Missouri Department of Natural Resources

Biological Assessment

Big Creek
Cass County, Missouri

2003-2004

Prepared for:

Missouri Department of Natural Resources
Water Protection and Soil Conservation Division
Water Protection Program
Water Pollution Control Branch

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1.0 Introduction

Big Creek originates near Greenwood, Missouri, east of Lees Summit, Missouri. The stream flows to the southeast for approximately 61 miles through Jackson, Cass, Johnson, and Henry counties before reaching its confluence with the South Grand River, about seven miles northwest of Clinton, Missouri. The area included in this study is from its headwaters south of Missouri Highway 150 to Pleasant Hill, Missouri in Cass County (Figure 1).

The Big Creek watershed is located in the Plains/Osage Ecological Drainage Unit (**EDU**). Big Creek is a class "P" stream from Missouri 150 to the mouth, which maintains permanent flow during dry periods (MDNR 2000). Big Creek has designated uses for "Livestock and Wildlife Watering" (**LWW**) and "Protection of Warm Water Aquatic Life and Human Health-Fish Consumption" (**AQL)**.

At the request of the Water Pollution Control Branch (**WPCB**), Water Protection Program (**WPP**), biological and stream habitat assessments were conducted on Big Creek, Cass County in the fall of 2003 and spring of 2004. The Aquatic Bioassessment Unit of the Water Quality Monitoring Section (**WQMS**), Environmental Services Program (**ESP**), Missouri Department of Natural Resources (**MDNR**) coordinated and conducted this study.

1.1 Justification

Approximately 49 miles of Big Creek are on the 2002 list of impaired waters under section 303(d) of the Federal Clean Water Act (40 CFR 130.7; Water Protection Program, Missouri Department of Natural Resources). Big Creek was placed on the list for excessive sediment deposits from agricultural non-point sources and is considered to be "Medium" priority for evaluation (http://www.dnr.mo.gov/wpscd/wpcp/waterquality/2002_303d_list.pdf). Fine sediment particles (ca. <2.0 mm) may homogenize and embed substrate when washed into streams, making it unsuitable for use by macroinvertebrate and fish communities (Chutter 1969; Murphy et al. 1981; Berkman and Rabeni 1987; Smale et al. 1995; Zweig 2000) (http://www.dnr.mo.gov/wpscd/wpcp/tmdl/info/habitat-info.pdf).

1.2 Purpose

Determine if Big Creek, Cass County is biologically impaired.

1.3 Objectives

1) Assess the macroinvertebrate community integrity and water quality in Big Creek, Cass County.

2) Assess the stream habitat quality of Big Creek, Cass County.

1.4 Tasks

1) Conduct a biological assessment, including macroinvertebrate and water physicochemical analyses, of Big Creek, Cass County.

2) Conduct a stream habitat assessment on Big Creek, Cass County.

3) Compare wadeable/perennial stream biological criteria scores between test stations on Big Creek.

1.5 Null Hypotheses

Big Creek, Cass County stations will be similar to wadeable/perennial stream biological criteria.

Big Creek, Cass County stations will be similar when compared longitudinally.

Water quality at Big Creek, Cass County will be similar between all stations and within acceptable Water Quality Standards (MDNR 2000).

Stream habitat on Big Creek, Cass County will be similar between test stations, as well as to the stream habitat control stations.

2.0 Methods and Analyses

The study area, station descriptions, Ecological Drainage Units, and land use are identified. Study timing is outlined. Methods for stream habitat assessment project procedures are discussed. Biological assessment collection and analyses are introduced. Physicochemical water collection and analyses methods are defined.

2.1 Study Area and Station Descriptions

Three test stations were allocated within the approximate seven-mile study area of Big Creek, Cass County (Table 1, Figure 1). Big Creek #3, the most upstream station is approximately 2 miles downstream from Missouri Highway 150. Station #2 is the mid-station approximately 5 miles downstream. Station #1 starts about 0.25 mile downstream from Missouri Highway 58 near the Cass County Fairgrounds and continues downstream through its reach. All of the test stations are within the 303(d) listed section of stream. All are included in the class "P" category, which maintain flow during drought conditions.

Table 1
Location and Descriptive Information for Big Creek, Cass County Stations, 2003-2004

Stream-Station Number	Location-Section, Township, Range	Description	County
Big Creek #3	SW ¼ sec. 02, T. 46 N., R. 31 W.	Upstream Test Station - @ Explosives Energies Inc.	Cass
Big Creek #2	SE ¼ sec. 18, T. 46 N., R. 30 W.	Mid-Test Station - Start Upstream-Boardman Road Bridge	Cass
Big Creek #1	SE ¼ sec. 30, T. 46 N., R. 30 W.	Downstream Test Station - 0.2 mile from Missouri Highway 58 @ Cass County Fairgrounds	Cass

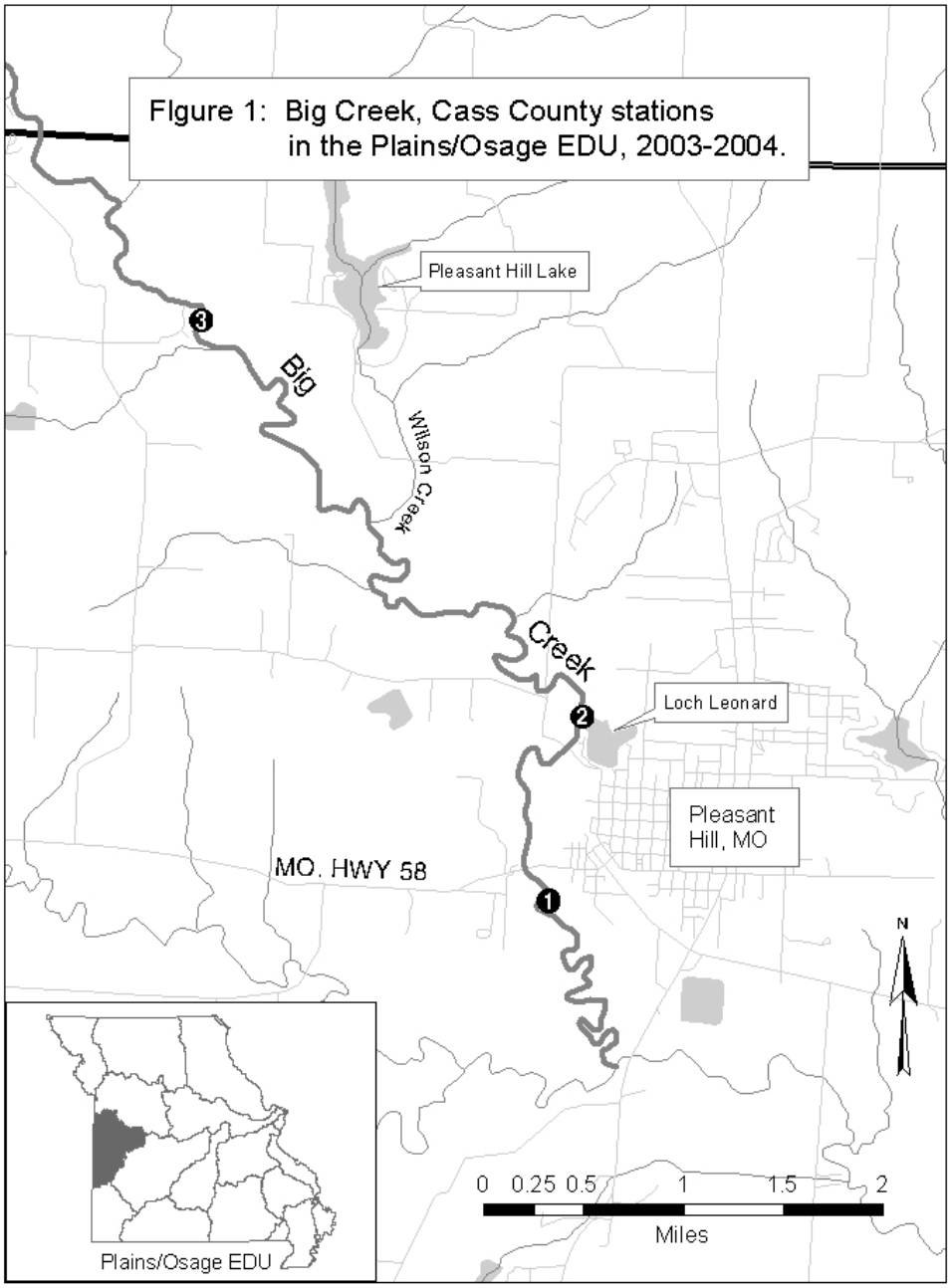

Figure 1: Big Creek, Cass County stations in the Plains/Osage EDU, 2003-2004.

2.1.1 Ecological Drainage Unit

Big Creek is within the Plains/Osage Ecological Drainage Unit (Figure 1). Ecological Drainage Units are delineated drainage units in which similar size streams are expected to contain similar aquatic communities and stream habitat conditions. Comparisons of biological and physicochemical results between similar size reference and test streams within the same EDU should then be appropriate.

2.1.2 Land Use Description

Land cover of the Plains/Osage EDU was compared to the 14-digit Hydrological Unit (**HUC-14**; Table 2) land cover of each station. Percent land cover data were derived from Thematic Mapper (TM) satellite data collected between 1991 and 1993 and interpreted by the Missouri Resource Assessment Partnership (**MoRAP**). The implication of this comparison is that land use is similar between all stations within the study and that it does not interfere with interpretation of the findings.

Table 2
Percent Land Cover in the Big Creek, Cass County Stations and the Plains/Osage EDU

Stations	HUC-14	Urban	Crops	Grassland	Forest	Swamp
Big Creek #3, #2, #1	10290108060003	1.8	31.7	44.9	17.7	0
Little Drywood Creek #2, #1 (SHAPP only)	10290104060003	1.3	13.9	62.9	19.7	0.1
Plains/Osage EDU	--	0.2	23	54.9	17.9	0.3

2.2 Study Timing

Biological assessments were conducted in the fall of 2003 and spring of 2004. Fall sampling was conducted at Big Creek on September 17 and 18, 2003. Spring assessments were conducted at Big Creek stations on March 17 and 18, 2004.

Stream habitat assessments were conducted in the spring of 2004. Big Creek stream habitat assessments were conducted on April 13, 2004. The assessment of the biological criteria reference station at Little Drywood Creek, Vernon County was conducted on April 14, 2004.

2.3 Stream Habitat Assessment

Stream habitat assessments were conducted at Big Creek and the stream habitat control stations according to a standardized Stream Habitat Assessment Project Procedure (**SHAPP**) for "Glide/Pool Prevalence" streams (MDNR 2003d). Assessment scores were compared between test stations and the stream habitat assessment control stations. Scores were also compared to the mean score of the stream habitat control stations. According to the SHAPP, the quality of an aquatic community is based on the streams' ability to support the aquatic community on a given scale. If SHAPP scores at test stations were ≥75% of the mean of the stream habitat controls, the test station's habitat was then considered to have comparable stream habitat quality.

Little Drywood Creek #2 and #1, Vernon County served as stream habitat control stations. Little Drywood Creek #2 is downstream of a county-line gravel road at S ½ section 36, T. 34 N., R. 32 W. Little Drywood Creek #1 is upstream of County road N at SW ¼ section 13, T. 34 N., R. 32 W. Both stations are within the Missouri Department of Conservation Bushwhacker Lake Conservation Area.

2.4 Biological Assessment

Sampling was conducted as stated in MDNR's Semi-quantitative Macroinvertebrate Stream Bioassessment Project Procedure (**SMSBPP,** MDNR 2003c). Biological assessments consisted of macroinvertebrate community and physicochemical water collection and analyses. Macroinvertebrates and water samples were collected at three stations in Big Creek, Cass County.

2.4.1 Macroinvertebrate Sampling and Analyses

Macroinvertebrates were sampled from multiple habitats as described in the SMSBPP. Big Creek is considered a glide/pool dominant stream and habitats were sampled accordingly. Areas that were sampled included non-flowing water over depositional substrates (**NF**), large woody debris (**SG**), and rootmat (**RM**) habitats.

Macroinvertebrate community data were analyzed using three strategies. Stream Condition Index (**SCI**) scores, individual biological criteria metrics, and dominant macroinvertebrate families (**DMF**) were examined and compared. All station results were grouped by season from upstream to downstream.

A Stream Condition Index is a qualitative rank measurement of a stream's aquatic biological integrity (Rabeni et al. 1997). The SCI was further refined for reference streams within each EDU in Biological Criteria for Perennial/Wadeable Streams (**BIOREF**) (MDNR 2002). Due to a shortage of reference quality glide/pool streams in the Plains/Osage EDU, another glide/pool dominant biological criteria reference stream from outside the EDU was used in the calculation of the biological criteria. East Fork Crooked River from the adjacent Plains/Missouri River Tributaries between the Blue and Lamine Rivers EDU was included in the BIOREF calculations to derive the biological criteria metrics.

The first analysis was of SCI scores by station, grouped by season. A station's SCI score is a compilation of rank scores given to the individual biological criteria metrics as a measure of biological integrity. Four primary metrics were used to calculate the SCI's per station: 1) Taxa Richness (**TR**); 2) Ephemeroptera/Plecoptera/Trichoptera Taxa (**EPTT**); 3) Biotic Index (**BI**); and 4) Shannon Diversity Index (**SDI**). Metric (TR, EPTT, BI, SDI) scores were compared to the BIOREF scoring range (SCI Scoring Table, Tables 4 and 5) and rank scores (5, 3, 1) were assigned to each metric (Tables 4 and 5). Rank scores for all metrics were compiled for each station and their total SCI's were completed. The SCI scores are interpreted as follows:
20-16 = fully biologically supporting; 14-10 = partially biologically supporting; and
8-4 = non-supporting of the biological community.

Secondly, the individual biological criteria metrics (TR, EPTT, BI, SDI) were compared to the BIOREF scoring range to identify unusual responses or interesting trends at each station. Variations in metrics may help identify the type and source of impairment.

The third biological analysis was an evaluation of the DMF per station as a percentage of the total number of individuals in the sample. The eight (8) dominant families, as a percentage of the total number of individuals, were listed for each station by season. Dominance by certain families may also help identify the type and source of impairment. A taxa list grouped by season is also included for each station (Appendix A).

2.4.2 Physicochemical Water Sampling and Analyses

Physicochemical water samples were handled according to the appropriate MDNR, ESP Standard Operating Procedure (**SOP**) and/or Project Procedure (**PP**) for sampling and analyzing physicochemical water samples. Results are reported for physicochemical water variables by season and station.

Fall 2003 and spring 2004 physicochemical water variables consisted of field measurements and grab samples that were returned to the ESP state environmental laboratory. Water was sampled according to the SOP MDNR-FSS-001 Required/Recommended Containers, Volumes, Preservatives, Holding Times, and Special Sampling Considerations (MDNR 2003b). Samples were collected and kept on ice for transport to ESP.

Temperature, pH, conductivity, dissolved oxygen, and discharge were measured in the field. The ESP, Chemical Analysis Section (**CAS**) in Jefferson City, Missouri conducted water sample analyses for ammonia-nitrogen, nitrate/nitrite-nitrogen, Total Kjeldahl Nitrogen (**TKN**), chloride, and total phosphorus. Turbidity was measured and recorded in the WQMS biology laboratory.

Laboratory results of the physicochemical water variable analyses were compared between stations from upstream to downstream, as well as with acceptable limits according to Missouri's Water Quality Standards (**WQS**, MDNR 2000). Interpretation of acceptable limits within the WQS may be dependent on a stream's classification and its beneficial-use designation (MDNR 2000). Big Creek is a class "P" stream downstream from Missouri Highway 150, with designated uses for LWW and AQL. Furthermore, acceptable limits for some variables may be dependent on the rate of exposure. These exposure or toxicity limits are based on the lethality of a toxicant given long (chronic toxicity, **c**) or short-term exposure (acute toxicity, **a**).

2.4.3 Discharge

Stream flow was measured using a Marsh-McBirney Flowmate™ flow meter at each station. Velocity and depth measurements were recorded at each station according to SOP, MDNR-WQMS-113 Flow Measurement in Open Channels (MDNR 2003a).

2.5 Quality Control

Quality control was conducted according to MDNR Standard Operating Procedures and Project Procedures.

3.0 Results and Analyses

Stream habitat and biological assessments were conducted for all Big Creek stations. Results are grouped by season and by station from upstream to downstream.

3.1 Stream Habitat Assessment

Stream habitat was similar in quality at Big Creek stations #3, #2, and #1 and control stations #2 and #1 at Little Drywood Creek (Table 3). Scores ranged from 110 to 134 at Big Creek, while the stream habitat control stations ranged from 106 to 122. The average at Big Creek (124) was higher than the mean of the stream habitat controls (114). Lastly, all of Big Creek station's SHAPP scores were greater than 75 percent of the mean of control scores. This indicates that the stream habitat at Big Creek stations was comparable to reference quality stream habitat (MDNR 2003).

Table 3
Stream Habitat Assessment (SHAPP) Scores for Big Creek, Cass County Stations and Little Drywood, Spring 2004

	Big Creek #3	Big Creek #2	Big Creek #1	Little Drywood #2, Control	Little Drywood #1, Control	Little Drywood Mean Score
SHAPP Scores	134	110	130	122	106	114
Percent of control mean	117	96	114	--	--	--

3.2 Biological Assessment

Biological assessments include stream macroinvertebrate community analyses and assessment of the quality of physicochemical water conditions. Station analyses are grouped by season and interesting trends and outstanding results are identified.

3.2.1 Macroinvertebrate Community Analyses

SCI scores showed that the macroinvertebrate communities were different between stations in the fall of 2003 (Table 4). Station #2 was partially supporting of the biological community with an SCI score of 12. Each of the four metrics (TR, EPTT, BI, and SDI) had scores of 3 at station #2. Both stations #3 (18) and #1 (18) were considered fully supporting of the biological community.

Individual biological criteria metrics illustrated impairment at station #2 in the fall of 2003 (Table 4). The TR (56), EPTT (5), and SDI (2.59) were low and the BI was high (8.03) at station #2. Metrics for stations #3 and #1 were comparable to BIOREFs in the fall, except for EPTT. All stations had low EPTT.

Table 4
Fall 2003 Biological Criteria Metric Scores and Stream Condition Index (SCI) Scores (n=11) for Big Creek, Cass County Stations. (SCI Scoring Table in light gray)

Stream and Station Number	Sample No.	TR	EPTT	BI	SDI	SCI	Supporting
Big Creek #3	0318721	70	**6**	7.60	3.04	18	Fully
Big Creek #2	0318720	**56**	**5**	**8.03**	**2.59**	**12**	**Partially**
Big Creek #1	0318719	64	**6**	7.47	3.30	18	Fully
Score=5	--	>57	>6	<7.63	>2.86	20-16	Fully
Score=3	--	57-28	6-3	7.63-8.82	2.86-1.43	14-10	Partially
Score=1	--	<28	<3	>8.82	<1.43	8-4	Non

SCI scores were similar between all stations on Big Creek in the spring of 2004 (Table 5). Station #3 (18) was slightly higher than either station #2 (16) or station #1 (16). All stations were considered to be fully supporting of the biological community in the spring of 2004.

Individual biological criteria metrics across all stations illustrated a trend in the spring of 2004. The BI score was higher than the criteria (more tolerant taxa) across all stations and the EPTT were slightly lower at stations #2 and #1.

Table 5
Spring 2004 Biological Criteria Metric Scores and Stream Condition Index (SCI) Scores (n=9) for Big Creek, Cass County Stations. (SCI Scoring Table in light gray)

Stream and Station Number	Sample No.	TR	EPTT	BI	SDI	SCI	Supporting
Big Creek #3	0418658	72	9	**7.82**	3.25	18	Fully
Big Creek #2	0418657	74	**7**	**7.67**	3.33	16	Fully
Big Creek #1	0418656	77	**8**	**7.49**	3.39	16	Fully
Score=5	--	>50	>8	<7.16	>2.29	20-16	Fully
Score=3	--	50-25	8-4	7.16-8.58	2.29-1.14	14-10	Partially
Score=1	--	<25	<4	>8.58	<1.14	8-4	Non

The dominant macroinvertebrate families illustrate the differences between stations in the fall of 2003 (Table 6). The percentage of Tubificidae was three-fold higher at station #2 (29.8) than the upstream station #3 (8.4) and downstream station #1 (9.9). The amphipod family Hyalellidae increased at station #2 to 27.1%, which was higher than station #3 (7.1) and station #1 (16.5).

Table 6
Dominant Macroinvertebrate Families (DMF) as a Percentage of the Total Number of Individuals per Station, Fall 2003

Station	Big Creek #3	Big Creek #2	Big Creek #1
Sample Number	0318721	0318720	0318719
Chironomidae	28.3	13.2	22.7
Caenidae	27.6	1.4	6.7
Tubificidae	8.4	**29.8**	9.9
Hyalellidae	7.1	**27.1**	16.5
Corbiculidae	4.9	--	--
Coenagrionidae	4.7	3.5	4.7
Physidae	3.4	2.5	--
Gerridae	2.6	--	--
Corixidae	--	9.4	6.4
Scirtidae	--	2.3	
Heptageniidae	--	--	6.4
Elmidae	--	--	5.9

The dominant macroinvertebrate family percentages were relatively similar across all stations in the spring of 2004 (Table 7). Chironomidae dominated the communities at stations #3 (54.8), #2 (71.9), and #1 (63.2). The percentage of Tubificidae was relatively consistent at stations #3 (14.8), #2 (6.8), and #1 (5.8).

Table 7
Dominant Macroinvertebrate Families (DMF) as a Percentage of the Total Number of Individuals per Station, Spring 2004

Station	Big Creek #3	Big Creek #2	Big Creek #1
Sample Number	0418658	0418657	0418656
Chironomidae	**54.8**	**71.9**	**63.2**
Tubificidae	14.8	6.8	5.8
Caenidae	6.5	1.6	8.9
Hyalellidae	3.6	-	4.5
Ceratopogonidae	3.4	1.1	-
Crangonyctidae	3.3	3.3	-
Physidae	2.9	1.4	1.7
Enchytraeidae	1.7	1.6	1.7
Heptageniidae	-	2.9	-
Coenagrionidae	-	-	1.2
Elmidae	-	-	1.1

3.2.2 Physicochemical Water Variables

Several physicochemical water variables were notable in the fall of 2003 and spring of 2004. Conductivity, dissolved oxygen, and turbidity were of interest while nutrients were present in moderate amounts in the fall and spring.

Conductivity was relatively high in the fall of 2003 (Table 8). Station #3 was highest at 694 uS. Station #2 was lower at 494 uS, while station #1 reached only 461 uS.

Dissolved oxygen was low at stations #2 (5.9 mg/L) and #1 (6.10 mg/L) in the fall of 2003 (Table 8). Station #2 was near the WQS (MDNR 2000) minimum of 5.0 mg/L.

Nutrients such as nitrate+nitrite-N and TKN were present in moderate amounts in the fall 2003 sample season (Table 8). Nitrate+nitrite-N maintained low levels from station #3 (0.59 mg/L) and station #2 (0.56 mg/L) to station #1 (0.57 mg/L). Total Kjeldahl Nitrogen (TKN) also followed a similar pattern at stations #3 (0.96 mg/L), #2 (0.91 mg/L), and #1 (0.80 mg/L). Total phosphorus levels were similar at stations #3 (0.13 mg/L), #2 (0.17 mg/L), and #1 (0.17 mg/L).

Table 8
Physicochemical Water Variables per Station, Big Creek, Cass County, Fall 2003
(Units mg/L unless otherwise noted)

Station Variable	Big Creek #3	Big Creek #2	Big Creek #1
Sample No.	0300516	0300515	0300514
pH (Units)	7.9	7.7	7.7
Temperature (C^0)	19.5	19.5	19.0
Conductivity (uS)	**694**	494	461
Dissolved O_2	7.30	**5.90**	**6.10**
Discharge (cfs)	0.93	3.55	2.91
Turbidity (NTUs)	24.5	49.8	45.3
Nitrate+Nitrite-N	0.59	0.56	0.57
TKN	0.96	0.91	0.80
Ammonia-N	<0.03	<0.03	<0.03
Chloride	22.7	17.0	15.8
Total Phosphorus	0.13	0.17	0.17

Discharge was higher in the spring due to a recent rain event (Table 9). From upstream to downstream, station #3 (11.4 cfs) was lower than station #2 (29.9 cfs) and station #1 (29.7 cfs) was approximately equal to station #2.

Turbidity was high upstream and decreased downstream in the spring (Table 9). Station #3 (81.9 NTUs) was more than twice that of station #2 (40.1 NTUs). Turbidity at station #1 (29.3 NTUs) was the lowest of all the stations.

Nutrients such as nitrate+nitrite-N and TKN were present in the spring 2004 sample season (Table 9). Nitrate+nitrite-N maintained low levels from station #3 (0.86 mg/L), station #2 (1.08 mg/L), and station #1 (1.03 mg/L). Total Kjeldahl Nitrogen (TKN) also followed a similar pattern at stations #3 (0.59 mg/L), #2 (0.55 mg/L), and #1 (0.67 mg/L). Total phosphorus levels were similar at stations #3 (0.13 mg/L), #2 (0.12 mg/L), and #1 (0.12 mg/L).

Table 9
Physicochemical Water Variables per Station, Big Creek, Cass County, Spring 2004
(Units mg/L unless otherwise noted)

Variable	Big Creek #3	Big Creek #2	Big Creek #1
Sample No.	0411021	0411020	0411019
pH (Units)	8.0	7.8	8.2
Temperature (C^0)	9.5	8.0	8.0
Conductivity (uS)	587	515	512
Dissolved O_2	11.1	12.4	12.2
Discharge (cfs)	**11.4**	**29.9**	**29.7**
Turbidity (NTUs)	**81.9**	40.1	29.3
Nitrate+Nitrite-N	0.86	1.08	1.03
TKN	0.59	0.55	0.67
Ammonia-N	<0.03	<0.03	<0.03
Chloride	29.2	29.0	29.5
Total Phosphorus	0.13	0.12	0.12

4.0 Discussion

The goal of this project was to determine if Big Creek, Jackson and Cass counties, was impaired. Stream habitat and biological assessment results are discussed in this section.

4.1 Stream Habitat Assessment

Big Creek stream habitat was comparable to the SHAPP control stations in the Plains/Osage EDU. The range of scores, means, and SHAPP comparisons all suggested that Big Creek stations were comparable to stream habitat controls or reference streams and capable of fully supporting a similar biological community.

Stream habitat at station #1 scored relatively high; however, the station had a considerable trash build-up in the primary floodplain. Station #1 is on the west edge of the Cass County Fairgrounds in Pleasant Hill, Missouri. Trash was found in two locations on or near the bank. Glass bottles, plastic, and paper products were frequently found on the stream bank. The trash should be removed from the stream bank and from within the stream wherever possible. Littering should be prevented in the area.

4.2 Biological Assessment

The biological assessment of Big Creek revealed seasonal differences. One station (#2) was considered slightly impaired in the fall. Stations were not impaired in the spring.

4.2.1 Fall 2003

During the fall, the macroinvertebrate community at station #2 was found to be partially impaired. No obvious contributors for impairment were found, however, general observations and physicochemical water variable results are discussed below.

4.2.1.1 Macroinvertebrate Community

In the fall of 2003, station #2 had an SCI score that designated it as partially supporting, while stations #3 and #1 were fully supporting of the biological community (Table 4). It also appeared that all of the biological criteria metrics contributed to the low score at station #2 in that they all had individual rank metric scores of 3, with a total SCI of 12. The TR, BI, and SDI were different than the other stations. The biological community had a reduced number of total taxa and EPT taxa, an increased BI, and lower SDI. The community at station #2 was less diverse and more tolerant to organic pollution and disturbance. Tubificid worms made up approximately 30 percent of the total number of individuals at station #2. Tubificid worms are tolerant to organic pollution, low dissolved oxygen levels, and fine sediment. Amphipods also made up approximately 30 percent of the sample at station #2. *Hyalella* species are considered tolerant taxa, which in high numbers may have influenced the TR, BI, and SDI. The large number of tolerant taxa influenced the metrics toward a more tolerant, less diverse community that would score lower. The high percentage of tubificids and amphipods at station #2 may have been largely influenced by habitat and discharge conditions.

Only tolerant ephemeroptera (mayflies) and tricoptera (Oecetis sp. and Cyrnellus sp.) were found in all stations in the fall season (Appendix A). It is possible that only more tolerant taxa occur at other streams in the EDU as well.

4.2.1.2 Physicochemical Water Quality

Nutrients were not observed in large concentrations during either season. However, dissolved oxygen at station #2 (5.90 mg/L) was near the minimum acceptable limit (5.0 mg/L) in the WQS (MDNR 2000). Dissolved oxygen was not measured in the early morning when it would naturally be lower during a 24-hour period. Dissolved oxygen may have decreased below WQS during those times, contributing to a shift in the community composition. High biochemical oxygen demand from organic enrichment may have contributed to the lower dissolved oxygen levels observed in the fall at stations #2 and #1. Streams in the Plains/Osage EDU tend to retain large quantities of woody debris and organic matter in their channels, which may be often associated with noticeable anaerobic conditions in the sediment.

4.2.1.3 General Observations

General observations suggested a possible scenario that may explain why station #2 was partially biologically supporting and why the dissolved oxygen level was lower than at other stations. A large debris dam blocked the lower portion of station #2, which reduced water velocity. What appeared to be fine sediment with high organic content was naturally deposited in this area. Low velocity, higher temperatures, woody debris, and fine sediment with high organic content were probable contributors to lower dissolved oxygen. Lower dissolved oxygen may have contributed to the partially impaired status at station #2 and the presence of tolerant taxa such as the tubificid worms.

The impairment was apparently not continuous. No impairment was observed at station #2 in the spring when flow was greater and temperature cooler. The dissolved oxygen level was higher at all sites, as is common in faster flowing colder water. Greater flow also had the potential to push the fine sediment in station #2 past the large debris dam. Any of these variables may have created more tolerable conditions for sensitive taxa. Thus, scores were better and the community was more intolerant than observed in the fall.

BOD analyses, dissolved oxygen measurements at the surface and immediately above the sediment, and quantifying and characterizing the fine sediment through total organic carbon analyses are needed in order to determine if the scenario at station #2 in the fall is plausible.

4.2.1.4 Potential Bias

The debris dam may have caused a bias at station #2. The large debris dam apparently created a condition of low flow and increased fine sediment deposition, which may have contributed to the impairment. Large debris dams were not found in any other station, so the condition was not representative of the entire stream. Station #2 may not be a good representative of Big Creek's natural condition. However, debris dams may be a common occurrence, as glide/pool streams tend to contain large quantities of woody debris. Debris dams may create localized demands within other streams as well.

4.2.2 Spring 2004

All stations were considered fully supporting of the biological community in the spring of 2004. However, the BI revealed that all stations were not as high in quality as the BIOREF streams. Secondly, observations and physicochemical variables such as flow, turbidity, and conductivity may have identified Dupuis Redi-Mix or Martin-Marietta Quarries as a potential source for suspended sediment (see 4.2.2.3).

4.2.2.1 Macroinvertebrate Community

The macroinvertebrate community illustrated an interesting trend across all stations in the spring. The BI was slightly higher than the BIOREFs at all stations, which suggests that the biological community in the entire study area was composed of taxa that were slightly more tolerant to organic pollution. Tubificids were found in relatively low percentages at all stations in the spring, suggesting that the influence on station #2 in the fall was not continuous. Two intolerant mayfly taxa, *Leptophlebia sp*. and *Acerpenna sp*., were found in either station #2 or station #1 in the spring (Appendix A). Two intolerant Tricoptera taxa, *Nyctiophylax sp*. and *Pycnopsyche sp.,* were found at station #3. So, despite the slightly higher BI, the assemblage of intolerant taxa indicated that the conditions were present for sensitive species in the spring.

4.2.2.2 Physicochemical Water Quality

No obvious difference was found in the physicochemical results by station in the spring, except for several variables that may point to a potential source for suspended sediment. High flow, turbidity, and conductivity illustrated a scenario in the spring that may identify the suspended sediment and determine its origin.

4.2.2.3 General Observations

Big Creek was sampled in the spring after a rain event. The water at station #3 appeared "milky" in color and very turbid, which suggested that silt was mixed in the runoff entering the stream. When the water was lower in the fall, small "flakes" of limestone were observed on the substrate of station #3 and the conductivity was slightly higher. These observations suggest that the white suspended sediment may have been powdered limestone.

Dupuis Redi-Mix Concrete and Martin-Marietta Quarries are less than two miles upstream from station #3 and are two potential sources for powdered limestone. The turbidity was lower in the fall, which suggests that the silt influence was rainfall dependent runoff. However, the high conductivity in the fall suggests that quarrying, agriculture, or sewage systems may continuously add ions to the stream.

No obvious effects were observed from the white suspended sediment. There was no obvious excessive accumulation of fine white sediment on the substrate in stations #3 or #1. Station #2 had slightly more fine sediment on the substrate than the other stations, as mentioned earlier, however it did not appear to be the same material that was observed at station #3.

While the influence did not appear to have an obvious effect on the macroinvertebrate community, the source for this limestone-like suspended sediment should be identified and it should be prevented from entering the stream.

5.0 Conclusion

The goal was to determine if Big Creek was impaired. Big Creek station #2 (Figure 1) was slightly impaired, while stations #3 and #1 were fully supporting of the biological community in the fall. All stations were fully supporting of the biological community in the spring.

Station #2 was slightly impaired in the fall of 2003, however, it may not be a good indicator of the condition of the stream. No obvious cause was found for the impairment of station #2 in the fall, although several variables may have contributed. Stream flow was low upstream from a large debris dam in station #2. Dissolved oxygen was lower at station #2, which may have been a function of the low flow. General observations revealed what appeared to be organic fine sediment in the stream substrate. Deposition would naturally occur in such low flow. Dissolved oxygen levels could also decrease in low flow areas with decomposition of organic material. The macroinvertebrate community observed at station #2 was more tolerant to organic pollution and other disturbances. The tubificid worms that dominated the samples at station #2 are tolerant to lower dissolved oxygen and fine sediment, so either may have contributed to their presence. The debris dam may have created the impairment, which did not have an effect on the rest of the stream. It is likely that fall conditions at station #2 were not representative of general conditions in Big Creek.

In the spring, with greater flow, all stations were fully supporting of the biological community. However, suspended sediment (possibly limestone) was observed in the stream after a rain event. Two potential sources are found upstream of the study area. Despite two potential sources, no excessive accumulation was noted, and no effect was observed on the community.

Hypotheses were dependent on the season. The macroinvertebrate community was different between stations in the fall at station #2. The communities were similar at all stations in the spring, which suggested that the influence is not continuous. The physicochemical water quality was slightly different (dissolved oxygen) in the fall at station #2. Otherwise, the spring water quality was similar between stations. The stream habitat quality was similar between stations and comparable to SHAPP controls. These hypotheses suggest that impairment was isolated and discontinuous.

The objectives were met by assessing the macroinvertebrate community integrity and physicochemical water quality, as well as the stream habitat quality.

6.0 Recommendations

- Remove trash in the primary floodplain near station #1 (Cass County Fairgrounds).

- In order to determine if this scenario is accurate for station #2, BOD analyses, dissolved oxygen measurements at the surface and immediately above the sediment, and quantification of fine sediment and characterization of the fine sediment through organic carbon analyses are needed. This may be conducted at other glide/pool streams in the Plains/Osage EDU to illustrate the natural organic loading in these streams

- The source for this limestone-like suspended sediment should be identified and the sediment kept from entering the stream.

7.0 Literature Cited

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Appendix A

Macroinvertebrate Bench Sheets for Big Creek, Cass County Stations
Fall 2003 and Spring 2004
(NF=nonflow, SG=large woody debris, RM=rootmat habitats; -99=Present)

Aquid Invertebrate Database Bench Sheet Report
Big Ck [0318721], Station #3, Sample Date: 9/18/2003 11:50:00 AM

ORDER: TAXA	CS	NF	SG	RM
"HYDRACARINA"				
Acarina		3		1
AMPHIPODA				
Hyalella azteca			12	40
ARHYNCHOBDELLIDA				
Erpobdellidae		-99		
COLEOPTERA				
Berosus		2	1	
Dubiraphia		3		2
Hydroporus				1
Peltodytes		1		
Scirtes				8
DECAPODA				
Palaemonetes kadiakensis				3
DIPTERA				
Ablabesmyia		4	4	1
Ceratopogoninae		5		4
Chaoborus		1		
Chironomus		4	4	1
Chrysops		2		
Cladotanytarsus		1		
Clinocera				3
Corynoneura		1		
Cricotopus/Orthocladius			2	
Cryptochironomus		6		
Dasyheleinae			2	
Dicrotendipes		5	38	14
Diptera			1	
Glyptotendipes			8	8
Hemerodromia			1	
Kiefferulus				1
Labrundinia				6
Natarsia			1	
Nemotelus				2
Parachironomus			1	4
Paratanytarsus		1	2	4
Polypedilum halterale grp		4		
Polypedilum illinoense grp			2	18
Procladius		1		1
Pseudosmittia			4	
Rheotanytarsus			1	
Tabanidae				1

ORDER: TAXA	CS	NF	SG	RM
Tanytarsus		17	12	9
Thienemannimyia grp.			3	6
Tribelos			5	1
Xestochironomus			2	
EPHEMEROPTERA				
Caenis latipennis		100	86	15
Caenis punctata				1
Callibaetis			2	
Hexagenia limbata		12	1	
Stenonema femoratum				1
HEMIPTERA				
Corixidae		3	3	1
Microvelia			1	
Neoplea				2
Palmacorixa				3
Rheumatobates				9
Trepobates				10
LIMNOPHILA				
Ancylidae			3	
Fossaria				1
Physella		5	7	13
Pseudosuccinea				1
LUMBRICINA				
Lumbricidae		1		
ODONATA				
Argia		2	4	24
Calopteryx			1	
Enallagma				2
Erythemis				1
Gomphidae			1	
Ischnura				3
Libellulidae				1
Nasiaeschna pentacantha				4
RHYNCHOBDELLIDA				
Glossiphoniidae		1		
TRICHOPTERA				
Oecetis		1		
TUBIFICIDA				
Aulodrilus		2		
Branchiura sowerbyi		3		
Tubificidae		45	11	1
VENEROIDEA				
Corbicula		24	12	

Aquid Invertebrate Database Bench Sheet Report
Big Ck [0318720], Station #2, Sample Date: 9/18/2003 2:30:00 PM

ORDER: TAXA	CS	NF	SG	RM
"HYDRACARINA"				
Acarina				1
AMPHIPODA				
Crangonyx				6
Hyalella azteca		1	21	177
COLEOPTERA				
Dubiraphia		2	2	
Hydroporus				1
Peltodytes				1
Scirtes			7	10
DECAPODA				
Orconectes virilis				-99
Palaemonetes kadiakensis			-99	4
DIPTERA				
Ceratopogoninae		6	3	
Chaoborus		3		
Chironomus		2	14	1
Cryptochironomus		6	1	
Dicrotendipes			6	1
Endochironomus			1	
Glyptotendipes			8	2
Labrundinia				1
Parachironomus				3
Paraphaenocladius				1
Paratanytarsus			1	1
Pilaria			1	
Polypedilum illinoense grp		1	6	4
Procladius		8		
Pseudochironomus			3	1
Stratiomys			1	
Tanytarsus			5	5
Thienemannimyia grp.		1	4	
Tribelos			10	
EPHEMEROPTERA				
Caenis latipennis		5	6	
Callibaetis			5	4
Hexagenia limbata		6		
Stenacron		1	3	
HEMIPTERA				
Corixidae		45	18	2
Microvelia				1
Neoplea				1

ORDER: TAXA	CS	NF	SG	RM
Palmacorixa		1		
Rheumatobates				4
Trepobates				1
Trichocorixa				3
ISOPODA				
Lirceus		1	1	3
LIMNOPHILA				
Ancylidae				2
Fossaria				2
Physella		1		18
MEGALOPTERA				
Chauliodes rastricornis				1
Sialis		1		
ODONATA				
Argia			6	8
Coenagrionidae		1		4
Enallagma				7
Libellulidae		1		
Nasiaeschna pentacantha				2
TRICHOPTERA				
Cyrnellus fraternus			1	
TUBIFICIDA				
Branchiura sowerbyi		11		1
Enchytraeidae				1
Limnodrilus cervix		3		
Tubificidae		196	5	3
VENEROIDEA				
Sphaerium		3	1	

Aquid Invertebrate Database Bench Sheet Report
Big Ck [0318719], Station #1, Sample Date: 9/18/2003 10:00:00 AM

ORDER: TAXA	CS	NF	SG	RM
"HYDRACARINA"				
Acarina		4		4
AMPHIPODA				
Hyalella azteca			8	117
ARHYNCHOBDELLIDA				
Erpobdellidae			1	
COLEOPTERA				
Dubiraphia		7	2	35
Hydrochus				1
Hydroporus				1
Peltodytes			1	
Scirtes				19
Stenelmis		1		
DECAPODA				
Palaemonetes kadiakensis		-99	1	3
DIPTERA				
Ablabesmyia		1		
Axarus		1		
Ceratopogoninae		10	2	1
Chaoborus		1		
Chironomus		11	5	
Chrysops				1
Clinotanypus		1	1	
Corynoneura			1	
Cricotopus/Orthocladius			1	
Cryptochironomus		1		
Dicrotendipes		1	7	4
Diptera		1	1	
Epoicocladius		1		
Forcipomyiinae			2	
Glyptotendipes		5		3
Labrundinia		4	2	
Microtendipes		2		
Parachironomus				2
Paralauterborniella		2		
Paratanytarsus		1	7	6
Polypedilum halterale grp		17	3	
Polypedilum illinoense grp		3	6	1
Polypedilum scalaenum grp			2	
Procladius		7		
Pseudochironomus			1	
Simulium			1	

ORDER: TAXA	CS	NF	SG	RM
Stenochironomus			2	1
Tanytarsus		2	14	3
Thienemannimyia grp.			10	2
Tribelos		1	27	
EPHEMEROPTERA				
Caenis latipennis		37	14	
Callibaetis			1	3
Hexagenia limbata		12		1
Procloeon			1	
Stenacron		25	22	2
HEMIPTERA				
Corixidae		26	23	
Microvelia				2
Rheumatobates				2
LIMNOPHILA				
Ancylidae		1	16	5
Ferrissia				2
Fossaria			1	2
Menetus		3		1
Physella			5	11
MEGALOPTERA				
Sialis		2		
ODONATA				
Argia		4	10	14
Enallagma				8
Libellulidae		1		
Nasiaeschna pentacantha				9
TRICHOPTERA				
Cyrnellus fraternus				1
TRICLADIDA				
Planariidae				1
TUBIFICIDA				
Branchiura sowerbyi		11		
Enchytraeidae				1
Tubificidae		58	2	4
VENEROIDEA				
Sphaeriidae		10	4	1

Aquid Invertebrate Database Bench Sheet Report
Big Ck [0418658], Station #3, Sample Date: 3/18/2004 12:15:00 PM

ORDER: TAXA	CS	NF	SG	RM
"HYDRACARINA"				
Acarina				3
AMPHIPODA				
Crangonyx			7	24
Hyalella azteca			2	32
ARHYNCHOBDELLIDA				
Erpobdellidae		-99		1
COLEOPTERA				
Berosus		2		
Dubiraphia		2		
Hydroporus		1		3
Laccophilus				1
DECAPODA				
Palaemonetes kadiakensis		-99		4
DIPTERA				
Ablabesmyia		2	3	2
Ceratopogoninae		27		5
Chaoborus		1		
Chironomus		2	1	
Corynoneura			1	1
Cricotopus bicinctus		1	65	29
Cricotopus/Orthocladius		5	77	43
Cryptochironomus		3		
Dicrotendipes		1	24	4
Endochironomus			2	
Eukiefferiella			2	
Glyptotendipes			4	
Hydrobaenus			10	23
Larsia				1
Nanocladius			1	
Paraphaenocladius			1	
Paratanytarsus			9	52
Paratendipes		2		
Phaenopsectra			3	5
Polypedilum convictum grp			5	
Polypedilum halterale grp		5		
Polypedilum illinoense grp		1	23	10
Polypedilum scalaenum grp			1	
Procladius		1		
Pseudochironomus			1	
Stictochironomus			1	
Tanytarsus		2	8	2

ORDER: TAXA	CS	NF	SG	RM
Thienemanniella		1	30	4
Thienemannimyia grp.			13	3
Tribelos		3	12	
Zavrelimyia				1
EPHEMEROPTERA				
Caenis latipennis		26	14	20
Hexagenia limbata		-99		
Stenacron			2	1
Stenonema femoratum			7	
HEMIPTERA				
Sigara		1		
Trichocorixa			1	1
LIMNOPHILA				
Ancylidae			4	
Fossaria	1	1		
Physella			10	17
Planorbella			1	
MEGALOPTERA				
Sialis		-99		
ODONATA				
Argia			2	
Calopteryx				1
Enallagma				4
Nasiaeschna pentacantha				1
Perithemis				1
PLECOPTERA				
Allocapnia			1	1
RHYNCHOBDELLIDA				
Piscicolidae				1
TRICHOPTERA				
Cheumatopsyche			12	2
Hydroptila		1		
Nyctiophylax			3	
Pycnopsyche			-99	
TUBIFICIDA				
Branchiura sowerbyi		2		
Enchytraeidae		15	1	
Ilyodrilus templetoni		1		
Limnodrilus angustipenis			1	
Limnodrilus cervix		3		
Limnodrilus claparedianus		2		
Limnodrilus hoffmeisteri		43	1	2
Tubificidae		76	5	1

ORDER: TAXA	CS	NF	SG	RM
VENEROIDEA				
Corbicula		3		
Sphaerium		7	1	1

Aquid Invertebrate Database Bench Sheet Report
Big Ck [0418657], Station #2, Sample Date: 3/18/2004 9:50:00 AM

ORDER: TAXA	CS	NF	SG	RM
N/A				
Branchiobdellida				5
"HYDRACARINA"				
Acarina		4		
AMPHIPODA				
Crangonyx			-99	45
Hyalella azteca		1		12
ARHYNCHOBDELLIDA				
Erpobdellidae		-99		
COLEOPTERA				
Dubiraphia		4		7
Gyrinus				-99
Hydroporus		2	1	6
Peltodytes				1
Scirtes			1	3
Tropisternus				1
DECAPODA				
Orconectes virilis		-99		-99
Palaemonetes kadiakensis		-99		2
DIPTERA				
Ablabesmyia		8	6	1
Axarus		1		
Ceratopogoninae		16		
Chaoborus		1		
Chironomus		2		
Corynoneura		8	35	4
Cricotopus bicinctus		6	164	32
Cricotopus/Orthocladius		3	103	15
Cryptochironomus		5		
Cryptotendipes		1		
Dicrotendipes			66	1
Eukiefferiella			2	
Glyptotendipes		1	13	
Hydrobaenus		9	58	19
Microtendipes		1		
Nanocladius		2	3	2
Parakiefferiella			9	
Paralauterborniella		9		
Paraphaenocladius		1	2	7
Paratanytarsus		15	47	46
Phaenopsectra		1	6	1
Polypedilum convictum grp			8	

ORDER: TAXA	CS	NF	SG	RM
Polypedilum fallax grp			5	
Polypedilum halterale grp		15		
Polypedilum illinoense grp			18	12
Polypedilum scalaenum grp		1		
Procladius		18	1	2
Rheocricotopus			1	
Simulium			6	
Smittia		1		
Stenochironomus			10	
Tanytarsus		10	27	11
Thienemanniella		2	65	14
Thienemannimyia grp.		2	6	3
Tipula				-99
Tribelos		14		
EPHEMEROPTERA				
Acerpenna				1
Caenis latipennis		7	6	9
Hexagenia limbata		11	1	
Stenacron		6	26	7
Stenonema femoratum			1	
HEMIPTERA				
Trichocorixa		3	1	
LIMNOPHILA				
Ancylidae			2	4
Menetus			1	
Physella			7	13
LUMBRICINA				
Lumbricidae			1	
MEGALOPTERA				
Sialis		1		
ODONATA				
Argia		1	1	3
Enallagma				1
Nasiaeschna pentacantha				1
RHYNCHOBDELLIDA				
Glossiphoniidae			1	
TRICHOPTERA				
Cheumatopsyche			2	
Oecetis		1		
TRICLADIDA				
Planariidae				8
TUBIFICIDA				
Aulodrilus		3		

ORDER: TAXA	CS	NF	SG	RM
Branchiura sowerbyi		8		
Enchytraeidae		7	4	11
Limnodrilus claparedianus		3		
Limnodrilus hoffmeisteri		7		
Tubificidae		65	5	
VENEROIDEA				
Sphaeriidae		16		

Aquid Invertebrate Database Bench Sheet Report
Big Ck [0418656], Station #1, Sample Date: 3/17/2004 1:45:00 PM

ORDER: TAXA	CS	NF	SG	RM
N/A				
Branchiobdellida				6
"HYDRACARINA"				
Acarina				1
AMPHIPODA				
Crangonyx				-99
Hyalella azteca				39
ARHYNCHOBDELLIDA				
Erpobdellidae		1		
COLEOPTERA				
Dubiraphia		6	1	2
Gyrinus				1
Hydroporus		1		3
Scirtes				1
Stenelmis		1		
DECAPODA				
Orconectes		1		
Palaemonetes kadiakensis		-99	-99	5
DIPTERA				
Ablabesmyia		7		3
Ceratopogoninae		8		2
Chironomus		6	1	1
Clinotanypus		1		
Corynoneura		10	6	19
Cricotopus bicinctus		2	18	8
Cricotopus/Orthocladius		12	100	19
Cryptochironomus		11		
Dicrotendipes		1	30	1
Diptera			1	1
Eukiefferiella			1	
Glyptotendipes		2	2	
Hydrobaenus		19	25	18
Labrundinia		1		
Limonia			3	
Micropsectra				1
Microtendipes		4	2	2
Nanocladius		1		
Natarsia		1		
Nemotelus		1		
Paralauterborniella		3		
Paraphaenocladius		1	1	2
Paratanytarsus		10	2	47

ORDER: TAXA	CS	NF	SG	RM
Paratendipes		1		
Polypedilum convictum grp			3	
Polypedilum fallax grp				3
Polypedilum halterale grp		19	2	
Polypedilum illinoense grp			8	4
Polypedilum scalaenum grp			1	
Procladius		6		
Simulium		7		
Stratiomys			1	
Tabanus		1		1
Tanytarsus		4	8	3
Thienemanniella		5	15	11
Thienemannimyia grp.		3	3	1
Tribelos		34	2	2
EPHEMEROPTERA				
Caenis latipennis		37	5	34
Callibaetis				1
Hexagenia limbata		6		
Leptophlebia				2
Stenacron		2		1
Stenonema femoratum		-99		
HEMIPTERA				
Corixidae		3		
ISOPODA				
Lirceus				3
LIMNOPHILA				
Ancylidae		1	1	6
Fossaria		1	8	
Menetus				1
Physella		6	3	6
MEGALOPTERA				
Sialis		-99		
ODONATA				
Argia		3		5
Enallagma				2
Gomphus		-99		
Ischnura		1		
Nasiaeschna pentacantha				2
RHYNCHOBDELLIDA				
Piscicolidae				1
TRICHOPTERA				
Cheumatopsyche		1	1	
Pycnopsyche			-99	4

ORDER: TAXA	CS	NF	SG	RM
TUBIFICIDA				
Branchiura sowerbyi		1		1
Enchytraeidae		6	1	8
Limnodrilus claparedianus		1		
Limnodrilus hoffmeisteri		8		4
Tubificidae		30	2	3
VENEROIDEA				
Sphaeriidae			1	
Sphaerium		4	1	