Changing Hudson Project

The Changing Hudson Project curriculum was developed by scientists and educators at The Cary Institute, to help students understand how the Hudson River changes over time. By collaborating with teachers, scientists, and management agencies, the curriculum has grown to include a wide range of topics that engage students with visualizations, readings, investigations, and actual scientific data.

Eutrophication http://www.caryinstitute.org/educators/teaching-materials/changing-hudson-project/pollution/day-12-eutrophication

Objectives

Students will know the difference between a pulse and a press event with regards to eutrophication and be able to graph the growth of algae over time.

Lesson Overview

1. Students discuss the implications of excess nutrients. 2. Students set up an experiment to observe eutrophication. 3. Every few days, students spend time counting algae under a microscope (alternatively, students can compare water color after a set amount of time)

Time:

Two 45-minute lessons, plus observation time daily

Setting:

Classroom

Materials

- 3 mason jars per group or beakers
- fertilizer
- graduated cylinders
- pipettes
- slides
- microscopes (or filter paper)
- pond water
- Optional: turbidity probe
- Optional: Nutrient Cycles powerpoint

Procedure

Preparation: You will need to obtain pond water for this experiment; if that is not possible you can substitute distilled water with added algae. You will also need a place for students to place their jars. This can be by a window or under grow lights.

Engagement: Ask students if they think it can be harmful to have too much of a resource? Examples for us include food and water. Discuss with students ways in which too much of a resource can be harmful to aquatic ecosystems.

Exploration: Have students set up experiments in groups. Each group will get three mason jars and a sample of pond water. Students should stir pond water and then pour the same amount into the three mason jars. Students should make observations about the amount of algae in each jar. Each student should obtain a slide and a microscope, and spend some time counting the number of algal cells they see. A turbidity probe is another option. Students should record their data in a data table. If you don't want to follow the procedure on the lab sheet with the microscope, you can 'quantify' the color of the water in the following manner: filter a sample of the pond water (generally 150-200 mL) through a paper filter, and then take a picture of the filter for future reference. The filter paper can be kept for later comparison as well.
Students will then add the amount of recommended fertilizer to jar 2, which will be the pulse jar. Jar 3 will be the press jar. Jar 1 will be the control and no fertilizer will be added. Student should place their jars in a place with adequate sunlight and will observe them for the next two weeks. Each time the students observe their jars they should fill out another data table and add more fertilizer to the press jar.

Explanation: Students should notice a spike in algal growth in jars 2 and 3. This can lead to a class discussion of algal blooms and their effects. Within the last century, humans have more than doubled the amount of fixed nitrogen that is pumped into the atmosphere every year. In addition to acid rain, nitrogen pollution contributes to the formation of ground level ozone (which can cause breathing problems), too much nitrogen in forests, groundwater contamination, and eutrophication of coastal waters.
Eutrophication is a process in which the ecosystem is enriched by nutrients, encouraging excess plant growth. This plant growth often strips the water of necessary oxygen, since microbes use up the oxygen as they decompose the excess plant material. Although eutrophication is a natural form of succession which usually takes hundreds or thousands of years, it can be enhanced through human inputs of nutrients. We call this 'cultural eutrophication'. As the pond becomes covered with surface vegetation, the organic matter settles at the bottom, slowly filling up the pond and causing low dissolved oxygen levels as decomposition takes place.
By increasing the amount of nutrients in an ecosystem, human activity can increase the rate of eutrophication. Fertilizers (including lawn fertilizer), pollution from sewers or septic tanks, agricultural runoff, and runoff from impervious surfaces can increase nutrient loads to the point where a pond becomes toxic. Algal blooms, anoxic conditions, and decreased biodiversity can result. Students have probably seen hyper-eutrophic ponds or lakes in the area, which are easy to spot, since they are often covered with a green layer of algae or other plant material.

Extension: After some time students should notice that jar 2 will recover from the large amount of algae while jar 3 will not. This can lead to a class discussion of the effect of a one time

pollution incident verse the continued pollution of a body of water.
Students can use the ' Eutrophication' reading as background for this lab. A powerpoint on nutrient cycles is also provided as extension material.

Evaluation: Students can graph their data, making a graph of amount of algae vs. time and plotting all three lines on one graph. They should submit the graph along with the experimental results and answers to the discussion questions. Make sure students can explain why algal growth increased, and what the possible implications of this might be for the aquatic system.

Lesson Resources

- [Worksheet](#) (pdf, 62 KB)
- [Nutrient Cycles in the Hudson Powerpoint](#) (pdf, 7 MB)
- [Worksheet answer key](#) (pdf, 15 KB)

NYS Standards

MST 1 - Mathematical analysis, scientific inquiry, and engineering design

MST 4- Physical setting, living environment and nature of science

MST 6- Interconnectedness of mathematics, science, and technology (modeling, systems, scale, change, equilibrium, optimization)

MST 7- Problem solving using mathematics, science, and technology (working effectively, process and analyze information, presenting results)

Benchmarks for Science Literacy

1B Scientific Inquiry

2A Patterns and Relationships

5E Flow of Matter and Energy

11C Constancy and Change

12B Computation and Estimation

12D Communication Skills

Related Reading
[Eutrophication](#)

Pollution: Eutrophication in the Hudson River

Objectives

Students will know the history of nutrient loading in the Hudson River, the consequences, and be able to recommend ways to reduce the levels of nitrogen and phosphorous in the future.

Lesson Overview

1. Students will discuss the implications of nutrient pollution on aquatic ecosystems. 2. Students will read and answer questions.

Time:
One 45-minute period
Setting:
Classroom
Materials

- Copies of worksheet

Procedure

Engage: Ask: What are the implications of high levels of nutrients in an aquatic system? Based on their experience with previous lessons, they should be able to answer this question. Ask: Do you think the Hudson is eutrophic? How could you find out?

Explore: Students will use the accompanying reading and graphs to answer a variety of questions about the nutrient levels in the Hudson River.

Explain: The Hudson River has always had problems with pollution, but the focus has shifted in the last twenty years from toxic substances to the control of nutrient pollution and consequent eutrophication. More than sixty percent of coastal waters in the U.S. are moderately to severely degraded by nutrient pollution, most of which originates in the interior of the U.S. Eutrophication from excess nutrients leads to decreasing biodiversity, increasing frequency of algal blooms, and degradation of water quality due to reduced dissolved oxygen levels. In the Hudson River, primary productivity has increased dramatically since the 1970s, and is considered eutrophic.

Extend: Students could research connections with human health.

Evaluate: Collect student answers to the reading.

References:
Howarth, R.W., Swaney, D., Butler, T.J., and Marino, R. 2000. Climatic control on eutrophication of the Hudson River estuary. Ecosystems. 3:210-215.

Howarth, R., Anderson, D., Cloern, J., Elfring, C., Hopkinson, C., Lapointe, B., Malone, T., Marcus, N., McGlathery, K., Sharpley, A., and D. Walker. 2000. Nutrient Pollution of Coastal Rivers, Bays, and Seas. Issues in Ecology. No. 7.

Howarth, R.W., Marino R., Swaney D., and E. W. Boyer. 2006. Wastewater and Watershed Influences on Primary Productivity and Oxygen Dynamics in the Lower Hudson River Estuary, in The Hudson River Estuary, Levinton & Waldman, editors. Cambridge Press.

Lesson Resources

- [Worksheet](#) (pdf, 252 KB)

NYS Standards
MST 1 - Mathematical analysis, scientific inquiry, and engineering design
MST 3- Mathematics in real-world settings
MST 4- Physical setting, living environment and nature of science
MST 6- Interconnectedness of mathematics, science, and technology (modeling, systems, scale, change, equilibrium, optimization)
Benchmarks for Science Literacy
1B Scientific Inquiry
2C Mathematical Inquiry
4B The Earth
11A Systems
11C Constancy and Change
12B Computation and Estimation
12C Manipulation and Observation
12D Communication Skills