvae (Chironomidae) were the dominant taxa at all sites, comprising a smaller percentage of the whole at the lower two stations. Square gill mayflies (Caenidae) were among the top five taxa at all sites except Peruque Creek Station 2. Riffle beetles (Elmidae) and aquatic worms (Tubificidae) both were present among the top five taxa at four of the six sites. Stonefly (Plecoptera) and caddisfly (Trichoptera) taxa were present in all spring samples; however only Station 3 had perlodid stoneflies (Perlodidae) among the five dominant taxa.

During the fall 2002 sample season, total taxa at Peruque Creek Station 6 dropped to 53 and EPT Taxa fell to 4, likely due to a lack of coarse substrate habitat at this site (Table 16). At Station 1, however, total taxa were relatively unchanged at 93 and EPT remained at 18. The proportion that mayflies (Ephemeroptera) and caddisflies contributed to the sample, however, increased greatly in the fall samples. This trend was especially true for the lower four stations where mayflies made up between 21.9 and 36.0 percent of the samples. With the exception of Station 3, caddisflies also were a major contributor to the total count at the lower four stations, comprising between 12.3 to 18.6 percent of samples. Peruque Creek Station 3, where caddisflies comprised 2.3 percent of the total sample, was most similar in this respect to Station 5, where caddisflies made up 2.2 percent of the sample. Chironomids contributed a much lower percentage of samples during the fall, but still were the dominant taxa at all but Station 5 and Station 2. At Station 5, physid snails (Physidae) were the dominant taxa (24.1 percent); caenid mayflies were the dominant taxa at Station 2 with 18.8 percent. Caenid mayflies were second in abundance only to chironomids at each of the four downstream Peruque Creek sample stations, except Station 2 where they were dominant. Elmid beetles, caenid mayflies, and scuds (Hyalellidae) each were among the five dominant taxa at four of the six sample sites. With the exception of a single common stonefly (Perlidae) collected at Peruque Creek Station 1, there were no stoneflies included in any of the fall samples.

Spring 2002 macroinvertebrate samples from North Fork Cuivre River, the control stream, exhibited roughly similar total taxa compared to Peruque Creek as a whole. The number of EPT Taxa was similar to the upper reaches of Peruque Creek where fewer EPT Taxa were documented. The proportions of mayflies in the North Fork Cuivre River samples, however, were much higher than Peruque Creek with mayflies comprising nearly 19 percent of samples at both stations. Chironomids were the dominant taxa at both sites, followed by caenid mayflies. Aquatic worms and riffle beetles also were included among the five dominant taxa. Although stoneflies and caddisflies were represented at both North Fork Cuivre River sites, neither were present in abundance and both comprised less than one percent of individuals in samples.

During the fall 2002 sample season, total taxa and EPT Taxa at North Fork Cuivre River again were comparable to the upper Peruque Creek stations. As was observed at Peruque

Creek fall samples, chironomids were dominant at both sites, but at much lower percentages. Riffle beetles and aquatic worms were nearly as abundant as chironomids at North Fork Cuivre River Station 1. At Station 2, caenid mayflies and limpet snails (Ancylidae) were second and third in abundance, respectively. Caddisflies were present in samples from both sites, but in relatively low abundance. Although several caddisfly genera were found in samples, *Cheumatopsyche*, was dominant among Trichoptera taxa. No stoneflies were collected at North Fork Cuivre River during the fall sample season.

Macroinvertebrate data for three PMSD EDU biocriteria reference streams sampled between spring 1999 and fall 2002 are presented in Table 17. For consistency, two samples from North River, which had been sampled as a glide-pool regime, and a sample collected from South Fabius River, which had no nonflow habitat, were excluded.

Total taxa for the biocriteria reference streams ranged from 78 to 85 during spring and from 66 to 82 during fall samples. Total EPT Taxa ranged from 17 to 22 in spring samples and from 14 to 21 during fall. No distinct trends were apparent among sites with respect to percent Ephemeroptera. Among South River samples, percent Ephemeroptera was slightly higher in fall samples compared to those collected in the spring, but was fairly stable among samples collected in 1999 and 2000. In South River fall 2002 samples, however, mayflies were nearly twice as abundant compared to spring samples of previous years. Mayflies comprised nearly half of individuals in the spring 1999 sample collected at South Fabius River, but were relatively sparse in fall 2001 North River samples. Caddisflies also were consistently higher in fall samples, but stoneflies were absent or nearly absent in the fall. Chironomids were more abundant in spring South River samples and were the dominant taxa in both 1999 seasons and in spring 2000. Chironomids also were the dominant taxa in South Fabius River and North River samples. Stout crawling mayflies (Tricorythidae) were the dominant taxa in South River fall samples, making up 26.1 percent of individuals in 2000 samples and 36.9 percent in 2002 samples. Chironomids and elmid beetles were among the dominant taxa for nearly all samples collected.

The fall 2002 South River sample exhibited some differences compared with samples collected from previous years at the same site. Both total taxa and EPT Taxa were lower, although one mayfly family, Tricorythidae, increased during this season, resulting in a higher relative abundance of mayflies. Also, the relative abundance of tubificid worms increased such that they were among the five dominant taxa.

5.5 Benthic Sedimentation Analysis

Percentage of benthic fine sediment was measured at each sample station on Peruque Creek and North Fork Cuivre River in July 2002. Peruque Creek Station 1 had fewer than the three riffle-pool complexes desired for sediment estimation. Subsequently, sediment estimation was based on a single quadrat at this site. At North Fork Cuivre River Station 2, only two riffle-pool complexes were available for benthic sediment

Table 17: Plains/Mississippi Tributaries between the Des Moines and Missouri Rivers EDU Biocriteria Reference Stream Macroinvertebrate Composition

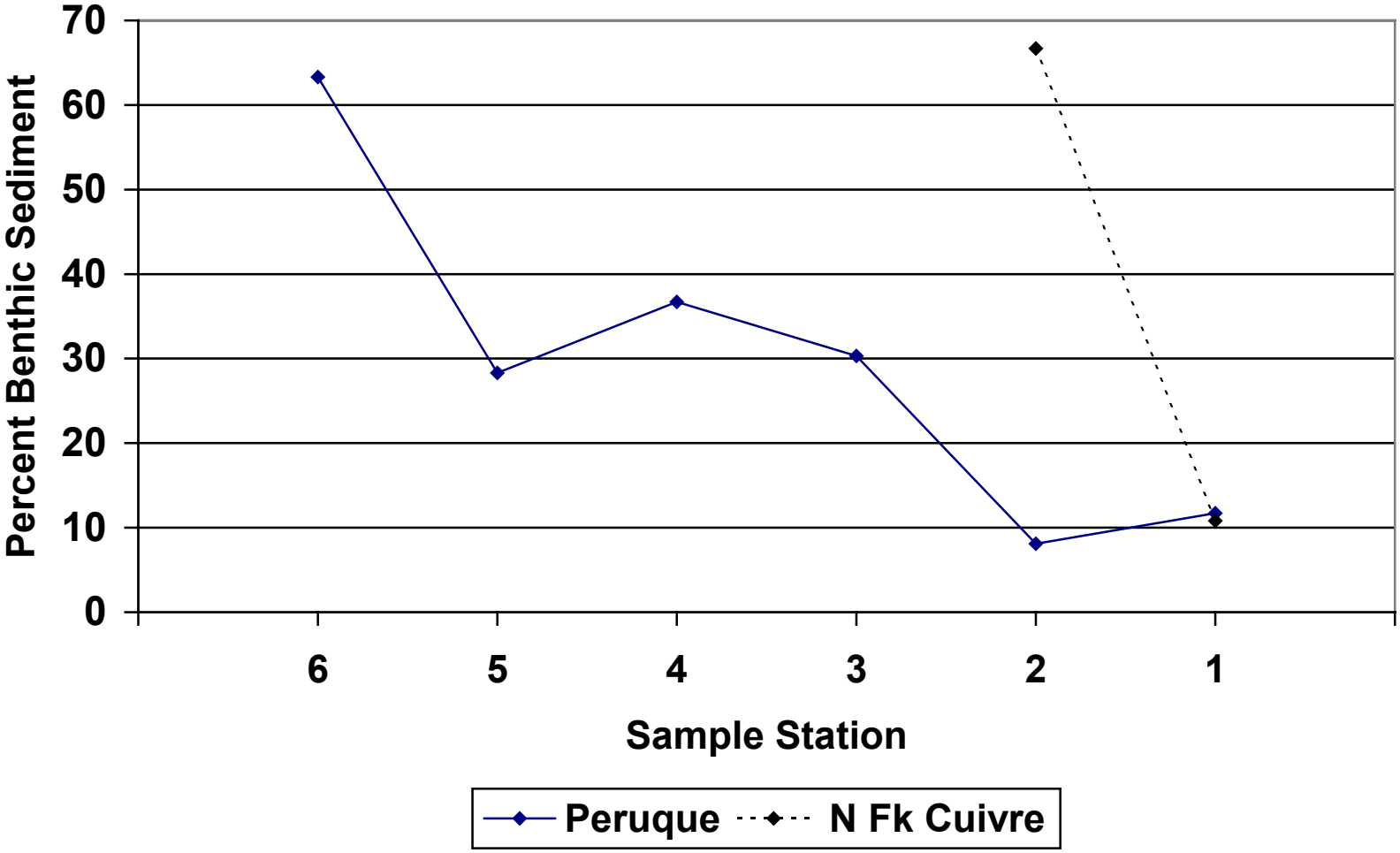
	South River		South Fabius River	South River		North River		South River
Variable-Season	Spring 1999	Fall 1999	Spring 1999	Spring 2000	Fall 2000	Fall 2001 (Station 1)	Fall 2001 (Station 2)	Fall 2002
Total Taxa	82	79	78	85	81	81	82	66
Number EPT	17	18	22	20	18	17	21	14
% Ephemeroptera	23.4	26.6	48.8	20.7	31.7	8.1	17.4	40.2
% Plecoptera	2.8	0.1	2.4	1.1	-	-	-	-
% Trichoptera	5.4	24.3	1.3	5.2	11.8	19.8	12.8	17.5
% Dominant Families								
Chironomidae	34.2	27.1	22.5	46.2	21.5	43.9	33.0	13.1
Elmidae	18.7	7.5	-	9.9	14.1	12.5	12.2	5.7
Caenidae	12.2	7.9	15.9	10.4	-	-	-	-
Tricorythidae	7.1	10.1	-	4.4	26.1	3.2	7.0	36.9
Gammaridae	3.8	-	-	-	-	-	-	-
Philopotamidae	-	10.2	-	-	-	-	-	10.5
Heptageniidae	-	-	9.0	5.1	-	-	-	-
Hydropsychidae	-	-	-	-	4.7	15.9	7.0	-
Tubificidae	-	-	7.7	-	-	-	-	6.7
Hyalellidae	-	-	-	-	6.7	-	10.8	-
Baetidae	-	-	17.8	-	-	-	-	-
Coenagrionidae	-	-	-	-	-	4.2	-	-

estimation. Mean percent fine sediment was calculated for all sites and used for statistical analysis, despite having less than the desired number of observations. Benthic sediment estimates for Peruque Creek and North Fork Cuivre River are presented in Table 18. Among Peruque Creek sample sites, mean percent sediment was highest at Peruque Creek Station 6 (63%) and tended to decrease in downstream stations (Figure 6), with the lowest percentage occurring at Station 2 (8%). Mean sediment percentage at Station 6 was significantly higher than both Stations 1 and 2 ($p<0.05$). Among Peruque Creek non-BMP sites, sedimentation at Station 4 (37%) was only significantly higher than Station 2 ($p<0.05$). No other statistically significant differences occurred among Peruque Creek sites. When using sediment estimates from North Fork Cuivre River Station 1 (11%) as a control to compare with Peruque Creek, only Peruque Creek Station 6 was significantly higher than the control ($p<0.05$).

Table 18
Percentage of Benthic Sediment Observed per Grid-Quadrat at Peruque Creek and North Fork Cuivre River Sample Stations, July 2002.

	Peruque Creek						North Fork Cuivre River	
Grid No.-Quadrat No.	Station 6	Station 5	Station 4	Station 3	Station 2	Station 1	Station 2	Station 1
1-1	100	100	30	0	0	0	90	55
1-2	70	40	45	85	10	0	100	30
1-3	75	95	50	5	5	50	100	15
1-4	10	20	30	5	5	0	100	0
1-5	45	5	100	0	5	0	80	10
1-6	100	5	85	15	10	20	100	15
2-1	75	5	5	70	5	----	90	5
2-2	50	10	10	35	0	----	5	5
2-3	20	15	5	15	100	----	0	5
2-4	35	5	20	100	0	----	5	20
2-5	30	0	80	100	5	----	30	0
2-6	40	0	10	100	0	----	100	15
3-1	100	30	5	5	0	----	----	5
3-2	100	100	10	0	0	----	----	5
3-3	85	5	60	5	0	----	----	5
3-4	100	0	5	0	0	----	----	0
3-5	5	50	15	5	0	----	----	0
3-6	100	25	95	0	0	----	----	5
Mean	**63**	**28**	**37**	**30**	**8**	**12**	**67**	**11**

Figure 6: Peruque Creek and North Fork Cuivre River Benthic Sediment Estimates



Sediment trends at North Fork Cuivre River may be similar to those observed at Peruque Creek. The highest fine sediment estimate was observed at the upstream site, Station 2 (67%), compared to 11% observed at the downstream site at Station 1. The relatively high sedimentation at North Fork Cuivre River Station 2 was comparable only to Peruque Creek Station 6. North Fork Cuivre River Station 2 sedimentation was most similar to the two downstream stations on Peruque Creek.

6.0 Discussion

Although some of the differences among water quality parameters can be attributed to seasonality, results from Peruque Creek and North Fork Cuivre River indicated important differences both among sample stations and between streams. Dissolved oxygen, turbidity, and NO_2+NO_3-N were higher in most spring samples at all sites. Other nutrients were not perceptibly different in spring versus fall samples.

When anomalous water quality results were noted in fall samples, many were associated with Station 5, which was located downstream from the Wright City WWTF. Conductivity, TKN, phosphorus, and chloride readings from Station 5 were all higher than those from samples collected upstream or downstream. Compared to samples collected at other Peruque Creek sites, each of these parameters from Station 5 were considerably higher in the fall samples. During the spring however, TKN and phosphorus were elevated, but chloride was comparable to other sites. Concentrations of NO_2+NO_3-N were higher in spring North Fork Cuivre River samples when compared to Peruque Creek stations. This observation is likely associated with the amount of cattle observed grazing in the watershed.

The highest fecal coliform concentrations consistently occurred at the Pointe Prairie site, which was located downstream of WWTFs from Wright City and Foristell. Based on design flow, the Wright City facility (350,000 gpd) is able to contribute considerably more effluent to Peruque Creek than the Foristell facility (11,700 gpd). With the exception of one extremely high reading of >6000 colony forming units (cfu), however, the fecal coliform concentration was lower by at least half at the State Road T site, which was downstream from the Wright City WWTF but upstream from the Foristell facility. Whether attenuation occurred by the time effluent reached the Hepperman Road site is questionable. Fecal coliform concentrations were actually higher in July and August in samples collected at the Hepperman Road site than at Pointe Prairie, the nearest upstream sample collection site.

Despite flowing through a watershed with greater urban influence than reference streams within the PMSD EDU (11 percent for Peruque Creek versus 1.1 percent for the EDU), habitat scores for Peruque Creek were at least 86 percent of the average of reference and control streams. A total of four Peruque Creek sites were chosen that had no active land disturbance immediately adjacent to the study reach and served as BMP sites. These sites generally had good riparian corridor widths, but other factors such as suitable substrate and water quality influences were variable. The remaining two non-BMP Peruque Creek

sites were situated near ongoing land disturbance, both of which were associated with the construction of new housing developments. Land use near Station 4, upstream of State Road T, included the clearing of a hillside for home construction and a stormwater ditch leading from the construction site to Peruque Creek. At the beginning of the study, during the spring 2002 sample season, the bottom of this ditch was approximately five feet higher than the bottom of the creek. When the ditch was observed during the fall 2002 sample season, it had eroded downward nearly two vertical feet. Peruque Creek Station 3 at Hepperman Road was also situated near an ongoing housing development. In addition, a golf course had been built between the subdivision and the creek. The creek at this study site had undergone considerable changes likely due to heavy stormwater runoff during the late spring and summer months of 2002. For example, at the outfall of a discharge pipe (12 to 18 inch diameter) leading from the golf course, stormwater had cut a gully approximately three feet deep through a gravel bar that parallels Peruque Creek on the right descending bank. A silt fence, which appeared to have come from the development site, was observed partially buried in the gully and stretching down into the creek.

Despite the observations described above, land use immediately adjacent to study sites appeared to have little discernible effect on the Peruque Creek macroinvertebrate community at the time of this study. Numbers of total taxa and EPT Taxa tended to increase while progressing downstream, a trend consistent among seasons. During the spring sample season, both non-BMP sites achieved a rating of partially supporting, as did each station upstream. Downstream from these sites, however, the remaining stations were fully supporting for biological life. During the fall season, each of the lower five stations was fully supporting, regardless of land use. Aquatic habitat availability likely played a more important role in determining the overall sustainability score among sites. Sites where macroinvertebrate numbers were poorest tended to have more bedrock as benthic substrate. At these sites, particularly at Stations 5 and 2, substrate types commonly sampled for nonflow and coarse substrate habitats were somewhat sparse. Coupled with habitat availability was the issue of flow status. Although each site except Station 6 (which was reduced to isolated pools) achieved the status of fully supporting, very little flowing water was present at many of the sites during the fall sample season. It is, therefore, curious that so many of the stations along Peruque Creek (i.e., the four upstream stations) only achieved a partially supporting rating during the spring sample season when flow was abundant. One explanation may be that high spring flows had possibly been sufficient to scour the stream bottom prior to sampling, resulting in lower insect numbers at Peruque Creek sites. Another may be that materials that accumulate over the winter on impervious surfaces (e.g. roads and parking lots) may be carried into the creek by runoff associated with snowmelt and early spring rains, which may have a negative effect on the macroinvertebrate community.

Relative to adjacent land use, no changes in benthic sedimentation among study sites was observed. Although erosion associated with land disturbance was observed at two Peruque Creek sample stations, sedimentation was not higher at either site or at downstream stations. Given the changes observed in some stream characters that took

place during the spring and summer of 2002 (e.g. elimination of gravel bars, downed trees), it is likely that sediment entering the stream during this time remained entrained through the study reach and was not deposited. In addition, bedrock was common at many of the study sites, which may reduce the amount of instream sediment deposition.

A notable characteristic of the macroinvertebrate data is the large increase Chironomidae taxa contribute to the spring samples compared to fall. Whereas chironomids comprise an average of 23.7 percent of individuals among Peruque Creek fall samples (range 10.7-38.0), they averaged 64 percent in spring samples (range 56.2-71.4). This increase in the proportion of chironomid taxa also was observed in North Fork Cuivre River samples, the local control site. At the bioreference sites for which spring and fall data are available, this trend appears to be variable. During the 2000 season at South River for example, chironomids made up 46.2 percent of samples in spring 2000, but only 21.5 percent in fall. In 1999 there was less of a discrepancy among seasons, with chironomids comprising 34.2 percent of samples in spring and 27.1 percent in fall. Although the relative contribution of chironomids in fall samples was less, they remained among the five most dominant taxa. Mayflies, however, made a more substantial contribution to the sample in fall, especially in the downstream four stations. At Peruque Creek Station 5, the relatively pollution-tolerant physid snails (*Physa* sp.), which have a biotic index value of 9.1 (with 10 being most tolerant), were the dominant taxa. At the remaining downstream stations, chironomids and caenid mayflies were most abundant.

7.0 Summary

1. In determining whether adjacent land practices directly impacted Peruque Creek, none of the factors studied-macroinvertebrate biological metrics and sustainability scores, water chemistry, fecal coliform concentrations, benthic sedimentation, nor habitat scores-were noticeably different at Peruque Creek BMP sites compared to non-BMP sites. Based on our observations, therefore, we are unable to reject the first five null hypotheses of the study. Conclusions for the remaining five hypotheses, comparing Peruque Creek with reference streams within the PMSD EDU, were variable.

2. Water quality samples collected at Peruque Creek Station 5, located downstream from the Wright City WWTF, exhibited higher TKN and phosphorus concentrations than samples collected at other sites. During the fall sample season, each of the following parameters was elevated at Station 5: NO_2+NO_3-N; TKN; phosphorus; and chloride.

3. Water quality samples collected at both North Fork Cuivre River stations had elevated levels of NO_2+NO_3-N during the spring season. Although levels were lower in fall samples, NO_2+NO_3-N concentrations at North Fork Cuivre River remained higher than all Peruque Creek sites except Station 5.

4. Peruque Creek fecal coliform concentrations tended to be highest at the Pointe Prairie monitoring site, which is downstream from both Wright City and Foristell WWTFs.

Fecal coliform levels at North Fork Cuivre River sites were consistently higher than at Peruque Creek.

5. Lack of available habitat and flow appeared to be a dominant factor affecting benthic macroinvertebrates at both Peruque Creek and North Fork Cuivre River.

6. Total taxa and EPT Taxa tended to increase in downstream Peruque Creek stations. Fall sample season trends among sites for these two metrics mirrored those from spring.

7. The Semi-quantitative Macroinvertebrate Stream Bioassessment Project Procedure found that during spring 2002 the macroinvertebrate community of Peruque Creek Stations 1 and 2 was fully supporting and partially supporting at the remaining upstream four sites. All Peruque Creek sample sites, with the exception of Station 6, were fully supporting during fall 2002. Although the creek at Station 6 was reduced to isolated pools, the macroinvertebrate community was partially supporting.

8. Benthic fine sediment was lower in downstream Peruque Creek stations. Sediment estimates from Station 6, however, were based on a single suitable area within the study reach. This factor may have contributed to an artificially high sediment estimate for this site.

8.0 Literature Cited

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Appendix A

Proposed Bioassessment Study Plan
Peruque Creek
January 16, 2002

Missouri Department of Natural Resources
Assessment Study Proposal
Peruque Creek, St. Charles County
January 16, 2002
Objectives

The Peruque Creek watershed originates in eastern Warren County, Missouri, with the majority occurring in St. Charles County. The downstream reach of this stream is located in a heavily developed urban area. The upper and middle portions of the watershed are rural, but are becoming increasingly urbanized as St. Louis urban sprawl continues westward. Peruque Creek was placed on the 303(d) list due to potential water quality degradation associated with urban development including stormwater runoff and likely detrimental effects on the stream channel and riparian areas. We propose, therefore, to conduct a macroinvertebrate, chemical, and physical assessment of Peruque Creek. Our objectives are to determine: 1) whether there is aquatic life impairment in the most urbanized portions of the creek relative to sections upstream; 2) whether aquatic life in Peruque Creek is impaired relative to that of regional reference streams; and 3) whether this stream is impaired due to nutrification and sedimentation from urban runoff.

Null Hypotheses

1) The macroinvertebrate assemblages will not differ between reaches of Peruque Creek where best management practices (BMPs) are in use in the watershed and reaches where poor management practices are used in the watershed.

2) Water chemistry will not differ between reaches of Peruque Creek where BMPs are in use in the watershed and reaches where poor management practices are used in the watershed.

3) Fecal coliform concentrations will not differ between reaches of Peruque Creek where BMPs are in use in the watershed and reaches where poor management practices are used in the watershed.

4) Benthic sediment percentage estimates will not differ between reaches of Peruque Creek where BMPs are in use in the watershed and reaches where poor management practices are used in the watershed.

5) Measures of habitat quality will not differ between reaches of Peruque Creek where BMPs are in use in the watershed and reaches where poor management practices are used in the watershed.

6) Macroinvertebrate assemblages will not differ between Peruque Creek and reference streams within the Plains/Mississippi Tributaries between Des Moines and Missouri Rivers Ecological Drainage Unit (EDU).

7) Water chemistry will not differ between Peruque Creek and reference streams within the Plains/Mississippi Tributaries between Des Moines and Missouri Rivers EDU.

8) Fecal coliform concentrations will not differ between Peruque Creek and reference streams within the Plains/Mississippi Tributaries between Des Moines and Missouri Rivers EDU.

9) Benthic sediment percentage estimates will not differ between Peruque Creek and reference streams within the Plains/Mississippi Tributaries between Des Moines and Missouri Rivers EDU.

10) Measures of habitat quality will not differ between Peruque Creek and reference streams within the Plains/Mississippi Tributaries between Des Moines and Missouri Rivers EDU.

Background

Streams subjected to urban development are particularly vulnerable to water quality and habitat degradations. Water quality could be reduced by wastewater treatment plant discharges, accidental or deliberate spills, illegal dumping, and sedimentation due to increased runoff. Habitat losses often result from residential or commercial development. It is believed that the pace and extent of development in the area may threaten the biological integrity of Peruque Creek, which flows through St. Charles County. This belief has prompted a joint effort between the Missouri Department of Natural Resources (MDNR) and the Missouri Department of Conservation (MDC) to determine the current status of Peruque Creek. The MDC has collected water quality samples, fish community surveys, and has conducted habitat assessments at sites along Peruque Creek. The MDNR and MDC will continue to collect water quality, bacteriological, and biological samples from the creek.

Study Design

General: The study area includes approximately 14 miles of Peruque Creek. The upstream boundary of the Peruque Creek study area is just south of Wright City at Ruge Park; the downstream boundary is at Duello Road, west of Lake St. Louis. A total of six Peruque Creek stations will be surveyed, one/two in which BMPs are used in the watershed and four/five where poor management practices are in use. The general locations are listed in Table 1 beginning with the most downstream site.

Table 1
Peruque Creek Sample Locations

Sample Site (Station Number)	Geographic Location	Watershed Size (mi^2)
Duello Road (#1)	SW ¼ sec. 32, T. 47 N., R. 2 E.	43
Wilmer Road (#2)	NE ¼ NE ¼ sec. 35, T. 47 N., R. 1 E.	35
Hepperman Road (#3)	Sur. 149, T. 47 N., R. 1 E.	24
State Road T (#4)	W ½ sec. 30, T. 47 N., R. 1 E.	18
Archer Road (#5)	SW ¼ SW ¼ sec. 23, T. 47 N., R. 1 W.	9
Ruge Park (#6)	W ½ sec. 22, T. 47 N., R. 1 W.	5

Peruque Creek is in a geologic and soil transition area where the Ozark/Moreau/Loutre EDU and the Plains/Mississippi tributaries between the Des Moines and Missouri Rivers EDU converge. Biological, chemical, bacteriological, and habitat comparisons will be made between the sample locations on Peruque Creek and two sites on North Fork Cuivre River, a local reference stream. In addition biological, chemical, bacteriological, and habitat comparisons will be made between the stations on Peruque Creek, North Fork Cuivre River, and three regional biocriteria reference streams.

Biological Sampling: Each macroinvertebrate station will consist of a length approximately 20 times the average stream width, and will contain at least two riffle areas. To assess variability among sampling stations, stream discharge measurements, water quality samples, and habitat assessments will be recorded during macroinvertebrate surveys. Sampling will be conducted during spring 2002 (March 15 through April 15) and fall 2002 (September 15 through September 30).

Macroinvertebrates will be sampled according to the guidelines of the Semi-Quantitative Macroinvertebrate Stream Bioassessment Project Procedure (SMSBPP). Peruque Creek will be considered a "riffle/pool" dominated stream, with samples to be collected from flow over coarse substrate, depositional (non-flow), and rootmat habitats. Each macroinvertebrate sample will be a composite of six subsamples within each habitat. Fish community surveys also have been conducted at each of the six sample sites and that information will be shared with MDNR.

Water Quality Sampling: Water quality samples will be collected on alternate weeks by MDC personnel from March 1, 2002 through September 30, 2002 at three locations on Peruque Creek and two sites on North Fork Cuivre River. The samples will be collected per MDNR-FSS-001 (Required/Recommended Containers, Volumes, Preservatives, Holding Times, and Special Considerations) and MDNR-FSS-002 (Field Sheet and Chain-of-Custody Record). All water samples will be analyzed for ammonia-nitrogen, nitrite- and nitrate-nitrogen, total Kjeldahl nitrogen, total phosphorus, chloride, turbidity,

and total and volatile suspended solids. Stream discharge measurements also will be taken at the time of sample collection using a Marsh-McBirney flow meter per MDNR-FSS-113.

In addition to the collection of water samples by MDC staff, MDNR water quality personnel will collect water samples at the time of each macroinvertebrate sampling event. These samples also will be collected per MDNR-FSS-001 and MDNR-FSS-002. The samples will be analyzed for ammonia-nitrogen, nitrite- and nitrate-nitrogen, total Kjeldahl nitrogen, total phosphorus, chloride, turbidity, and total and volatile suspended solids. Field measurements will be taken at the time of water sample collection and will include pH (per MDNR-FSS-100), temperature (per MDNR-FSS-101), conductivity (per MDNR-FSS-102), dissolved oxygen (per MDNR-FSS-103), and stream discharge using a Marsh-McBirney flow meter (per MDNR-FSS-113).

MDNR water quality personnel also will collect water samples at three sites on Peruque Creek and two sites on North Fork Cuivre River for fecal coliform analysis. They will collect three replicate samples each month from June through September 2002. Samples will be collected four times during this low flow period, at least two weeks apart. All samples will be collected and processed in accordance MDNR-FSS-108 (Field Analysis of Fecal Coliform Bacteria).

MDC personnel will collect water samples twice during storm events. Samples will be collected immediately after rainfall events greater than one inch and analyzed by the MDNR Environmental Service Program (ESP) laboratory for volatile suspended solids and nonfilterable residues. MDNR personnel also will provide technical assistance to MDC personnel regarding collection of these samples.

Benthic Sediment Percentage: To ensure uniformity in estimating benthic sediment percentage, depositional areas will be sampled instream at the upper margins of pools and lower margins of riffle/run habitat. Depths of the sample areas will not exceed two (2.0) feet and water velocity will be less than 0.5 feet per second (fps). A Marsh-McBirney flow meter will be used to ensure that water velocity of the sample area is within this range.

Instream deposits of fine sediment [i.e., less than particle size of approximately 2 mm (coarse sand)] will be estimated for percent coverage per area. A visual method will be used to estimate the percentage of fine sediment. A total of three fine sediment sample areas (grids) will be set up at each water quality/macroinvertebrate sample site. The sample areas will consist of six contiguous transects across the stream. A tape measure will be placed directly on the substrate within each of the six transects using a random number that equates to one-foot increments. The trailing edge of the quadrat will be placed on the random foot increment. Two MDNR water quality personnel will estimate the percentage of the stream bottom covered by fine sediment within each quadrat. If estimated percentages are within ten percent between the MDNR personnel, it will be accepted. If estimates diverge more than ten percent, they will repeat the process until

the estimates are within the acceptable margin of error. An average of these two estimates will be recorded and used for analysis.

Habitat Sampling: Stream habitat assessments were conducted by MDC personnel at each of the fish study sites following the Regional Environmental Monitoring and Assessment Program (REMAP) protocol in conducting the assessments.

Laboratory Methods: All water quality samples will be analyzed at the MDNR ESP laboratory. The samples of macroinvertebrates will be processed and identified per MDNR-FSS-209 (Taxonomic Levels for Macroinvertebrate Identification).

Data Recording and Analyses: Macroinvertebrate data will be entered in a Microsoft Access database in accordance with MDNR-WQMS-214 (Quality Control Procedures for Data Processing). Data analysis is automated within the Access database. A total of four standard metrics will be calculated for each sample reach according to the SMSBPP: Total Taxa (TT); Ephemeroptera, Plecoptera, Trichoptera Taxa (EPTT); Biotic Index (BI); and the Shannon Index (SI). Additional metrics, such as Quantitative Similarity Index for Taxa (QSI-T) or Percent Scrapers (PS), may be used to discern differences in taxa between control and impacted stations.

Macroinvertebrate data will be analyzed in three specific ways. First, a comparison of metrics will be made between sample reaches on Peruque Creek where best and poor management practices are in use. Data will be summarized and presented in bar graphs comparing means of the four standard metrics (and other biological parameters) among the six study reaches. Second, Peruque Creek data will be compared to that collected at a local reference stream site (North Fork Cuivre River). Finally, both Peruque Creek and North Fork Cuivre River data will be compared to historic and current data collected at three regional reference sites (North River, South River, and South Fabius River).

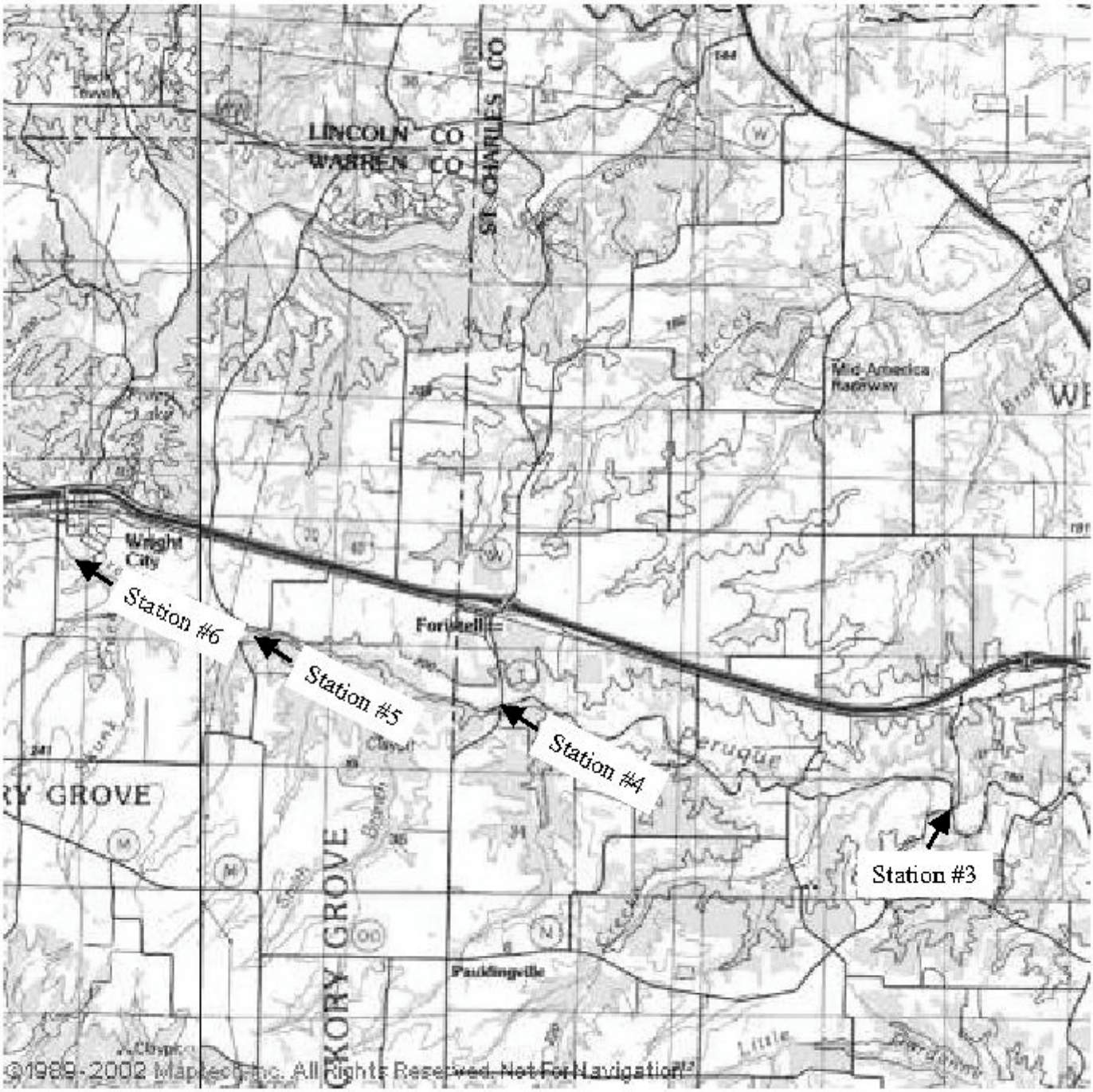
Ordination of macroinvertebrate data may be performed and regression analysis used to examine potential associations with water chemistry and habitat data. Habitat, fish community, and water quality data also will be used to help interpret macroinvertebrate data.

Water quality data will be entered in the Laboratory Information Management System (LIMS) database. Data analysis will be summarized and interpreted using Microsoft Access and Excel software as well as Jandel Scientific software, SigmaStat.

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.

Attachments: Map of Peruque Creek sampling stations.


LINCOLN CO
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ST. CHARLES CO
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Peruque Creek
St. Charles County, Missouri
Downstream Sampling Stations

Appendix B

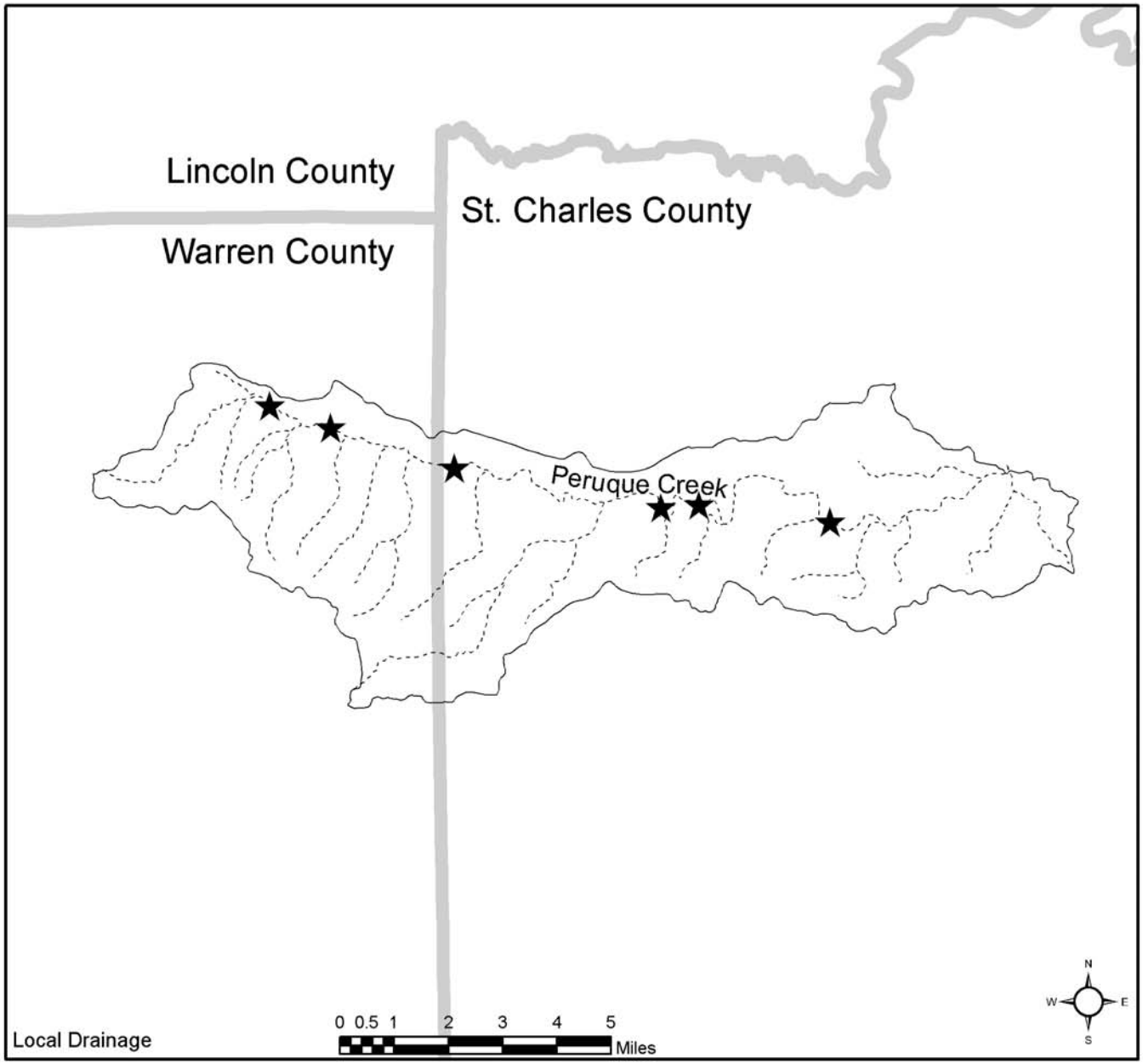
Maps

Peruque Creek
Plains/Mississippi Tributaries between the Des Moines and Missouri Rivers EDU

&

North Fork Cuivre River
Plains/Mississippi Tributaries between the Des Moines and Missouri Rivers EDU

Peruque Creek Study Site



Sampling Location

County Boundary

Local Drainage

Stream/River

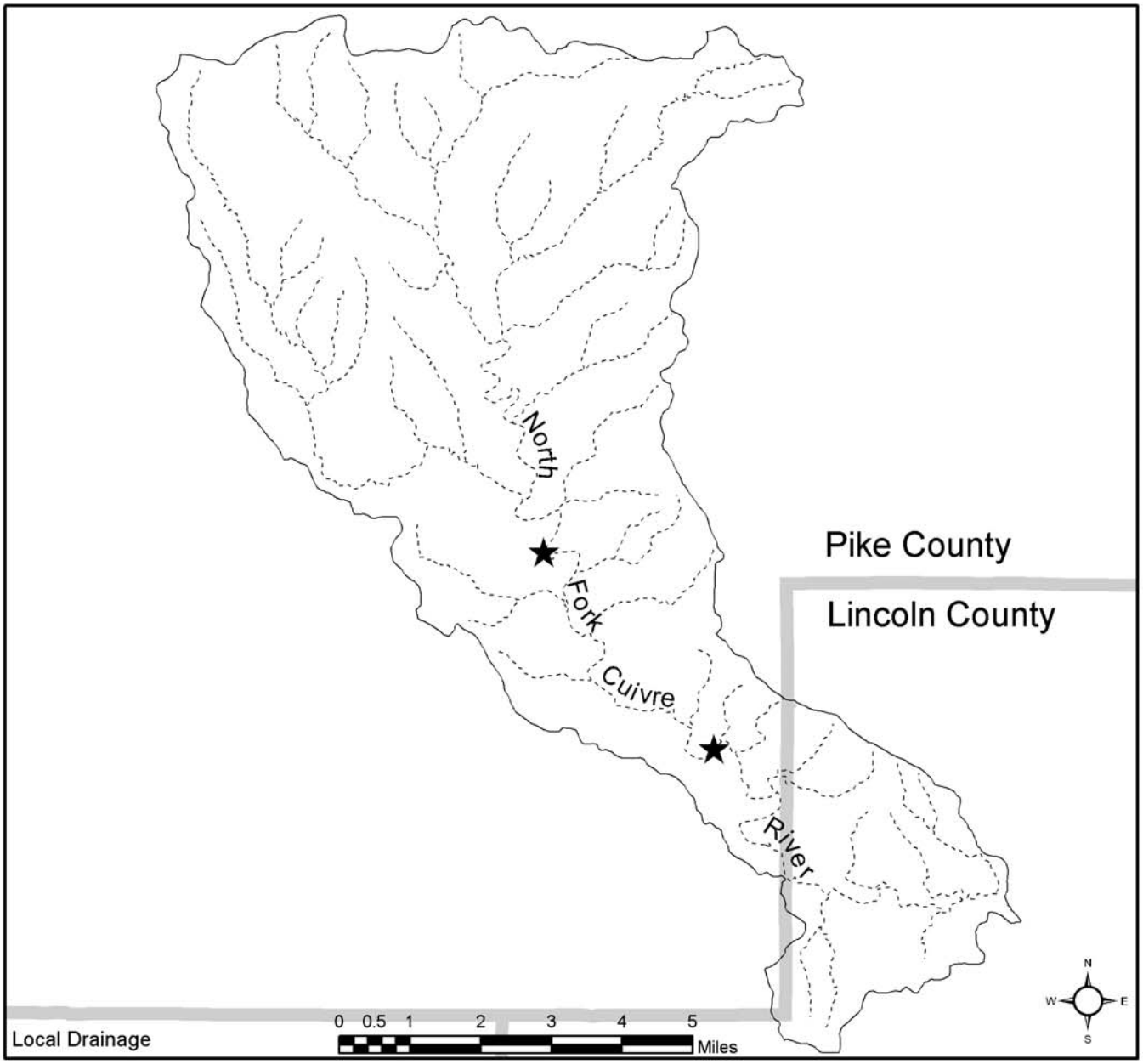
Local Drainage and Biologic Sampling Site Location

Ecolocial Drainage Unit (EDU) - An EDU is an area that contains a unique combination of habitats and organisms. Missouri is divided into 19 EDUs as shown in the inset map below. This site is located in the highlighted EDU.

Local Drainage - The local drainage area, also known as a 14 Digit Hydrologic Unit, is shown in the main map at left. This area is a portion of the local watershed. Missouri is split into over 1500 such units.

Ecological Drainage Unit

North Fork Cuivre River Study Site



Sampling Location

County Boundary

Local Drainage

Stream/River

Local Drainage and Biologic Sampling Site Location

Ecolocial Drainage Unit (EDU) - An EDU is an area that contains a unique combination of habitats and organisms. Missouri is divided into 19 EDUs as shown in the inset map below. This site is located in the highlighted EDU.

Local Drainage - The local drainage area, also known as a 14 Digit Hydrologic Unit, is shown in the main map at left. This area is a portion of the local watershed. Missouri is split into over 1500 such units.

Ecological Drainage Unit

Appendix C

Peruque Creek and North Fork Cuivre River Macroinvertebrate Taxa Lists

Peruque Creek #1: Spring 2002

Taxa	CS	NF	RM
Acarina		3	3
Crangonyx	2		7
Gammarus			-99
Hyalella azteca			48
Erpobdellidae	1		
Berosus	1	6	
Dubiraphia		3	9
Gyretes			1
Hydrobius			1
Hydroporus			1
Peltodytes			1
Scirtes			1
Stenelmis	85	2	2
Orconectes luteus		-99	
Palaemonetes kadiakensis			2
Ablabesmyia		2	
Ceratopogoninae		37	
Chironomus		6	
Cladopelma		1	
Cladotanytarsus	1	8	
Clinocera	4		
Corynoneura		4	9
Cricotopus bicinctus	1		
Cricotopus/Orthocladius	122	4	100
Cryptochironomus	3	10	
Dicrotendipes		1	6
Diplocladius	1		
Gonomyia	16		3
Hemerodromia	1	1	
Hexatoma	4		
Hydrobaenus	150	13	21
Krenopelopia		1	
Labrundinia			1
Nanocladius			4
Ormosia		1	
Orthocladius (Euorthocladius)	3		
Paralauterborniella		1	
Paratanytarsus		2	43
Paratendipes		16	2
Polypedilum convictum grp	2		
Polypedilum halterale grp	2	35	
Polypedilum illinoense grp			8
Polypedilum scalaenum grp		4	
Procladius		2	1
Pseudochironomus	1		1
Rheocricotopus			2
Rheotanytarsus	1		
Simulium	6		
Stempellinella		1	1
Stictochironomus	3	22	
Sympotthastia	1		
Tanytarsus	4	13	32
Thienemannimyia grp.	16	1	3
Tipula	-99		

Peruque Creek #1 (continued): Spring 2002

Tribelos		1	
Tvetenia bavarica grp	5		
Acerpenna	27		4
Caenis latipennis	6	11	17
Caenis punctata			8
Centroptilum			3
Hexagenia limbata		2	
Stenacron	4		
Stenonema femoratum	18	8	3
Ranatra fusca			-99
Caecidotea	11		1
Caecidotea (Blind & Unpigmented)	16		
Ferrissia		1	1
Menetus			7
Physella			1
Lumbricidae	12		
Sialis		-99	
Argia		1	1
Basiaeschna janata		-99	
Calopteryx			-99
Enallagma		1	19
Allocapnia	5		1
Amphinemura	1		1
Hydroperla crosbyi	-99		
Isoperla	11		
Perlesta	3		
Cernotina			1
Cheumatopsyche	-99		
Chimarra	8		
Pycnopsyche			-99
Rhyacophila	1		
Triaenodes			7
Planariidae	2		
Aulodrilus		6	
Branchiura sowerbyi	1	15	
Enchytraeidae	1	1	
Limnodrilus angustipenis		1	
Limnodrilus cervix		2	
Limnodrilus claparedianus		3	
Limnodrilus hoffmeisteri		10	
Tubificidae		19	
Sphaerium	6	4	

CS = Coarse Substrate Habitat

NF = Non-flow Habitat

RM = Rootmat Habitat

-99 = Present in Samples

Peruque Creek #2: Spring 2002

Taxa	CS	NF	RM
Branchiobdellida			1
Gordiidae	1		
Acarina	1	2	3
Crangonyx		18	2
Gammarus		2	6
Hyalella azteca			45
Berosus	1	2	
Dubiraphia	1	1	2
Helichus lithophilus			1
Hydroporus			3
Peltodytes			3
Stenelmis	62	1	1
Orconectes luteus	1	1	
Orconectes virilis			-99
Ablabesmyia		1	4
Ceratopogonidae		14	
Chironomus		2	
Cladotanytarsus		10	
Clinocera	8	2	
Corynoneura	12	10	17
Cricotopus bicinctus	1		4
Cricotopus trifascia	18	1	
Cricotopus/Orthocladius	104	29	46
Cryptochironomus		4	
Dicrotendipes	1	3	3
Diptera		1	
Djalmabatista		1	
Eukiefferiella brevicalcar grp	4		
Hexatoma	6		
Hydrobaenus	69	54	47
Nilotanypus	1		
Orthocladius (Euorthocladius)	17	1	
Paralauterborniella		4	
Parametriocnemus	1		
Paratanytarsus	2	4	23
Paratendipes		3	
Phaenopsectra			1
Polypedilum convictum grp	3		
Polypedilum halterale grp		11	
Polypedilum illinoense grp		1	1
Polypedilum scalaenum grp	1		
Prosimulium	3		
Simulium	1		
Stempellinella		1	
Stictochironomus	6	17	
Sympotthastia	1		
Tanytarsus	6	33	5
Thienemanniella	1		2
Thienemannimyia grp.	11	3	3
Tipulidae	1		
Tvetenia	7		
Zavrelimyia	1		
Acerpenna	20	1	4
Caenis latipennis	19		7

Peruque Creek #2 (continued): Spring 2002

Centroptilum		1	14
Hexagenia limbata		-99	
Stenacron	1	1	
Stenonema femoratum	14	14	3
Belostoma			1
Notonecta			1
Caecidotea (Blind & Unpigmented)	1		
Fossaria		1	
Menetus			1
Lumbricidae	62	1	
Corydalus	1		
Argia	3		1
Basiaeschna janata			-99
Enallagma			9
Allocapnia	3		
Amphinemura	4		
Chloroperlidae	2		
Isoperla	31		1
Perlesta	23	1	
Perlinella drymo			2
Cheumatopsyche	1		
Chimarra			1
Hydroptila	2		
Pycnopsyche			1
Rhyacophila	-99		
Triaenodes			1
Enchytraeidae	2		
Limnodrilus hoffmeisteri	1	4	
Tubificidae		9	
Sphaerium	3	1	1

CS = Coarse Substrate Habitat
NF = Non-flow Habitat
RM = Rootmat Habitat
-99 = Present in Samples

Peruque Creek #3a: Spring 2002

Taxa	CS	NF	RM
Crangonyx			5
Hyalella azteca		2	26
Erpobdellidae	-99		
Berosus	1	6	2
Dubiraphia		7	7
Hydroporus			1
Paracymus		1	
Peltodytes		1	7
Scirtes			6
Stenelmis	7	7	1
Ablabesmyia		8	8
Ceratopogoninae		31	1
Chaoborus		1	
Chironomus		4	
Cladotanytarsus	8	5	
Clinocera	1	2	
Corynoneura	6	2	32
Cricotopus bicinctus	1		2
Cricotopus trifascia	3		1
Cricotopus/Orthocladius	95	4	56
Demicryptochironomus	1		
Dicrotendipes	1		1
Diptera		2	
Dolichopodidae		1	
Eukiefferiella brevicalcar grp	3		
Glyptotendipes		1	
Gonomyia		3	
Hexatoma	3	3	
Hydrobaenus	226	68	37
Orthocladius (Euorthocladius)	4		
Paralauterborniella		1	
Paratanytarsus	1	2	5
Paratendipes	1	10	
Phaenopsectra		4	2
Polypedilum convictum grp	5		
Polypedilum halterale grp		6	
Polypedilum illinoense grp			3
Polypedilum scalaenum grp	9		
Procladius			1
Prosimulium	3		
Simulium	15		
Stempellinella			1
Stictochironomus		19	
Tabanus	1		
Tanytarsus	11	5	9
Thienemanniella	1		5
Thienemannimyia grp.	9		6
Tipula	-99		
Tvetenia	10		
Acerpenna	6		2
Caenis latipennis	8	9	36
Centroptilum			5
Stenacron		1	
Stenonema femoratum	1		2

Peruque Creek #3a (continued): Spring 2002

Microvelia		1	
Caecidotea		1	
Caecidotea (Blind & Unpigmented)	1		
Ancylidae	1		
Fossaria			3
Physella		2	
Lumbricidae	10	30	1
Argia		2	5
Calopteryx	-99		1
Enallagma		2	18
Nasiaeschna pentacantha			-99
Amphinemura	8		
Chloroperlidae	2		
Clioperla clio			1
Hydroperla crosbyi	1		
Isoperla	35		
Perlesta	16		2
Perlinella drymo			4
Cheumatopsyche	-99		
Chimarra	2		
Ironoquia			1
Pycnopsyche			1
Triaenodes			11
Limnodrilus claparedianus		1	
Limnodrilus hoffmeisteri		9	
Tubificidae		7	1
Corbicula	-99		
Sphaerium		1	

CS = Coarse Substrate Habitat
NF = Non-flow Habitat
RM = Rootmat Habitat
-99 = Present in Samples

Peruque Creek #3b: Spring 2002

Taxa	CS	NF	RM
Acarina			1
Crangonyx		-99	
Hyalella azteca			26
Berosus	3	3	1
Dubiraphia	1	1	1
Peltodytes		3	3
Scirtes			1
Stenelmis	24	1	1
Orconectes virilis			-99
Ablabesmyia		4	7
Ceratopogoninae	1	6	
Cladotanytarsus	4	7	
Clinocera	6	1	
Corynoneura		6	24
Cricotopus trifascia	2		
Cricotopus/Orthocladius	86	16	54
Cryptochironomus		1	
Dicrotendipes	1	2	
Diptera			1
Dolichopodidae		1	
Eukiefferiella brevicalcar grp	1		1
Gonomyia		6	
Hexatoma	11	1	2
Hydrobaenus	170	45	40
Labrundinia			1
Micropsectra			2
Nanocladius	1		
Nilothauma	1		
Orthocladius (Euorthocladius)	10		
Parametriocnemus	3		
Paratanytarsus	1		20
Paratendipes		14	1
Phaenopsectra		1	
Polypedilum convictum grp	3		2
Polypedilum halterale grp		5	
Polypedilum illinoense grp			3
Polypedilum scalaenum grp	3	2	
Pseudochironomus		2	
Rheocricotopus	1		1
Rheotanytarsus	1		1
Simulium	14		1
Stempellinella			1
Stictochironomus		9	
Tabanus	6		
Tanytarsus	12	13	18
Thienemanniella	1		3
Thienemannimyia grp.	10		11
Tvetenia	11		
Acerpenna	13		
Caenis latipennis	7	17	34
Centroptilum		2	2
Leptophlebia			1
Stenacron		2	
Stenonema femoratum	7	5	3

Peruque Creek #3b (continued): Spring 2002

Caecidotea (Blind & Unpigmented)	1		
Ancylidae	3		
Fossaria			1
Physella	1		
Lumbricidae	39	3	
Argia			3
Cordulegaster		1	
Enallagma		1	10
Hagenius brevistylus		1	
Libellulidae			1
Allocapnia	2		1
Amphinemura	11		1
Chloroperlidae	4		
Hydroperla crosbyi	-99		
Isoperla	67		
Perlesta	29		
Perlinella drymo			-99
Cheumatopsyche	9		
Chimarra	26		
Hydropsyche	1		
Pycnopsyche			-99
Triaenodes			3
Enchytraeidae	2	3	1
Limnodrilus hoffmeisteri		1	
Tubificidae	5	6	
Sphaerium	4		

CS = Coarse Substrate Habitat
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RM = Rootmat Habitat
-99 = Present in Samples

Peruque Creek #4: Spring 2002

Taxa	CS	NF	RM
Crangonyx	2	-99	2
Hyalella azteca			1
Erpobdellidae	-99		
Berosus	3	3	10
Dubiraphia		2	
Enochrus			1
Gyrinus			1
Peltodytes		1	1
Stenelmis	1		3
Ablabesmyia			2
Ceratopogoninae		12	
Chrysops		1	
Cladotanytarsus	1	1	
Clinocera	3		1
Corynoneura		1	4
Cricotopus bicinctus			1
Cricotopus trifascia		2	
Cricotopus/Orthocladius	22	8	30
Dicrotendipes	1		1
Diplocladius			1
Diptera	1	2	
Eukiefferiella brevicalcar grp	1		
Glyptotendipes			1
Gonomyia	1	3	2
Hexatoma	7	2	
Hydrobaenus	455	63	29
Paratanytarsus			7
Paratendipes	1	35	
Pericoma	1	1	
Polypedilum halterale grp		3	
Polypedilum illinoense grp	1		1
Polypedilum scalaenum grp	3	2	
Pseudochironomus		1	
Pseudosmittia	1	1	
Rheotanytarsus			1
Stictochironomus		58	
Tabanus		1	
Tanytarsus	1	3	14
Thienemanniella	1		1
Thienemannimyia grp.			2
Tvetenia	18		9
undescribed Empididae		1	
Zavrelimyia	1	1	
Caenis latipennis	5	34	132
Caenis punctata		1	
Stenonema femoratum	2	1	1
Aquarius			1
Microvelia			2
Fossaria			3
Lumbricidae			1
Sialis		-99	
Argia			2
Calopteryx			1
Enallagma		-99	2

Peruque Creek #4 (continued): Spring 2002

Amphinemura	1		1
Chloroperlidae	2		
Isoperla	4		
Perlesta	2	1	1
Perlinella drymo			1
Cheumatopsyche			2
Helicopsyche			1
Ironoquia			1
Triaenodes			9
Enchytraeidae	6	4	5
Limnodrilus hoffmeisteri	1	10	
Tubificidae	3	16	2
Sphaerium		2	

CS = Coarse Substrate Habitat

NF = Non-flow Habitat

RM = Rootmat Habitat

-99 = Present in Samples

Peruque Creek #5: Spring 2002

Taxa	CS	NF	RM
Branchiobdellida		4	1
Acarina			1
Crangonyx	3	13	23
Erpobdellidae		-99	
Cybister			1
Dubiraphia		1	
Hydrobius			1
Hydroporus			2
Peltodytes		1	5
Stenelmis	118	4	2
Tropisternus			1
Orconectes luteus	-99	-99	
Orconectes virilis			-99
Ablabesmyia		1	3
Ceratopogoninae	3	5	1
Chironomus		1	
Cladotanytarsus	1		
Clinocera	1	1	
Corynoneura	4		6
Cricotopus/Orthocladius	78	24	51
Cryptochironomus	5	1	
Dicrotendipes	1		1
Diptera		2	
Eukiefferiella	1		
Eukiefferiella brevicalcar grp	2		
Glyptotendipes			1
Hexatoma	-99		
Hydrobaenus	227	105	56
Micropsectra			1
Natarsia	2	3	1
Orthocladius (Euorthocladius)	3		
Parametriocnemus	1		1
Paratanytarsus	1		14
Paratendipes	4	24	2
Phaenopsectra			18
Polypedilum halterale grp		3	
Polypedilum illinoense grp			10
Polypedilum scalaenum grp	20	2	
Prosimulium	1		
Stictochironomus	3	32	1
Tabanus	1		
Tanytarsus	12	1	3
Thienemannimyia grp.	9		5
Tribelos			1
Tvetenia	4		
undescribed Empididae	1		
Caenis latipennis	12	21	24
Centroptilum		1	2
Stenacron	1		
Stenonema femoratum	1	4	3
Belostoma			1
Ranatra fusca			1
Ancylidae	2		1
Fossaria		1	

Peruque Creek #5 (continued): Spring 2002

Menetus			3
Physella		1	4
Chauliodes pectinicornis			1
Basiaeschna janata			2
Enallagma	1		1
Isoperla	1		
Perlesta	2		
Cheumatopsyche	2		-99
Ironoquia			4
Enchytraeidae		1	2
Limnodrilus claparedianus		2	
Limnodrilus hoffmeisteri	5	23	1
Tubificidae	26	28	7

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Peruque Creek #6: Spring 2002

Taxa	CS	NF	RM
Branchiobdellida		1	
Acarina		1	1
Hyalella azteca			4
Erpobdellidae	-99		
Agabus			1
Dubiraphia		5	4
Peltodytes		1	1
Stenelmis	49		5
Orconectes virilis		-99	1
Ablabesmyia		5	15
Ceratopogoninae	4	6	
Chaoborus		1	
Chironomus		11	
Chrysops	-99		
Cladotanytarsus		2	
Clinocera	5		
Corynoneura		2	3
Cricotopus/Orthocladius	106	13	37
Cryptochironomus		1	
Dicrotendipes		3	6
Diptera	1	4	
Eukiefferiella brevicalcar grp	4		
Glyptotendipes		1	
Gonomyia	2		
Hydrobaenus	343	57	
Mesosmittia		1	
Nanocladius		1	5
Natarsia		1	
Parachironomus	1	1	7
Parametriocnemus			1
Paratanytarsus		3	23
Paratendipes		34	
Pericoma		1	
Phaenopsectra			1
Pilaria	1	1	
Polypedilum halterale grp		13	
Polypedilum illinoense grp	1		
Polypedilum scalaenum grp	2	2	
Prosimulium			1
Stempellinella	1		1
Stictochironomus		28	
Tabanus			-99
Tanytarsus	2	4	12
Thienemannimyia grp.	3		4
Tipula	1		
Tvetenia	6		
Zavrelimyia		1	
Caenis latipennis	9	19	18
Caenis punctata		1	
Centroptilum		10	1
Stenonema femoratum	7	2	2
Ferrissia			2
Fossaria		1	1
Menetus			11

Peruque Creek #6 (continued): Spring 2002

Physella	1	-99	1
Lumbriculidae		-99	
Argia		1	1
Basiaeschna janata		-99	
Calopteryx			-99
Enallagma			8
Hetaerina		1	
Ischnura			-99
Libellulidae			2
Nasiaeschna pentacantha			-99
Progomphus obscurus		-99	
Allocapnia	2	1	
Clioperla clio	-99		
Perlesta	2		
Cheumatopsyche	-99		
Triaenodes			5
Enchytraeidae	9	1	1
Limnodrilus cervix		7	
Limnodrilus hoffmeisteri	9	27	
Tubificidae	25	16	1
Sphaerium	1		

CS = Coarse Substrate Habitat
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North Fork Cuivre River #1a: Spring 2002

Taxa	CS	NF	RM
Crangonyx			1
Hyalella azteca			9
Berosus	1		
Dubiraphia	1	3	4
Oreodytes		6	
Peltodytes		2	1
Scirtes			1
Stenelmis	71	6	1
Orconectes virilis			-99
Ablabesmyia		5	4
Ceratopogoninae		1	
Chironomus		4	
Chrysops		1	
Cladotanytarsus		22	
Corynoneura	4	3	17
Cricotopus bicinctus	8		7
Cricotopus/Orthocladius	345	9	72
Cryptochironomus	1	2	
Demicryptochironomus	1		
Diamesa	1		
Dicrotendipes	1	8	7
Eukiefferiella brevicalcar grp	10		
Glyptotendipes			2
Gonomyia		1	
Hemerodromia	2		
Hydrobaenus	4	3	7
Lipiniella		4	
Microtendipes		1	1
Nanocladius			1
Ormosia		4	
Orthocladius (Euorthocladius)	18		
Parametriocnemus	2		
Paratanytarsus	4	2	105
Paratendipes	2	17	3
Phaenopsectra		3	2
Polypedilum convictum grp	3		
Polypedilum halterale grp		2	
Polypedilum illinoense grp	1	1	
Polypedilum scalaenum grp	6	7	
Procladius		1	
Rheotanytarsus	2		5
Simulium	3		
Stempellinella	4		
Stictochironomus		59	6
Tabanus	-99		1
Tanytarsus	13	35	33
Thienemanniella	31		10
Thienemannimyia grp.	19	1	4
Tipula	-99		
Acerpenna	47		1
Caenis latipennis	25	55	103
Hexagenia limbata		1	
Stenacron	3	2	
Stenonema femoratum	23		5

North Fork Cuivre River #1a (continued: Spring 2002)

Tricorythodes	1		
Belostoma			-99
Caecidotea			1
Physella			-99
Basiaeschna janata			-99
Enallagma			5
Gomphus		1	
Allocapnia	1		
Hydroperla crosbyi	-99		
Isoperla	7		
Perlesta	4		
Cheumatopsyche	5		
Pycnopsyche			1
Triaenodes			1
Planariidae			1
Branchiura sowerbyi		2	
Enchytraeidae	16	2	2
Limnodrilus hoffmeisteri	1	3	1
Tubificidae	14	14	1

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North Fork Cuivre River #1b: Spring 2002

Taxa	CS	NF	RM
Branchiobdellida		1	
Hyalella azteca			8
Erpobdellidae	-99		
Berosus		3	1
Dubiraphia		5	1
Oreodytes		1	3
Peltodytes		2	1
Scirtes			2
Stenelmis	44	2	4
Orconectes luteus	-99		
Ablabesmyia		8	1
Ceratopogoninae		1	
Chironomus		8	
Cladotanytarsus	1	14	
Cnephia	1		
Corynoneura	13	3	9
Cricotopus bicinctus	2		7
Cricotopus/Orthocladius	282	13	61
Cryptochironomus	1	3	
Dicrotendipes		7	13
Eukiefferiella	1		
Eukiefferiella brevicalcar grp	2		
Glyptotendipes		1	1
Hydrobaenus	7	7	2
Larsia		1	
Microtendipes		1	1
Nanocladius	1		10
Ormosia	1	1	
Orthocladius (Euorthocladius)	17		
Parametriocnemus	3	1	
Paratanytarsus	1	4	64
Paratendipes	2	10	
Phaenopsectra		4	2
Polypedilum convictum grp	3		
Polypedilum halterale grp		11	
Polypedilum illinoense grp	1		4
Polypedilum scalaenum grp	4	5	
Pseudochironomus		2	
Rheotanytarsus	3		3
Stempellinella	1	4	1
Stenochironomus			1
Stictochironomus		50	1
Tabanus	2		
Tanytarsus	13	32	14
Thienemanniella	39		7
Thienemannimyia grp.	21	1	20
Tipula	-99		
Acerpenna	48		
Caenis latipennis	39	63	91
Centroptilum			1
Stenacron	6		
Stenonema femoratum	22	3	2
Microvelia			1
Caecidotea	1		

North Fork Cuivre River #1b (continued): Spring 2002

Menetus			1
Physella			2
Argia			2
Enallagma			15
Progomphus obscurus		-99	
Allocapnia	5	1	
Amphinemura	2		
Hydroperla crosbyi	-99		
Isoperla	5		
Perlesta	1		
Perlinella drymo			-99
Cheumatopsyche	2		
Planariidae			1
Branchiura sowerbyi		2	
Enchytraeidae	11	2	
Limnodrilus hoffmeisteri	1	11	
Tubificidae	4	14	1
Sphaerium	1		

CS = Coarse Substrate Habitat
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RM = Rootmat Habitat
-99 = Present in Samples

North Fork Cuivre River #2: Spring 2002

Taxa	CS	NF	RM
Acarina		4	2
Crangonyx	3		8
Hyalella azteca			2
Erpobdellidae		1	
Berosus	1	4	
Dubiraphia		4	1
Gyrinus			1
Helichus lithophilus	1		
Hydroporus		2	2
Oreodytes		2	-99
Peltodytes		5	1
Stenelmis	36	1	2
Orconectes luteus	-99		-99
Orconectes virilis			-99
Ablabesmyia	1	2	
Ceratopogonidae		1	
Chironomus	6	4	
Chrysops	-99		
Cladotanytarsus		3	
Clinocera	1	1	
Corynoneura	3		18
Cricotopus bicinctus	4		6
Cricotopus trifascia	2		
Cricotopus/Orthocladius	280	13	100
Cryptochironomus	1	1	
Dicrotendipes	1	17	4
Eukiefferiella	1		1
Eukiefferiella brevicalcar grp	8		1
Glyptotendipes	1		
Hydrobaenus	57	4	1
Microtendipes	2	1	1
Nanocladius			1
Ormosia	1		
Orthocladius (Euorthocladius)	37		1
Parametriocnemus	9		
Paratanytarsus	1	1	18
Paratendipes	2	7	1
Phaenopsectra		1	8
Polypedilum convictum grp	6		
Polypedilum halterale grp			1
Polypedilum illinoense grp	1		10
Polypedilum scalaenum grp	19	2	
Procladius		1	
Pseudochironomus	3		
Rheotanytarsus	1		
Simulium			1
Stempellinella		5	1
Stictochironomus	7	3	
Tabanus	1		
Tanytarsus	2	28	12
Thienemanniella	17		24
Thienemannimyia grp.	11	4	5
Tipula	-99	-99	1
Tvetenia			2

North Fork Cuivre River #2 (continued): Spring 2002

Acerpenna	4		2
Caenis latipennis	10	127	61
Hexagenia limbata		4	
Stenonema femoratum	14	12	11
Microvelia		1	
Trichocorixa		1	
Ferrissia	3	1	1
Fossaria			-99
Physella	1	1	8
Lumbricidae	1	1	
Sialis		-99	
Basiaeschna janata			-99
Calopteryx			-99
Enallagma			7
Gomphus		-99	
Libellula		-99	
Allocapnia	1		
Amphinemura	1		
Isoperla	-99		
Perlesta	1		
Glossiphoniidae			1
Cheumatopsyche	6		
Chimarra	2		
Ironoquia			-99
Oecetis	1		
Enchytraeidae	3	1	1
Limnodrilus cervix		5	
Limnodrilus hoffmeisteri		18	
Tubificidae	1	99	2
Sphaerium		1	1

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Peruque Creek #1: Fall 2002

Taxa	CS	NF	RM
Branchiobdellida			1
Acarina	6	4	5
Hyalella azteca			49
Erpobdellidae	-99		
Berosus	1	1	
Coleoptera	1		
Dubiraphia		3	7
Helichus lithophilus	1		
Hydrochus			4
Scirtes			24
Stenelmis sexlineata	90		1
Orconectes luteus	2		
Orconectes virilis			1
Palaemonetes kadiakensis			4
Ablabesmyia	1	6	
Anopheles			3
Ceratopogoninae	10	11	4
Chaoborus		5	
Chironomus		5	
Cladotanytarsus		2	
Clinotanypus			1
Corynoneura	1		3
Cricotopus/Orthocladius	1		1
Cryptochironomus	1	2	
Culex			1
Dicrotendipes		8	2
Diplocladius	1		
Diptera	1		
Glyptotendipes		8	12
Hemerodromia	4	1	
Hexatoma	2		
Labrundinia			6
Microchironomus		2	
Nanocladius	1		
Nilotanypus	3		
Parachironomus		1	10
Phaenopsectra		1	
Polypedilum	1		
Polypedilum convictum grp	47		2
Polypedilum fallax grp	1		
Polypedilum halterale grp		5	
Polypedilum illinoense grp	9		2
Polypedilum scalaenum grp	3		
Procladius		8	
Rheotanytarsus	3		
Stenochironomus	1		2
Stictochironomus		2	
Tabanus	-99		-99
Tanypus		5	
Tanytarsus	22	5	8
Thienemannimyia grp.	23		3
Tipula	-99		
undescribed Empididae	3		
Acerpenna	47		

Peruque Creek #1 (continued): Fall 2002

Apobaetis		13	
Baetis	1		
Caenis latipennis	8	75	38
Callibaetis		1	3
Choroterpes	2		
Hexagenia limbata		9	
Procloeon		1	1
Stenacron	5	1	5
Stenonema femoratum	28	7	2
Tricorythodes	11	5	
Corixidae		12	
Microvelia			2
Neoplea			1
Caecidotea	1		
Caecidotea (Blind & Unpigmented)		1	
Ancylidae	1		
Menetus		3	38
Physella		2	6
Lumbricidae	6		
Chauliodes pectinicornis	-99		
Corydalus	-99		
Sialis	-99		
Argia	5	1	8
Enallagma			18
Libellula		1	
Nasiaeschna pentacantha			1
Perlidae	1		
Cheumatopsyche	94		3
Chimarra	96	5	
Hydroptila	2	1	
Orthotrichia			4
Polycentropodidae			1
Triaenodes			17
Planariidae	45	2	7
Aulodrilus		3	
Branchiura sowerbyi	2	34	
Tubificidae	3	11	
Corbicula	18	1	
Sphaerium	1		

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Peruque Creek #2: Fall 2002

Taxa	CS	NF	RM
Acarina	6	4	1
Hyalella azteca			142
Berosus	35	2	10
Dubiraphia		1	10
Macronychus glabratus			1
Psephenus herricki	13		
Scirtes			22
Stenelmis	41		
Ablabesmyia		3	2
Anopheles			1
Ceratopogoninae	3	25	1
Chironomus		2	
Cladopelma		1	
Cladotanytarsus	1	13	
Corynoneura	2		
Cricotopus bicinctus	2		
Cricotopus/Orthocladius	2		3
Dicrotendipes	1	2	1
Diptera	1		
Forcipomyiinae	2		
Hemerodromia	6		
Hexatoma	-99		
Labrundinia		1	1
Nanocladius	1	1	1
Paralauterborniella		1	
Paraphaenocladius		2	
Paratanytarsus			5
Paratendipes		3	
Pentaneura	1		
Phaenopsectra			2
Polypedilum convictum grp	6		1
Polypedilum halterale grp		10	
Polypedilum illinoense grp	5	1	2
Polypedilum scalaenum grp	1	4	
Procladius		1	
Rheocricotopus	1		
Rheotanytarsus	12		
Stempellinella		1	
Stictochironomus	1	9	
Sublettea		1	
Tabanus	1		
Tanytarsus	5	6	10
Thienemannimyia grp.	7	1	
Tipula	-99		
undescribed Empididae	1		
Acentrella	8		
Acerpenna	22		
Baetis	52		
Caenis latipennis	62	156	27
Callibaetis			1
Centroptilum		2	1
Stenacron	2		
Stenonema femoratum	10	1	1
Tricorythodes	124		1

Peruque Creek #2 (continued): Fall 2002

Rhagovelia	4		
Ancylidae	6	2	21
Fossaria	11	1	4
Menetus	3		12
Physella	15		3
Lumbricidae	11		-99
Corydalus	-99		
Argia	46		9
Basiaeschna janata			-99
Enallagma	2		13
Erythemis			-99
Cheumatopsyche	87		2
Chimarra	32		
Helicopsyche	7		1
Hydropsyche	2		
Hydroptila	5	1	3
Nectopsyche	4		
Oecetis	7		1
Oxyethira		1	1
Phryganeidae		1	
Triaenodes			6
Planariidae	5		1
Aulodrilus		11	
Tubificidae	1	6	
Corbicula	17	-99	-99
Sphaeriidae	1		

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RM = Rootmat Habitat
-99 = Present in Samples

Peruque Creek #3: Fall 2002

Taxa	CS	NF	RM
Acarina	15	4	2
Hyalella azteca		2	88
Berosus	7	1	
Dubiraphia	2	2	16
Helichus lithophilus	2		2
Macronychus glabratus			1
Psephenus herricki	2		
Scirtes			2
Stenelmis	37	1	4
Tropisternus	1		
Orconectes luteus	-99		-99
Orconectes virilis			1
Palaemonetes kadiakensis			1
Ablabesmyia	2	2	1
Ceratopogoninae	16	34	3
Chironomus		39	
Cladopelma		5	
Cladotanytarsus		4	
Corynoneura			2
Cricotopus bicinctus	1		
Cricotopus/Orthocladius	3		
Cryptochironomus	1		
Dasyheleinae	3		
Dicrotendipes	3	13	2
Dolichopodidae	1		
Einfeldia		4	
Endochironomus			1
Glyptotendipes		2	2
Hemerodromia	6		
Hexatoma	3		
Labrundinia		5	5
Nanocladius	2	2	2
Nilotanypus	3		1
Parakiefferiella		1	
Paratanytarsus		4	18
Pentaneura	2		
Phaenopsectra		1	
Polypedilum convictum grp	19		10
Polypedilum halterale grp	1	4	
Polypedilum illinoense grp	7	1	4
Polypedilum scalaenum grp	1		
Procladius		2	
Pseudochironomus	1		
Rheotanytarsus	6		2
Stempellinella	2	3	
Stenochironomus			1
Stictochironomus		18	
Sublettea	1		
Tabanus	-99		1
Tanypus		2	
Tanytarsus	28	13	12
Thienemannimyia grp.	5		14
Tipula	1		
Tribelos			1

Peruque Creek #3 (continued): Fall 2002

undescribed Empididae	3		1
Zavreliella		2	
Zavrelimyia	1		
Acerpenna	22		1
Apobaetis		7	
Baetis	11		5
Caenis latipennis	182	12	15
Callibaetis		1	
Heptageniidae	5	1	1
Hexagenia limbata	2		1
Leptophlebiidae	2		
Procloeon		2	
Stenacron	12		7
Stenonema femoratum	13	6	2
Tricorythodes	5		1
Neoplea			1
Trepobates		1	
Ancylidae	2		5
Menetus	1	4	13
Physella	25	2	2
Lumbricidae	9	2	3
Corydalus	-99		
Argia	12		31
Enallagma	4		12
Libellulidae			2
Pachydiplax longipennis			-99
Cernotina			1
Cheumatopsyche	4		5
Hydroptila	1		
Oecetis	3		
Orthotrichia			1
Triaenodes			10
Planariidae			17
Aulodrilus		1	
Enchytraeidae	1		
Limnodrilus hoffmeisteri		1	1
Tubificidae	7	4	3
Sphaerium	1		

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Peruque Creek #4: Fall 2002

Taxa	CS	NF	RM
Acarina	1	4	1
Hyalella azteca		100	1
Erpobdellidae	-99		
Berosus	11	7	2
Dubiraphia			7
Helichus lithophilus	1		
Psephenus herricki	4		
Scirtes			9
Stenelmis	19	5	2
Orconectes luteus		-99	
Orconectes virilis			-99
Ablabesmyia		2	1
Ceratopogoninae	4	8	
Chironomus		6	1
Chrysops		1	
Cladotanytarsus	1		
Corynoneura	1	2	
Culex			1
Dicrotendipes	1	6	2
Einfeldia		1	
Forcipomyiinae	1		
Hemerodromia	2		
Hexatoma	-99		
Kiefferulus		2	3
Krenosmittia			1
Labrundinia	1	1	9
Microtendipes	2		2
Nilotanypus	5		1
Parachironomus			1
Paramerina			1
Parametriocnemus	4		
Paraphaenocladius		1	
Paratanytarsus	2		49
Paratendipes			1
Phaenopsectra			2
Polypedilum convictum grp	16		
Polypedilum illinoense grp			1
Polypedilum scalaenum grp	106	3	
Pseudochironomus		1	
Rheotanytarsus	2		
Simulium	1		
Stempellinella	5	1	
Stictochironomus		5	
Tabanus	2		
Tanytarsus	13	6	7
Thienemannimyia grp.	17	1	6
Tipula	1		
undescribed Empididae	5	3	
Acentrella	1		
Acerpenna	37		1
Baetis	20		
Caenis latipennis	73	184	15
Paracloeodes			1
Stenacron	3		

Peruque Creek #4 (continued): Fall 2002

Stenonema femoratum	34	6	5
Tricorythodes	4		
Microvelia			1
Ranatra nigra		-99	
Ancylidae	2	1	11
Fossaria			3
Menetus			12
Physella	18	7	7
Argia	1		1
Enallagma			4
Erythemis			3
Ischnura		1	
Libellula	-99	1	
Stylogomphus albistylus	4		
Glossiphoniidae			1
Cheumatopsyche	81		1
Chimarra	63		2
Helicopsyche	3		
Hydropsyche			1
Hydroptila	3		
Nectopsyche	1		
Oecetis	3	3	
Triaenodes			6
Planariidae			24
Tubificidae	1	2	1

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Peruque Creek #5: Fall 2002

Taxa	CS	NF	RM
Branchiobdellida			2
Chordodidae			1
Acarina		23	7
Crangonyx	1		
Hyalella azteca	1		42
Erpobdellidae	-99		
Berosus	18	7	1
Dubiraphia		3	27
Enochrus	2		
Helichus basalis	1		
Peltodytes			-99
Psephenus herricki	1		
Scirtes			3
Stenelmis	117	1	12
Orconectes virilis	-99		1
Ablabesmyia		3	3
Anopheles			2
Ceratopogoninae	1	2	
Chironomus		20	
Chrysops		2	
Cladotanytarsus		20	
Cricotopus bicinctus	1		
Cryptochironomus		4	
Culex			1
Dicrotendipes			4
Diptera			1
Forcipomyiinae	1	1	
Hemerodromia	3		
Labrundinia	4	2	
Larsia	1		
Microtendipes	2	1	1
Nanocladius			1
Nilotanypus	5		1
Parachironomus			2
Paraphaenocladius	1		
Paratanytarsus	2	1	12
Paratendipes		3	1
Polypedilum convictum grp	28		
Polypedilum halterale grp		4	
Polypedilum illinoense grp	5		
Polypedilum scalaenum grp		6	
Procladius		4	
Pseudosmittia		2	
Rheotanytarsus	2		
Simulium	2		
Stempellinella		1	
Stictochironomus		11	
Tanytarsus	69	15	7
Thienemannimyia grp.	18	1	
Tipula	4		
Caenis latipennis	1	24	
Hexagenia limbata		1	
Stenacron	16	3	
Stenonema femoratum	71	7	4

Peruque Creek #5 (continued): Fall 2002

Corixidae		4	
Microvelia	1		
Trepobates		1	
Ancylidae	29	26	7
Fossaria	1	4	3
Menetus	4	2	82
Physella	237	40	33
Lumbricidae	1		
Argia			1
Calopteryx	3		
Enallagma			3
Ischnura			1
Nasiaeschna pentacantha		1	
Pachydiplax longipennis			-99
Progomphus obscurus		-99	
Stylogomphus albistylus	2		
Cheumatopsyche	16		
Chimarra		1	
Helicopsyche	2		1
Oecetis		2	2
Phryganeidae		1	
Triaenodes			3
Planariidae			39
Limnodrilus hoffmeisteri	2		
Tubificidae	26	17	1
Sphaerium	1	1	

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Peruque Creek #6: Fall 2002

Taxa	NF	RM
Acarina	1	10
Hyalella azteca	3	61
Berosus	1	2
Dubiraphia	5	79
Scirtes	1	9
Stenelmis	2	1
Ablabesmyia	2	4
Anopheles	1	
Ceratopogoninae	30	3
Chaoborus	1	
Chironomus	55	6
Cladotanytarsus	5	
Cryptochironomus	3	
Cryptotendipes	1	
Culex		2
Dicrotendipes	16	24
Diptera	1	
Glyptotendipes	1	19
Labrundinia		5
Parachironomus	1	6
Paraphaenocladius	2	
Paratanytarsus	2	8
Phaenopsectra		1
Polypedilum halterale grp	16	
Polypedilum illinoense grp	5	4
Procladius	19	
Pseudochironomus	1	
Stictochironomus	20	
Tabanus	1	
Tanypus	1	
Tanytarsus	29	2
Caenis latipennis	8	7
Procloeon	2	
Stenonema femoratum		2
Neoplea	1	1
Trepobates	1	
Ancylidae		2
Menetus	1	70
Physella	20	38
Argia	1	10
Basiaeschna janata		-99
Enallagma		5
Hetaerina		1
Libellulidae	1	
Nasiaeschna pentacantha		2
Pachydiplax longipennis		1
Perithemis	-99	-99
Glossiphoniidae		-99
Triaenodes		6
Aulodrilus		1
Limnodrilus hoffmeisteri	3	
Tubificidae	20	1
Sphaerium	2	

NF = Non-flow Habitat

RM = Rootmat Habitat

-99 = Present in Samples

North Fork Cuivre River #1a: Fall 2002

Taxa	CS	NF	RM
Acarina		6	7
Erpobdellidae	-99	-99	
Berosus	9	2	30
Dubiraphia		8	11
Enochrus	5		
Helichus lithophilus			3
Scirtes	1		12
Stenelmis	206	2	7
Ablabesmyia	15	1	
Anopheles			1
Ceratopogoninae	4	16	
Chironomus		13	
Chlorotabanus			-99
Cladopelma		1	
Cladotanytarsus	1	5	
Cricotopus bicinctus	2		
Cricotopus/Orthocladius	3		
Cryptochironomus	1		
Culex			1
Dasyheleinae	1	1	
Demicryptochironomus	2		
Dicrotendipes	1	1	4
Diptera			1
Dolichopodidae	1		
Ephydridae	1		
Forcipomyiinae	2		
Glyptotendipes	2		9
Hemerodromia	2		
Labrundinia	1		5
Nilotanypus	2		
Parachironomus			2
Paratanytarsus			5
Paratendipes	1		
Pentaneura	2		
Polypedilum	1		1
Polypedilum convictum grp	16		
Polypedilum halterale grp	1	9	
Polypedilum illinoense grp	18	1	1
Polypedilum scalaenum grp	15	2	
Procladius		7	1
Rheotanytarsus	13		
Stempellinella	1	1	
Stictochironomus	1	1	
Tabanus	2		
Tanytarsus	46	11	4
Thienemanniella	1		
Thienemannimyia grp.	16		2
Caenis latipennis	97	18	4
Callibaetis			1
Choroterpes	1		
Hexagenia		1	
Procloeon		4	
Stenonema femoratum	3		
Tricorythodes	65	1	

North Fork Cuivre River #1a (continued): Fall 2002

Microvelia			1
Caecidotea (Blind & Unpigmented)	1		
Ancylidae	9	1	4
Menetus			72
Physella	76	2	21
Argia	1		14
Enallagma		1	9
Erythemis			-99
Gomphidae		1	
Gomphus			1
Macromia			-99
Nasiaeschna pentacantha			-99
Glossiphoniidae		1	
Ceratopsyche	1		
Cheumatopsyche	28	1	
Nectopsyche			1
Oecetis	1		
Pycnopsyche			-99
Planariidae			26
Aulodrilus		12	1
Branchiura sowerbyi	2	41	1
Limnodrilus cervix		2	
Limnodrilus hoffmeisteri		22	
Tubificidae	6	134	4
Sphaerium	3	3	7

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North Fork Cuivre River #1b: Fall 2002

Taxa	CS	NF	RM
Chordodidae	-99		
Acarina	1	10	5
Hyalella azteca			1
Berosus	9	3	28
Dubiraphia		3	16
Enochrus	2		
Helichus lithophilus	9		
Macronychus glabratus			5
Paracymus	1		
Scirtes			6
Stenelmis	183	3	9
Ablabesmyia	5	1	1
Anopheles			1
Axarus	1		
Ceratopogoninae	8	9	
Chaoborus		2	
Chironomus		15	
Cladotanytarsus	3	16	
Cricotopus/Orthocladius	2		
Cryptochironomus	14	3	
Dasyheleinae		1	
Demicryptochironomus	3		
Dicrotendipes	2	1	6
Diptera	2	1	
Forcipomyiinae	2	1	
Glyptotendipes			15
Hemerodromia	1		
Labrundinia			9
Nanocladius		1	1
Nilotanypus	1		
Parachironomus			5
Paratanytarsus		2	19
Paratendipes	5	1	
Phaenopsectra			2
Polypedilum convictum grp	40		
Polypedilum halterale grp	1	10	
Polypedilum illinoense grp	27		1
Polypedilum scalaenum grp	24	2	
Procladius		4	
Pseudochironomus		1	
Rheotanytarsus	6		
Stempellinella	3	5	
Stictochironomus		1	
Tabanus	4		
Tanypus		1	
Tanytarsus	73	36	18
Thienemanniella	1		1
Thienemannimyia grp.	10		1
Caenis latipennis	131	39	15
Choroterpes	1		
Procloeon		2	
Stenacron	2		1
Stenonema femoratum	19	3	
Tricorythodes	32		

North Fork Cuivre River #1b (continued): Fall 2002

Ancylidae	6		14
Menetus		1	102
Physella	44	6	29
Argia	4		14
Enallagma	1		41
Gomphus		3	
Libellulidae		1	
Progomphus obscurus		-99	
Cheumatopsyche	17		
Chimarra	1		
Hydroptila			1
Nectopsyche		1	1
Nyctiophylax			1
Oecetis	1		2
Pycnopsyche			1
Triaenodes			1
Planariidae			55
Branchiura sowerbyi	2	13	
Enchytraeidae	1		
Limnodrilus cervix		5	
Limnodrilus hoffmeisteri		12	
Tubificidae	4	101	

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North Fork Cuivre River #2: Fall 2002

Taxa	CS	NF	RM
Acarina	18	21	6
Berosus	20	1	16
Dubiraphia		1	11
Enochrus	6		1
Helichus lithophilus			3
Macronychus glabratus			1
Scirtes			11
Stenelmis sexlineata	36	1	2
Ablabesmyia	5	5	1
Anopheles			1
Ceratopogoninae	10	6	
Chironomus	2	35	
Cladotanytarsus	11	11	1
Corynoneura			1
Cryptochironomus		2	
Dicrotendipes	2	6	
Labrundinia		1	6
Microtendipes	1		
Nilotanypus	5		
Paracladopelma		1	
Paratanytarsus			15
Paratendipes	4	1	
Pentaneura	1		
Phaenopsectra			1
Polypedilum convictum grp	16		1
Polypedilum halterale grp		2	
Polypedilum illinoense grp	15	1	3
Polypedilum scalaenum grp	58	2	
Procladius	1	5	
Pseudochironomus	2		
Rheotanytarsus	6	1	
Stempellinella	10	1	
Stenochironomus			1
Tabanus	1		
Tanytarsus	68	6	1
Thienemannimyia grp.	12		7
undescribed Empididae	13		
Baetidae	1		
Caenis latipennis	99	101	34
Procloeon		2	
Stenacron	3		1
Stenonema femoratum	9	1	8
Tricorythodes	13		
Microvelia			2
Rhagovelia	1		
Trepobates		1	
Ancylidae	17	38	155
Fossaria	5		2
Menetus	5	9	4
Physella	50	1	24
Lumbricidae	1		
Argia	-99	1	6
Basiaeschna janata			-99
Calopteryx	-99		1

North Fork Cuivre River #2 (continued): Fall 2002

Enallagma			28
Erythemis			1
Gomphus		-99	
Ischnura			1
Macromia			-99
Somatochlora		-99	
Cheumatopsyche	7		
Chimarra	8		
Helicopsyche	1		
Hydroptila			1
Nectopsyche			2
Oecetis		1	
Triaenodes			2
Aulodrilus		13	
Enchytraeidae	1		
Limnodrilus hoffmeisteri		2	
Tubificidae	5	22	
Sphaerium		1	1

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