NUTRIENTS AND WATER QUALITY

SUBJECTS:
Biology, Ecology

TIME:
Takes place over the course of about one month. Set up approximately two weeks ahead of experiment.

MATERIALS:
5 clear 1-qt or larger containers (plastic soda bottles or canning jars)
water with algae from a freshwater pond or purchased from a supply house
plant food
aged tap water (allow to sit about 48 hours)
light source (direct sunlight or strong artificial light)
pollutants: cooking oil (colored red), detergent (not green), vinegar
camera and film (optional)
student sheet

OBJECTIVES

The student will do the following:

1. List changes in water conditions caused by various pollutants, such as household chemicals, that often end up in aquatic environments.

2. Describe potential effects on animals and plants caused by these pollutants.

3. Classify sources of pollution.

BACKGROUND INFORMATION

Two nutrients that are essential for the growth and metabolism of plants and animals are nitrogen (N), and phosphorus (P). Plant growth depends on the amount of phosphorus available. Phosphorus is present in low concentrations in numerous bodies of water, so it is a growth-limiting factor. Since nitrogen is found in several forms, it is frequently more available than phosphorus. Nitrogen is used by plants to make plant proteins, which animals convert into their own proteins when they eat the plants.

Even though nutrients are needed, too much nutrient material in the water can cause pollution. Algae use up phosphorus quickly. When there is excess phosphorus, a vast growth of algae called an algal bloom can occur. The water may then look like pea soup. The algae rob the water of oxygen needed to sustain life. Some forms of nitrogen can cause similar problems in water.

There are several ways that excess nutrients get into the water. Both nitrogen and phosphorus are part of living plants and animals and become part of organic matter when the plants and animals die and decompose. Nutrients come from human, animal (including pet), and industrial wastes. Other sources of nutrients are human activities that disturb the land and its vegetation, such as road and building construction, farming, and draining of wetlands for development. Normally, nutrients are held in the soil and stored in the wetlands. When soil erodes and washes away, it carries the nutrients along until it ends up in the water. If wetlands are drained for development, they can no longer filter nutrients from runoff.

Terms

nutrient: an element or compound, such as nitrogen, phosphorus, and potassium, that is necessary for plant growth.

algal bloom: a heavy growth of algae in and on a body of water; usually results from high nitrate and phosphate concentrations entering water bodies from farm fertilizers and detergents; phosphates or algal blooms also occur naturally under certain conditions.

point source pollution: pollution that can be traced to a single point source, such as a pipe or culvert (Example: industrial and wastewater treatment plant discharges).

nonpoint source pollution (NPS): pollution that cannot be traced to a single point, because it comes from many individual places or a widespread area (Example: urban and agricultural runoff).

ADVANCE PREPARATION

A. Set up jars at least two weeks before the experiment begins. Explain to the class that they are setting up model water environments for an experiment to be done later. Plants in a wetland or other aquatic system need nutrients to grow. Nutrients are found in all natural systems. Fill the jars with aged tap water. Add one teaspoon of plant food to each jar and stir well.

B. To improve the quality of the model, use pond water or try adding a bit of soil from a pond or aquarium gravel along with the water. Place the jars in a window where they will get good indirect light or light provided by an incandescent or fluorescent light source. The jars should not be placed in a cold location.

C. Explain to the students that they will be using the model aquatic environments to test the effects of certain pollutants that come from home. Students should decide on household products to use—products that they feel are used frequently, are often dumped down the drain, and thus end up in waterways. Students should bring samples of these materials from home.

PROCEDURE

I. Setting the stage

A. Begin with a classification exercise explaining that students are to organize what they already know about pollution. Some water pollution comes from specific sources such as drains, pipes, effluent from industry—outfalls. This is called point source pollution. Other kinds of pollution come from many widespread sources and are called non-point source pollution. Write these terms on the chalkboard making two columns. Have students suggest things that pollute the water and place them in categories in the chart.

B. Explain that students will conduct pollutant tests with the models set up two weeks ago.

II. Activity

A. Take out the jars, which by now should have algae growing in them. Have the class decide on three safe pollutants to test—use more plant food for the fourth jar, use the fifth jar as a control. When the class has decided what to test, add the materials to the four jars. Add a reasonable amount: two tablespoons of a strong detergent; enough oil to just cover the surface; 1/4–1/2 cup of vinegar; one or two teaspoons of plant food. Ask students to explain how each pollutant could get into the environment in real life.

B. Leave the jars in the light as before. Have the students write their predictions as to what will happen in each container. Photograph the jars (with labels and dates showing) two or three times each week for several weeks.

III. Follow-Up

A. Results will depend on the type of pollutant used.

1. Some pollutants, such as the plant food, favor plant growth and will cause an algal population explosion. This is not healthy since it disrupts the balance of organisms. When the algae die and decompose, oxygen is used up. Ask students to name some plants and animals that would be affected by this situation. Oysters and clams would suffocate because they are unable to move to another location to get more oxygen. A thick mat of algae will block out sunlight needed by other plants.

2. Other pollutants, such as acids, would cause the water to be clear since everything in the water would be killed.

3. The sample with the oil spill may surprise students. If the algae have enough sunlight, they may produce enough oxygen to keep things alive below the oxygen-impervious oil layer. Ask students to consider the effects of a larger spill—ducks and other birds would become coated with oil and not be able to fly, fish gills would be clogged, etc. Ask the students for their conclusions.

B. Human activities which result in water pollution can affect the water environment in ways that are disastrous for natural communities. Some nutrients are necessary for an aquatic habitat, but having too many is harmful. Have the students explain how.

IV. Extensions

A. Ask students whether or not they can devise a method to reverse the pollution in their models. (Example: Add baking soda to the acid model to neutralize the acid, which is similar to adding limestone rocks to lakes or streams to lessen the effects of acid rain. Example: Mop up the oil spill with sawdust, cotton, etc. Could students skim off the oil from their model and let oxygen through again?)

B. Discuss ways to keep pollutants from reaching the water and ways to reduce the amounts that do get through.

RESOURCES

"What's In the Water?" Living In Water, pp. 55-57.

WOW!: The Wonders of Wetlands, pp. 80, 87-89.

Directions: Record your observations of changes in water conditions caused by pollutants.

	3 days	6 days	9 days	12 days	15 days	18 days	21 days
Jar #1 (1 tsp. plant food added — pollutant added is motor oil)							
Jar #2 (1 tsp. plant food added — pollutant added is strong detergent)							
Jar #3 (1 tsp. plant food added — pollutant added is vinegar)							
Jar #4 (1 tsp. plant food added — pollutant is 2 more tsp. plant food)							
Jar #5 (1 tsp. plant food added — no pollutant added. This is the control.)							