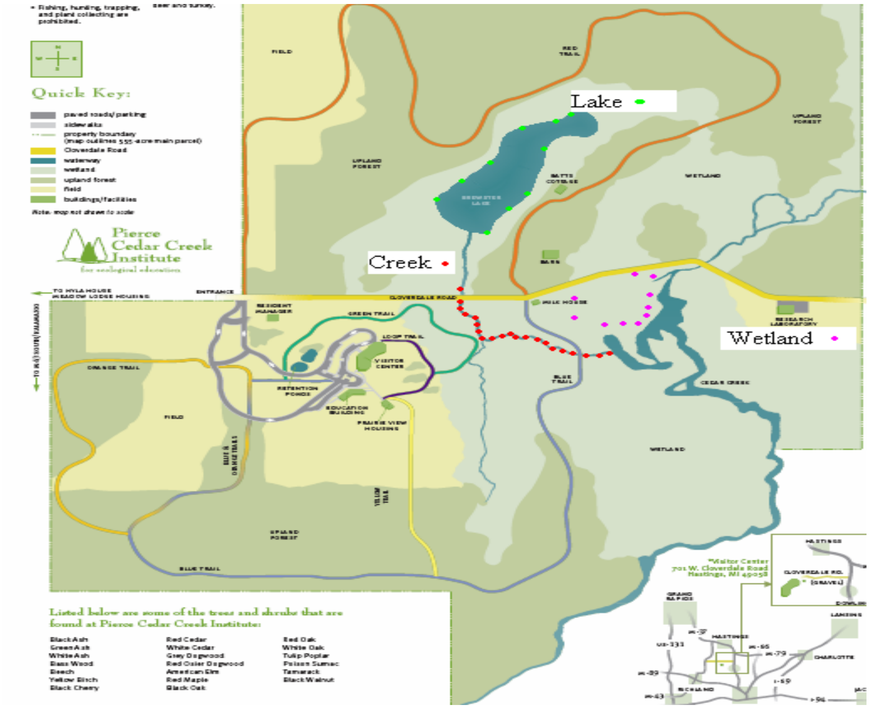
A Survey of Macroinvertebrates of the Lentic and Lotic Ecosystems of Pierce Cedar Creek Institute

by David Baylis and Lareina Van Strien and Dr. Robb Bajema

Aquinas College

Introduction: The purpose of this project was to survey and record the abundance and diversity of macroinvertebrates of the Pierce Cedar Creek Institute's three main water habitats, steam, wetland and lake. The influence of abiotic factors on aquatic insects was also examined.

Methods: Forty-one sites were established to collect organisms and data. These sites started at the wetlands and were spaced twenty meters apart. Twenty sites were selected downstream of Cloverdale road, one site was upstream of the road. An additional ten sites were selected in the wetland area just east of the creek. Each site was chosen based on availability of water. Ten sites were chosen on Brewster Lake. These sites were based on suitable habitat such as shallow water and substrate. Each site was marked with biodegradable bamboo stakes and tape (Fig. 1).



Data collection started on May 16th and concluded July 18th. Within the wetland and lake area one square meter was marked and substrate was collected from that area using a dip net. The sample was then taken back to the lab and sorted by hand. Identification of taxonomic family was made using various keys and texts (see References). The classification and abundance of each organism was recorded. General weather conditions, air temperature, water temperature and pH were recorded for each site. Dissolved oxygen was recorded for the creek sites and lake sites using the Milwaukee 600 model. The creek samples were collected using a kick net, the kick net was held down stream and then substrate was kicked up from a one meter square area. Sediment samples were collected from only the creek sites, taken back to the lab and dried. Each sample was then weighed and sorted for percent clay, silt and sand using standardized sieves.

Statistics were performed using Microsoft Excel using an f-alpha level of .05. Linear regression analysis was performed on several of the relationships, including water temperature, air temperature, pH, DO and sediment compared to abundance and diversity.

Results

Statistical Analysis – Regression Models

The data tables used in these regression formulas can be found in the appendix at the end of the paper. A two variable regression was chosen to compare the number of families and the number of organisms to pH, air temperature, water temperature, DO, and sediment composition (as determined by Alpha level below .05). Regression tests were done, using Excel, comparing the number of organisms and the number of families to each factor in the lake, stream, wetland and total tables. As the names indicate, the tables were organized by test sites. The total table was a compilation of data from the other three tables. After each regression test was completed, nine individual regression tests had F values that were less than 0.05, indicating significance (see below). The corresponding negative or positive correlation of each test was made apparent by the slope of the linear trend-line which was added to the graph.

Significant F Test Graphs.

Figure 1 below compares the total number of families at twenty one stream sites with the air temperature reading at each site. From this graph we can see that there is a negative correlation between air temperature and number of families. The number of families, or the diversity, goes up as air temperature drops. We can also see a similar trend in the stream sites between the number of individual organisms and air temperature as evidenced by Figure 2 below.   The number of organisms, or abundance, increases as air temperature decreases. The final stream graph in Figure 3 also indicates a negative correlation between the number of organisms and water temperature. The stream sites

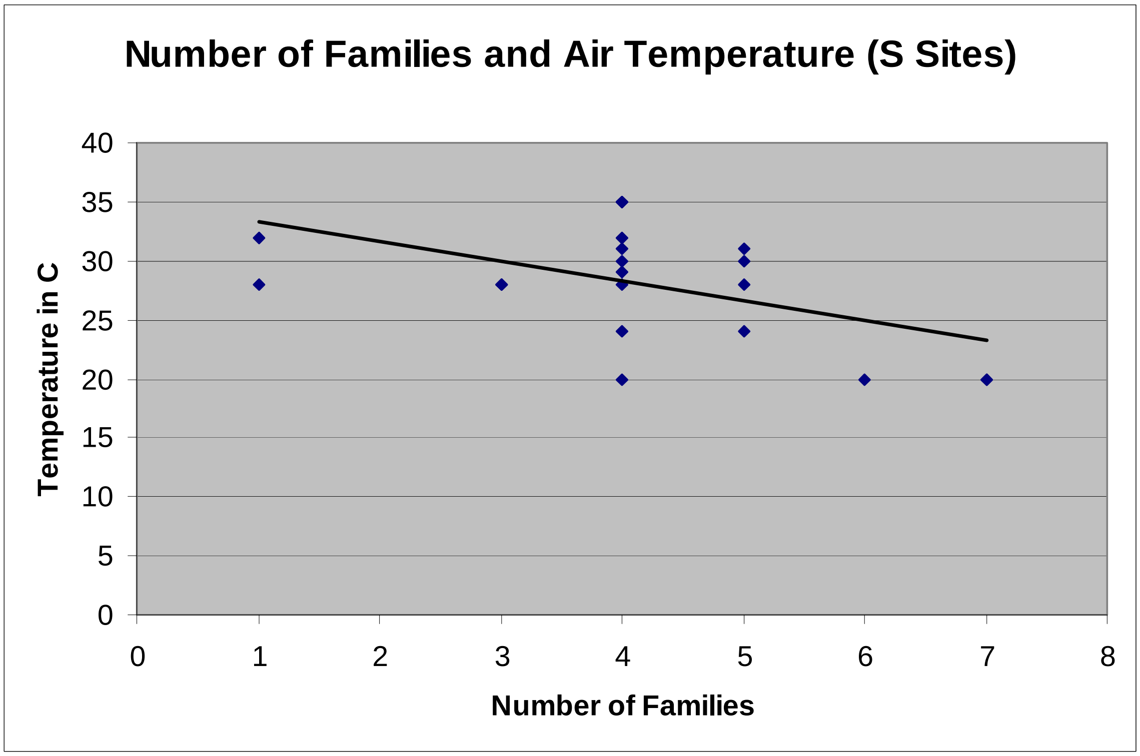


Figure 1 – Significance = 0.020488928

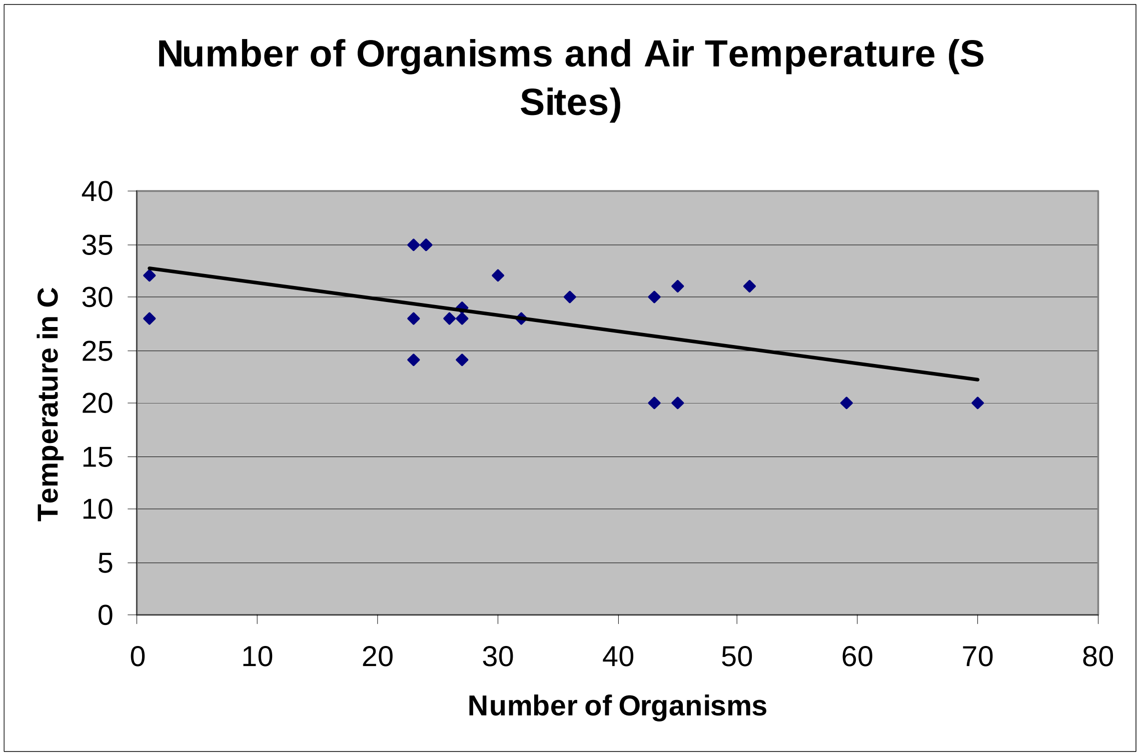


Figure 2 – Significance = 0.01839186

were the only sites as an individual group that indicated any significant relationship between factors.

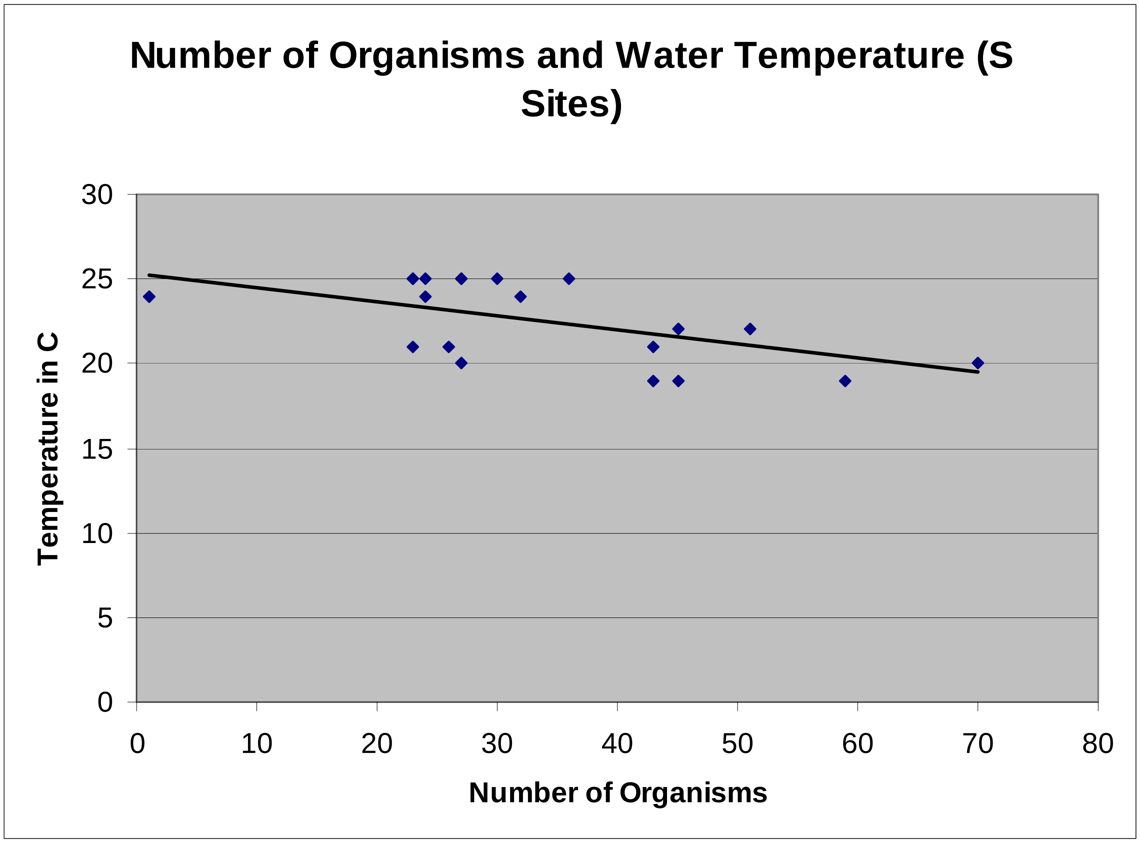


Figure 3 – Significance = 0.004448999

The next two graphs are total sites that compared all families and organisms at each lake, wetland and stream site to the environmental factors that were recorded. The total sites graphs are very similar to the stream sites graphs. Figure 4 indicates a negative correlation between the total number of organisms and water temperature. The abundance increases as water temperature decreases. Figure 5 indicates the same negative correlation exists between the total number of families and water temperature. The variety of families increases as the water temperature decreases.

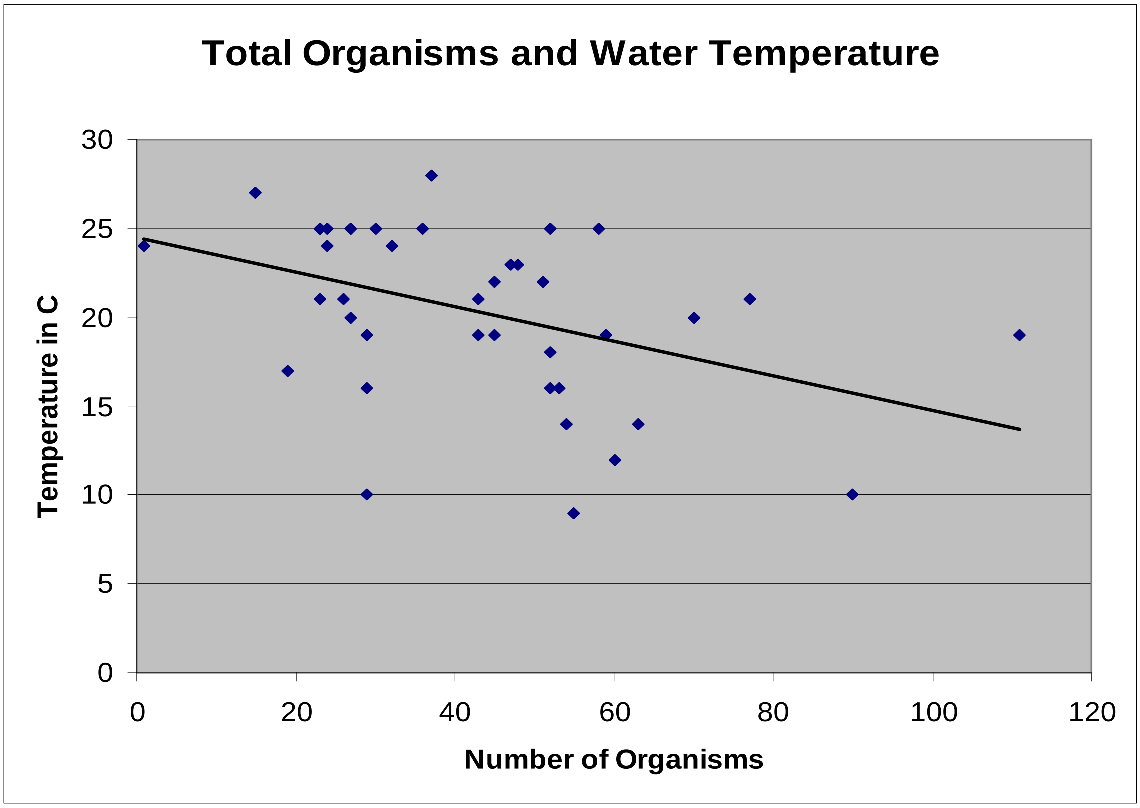


Figure 4 - Significance = 0.003874655

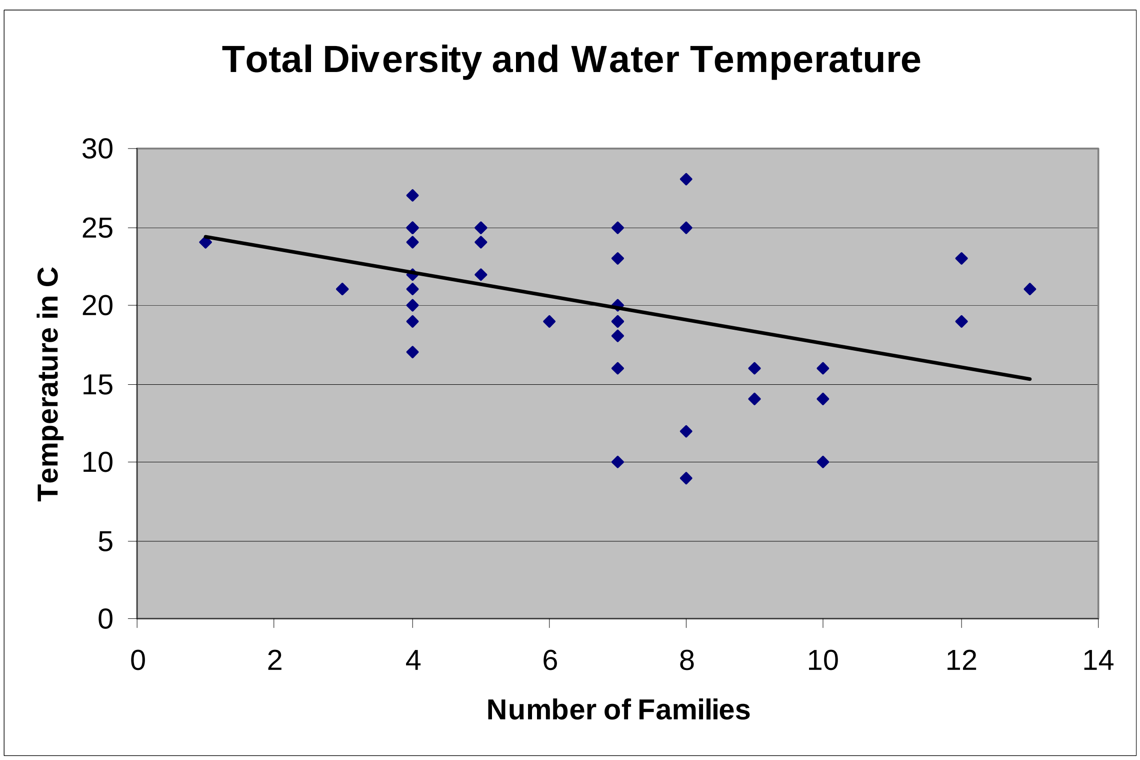


Figure 5 – Significance = 0.00352268

The final set of graphs compares individual families to certain environmental characteristics. The five families chosen were the most abundant found in the three habitats. In order to be used quantitatively, only those families that had exact totals for each site (not simply presence which indicates more than 20) could be included in the count. Under those criteria, the five most abundant were: family – chironomidae (midges), family – coenagrionidae (narrow-winged pond damselfly), family - ephemerellidae (mayflies), family – simuliidae (blackflies), and family – tipulidae (craneflies). A list of the sites and environmental conditions where each family was found and two-variable regression tests were again used to analyze the data. The following graphs indicate significant relationships that were found. Figure 6 indicates that a negative correlation existed between the abundance of chironomidae and the air

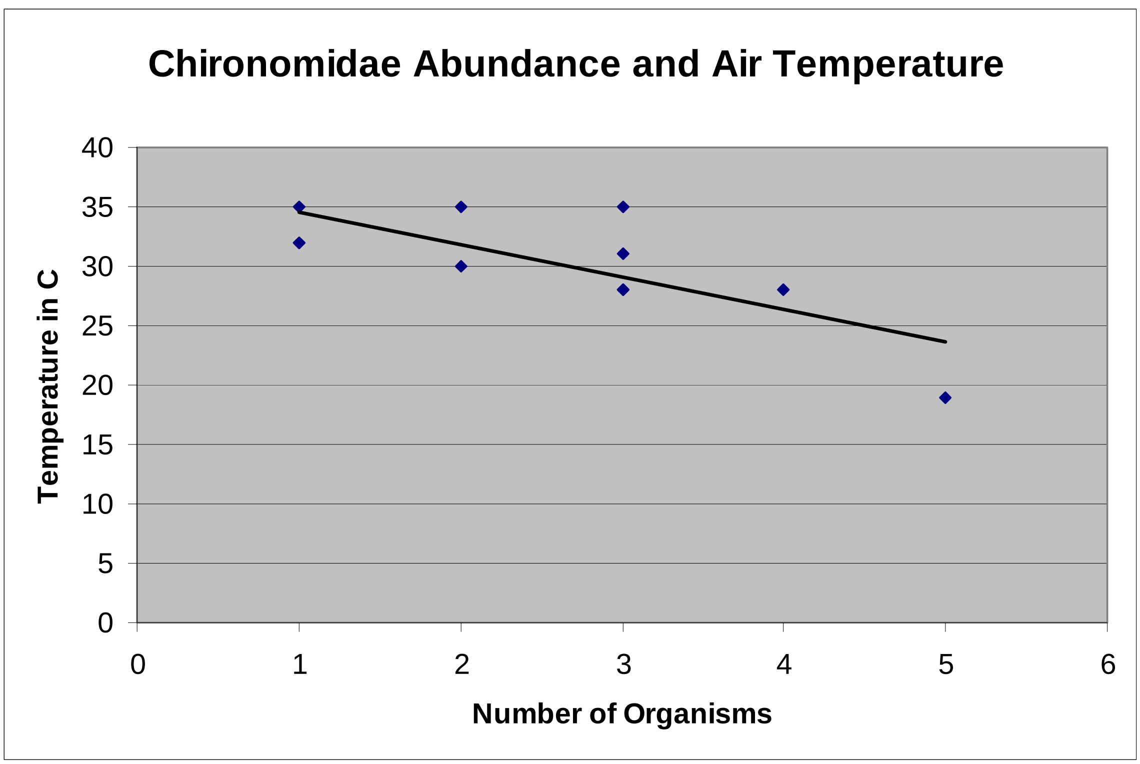


Figure 6 – Significance = 0.006763782

temperature at each site where chironomidae were located. Chironomidae abundance increased as air temperature decreased. Figure 7 shows that a negative correlation exists

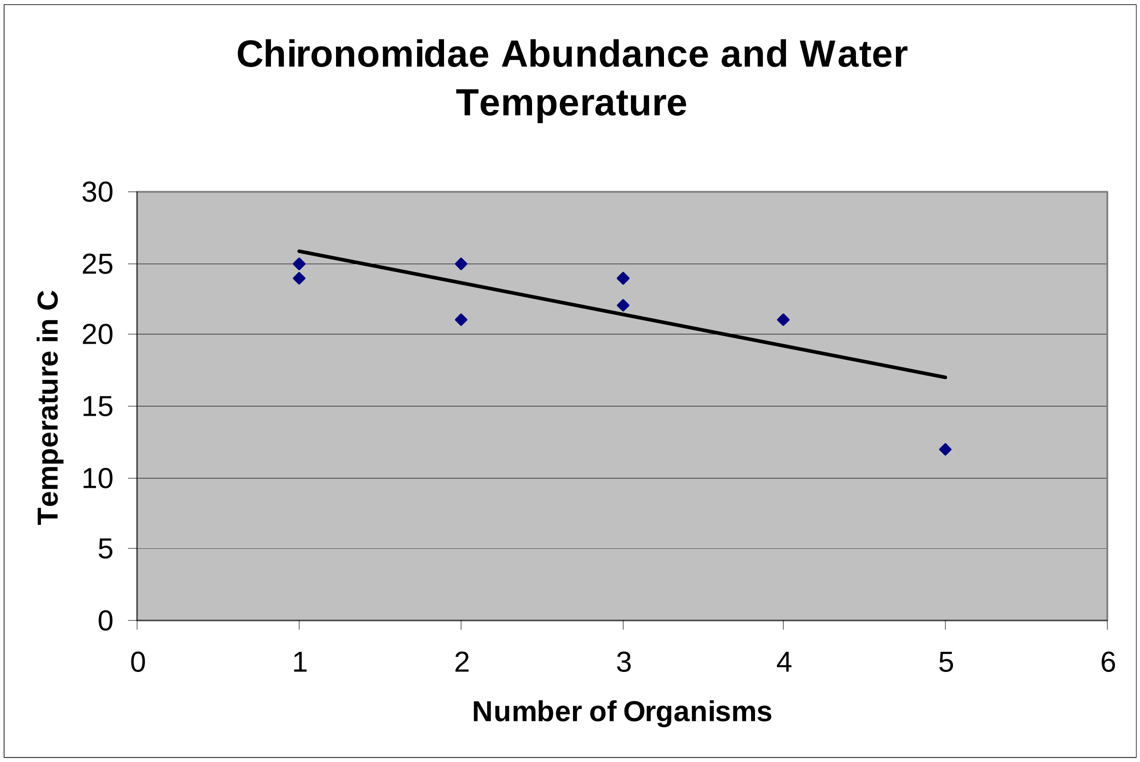


Figure 7 – Significance = 0.007640193

between the abundance of chironomidae and water temperature as well. Figure 8 shows that a positive correlation exists between ephemerellidae abundance and water temperature. Figure 9 shows a positive correlation between simuliidae abundance and air temperature.

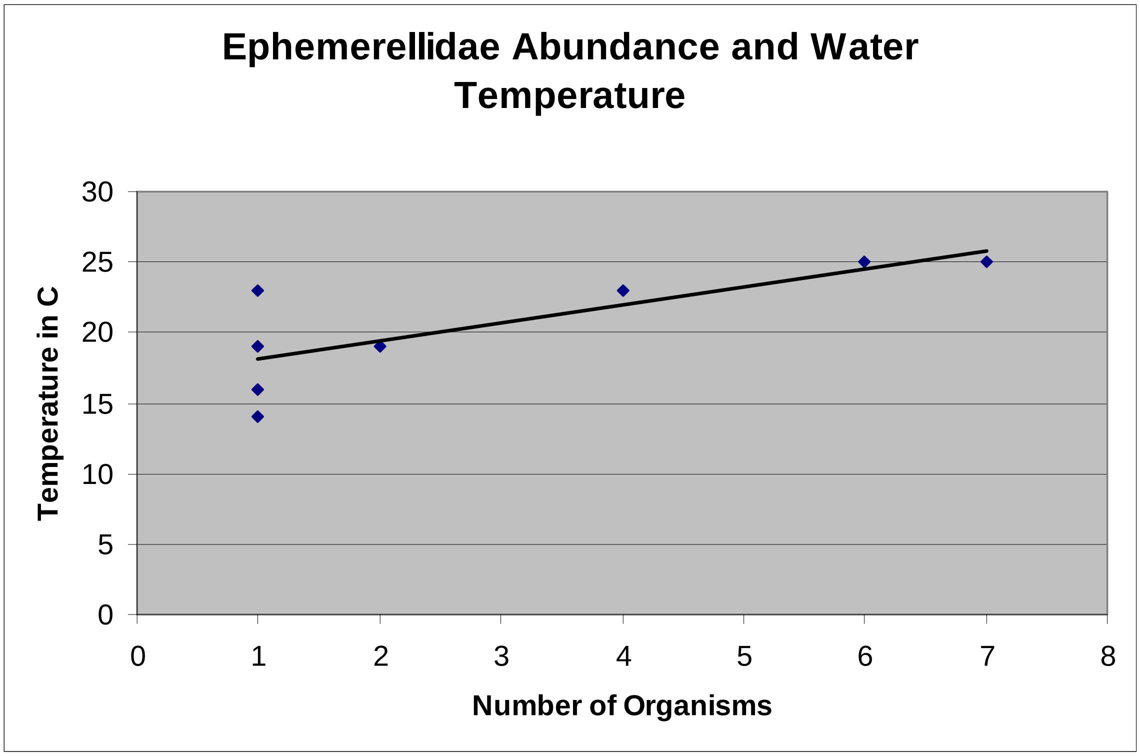


Figure 8 – Significance = 0.024263229

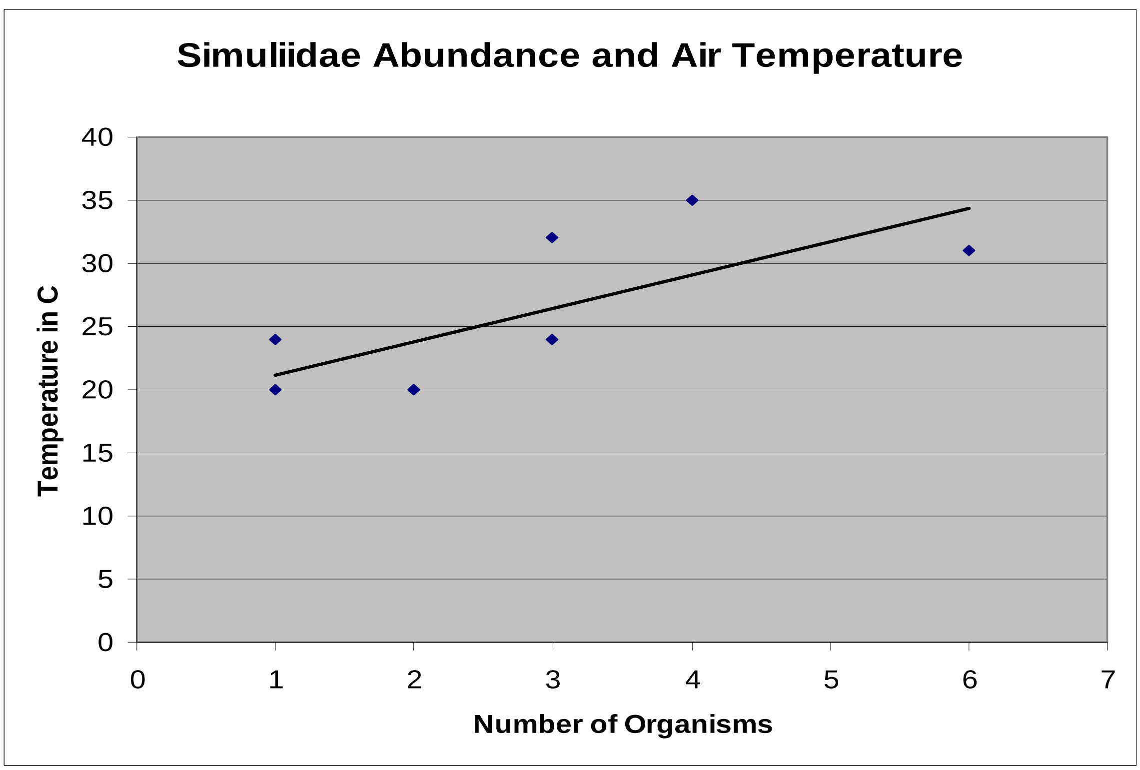


Figure 9 – Significance = 0.041112784

Discussion

This project's initial goal was to generate a thorough survey analysis of the type and abundance of macro-invertebrates found at three aquatic sites at Pierce Cedar Creek Institute in Hastings, Michigan. The forty-one site breakdown is listed in a table along with a photo reference of the various macro-invertebrates categorized by family. The macro-invertebrates were categorized by family due to the inherent difficulties in classifying these organisms by species. A statistical regression analysis comparing macro-invertebrate type and abundance with various environmental characteristics (air temperature, water temperature, pH, DO, sediment composition) showed that a significant relationship did exist between the macro-invertebrates in some of the wetland sites. These regression graphs highlight the individual characteristics that may provide essential habitats for varying macro-invertebrate families.

One interesting problem that occurred during the study that could serve as a future project was the relative change that occurred in the species composition of the habitat over time. Different macro-invertebrates go through different life cycles at various times throughout the year. The macro-invertebrate composition of a particular aquatic habitat may experience a significant change in diversity and abundance over a relatively short period of time. If a survey project could be conducted in a much shorter time-frame, it would be interesting to see how family' and organism's reactions to environmental factors might be different than those found in our research project. By shortening and intensifying the time frame of the study, one might be able to concentrate on specific macro-invertebrate families or possibly even species. Also, a larger sampling at a greater number of sites would undoubtedly provide a statistical advantage in comparing environmental factors to macro-invertebrate type and abundance. For example, 21 stream sites were analyzed in this study compared with 10 at the lake and wetland. The increased number of wetland sites studied may have contributed to the fact that the stream sites were the only ones to individually exhibit any significant relationships between environmental factors in the statistical analysis. The stream is also a dynamically different aquatic habitat than the lake or wetland.

Many of the significant relationships indicated in the analysis related to water temperature. Since the study was conducted during the summer months, the water never reached cold temperatures, and the graphs seemed to show that most families tended to thrive in mild to cool waters as opposed to fairly warm waters. The varying graphs also seem to indicate that there could be several competing environmental factors that determine the variety and abundance in an environment. Each family/species needs a different set of requirements in order for it to survive or thrive. Further research projects could attempt to isolate these factors to determine relative importance.

It is hoped that the information provided by this research project can lead to future studies of the macro-invertebrate population of Pierce Cedar Creek Institute and their overall larger role in the local ecosystem.

References

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