

Evaluation and Summary of the Aquatic Macroinvertebrate Fauna of the Sauk River, Todd County, Minnesota.

Submitted to:

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March 10, 2010



INTRODUCTION

The Sauk River Watershed District (District) entered into a Joint Powers Agreement under which the District would provide physical assessments, chemical monitoring, and aquatic macroinvertebrate assessment of aquatic habitats for the State of Minnesota Pollution Control Agency (MPCA). The project is known as the Upper Sauk River Water Quality Assessment Project. The District worked in cooperation with the Lake Superior Research Institute (LSRI) at the University of Wisconsin-Superior to provide professional training to its staff in the collection of samples of aquatic macroinvertebrates. Furthermore, the District contracted with LSRI to process these samples and taxonomically analyze the organisms. This report summarizes the work that was accomplished in the field and laboratory, and provides an evaluation of the Sauk River based on the aquatic macroinvertebrates that occur in the river.

METHODS

District personnel determined *a priori* that six sites along the Upper Sauk River in Todd County would be sampled. These sites included:

1. The Anderson site (most upstream site) located 1-2 miles from the outlet of Lake Osakis
2. Downstream of County Road 57
3. Downstream of County Road 171, approximately 0.5 miles downstream of Guernsey Lake
4. Downstream of County Road 11, immediately downstream of Little Sauk Lake
5. Upstream of Cedar Lake Road
6. Upstream of County Road 2, immediately downstream of Mud Lake

Sampling methods followed those established by the MPCA (Genet and Chirhart 2004). A reconnaissance of the river at each site was conducted to establish that adequate, productive habitat for macroinvertebrates was available within a 75-100 m reach of stream. A qualitative, multihabitat sample was collected at each site using a D-frame net (500 μ m mesh) and a five-gallon pail. A total of 20 netting efforts (or jabs) were collected at each site. Each of the major habitat types (riffles, undercut banks, submerged or emergent macrophytes, snags and woody debris, and leaf packs) that were present within the reach of river were sampled in equal proportions. All of the material from the 20 netting efforts (minus the water) was consolidated in the five-gallon bucket and preserved in 10% formalin solution.

In the laboratory, the sample was thoroughly rinsed and the debris was spread onto a gridded Caton tray. Grids were randomly chosen and the material in the grid was removed to be examined under a dissecting microscope. All organisms were systematically sorted from the debris until 300+ specimens were obtained. A grid was picked in its entirety if 300 specimens were achieved before the grid was completely processed.

Identifications were made by the author to the lowest taxonomic level practical based on the scientific literature and the expertise of the author. Processed samples will be kept and stored at LSRI.

RESULTS

Anderson Site

Based on the HBI values, which ranged from 5.07 to 6.34, this site was assessed as “fair” for all of the dates except the most recent date in which it was assessed as “good” (Table 1). Taxa richness ranged from 29 to 46 with an average of 39.8, and EPT taxa richness ranged from 11 to 19 with an average of 13.8. Both of these values were the second highest values for the six sites.

The dominant taxa were baetid mayflies (6.4% to 56.4%), chironomid midges (<4.5% to 33.5%), and blackflies (<4.5% to 35.6%) (see below). This was one of only two sites (County Road 57) where stoneflies were found, a group that is the least tolerant to low dissolved oxygen levels.

The top four taxa by percentage.

	May 28		July 20-21		Sept 11, 14	
	<u>2008</u>	<u>2009</u>	<u>2008</u>	<u>2009</u>	<u>2008</u>	<u>2009</u>
Baetidae	6.4	23.8	36.3	22.7	20.9	56.4
Caenidae	12.9	5.7				
Chironomidae	33.5	28.0	7.0	18.4	9.8	
Simuliidae	27.3	35.6	31.0	14.2	27.0	
Hydropsychidae			10.4	13.2		
<i>Hyalella azteca</i>					20.9	7.2
Heptageniidae						4.5
Leptophlebiidae						5.1
Cumulative %	80.0	93.1	84.7	68.5	78.6	73.2

County Road 57

This site was rated the best site at “fair” and “good” with HBI values that ranged from 4.72 to 6.06 (Table 1). The average taxa richness value at 43.7 (range 32-51) was the highest among the six sites, as was the average EPT taxa richness value at 17.8 (range 9-25).

This site was similar to the Anderson site with regard to dominant taxa. Baetid mayflies (8.4% to 53.0%), chironomid midges (<6.4% to 35.3%), and blackflies (<8.7% to 44.6%) were the most abundant groups (see below). This was the other site where stoneflies were collected. Additional common groups were hydropsychid caddisflies, and mayflies in the families Heptageniidae and Leptophlebiidae.

The top four taxa by percentage.

	May 28		July 20-21		Sept 11, 14	
	<u>2008</u>	<u>2009</u>	<u>2008</u>	<u>2009</u>	<u>2008</u>	<u>2009</u>
Baetidae	8.4	24.6	26.5	53.0	38.2	27.6
Chironomidae	35.3	23.6			15.0	10.4
Simuliidae	27.9	44.6	19.1	6.4	21.9	
<i>Hyalella azteca</i>	7.3					
Hydropsychidae			15.2	7.5		
Heptageniidae			11.1	6.9	8.3	8.7
Leptophlebiidae						27.2
Cumulative %	78.9	92.8	71.9	73.8	83.4	73.9

County Road 171

This was the poorest ranked site. The average HBI value was 8.47, which gave the site an overall assessment of “poor” (Table 1). However, individual dates were assessed at “very poor” to “fairly poor” because HBI values ranged from 6.95 to 9.35, and 9.35 was the highest value observed for the study. Taxa richness values ranged from 28 to 51, but EPT taxa richness values were the lowest in the study, ranging from 0 to 6 and an overall average of 4.0.

Chironomid midges dominated this site, and the majority of the midges were very tolerant species to organic enrichment (see below). In 2009, oligochaete worms (especially *Chaetogaster* sp.) were very abundant in May and less so in July.

The top one to four taxa by percentage.

	May 28		July 20-21		Sept 11, 14	
	<u>2008</u>	<u>2009</u>	<u>2008</u>	<u>2009</u>	<u>2008</u>	<u>2009</u>
Chironomidae	66.5	16.0	88.8	16.8	70.1	49.9
<i>Hyalella azteca</i>	16.9			13.5	18.4	12.2
Caenidae	6.6					
Coenagrionidae	4.4				8.2	
Tubificidae		75.1		27.9		
<i>Hydra</i> sp.		6.4				
Corixidae				11.7		
Gastropoda						11.2
Turbellaria						8.9
Cumulative %	94.4	97.0	88.8	69.9	96.7	82.2

County Road 11

This was the second poorest ranked site. The average HBI value was 8.29, but values ranged from 7.64 to 9.03, resulting in assessments of “very poor” to “fairly poor” (Table 1). The average taxa richness value was the lowest for the study at 31.3; values ranged from 20 to 47. The average EPT taxa richness was the second lowest among the six sites at 4.8, with values that ranged from 2 to 10.

Chironomid midges were again the dominant group (<7.1% to 73.5%, see below). Other taxa were also present in relatively large numbers, but the major groups varied between dates and years.

The top three to four taxa by percentage.

	May 28		July 20-21		Sept 11, 14	
	<u>2008</u>	<u>2009</u>	<u>2008</u>	<u>2009</u>	<u>2008</u>	<u>2009</u>
Chironomidae	53.2		58.5	13.7	73.5	34.7
Caenidae	6.5					
Simullidae	14.4	9.6	21.1			
Tubificidae	10.7	17.0				
<i>Hyalella azteca</i>			6.8	38.5	6.1	14.9
<i>Hydra</i> sp.		51.5				
Asellidae		7.1				
Hydropsychidae				9.4	5.8	
Gastropoda				12.4		14.9
Turbellaria						7.0
Cumulative %	84.8	85.2	86.4	74.4	85.4	71.5

Cedar Lake Road

This site was ranked “fairly poor” overall with an average HBI value of 6.77; values ranged from 6.28 to 7.36 with assessments of “fairly poor” to “fair” (Table 1). The average taxa richness value was the second highest at 39.8 (range 33-50). Average EPT taxa richness was 9.0 (range 7-12).

Chironomid midges and *Hyalella azteca* were the two most dominant groups (see below). Baetid mayflies reappeared as a major group. Several other taxa were also present in large numbers, but these groups varied between dates and years.

The top four taxa by percentage.

	May 28		July 20-21		Sept 11, 14	
	<u>2008</u>	<u>2009</u>	<u>2008</u>	<u>2009</u>	<u>2008</u>	<u>2009</u>
Baetidae	7.1	5.6	3.4	27.8	7.2	
Caenidae	10.3					
Chironomidae	28.2	8.1	25.7	20.0		31.4
<i>Hyalella azteca</i>	30.1		30.9	28.6	22.0	31.3
Tubificidae		18.3			3.2	
Simuliidae			29.1		47.2	
<i>Hydra sp.</i>		51.4				
Turbellaria				8.4		
Hydroptilidae						9.8
<u>Polycentropodidae</u>						<u>10.5</u>
Cumulative %	75.7	83.4	89.1	84.8	79.6	83.0

County Road 2

This site was also assessed as “fairly poor” overall with an average HBI value of 6.79, nearly identical to the Cedar Lake site (Table 1). Values ranged from 5.62 to 7.87, resulting in assessments of “poor” to “fair.” Average taxa richness was 36.0 with a range of 28 to 51. EPT taxa richness ranged from 5 to 12 with an average of 8.5.

The major components at this site were very similar to the previous site; chironomid midges and *Hyalella azteca* were the two dominant taxa (see below). Baetid mayflies were also present, and several other groups were also dominant taxa, but their numbers varied between dates and years.

The top three to four taxa by percentage.

	May 28		July 20-21		Sept 11, 14	
	<u>2008</u>	<u>2009</u>	<u>2008</u>	<u>2009</u>	<u>2008</u>	<u>2009</u>
Caenidae	6.3					
Chironomidae	38.1	8.8	30.7	6.9	19.4	23.2
Coenagrionidae	4.7					
<i>Hyalella azteca</i>	38.8		38.5		10.7	33.8
Tubificidae		26.3				
<i>Hydra sp.</i>		34.7				
Asellidae		14.1				
Baetidae			11.8	10.3	58.5	
Simuliidae				71.0		6.2
<u>Turbellaria</u>						<u>11.1</u>
Cumulative %	87.9	83.9	87.0	88.2	88.6	74.3

DISCUSSION

The two fast-flowing, rocky and sandy upstream sites (Anderson and County Road 57) were rated the least polluted sites, with “fair” and “good” assessments. These assessments reflected the highest taxa richness values among the six sites, and in particular, the highest EPT taxa richness values. Both sites were fairly similar to each other with regard to the faunal composition. Baetid mayflies, hydropsychid caddisflies, chironomid midges, and blackflies were the dominant groups at both sites. Blackflies and hydropsychid caddisflies are often quite abundant below dams and outflows of lakes. These two groups are filter feeders that benefit from the algae and particulate organic matter that accumulate in lakes and then are released downstream. Baetid mayflies feed on the algae that grow or accumulate on substrates. Clear water is generally needed to allow sunlight to reach the substrates to allow algal growth.

The site at County Road 57 rated “better” (higher taxa richness, higher EPT richness, lower HBI value) than the Anderson site for nearly every sampling date (Table 1). This may be due to the closer proximity of the Anderson site to Lake Osakis and the exposure to greater amounts of organic inputs from this source. One example of a possible consequence of this situation is that *Hyalella azteca* was more abundant at the Anderson site. This amphipod has a high tolerance to organic input (HBI value of 8). Site County Road 57 was more remote from the influence of Lake Osakis, and this situation likely contributed to the presence of several additional taxa of mayflies (or greater abundance for some taxa shared at both sites). Most of these taxa have low to moderate tolerance to organic input, which contributed to a lower overall HBI value.

The site at County Road 171 was in stark contrast to the upstream sites. Water flow at this site was very slow, the substrate was soft sediments, and there was significant organic input from the surrounding area. Not surprisingly, this site was dominated by highly tolerant taxa of chironomid midges (e.g. *Endochironomus* sp., *Glyptotendipes* spp.), and to a lesser extent tubificid worms and *Hyalella azteca*. Still, the extremely high HBI values (as high as 9.35) were surprising; I have not commonly encountered such high values. Despite being rated “very poor” to “poor,” taxa richness values were not the lowest among the six sites; the values were the second lowest on average (Table 1). However, these values in 2009 were inflated by the presence of 12 taxa that consisted of lentic (still water) beetles and true bugs (including surface dwellers), a further testament to the fact that this site resembled a wetland more than a stream. Low EPT taxa richness values (0-6) verified the poor-water quality assessment, and nearly all of the EPT taxa that were found represented tolerant, and often lentic, taxa (tolerance values 3-9). On five of the six sampling dates, a single taxon accounted for at least 25% of the number of specimens in a sample (*Endochironomus* sp., *Glyptotendipes* sp. grp. A, or *Chaetogaster* sp.). In highly polluted or disturbed habitats, one taxon (or a few taxa) can dominate the fauna for various reasons, and this site provided a good example of this situation.

The site at County Road 11 was immediately downstream from Little Sauk Lake. Water flow was swift, the substrate consisted of sand, soft mineral deposits, some gravel, and emergent macrophytes. Chironomid midges, blackflies, tubificid worms, and *Hyalella azteca* were the dominant taxa. These taxa would be expected to occur below the outflow of a lake because they are able to take advantage of warmwater and the suspended algae and particulate organic matter that flowed from Little Sauk Lake. This site exhibited the lowest overall taxa richness values and the second lowest EPT taxa richness values. HBI values were high and the assessments ranged from “very poor” to “fairly poor” (Table 1). On all six sampling dates, a single taxon accounted for at least 23% of the number of specimens in a sample (*Glyptotendipes* sp. grp. A, *Hyalella azteca*, or

Hydra sp.). Again, in highly polluted or disturbed habitats, one taxon (or a few taxa) can dominate the fauna for various reasons, and this site provided another good example of this situation. Clearly the stream at County Road 11 continued to be impacted by the slow water flow and organic inputs within the 3-4 mile upstream stretch of the river, which included the previous, highly impacted site on County Road 171.

The upstream site on Cedar Lake Road was in clear contrast to the previous two upstream sites. It was shallow and swift-flowing with a substrate consisting of sand, gravel and some rock. Water quality assessment reflected the change in the river. HBI values were down, which resulted in “fairly poor” to “fair” assessments. Taxa richness values increased and EPT richness values doubled. However, the aquatic community did not reflect the same composition as the two most upstream sites. Various tolerant taxa were more abundant at Cedar Lake Road than compared to the two upstream sites, and the EPT taxa richness values varied from 11% to 64% lower for all of the sampling dates (Table 1). Thus, despite the return of similar stream morphology, substrate, and flow at Cedar Lake Road, the aquatic macroinvertebrate fauna reflected a more impacted community compared to the two most upstream sites. This situation was likely a reflection of the lingering effects of the two highly impacted sites immediately upstream.

The upstream site at County Road 2 was directly downstream from Mud Lake. Water levels were deep, the current was strong, and the substrate was mainly sand and gravel with some silts. Water quality assessments (poor to fair) decreased slightly compared to the upstream site at Cedar Lake Road; assessments were lower on three dates, the same on two dates, and higher on one date (Table 1). The average taxa richness and EPT taxa richness were slightly lower, also. The dominant macroinvertebrate taxa varied more from one sampling date to another, and between years, with most of the taxa representing tolerant groups. The fauna indicated a clear improvement from the two highly impacted sites at county roads 171 and 11, but Mud Lake likely provided organic enrichment to this site that slightly decreased its water quality assessment compared to the immediate upstream site on Cedar Lake Road.

The two upstream sites clearly show that the Upper Sauk River has potential for good water quality and a diverse, macroinvertebrate fauna. Overall, the minimum total taxa richness for all six sites was 201 (i.e. at least 201 species of aquatic macroinvertebrates were collected from the Upper Sauk River). Among this total, at least 50 species were mayflies, stoneflies, and caddisflies (i.e. minimum total EPT richness = 50), which are groups that are generally considered the least tolerant to organic enrichment and stream degradation. The data also show that major problems obviously exist along sections of the river. Data collected in the middle sections of the river at county roads 171 and 11 revealed extremely high HBI values. The data also show that the river has the ability to recover from these highly degraded areas, and the two downstream sites demonstrated this ability.

LITERATURE CITED

Genet, J. and J. Chirhart. 2004. Development of a macroinvertebrate index of biological integrity (MIBI) for rivers and streams of the Upper Mississippi River Basin. Minnesota Pollution Control Agency, Biological Monitoring Program. St. Paul, MN.

Hilsenhoff, W.L. 1987. An improved biotic index of organic stream pollution. *The Great Lakes Entomologist* 20: 31-39

Table 1. Values for taxa richness, EPT (Ephemeroptera, Plecoptera, Trichoptera) richness, HBI (Hilsenhoff Biotic Index), and HBI assessment (Hilsenhoff 1987) for six sites that were sampled on the listed dates.

	May 28 <u>2008</u>	May 28 <u>2009</u>	July 21 <u>2008</u>	July 20 <u>2009</u>	Sept 11 <u>2008</u>	Sept 14 <u>2009</u>	<u>Average</u>
<u>Anderson Site</u>							
Taxa Richness	40	40	29	46	39	45	39.8
EPT Richness	11	12	13	15	13	19	13.8
HBI Value	5.54	6.24	5.79	5.64	6.34	5.07	5.77
Assessment	Fair	Fair	Fair	Fair	Fair	Good	Fair
<u>County Road 57</u>							
Taxa Richness	44	32	44	48	43	51	43.7
EPT Richness	13	9	25	21	20	19	17.8
HBI Value	5.64	6.06	5.23	4.99	5.50	4.72	5.36
Assessment	Fair	Fair	Good	Good	Good	Good	Good
<u>County Road 171</u>							
Taxa Richness	37	28	33	51	29	34	35.3
EPT Richness	5	0	6	5	4	4	4.0
HBI Value	8.59	6.95	9.35	7.65	9.01	9.29	8.47
Assessment	Very Poor	Fairly Poor	Very Poor	Poor	Very Poor	Very Poor	Poor
<u>County Road 11</u>							
Taxa Richness	30	24	33	47	34	20	31.3
EPT Richness	2	4	6	10	4	3	4.8
HBI Value	8.21	7.64	8.78	7.22	8.87	9.03	8.29
Assessment	Poor	Poor	Very Poor	Fairly Poor	Very Poor	Very Poor	Poor
<u>Cedar Lake</u>							
Taxa Richness	50	35	35	33	42	44	39.8
EPT Richness	9	8	9	7	9	12	9.0
HBI Value	6.92	6.86	7.36	6.28	6.94	6.28	6.77
Assessment	Fairly Poor	Fairly Poor	Fairly Poor	Fair	Fairly Poor	Fair	Fairly Poor
<u>County Road 2</u>							
Taxa Richness	38	28	36	29	34	51	36.0
EPT Richness	9	5	10	6	9	12	8.5
HBI Value	7.87	6.91	6.72	6.60	5.62	7.03	6.79
Assessment	Poor	Fairly Poor	Fairly Poor	Fairly Poor	Fair	Fairly Poor	Fairly Poor
<u>Biotic Index Range</u>	<u>Water Quality Assessment</u>		<u>Degree of Organic Pollution</u>				
0.00 – 3.50	Excellent		No apparent organic pollution				
3.51 – 4.50	Very Good		Possible slight organic pollution				
4.51 – 5.50	Good		Some organic pollution				
5.51 – 6.50	Fair		Fairly significant organic pollution				
6.51 – 7.50	Fairly Poor		Significant organic pollution				
7.51 – 8.50	Poor		Very significant organic pollution				
8.51 – 10.00	Very Poor		Severe organic pollution				