Abstract:

Four streams in the Lower Chippewa River Basin were studied in order to determine the link between the land use surrounding a stream and the stream's health and water quality. The testing included Flow, Volume, Phosphorus, Nitrogen, Dissolved Oxygen, and the Family Biotic Index. Of the four streams tested, one was in a mostly natural watershed, one was in a mostly urban watershed, and two were mostly agricultural watersheds. One site was tested on each stream. To ensure comparability, the sites were selected with the assistance of Ken Schreiber of the West Central Region of the WI-DNR. Results indicate that streams with natural watersheds have a higher water quality than streams with urban and agricultural watersheds do.

Introduction:

I wanted to do a project that involved both being outside and lab work. Since I've always been fascinated with streams and the creatures that live in them I decided to test the health of various streams in different watersheds, and find out how much affect on the stream the type of watershed has.

Streams are formed when rain fall runs downhill and accumulates. The total area of land that contributes to a stream is called its watershed. The depth and flow of a stream is determined by the amount of rainfall in a particular area. Streams run together to form rivers and these rivers run together to form even larger rivers. Streams provide water for humans and animals, a home for aquatic animals, and also aesthetic beauty.

Critical factors that affect stream quality are the flow rate, the types of creatures living in them, dissolved oxygen content, and the phosphorus and nitrogen levels. The flow rate is the rate at which the water is flowing, and it is important because it keeps the water from becoming stagnant, too warm, and it also helps to mix oxygen in with the water. The types, diversity, and number of creatures living in a stream are important because they help to indicate whether or not a stream is polluted. The dissolved oxygen content is important because aquatic animals, just like land animals, need to be able to breathe. Fish need 5-6 mg/L to survive (Campbell and Wildberger et al. 1992). Factors that affect the dissolved oxygen content are the temperature of the stream and the macrophytes (aquatic plants) in the stream. The colder the water is, the higher the DO content. The greater amount of macrophytes there are in a stream, the lower the DO content is, because they cause bacteria to grow, and the bacteria deplete the oxygen levels (Campbell and Wildberger et al. 1992). The amount of phosphorus and nitrogen in a stream are important because they can cause too many macrophytes to grow, and at very high levels, they can even be toxic.

Monitoring stream quality is important because by monitoring the quality of the water, we can determine if it is safe to drink, eat fish out of, and swim or wade in. If the water quality is poor, steps can be taken to improve the quality, or people can be informed that they shouldn't be using the water.

The streams chosen were: Beaver Creek at the 140th Ave. Bridge, which is in a natural setting, Otter Creek at the CTY AA bridge, which is in an urban setting, Fall Creek at the CTY J bridge, which is in an agricultural setting, and Bear's Grass Creek at the Lincoln Ave. bridge, which is also in an agricultural setting.

A natural setting, is a stream that is largely undisturbed by human activity. An urban setting is one in a town or city, with many roads and houses near it. A stream in an agricultural setting is one surrounded by farmland.

The streams were chosen based on their proximity to the Citizen Science Center. Ken Schreiber of the Western WI-DNR assisted me in picking comparable streams, and a major reason they are comparable is that they are all in the same watershed, the Lower Chippewa River Basin. Otter Creek and Beaver Creek are both third order streams. Bear's Grass Creek and Fall Creek are both second order streams.

The purpose of this study was to determine the affect of the general land use characteristics around a stream on the stream itself. I believed that the stream quality would be dramatically affected by the land use.

Methods and Materials:

Flow:

To find the flow rate of a stream, a string with markings every 6 inches was stretched across the stream and secured at both ends with stakes. Then the depth of the stream was measured and recorded every foot. The flow monitor was held at 60% below the surface, and the results were recorded at the same intervals as the depth. To calculate the total flow of the stream, the flow column was multiplied by the depth column, which gave the flow in feet/second cubed. To put this into meters, 35.5 was subtracted from this number.

Family Biotic Index:

To collect the macro invertebrates, a D frame net was dragged upstream across a gravelly stretch in each stream. The macro invertebrates were put in a bucket and taken back to the station, where they were put in a gridded pan with alcohol. 100 of them were selected randomly by starting at a random square and going lengthwise across the pan until 100 were collected. These 100 critters were put into a jar with alcohol to preserve them. They were then identified using a microscope and dichotomous keys, and assigned them numbers between 0 and 10 using the Family Biotic Index. To get the stream rating, an average of all 100 macro-invertebrate tolerance values was taken. The rating of a streams falls in between 0 and 10, with 0 being the absolute best and 10 being the worst. The samples used in this study were collected in October 2005.

Dissolved Oxygen:

To find the amount of dissolved oxygen in the water a YSI 55 DO meter was calibrated and then placed halfway down in a fast-moving part in each stream.

Phosphorus and Nitrogen:

To find the amount of phosphorus and nitrate nitrogen in the water, samples were taken from each stream in early November. They were then brought back to the lab, where a Hach DR/2000 Direct Reading Spectrophotometer was used to test them. The method used to test phosphorus was Phosphorus, Reactive, test number 536, method number 10011, test'n'tube procedure. One test was done with a blank for each stream to make sure the procedure was working properly, and then three tests were done on the water. The results from the samples were averaged for each stream. The method used to test the amount of nitrate nitrogen was the Nitrate MR test, cadmium reduction using powder pillows, method number 8171. Each of these tests includes a blank, so 3 were done on each stream and then averaged.

Results:

Stream Name	Setting	Flow Rate (m3/sec.)	FBI	DO (mg/L)	Phosphorus (mg/L P)	Nitrate (mg/L NO3)
Beaver Creek	Natural	0.057	1.85	12.06	0.073	0.55
Otter Creek	Urban	0.485	2.45	12.42	0.263	2.33
Bear's Grass Creek	Agricultural	0.080	1.74	12.2	0.303	2.58
Fall Creek	Agricultural	0.035	3.89	10.6	0.403	2.17

Table 1: The results of all the tests.

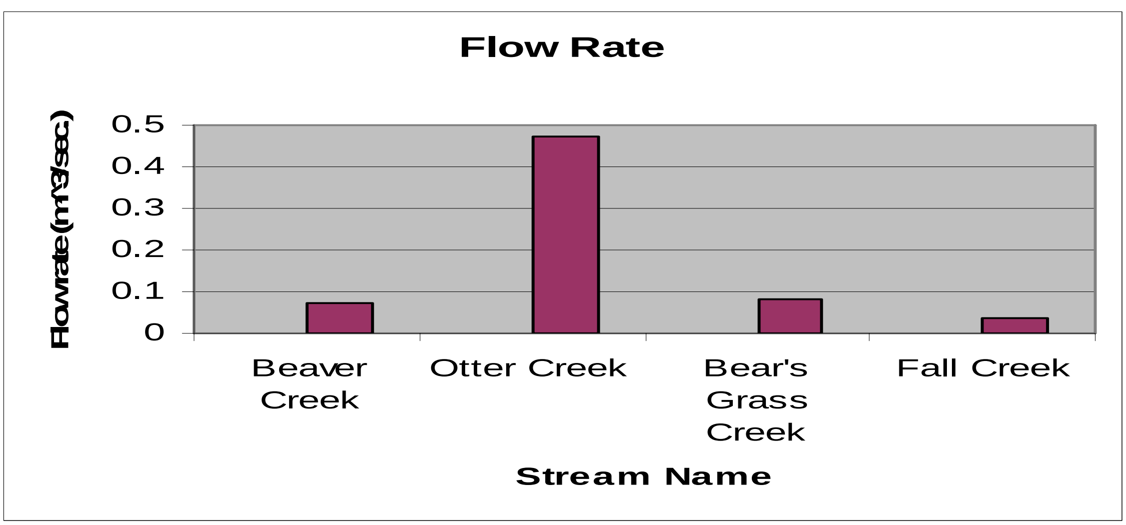


Figure 1: The flow rates of every stream.

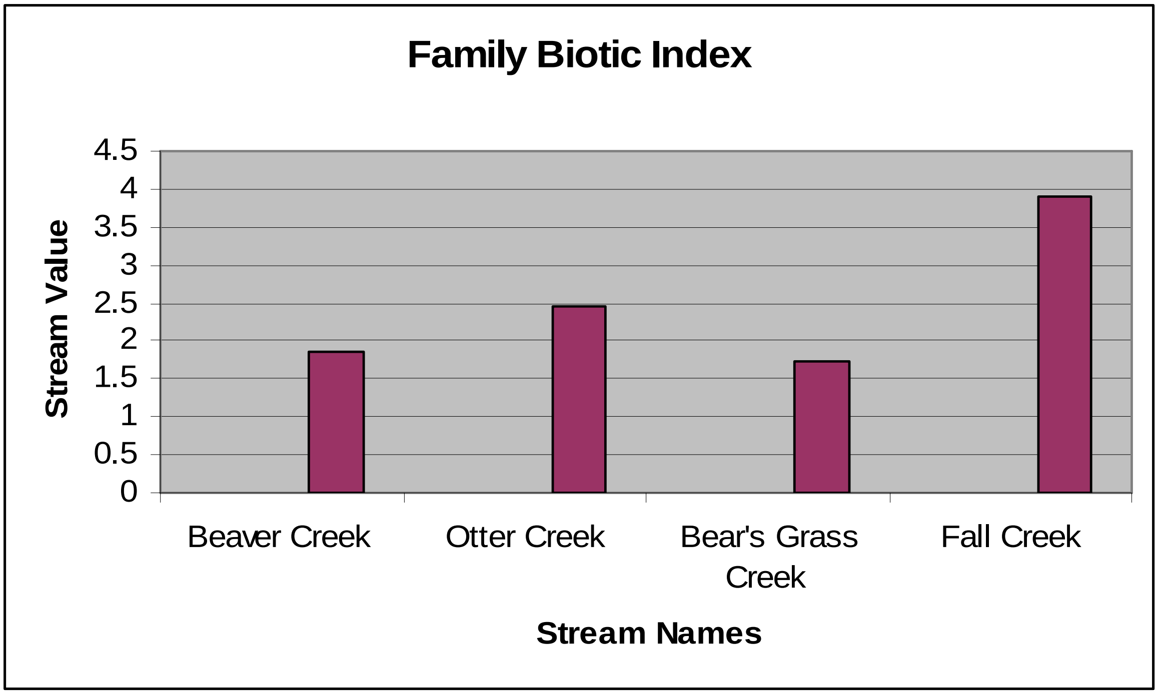
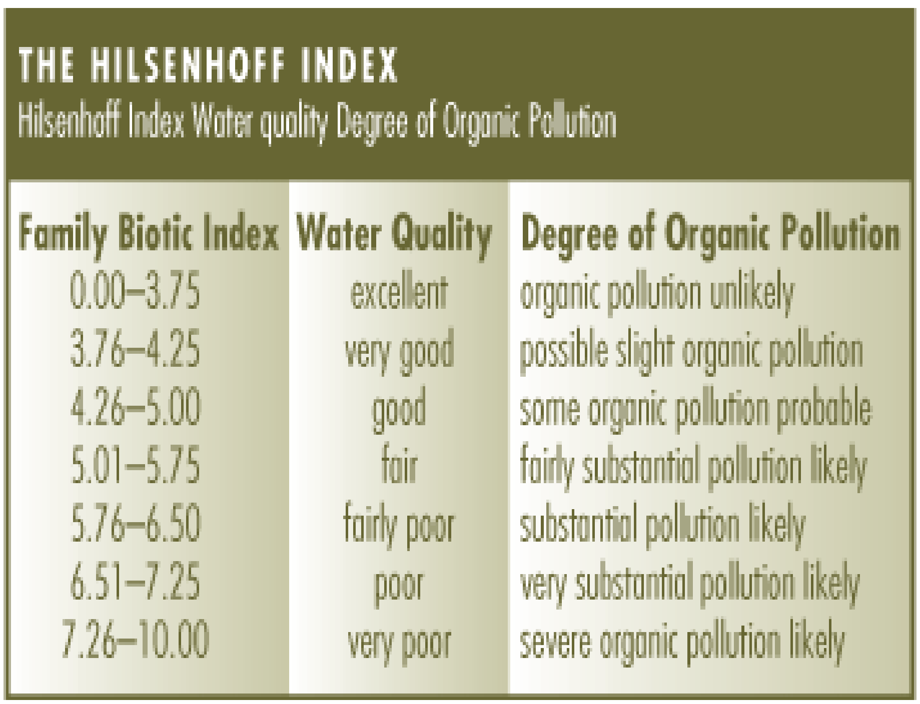


Figure 2: The results of the Family Biotic Index for every stream. The samples used in this study were collected in October.



THE HILSENHOFF INDEX

Hilsenhoff Index Water quality Degree of Organic Pollution

Family Biotic Index	Water Quality	Degree of Organic Pollution
0.00–3.75	excellent	organic pollution unlikely
3.76–4.25	very good	possible slight organic pollution
4.26–5.00	good	some organic pollution probable
5.01–5.75	fair	fairly substantial pollution likely
5.76–6.50	fairly poor	substantial pollution likely
6.51–7.25	poor	very substantial pollution likely
7.26–10.00	very poor	severe organic pollution likely

Table 2: The Hilsenhoff Index.

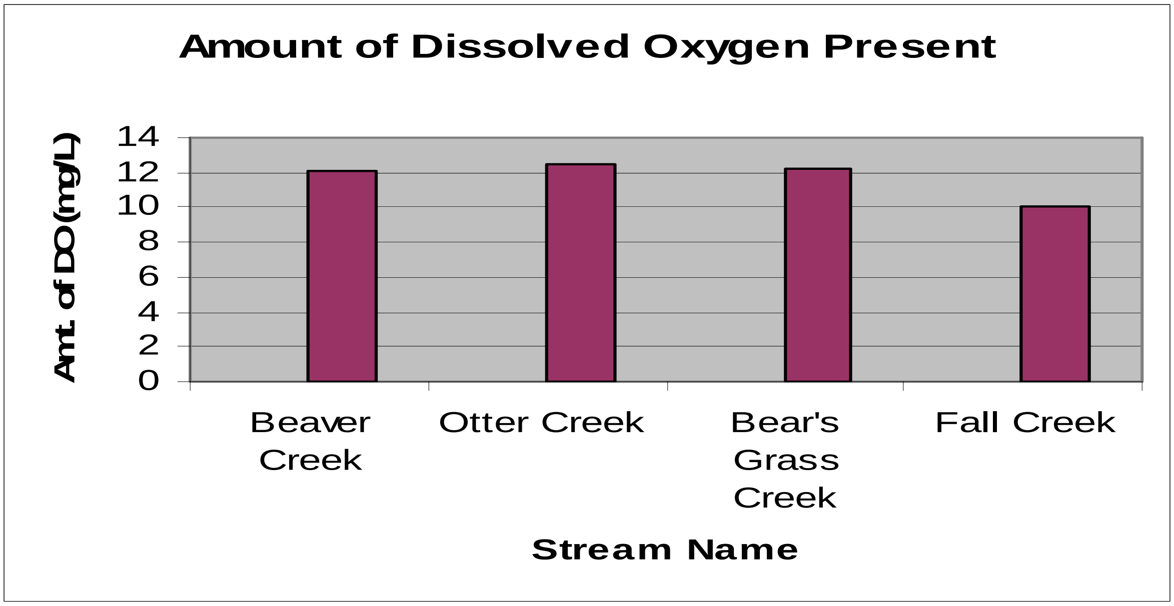


Figure 3: The amount of Dissolved Oxygen present in each stream. Beaver Creek, Fall Creek, and Bear's Grass Creek were tested for DO on the 23rd of November, and Otter Creek was tested on the 6th of December.

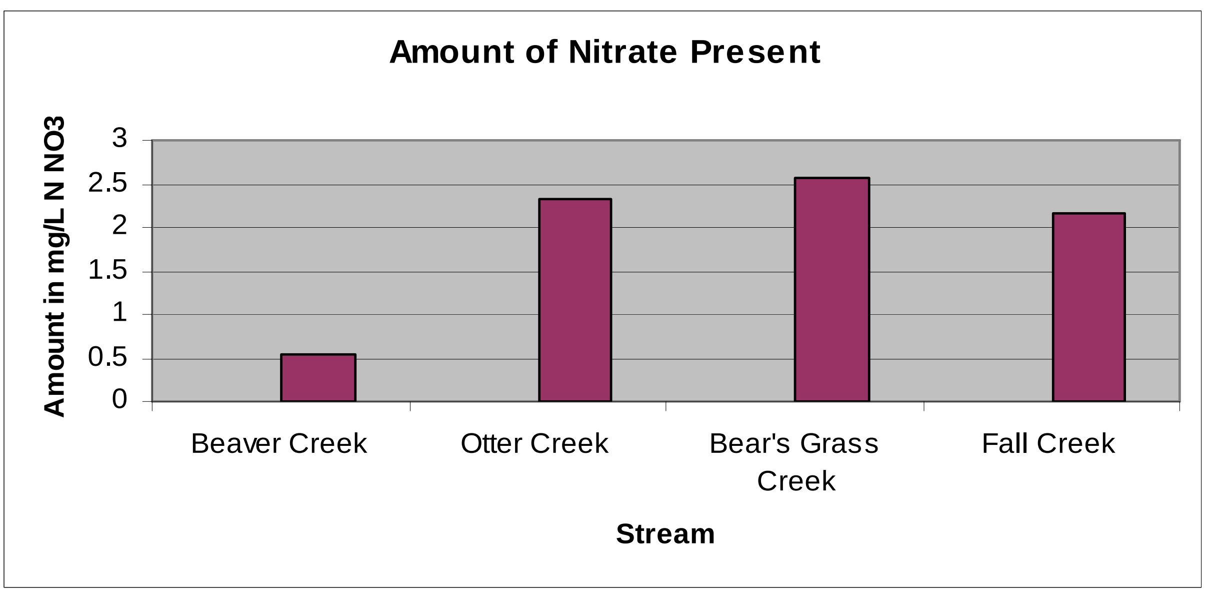


Figure 4: The amount of nitrogen present in each stream. The samples of Beaver Creek, Fall Creek, and Bear's Grass Creek were collected on the 23rd of November, and the sample for Otter Creek was collected on the 6th of December.

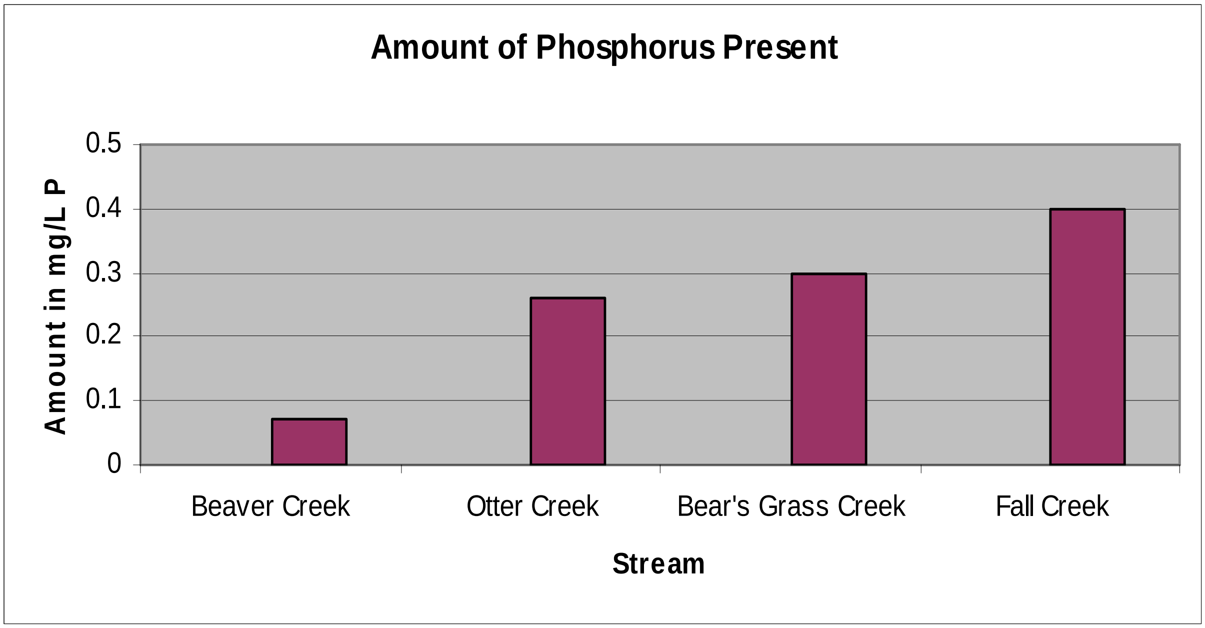


Figure 5: The amount of phosphorus present in each stream. The samples of Beaver Creek, Fall Creek, and Bear's Grass Creek were collected on the 23rd of November, and the sample of Otter Creek was collected on the 6th of December.

Discussion:

The flow rates of these streams are all good relative to their mean stream width and volume. Beaver Creek's mean stream width is 5.28 meters. Otter Creek's mean stream width is 11.33 meters. Bear's Grass Creek's mean stream width is 6.5 meters. Fall Creek's mean stream width is 4.18 meters. Because Otter Creek's mean stream width is so much larger than the other streams, its water should be flowing faster.

The FBI shows that Beaver Creek, Otter Creek, and Bear's Grass Creek have excellent quality because they scored between 0 and 3.75 and Fall Creek has very good quality because it scored between 3.76 and 4.25 (see figure 2 and table 2). These tests were conducted in October; to get comparable data and see if the streams have changed quality, the macro-invertebrates would have to be collected in October again, because in the spring or summer different results might be obtained.

The dissolved oxygen content (see figure 3) for all of these streams is excellent. When the DO is less than 5 mg/L, aquatic animals are put under stress. All of these streams had between 10.6 and 12.42 mg/L DO. This test was done in late November/ early December when the water was extremely cold, so to get comparable data the tests would have to be done in early winter. Because DO is partly dependent on the water temperature, the results might have been different in the summer, but for this study, the results of this test were excellent for all of the streams.

The acceptable quantity of nitrate nitrogen (see figure 4) in a stream is less than 10 mg/L, with under 2mg/L being ideal. All of these streams have less than 10 mg/L, but only Beaver Creek has less than 2 mg/L.

There is no accepted water quality standard for Phosphorus (see figure 5), but under 0.05 mg/L is considered good. All of these streams were under that amount, which means that phosphorus pollution is not causing excessive problems.

The results of this study indicate that streams in natural watersheds have a higher water quality than streams in urban and agricultural watersheds, but provide no conclusive evidence as to exactly how much the watershed affects the quality. There must be some other factors besides the surrounding land use that impact stream quality because if the land use were the only factor, Fall Creek and Bear's Grass Creek would have had more similar results. Some of these factors may be the size of the watershed and the actual land use percentages of each watershed.

One possible other major factor is riparian buffers, and how much they protect a stream from incoming pollution. A riparian buffer is made up of grasses, trees, and shrubs that surround a river or stream and it serves as a shield from pollution. The water quality of each stream could be affected by the amount of riparian buffer. Buffers could be the reason that Bear's Grass Creek and Fall Creek scored so differently despite the fact that they are surrounded by the same type of land use. Work with riparian buffers and how much they affect streams would be a good continuation of this study.

Acknowledgements:

Ken Schreiber for his help in picking the stream testing sites and for taking time out of his busy schedule to teach me how to test.

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I could not have done it without you, thanks for all of the support.

References:

Campbell, G. and Wildberger, S. 1992. The Monitor's Handbook. 36-39, 46-49