DIVERSE WATER QUALITY AND NUTRIENT PROFILE IN GEOLOGICALLY VARIANT SURFACE WATER AND WETLANDS AT MENDON PONDS PARK

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Abstract

This study investigates various water quality parameters in surface water and wetlands in a geologically diverse area in Mendon Ponds Park, Rochester, NY. It also determines the trophic profile of these water bodies in terms of nitrate and phosphate to understand their eutrophication potential. The unique water signatures of these water bodies lie in their geological origin through glacial melting since last ice age. Different pattern of aquatic and wetland flora and fauna indicates variance in their water quality and nutrient profiles. To validate this hypothesis, two water bodies, a pond (Deep Pond) and a kettle pond (Devil's Bathtub) that are separated by an esker; and two wetlands, a vernal pool and a bog (Kennedy's Bog) were selected. Triplicate samples were collected from each of the sample locations, which were carefully selected, based on their accessibility, to attain adequate representation. All samples were analyzed for pH, electrical conductivity (EC), dissolved oxygen (DO), nitrate, and total phosphorus (TP) as a measure of phosphate. The GPS coordinate of each sample location is recorded to maintain the uniformity of repeated sampling at different seasons in future. Results showed unique and diverse characteristics of water at each sampling location. For instance, the pH of the kettle pond is lower but did not vary significantly ($p>0.05$) as compared to the Deep Pond and the vernal pool. However, as expected, the pH of the bog is significantly lower ($p<0.0001$) than the rest. DO is significantly lower ($p<0.0001$) in the vernal pool as compared to others; this can be explained by the dead leaves covering most of the air-water interface at the surface of the pool. The EC, nitrate, and the TP of Deep Pond is significantly higher ($p<0.0001$) than the kettle pond and the vernal pool, which are segregated by an esker that restricts the input flow from the surrounding land. The bog water also showed its characteristic low nutrient profile. Statistical correlation between these water quality parameters also suggests information about the potential sources of nutrients from the surrounding area. The data generated in this preliminary study are highly encouraging and set base to achieve our long-term goal of studying water quality and trophic profile of these geologically diverse surface water and wetlands in Mendon Ponds Park, as functions of seasonality and occurrence of big storm events.

Introduction

- Mendon Ponds Park is a National Natural Historic Landmark due to its 2500 acres of woodlands, ponds, wetlands, and glacially created landforms.
- Samples were collected from two different water bodies, a pond (Deep Pond) and a kettle pond (Devil's Bathtub) that are separated by an esker; and two wetlands, a vernal pool, and a bog (Kennedy's Bog).
- Each water body and their immediate surroundings displayed significant variation in flora and fauna, indicating a variance in water quality and nutrient profiles as well.
- The water quality of the samples collected was analyzed based on five different criteria: pH, electrical conductivity (EC), nitrate content, total phosphorus content (TP), and dissolved oxygen content (DO).

Objectives

The specific objectives for this study are to :

1. Investigate the various water quality parameters in surface water and wetlands.
2. Create a trophic profile through measuring the nutrients like nitrate and total phosphorus.
3. Determine the statistical correlation of these measured water qualities to understand the potential sources of the nutrients.

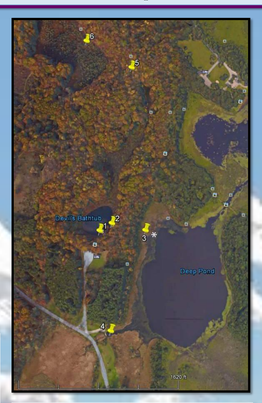

Figure 1. Sample collection map of different locations at Mendon Ponds Park. Latitudes and longitudes of each sampling site was recorded using a field GPS meter and the map was created marking the locations at Google Earth.

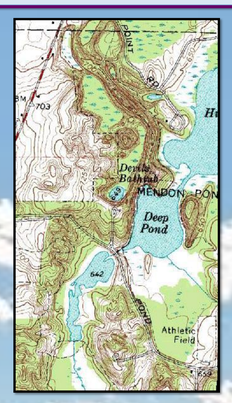

Figure 2. Topographic map of the study area at Mendon Ponds Park showing the unique geography of the sampling locations.
(Source - http://www.gpsrunner.net/tom_perry/garmin-news.htm)

Experimental Design & Analysis

Analysis and Statistics

pH	Measured using a VWR Scientific pH probe. Three point calibration was performed and quality control (QC) samples were checked ((100 ± 1)%) before, after, and in between 10 samples.
Electrical Conductivity (EC)	Measured using a Vernier conductivity probe. Two point calibration was performed and quality control (QC) samples were checked ((100 ± 1)%) before, after, and in between 10 samples.
Dissolved Oxygen (DO)	Measured using a Vernier DO probe. Two point calibration was performed and quality control (QC) samples were checked ((100 ± 5)%) before, after, and in between 10 samples.
Nitrate	Measured using a Vernier nitrate probe. Three point calibration was performed and quality control (QC) samples were checked ((100 ± 5)%) before, after, and in between 10 samples.
Total Phosphorus	Measured using a microplate method (D'Angelo et al., 2001). Five point calibration was performed and several quality control (QC) samples were checked ((100 ± 5)%).
Statistical Analysis	Statistical Analyses were performed using the JMP.In version 11. Q tests were performed on all data to eliminate possible outliers at the 95% confidence intervals. Mean values were developed along with their standard deviations. Tukey Kramer honest significant difference test was conducted to evaluate the significant differences along treatment means. Pairwise multivariate correlation was performed using all the water quality and nutrient data.

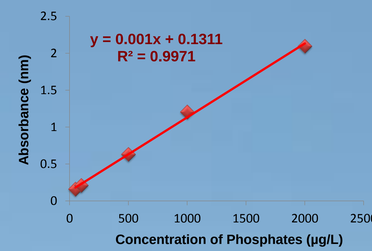

Figure 4. Standard curve for total phosphorus (at 595 nm)

Figure 3. Different sampling locations

Devil's Bathtub
A Kettle Pond

Deep Pond

Vernal Pool

Kennedy's Bog

Conclusion

Overall, the results from this experiment show that the water quality varies significantly among the tested surface water/wetlands at Mendon Ponds Park attributing to its unique geographic characteristics.
The trophic profile of the Deep Pond shows that it is at the greatest risk of eutrophication as compared to the other water bodies observed.

The future directions that can be taken with this project would be to sample the same locations at different times throughout the year, to monitor seasonal change. Another experiment aims to measure the trophic profiles after major storm events.

References

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Results & Discussion

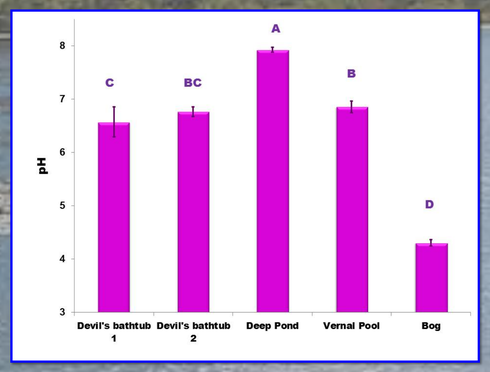

Figure 5. pH of water at various sampling locations. Data are expressed as mean (n=5) ± one standard deviation. Mean comparison was conducted using Tukey Kramer honest significant difference (HSD) test. Different letters express significant differences among the sample means.

- The pH varies significantly ($p<0.0001$) among different sampling sites.
- The pH of these water bodies provides evidence as to why certain species exist or don't exist at respective locations.
- The bog was by far the most acidic; consequently, it contains organisms that could survive under this acidic condition.
- Dwarf larch pine, cotton grass, and carnivorous plants like pitcher plant, sundew were the most observed plant species in the bog.
- The pH of Deep Pond is slightly alkaline, which expresses the characteristic water signature of the area as it contains limestone.
- In comparison, Devil's Bathtub and the vernal pool exhibited lesser pH, which probably accounts for their stagnant nature and higher decomposition, resulting in production of more organic acids.

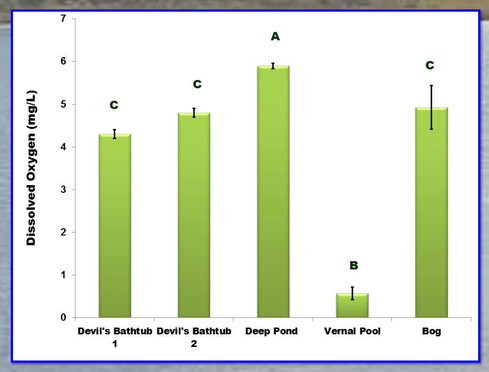

Figure 6. Dissolved Oxygen (mg/L) of water at various sampling locations. Data are expressed as mean (n=5) ± one standard deviation. Mean comparison was conducted using Tukey Kramer honest significant difference (HSD) test. Different letters express significant difference among the sample means.

- The DO varies significantly ($p<0.0001$) among different sampling sites.
- The highest DO of Deep Pond exhibits characteristics of a healthy aquatic system that sustains a diverse flora and fauna, which was observed during the study period.
- The vernal pool had the lowest dissolved oxygen, significantly lower as compared to any other sampling locations. This can be attributed to the presence of decomposing leaves covering a majority of the water surface. As evident in figure 3, the dark color of water, which accounts for the decomposed organic debris, also explains the least DO measured in the vernal pool.
- The DO profile of water at these sampling locations corroborates well with the species diversity observed in these unique water bodies/wetlands.

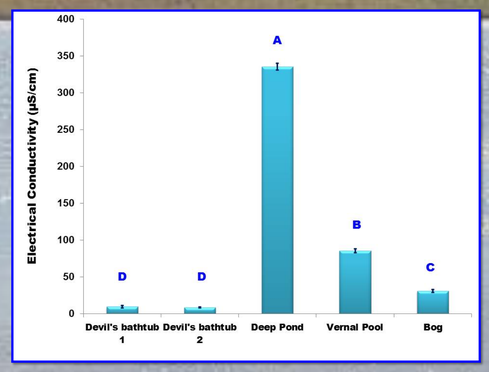

Figure 7. Electrical Conductivity (µS/cm) of water at various sampling locations. Data are expressed as mean (n=5) ± one standard deviation. Mean comparison was conducted using Tukey Kramer honest significant difference (HSD) test. Different letters express significant difference among the sample means.

- The EC varies significantly ($p<0.0001$) among different sampling sites.
- The Deep Pond shows the highest electrical conductivity which suggests presence of most ions in it as compared to the other locations.
- EC showed significantly ($p<0.05$) strong correlation with nitrate and phosphate (table 2), which explains the higher EC in Deep pond and least in Devil's bathtub and the bog.

Variable	by Variable	Correlation Coefficient (r)
pH	DO	0.44
EC	DO	0.93
EC	pH	0.63
Nitrate	**DO**	**0.95***
Nitrate	pH	0.55
Nitrate	**EC**	**0.99****
Phosphate	DO	0.91
Phosphate	pH	0.76
Phosphate	**EC**	**0.97***
Phosphate	**Nitrate**	**0.95***

Table 2. **Pairwise Correlation. * shows the level of significance . * (95%); ** (99%)**

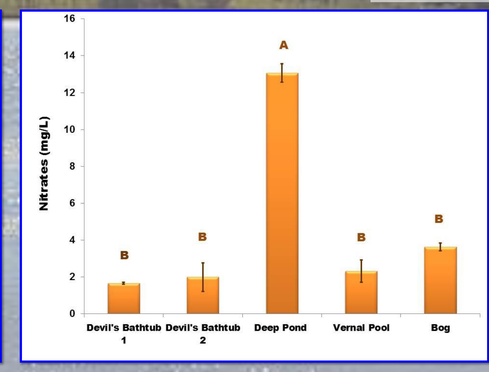

Figure 8. Nitrate (mg/L) of water at various sampling locations. Data are expressed as mean (n=5) ± one standard deviation. Mean comparison was conducted using Tukey Kramer honest significant difference (HSD) test. Different letters express significant difference among the sample means.

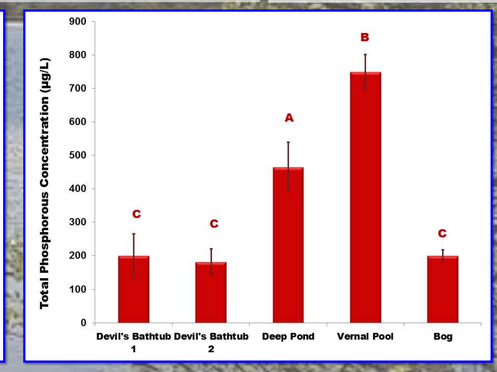

Figure 9. Total Phosphorous Concentration (µg/L) of water at various sampling locations. Data are expressed as mean (n=5) ± one standard deviation. Mean comparison was conducted using Tukey Kramer honest significant difference (HSD) test. Different letters express significant difference among the sample means.

Trophic Profiles

- The trophic profile of the tested surface water/wetlands are expressed as nitrates (Figure 8) and total phosphorus (as an account for phosphate; Figure 9). Like the other water quality parameters, trophic profiles also vary significantly ($p<0.0001$) among different sampling sites.
- The high trophic profile for Deep Pond exhibits evidences of fertilizer run-offs from the surrounding area, which is largely covered by farmlands. Concentrations of both nitrate and total P are much higher than the advisory level (20 µg/L), establishing the need for precautionary measures and planning to prevent subsequent eutrophication of the pond over time.
- The striking difference between Devil's Bathtub and the Deep Pond in their trophic profile is attributed to their physical separation by the esker, which restricts the south-westward flow of water and runoffs.
- The bog exhibits its characteristic low nutrient profile. The very high level of TP is attributed to the closest contact between its water and sediments (as a result of minimal depth), which serves as a great sink of phosphate in lentic systems.
- Significant nitrate-phosphate correlation (Table 2) indicates a similar source, potentially fertilizer runoffs from the surrounding large farmlands.