

A Comparison of Stream-Bottom Invertebrate Sampling Methods

An Honors Thesis (HONRS 499)

by

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A handwritten signature in black ink that reads "David C. LeBlanc". The signature is written in a cursive style and extends to the right with a long, sweeping underline.

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### ABSTRACT

Two methods of sampling stream-bottom invertebrates, surber sampling and D-net (or kick-and-net), were performed along a presumed water pollution gradient in the White River near Muncie, Indiana. The objective was to determine if the methods gave similar results. The surber sampling resulted in a larger total number of organisms per sample. However, the number of organisms obtained per unit time was similar for both methods. The site with the presumed greatest amount of pollution had the highest relative abundance of species indicative of pollution. The other two sites had greater numbers of species indicative of more pollution-free waters. Similar between site differences in indicator species abundances were found in results from the two sampling methods.

## INTRODUCTION

With the passage of the Clean Water Act in 1972, the Environmental Protection Agency mandated that the quality of water be monitored. Water quality monitoring is something that must be done on a regular basis to oversee the quality of our lakes, streams, and rivers.

There are a variety of ways that one can go about monitoring water quality. One of the simplest ways is by using aquatic invertebrates as indicators of pollution. "Pollution is essentially a biological phenomenon in that its primary effect is on living organisms," (Gaufin, 1973). The presence or absence of certain species of aquatic invertebrates yields a lot of information as to the quality of the water. However, one must be careful not to place too heavy an emphasis on the presence or absence of a single species at a given site. For instance, Gaufin (1973) found that species which occurred in polluted waters were also found in much smaller numbers in cleaner waters. Also, "several environmental factors, other than the presence of a pollutant, may affect or limit the distribution of certain species." These factors may include flooding, erosion, stream size, substrate type, flight range of the insect, current speed, water depth, and various other conditions. (Gaufin, 1973).

Exactly how to go about sampling these aquatic invertebrates is a very important issue to consider. There are a variety of methods one can use. The method chosen may be dependent on the amount of time one has to sample or the type of study being done. The objectives of this study were to compare two common methods of sampling stream-bottom invertebrates, surber and D-net (or kick-and-net), to determine if the two methods yield similar results, and to study invertebrate communities along an assumed pollution gradient.

## METHODS

### Sampling Sites:

Three sites on the White River chosen for this study were: (1) Burlington Street behind the Southern Baptist Church, up-stream of Muncie; (2) Nebo Road Bridge, immediately down-stream of Muncie; and (3) Yorktown, approximately 1.60 miles down-stream of Muncie. All three of these sites are considered to be runs since the water flow is moderate. Each of these sites was sampled twice, at the end of August, 1995 and the end of October, 1995, and the data for the two samples from each method were combined for each site.

The Burlington site is rather secluded. It has minimal shading due to trees. The river substrate is rocky, with both pebble-sized and large rocks. It also has many shells from dead clams and snails. The Nebo Road site is along a fairly heavily traveled road of Muncie. It not only receives the outflow from the waste water treatment plant immediately up-stream, but also pollution from human dumping of trash, tires, and other materials foreign to the river. The Nebo site, on the up stream side of the Nebo Road Bridge on Muncie's South West side, has a more sandy river bottom with fewer rocks. It is also covered with algae and clam and snail shells. This particular site is subject to all available sunlight as it has no large trees on either side of the banks for shading. The Yorktown site, located behind the Yorktown schools on Yorktown's East side, is secluded and partially shaded. The river bottom is fairly rocky with many larger rocks.

### Sampling Procedures:

A D-net was used in the kick-and-net sampling procedures. It has a flat bottom and a crescent-shaped top to its opening. The remainder of the net is made of canvas with the back being made up of the net to trap the organisms in. This entire apparatus is connected to a long, wooden handle.

The kick-and-net sampling method was carried out in the following manner:

-Standing in the river, holding the net on the down-stream side such that the water flows into it, the river sediment directly up-stream of the net was kicked and stirred up; the loosened invertebrates were swept into the net. This process was repeated for one minute moving up-stream in a straight line.

The net, which now contained the invertebrates, was inverted into a bucket, approximately three-fourths full of river water to rinse the invertebrates from the net. The contents of the bucket were stirred and quickly poured through a number 30 sieve, taking care not to pour off any of the larger matter that may have been kicked into the net. The bucket was partially filled again, and the process repeated four additional times. The invertebrates in the sieve were picked out and collected for ten minutes and placed in appropriately labeled vials filled with ethyl alcohol. They were counted and identified down to the family level using *Freshwater Macroinvertebrates of Northeastern North America* (Peckarsky, et al., 1993).

This entire process was repeated along another line in the river so that there were two kick-and-net samples collected at each particular site on each date.

A surber sampler has a one square foot open metal frame and a net that folds up from the frame to form a ninety degree angle. The surber sampler frame was placed on the river bottom with the net opening upright and facing up-stream such that organisms disturbed from the bottom would flow into the net.

The surber sampling method was carried out in the following manner:

-The large rocks contained within the one square foot of the sampler frame on the river bottom were washed and scrubbed to release any invertebrates which may have been attached to them. The remaining river bottom was agitated in order to stir up any invertebrates in the stream bottom and wash them into the net. This process was repeated three additional times, five paces apart, moving up-stream.

The invertebrates were removed from the sampler net in the same manner as the kick-and-net method. However, the sample was picked until all organisms were removed. This entire process was repeated at another line in the river such that there were two surber samples from each of the three sites. All invertebrates collected were then placed in appropriately labeled vials with alcohol and identified and counted in the same manner as the kick-and-net samples.

A pairwise community similarity ( $C = \sum \text{MIN}(\text{Relative Abundance}_{x,1}, \text{Relative Abundance}_{x,2})$ ) analysis was calculated to compare the over-all community composition between samples. The relative abundance of indicator species was also computed. Species richness and species diversity (Shannon-Wiener Diversity Index =  $H' = -1.4427 \times \sum (p_j \times \ln p_j)$ ) were calculated as well.

## RESULTS

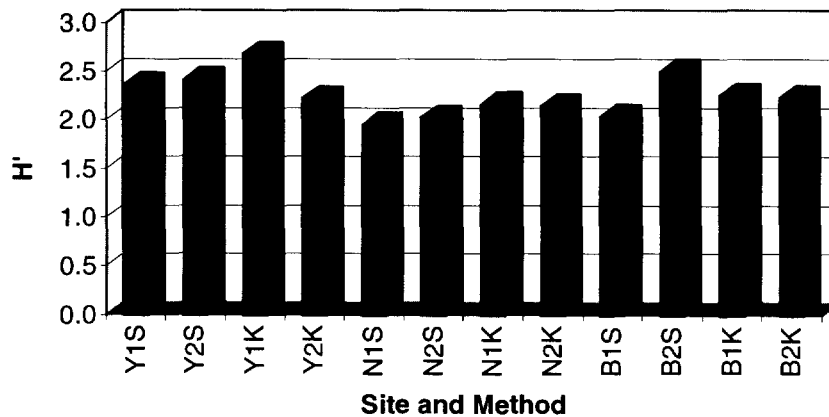
The species richness (the number of different taxa) was generally about the same for all sites and all methods (Table 1).

**Table 1. Species Richness**

Sampling Site and Method	Species
Yorktown Surber One (Y1S)	7
Yorktown Surber Two (Y2S)	7
Yorktown Kick One (Y1K)	7
Yorktown Kick Two (Y2K)	6
Nebo Surber One (N1S)	7
Nebo Surber Two (N2S)	6
Nebo Kick One (N1K)	5
Nebo Kick Two (N2K)	6
Burlington Surber One (B1S)	6
Burlington Surber Two (B2S)	10
Burlington Kick One (B1K)	6
Burlington Kick Two (B2K)	6

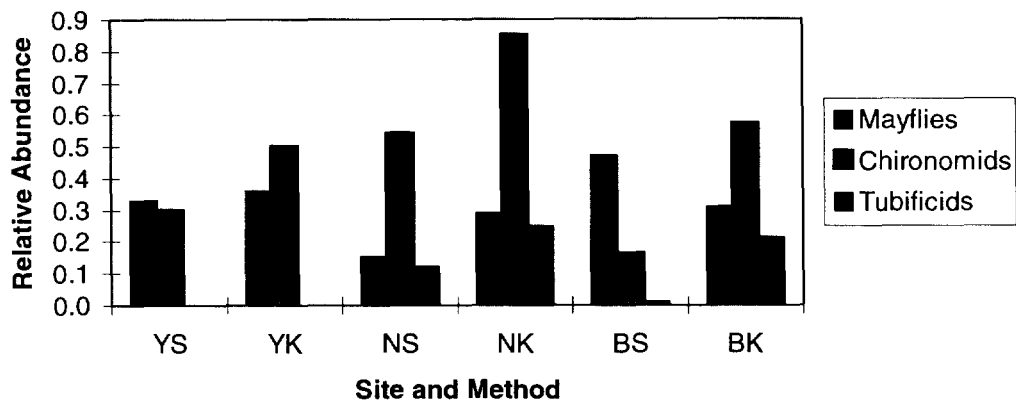
Overall, the species diversity ( $H'$ ) was about the same for both sampling methods (Figure 1). The species diversity was similar for both the Burlington and Yorktown sites and slightly lower at the Nebo Street site.

**Figure 1. Species Diversity**



The relative abundance of three indicator taxa, epemeroptera (mayflies), chironomidae (chironomids) and tubificidae (tubificids), can be seen in Figure 2. The relative abundance of chironomids and tubificids (pollution indicator species) was highest at the presumed most polluted site, Nebo Road Bridge. The relative abundance of the mayflies (a clean water species) was highest at Burlington, the presumed least polluted site.

**Figure 2. Relative Abundance of Indicator Species**



In Table 2, the mean similarity between samples collected by the same method and mean similarity between samples collected by different methods is shown. These pairwise similarity values are very similar regardless of whether the samples were collected by the same methods or not.

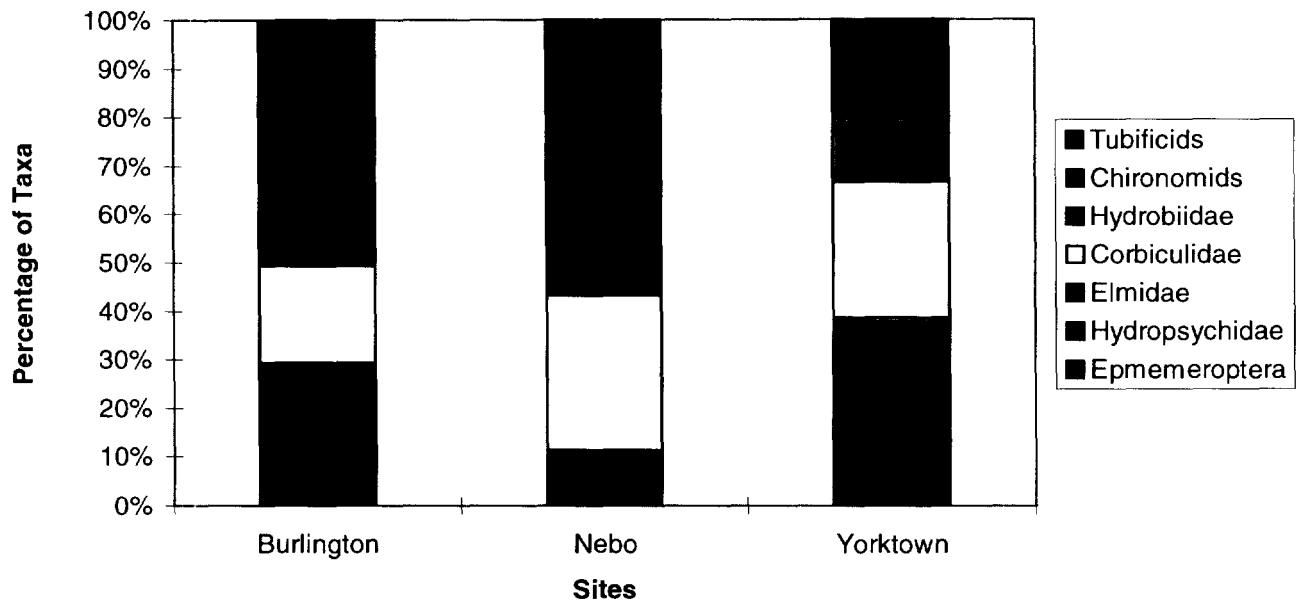
**Table 2. Average Between Sample Similarities**

Sample Collected By:	Number of Pairwise Comparisons	Mean Similarity	Range (Min-Max)
Same Method	6	0.668	0.59-0.79
Different Method	12	0.658	0.51-0.77

The relative abundance of clean-water indicator species is greater at Burlington and Yorktown than at the Nebo Street site. The relative abundance of the pollution indicator species, chironomids and tubificids, was highest at the presumed most polluted site, Nebo Street (Figure 3). The Chi-square value indicates that the differences in relative abundances of the various taxa between the three sites are unlikely to be due to random variability alone, i.e., these differences are real.

**Figure 3. Comparison of Sites**

$$\chi^2 = 97.72 \quad p < 0.0005 \quad n = 695$$

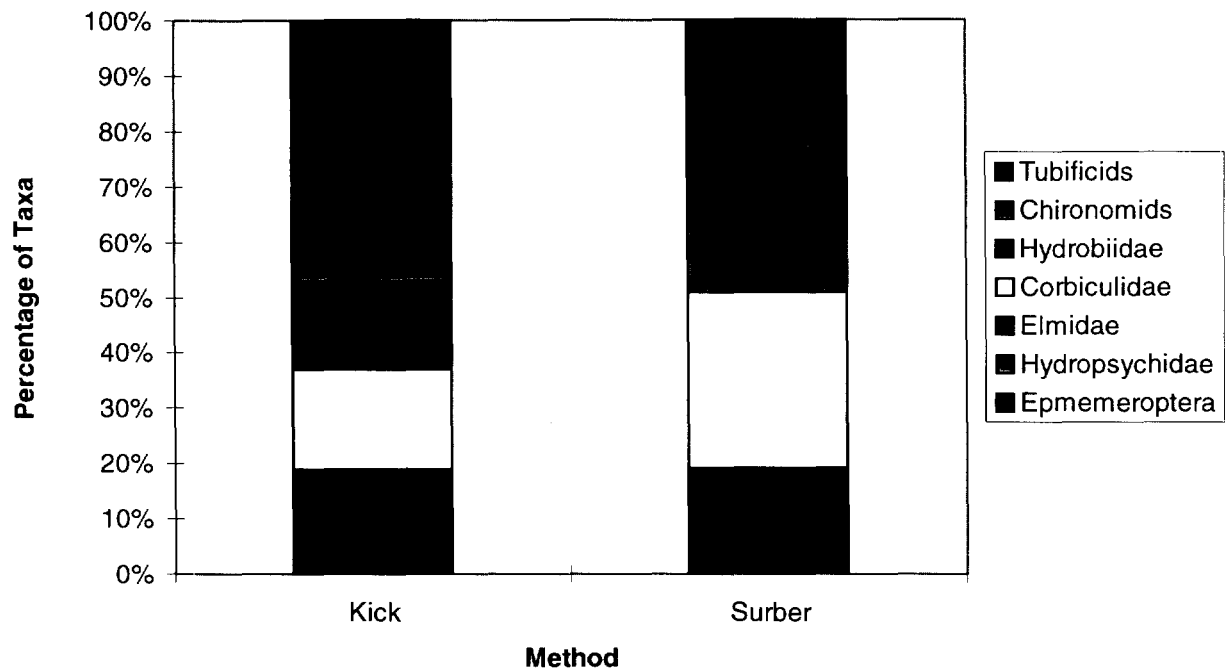


In figure 4, the comparison of the two methods can be observed. The proportion of taxa do vary between the two methods. The Chi-square value indicates that these differences are statistically significant. Clams and snails are underrepresented in the kick-and-net method. The

percentage of some taxa are greater with the kick-and-net method because the clams and snails are underrepresented consequently increasing the percentage of other taxa, especially the chironomids and tubificids.

**Figure 4. Comparison of Methods**

$$\chi^2 = 46.84 \quad p < 0.0005 \quad n = 695$$



## DISCUSSION

Certain taxa can be used as biological indicators of clean or polluted aquatic environments. Chironomids and tubificids are common pollution indicator species. These species are good pollution indicator species because they are able to obtain oxygen in low-oxygen environments. Chironomids have a special hemoglobin that gives them this capability. Both species also feed on organic matter which is often abundant in polluted water (Hart, 1974). Mayflies are common clean water species because they are gill-breathing insects. These insects

are greatly affected by very low dissolved oxygen concentrations typical of polluted aquatic environments and are commonly found only in cleaner waters because of this (Gaufin, 1973).

Somewhat lower species diversity and lower relative abundances of mayflies and high relative abundances of chironomids and tubificids all are indicative of degraded water quality at the Nebo Street site. According to Kaesler, et al, "the general effect of pollution seems to be a reduction in species number with the most tolerant forms surviving" (1978). The Indiana Department of Environmental Management's 305 (b) (1992-93) report indicates that there is little urban pollution occurring up-stream of Muncie. Most of the pollution that does occur is due to agricultural run-off. Therefore, Nebo may be impacted by both urban pollution and the waste water treatment plant immediately up-stream. However, the change in community composition may also be due in part to the less-rocky, more sandy bottom conditions at Nebo Street.

Burlington Street was assumed to be the least polluted site because of its location up-stream of Muncie. Yorktown was assumed to be more polluted than Burlington but less polluted than Nebo due to dilution and degradation of the pollution as it is about two miles further down-stream from Muncie.

The difference in relative abundances of clams and snails in samples obtained by the kick-and-net method versus the surber sampler is likely due to both the method and the organisms. Clams and snails are heavy organisms because of their shells. Therefore, these species are less likely to float. The kick-and-net method is more likely to collect organisms that float well. However, with the surber sampler, the river substrate is more thoroughly stirred up with the hands, and large rocks and debris are also scrubbed. Therefore, it is more likely to obtain clams and snails with the surber sampler than with the kick-and-net method.

## CONCLUSIONS

From the data compiled in this study, we conclude that the results obtained from the two methods of sampling do differ significantly. However, when comparing the number of organisms obtained per unit time, the results from both methods are similar. The surber sampling results in approximately three times as many organisms as the D-net sampling but takes about three times as long to perform.

From the use of the indicator species collected, we can conclude that there is pollution occurring along the gradient as expected. The Nebo Street site was most heavily impacted by pollution. However, since cleaner water species were also found at the presumed most polluted site and the species richness and diversity were about the same for all sites, it would have to be concluded that the severity of the pollution is moderate.

## REFERENCES

- Gaufin, A. R. 1973. "Use of Aquatic Invertebrates in the Assessment of Water Quality." *Biological Methods for the Assessment of Water Quality*, ASTM STP 528: 96-116.
- Hart, C. W. and S. L. H. Fuller (eds.). 1974. *Pollution Ecology of Freshwater Invertebrates*. New York: Academic Press.
- Indiana Department of Environmental Management. Indiana 305 (b) Report, 1992-93.
- Kaesler, R. L., E. E. Herricks, and J. S. Crossman. 1978. "Use of Indices of Diversity and Hierarchical Diversity in Stream Surveys." *Biological Data in Water Pollution Assessment; Quantitative and Statistical Analyses*, ASTM STP 652: 92-111.
- Peckarsky, Barbara L., Pierre R. Fraissinet, Marjory A. Penton, and Don J. Conklin, Jr. 1993. *Freshwater Macroinvertebrates of Northeastern North America*. Ithaca: Cornell University Press.

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