How does Climate Change Affect the Great Lakes?

BY CARI RITZENTHALER & CAITLIN MALONEY OF BUGS & STUFF PODCAST

LAB

TEACHER'S INSTRUCTIONS

Introduction

Climate change is affecting the Great Lakes in multiple ways, most notably by changing the plant life within the lakes. Recently Lake Erie has been in the news for excessive aquatic plant growth. Seasonally, the amount of algae, a type of aquatic plant, grows to the point where it begins to collapse our food webs. Initially, the algal blooms can be good for the fish because it increases the amount of food they have available, but as the bloom quickly grows out of control, it covers the surface water causing severe negative effects. For example, the thick layer of algae on the surface stops sunlight from reaching the bottom of the lake, thus starving the aquatic plants that live there. Another issue we have with the massive algal blooms is when it dies. The influx of all of that biological material to the lake bed might look like dinner to the decomposers living there, but spells disaster for the rest of the lake. As these decomposers eat the algae they use up all of the oxygen, leading to the suffocation and death of fish and other animals living in the area. This process is known as eutrophication. With the intense algal blooms becoming an ever-increasing issue, we have to ask ourselves: how will this change with increasing climate change? Will it get worse for our Great Lakes?

Key Questions

- How does eutrophication occur in lakes and other bodies of water?
- What does eutrophication do to the freshwater ecology of the lakes?
- How might climate change affect eutrophication?
- What are some solutions to this issue?

Learning Objectives

- Students should come away with learning about how eutrophication works and what causes it.
- They should know how temperature affects algae blooms.
- They should make hypotheses about what will affect their samples.
- They should understand how to collect scientific data and analyze it to form conclusions.

Key Terms

- Climate change
- Freshwater ecology
- Greenhouse gas
- Bacteria
- Eutrophication
- Algae
- Lakes

Time Requirement

- One class period to set up
- Two weeks to follow

Lesson Plan

1. Have students complete a "Know, Want to know, Learned" (KWL) chart. First ask students what they know about the Great Lakes and the ecosystem within them. Then ask them what they would like to know about the ecosystem.
2. Read **How does climate change affect the Great Lakes?** with the class. Discuss any questions the students have and the major findings of the paper. Highlight any key terms throughout the paper and discuss the terms.
3. Read through the lab and answer any questions/discuss the key terms presented in the introduction.

   "In this lab, we want to know how changes in temperature impact algae growth. We will be setting up our own algae growth chambers under room temperature and under heat lamps to mimic how the Earth's temperature is increasing because of climate change".
4. Complete the lab portion of the class.

   "Before starting take a moment to come up with a hypothesis for what will happen at the end of the experiment. How do you think the algae growth chambers will look under room temperature compared to under the heat lamps?"
5. Following the end of the experiment, finish "Learned" column of KWL chart.

Materials

- Algae plants
- Heat lamp
- Plastic/glass test tubes
- Spectrophotometer/Microscopes
- Test tube rack
- Pipettes

Alternative Options/Helpful Sources for Teachers

Other options for cheaper lab materials:
- **Local pond scum** (in place of buying algae plants)
- **Plastic bottles/plastic or glass jars** (maybe a recycle project, in place of the test tubes and rack)
- **Magnifying glasses** (in place of spectrophotometer and microscopes)

Lab Extension

Climate change is not the only force acting on the aquatic plant of the Great Lakes. Algal blooms are also linked to nutrient runoff from agriculture. Like animals, plants and algae also need nutrients in order to survive. Farmers put a lot of nutrients onto the crops but often these nutrient runoff, or leach, into waterways like the Great Lakes. Nutrients then cause algae to grow leading to similar issues with overgrowth and later eutrophication.

Students could explore this as well by adding different amounts of nutrients (specifically N, P, and K) to their water. Which nutrient increases the algae growth the most? Do combinations of the nutrients work better than when the nutrients are added alone? What happens when nutrients AND climate change are acting on the algae together?

Writing Extension

Have students write a scientific paper about the study they did. Model it off of the adapted paper they read before completing their lab experiment.

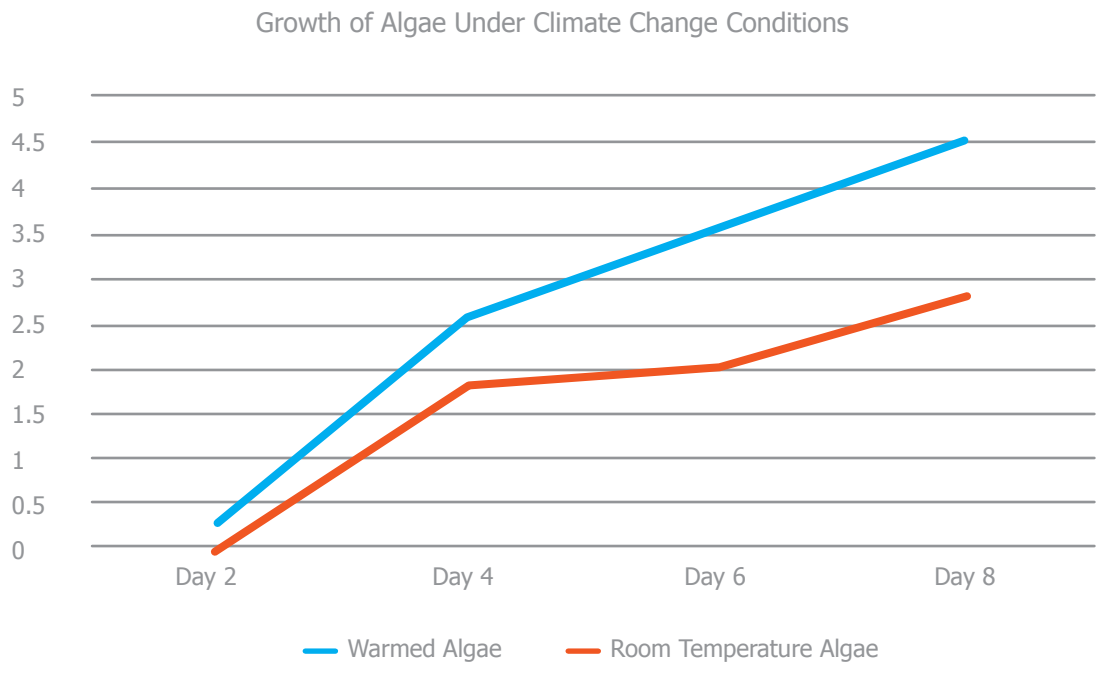
Data and Modeling Extension

Upper level students can use statistics to test whether or not their treatments resulted in statistically significant differences. Use a paired T-test.

Critical Thinking/Policy Extension

Have students brainstorms how we might stop these detrimental algal blooms. What can we do to reduce their size? Can we legally do anything to stop the blooms from happening?

Example Graph



Visualizing Algae:

- **Spectrophotometer:** students can place a sample from their test tube in the spectrophotometer. It measures how much light gets through the sample, and therefore can tell students how dense their algal bloom is.
- **Microscope:** students can place a sample from their test tube on a slide and view their algal growth. They can quantify how much their algae have grown based on how much of the slide is covered and use this chart to rank the growth:

Rank	Description
1	There are no algae at all in the viewing area.
2	Much of the viewing area is empty, but there are a few patches of algae.
3	The slide viewing area is equal parts algae and empty slide where I can see through to the light.
4	Much of the viewing area is covered by algae, but there are a few spaces where I can see through the slide.
5	Entire viewing area is covered by algae.

- **Magnifying glass:** similar to the microscope approach, students will view the test tubes directly and quantify how much algae has grown. They can rank the algae growth using this chart:

Rank	Description
1	There is no algae at all in the test tube.
2	There is a little bit of algae, but most of the test tube is clear.
3	There is equal parts algae and clear water in the test tube.
4	There is a little bit of clear water in the test tube, but most of it is filled with algae.
5	The entire test tube is filled with algae.

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STUDENT WORKSHEET

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Key Questions

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Methods

1. First fill your test tubes with 7 mL of water. On top of that water, you will then add 5 mL of algae. It is important that each test tube start out with the same amount of algae so you can compare later on.
2. Slip your test tubes into two treatments. One treatment should be labeled "Room Temperature" and the other treatment should be labeled "Climate Change". Place your test tubes in the correct area of the room.
3. The algae will be grown in this spot for 1-2 weeks. You will decide as a class how long you want the experiment to continue. Data should be taken throughout the experiment. You can make observations about how the algae are doing and how much appear to be in each treatment. Do the algae seem to be growing in one treatment compared to the other?
4. When your class decides, you can place a small sample of your algae onto the microscope/spectrophotometer.
5. If using a microscope, you can use this ranking system to determine how much your algae has grown.

Rank	Description
1	There are no algae at all in the viewing area.
2	Much of the viewing area is empty, but there are a few patches of algae.
3	The slide viewing area is equal parts algae and empty slide where I can see through to the light.
4	Much of the viewing area is covered by algae, but there are a few spaces where I can see through the slide.
5	Entire viewing area is covered by algae.

What do you notice about your algae growth? Has it changed since the beginning of the experiment? Which treatment seems to have the most algae growth?

At the end of the experiment, graph the growth of your algae below. Remember to include labels for your axes.