



Missouri
Department of
Natural Resources

BIOLOGICAL ASSESSMENT AND HABITAT STUDY

**Upper Mussel Fork
Sullivan and Adair Counties**

2002 -2003

Prepared for:

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Water Protection and Soil Conservation Division
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1.0 Introduction

At the request of the Missouri Department of Natural Resources (**MDNR**), Water Pollution Control Program (**WPCP**), the Environmental Services Program (**ESP**), Water Quality Monitoring Section (**WQMS**) conducted a macroinvertebrate bioassessment and habitat study of Mussel Fork in Sullivan and Adair Counties in north central Missouri. Approximately 29 miles of Mussel Fork in Sullivan, Macon, and Adair Counties are included on the 1998 303(d) list for sediment pollution from agricultural nonpoint sources. Although habitat loss is not an impact found on the 303(d) list, there are segments of Mussel Fork that have poor habitat due to channelization, vertical banks, and poor riparian zones. This survey assessed the upper 15 miles of Mussel Fork from the confluence of Little Mussel Fork in Adair County, to Section 2, Township 62 North, Range 18 West, in Sullivan County. The 15 miles of upper Mussel Fork addressed in this study are listed as Class C waters, water body I.D. #0674 (MDNR 2000), and constitute approximately the upper ½ of the listed segment. On August 30, 2002 a study plan was submitted to the WPCP (Appendix A).

1.1 Purpose

The purpose of the study was to determine if the upper Mussel Fork biological community is impaired and, if so, determine potential causes.

1.2 Objectives

- 1) Define the habitat characteristics of upper Mussel Fork.
- 2) Define the water quality characteristics of upper Mussel Fork.
- 3) Determine if the macroinvertebrate community and water qualities of upper Mussel Fork are affected by factors related to habitat loss.

1.3 Tasks

- 1) Conduct a bioassessment of the macroinvertebrate community of upper Mussel Fork.
- 2) Conduct a water quality assessment of upper Mussel Fork.
- 3) Conduct a habitat assessment of upper Mussel Fork.

1.4 Null Hypotheses

- 1) Macroinvertebrate assemblages will not substantially differ between Mussel Fork and biocriteria reference streams within the Plains/Grand/Chariton Ecological Drainage Unit (EDU).
- 2) Macroinvertebrate assemblages and habitat will not differ among Mussel Fork stream segments.

2.0 Study Area

The headwaters of Mussel Fork lie in an area between the cities of Green City and Green Castle in northeastern Sullivan County. It flows south for approximately 60-70 miles through Adair, Macon, Linn, and Chariton counties to its confluence with the Chariton River approximately 2 miles south of Keytesville and approximately 6 miles north of the confluence of the Chariton River with the Missouri River. The entire drainage of the creek is approximately 350 square miles. The drainage basin is linear in shape stretching almost 60 miles north to south and being approximately 8 miles wide at its widest point.

Northern Missouri landforms are the result of glaciation and consist of plains and low rolling hills. Agriculture is a major industry in northern Missouri including row crops and confined animal feeding operations. In many cases row crops are planted up to the banks of streams, thereby decreasing the quality of the riparian zone and leading to unstable banks and a loss of woody debris input to the stream, which in turn results in a loss of habitat. Many of the larger streams and rivers in northern Missouri have been channelized to provide more area in the river bottoms for cropland. Channelization causes a loss of channel structure, which would normally promote the formation of good quality habitats.

2.1 Site Descriptions

Six stations were chosen along upper Mussel Fork. These stations were selected to maximize differences in the amount of row crops, forestland, degree of sinuosity, and riparian condition between stations. See Figure 1 for a map of study locations.

Mussel Fork Station 1: (sec. 31, T. 61 N., R. 17 W.) Station 1 is located at the lower limit (southern end) of the study reach and below its confluence with Little Mussel Fork. It lies just north of the Adair and Macon county line. It has a poor riparian zone with crops up to the stream bank and is considered channelized. Geographic coordinates for this study station are Latitude 40° 2' 14.1", Longitude -92° 50' 37.0".

Mussel Fork Station 2: (sec. 30, T. 61 N., R. 17 W.) Station 2 is located approximately 1.8 miles upstream in a less channelized area. There is more forest in the riparian zone, however row crops dominate the stream valley. Geographic coordinates for this study station are Latitude 40° 3' 37.4", Longitude -92° 51' 18.2".

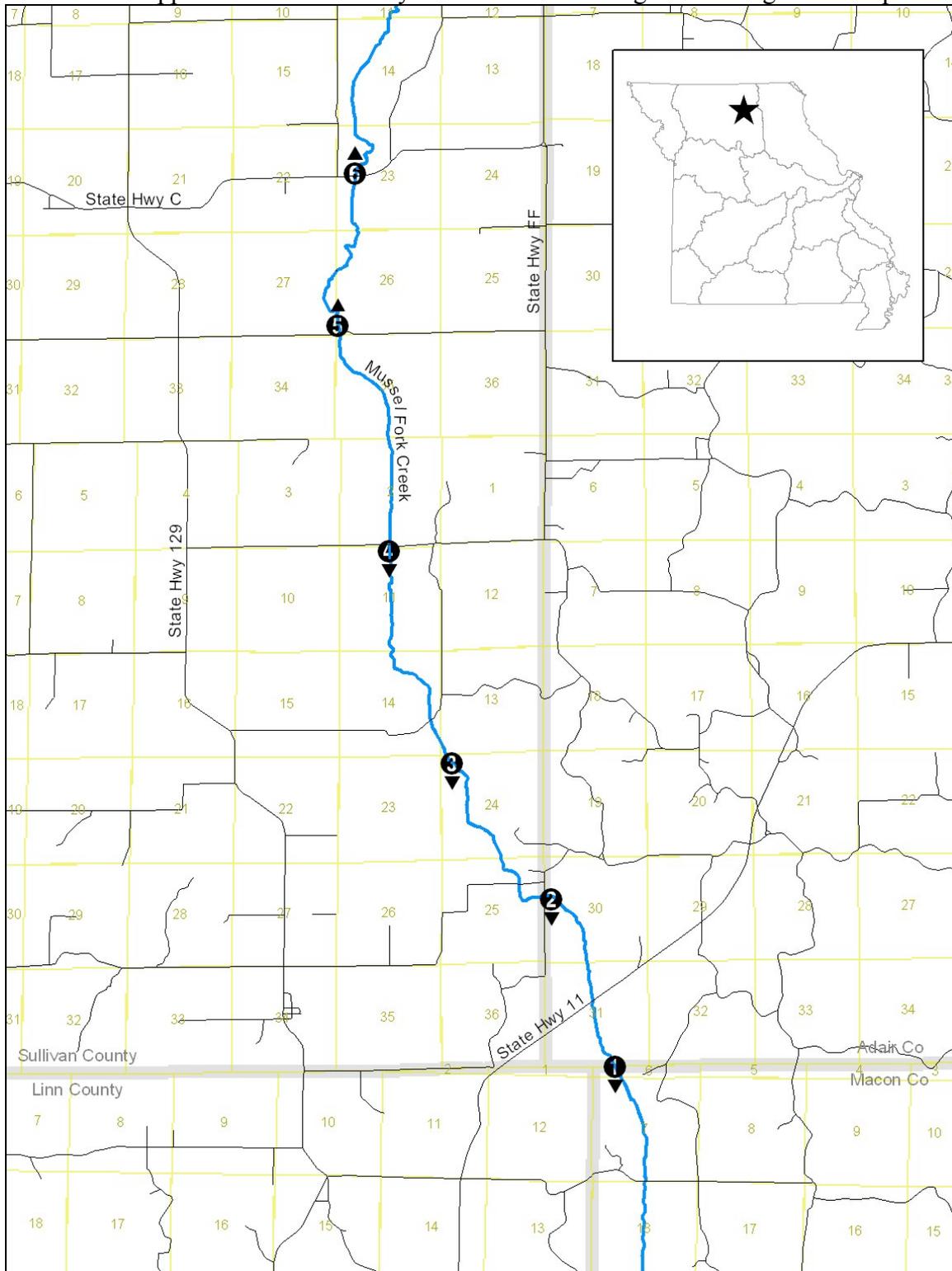
Mussel Fork Station 3: (NW ¼ sec. 24, T. 61 N., R. 18 W.) The final location of this station was different from the proposed location in the study plan because the landowner withdrew permission. Station 3 is located approximately 1.9 miles upstream from Station 2. Row crops and grassland almost wholly dominate the stream valley and riparian zone. Geographic coordinates for this study station are Latitude 40° 4' 45.4", Longitude -92° 52' 22.3".

Mussel Fork Station 4: (sec. 11, T. 61 N., R. 18 W.) Station 4 is located approximately 2.2 miles above Station 3 in a mixed area. The east side of the stream is dominated by forestland. The west is dominated by row crops, up to the edge of the stream in some cases. Geographic coordinates for this study station are Latitude 40° 6' 31.4", Longitude -92° 52' 3.4".

Mussel Fork Station 5: (sec. 26, T. 62 N., R. 18 W.) Station 5 is located approximately 2.4 miles upstream from Station 4. The creek valley here is dominated by row crops and grassland and is in a more sinuous reach of stream. Geographic coordinates for this study station are Latitude 40° 8' 23.8", Longitude -92° 53' 36.7".

Mussel Fork Station 6: (sec. 23, T. 62 N., R. 18 W.) Station 6 is located at the northern end of the study reach, approximately 1.8 miles above Station 5. This station lies on a stream segment that is the most sinuous of the study reach. The west side is dominated by forest and the east side by row crops.

Figure 1
Upper Mussel Fork Study Locations and Ecological Drainage Unit Map



This station lies 3-4 miles below the headwater area for Mussel Fork. Geographic coordinates for this study station are Latitude 40° 9' 40.2", Longitude -92° 53' 24.8".

3.0 Methods

Randy Sarver, Stuart Harlan, Carl Wakefield, Ken Lister, Steve Humphrey, and other staff of the Missouri Department of Natural Resources, Air and Land Protection Division, Environmental Services Program conducted this study. Sampling was conducted during the fall of 2002 and the spring of 2003. Fall sampling was conducted on September 16, 17, and 18, 2002, and consisted of macroinvertebrate sampling, water quality sampling, habitat assessments, and width to depth ratios measurements at six stations on upper Mussel Fork. Samples were collected at sites that had a gradient of habitat characteristics. Spring sampling was conducted on April 25 and 26, 2003, and consisted of macroinvertebrate and water quality sampling.

3.1 Habitat

Mussel Fork was 303(d) listed for stream habitat degradation through excessive sedimentation. No suspended data exists to directly document sediment as a significant impact to the stream. General fisheries data and the effect of sediment upon fish were the initial data to consider Mussel Fork for 303(d) listing. Sedimentation is one of many instream habitat problems associated with land use. Although instream habitat can be directly measured, the causes of the degradation can range from local scale sources to watershed scale sources. We collected habitat measures at the watershed scale, the reach scale, and the habitat scale to better allow us to evaluate the causes of poor habitat conditions.

3.1.1 Land Use

The land use conditions were summarized from land cover GIS files. These land cover files were provided by the Missouri Resource Assessment Partnership (MoRAP) and derived from 1991-1993 LANDSAT data. USGS aerial photographs taken within the past 10 years were also used to estimate riparian health of the sampling reach.

In addition, Mussel Fork was included in a study in which the MDNR provided funding to the University of Missouri for evaluation of reference streams in Northern Missouri (Haithcoat et al., 2003). As part of the final report to the department, a five parameter land cover model was developed to facilitate the definition of reference streams.

3.1.2 Habitat Assessment

A standardized assessment procedure was followed as described for Glide/Pool Habitat in the Stream Habitat Assessment Project Procedure (**SHAPP**) (MDNR 2003b). The habitat assessment was conducted on Mussel Fork during the September 2002 sample season.

3.1.3 Sinuosity

Sinuosity was used as a rough indicator of the amount of channelization that has taken place. Sinuosity was measured from aerial photographs of the area and is represented as a ratio of the straight line distance between two points on the stream to the length of stream between the two points.

3.1.4 Riparian Zone Condition

The riparian zone condition was visually observed and was qualitatively described as very poor, poor, good, or mixed. A very poor riparian zone condition is characterized by mostly crops and/or grassland up to the stream bank. Poor riparian zone condition is characterized by row crops planted up to the stream bank with a thin zone of trees in the riparian zone. Good riparian zone condition is characterized by little influence from row crops and abundant forest coverage. A mixed riparian zone condition is characterized by having one side of the stream rated differently than the other (e.g. very poor and good).

3.1.5 Width to Depth Ratio

Lack of instream habitat can be observed in Northern Missouri streams that are wide and shallow. Wider, shallower streams tend to have less ability to develop pools and retain woody debris (Haithcoat et al. 2003). At each sampling station a series of 10 bank to bank transects were established. Each transect was equally spaced within the sampling reach, which is 20x the average width. Measurements taken at each transect included lower bank width (see the Stream Habitat Assessment Procedure for a definition of Lower Bank), wetted width, and water depth at $\frac{1}{4}$, $\frac{1}{2}$, and $\frac{3}{4}$ of the distance across the wetted width. In order to document critical habitat conditions, measurements were collected during the fall low flow period.

3.2 Physicochemical Water Parameters

Physical and chemical water samples were collected from all stations during both fall and spring. Parameters collected were nitrate+nitrite-nitrogen, ammonia-nitrogen, Total Kjeldahl Nitrogen, chloride, turbidity, temperature, conductivity, dissolved oxygen, pH, and discharge. WQMS personnel analyzed temperature, conductivity, dissolved oxygen, pH, and discharge in the field and turbidity in the biology laboratory. All other parameters were delivered to the ESP, Chemical Analyses Section for analyses. All samples were collected according to the standard operating procedure MDNR-FSS-001: Required/Recommended Containers, Volumes, Preservatives, Holding Times, and Special Sampling Considerations (MDNR 2002b) and were recorded on a MDNR chain-of-custody (MDNR 2001).

3.3 Biological Assessment

The biological assessment was conducted according to the Semi-quantitative Macroinvertebrate Stream Bioassessment Project Procedure (**SMSBPP**) (MDNR 2003a). All stations were sampled in September 2002 and April 2003. Three standard habitats of glide/pool streams (e.g. woody debris substrate, depositional substrate in non-flowing water, and rootmat substrate) were sampled at all locations.

Macroinvertebrate data were evaluated by comparison to Biological Criteria for Perennial/Wadeable streams of the Plains/Grand/Chariton Ecological Drainage Unit (**EDU**). An EDU is an ecological area in which the aquatic biological communities and stream habitat can be expected to be similar. See Figure 1 for a map of the EDU's of Missouri.

Biological criteria are calculated separately for the fall (mid-September through mid-October) and spring (mid-March through mid-April) index periods. The SMSBPP provides details on the calculation of metrics and scoring of the multi-metric Macroinvertebrate Stream Condition Index (**MSCI**). The four core metrics of the MSCI are: Taxa Richness (**TR**); Ephemeroptera,

Plecoptera, and Trichoptera Taxa (**EPTT**); Biotic Index (**BI**); and the Shannon Diversity Index (**SDI**). An MSCI score of 16-20 is considered full biological sustainability, 10-14 is partial biological sustainability, and 4-8 is non-biological sustainability. Table 1 provides scoring criteria for the fall index period and Table 2 for the spring index period.

Table 1
Biological Criteria for Glide/Pool- Fall Index Period
Plains/Grand/Chariton EDU

Metric	Score = 1	Score = 3	Score = 5
TR	< 25	25 - 50	> 50
EPTT	< 4	4 - 9	> 9
BI	> 8.60	8.60 – 7.19	< 7.19
SDI	< 1.34	1.34 – 2.69	> 2.69

Table 2
Biological Criteria for Glide/Pool- Spring Index Period
Plains/Grand/Chariton EDU

Metric	Score = 1	Score = 3	Score = 5
TR	< 24	24 - 48	> 48
EPTT	< 4	4 – 7	> 7
BI	> 8.62	8.62 – 7.24	< 7.24
SDI	< 1.26	1.26 – 2.52	> 2.52

4.0 Results and Analyses

4.1 Land Use

The upper reach of the Mussel Fork drainage basin, which is the subject of this report, is comprised of mainly cool season grassland (~75%), deciduous forest (~10%), and row crops (~12%). This watershed contains slightly more grassland, in place of deciduous forest and row crops, than the surrounding watersheds.

Table 3 provides two scales of land use comparison. A broad scale comparison is provided by comparing the 14 digit hydrologic units (**HU**) for upper Mussel Fork stations with the Plains/Grand/Chariton EDU. A watershed comparison is provided by comparing the 14 digit HU for upper Mussel Fork stations with the 14 digit HU of three nearby wadeable/perennial biocriteria reference streams (**BIOREF**) in the EDU. Upper Mussel Fork HU values in bold are those that potentially indicate poorer land use. No clear patterns are evident, although the HU with Mussel Fork #6 has lower forest cover.

Additional land cover information is available as part of a reference watershed model developed by Haithcoat et al. (2003). Mussel Fork is not considered a reference stream, but was included as a potentially impacted stream. Mussel Fork was the highest ranked test stream and in fact land cover parameters did as well as many reference streams. In fact, Mussel Fork was not included as a potentially impacted stream because of general watershed problems, but because of past

water quality problems resulting from hog manure spills from a large confined animal feeding operation in it's headwaters.

Table 3 – Land Use

Watershed	% Urban	% Row Crops	% Grassland	% Forest
Plains Grand/Chariton EDU	0.2	30.3	53	15.2
Mussel Fork Station 1	0	7.8	65	26.9
Mussel Fork Stations 2,3,4,5	0	8.4	78.5	12.9
Mussel Fork Station 6	0.9	15.9	73.8	8.7
BIOREF Locust Creek	0	8.5	75.5	15.7
BIOREF Spring Creek- Adair Co.	0.4	9.7	45.6	43.9
BIOREF West Locust Creek	0	16.4	71.7	11.6

4.2 Habitat Assessment

The results of the habitat assessment are found in Table 4. Mussel Fork Station 3 is ranked lowest (71) and Station 4 the highest (95). In the SHAPP, $\geq 75\%$ similarity is the guidance for considering habitats comparable between stations. Comparable habitats should be able to support comparable biological communities. When the highest Mussel Fork habitat score (Station 4) is used as the best available habitat, the lowest scoring station (Station 3) is 75% similar and at the very bottom end of comparability.

Table 4
Mussel Fork Habitat Assessment Scores

Station	Habitat Assessment Score
Mussel Fork 1	88
Mussel Fork 2	75
Mussel Fork 3	71
Mussel Fork 4	95
Mussel Fork 5	85
Mussel Fork 6	88

4.3 Sinuosity

Points were chosen along the length of upper Mussel Fork at one mile increments using stream miles. Sinuosity measurements near 1 are considered potentially channelized. The sinuosity of upper Mussel Fork ranges from 0.75 to 0.98. The likelihood of channelization is based on the sinuosity and visual inspection of the aerial photographs. Table 5 (Station Reach Characteristics) lists sinuosity and riparian channel characteristics for each sample station.

4.4 Riparian Zone Condition

In Table 5 the riparian zone condition is described as very poor, poor, good, or mixed. The lowest ranked riparian zone conditions are Mussel Fork Stations 3 & 5, which are rated as very poor on both stream banks. The highest ranked riparian zone conditions are Mussel Fork Stations 4 & 6, which are rated as mixed (very poor on one bank and good on the other bank).

Table 5 – Station Reach Characteristics

Station	*Sinuosity (miles/mile)	Likely to be Channelized	Riparian Zone Condition
1	0.93	Yes	Poor
2	0.82	No	Poor
3	0.89	Yes	Very Poor
4	0.98	Yes	Mixed (Very Poor/Good)
5	0.85	Yes	Very Poor
6	0.75	No	Mixed (Very Poor/Good)
*Higher number equates to less sinuosity.			

4.5 Width to Depth Ratios

Station transect measurements for lower bank channel width, wetted width, and depth are provided in Appendix D.

Some channel measurements, such as average channel width, reflect the fact that the stream width increases with increasing watershed size. The Mussel Fork study shows a clear progression in channel width data (Table 6) with the most upstream station (6) at 27.9 feet and the most downstream station (1) at 82.2 feet.

Other channel measurements, such as average depth and average wetted width, do not necessarily reflect trends associated with size. Station 5, which is toward the upstream end of the study reach, has both the greatest average depth and wetted width. These measurements indicated greater water volume by documenting the fact that water is deeper and potentially takes up more of the width of the stream than other stations. Average depth is poorest at Station 3 and Station 6. Station 6 was completely pooled during the fall 2002 sampling season.

In order to be able to do comparisons of stream stations in a longitudinal stream study it is sometimes necessary to incorporate ratios of measurements. Ratios can standardize measurements so that data such as channel width can be used in a manner that allows comparison of study stations regardless of their longitudinal placement. The ratios of channel width/wetted width, channel width/average depth, and wetted width/average depth are given in Table 6. These ratios reflect the wide shallow characteristics of the stream, which result in poorer habitat.

Mussel Fork Station #1 has a high ratio of channel width/wetted width, which demonstrates that not only is the channel the widest of all stations, but it is also approximately 7 times as wide as the stream flow within the channel. Wide channels have less potential for riparian shading, which is further diminished when stream flow meanders within the channel.

Mussel Fork Station #3 has a high ratio of wetted width/average depth, which demonstrates a relatively wide shallow stream flow indicative of poor pool habitat. Since channel measurements were taken during the summer low flow period, this station presents conditions with less potential for a diverse fish and macroinvertebrate community.

Table 6 – Stream Width and Depth Measurement Summary

Mussel Fork Station	Avg. Channel Width (ft)	Avg. Wetted Width (ft)	Avg. Depth of stream (ft)	Channel Width / Wetted Width	Channel Width / Depth	Wetted Width / Depth
1	82.2	12.1	0.37	6.79	204	30.1
2	75.3	14.9	0.37	5.05	186	36.8
3	65.9	14.0	0.23	4.70	235	50.0
4	49.9	16.2	0.5	3.07	94.1	30.6
5	47.4	23.5	0.93	2.01	47.5	23.6
6	27.9	7.0	0.23	3.98	95.1	23.8

4.6 Physicochemical Results

Results from the fall 2002 sampling season can be found in Table 7 and spring 2003 in Table 8.

The only violation of water quality standards occurred during the fall 2002 sampling season at Station 2, with a dissolved oxygen result of 3.2 mg/L. The numeric criterion is a minimum of 5.0 mg/L.

The other parameter of interest are spring 2003 phosphorus results, which were the highest at Mussel Fork Stations 5 and 6 at 0.1 and 0.11 mg/L respectively.

A comparison of spring 2003 Mussel Fork results against the biocriteria reference stream, Spring Creek, reveal that all Mussel Fork stations are higher in chloride and Total Kjeldahl Nitrogen. Mussel Fork Stations 2, 5, and 6 are higher in total phosphorus. However, Spring Creek flow and turbidity are approximately twice those of any Mussel Fork station. This indicates that rainfall, rather than watershed differences, may have been responsible for the differences in chemical parameters between Mussel Fork and Spring Creek

Table 7 – Fall 2002 Physicochemical Results

Sample Number	Station	Ammonia as N - mg/L	Chloride mg/L	Dissolved Oxygen - mg/L	Flow (cubic ft/sec)	Nitrate + Nitrite as N - mg/L	pH	Specific Conductivity umhos/cm	Temperature Degrees C	Total Kjeldahl Nitrogen mg/L	Total Phosphorus mg/L	Turbidity NTU
218103	Mussel Fk 1	< 0.05	10.5	7.5	0.03	< 0.05	7.4	519	18	0.45	< 0.05	4.42
218104	Mussel Fk 2	< 0.05	9.71	3.7	0.05	< 0.05	7.4	440	20.5	0.59	0.07	10
218105	Mussel Fk 3	< 0.05	13.4	6.7	0.03	< 0.05	7.8	422	24	0.72	0.08	14.1
218106	Mussel Fk 4	< 0.05	6.7	10	0.05	< 0.05	8.1	458	18	0.38	< 0.05	5.27
218107	Mussel Fk 5	< 0.05	9.12	9.2	0.05	< 0.05	7.9	403	24.5	0.6	< 0.05	13.4
218108	Mussel Fk 6	< 0.05	15.3	8.6	0	< 0.05	7.8	427	23	1.21	0.09	24.8

Table 8 – Spring 2003 Physicochemical Results

Sample Number	Station	Ammonia as N - mg/L	Chloride mg/L	Dissolved Oxygen - mg/L	Flow (cubic ft/sec)	Nitrate + Nitrite as N - mg/L	pH	Specific Conductivity umhos/cm	Temperature Degrees C	Total Kjeldahl Nitrogen mg/L	Total Phosphorus mg/L	Turbidity NTU
318657	Mussel Fk 1	< 0.03	16.5	9.7	0.33	< 0.01		443	14	0.47	0.05	4.94
318658	Mussel Fk 2	< 0.03	21.7	7.9	0.34	< 0.01		449	13.5	0.69	0.09	5.92
318659	Mussel Fk 3	< 0.03	30.3	8.2	0.25	< 0.01		436	15.6	0.77	0.07	15.3
318660	Mussel Fk 4	< 0.03	30.7	12.8	0.22	< 0.01		479	17.9	0.9	0.06	5.8
318663	Mussel Fk 5	< 0.03	29.1	8.3	0.1	< 0.01		424	13.9	1.12	0.1	18.6
318664	Mussel Fk 6	< 0.03	43	8.6	0.1	< 0.01		380	11.6	1.44	0.11	13.2
318662	Spring Ck 1	< 0.03	6.69	10.2	0.67	< 0.01		464	8.9	0.31	0.08	39.9

4.7 Biological Assessment

4.7.1 Macroinvertebrate Stream Condition Index Scores

The Mussel Fork metric results and MSCI scores for fall 2002 and spring 2003 are found in Table 9 and Table 10 respectively. MSCI scores are calculated by scoring station metrics against the appropriate criteria in Table 1 or Table 2.

Table 9
Fall 2002 Macroinvertebrate Stream Condition Index Scores

Sampling Station	Mussel Fk 1	Mussel Fk 2	Mussel Fk 3	Mussel Fk 4	Mussel Fk 5	Mussel Fk 6
Sample Number	0218103	0218104	0218105	0218106	0218107	0218108
Taxa Richness	67	57	50	60	64	57
EPT Taxa	13	11	8	9	7	8
Biotic Index	7.47	7.46	7.47	6.99	7.72	7.42
Shannon Index	2.86	2.48	2.7	2.66	2.82	2.68
SCI Score	18	16	14	16	16	14
Sustainability	Full	Full	Partial	Full	Full	Partial

Table 10
Spring 2003 Macroinvertebrate Stream Condition Index Scores

Sampling Station	Spring Ck 1a	Spring Ck 1b	Mussel Fk 1	Mussel Fk 2	Mussel Fk 3	Mussel Fk 4	Mussel Fk 5	Mussel Fk 6
Sample Number	0318661	0318662	0318657	0318658	0318659	0318660	0318664	0318663
Taxa Richness	68	68	52	61	61	52	48	47
EPT Taxa	10	11	6	11	9	9	5	3
Biotic Index	7.1	7.01	7.03	7.41	7.01	7.16	7.12	8.03
Shannon Index	3.2	3.08	2.31	2.76	2.82	2.54	2.71	2.54
SCI Score	20	20	16	18	20	20	16	12
Sustainability	Full	Full	Full	Full	Full	Full	Full	Partial

4.7.2 Longitudinal Analyses

In general Mussel Fork MSCI scores indicate that most of the stream stations were ≥ 16 , which is assigned full biological sustainability.

Station 6 was consistently < 16 and assigned partial biological sustainability in both sampling seasons. The only other station to score < 16 was Station 3 during the fall 2002 sampling season.

4.7.3 Ecoregional Analyses

As a temporal control, Spring Creek, Adair County, a nearby biocriteria reference stream was re-sampled during spring 2003. Study streams are evaluated during time periods that potentially include drought periods, and in fact Mussel Fork was sampled under these conditions. Therefore, a low reference stream score could indicate a response to natural low water levels as well as anthropogenic impacts. Spring Creek MSCI scores (Table 10) scored the maximum potential points (20) and did not indicate weather induced problems.

5.0 Discussion

Results of the bioassessment indicate that two stations failed to meet a full biological sustainability MSCI score. Station 3 received a score of 14 during the fall sampling season and Station 6 received scores of 14 and 12 respectively during the fall and spring. Scores from 10-14 are considered partial biological sustainability.

5.1 Station 3

Bioassessments at stations that have different biological sustainability categories across seasons are generally treated as indeterminate. However, when the metrics for Station 3 are examined for fall, the sample is found to be at the very top (50 taxa) of the criteria for Taxa Richness (50 = score of 3; 51 = score of 5). One additional taxa found would have allowed an MSCI score of 16. Although a combined metric error has not been calculated for wadeable perennial stream biological criteria, 89% of all duplicate samples in the ESP database have a taxa richness difference of ≥ 1 taxa. This allows a significant probability that a +/- 1 taxon error could place the score for Station 3 at 51 taxa, which would allow a score of 5 and a full biological sustainability score.

Habitat data for Station 3 indicated that the average depth (0.23) was among the lowest and the wetted width/average depth ratio (50) was the highest of all stations on Mussel Fork. These parameters were measured during low flow summer conditions when the amount of water is critical to aquatic organisms. This station also had the lowest (71) habitat assessment score, was observed to have a poor riparian corridor on both banks, and had sinuosity measures that indicated the potential for past channelization.

5.2 Station 6

Station 6 scores consistently equated to partial biological sustainability. Although all Mussel Fork stations fell within a Class C segment of stream, Station 6 was the most upstream and was the only station that was completely pooled during the fall sampling period. The potential macroinvertebrate habitat for this station was significantly reduced during the fall 2002 sampling by lack of water, with the effects most likely extending into the following spring. Lack of water ultimately overshadows the ability to use any other data to interpret the results of a bioassessment.

Habitat data for Station 6 indicated that the average depth (0.23) was among the lowest. Wetted width measurements (Appendix D) for Station 6 showed no water at 4 of 10 transects. In addition to lack of water, Station 6 had the highest percent urban land use (0.9), the lowest

percent forest cover (8.7), and highest percent row crops of the three 14 digit watersheds that contained the 6 sampling stations. The spring 2003 water chemistry values for Station 6 were the highest of all stations for Total Kjeldahl Nitrogen (1.44 mg/L) and Total Phosphorus (0.11 mg/L).

5.3 Upper Mussel Fork Stream Segment

The overall bioassessment for the upper Mussel Fork segment covered by this study suggests no biological impairment. Exactly 75% of the MSCI scores are ≥ 16 (full biological sustainability). During the development of biological criteria (MDNR 2002a) it was demonstrated that wadeable perennial reference streams stations scored ≥ 16 about 86% of the time.

A reference watershed model developed by Haithcoat et al. (2003) ranked Mussel Fork land cover among the highest of all test streams (potentially impacted) with desirable land cover parameters similar to many reference streams. In fact, Mussel Fork was not included as a test stream because of watershed problems, but because of water quality problems resulting from a 1995 hog manure spill from a large confined animal feeding operation in it's headwaters.

Habitat is comparable throughout the longitudinal segment. As expected, some stations exhibited poorer local habitat conditions relative to other stations. All stations are comparable in habitat and are, therefore, expected to be biologically comparable. Water quantity was an important factor in Station 6, the station with the lowest MSCI scores.

Beaver dams were common along the reach from Stations 1-5. Dams were typically low height (1-2 ft. high) but created significant upstream pools. WQMS personnel attempted to minimize the influence of the pools on macroinvertebrate sampling and physical measurements. However, beavers are now, and were historically, ubiquitous in Northern Missouri streams and are an important component of stream ecology. Future studies should treat the pools as a permanent characteristic of the study stream.

Missouri Water Quality Standards numeric criteria were violated for dissolved oxygen in 1 of 12, or 8% of the measurements. Nutrient levels were highest at the most upstream stations.

5.4 Erosion Potential

Mussel Fork was originally 303(d) listed for sediment from agricultural non-point sources. Sediment load can be estimated using the Spreadsheet Tool for the Estimation of Pollutant Load (STEPL), version 2.01. The STEPL model was developed for the U.S. Environmental Protection Agency by Tetra Tech, Inc, May 2002. The model calculates soil loss in tons/year.

In a memorandum from the ESP to the WPCP, dated June 4, 2003, northern Missouri reference streams were analyzed for erosion potential using the STEPL model. Using this model, northern Missouri reference stream watershed soil loss was estimated to range from 0.23 – 1.10 tons/acre/year. Using the STEPL model, soil loss potential was also calculated for the watershed of each Mussel Fork station (Table 11). The lower Mussel Fork stations (1-3) fell within the reference stream range and the upper stations (4-6) slightly exceeded the range. A definitive

relationship does not exist between soil loss and aquatic community health and there are no criteria for judging the point at which impacts can be measured. The soil loss from Mussel Fork does not differ measurably as compared to reference streams from which biological criteria have been established.

Table 11 – Mussel Fork Watershed Soil Loss

Watershed	tons/year	acres	tons/acre/year
Mussel Fork 1	47184.2	52313.7	0.9
Mussel Fork 2	39339.7	38116.8	1.0
Mussel Fork 3	35996.2	33057.6	1.1
Mussel Fork 4	32539.0	26957.4	1.2
Mussel Fork 5	27950.3	21735.6	1.3
Mussel Fork 6	21101.6	15019.1	1.4

6.0 Conclusions

Two null hypotheses were stated in the introduction: 1) Macroinvertebrate assemblages will not substantially differ between Mussel Fork and biocriteria reference streams within the Plains/Grand/Chariton Ecological Drainage Unit (EDU); and 2) Macroinvertebrate assemblages and habitat will not differ among Mussel Fork stream segments.

Null hypothesis #1 is accepted. The macroinvertebrate community of upper Mussel Fork did not substantially differ from the MSCI, which is calculated from biocriteria reference streams. Overall, upper Mussel Fork is considered fully biologically supporting.

Null hypothesis #2 is rejected. Macroinvertebrate assemblages and habitat from Station 3 and 6 did differ from Stations 1, 2, 4, and 5. Stations 3 and 6 were of lower quality relative to other stations.

7.0 Recommendations

- 1) Propose the upper 15 miles of the listed portion of Mussel Fork for de-listing from the 303(d) list.
- 2) Conduct bioassessments of extensively channeled streams to further evaluate the relationship between biological health and stream channel characteristics.
- 3) Conduct bioassessments of extensively row cropped watersheds to further evaluate the relationship between biological health and soil loss as predicted through use of the STEPL model.

8.0 Literature Cited

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Missouri Department of Natural Resources. 2000. Title 10. Rules of Department of Natural Resources Division 20-Clean Water Commission, Chapter 7-Water Quality. 10 CSR 20-7.031 Water Quality Standards. Missouri Department of Natural Resources, Water Pollution Control Program, P.O. Box 176, Jefferson City, Missouri 65102. pp. 10-136.

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Appendix A
Upper Mussel Fork Bioassessment Study Plan
Sullivan & Adair Counties

Missouri Department of Natural Resources
Upper Mussel Fork Bioassessment Study Plan
Sullivan & Adair Counties
August 30, 2002

Objective

This study will characterize the aquatic macroinvertebrate community and habitat in upper Mussel Fork to determine whether the stream is impaired from habitat degradation and warrants continued 303(d) listing. Our specific objectives are to determine: 1) whether there are aquatic life impairments in the stream relative to biocriteria reference streams; 2) if biological impairment is present, determine if it is related to channelized segments or segments with little riparian and heavy concentration of row crops relative to more natural segments on biocriteria reference streams; and 3) if biological impairment is present, determine if it is related to channelized segments or segments with little riparian and heavy concentration of row crops relative to unchannelized segments and segments with better riparian and lesser amount of row crop on Mussel Fork.

Null Hypotheses

- 1) Macroinvertebrate assemblages and habitat will not substantially differ between Mussel Fork and biocriteria reference streams within the Plains/Grand/Chariton Ecological Drainage Unit (EDU).
- 2) Macroinvertebrate assemblages and habitat will not differ between Mussel Fork stream segments.

Background

Mussel Fork, in Sullivan, Adair, and Macon counties, was listed as a 303(d) stream in the Total Maximum Daily Load (TMDL) listing of 1998 by the Water Pollution Control Program (WPCP). A 29-mile section of stream was originally listed for sediment impairment from agricultural non-point sources. In the proposed 2002 TMDL listing the pollutant is listed as Habitat Loss. The assessment of the 29-mile reach of 303(d) listed section of Mussel Fork will be broken into two years. In 2003 the upper 14 miles of stream (from the upstream point to the mouth of Little Mussel Fork) will be assessed. In 2004 the same approach will be applied to the lower 15 miles.

Study Design

General:

Six (6) Mussel Fork stations will be surveyed. The approximate locations are as follows: Station #1) S31, T61N, R17W @ river mile 74.9; Station #2) S30, T61N, R17W @ river mile 76.1; Station #3) SW ¼, S13, T61N, R18W @ river mile 78.3; Station #4); S11, T61N, R18W @ river

mile 81.0; Station #5) S26, T62N, R18W @ river mile 83.2; and Station #6) S23, T62N, R18W @ river mile 85.1.

Each station will consist of a length approximately 20 times the average stream width, and will contain at least two pool/glide sequences, as outlined in MDNR-FSS-032. In order to assess variability among sampling stations, stream discharge, habitat assessment, and water chemistry will be determined during macroinvertebrate surveys. Sampling will be conducted during the fall of 2002 (September 15 through October 15) and spring of 2003 (March 15 through April 15).

Biological Sampling Methods: Macroinvertebrates will be sampled per the guidelines of the Semi-Quantitative Macroinvertebrate Stream Bioassessment Project Procedure (SMSBPP). Mussel Fork will be considered a glide/pool predominant streams; therefore samples will be collected from depositional (non-flowing water over depositional habitat), large woody debris, and root-mat habitats. Macroinvertebrate samples will be composites of six subsamples within non-flow and rootmat habitats and 12 subsamples within large woody debris habitat.

Habitat Sampling Methods:

- 1) Stream discharge will be measured at each sampling location using a Marsh-McBirney flow meter.
- 2) Stream habitat assessments will also be conducted within each study area following the guidelines of MDNR-FSS-032.
- 3) GIS analyses will be used to quantify the sinuosity, riparian, and row crop characteristics of the study segment.
- 4) Quantitative channel measurements of width, wetted width, and maximum water depth will be collected at Mussel Fork.

Water Quality Sampling Methods: Water samples from all sampled stations will be analyzed at the ESP laboratory for ammonia, nitrogen as $\text{NO}_2 + \text{NO}_3$, Total Kjeldahl Nitrogen, total phosphorus, chloride, and turbidity. Field measurements will include pH, conductivity, temperature, and dissolved oxygen.

Laboratory Methods: All samples of macroinvertebrates will be processed and identified as per MDNR-FSS-209, Taxonomic Levels for Macroinvertebrate Identification. Turbidity samples will be analyzed at the MDNR biological laboratory

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. Four standard metrics are calculated according to the SMSBPP: Total Taxa (TT); Ephemeroptera, Plecoptera, Trichoptera Taxa (EPTT); Biotic Index (BI); and the Shannon Index (SI) will be calculated for each reach. Additional metrics, such as Quantitative Similarity Index for Taxa (QSI-T) may be employed to discern differences in taxa between stations.

Macroinvertebrate data will be analyzed in two specific ways. First, a stratified comparison between habitat degraded (i.e. channelized vs. non-channelized; high density

row crop/little riparian vs. low-density row crop/intact riparian) and habitat intact reaches on Mussel Fork will be performed. Secondly, the data from the Mussel Fork sites will be compared to numeric biological criteria from reference streams within the same EDU & watershed size classification.

As interpretive information for biological data, the habitat scores and landscape scale characteristics will be ranked against the macroinvertebrate Stream Condition Index scores.

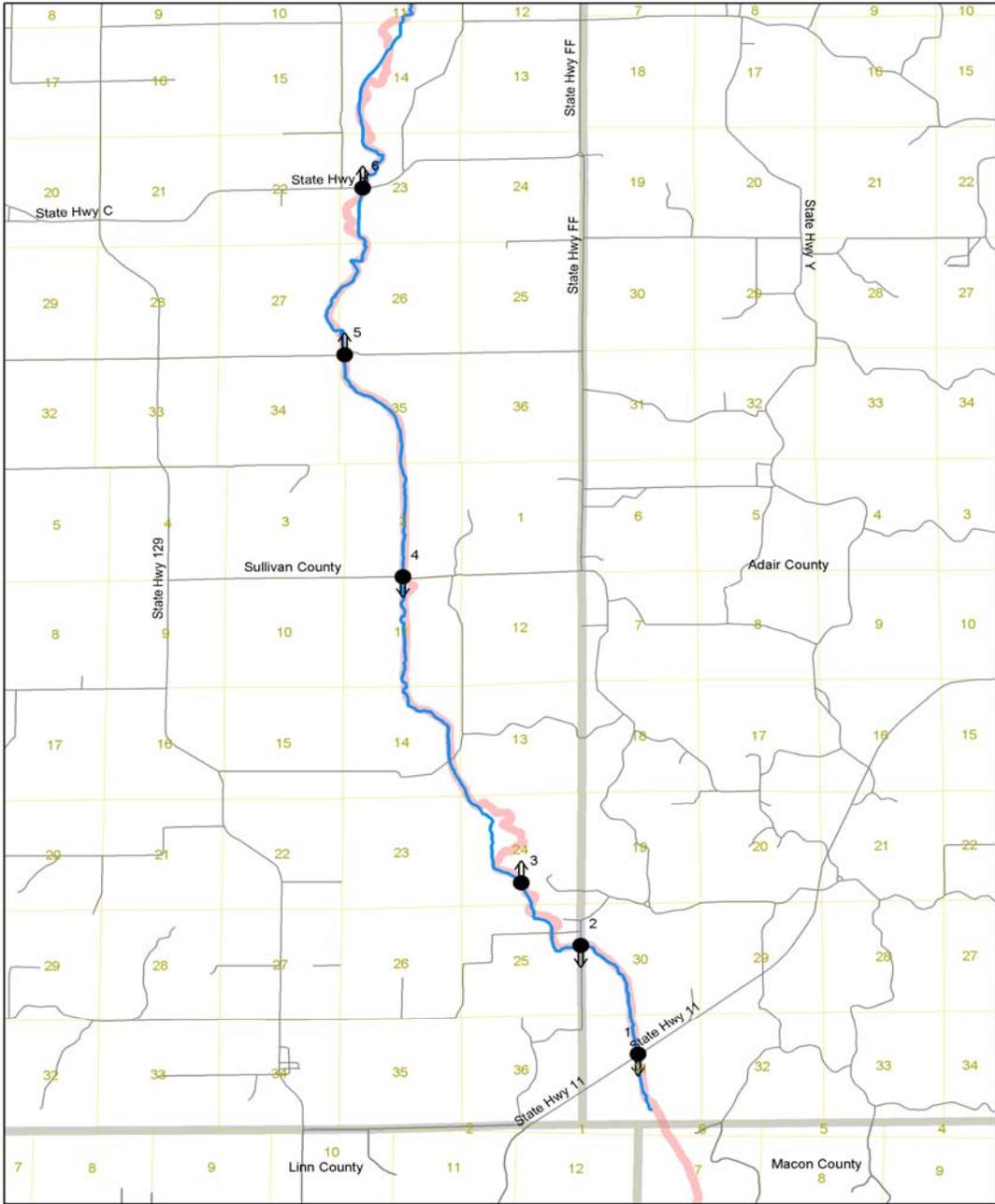
Data Reporting: Results of the study will be summarized and interpreted in report format.

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

Attachments

Map of all sampling stations in this study

**Upper Mussel Fork Bioassessment Study Plan
Sullivan & Adair Counties**



APPENDIX B
Fall 2002
Macroinvertebrate Bench Sheets

Aquatic Invertebrate Database Bench Sheet Report

September 16, 2002 - Mussel Fk [0218103], Station #1

ORDER (Taxa)

"HYDRACARINA"

Acarina

RM 1 SG 1 NF 2

COLEOPTERA

Oreodytes

RM 1

Berosus

RM 11 SG 2 NF 1

Enochrus

SG 3

Tropisternus

RM -99

Helichus lithophilus

RM 1 SG 3

Scirtes

RM 1 SG 7 NF 1

Dubiraphia

RM 4 NF 2

DIPTERA

Culex

RM 11

Dasyheleinae

SG 1

Forcipomyiinae

SG 2

Ceratopogoninae

RM 6 SG 11 NF 3

Ablabesmyia

RM 8 SG 2 NF 19

Larsia

RM 5

Procladius

NF 6

Cricotopus bicinctus

RM 1

Cryptochironomus

NF 3

Dicrotendipes

SG 17 NF 11

Glyptotendipes

SG 1

Phaenopsectra

SG 1

Polypedilum halterale grp

NF 13

Stenochironomus

SG 1

Polypedilum illinoense grp

RM 5 SG 3 NF 1

Polypedilum scalaenum grp

NF 1

Pseudochironomus

RM 1 SG 1 NF 1

Cladotanytarsus

RM 2 NF 10

Paratanytarsus

RM 1

Rheotanytarsus

RM 2 SG 3

Stempellinella

NF 2

Tanytarsus

RM 41 SG 34 NF 18

Dixella

RM 5

Zavreliella

RM 3

Clinotanypus

NF 1

Thienemannimyia grp.

SG 5 NF 1

Labrundinia

RM 4 NF 5

Diptera

RM 1

EPHEMEROPTERA

Callibaetis

RM 5

Paracloeodes

SG 3

Stenacron

SG 9

Stenonema pulchellum

SG 1 NF 1

Caenis latipennis

RM 10 SG 77 NF 177

Leptophlebiidae

SG 3

Hexagenia limbata

RM 1 NF 7

HEMIPTERA

Veliidae

RM 3

ORDER (Taxa)	CS	RM	SG	NF
Rheumatobates			3	2
Belostoma		3		
Corixidae				1
Pelocoris		-99		
LIMNOPHILA				
Lymnaeidae			1	
Physella		73	29	11
Helisoma			1	
Planorbella			1	
ODONATA				
Hetaerina		4		
Argia		11	31	4
Enallagma		93	7	
Gomphus			1	1
Progomphus obscurus				2
Libellulidae				1
Macromia		-99	2	2
Erythemis		-99	-99	-99
TRICHOPTERA				
Cheumatopsyche			6	
Hydroptilidae		2		1
Hydroptila			2	
Oxyethira		8	9	9
Nectopsyche		4	3	2
Oecetis		5		2
VENEROIDEA				
Sphaerium		1		4

Aquatic Invertebrate Database Bench Sheet Report

September 16, 2002 - Mussel Fk [0218104], Station #2

ORDER (Taxa)**"HYDRACARINA"**

	CS	RM	SG	NF
Acarina		3	5	2

AMPHIPODA

Hyalella azteca		1		
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COLEOPTERA

Berosus		1	1	2
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Scirtes		24	7	1
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Dubiraphia		1		3
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DIPTERA

Forcipomyiinae		1	1	
----------------	--	---	---	--

Ceratopogoninae		1		3
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Ablabesmyia		12	8	11
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Procladius		6		4
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Corynoneura			1	
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Nanocladius		1		1
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Endochironomus		8		
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Axarus				2
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Chironomus				2
------------	--	--	--	---

Cryptochironomus			1	6
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Dicrotendipes		13	25	10
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Glyptotendipes		6	25	3
----------------	--	---	----	---

Cryptotendipes				2
----------------	--	--	--	---

Paratendipes			1	
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Microchironomus				2
-----------------	--	--	--	---

Polypedilum halterale grp			1	6
---------------------------	--	--	---	---

Stenochironomus			1	
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Polypedilum illinoense grp		6	2	
----------------------------	--	---	---	--

Polypedilum scalaenum grp		1		
---------------------------	--	---	--	--

Tribelos			10	
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Pseudochironomus				1
------------------	--	--	--	---

Cladotanytarsus		1	1	1
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Paratanytarsus		7	5	1
----------------	--	---	---	---

Stempellinella		1		
----------------	--	---	--	--

Tanytarsus		32	8	8
------------	--	----	---	---

Thienemannimyia grp.		6	4	
----------------------	--	---	---	--

Labrundinia		15	6	1
-------------	--	----	---	---

EPHEMEROPTERA

Paracloeodes				1
--------------	--	--	--	---

Procloeon				2
-----------	--	--	--	---

Stenacron			4	
-----------	--	--	---	--

Tricorythodes		1		1
---------------	--	---	--	---

Caenis latipennis		69	96	237
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Leptophlebiidae		5	2	1
-----------------	--	---	---	---

Hexagenia limbata		1		6
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LIMNOPHILA

Physella		37	12	1
----------	--	----	----	---

MEGALOPTERA

Sialis				-99
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ODONATA

ORDER (Taxa)	CS	RM	SG	NF
Argia		17	55	1
Enallagma		23	6	
Gomphus		2		-99
Progomphus obscurus				1
Macromia				1
Erythemis		1		
Libellula				-99
TRICHOPTERA				
Hydroptila		1		
Oxyethira		3		2
Triaenodes		1		
Oecetis		2	1	
TUBIFICIDA				
Tubificidae		1		2
Aulodrilus		2		1
Enchytraeidae		1		
UNIONIDA				
Unionidae				-99
VENEROIDEA				
Sphaerium		1		-99

Report Date: 07/22/03

Page 2

Mussel Fk [0218104]

Aquatic Invertebrate Database Bench Sheet Report

September 17, 2002 - Mussel Fk [0218105], Station #3

ORDER (Taxa)**"HYDRACARINA"**

Acarina

CS	RM	SG	NF
		1	2

COLEOPTERA

Gyretes

1

Tropisternus

1

Helichus lithophilus

2

4

Scirtes

2

Dubiraphia

1

1

DIPTERA

Ormosia

2

Anopheles

4

1

Forcipomyiinae

12

Ceratopogoninae

5

Ablabesmyia

4

2

Larsia

1

Cricotopus/Orthocladius

1

Nanocladius

1

1

Chironomus

2

Cryptochironomus

8

Dicrotendipes

1

57

10

Glyptotendipes

21

Cryptotendipes

3

Paratendipes

1

Polypedilum halterale grp

61

Polypedilum convictum grp

1

Stenochironomus

1

Polypedilum illinoense grp

4

Polypedilum scalaenum grp

1

1

Pseudochironomus

4

Cladotanytarsus

1

43

Paratanytarsus

2

Rheotanytarsus

3

Stempellinella

2

18

Tanytarsus

31

16

29

Chrysops

1

Zavreliella

1

Thienemannimyia grp.

9

7

Labrundinia

1

EPHEMEROPTERA

Paracloeodes

17

2

Procloeon

1

Stenacron

1

8

Caenis latipennis

14

58

151

Leptophlebiidae

1

Hexagenia limbata

6

LIMNOPHILA

Physella

180

1

ODONATA

Coenagrionidae

53

ORDER (Taxa)

Argia
Enallagma
Gomphus
Progomphus obscurus

CS

RM

SG

NF

18

17

16

2

2

-99

TRICHOPTERA

Cheumatopsyche
Nectopsyche

1

15

7

VENEROIDEA

Sphaerium

1

1

Report Date: 07/22/03

Page 2

Mussel Fk [0218105]

Aquatic Invertebrate Database Bench Sheet Report

September 17, 2002 - Mussel Fk [0218106], Station #4

ORDER (Taxa)

"HYDRACARINA"

Acarina

8 3

AMPHIPODA

Hyalella azteca

4 2

COLEOPTERA

Helichus lithophilus

1 1

Scirtes

9 7

Dubiraphia

7 1 2

DECAPODA

Orconectes virilis

-99

DIPTERA

Limonia

1

Anopheles

1

Forcipomyiinae

2

Ceratopogoninae

1 5

Ablabesmyia

5 5

Procladius

4 3

Cricotopus bicinctus

3

Corynoneura

3

Axarus

1

Cryptochironomus

4

Dicrotendipes

3 41 6

Glyptotendipes

2 4

Cryptotendipes

1

Paralauterborniella

1 1

Nilothauma

1

Polypedilum halterale grp

11

Stenochironomus

1 5

Polypedilum illinoense grp

9 1 4

Stictochironomus

2

Cladotanytarsus

1 24

Paratanytarsus

22 1 4

Rheotanytarsus

2

Stempellinella

1 1 6

Tanytarsus

31 11 7

Chrysops

2 1 1

Clinotanypus

1

Thienemannimyia grp.

8

Labrundinia

3

Epoicocladius

1

EPHEMEROPTERA

Paracloeodes

1 3 4

Procloeon

1 1

Stenacron

5 23

Stenonema femoratum

3 2

Brachycercus

1 2

Caenis latipennis

92 156 110

Leptophlebia

23 4

Hexagenia limbata

4 86

ORDER (Taxa)	CS	RM	SG	NF
HEMIPTERA				
Rheumatobates			1	
Ranatra fusca		-99		
LIMNOPHILA				
Lymnaeidae		2		
Physella		6	2	
Ferrissia		3		
ODONATA				
Argia		12	11	
Enallagma		12	3	
Dromogomphus		2		
Gomphus			1	1
Progomphus obscurus		1		-99
Libellula		1	2	
RHYNCHOBDELLIDA				
Glossiphoniidae			-99	
TRICHOPTERA				
Nectopsyche		3		1
TUBIFICIDA				
Tubificidae				3
Aulodrilus		2	1	1
UNIONIDA				
Unionidae		-99		2
VENEROIDEA				
Sphaerium		2	1	-99

Aquatic Invertebrate Database Bench Sheet Report

September 17, 2002 - Mussel Fk [0218107], Station #5

ORDER (Taxa)

"HYDRACARINA"

Acarina

1

AMPHIPODA

Hyalella azteca

6

COLEOPTERA

Hydroporus

1

Berosus

7

Scirtes

10

Dubiraphia

3

DIPTERA

Limonia

1

Anopheles

2

Culex

2

Chaoborus

16

Forcipomyiinae

2

Ceratopogoninae

7

1

Ablabesmyia

3

3

4

Larsia

1

Procladius

4

Nanocladius

1

1

Parakiefferiella

2

7

Paraphaenocladius

1

Endochironomus

5

Chironomus

13

Cladopelma

1

Cryptochironomus

12

Dicrotendipes

11

64

33

Glyptotendipes

45

58

1

Cryptotendipes

17

Nilothauma

1

Parachironomus

1

2

Phaenopsectra

1

Polypedilum halterale grp

1

21

Polypedilum fallax grp

1

Stenochironomus

1

Polypedilum illinoense grp

23

5

1

Polypedilum scalaenum grp

1

Pseudochironomus

2

1

Cladotanytarsus

8

8

Paratanytarsus

6

1

1

Stempellinella

1

2

Tanytarsus

11

4

7

Stratiomys

-99

Tanytus

1

Labrundinia

5

1

EPHEMEROPTERA

Procloeon

1

1

Stenacron

2

1

Stenonema femoratum

1

ORDER (Taxa)	CS	RM	SG	NF
Caenis latipennis		30	94	109
Leptophlebiidae		1		
Hexagenia limbata				2
HEMIPTERA				
Rheumatobates		12		
Trepobates		2		
Neoplea		1		
Corixidae				1
LIMNOPHILA				
Lymnaeidae		2	1	
Physella		18	18	
Helisoma		-99	1	
Planorbella		1		
ODONATA				
Argia		2	-99	
Enallagma		47	1	1
Dromogomphus				1
Macromia		1		
TRICHOPTERA				
Oecetis		1		
TUBIFICIDA				
Tubificidae				4
Aulodrilus				3
VENEROIDEA				
Pisidium				2
Sphaerium			1	2

Aquatic Invertebrate Database Bench Sheet Report

September 17, 2002 - Mussel Fk [0218108], Station #6

ORDER (Taxa)

"HYDRACARINA"

Acarina

13 18

AMPHIPODA

Hyalella azteca

15

COLEOPTERA

Tropisternus

1

Helichus lithophilus

5

Scirtes

8

Dubiraphia

3

DECAPODA

Orconectes immunis

1

Orconectes virilis

-99

DIPTERA

Chaoborus

1

4

Ceratopogoninae

4

2

10

Ablabesmyia

2

1

7

Procladius

14

Nanocladius

1

1

Axarus

1

Chironomus

2

1

Cryptochironomus

1

1

Dicrotendipes

4

25

13

Glyptotendipes

28

72

Parachironomus

4

Phaenopsectra

1

Polypedilum halterale grp

1

14

Stenochironomus

3

Polypedilum illinoense grp

6

Stictochironomus

1

Cladotanytarsus

6

Paratanytarsus

11

3

Stempellinella

9

Tanytarsus

2

9

9

Tabanus

1

Dolichopodidae

1

2

Clinotanypus

2

Tanypus

1

Labrundinia

1

1

EPHEMEROPTERA

Proclaeon

5

Stenacron

1

18

Stenonema femoratum

1

1

Caenis latipennis

43

147

125

Leptophlebiidae

1

Hexagenia limbata

2

2

34

HEMIPTERA

Ranatra fusca

1

Neoplea

1

Corixidae

2

ORDER (Taxa)	CS	RM	SG	NF
Mesovelgia		1		
LIMNOPHILA				
Physella		5	3	1
Helisoma		1		
Ancylidae		2	3	1
ODONATA				
Argia		13	6	
Enallagma		22		
Gomphus		2		
Progomphus obscurus				-99
RHYNCHOBDELLIDA				
Glossiphoniidae			-99	
TRICHOPTERA				
Triaenodes		7		
Oecetis		1		4
TUBIFICIDA				
Tubificidae		10		2
UNIONIDA				
Unionidae		-99		
VENEROIDEA				
Sphaerium		6	1	1
Corbicula		11		

Appendix C
Spring 2003
Macroinvertebrate Bench Sheets

Aquatic Invertebrate Database Bench Sheet Report

March 25, 2003 - Mussel Fk [0318657], Station #1

ORDER (Taxa)**"HYDRACARINA"**

Acarina

2

AMPHIPODA

Hyaella azteca

1

1

Crangonyx

-99

COLEOPTERA

Agabus

-99

Oreodytes

1

Hydroporus

-99

Berosus

1

2

1

Helichus lithophilus

3

DIPTERA

Dasyheleinae

2

1

3

Ceratopogoninae

14

9

61

Simuliidae

1

Ablabesmyia

2

12

Larsia

1

Monopelopia

9

3

38

Procladius

3

Cricotopus bicinctus

18

6

Corynoneura

5

1

Cricotopus/Orthocladius

11

9

1

Paraphaenocladius

8

2

Hydrobaenus

3

1

Thienemanniella

1

1

Dicrotendipes

9

19

5

Phaenopsectra

4

Polypedilum halterale grp

1

7

Polypedilum illinoense grp

5

23

3

Stictochironomus

2

Pseudochironomus

1

Cladotanytarsus

1

1

3

Paratanytarsus

5

2

Rheotanytarsus

3

3

Tanytarsus

137

159

54

Tabanus

-99

1

-99

Thienemannimyia grp.

5

4

1

Labrundinia

3

1

EPHEMEROPTERA

Callibaetis

1

Stenacron

1

Caenis latipennis

33

41

64

Leptophlebia

1

-99

Hexagenia limbata

1

HEMIPTERA

Belostoma

-99

Ranatra fusca

-99

LIMNOPHILA

Fossaria

2

ORDER (Taxa)	CS	RM	SG	NF
Physella			12	17
ODONATA				
Argia				1
Enallagma		1		
Gomphus				-99
Progomphus obscurus				-99
Libellula		1	1	2
TRICHOPTERA				
Oecetis				1
TRICLADIDA				
Planariidae			1	
VENEROIDEA				
Sphaeriidae		1		3
Pisidium				1

Report Date: 10/14/03

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Mussel Fk [0318657]

Aquatic Invertebrate Database Bench Sheet Report

March 25, 2003 - Mussel Fk [0318658], Station #2

ORDER (Taxa)**"HYDRACARINA"**

Acarina

6 3 2

AMPHIPODA

Hyaella azteca

2 13

COLEOPTERA

Oreodytes

3 2

Berosus

1

Enochrus

1

Helophorus

1

Tropisternus

1

Scirtes

15 2

Dubiraphia

2 4

DIPTERA

Ceratopogoninae

2 8 43

Ablabesmyia

3 10 12

Procladius

3 4

Cricotopus/Orthocladius

1 1

Nanocladius

1 1

Paraphaenocladius

6 2 1

Hydrobaenus

1 3

Endochironomus

9 3

Chironomus

3

Dicrotendipes

9 17 14

Glyptotendipes

10 31

Cryptotendipes

2

Paralauterborniella

1

Paratendipes

2

Phaenopsectra

8 12

Polypedilum halterale grp

2 16

Polypedilum illinoense grp

4 7 2

Stictochironomus

1

Pseudochironomus

1

Cladotanytarsus

1 12

Paratanytarsus

41 16 5

Tanytarsus

1 3 52

Dolichopodidae

1

undescribed Empididae

1

Clinotanypus

2

Tanypus

1

Thienemannimyia grp.

1

Labrundinia

2 2

EPHEMEROPTERA

Callibaetis

2

Stenacron

5 1

Stenonema femoratum

1

Caenis latipennis

74 114 125

Leptophlebia

2 1

Hexagenia limbata

2

HEMIPTERA

ORDER (Taxa)	CS	RM	SG	NF
Corixidae			1	2
LIMNOPHILA				
Fossaria		5		
Physella		36	25	4
Helisoma		1		
Ancylidae			1	
ODONATA				
Argia		12	2	1
Enallagma		12	3	
Nasiaeschna pentacantha		1		
Progomphus obscurus				1
Libellula			1	-99
TRICHOPTERA				
Polycentropus				1
Agrypnia		-99	-99	1
Pycnopsyche		-99		
Triaenodes			1	
Oecetis		3	1	1
TUBIFICIDA				
Tubificidae		2		
Aulodrilus		1	1	
Limnodrilus hoffmeisteri		1		
VENEROIDEA				
Sphaeriidae				4

Aquatic Invertebrate Database Bench Sheet Report

March 25, 2003 - Mussel Fk [0318659], Station #3

ORDER (Taxa)**"HYDRACARINA"**

Acarina

1

AMPHIPODA

Hyalella azteca

4

Crangonyx

-99

COLEOPTERA

Agabus

-99

Oreodytes

3

-99

Berosus

1

Helichus lithophilus

5

Scirtes

1

1

DIPTERA

Gonomyia

1

Ceratopogoninae

8

11

25

Ablabesmyia

11

6

2

Larsia

3

1

4

Procladius

1

1

Cricotopus bicinctus

21

3

1

Cricotopus/Orthocladius

2

3

Nanocladius

4

Parakiefferiella

2

Paraphaenocladius

1

Hydrobaenus

5

Chironomus

1

1

Dicrotendipes

2

34

7

Glyptotendipes

16

Cryptotendipes

2

Nilothauma

3

1

Phaenopsectra

2

Polypedilum halterale grp

5

31

Saetheria

1

Polypedilum illinoense grp

5

4

2

Polypedilum scalaenum grp

6

Stictochironomus

6

1

Pseudochironomus

10

2

Cladotanytarsus

1

7

44

Paratanytarsus

11

1

1

Rheotanytarsus

1

Tanytarsus

82

29

50

Hemerodromia

1

Thienemannimyia grp.

9

Labrundinia

1

1

EPHEMEROPTERA

Acerpenna

1

Caenis latipennis

57

94

60

Leptophlebia

1

1

Hexagenia limbata

1

1

HEMIPTERA

Corixidae

2

4

Report Date: 10/14/03**Page 1****Mussel Fk [0318659]**

ORDER (Taxa)	CS	RM	SG	NF
LIMNOPHILA				
Fossaria			2	
Physella		26	7	3
Ferrissia		1		
LUMBRICULIDA				
Lumbriculidae		2		
ODONATA				
Argia		3	1	
Enallagma		1		
Progomphus obscurus				-99
Libellula			1	
TRICHOPTERA				
Oxyethira			2	1
Agrypnia		1		
Uenoidae				-99
Nectopsyche		11	2	1
Oecetis			1	
TUBIFICIDA				
Tubificidae		1		5
Aulodrilus			5	11
VENEROIDEA				
Sphaeriidae		1		7
Pisidium			1	1
Sphaerium			1	

Report Date: 10/14/03

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Mussel Fk [0318659]

Aquatic Invertebrate Database Bench Sheet Report

March 25, 2003 - Mussel Fk [0318660], Station #4

ORDER (Taxa)

"HYDRACARINA"

Acarina

23

AMPHIPODA

Hyalella azteca

2

2

1

COLEOPTERA

Laccophilus

-99

Berosus

1

Helichus lithophilus

3

1

Dubiraphia

9

2

DIPTERA

Ceratopogoninae

7

3

Ablabesmyia

6

4

7

Procladius

9

Cricotopus bicinctus

1

Cricotopus/Orthocladius

3

3

Nanocladius

1

Paraphaenocladius

4

2

Hydrobaenus

3

3

Cryptochironomus

2

3

Dicotendipes

14

26

20

Glyptotendipes

5

6

Phaenopsectra

15

4

Polypedilum halterale grp

3

2

3

Polypedilum fallax grp

2

Stenochironomus

1

2

Polypedilum illinoense grp

4

1

Stictochironomus

6

6

Cladotanytarsus

4

7

31

Paratanytarsus

66

9

13

Tanytarsus

29

23

13

Thienemannimyia grp.

11

21

1

Labrundinia

1

Diptera

1

EPHEMEROPTERA

Stenacron

1

Caenis latipennis

82

99

164

Leptophlebia

1

2

Hexagenia limbata

2

2

3

LIMNOPHILA

Fossaria

2

Physella

4

8

2

Ancylidae

1

1

MEGALOPTERA

Sialis

1

ODONATA

Enallagma

3

1

1

Progomphus obscurus

2

Libellula

1

2

Plathemis

-99

ORDER (Taxa)	CS	RM	SG	NF
TRICHOPTERA				
Cheumatopsyche			1	
Hydroptila		2		
Limnephilidae		1		
Triaenodes		2	4	
Oecetis			4	
TUBIFICIDA				
Tubificidae		9		
Aulodrilus		2		1
Limnodrilus hoffmeisteri		2		
Enchytraeidae		1		
VENEROIDEA				
Pisidium		2		
Sphaerium		1	1	2

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Mussel Fk [0318660]

Aquatic Invertebrate Database Bench Sheet Report

March 26, 2003 - Mussel Fk [0318664], Station #5

ORDER (Taxa)

"HYDRACARINA"

Acarina

10 11 8

AMPHIPODA

Hyalella azteca

4

COLEOPTERA

Oreodytes

1

Tropisternus

-99

Scirtes

2

DIPTERA

Ormosia

1

1

Chaoborus

3

Dasyheleinae

1

Ceratopogoninae

8

13

Ablabesmyia

7

6

2

Procladius

2

Cricotopus/Orthocladius

1

Nanocladius

9

1

Parakiefferiella

1

6

Paraphaenocladius

2

3

1

Hydrobaenus

1

1

Endochironomus

3

12

Chironomus

1

Cryptochironomus

1

1

Dicotendipes

21

96

26

Glyptotendipes

61

48

2

Cryptotendipes

1

2

Nilothauma

3

1

Phaenopsectra

3

2

Polypedilum halterale grp

11

42

Polypedilum illinoense grp

15

12

4

Polypedilum scalaenum grp

1

Pseudochironomus

2

1

Cladotanytarsus

1

62

64

Paratanytarsus

62

17

2

Tanytarsus

4

22

21

Thienemannimyia grp.

2

2

Labrundinia

1

2

Diptera

1

EPHEMEROPTERA

Caenis latipennis

109

47

34

Leptophlebia

1

1

HEMIPTERA

Microvelia

1

LIMNOPHILA

Fossaria

10

2

Physella

2

2

LUMBRICINA

Lumbricidae

4

ODONATA

ORDER (Taxa)

Enallagma

Gomphus

TRICHOPTERA

Agrypnia

Nectopsyche

Triaenodes

TUBIFICIDA

Tubificidae

Limnodrilus hoffmeisteri

Enchytraeidae

CS

RM

SG

NF

3

1

-99

-99

1

1

2

1

21

1

1

12

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Mussel Fk [0318664]

Aquatic Invertebrate Database Bench Sheet Report

March 26, 2003 - Mussel Fk [0318663], Station #6

ORDER (Taxa)

"HYDRACARINA"

	CS	RM	SG	NF
Acarina		9	4	5

AMPHIPODA

Hyaella azteca		15	15	1
----------------	--	----	----	---

COLEOPTERA

Peltodytes				1
Berosus			1	
Tropisternus			1	
Scirtes			1	
Dubiraphia			1	

DIPTERA

Pilaria				1
Ceratopogoninae		1	5	5
Ablabesmyia			5	
Procladius		8		12
Cricotopus/Orthocladius		13	10	4
Nanocladius			1	
Paraphaenocladius			1	
Psectrocladius				4
Hydrobaenus		14	13	20
Chironomus			1	24
Dicrotendipes		3	21	
Glyptotendipes		108	60	1
Parachironomus		3		1
Phaenopsectra		1		
Polypedilum halterale grp			2	5
Stenochironomus			2	
Polypedilum illinoense grp			2	
Pseudochironomus			1	
Cladotanytarsus			1	3
Paratanytarsus		2	6	1
Tanytarsus			4	3
Tabanus		4		3
Diptera		1	2	

EPHEMEROPTERA

Caenis latipennis		52	149	12
-------------------	--	----	-----	----

HEMIPTERA

Belostoma		-99		
Ranatra fusca		1		

ISOPODA

Caecidotea		2		
------------	--	---	--	--

LIMNOPHILA

Fossaria			3	
Physella			21	3
Ancylidae			1	

LUMBRICINA

Lumbricidae		1		
-------------	--	---	--	--

TRICHOPTERA

Limnephilidae			2	
---------------	--	--	---	--

ORDER (Taxa)

Triaenodes

CS RM SG NF

3

TUBIFICIDA

Tubificidae

7

9

Aulodrilus

1

1

Ilyodrilus templetoni

3

Limnodrilus hoffmeisteri

7

6

Enchytraeidae

2

1

VENEROIDEA

Sphaeriidae

1

5

Pisidium

2

Report Date: 10/14/03

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Mussel Fk [0318663]

Appendix D
Fall 2002
Channel Width and Depth Data

Station 1

Transect	Channel Width (ft)	Wetted Width (ft)	Depth of stream at % of wetted width (ft):		
			25%	50%	75%
1	70.6	10.1	0.1	0.2	0.3
2	68.1	13.3	0.5	0.3	0.15
3	66.1	11.1	0.2	0.2	0.05
4	66.5	2.3	0.05	0.1	0.15
5	66.2	11.9	0.2	0.15	0.05
6	51.7	25.9	0.6	1	1.1
7	89.9	16.7	0.9	1.4	1.55
8	115	10	0.15	0.2	0.15
9	115	12.9	0.4	0.6	0.9
10	113	6.8	0.1	0.15	0.15
Average	82.2	12.1	0.3	0.4	0.4

Station 2

Transect	Channel Width (ft)	Wetted Width (ft)	Depth of stream at % of wetted width (ft):		
			25%	50%	75%
1	85	42	0.3	0.3	0.6
2	78	11.3	0.55	0.6	0.3
3	57	13	0.2	0.15	0.3
4	92	5	0.3	0.2	0.05
5	83	8	0.5	0.3	0.1
6	77	6.5	0.3	0.4	0.2
7	75	14.5	0.6	0.35	0.3
8	56	19	0.55	1.1	1.15
Average	5.3	14.9	.4	0.4	0.3

In order to characterize a homogenous stretch of stream only eight transects were measured at this station.

Station 3

Transect	Channel Width (ft)	Wetted Width (ft)	Depth of stream at % of wetted width (ft):		
			25%	50%	75%
1	52	6	0.2	0.1	0.05
2	47	4.5	0.2	0.25	0.2
3	57	5	0.1	0.15	0.15
4	67	7.5	0.1	0.15	0.1
5	66	18	0.2	0.15	0.25
6	77	19	0.1	0.1	0.15
7	77	24.5	0.1	0.2	0.5
8	68	8	0.2	0.2	0.2
9	65	18.5	0.2	0.2	0.2
10	83	29	1.9	1.1	0.7
Average	65.9	14.0	.3	0.2	0.2

Station 4

Transect	Channel Width (ft)	Wetted Width (ft)	Depth of stream at % of wetted width (ft):		
			25%	50%	75%
1	60	36	0.5	0.5	0.4
2	52	7	0.1	0.1	0.2
3	55	10.8	1.6	1.3	0.6
4	46	40	1.3	1.1	0.8
5	60	5	0.25	0.2	0.05
6	40	12.5	0.75	0.5	0.3
7	46	15	0.4	0.5	0.6
8	53	21	0.7	0.8	1.1
9	44	9.5	0.1	0.15	0.1
10	43	5.5	0.4	0.3	0.2
Average	9.9	16.2	.6	0.5	0.4

Station 5

Transect	Channel Width (ft)	Wetted Width (ft)	Depth of stream at % of wetted width (ft):		
			25%	50%	75%
1	42	25	2.6	2.5	1.8
2	44	9	0.9	1.3	1
3	51	22	1.2	2.4	1.3
4	56	17	1.2	0.6	0.5
5	52	38	0.8	0.8	0.7
6	48	25	0.6	0.65	0.5
7	52	25.5	1.6	1.3	0.8
8	48	21	0.7	0.6	0.225
9	42	25	0.5	0.8	0.6
10	39	28	0.5	0.5	0.4
Average	7.4	23.5	1.0	1.1	0.7

Station 6

Transect	Channel Width (ft)	Wetted Width (ft)	Depth of stream at % of wetted width (ft):		
			25%	50%	75%
1	22	12.5	0.7	0.8	0.4
2	30	8	0.2	0.3	0.1
3	35	7.5	0.2	0.45	0.3
4	25	19	0.65	1.4	1.4
5	36	19.5	0.4	0.6	0.4
6	30	0	0	0	0
7	27	0	0	0	0
8	24	0	0	0	0
9	24	3.5	0.15	0.15	0.2
10	26	0	0	0	0
Average	7.9	7.0	0.2	0.3	0.2