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PRESENTING OUR PROJECT

reHAB

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WHAT ARE HABS?

Harmful algal bloom (HABs) : (noun) the occurrence of uncontrollable algal growth in bodies of water that create risks to human health and marine life

ORIGIN & MAIN CAUSES

The rapid growth of harmful algae can result from a number of different factors. For example, a wind-driven rise of nutrient-rich waters near the coast, referred to as **upwelling circulation**, has the ability to overcome the nutrient and light limitations that might typically hinder the growth of harmful algae. In other instances, HABs may also occur when **nutrient runoff** from lawns and farmlands near the coast transfer excess amounts of phosphorus, nitrogen, and carbon to the water, "overfeeding" the preexisting algae.

Image from https://ithacavoice.com/2019/07/harmful-algal-blooms-have-started-reappearing-in-cayuga-lake/

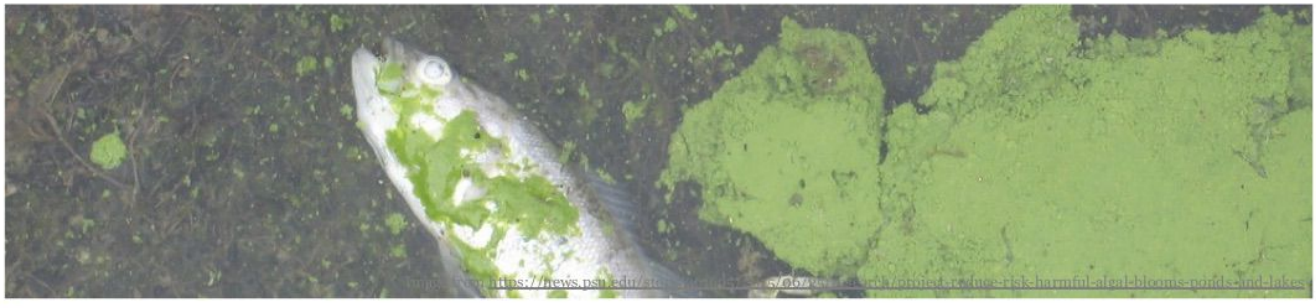
PREVALENCE

HABs can be found in every U.S. coastal and Great Lakes state. However, the exact nature of each bloom varies from place to place. Certain **coastal areas** experience "red tide" due to algal species such as *Alexandrium fundyense* (Atlantic coast from Canadian Maritimes to southern New England), *Alexandrium catenella* (Pacific coast from California to Alaska), and *Karenia brevis* (Gulf of Mexico along the west coast of Florida). Other cases of HABs can be attributed to blue-green algae known as cyanobacteria that proliferate in **warm, nutrient-rich waters**. Recently, a type of cyanobacteria called *Cylindrospermopsis raciborskii* has taken over as the dominant alga in **global water sources**. In the United States, *C. raciborskii* has been found in regions near the **surrounding states of Michigan, Illinois, and Ohio**.

EFFECTS

Humans

Through swimming in the water, breathing in droplets, or drinking and eating contaminated marine animals, people can get sick from the toxins produced by algal blooms. The type of common diseases depends on whether algal blooms occur in freshwater or marine environments. In freshwater, phytoplankton cause HABs to form, which create toxins called cyanotoxins. People can get **skin, eye, nose, throat, and respiratory irritation** when exposed to cyanotoxins. In marine environments, two major groups of phytoplankton, diatoms and dinoflagellates, produce toxins. Ciguatera fish poisoning, for example, occurs when people consume fish that have been contaminated with the ciguatera toxin produced by dinoflagellates. Once consumed, the toxin causes symptoms such as **diarrhea, abdominal pain, nausea, and vomiting**.



Marine Life

Algal blooms can impact marine life by **blocking sunlight and creating hypoxic zones (areas of low oxygen levels)** that force aquatic animals, such as young fish, crabs, and clams to leave their habitats. The algal blooms also **clog fish gills** and are responsible for **releasing toxins into the water**. If the toxin is consumed by small animals in the water such as shellfish, larger animals higher up in the food chain will also be impacted by the toxins.

CURRENT SOLUTIONS

Rain Barrels

Tanks used for collecting and storing rainwater runoff

- ✓ Can be used to decrease polluted runoff
- ✓ Easy to install
- ✓ Collect water for reuse
- × Water can be easily contaminated
- × Collected water is small in volume

Xeriscape Landscaping

Process of landscaping that minimizes the need for supplemental irrigation

- ✓ Uses slow-growing and drought-tolerant plants to conserve water
- ✓ Reduces environmental footprint and makes water consumption efficient
- × High labor investment
- × Environment lacks diversity

Phosphorus-Free Fertilizers

Fertilizers that do not rely on phosphorus

- ✓ Decrease the amount of phosphorus used in agriculture
- × Lack of phosphorus can impact plants that prevent runoff, e.g. turf grass

Phoslock and Alum

Solids that bind to free reactive phosphorus

- ✓ Do not harm the marine ecosystem
- × Difficult to determine the appropriate amount of material to apply in water

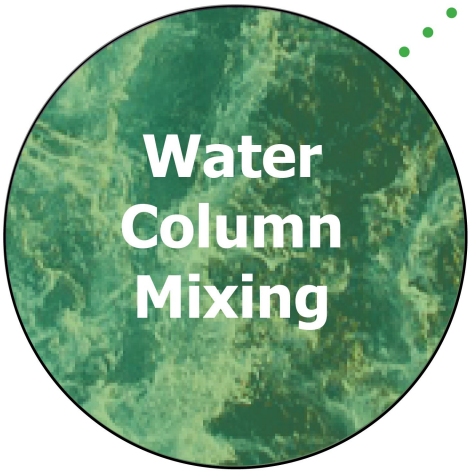
DETECTION METHODS

Enzyme-Linked Immunosorbent Assay (ELISA)

The specific type of ELISA most commonly used for detection of HABs is **direct ELISA**, which uses an antibody directly conjugated to an enzyme to detect an antigen bonded directly to a multi-well plate. Some benefits of using ELISA include the **ease of using and interpreting data**, as well as **very high throughput**. However, the **lack of specificity** in the method of immobilizing the antigen may cause higher background noise, which affects ELISA's ability to display accurate information. Another problem is that ELISA is **less flexible** since a specific conjugated primary antibody is needed for each target protein. There is also **no signal amplification** which reduces assay sensitivity.

Liquid Chromatography-Mass Spectrometry

In LC-MS, the sample is amplified in a column. LC is meant for separation and MS is meant for detection. A benefit of LC-MS is that it is **extremely sensitive**, often detecting compounds in the attomole. It can also **differentiate between compounds** that are very similar in structure. However, one of the major problems of LC-MS is the equipment costs. Not all places have access to this highly sophisticated technology, which can **cost upwards of $100,000**. It also takes a fairly **long time to collect data** and is extremely **difficult to operate**.



- Occurs in closed systems, e.g. lakes and reservoirs
- Water is mixed with a pump to negate algal buoyancy

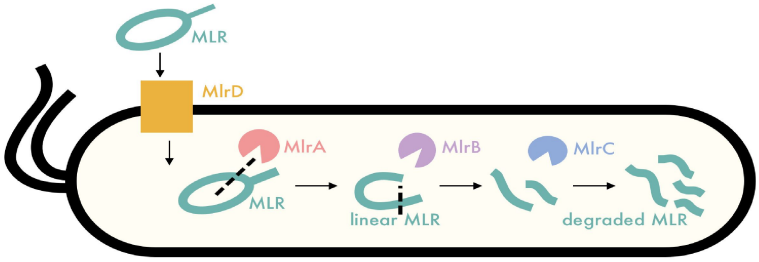
- Release of hydrogen peroxide produces hydroxyl radical by-products that can control HAB formations
- Most effective for clearing algal blooms without harming aquatic wildlife
- Degrades to form water and releases hydrogen atoms, i.e. harmless to the environment
- Effects are not long-lasting
- The amount needed to clear a large lake is very significant

- Involves placement of offsite material over the treatment or hydraulic suction dredging
- For hydraulic suction dredging, dredged material is removed from one area and discharged over the treatment area

WHAT IS OUR PROJECT ALL ABOUT

HABLab

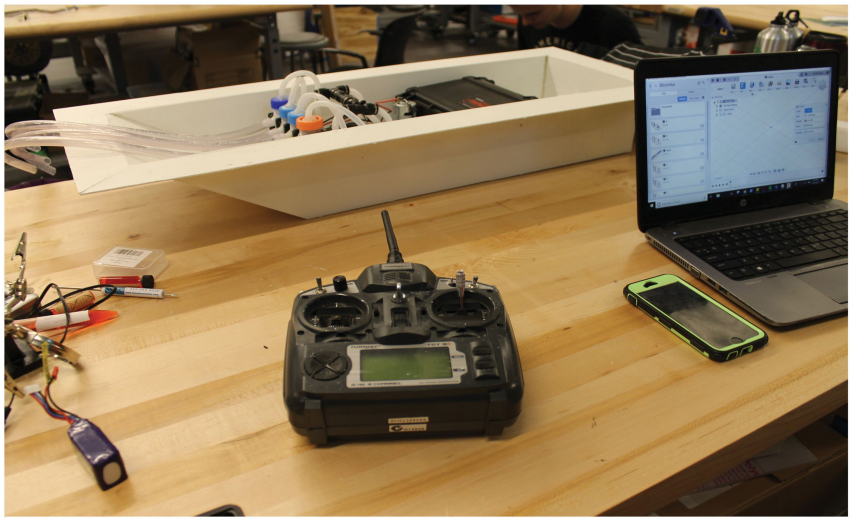
HABLab is the bio-reactor component of our project. We aim to tackle the issue of inefficent microcystin treatment by introducing microcystin degrading bacteria. These bacteria will be located in a bioreactor with a novel alginate bead design to increase efficiency of degradation. This installation would ideally be in water treatment plants to prevent the high price of repair microcystin and HABs cause.



E. coli

HABGrab

HABGrab is the detection component of our project. We want to use a boat equipped with a GPS to help map and obtain HAB samples that can then be used for testing. Once the sample is obtained, we will use a DNA aptamer dection system to identify whether microcystins are present in a water sample or not. This will not only limit the costs of detection, but also the long waiting times for getting the results back.



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Current Solutions, Detection Methods, Prevention Methods

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