Population Dynamics of Freshwater Invertebrates in Beltrami County

Amanda Johnson
Aquatic Biology
Bemidji State University

Freshwater invertebrates are an integral part of lake and stream ecosystems. Identifying the type, density and diversity of invertebrates is important in understanding the dynamics of a body of water. By calculating a Family Biotic Index it is possible to determine water quality. This study illustrated the invertebrate population density and diversity in the years 2006 and 2007 in Beltrami County. Field collections were made by Bemidji State University students in the fall semesters of 2006 and 2007. Results, on average, showed a change in the number of specimens for many of the major phyla in 2007 compared to a similar collecting period in 2006. Higher temperatures and lower precipitation may play a role in accounting for these differences. These data suggest that populations of invertebrates vary from year to year in both species density and diversity.

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INTRODUCTION

Freshwater ecosystems comprise a number of habitats that provide habitats for a myriad of species of organisms including macroinvertebrates. Freshwater macroinvertebrates are organisms that live in freshwater, do not contain an internal skeleton and are large enough to be seen by the unaided eye (Voshell 2002). They are increasingly being found to play an important role in ecosystems and the complex food webs within ecosystems and have been found in every part of a body of water they inhabit. The distribution of freshwater invertebrates is influenced by interactions among physical, chemical, and biological characteristics (Thorp and Covich 2001) and although the chemical and biological aspects are important, it is the effect of a change in the physical characteristics that will be the focus of this study. Invertebrates living in lotic environments have three main physical factors that their survival depends on: temperature, current, and for the overwhelming majority, proper substrate (Allan 1995).

Information gained from the studies of freshwater invertebrates has been used in sport-fishery related investigations and for answering questions related to population dynamics, predator-prey interactions, physiological and trophic ecology (Merritt and Cummins 1996). These studies also have proven to be a useful tool for the management of certain species of aquatic insects that are considered "pests" to humans (Merritt and Cummins 1996). Locally, the popularity and economic impact of fishing in Northern Minnesota drives the need for researchers and aquatic biologists to understand freshwater invertebrates, as they are the main food source of many fishes.

Perhaps more important to the scientific community is the use of aquatic macroinvertebrates as indicators of water quality. Like all aquatic organisms, freshwater invertebrates must depend on the water around them to supply much needed oxygen, and the amount of oxygen in a body of water often depends on the trophic status of a lake or river. Pollutants and chemicals can often tie-up oxygen and drive down the health of a system. In waters where dissolved oxygen (DO) is low, only organisms that have low DO requirements or special adaptations will survive (Gaufin and Tarzwell 1952). Insects such as mosquitoes, rattail maggots and aquatic beetles have adaptations that allow them to thrive and even increase population sizes in the presence of low DO (Gaufin and Tarzwell 1952). The use of living organisms to assess water quality is a century-old approach, but has become more recently widespread

in North America and the United Kingdom (Hauer and Lamberti 1996). A Family Biotic Index (FBI) is one method of many that can be used to determine water quality and is based on the tolerance levels of aquatic insects. It is beneficial in that it can give an indication of past conditions as well as current conditions unlike a physiochemical approach that can only give only a "snapshot" of water quality conditions (Hauer and Lamberti 1996).

Temperature and water current also contribute to water quality and, in regards to this study, dispersal and density of freshwater invertebrates. Therefore, the following was conducted to: 1) demonstrate how invertebrate populations vary from year to year, 2) show how differing water levels and temperature may correlate with the diversity and density, 3) provide an inventory of invertebrates in Beltrami County and 4) calculate an FBI and assess the water quality of local bodies of water in Beltrami County.

METHODS

Field Work

All field samplings occurred between September and October of 2006 and 2007. Some freshwater invertebrates were collected using benthic and planktonic sampling nets. Specimens were also manually removed from the substrate and all specimens were preserved in ~50% ETOH. Winged insects, whose life cycle includes an aquatic stage, were caught using terrestrial nets and were immediately immobilized by a fumigant. The invertebrates collected were then taxonomically keyed by students using dichotomous keys.

Site Description

The primary locations of collection included the Mississippi and Turtle Rivers and Lake Bemidji in Beltrami County, Minnesota (Fig. 1).

Figure 1

Beltrami County, Minnesota.

It is worthy to note, however, that students were not limited to these two sites and as a result, some specimens collected originated outside of Beltrami County and in bodies of water other than the aforementioned. For the purposes of this study the Mississippi and Turtle Rivers and Lake Bemidji of Beltrami County will be the only sites considered.

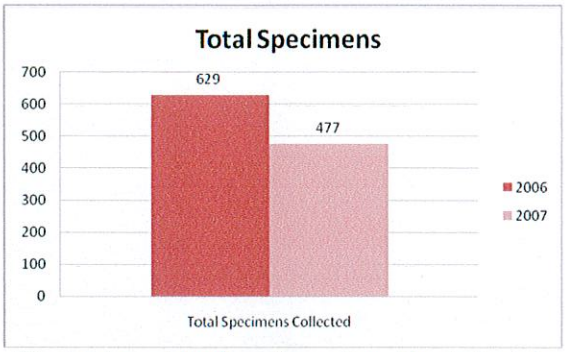
Data Acquisition

Twenty three Bemidji State University students (13 in 2006 and 10 in 2007) were required to complete an invertebrate collection for the course BIOL 3200: Freshwater Invertebrates. The collections were required to contain a minimum of fifty specimens that were organized according to the traditional classification scheme.

RESULTS

The total number of collections turned in by students was not the same for the years 2006 and 2007. In 2006, 13 collections were handed in, while in 2007 there were only 10 (Fig.2).

Figure 2.

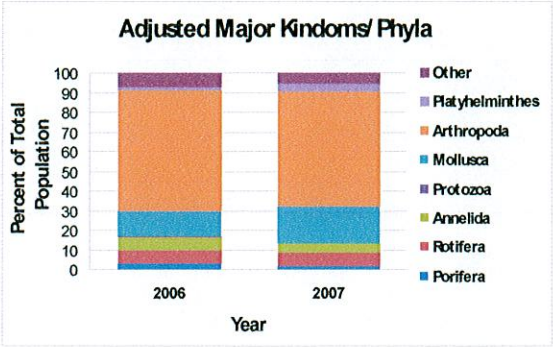


The total number of specimens found by students in 2006 and 2007.

The difference in total specimens collected was accounted for by finding the percentage of the total for each taxonomic grouping.

In both years the arthropods and mollusks were the most prevalent groups of invertebrates. In 2006, Arthropods accounted for 61% and Mollusca 13% of the total specimens while in 2007, Arthropods accounted for 58% and Mollusca 18% of the total specimens (Fig. 3).

Figure 3.

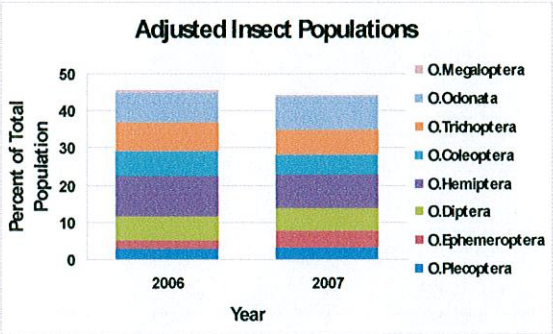


The adjusted differences in major kingoms and phylums. Phylum Arthropoda accounted for the majority of the invertebrate population.

Several other groups were prominent such as the Porifera, Annelida, Rotifera and Platyhelminthes, and together accounted for nearly 18% of the total specimens in both 2006 and 2007 (Fig.3). Only 2% of the specimens collected in 2006 were Nematoda and Tardigrada, but in 2007, neither of these taxonomic groups was collected.

On average, many of the orders of insects collected in 2007 represented a similar or smaller percentage of the total than those collected in 2006. The largest difference was found in the order Ephemeroptera. In 2006, only 2% of the specimens collected were Ephemeroptera, whereas in 2007 over 4% were Ephermeroptera (Fig. 4).

Figure 4.



The adjusted differences in the orders of insects. Many illustrated similar population numbers between years.

Insects from the order Hemiptera accounted for the highest percentage of total specimens in 2006 (11%) whereas insects from the order Odonata accounted for the highest percentage in 2007 (9%) (Fig. 4). Insects from the order Megaloptera accounted for the lowest percentage of total specimens for both 2006 (0.64%) and 2007 (0.21%) (Fig 4). Also worth noting were the aquatic Arachnida found. In 2006, 3% of the total specimens were Arachnida and in 2007, only 0.62%.

Several individual species stood out by being abundant one year and absent the next. Several of the flatworms *Triaenophorus crassus* and *Uvulifer ambloplites* were collected in 2007, but not in 2006. The rotifer *Asplanchna sp.* was found only in 2007, while *Trichocerca multicrinis* and *Polyarthra remata* were found only in 2006. It was only in 2006 that the crustacean *Gammarus* (commonly known as a side-swimmer, or scud) was documented and only in 2007 that *Orconectes virilis* (a species of crayfish) and *Bythotrephes cederstroemi* (commonly known as the spiny water flea) were found.

Precipitation and temperature data were obtained from The Old Farmers Almanac and from volunteer observers with the Soil and Water Conservation District (SWCD). It showed that nearly 12 inches of precipitation was recorded for the 2006 growing season and only 16 inches was recorded for the 2007 growing season (Table 5).

Table 5.

Total Precipitation (Inches)

	2006	2007
May	2.70	2.71
June	2.73	4.68
July	2.20	2.87
August	0.68	0.77
September	3.89	4.96
Total	12.20	15.99

The SWCD defines the growing season as the months of May through September. The month of June 2007 received nearly double the amount of precipitation as June 2006. The mean temperatures for the growing season were very similar to each other if not exactly the same, as in September (Table 6).

Table 6.

Mean Temperature (◦F)

	2006	2007
May	56	57
June	65	66
July	73	71
August	68	65
September	56	56

In 2006, the FBI was found to be 4.69 and in 2007, it was found to be 4.43. According to a scale developed for Wisconsin, these scores earn the

sampling sites a water quality rating of "good" (Table 7).

Table 7.

Water Quality Based on Family Biotic Index Values

Family Biotic Index	Water Quality
0.00-3.75	Excellent
3.76-4.25	Very Good
4.26-5.00	Good
5.01-5.75	Fair
5.76-6.50	Fairly Poor
6.51-7.25	Poor
7.26-10.00	Very Poor

Note: From Hauer and Lamberti (1996)

DISCUSSION

The results of this study show that variation among invertebrates occurs from one year to the next. There were no instances in which the number of invertebrates in a given group was exactly the same in 2006 as in 2007 even though many were very similar. The Arthropoda and the Mollusca were found in abundance and were the most common types of macroinvertebrates found in the area. The larger size and quantity of these two groups may have made it easier for students to see structures on the organisms and probably helped them identify the taxonomic group it belonged to. In the case of the Nematoda and the Tardigrada, several were found in 2006, but despite efforts made searching for them in 2007, there were none found.

Precipitation and temperature may not have played as big of a role as first suspected. The temperatures during the summer months were very similar in both years and no one month had particularly extreme temperatures as compared to other months. The same applies for the precipitation as well. Although 2007 received nearly 4 more inches of precipitation, it probably was not enough to cause any major population differences in invertebrates.

The water quality was found to be in good condition in both 2006 and 2007 based on the FBI scores. The scores also illustrate that, although the water is not of the best possible quality, it is above average. Based on the presence of many families of invertebrates intolerant of harsh conditions, it is evident that pollution is not an overwhelming problem in area lakes and rivers.

There were several problems with the data that could have caused potential error. The primary issue is that although several field trips were made to the Turtle River, Mississippi River and Lake Bemidji, students were not restricted to these sites. Several students took this opportunity to collect from other areas around the state and although exact origins are not known, it is unlikely that any specimens were collected outside of the state. Having data such as this in a study has the potential to cause a misrepresentation of the invertebrate populations in Beltrami County. However, because the overwhelming majority of specimens were collected within the county, the data are considered to be well representative of the county's populations. Future studies might do well to document the origins of all specimens and to only include those collected within the county. Also, the measurement of water temperatures and oxygen levels of the bodies of water might help explain the presence of different types of invertebrates.

LITERATURE CITED

Allan, J.D. 1995. Stream ecology: structure and function of running waters. Kluwer Academic Publishers. p45.

Gaufin, A.R. and C.M. Tarzwell. 1952. Aquatic invertebrates as indicators of stream pollution. Public Health Reports 67:57-64.

Hauer, F.R. and G.A. Lamberti. 1996. Methods in stream ecology. San Diego: Acedemic Press. p. 647-65.

Merritt, R.W. and K.W. Cummins. 1996. An introduction to the aquatic insects of North America. 3rd ed. Dubuque: Kendall/Hunt Publishing Company. p1.

Thorp, J. and A. Covich. 2001. Ecology and classification of North American freshwater invertebrates. 2nd ed. San Diego: Academic Press. p19.

Voshell, J.R. 2002. A guide to common freshwater invertebrates of North America. Blacksburg: McDonald & Woodward Publisher. p9.