The Effect of Harmful Algae and Their Treatments on Species of Aquatic Plants and Algae in Northern NJ Lakes

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URBAN BARCODE RESEARCH PROGRAM
Supported by the Pinkerton Foundation & Science Sandbox

CSH Cold Spring Harbor Laboratory DNA Learning Center

Abstract

The objective of this study was to determine the effect of chemical treatments of algal blooms on biodiversity and nitrate and phosphate levels in bodies of water in New Jersey. Different algal species are capable of surviving in different environmental conditions and in the treatment process the lakes that are found to have blooms undergo radical change in the conditions of the existing water. We collected samples of water from four lakes and test for the levels of phosphates, nitrates, dissolved oxygen, and alkalinity. We used DNA barcoding to test for the most prevalent species in the water.

Introduction

This past summer, bodies of water around the U.S. experienced an influx of algal blooms[1]. 47 bodies of water in New Jersey alone were suspected of or found to have harmful algal blooms[2]. Algal blooms are known to feed off excess nitrates in water produced from a variety of human related sources. These blooms are harmful for aquatic ecosystems because they can limit the oxygen availability for other aquatic species[3]. Algal blooms can also release toxins which cause skin irritation, lung irritation, and neurological conditions.

Harmful Algal Blooms have become a large problem for many lakes in northern NJ. The chemicals and other methods used to get rid of these could have an effect on the biodiversity of the lake and surrounding area by killing off other species. Common chemicals used to treat algae include: Copper Sulfate, Copper (II) Akanolomine, Copper citrate, Hydrogen Peroxide, Chlorine, Calcium Hydroxide, and Barley straw. Previous research in Massachusetts indicated that treating the bodies of water with CuSO4 in order to control algal bloom growth changed the species that was most prevalent in the body of water. Researchers in this study suggested that this was because the different species of phytoplankton had different tolerance to copper ions[6].

Phosphorus and nitrogen are essential components of aquatic ecosystems. These substances occur both naturally and synthetically in nature. Even a slight increase in phosphorus or nitrogen in aquatic ecosystems can cause an influx in plant and algae growth, as well as changes the biodiversity of aquatic species because of lack of oxygen.

Lake Rogerene and Lake Mohawk have confirmed harmful algal blooms and they were both treated. Lake Musconectong and Fox Hollow lake have had no reported algal blooms[3]. They were chosen as controls because of their proximity to the other lakes and their lack of algal blooms. The objective of this Urban Barcoding Project was to determine the effects of treating harmful algae on biodiversity in Northern NJ lakes. We looked for the most prevalent species within samples of water from different areas of the lakes.

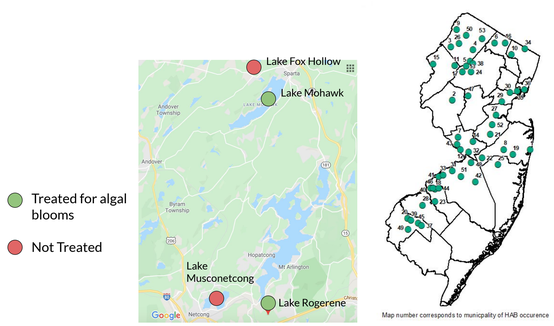


Figure 1: The Locations of Lake From Which Samples Were Taken.

Map number corresponds to municipality of HAB occurence

Figure 2: Locations of Reported Harmful Algal Blooms: .https://www.state.nj.us/dep/wms/bfbm/cyanoHABevents.html

Materials & Methods

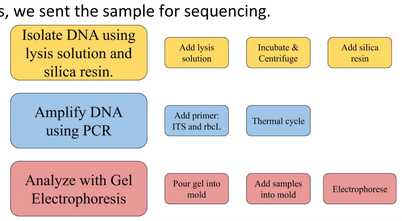
The bodies of water we collected from are Lake Rogerene as well as Lake Musconetcong in Morris County, New Jersey and Lake Mohawk as well as Fox Hollow lake, both in Sparta, New Jersey.

We collected water samples from the bodies of water we will be observing. Each sample will be 125 mL, and will be stored at room temperature. We collected 7 separate samples of water from each body of water. 2 of the samples will be used to test for water quality in terms of nitrates, phosphates, and chemical treatments. The other 5 samples were used to test the biodiversity of algae and plant species floating in the water.

The water pH was measured with a pH meter at the testng site. We tested dissolved O2 with a dissolved O2 meter. We tested phosphate, nitrate, sulfate, alkalinity, and total solids levels in the water. We tested for phosphorus via the Ascorbic Acid Method. This method consists of adding a mixture of sulfuric acid, potassium antimonyl tartrate, ammonium molybdate, and ascorbic acid to a 25-50 mL sample of lake water. This mixture will color the sample blue proportional to the quantity of phosphorus in the sample. The color is compared using a color comparator with a scale in milligrams per liter that increases with the increase in color hue to determine the proportion of phosphorus to water.

We tested for nitrogen compounds in the form of ammonia (NH4), nitrates (NO3) and nitrites (NO2) via the Cadmium Method. In this method, nitrates come into contact with cadmium particles which causes them to convert to nitrites. These nitrites react with a reagent to form a red hue, which can be used to determine the quantity of nitrates in the sample. Comparison to a color wheel with a scale in milligrams per liter that increases with the increase in color hue.

To identify the species, we first collected samples of algae (one species per sample) and store them in properly labeled and sealed containers. We took these samples to the DNAC Lab in Harlem, New York, and once there we began the DNA barcoding process. First, we isolated the algae DNA in the sample. The samples collected from Lakes Mohawk and Fox Hollow were repeatedly centrifuged to concentrate the samples. To the samples of algae we collected, we added 300 µl of lysis solution and ground up the sample in the solution. We incubated the samples at 65 degrees celsius for 10 minutes. After , we centrifuged the samples for one minute, and then transferred the supernatant from the samples to a fresh tube, where 3 µl of silica resin was added and mixed in. The samples were incubated and centrifuged again. We repeated the mixing, centrifuging, use of a washing buffer, and the removal of the supernatant until we had gone through the entire tissue sample. After this stage of the process had been completed, we added distilled water and mixed and incubated one more time. These solutions were transferred to fresh tubes and chilled. Next we amplify the DNA by PCR using the algae specific primer rbcL and the plant specific primer ITS. We added PCR to a clean test tube and transferred the DNA to that tube. We amplified it in a thermal cycler and chilled these solutions on ice. To analyze the PCR products, we used gel electrophoresis. To do this, we melted the agarose substance and let it set. We added SYBR Green to a fresh tube and transferred DNA from the PCR tube and then put the samples through electrophorese. To sequence and analyze the results, we sent the sample for sequencing.



Results

DNA Barcoding Results

- Lake Rogerene:
  - 4 samples; 3 algae, 1 plant
- Lake Fox Hollow:
  - 2 samples; 2 plants
- Lake Musconetcong:
  - 4 samples; 4 plants
- Lake Mohawk:
  - No samples

- 6 total species identified
  - 2 Algae
  - 4 Aquatic plants

- Species Identified:
  - Plants: watermilfoil, western waterweed, najas guadalupensis, small pondweed
  - Algae: green algae, japanese freshwater algae

Sample	Species	Common Name	Primer	Lake	Latitude	Longitude
KJN-002	Cosmarium quadrum f. dilatatur	Japanese Freshwater Algae	rbcL	Lake Rogerene	40.8966	74.6547
KJN-003	Cosmarium botrytis	green algae	rbcL	Lake Rogerene	40.8966	74.6531
KJN-004	Myriophyllum spicatum	watermilfoil	ITS	Lake Rogerene	40.8966	74.6531
KJN-004	Cosmarium botrytis	green algae	rbcL	Lake Rogerene	40.8966	74.6531
KJN-005	Myriophyllum spicatum	watermilfoil	ITS	Lake Fox	41.03694444	74.6675
KJN-005	Myriophyllum sp. 'Lake Ronkor	Eurasian watermilfoil	rbcL	Lake Fox Locat	41.03694444	74.6675
KJN-006			rbcL	Lake Fox Locat	41.04138889	74.6675
KJN-007			rbcL	Lake Fox Locat	41.04138889	74.6675
KJN-008	Elodea nuttallii	western waterweed	rbcL	Lake Rogerene	40.8985	74.6547
KJN-009	Najas guadalupensis	southern water nymph	rbcL	Lake Musconet	40.9012	74.7036
KJN-010	Elodea nuttallii	western waterweed	ITS	Lake Fox	41.04138889	74.6675
KJN-010	Elodea nuttallii	western waterweed	rbcL	Lake Fox locati	41.04138889	74.6675
KJN-011	Potamogeton pusillus	small pondweed	ITS	Lake Musconet	40.9023	74.7044
KJN-011	Elodea nuttallii	western waterweed	rbcL	Lake Musconet	40.9023	74.7044
KJN-012	Potamogeton pusillus	small pondweed	ITS	Lake Musconet	40.9023	74.7044
KJN-012	Potamogeton pusillus	small pondweed	rbcL	Lake Musconet	40.9023	74.7044
KJN-013			rbcL	Lake Mohawk	41.03138889	74.64083333
KJN-017			rbcL	Lake Mohawk	41.03138889	74.64083333

Water Testing Results

- pH of all lakes was within the 7.0-8.5 range
- Nitrates and phosphates of Lake Rogerene were significantly higher than all other lakes
  - Levels corroborate with algae testing result

Test*	Mohawk Samples 1/2	Fox Hollow Samples 1/2	Rogerene Samples 1/2	Musconetcong Samples 1/2
pH	8.0/8.0	7.5/7.5	7.0/7.5	7.0/7.5
Nitrate (ppm)	0.4/0.4	0.6/0.6	1.0/1.0	0.1/0
Phosphate (ppm)	0/0	0.2/0	0/1.0	0.1/0

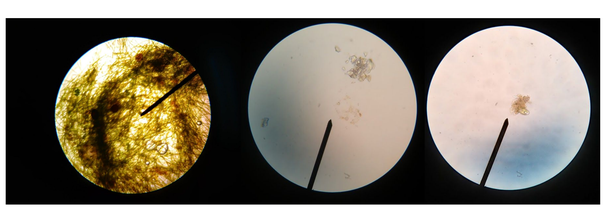


Figure 3: Samples KJN-002 from Lake Rogerene and Sample KJN-017 from Lake Mohawk under microscope (before concentration)

Discussion

- Different species of aquatic plants and algae were found at all the different locations.
- Lake Rogerene was found to still have algae, indicating that the treatment of $CuSO_4$ was unsuccessful in removing all algae.
- Lake Rogerene had highest levels of nitrates and phosphates which could have contributed to the presence of algae.
- All lakes shared a common species, Western Waterweed

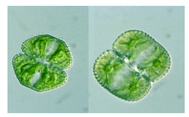


Figure 4: Microscopic images of species of algae identified Cosmarium Botrytis and cosmarium Quadrum.

Figure 5: *Elodea nuttallii* (Western Waterweed)

Conclusion and & Further Research

- Nitrate and phosphate levels contribute to presence of algae in Northern NJ Lakes
- More research is needed to determine the effect of treatment of algae on biodiversity
  - Taking more samples
  - More locations

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Acknowledgements

We would like to thank Ms. Rubenchik for guiding our group through this project. We would also like to thank Dr. Kennedy and his AP Environmental Science class for helping us with the water testing. Finally, we would like to thank Ms. Melissa Lee for providing us with the lab necessary to complete this project and guiding us through the DNA barcoding steps.