Invertebrate Diversity of Ponds within Gremel Wildlife Sanctuary and Amboy Marsh

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Introduction

Aquatic macroinvertebrates are great bioindicators for the quality of a body of water. Each macroinvertebrate has it's own tolerance value: a representation of how well each macroinvertebrate can survive in different environments with varying water qualities (Lamberti and Hauer 810). There are many factors that go into determining water quality. The factors measured were the size of the body of water, dissolved oxygen levels, pH, conductivity, total dissolved solids, nitrate levels, temperature, ammonia levels, and phosphate levels. These factors directly impact macroinvertebrate diversity within their environments. The relationships between these factors and the diversity of macroinvertebrate populations within each pond were analyzed, and the most significant factors affecting diversity were the size of the body of water, dissolved oxygen levels, and pH due to their importance in maintaining life.

Research Question

How do the differences in the water quality of ponds affect the aquatic macroinvertebrate populations within them?

Hypothesis

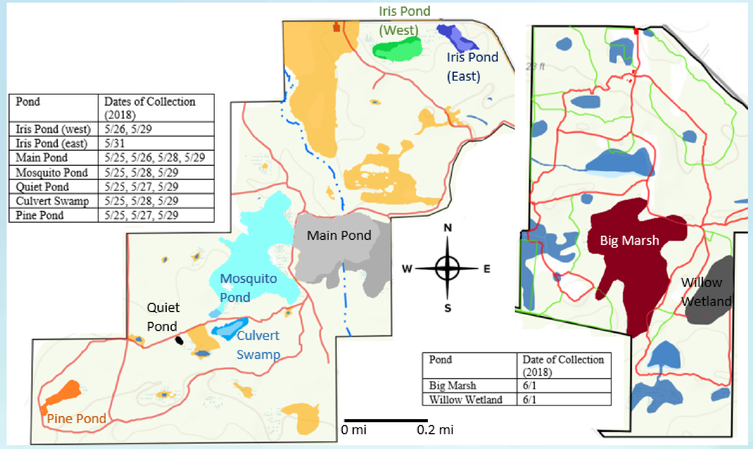
The higher the level of dissolved oxygen in a body of water, the greater the sustainability for life. Therefore, a greater aquatic macroinvertebrate diversity will be observed in bodies of water with high levels of dissolved oxygen.

Methods

Two water samples were taken from each pond, one on the first day of data collection and one towards the last days of data collection. Then, ten uniform dipnet samples were taken from various areas of each pond to collect macroinvertebrates (see figure 1 for dates). While at the ponds, a YSI Pro Plus Multiparameter Meter was used to collect pH, temperature, dissolved oxygen, nitrate levels, conductivity, and total dissolved solids. Ammonia and phosphate levels were measured from each water sample with the Hach Potable Water Lab Kit. All of this data was collected twice , and the two measurements were averaged. Once back in the lab, dissecting scopes and dichotomous keys (Bouchard, et al.) helped to identify the family of each invertebrate that was collected. Finally, the surface area and volume of each pond was calculated via an online interactive map (Augustana). The surrounding wetland areas were also included in these calculations.

Results

In total, 1,288 individual invertebrates spanning 32 different families from 9 different ponds were collected and recorded. Each pond contained a different level of diversity, species richness, and species evenness. The water quality differed between each pond; a visual comparison of each pond's turbidity can be seen in Figure 2. Turbidity is a measure of particulates suspended in the water and a way to determine water clarity (Calwell). As seen in Figure 2, Main Pond had low turbidity and Mosquito Pond had high turbidity. Based on figures 3 and 4, ponds with a higher Simpson's Diversity show a greater species richness. However, there does not seem to be a significant difference in species evenness among the ponds regardless of Simpson's Diversity. Figure 5 shows the significant relationship found between Simpson's Diversity and pond surface area. However, Big Marsh was excluded from the final results due to its vastly different environment. The ponds in the Gremel Wildlife Sanctuary and Willow Wetland were dominated by topwater plants such as *Ranunculus aquatilis* (crowfoot) and *Lemnoideae* (duckweed); whereas, Big Marsh was primarily dominated by *Nymphaeaceae* (lily pads) and had a very high nitrate concentration (0.64 mg/ L higher). The different environment of Big Marsh affected the results, and a more significant relationship was observed when it was excluded. Two further significant relationships were observed: one between dissolved oxygen and pH and another between volume and pH. The relationship between dissolved oxygen and pH, figure 6a, is observed due to a high concentration of hydrogen ions at a low pH that react with dissolved oxygen in the water. Additionally, high rates of decomposition occurring in the sediment consume oxygen and lower pH. The relationship between volume and pH, figure 6b, is attributed to these rates of decomposition in the sediment; larger ponds will have less water come in contact with decomposition and result in increased pH.



Pond	Dates of Collection (2018)
Iris Pond (west)	5/26, 5/29
Iris Pond (east)	5/31
Main Pond	5/25, 5/26, 5/28, 5/29
Mosquito Pond	5/25, 5/28, 5/29
Quiet Pond	5/25, 5/27, 5/29
Culvert Swamp	5/25, 5/28, 5/29
Pine Pond	5/25, 5/27, 5/29

Pond	Date of Collection (2018)
Big Marsh	6/1
Willow Wetland	6/1

Figure 1. This map shows the location and relative surface areas of each pond, as well as the dates data was collected at each of them. The map on the left is Gremel Wildlife Sanctuary. The map on the right is Amboy Marsh.

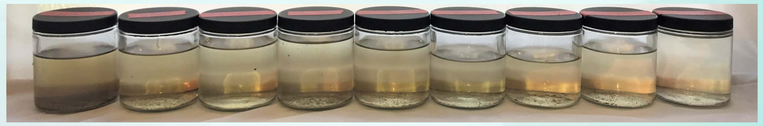


Figure 2. Water samples were taken from all nine ponds to create a visual comparison of the turbidity of each pond's water. The samples are ordered from left to right: Mosquito Pond, Iris West Pond, Quiet Pond, Pine Pond, Iris East Pond, Culvert Swamp, Big Marsh, Willow Wetland, and Main Pond.

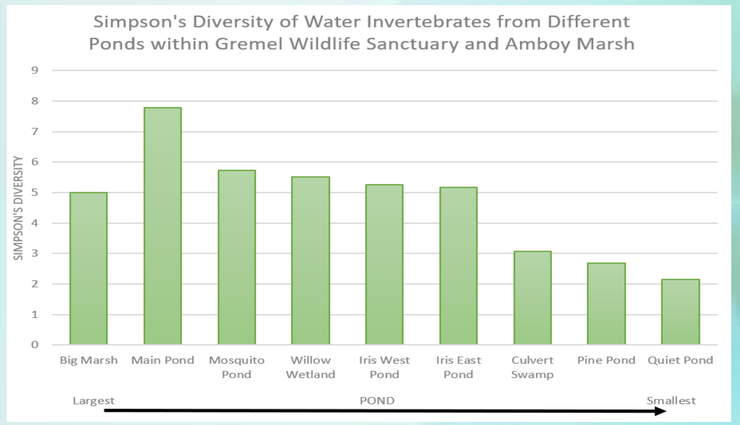


Figure 3. Simpson's Diversity of each pond was calculated using the number of invertebrates collected in the dipnet samples. The arrow represents the order of the ponds from largest to smallest in size.

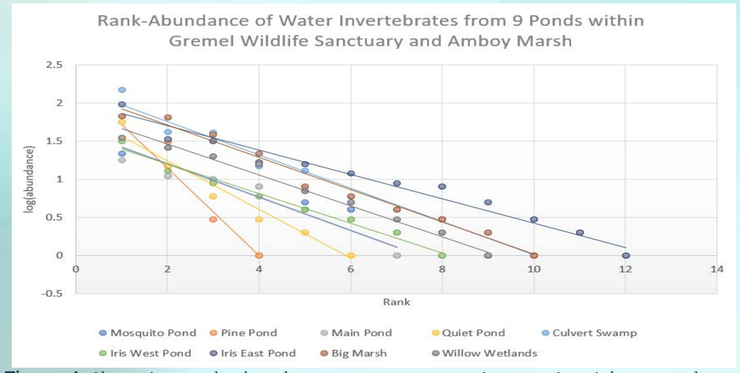


Figure 4. Above is a rank-abundance curve representing species richness and evenness within each of the ponds. Iris East Pond had the highest species richness and Pine Pond had the lowest. All of the ponds had similar species evenness represented by similar slopes in the trendlines.

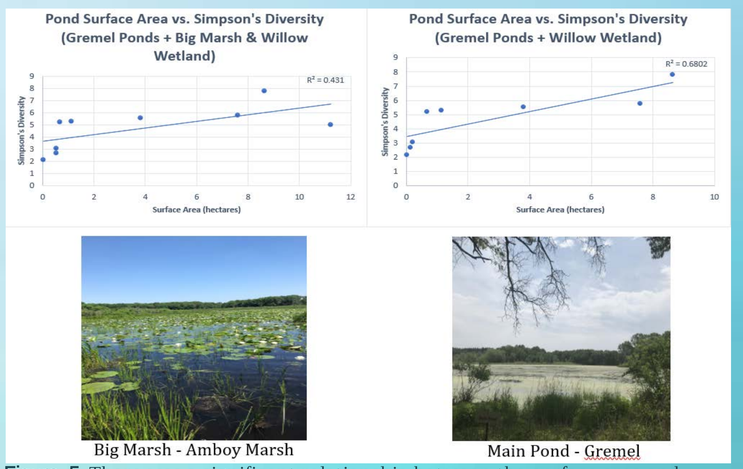


Figure 5. There was a significant relationship between the surface area and Simpson's Diversity of each pond. When all nine pond were compared, the regression resulted in the following: F=5.302826, p-value= 0.054766, adjusted R square= 0.349743. When Big Marsh was excluded and only the Gremel ponds and Willow Wetland were compared, the regression showed the following results: F= 12.76142, p-value= 0.011751, and adjusted R square= 0.626894.

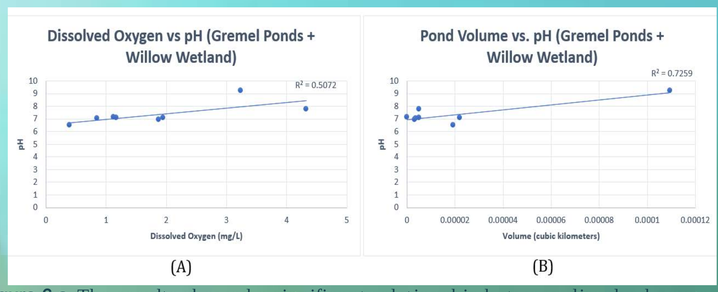


Figure 6a. The results showed a significant relationship between dissolved oxygen and pH. Dissolved oxygen and pH show a positive correlation. The regression results are as follows: F= 6.176328, p-value= .047468, adjusted R squared= .425114.

Figure 6b. The results also showed a significant positive correlation between volume and pH. The regression results are as follows: F= 15.89152, p-value= 0.00723, adjusted R square= 0.680241.

Discussion

Previous literature supports the accuracy of the results of the study. The Species-Area Relationship (SAR) states that the larger the habitat, the greater the number of species within that habitat (Hanski et al.). The SAR could account for the significant relationship we observed between diversity and surface area as opposed to our original hypothesis of a relationship between dissolved oxygen and diversity. Throughout the study, there were a few limiting factors. Human error is one of those limiting factors. The sampling was as thorough as possible, but the collection techniques were not perfect as some organisms may have escaped the dipnet. In the case of Mosquito Pond, the wetland area was not accessible; therefore, we only sampled from a small area that was accessible.

Conclusion

There was no direct relationship between dissolved oxygen and diversity as originally hypothesized. There were significant relationships between surface area and Simpson's Diversity, dissolved oxygen and pH, and volume and pH. According to the data collected in the study, macroinvertebrates indicated a higher Simpson's Diversity in larger ponds. All of the data found and tests ran support the idea that increasing size of habitat leads to increased species diversity.

Acknowledgements

We would like Augustana College and the Audubon Society for making this trip possible. We would also like to thank Kennedy Ware and Hannah Buchanan for assisting us in data collection.

References

Arnett RH, Downie NM, Jaques HE. How to know the beetles. Dubuque, IA: WCB McGraw-Hill; 1980.

Augustana College Field Stations – Green Wing Environmental Laboratory. Augustana College. [accessed 2018 May 30]. https:/ / sites.google.com/ augustana.edu/ field-stations/ green-wing-environmental-laboratory.

Bouchard RW, Ferrington LC, Karius ML. Guide to aquatic invertebrates of the upper midwest: identification manual for students, citizen monitors, and aquatic resource professionals. St. Paul, MN: University of Minnesota; 2004.

Calwell L. Water Clarity. [accessed 2018 Jun 13]. http:/ / www.kansasriverscience.org/ whats-water/ water-quality/ water-clarity.

Hanski I, Zurita GA, Bellocq MI, Rybicki J. Species-fragmented area relationship. Proceedings of the National Academy of Sciences. 2013;110(31):12715–12720.

Lamberti GA, Hauer FR. Methods in stream ecology. 2nd ed. London: Academic Press; 2011.

Merritt RW, Cummins KW. An introduction to the Aquatic insects of North America. Dubuque, IA: Kendall/ Hunt Pub. Co.; 2008.

Thorp JH, Covich AP. Ecology and classification of North American freshwater invertebrates. London: Academic Press; 2015. http:/ / lakes.chebucto.org/ ZOOBENTH/ BENTHOS/ tolerance.html# Oligochaeta.