Examining the Effects of Harmful Algal Blooms (HABs) on the Plant Diversity in Central Park

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Abstract

Harmful algae blooms (HABs) are an increasing problem in Central Park. They not only damage the lake's ecosystem, but also harm people, pets, and surrounding wildlife. The purpose of this project was to examine if there was a correlation between the frequency of HABs occurrence and plant diversity. Plant species with high mortality upon exposure to HABs could be used as a visual indicator of HABs formation and alert us of the ecosystem's health. We tested several Central Park water bodies for water quality and identified plant samples near the water using DNA barcoding. The Lake appears to be affected by HABs due to higher level of measured phosphorus, and has a much higher occurrence of *Artemiza tridentata* and *Smilax biflora*. *The Lake* shows a lower plant diversity (D=0.459) as compared to Harlem Meer (D=0.628). We

Introduction

- Harmful algae blooms (HABs) devastate the local ecosystem by causing hypoxia, which lead to "dead zones" where marine animals and plants suffocate and die. [1]
- DNA barcoding HABs "simultaneously (1) alerts us to new occurrences of algae from harmful genera, (2) expands our knowledge of co-occurring conditions and species associated with the growth of these organisms in changing marine environments, and (3) suggests a pathway for multispecies monitoring and management moving forward."[2].
- Plant species with high or extremely low mortality upon exposure to HABs could be used as visual indicators of HABs formation.

Materials and Methods

- Water samples and plant specimens were collected from five Central Park water bodies, with successful barcoding done for samples from Harlem Meer and The Lake
- We tested each water sample for pH, ammonia, nitrate, and phosphorus using the *eXact Eco-Check Water Test Kit.*
- DNA was extracted from plant tissue and a polymerase chain reaction (PCR) was performed to amplify the rBCL genes of the samples.
- Positive PCR results were sequenced, and BLAST was used to determine the identity of the plant species.

Results

Harlem Meer

Sample ID	Number of Population	BLASTN Species Result
KFH-015	57	*Impatiens pallida*
KFH-016	790	*Cornus amomum*
KFH-017	26	*Potentilla erecta*
KFH-018	6	*Poa compressa*
KFH-019	2	*Chrysanthemum lucidum*
KFH-020	141	*Sorbus scopulina*
KFH-021	3	*Iris virginica*
KFH-022	22	*Taraxacum officinale*
KFH-023 & KFH-024	387	*Taraxacum officinale*

The Lake

Sample ID	Number of Population	BLASTN Species Result
KFH-002	239	*Smilax biflora*
KFH-003	9	*Cotoneaster acutifolius*
KFH-004	26	*Morus alba*
KFH-005	32	*Quercus stellata*
KFH-006	13	*Mitragyna hirsuta*
KFH-007	49	*Fallopia japonica*
KFH-008	37	*Ulmus glabra*
KFH-009	2	*Cornus sericea*
KFH-010	12	*Solanum dulcamara*
KFH-011	45	*Osmunda lancea*
KFH-012	1246	*Artemisia tridentata*
KFH-013	8	*Viburnum opulus*
KFH-014	1	*Silphium perfoliatum*

Table 1: Species identification. This table contains results from the DNA sequencing. The sample ID is on the left. The center contains the population count we logged during our collection process. The BLATN species result is on the right most column.

Body of Water	pH	Ammonia	Nitrate	Phosphorus
Harlem Meer	7.0	0.0	0.0	0.0
The Lake	9.0	0.0	0.0	0.5
subregion Lake HABs	7.0	0.0	0.0	8.0
The Pond	7.0	0.0	0.0	1.5
Turtle Pond	6.5	6.5	0.0	1.0
Control (Tap Water)	6.5	0.0	0.0	2.0

Table 2: Water quality testing. This table contains results from our water quality measurements. The location of the sample is the left most column. From left to right are our results for tests of pH, Ammonia, Nitrate and Phosphorus. High counts for Nitrate and Phosphorus can lead to HABs formation in water.

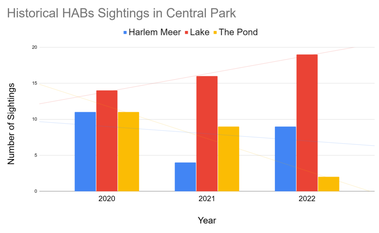

Figure 1: Historical HABs sightings. This chart shows the number of visual HABs sightings from 2020-2022. Different colors represent different locations (Harlem Meer, Lake, The Pond). As seen, the Lake has had consistently more HABs sightings versus other water bodies.

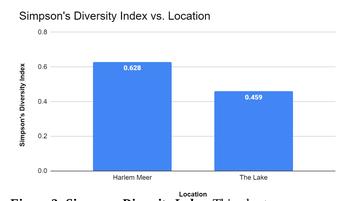

Figure 2: Simpsons Diversity Index. This chart shows the Simpson's Diversity Index for two sites. The Lake (right) shows materially less diversity than Harlem Meer (left)

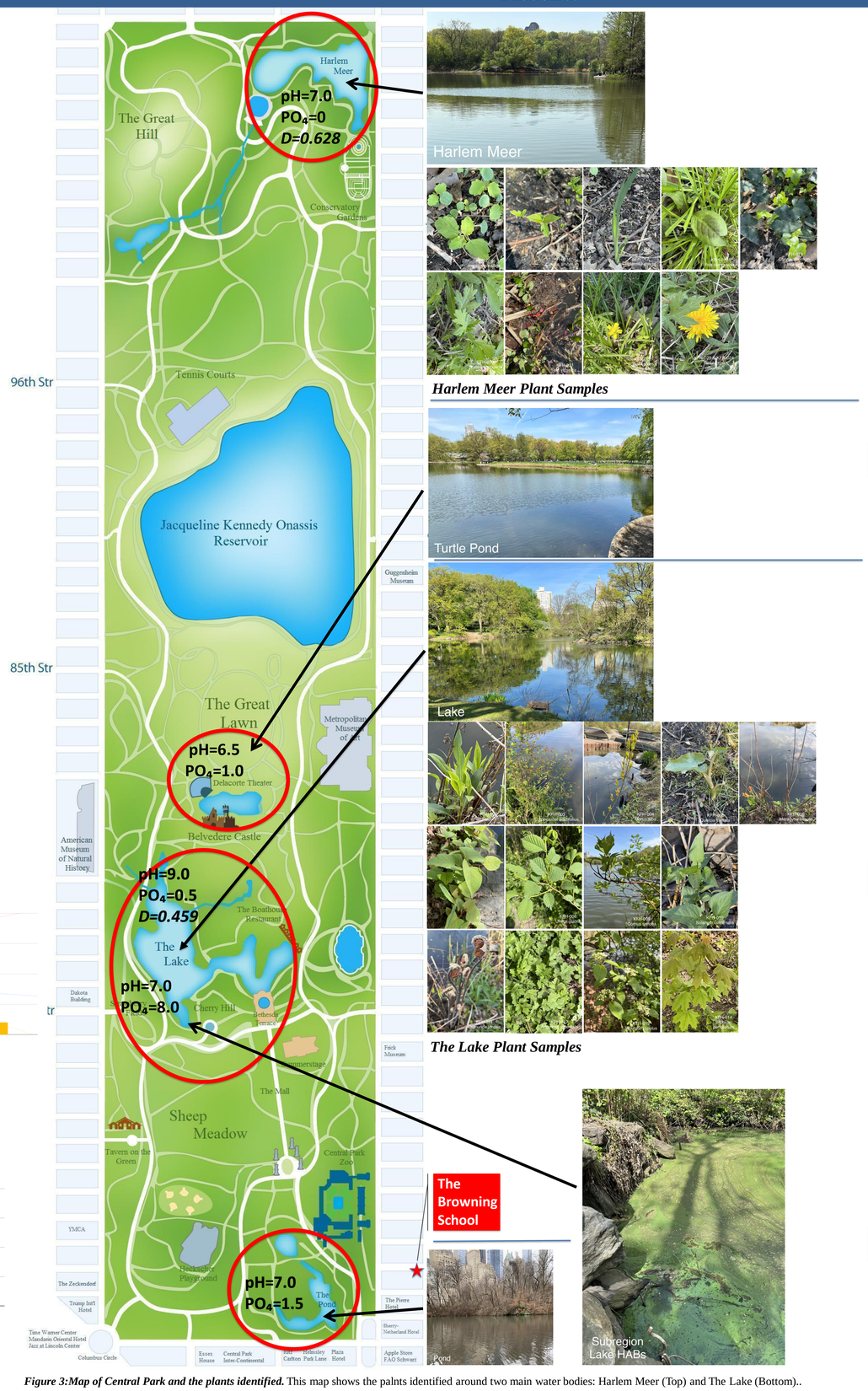

Figure 3:Map of Central Park and the plants identified. This map shows the palnts identified around two main water bodies: Harlem Meer (Top) and The Lake (Bottom)..

Harlem Meer Plant Samples

The Lake Plant Samples

- We visually inspected several water bodies. A section of the Lake in Central Park had a dark green appearance that is typical of HABs. We called this subregion Lake HABs (Figure 3).
- Subregion Lake HABs had a much higher level of measured phosphorus than all other water bodies. The readings for pH, Ammonia and Nitrate did not differ from other water bodies in Central Park (Table 2).
- We successfully extracted DNA from several plant samples around the Lake and Harlem Meer. All BLASTN results from 22 positive PCR results returned alignment >500bp and 0 mismatch.
- The Lake had a high occurrence of *Artemiza tridentata* and *Smilax biflora* vs. other species. The Harlem Meer had a more even population distribution of plants.
- The totality across the Lake showed a lower Simpson's Diversity Index of 0.459 than the Harlem Meer, which had an index value of 0.628.

Discussion

- Consistent with our hypothesis, the presence of HABs correlated with a lower biodiversity of plant life. We relied on visual inspections to identify the present of HABs.
- Historically, water with a high level of HABs tends to have high levels of nitrogen and phosphorus. Our own testing showed only elevated levels of phosphorus in the area we believed contained HABs.
- Some BLAST sequence's result does not match with the description of the plants, prompting future research.
- Due to limitations in the project timeline, our data collection did not take place during typical peak HABs season during June-September. We believe our data quality and results would be improved if we ran our experiment later in the year.

Selected References

[1]US EPA,OW. "Learn about Cyanobacteria and Cyanotoxins | US EPA." *US EPA*, 4 June 2019, www.epa.gov/cyanohabs/learn-about-cyanobacteria-and-cyanotoxins.

[2]Jacobs-Palmer, Emily. "Environmental DNA Metabarcoding for Simultaneous Monitoring and Ecological Assessment of Many Harmful Algae." *www.frontiersin.org*, Frontiers, 17 May 2021, www.frontiersin.org/articles/10.3389/fevo.2021.612107/full.

[3]"Central Park Map." *BikeToursCentralPark.com*, biketourscentralpark.com/central-park-map.

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