Otter Creek Water Quality Monitoring
2011

Submitted by: Rick Klann
Upper Iowa University

Date: October 27, 2011

Introduction

This report presents an analysis of physical and chemical parameters of water quality of Otter Creek from May – October in 2011. This report also presents the results of benthic invertebrate surveys conducted during May and September of 2011.

Methods

Three sites on Otter Creek were identified for monitoring. Site 1 is located immediately downstream of where Linden Road crosses the stream. Site 5 is the riffle upstream from where Pine Street crosses the creek, and Site 6 is located at the parking/picnicking area in Echo Valley Park, immediately upstream from the FFA walking bridge. In addition, the water flowing out of three drainage pipes that empty into the ditch along Union Street (which ultimately empties into Otter Creek) were sampled. These three pipes are identified as, from west to east, Sites 2, 3, and 4. Finally, Site 7 is located at the ford on Glovers Creek in Echo Valley Park, shortly before it empties into Otter Creek (which is below Site 6).

Each site was visited a total of seven times following significant rain events, which is defined as at least 0.5 inches of rainfall in a 24 hour period. Emphasis was placed on sampling immediately after the rain while water was flowing from the drainage pipes. In addition, the on-stream sites were visited once in September following an extended period without rain.

During each visit, the following parameters were measured on site using a multi-probe device: temperature (degrees Celsius), pH, specific conductance (microSiemens/cm) and dissolved oxygen (mg/L). A nephelometer was used to measure

turbidity (NTU) and a flowmeter was used to measure current speed. Water samples were collected and returned to the lab for immediate measurement of chloride, total phosphorus, total nitrogen, and suspended solids (all reported as mg/L). Also in the lab, 100 ml of each sample were filtered for fecal coliform analysis (using *E. coli* as an indicator organism). The filter was incubated for 24 hours in FC broth with Rosolic Acid at 44-45 degrees C, after which the number of colony-forming units was counted.

Typically, there is not enough water flowing through a pipe to submerge a probe. Thus, results for temperature, pH, conductivity, dissolved oxygen and flow were obtained at the junction of flow from all three pipes, and therefore the results for these parameters reported from Sites 2, 3 and 4 are identical. Finally, there was no water flowing from the pipe at Site 3 on 8/23/11, rendering it impossible to collect data on the other physical and chemical parameters of water quality on that date.

In May and September, the four on-stream sites were sampled for benthic invertebrates using a kick net. All invertebrates collected from five meters of riffle at each site were identified (to genus wherever possible) and the Family Biotic Index was calculated according to Hilsenhoff (1988). When calculating the FBI, results for the May and September collections were combined in order to eliminate variations based on season, such as times of emergence and development.

Results and Discussion

Physical parameters of water quality are presented in Table 1. The mean, median and range for the variables measured are included. For Sites 1, 5, 6 and 7 these are based

on eight samples (seven rain events and one non-rain event). For Sites 2, 3 and 4, those calculations are based on seven samples (rain events only).

Runoff from the drainage pipes at Sites 2, 3 and 4 tended to be warmer than water in the stream, similar to results from previous years (Klann, 2009 and Klann, 2010). On the other hand, there was less variation in pH among sites. Iowa groundwater is typically hard, producing an alkaline pH. Values for pH were lower following the rain events as runoff diluted the groundwater.

Conductivity tended to be higher at Sites 6 and 7. This differs from the results in previous years, where conductivity was higher in runoff from the drainage pipes. Care needs to be taken in interpreting these results, since the highest conductivity measurements from Sites 6 and 7 were obtained from the samples collected following the extended dry period, whereas the highest results from the drainage pipes were encountered following a heavy rain. Conductivity measures the ability of water to conduct an electrical current, which is correlated to the amount of dissolved ions in the water. Northeast Iowa streams tend to have a fairly high conductivity, due to ions picked up through erosion of material like limestone. Rain events typically lower the conductivity, due to a dilutive effect. Thus, the highest measurements for conductivity at the on-stream sites were detected during the non-rain sampling. However, following most rain events, water flowing through pipes at Sites 2, 3 and 4 accumulates a significant amount of dissolved substances and can display higher conductivity.

Dissolved oxygen levels at all sites were usually above the minimum required to support coldwater fish such as trout. The highest levels were recorded during the non-rain

sampling events, emphasizing how run-off can negatively impact dissolved oxygen levels.

Turbidity measurements provide an indication of water clarity. Rain events typically produce increased turbidity measurements (and hence, reduced clarity), as runoff carries sediment into the stream. Usually, the highest turbidity measurements are encountered at on-stream sites that receive runoff from bare ground and turbidity values tended to be much lower in water flowing through the drainage pipes. However, this year the water flowing out of the drainage pipes (in particular Sites 2 and 4) was more turbid compared to previous years, probably due to the construction taking place downtown.

Suspended solids displayed the same pattern as that noted for turbidity. As was the case in 2009 and 2010, maximum values for both turbidity and suspended solids measurements were encountered in Glovers Creek and Site 7 in Otter Creek.

Chemical parameters of water quality are presented in Table 2. The same descriptive statistics were computed. Once again for Sites 2, 3 and 4, those calculations are based on seven samples, only.

It is not unusual for total phosphorus levels in Otter and Glovers Creek to increase four to five-fold following rain events. Although levels in the drainage pipes are typically lower than those in the streams, they are contributing some phosphorus to the stream. Most phosphorus in Iowa streams is attributed to runoff carrying or human or animal waste and the highest levels were encountered at Site 6, which is downstream of the wastewater treatment plant.

Total nitrogen levels were highest at the on-stream sites. This is not surprising, since Iowa groundwater is contaminated with nitrates, and significant amounts of

nitrogen are washed in from fertilizer runoff. Relative to their flow, the three drainage pipes appear to be contributing very little nitrogen to Otter Creek.

The chloride results (Table 3) indicate that typically chloride levels are low in Otter and Glovers Creek. The three drainage pipes, on the other hand, carry more chloride.

Fecal coliform bacteria counts were usually very high. The limit for water sources with primary contact recreation (swimming) is 200 colony forming units/100 ml of water. All samples were over this limit (Table 4). On Iowa streams, significant rain events typically produce high counts due to runoff washing in bacteria from livestock operations and septic tanks. Not surprisingly, the lowest counts for the on-stream sites were typically encountered during the non-rain samples. Unlike previous years, the drainage pipes also carried very high levels of bacteria, perhaps due to the construction impacting the sewer system.

The results of the benthic invertebrate surveys are presented in Table 5. Table 6 displays the number of taxa, total number of individuals and the Family Biotic Index (FBI) at each of the four sites. The FBI is computed based on the number of individuals in each family and the tolerance value for that family. Only taxa for which a tolerance value is available were utilized. Table 7 provides an evaluation of water quality based on the value for the FBI.

Sites 1, 5 and 6 on Otter Creek achieved a rating of Good, indicating some organic pollution (nitrogen and phosphorus) probable. This is a slight decline compared to the results from 2010, but similar to the results from 2009. Site 7 on Glovers Creek just barely achieved a rating of Very Good, indicating possible slight organic pollution, which

is also similar to the rating achieved in 2009. It is likely that differences detected from year to year are due to variation in natural populations, as opposed to dramatic changes in the amount of organic pollution entering the stream.

Caddisflies, mayflies and midges were the dominant taxa at all four sites. The FBI was lower at Site 7 (Glovers Creek) because fewer midges and blackflies, which have a higher tolerance for organic pollution, were recovered from this location. The benthic macroinvertebrate data continue to indicate that Otter Creek does not suffer significant negative impact due to the runoff from the three drainage pipes.

References

Hilsenhoff. W.L. 1988. Rapid field assessment of organic pollution with a family-level biotic index. J. N. Am. Benthol. Soc. 7(1):65-68.

Klann, R. 2010. Otter Creek 2010 Water Quality Monitoring Report. Fayette Soil and Water Conservation District.

Klann, R. 2009. Otter Creek 2009 Water Quality Monitoring Report. Fayette Soil and Water Conservation District.

Table 1. Otter and Glover Creeks 2011 physical water quality data (mean with median, range and non-rain results below).

Location	Temperature	pH	Conductivity	Dissolved Oxygen	Turbidity	Suspended Solids	Flow
Site 1	15.2	7.5	480	8.8	129	72.28	24.4
	14.4	7.5	537	8.8	20	34.54	24.7
	12.1 - 19.1	7.3 - 7.7	242 - 659	7.7 - 10.1	9 - 824	14.20 - 280.00	10.9 - 38.5
Non-rain	12.1	7.5	659	10.1	17	42.75	10.9
Site 2	18.0	8.0	479	9.5	182	102.32	21.2
	19.8	7.9	414	9.4	134	72.00	14.2
	13.3 - 21.5	7.9 - 8.6	100 - 1219	7.9 - 10.7	14 - 445	6.75 - 320.00	5.2 - 66.3
Site 3	18.0	8.0	479	9.5	27	36.35	21.2
	19.8	7.9	414	9.4	12	4.6	14.2
	13.3 - 21.5	7.9 - 8.6	100 - 1219	7.9 - 10.7	5 - 107	3.40 - 174.00	5.2 - 66.3
Site 4	18.0	8.0	479	9.5	198	129.61	21.2
	19.8	7.9	414	9.4	138	89.00	14.2
	13.3 - 21.5	7.9 - 8.6	100 - 1219	7.9 - 10.7	20 - 435	17.50 - 370.00	5.2 - 66.3
Site 5	15.8	7.9	481	9.3	249	180.90	19.3
	16.2	7.7	495	8.8	158	137.50	15.2
	11.3 - 19.8	7.6 - 8.3	227 - 719	7.5 - 13.1	7 - 739	2.20 - 432.00	5.8 - 44.4
Non-rain	11.3	8.0	719	13.1	7	2.20	13.5
Site 6	16.5	8.1	565	9.4	393	333.45	26.1
	16.9	8.0	601	9.2	173	111.16	26.6
	11.7 - 21.1	7.7 - 8.8	258 - 810	7.6 - 12.3	9 - 1018	12.80 - 1230.00	10.8 - 39.2
Non-rain	11.9	8.8	810	12.3	12	29.50	14.3
Site 7	14.2	8.1	534	9.9	349	261.19	16.6
	12.4	8.1	615	10.2	36	58.00	13.2
	10.9 - 19.0	7.8 - 8.8	245 - 702	8.1 - 12.6	9 - 1680	4.25 - 114.00	5.2 - 33.9
Non-rain	10.9	8.8	702	12.6	11	4.25	13.2

Table 2. Otter and Glover Creeks 2011 chemical water quality data (mean with median, range and non-rain results below).

Location		Total Phosphorus	Total Nitrogen
Overall (15 samples)		1.04	9.5
		0.70	9.6
		0.26 - 2.76	5.4 - 12.8
	Non-rain	0.9	11.2
Site 1		0.81	3.5
		0.87	2.9
		0.20 - 1.29	0.9 - 7.3
Site 2		0.54	2.7
		0.36	1.6
		0.12 - 1.49	0.0 - 6.2
Site 3		0.77	3.8
		0.71	3.7
		0.00 - 1.47	1.3 - 7.8
Site 4		1.19	7.6
		1.04	7.4
		0.36 - 2.76	3.7 - 11.4
	Non-rain	0.56	8.9
Site 5		3.08	9.7
		2.55	9.0
		0.24 - 7.02	7.9 - 14.1
	Non-rain	1.19	8.3
Site 6		2.00	10.2
		0.57	9.9
		0.09 - 6.95	4.5 - 17.7
	Non-rain	0.57	10.3
Site 7			

Table 3. Otter and Glover Creeks 2011 chloride results.

Date	Site 1	Site 2	Site 3	Site 4	Site 5	Site 6	Site 7
5/25/11	*	*	*	*	*	*	*
6/15/11	<27	40	<27	47	<27	27	<27
7/11/11	<27	55	<27	47	79	47	<27
7/22/11	<27	55	<27	34	<27	<27	<27
7/28/11	<27	47	27	34	<27	40	<27
8/23/11	27	139	*	62	27	40	*
9/16/11**	<27	*	*	*	<27	<27	<27
9/26/11	<27	<27	<27	<27	<27	64	<27

**Non-rain results

Table 4. Otter and Glover Creeks 2011 fecal coliform analysis.

Date	Colonies/100 ml Site 1	Site 2	Site 3	Site 4	Site 5	Site 6	Site 7
5/25/11	20000	10000	5000	12000	23000	52000	99000
6/15/11	7510	3560	8090	5600	9110	1300	4250
7/11/11	3000	67000	78000	97000	30000	5000	2000
7/22/11	326000	141000	207000	88000	32000	409000	59000
7/28/11	63000	32000	17000	41000	123000	178000	161000
8/23/11	825000	704000	*	22000	55000	1608000	*
9/16/11**	2900	*	*	*	2100	3200	1300
9/26/11	77000	130000	57000	379000	31000	43000	413000
Mean	165551.25	155365.7143	62015	92085.71	38151.25	287437.5	105650
Median	41500	67000	37000	41000	30500	47500	59000
Minimum	2900	3560	5000	5600	2100	1300	1300
Maximum	825000	704000	207000	379000	123000	1608000	413000

**Non-rain results

Table 5. Otter and Glovers Creek 2011 Benthic Invertebrate Surveys										
		Location 1		Location 5		Location 6		Location 7		
	Location	May	Sept	May	Sept	May	Sept	May	Sept	
Taxonomy (Tolerance Value)	Common name									
Order Trichoptera	caddisflies									
Family Hydropsychidae (4)	common netspinners									
Hydropsyche	spotted sedge	59	38	117	98	67	63	16	15	
Family Leptoceridae (4)										
Ceraclea			4		4			1	4	
Order Ephemeroptera	mayflies									
Family Baetidae (4)	small minnow mayflies									
Baetis		10	15	51	22		24	35	28	
Family Heptageniidae (4)	flatheaded mayflies									
Stenacron	light cahill	11					3	1	1	
Family Ephemerellidae (4)										
Ephemerella		2		20				12		
Order Diptera	true flies									
Family Chironominidae (6)	midges	91	8	36	10	30	2	10	2	
Family Simulidae (6)	blackflies									
Simulium		2	5	10	15		6	1	2	
Family Tipulidae (3)	craneflies									
Tipula			4	4	16		1			
Family Empididae (6)										
Hemerodromia			1							
Order Coleoptera	beetles									
Family Elmidae (4)	riffle beetles									
Optioservus		6	8		13		4			
Order Amphipoda										
Family Gammaridae (4)	scuds									
Gammarus								2		

Table 5. Continued													
Other													
Planaria							2			3		2	16
Leeches				1									
Sampling	5/2/2011												
	9/6/2011												

Table 6. Otter and Glover Creeks 2011 comparison of sites based on benthic invertebrate sampling.

Site	1	5	6	7
Number of taxa	11	9	8	9
Total number of individuals	324	418	203	148
Family Biotic Index	4.65	4.29	4.38	4.23

Table 7. Evaluation of water quality based on FBI index (from Hilsenhoff, 1988).

Water Quality	FBI	Degree of Organic Pollution
Excellent	0.00-3.75	Organic pollution unlikely
Very good	3.76-4.25	Possible slight organic pollution
Good	4.26-5.00	Some organic pollution probable
Fair	5.01-5.75	Fairly substantial pollution likely
Fairly poor	5.76-6.50	Substantial pollution likely
Poor	6.51-7.25	Very substantial pollution likely
Very poor	7.26-10.0	Severe organic pollution likely