Mathematical Characterization of Aquatic Communities in DuPage County

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Introduction

Macroinvertebrates are small visible organisms found in water. The objective of the experiment was to compare macroinvertebrates at pipe and non-pipe locations of two lakes and two ponds of interest in DuPage County Forest Preserve. Mathematical models were used to characterize communities by calculating diversity, similarity, and evenness indexes. Also, using the probability of connectivity we can answer the question as to where do specific macroinvertebrates, such as mosquito larvae (*Culex* pipens), originate from and where they go.

Methods

Shannon-Wiener Diversity Index [b]

$$H' = -\sum_{i=1}^{n} pi \cdot \ln(pi)$$

Sorenson Similarity Index [c]

$$S = \frac{2C}{A+B}, 0 \le S \le 1$$

Pielou Evenness Index [d]

$$J' = \frac{H'}{Hmax} = \frac{H'}{\ln(S)}, 0 \le J' \le 1$$

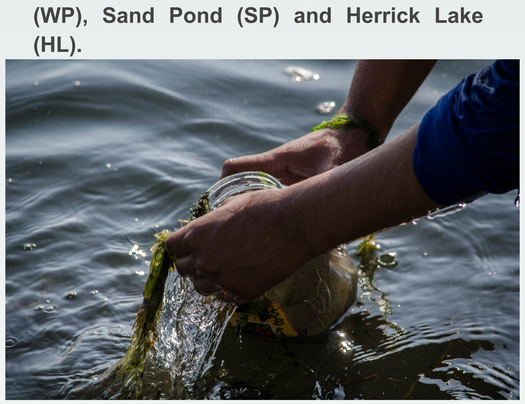
Probability of Connectivity Index [e]

$$PC = \frac{\sum_{i=1}^{n}\sum_{i=1}^{n} ai \cdot aj\left(e^{-k \cdot dij}\right)}{AL^2}$$

Procedures

Samples were collected from two lakes and two ponds in the DuPage County. Collected macroinvertebrate samples were used to calculate different indexes.

Locations: Silver Lake (SL), White Pine (WP), Sand Pond (SP) and Herrick Lake (HL).



Water, sediment, and vegetation were collected and filtered for macroinvertebrates.

Macroinvetebrates were then placed in vials and then identified to families.

Results

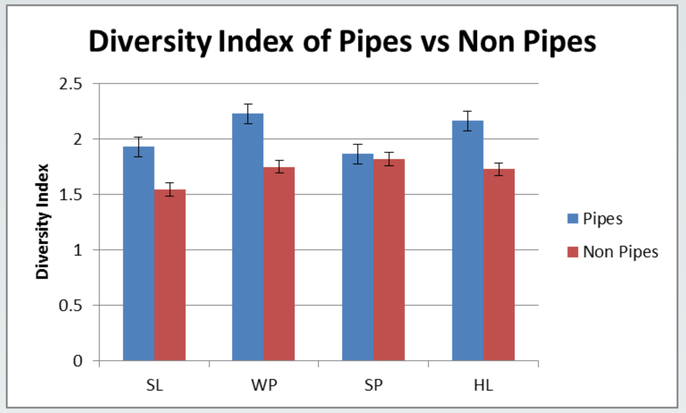


Figure 1: Diversity comparison of Lakes and Ponds: No significant differences of diversity were detected between pipes and non pipes (Kruskal Wallis ANOVA H = 11.413; df = 7; *P* = 0.122).

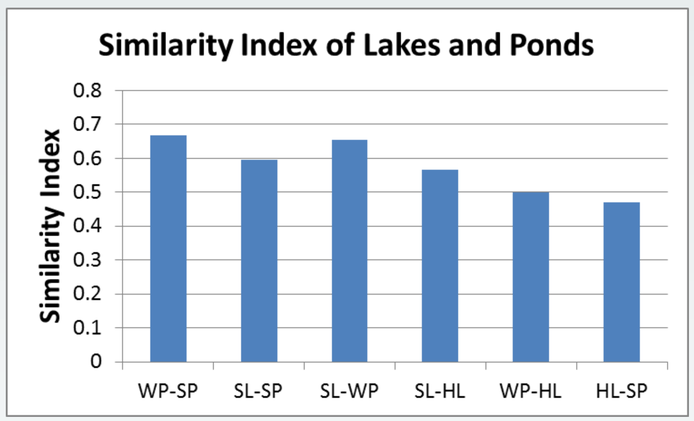


Figure 2: Similarity comparison of Lakes and Ponds: None of the comparisons between lakes[f] were close to one indicating complete similarity (Kruskal Wallis ANOVA H = 5; df = 5; *P* = 0.416).

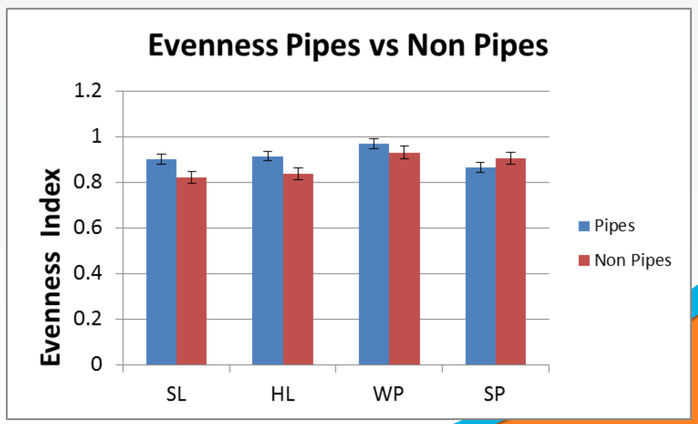


Figure 3: Lake and Pond Evenness comparison: No significant differences of evenness were detected between pipes and non pipes (Kruskal Wallis ANOVA H = 7; df = 7; *P* = 0.429).

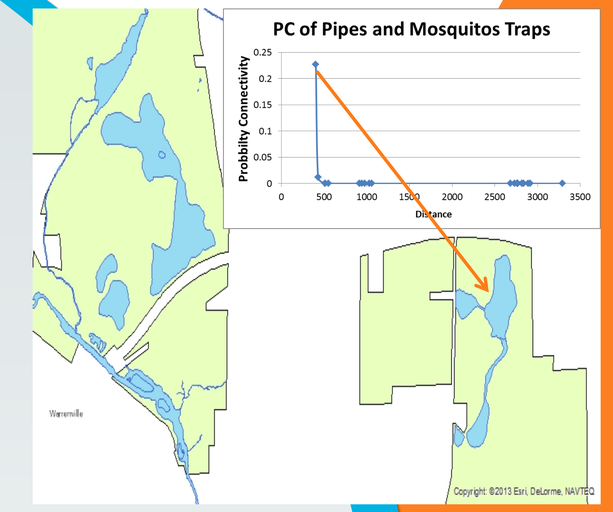


Figure 4: Probability of Connectivity of Pipes and Mosquitos Trap: Distance (m) influences connectivity value. Orange arrow indicates area of highest connectivity.

Conclusion

- Pipes do not seem to be a factor. A possible factor could be dissolved oxygen.
- Mosquitos do not travel far from breeding grounds.

Future Studies

- Collect more macroinvertebrate data using better equipment and techniques.
- Perform more mathematical models.
- Conduct network theory and PCA analysis to compare lakes and rivers.
- Compare indexes of lakes and rivers.

Acknowledgments

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References

a:Trigal et al.(2009). *Hydrobiologia* 618.1: 109-23.
b: *pi*-proportion of individual species.
c: C-common species, A-location 1 species, B-location 2 species
d: H'-Shannon Wiener Index, H*max*-maximum evenness
e: ai- larvae location 1, aj-adult location 2, k-constant (.0462), dij-distance between ai and aj, AL-area.
f: White Pine (WP), Sand Pond (SP), Silver lake (SL), Herrick Lake (HL)
g:Magurran, A. E. (2004) *Measuring Biological Diversity*. Oxford: Blackwell.
h: Ricotta et al. (2009). Theoretical Population Biology 70: 237-243
i: Saura et al. (2011). Forest Ecology and Management 262: 150-160