Roll Tide!

Algal Blooms

Difficulty

Investment

Objective

Ecology – Principles of Ecology – Biogeochemical Cycles

Introduction

Algal blooms, commonly known as red tides, are destructive ecological events that occur when large numbers of algae accumulate in water columns. The accumulation of the microorganisms often causes the water to become discolored and appear green, brown, or sometimes red. The algae are not always a problem on their own (some algae do produce neurotoxins and other harmful chemicals), but the blooms cause a boom and bust of the populations in the area. Entire populations can starve or be destroyed by over-predation when the food chain crashes. Further, the high numbers of consumers in the area can deplete the dissolved oxygen in the water and much of the marine life can suffocate.

Algal blooms are often caused by a spike in resources in the area, which can be caused by fertilizer runoff. Algal blooms will often destroy entire ecosystems. As a result, they cannot ethically be reproduced in a functioning community. However, students can observe the effects of fertilization on algal growth alone, without watching the associated ecosystem crash. By adding varying amounts of fertilizer to containers of water exposed to the environment, students will be able to see the additional algal growth in the containers with added nitrogen and phosphorous.

Independent Variable – Fertilizer amount

Dependent Variable – Algal growth

Procedure

Materials: 2 Liter Bottle, garden fertilizer, algae samples

1. Cut the top off many 2 liter bottles, leaving simple cylindrical containers.
2. Fill each 75% full of tap water (contaminants are acceptable).
3. Prepare a serial dilution of fertilizer solution
    a. Start with 100 mL of recommended concentration solution (look on the package)
    b. Pour 50 mL of the fertilizer solution into a new beaker
    c. Add 50 mL of water to the new beaker, bringing the volume to 100 mL (producing a half strength solution)
    d. Pour 50 mL of the now half strength solution into a third beaker.
    e. Bring the new beaker to 100 mL (producing quarter strength).
    f. Continue this process until there is one concentration for each two liter test chamber
4. Add several milliliters of each concentration of fertilizer solution to a different test chamber.
    a. Remember to use a negative control (several drops of tap water)
5. Add a small sample of algae to each test chamber to begin the algal growth.

6. Wait two weeks.
7. Mix the test chamber to homogenize the algal suspension.
8. Mass two empty centrifuge tubes.
9. Take a 1mL sample from the top of the chamber.
10. Take a second sample from near the bottom of the chamber.
11. Place both samples into one of the massed centrifuge tubes.
12. Spin the tubes in a centrifuge.
13. Remove the supernatant from each tube.
14. Mass the tubes again with the pellet.
15. Average the mass of the two pellets to obtain the average density (mg/mL) of the algal suspension.

Discussion

The way elements important to biological processes cycle through the environment is an idea to which students have probably already been exposed. They should be familiar with the water cycle, and one or two may break into song at the mention of the water cycle (evaporation… condensation… precipitation brings the rain). This pre-existing knowledge will give the students a schema from which they can build their knowledge of the other biogeochemical cycles.

The students may ask "Why do these cycles matter in the real world?" An answer to such a question nearly always contains a reference to algal blooms. This procedure is an opportunity to observe a mechanism that causes algal blooms in a controlled setting. It is especially relevant to a discussion of fertilizer runoff.

This lab examines variations in a small part of the larger nitrogen and phosphorous cycles. From this experience students should start to think about where the nitrogen and phosphorous in the fertilizer originated. Maintain a clear distinction between nitrogen and phosphorous in class discussions. The two cycles are very different, but both elements play a role in algal blooms. The experience with algal blooms provides a concrete starting point from which students can begin to build their knowledge of the rest of the cycle.

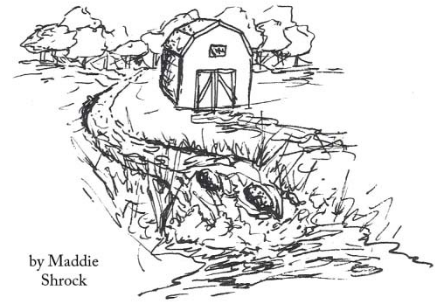
Frequently Encountered Challenges

- <u>Sometimes</u> – This procedure depends on wild algal growth for success. As a result, there will likely be a large amount of variation in the amount of growth from trial to trial. This is another opportunity to discuss error analysis with students. Students should be reminded that scientists do not always see what they expect in the lab and that does not necessarily mean failure.

Alternatives / Adaptations

- **Inquiry Upgrade** – The teacher could set up the test chambers outside of class. Each group could be assigned an unknown test chamber and the class objective would be to predict the amount of fertilizer contamination each received. The control should be given. This procedure would raise the level of inquiry, but increase the workload for the teacher and take the bulk of the lab experience away from the students.

- **Technology Opportunity** – Transmittance is another option for quantifying algal growth in each test chamber. Mix the test chamber water to create a homogenous suspension of the algae. Fill a cuvette with a sample of the suspension. Use a spectrophotometer to measure the transmittance of the sample. A colorimeter can also be used to gather transmittance data.



Roll Tide!

Algal Blooms

Name:____

Class:______________________

Background

Algal blooms, commonly known as red tides, are destructive ecological events that occur when large numbers of algae accumulate in the water column. Large numbers of the microorganisms often cause the water to become discolored and appear green, brown, or sometimes red. The algae are not always a problem on their own (some algae do produce neurotoxins and other harmful chemicals), but the blooms cause a boom and bust of the populations in the area. When populations boom they grow to enormous numbers quickly. When they bust the large population runs out of resources and most of the organisms die. Entire populations can starve or be destroyed by over-predation when the food chain crashes. The high numbers of consumers in the area can deplete the dissolved oxygen in the water and much of the marine life can suffocate.

Procedure

You can test the phenomenon of algal blooms fairly easily using tap water, 2 liter bottles and a serial dilution of fertilizer. (If you have a pond or lake in your area you can test specifically for algae that grow in that lake).

1. Discuss what your constants would be if you set up a series of 2 liter bottles to test algae growth. (Include what type of water you should use in your list). **Write your list here:**

2. What would you need for a control?

3. Now you need to make a serial dilution of fertilizer. What is a serial dilution and why are you using it in your experiment?

4. Prepare the necessary number of 2 liter bottles by labeling each with the correct dilution, date, and team name.

5. Prepare a serial dilution in the following way:
    a. Start with 100 mL of recommended concentration solution (look on the package)
    b. Pour 50 mL of the fertilizer solution into a new beaker
    c. Add 50 mL of water to the new beaker, bringing the volume to 100 mL (producing a half strength solution)
    d. Pour 50 mL of the now half strength solution into a third beaker.
    e. Bring the new beaker to 100 mL (producing quarter strength).
    f. Continue this process until there is a concentration for each test chamber

6. Add several milliliters of fertilizer solution to each corresponding 2 liter container. Each container should receive the same amount! (Don't forget to make a control container)

Data

Build a data table to track your results. Don't forget all of the elements of a good data table. Talk with your teacher about how long you will run your experiment so you can plan accordingly.

Analysis

7. Make a list for your various containers and describe the algal growth that occurred in each.

8. Describe which container would represent the following:
    a. Too little nitrogen/phosphorus:
    b. Too much nitrogen/phosphorus:
    c. The “ideal” amount of nitrogen/phosphorus:

9. Give an explanation based on your knowledge of the nitrogen and phosphorus cycle that will describe why you saw the results you did in number 8.

10. Based on your observations, why is an overabundance of algae referred to as an “algal bloom”?

11. If algae photosynthesize (which they do), and if they produce oxygen from photosynthesis (which they do), why is there typically massive fish mortality associated with an algal bloom?

12. List some ways that excess nitrogen and phosphorus get into rivers and lakes.

13. What are some ways farmers could prevent fertilizer from getting into the water supply?