CLEAN CLOTHES - CLEAN ENVIRONMENT? PHOSPHATES

9-12

OBJECTIVES

The student will do the following:

1. Develop a survey form.
2. Collect data on consumer use and knowledge.
3. Design graphs using collected data.

SUBJECTS:
Science (Chemistry, Biology), Math, Social Studies (Economics)

TIME:
2 class periods

MATERIALS:
paper
pencil/pen
computer (optional to organize data)
labels from detergent products
examples of various detergents
dish and laundry survey form for consumers (student developed)
data collection table (student developed)
water or phosphate analysis kit (if water survey is desired)

BACKGROUND INFORMATION

Phosphate is a nutrient necessary for plant and animal growth. Almost all fertilizers contain phosphates. When it rains, varying amounts of phosphates wash from golf courses, sod farms, and farm soils into nearby waterways. Phosphates stimulate the growth of plankton and water plants that provide food for fish. This may increase the fish population and improve the waterway's quality of life. When too much phosphate is present, algae and water weeds grow wildly and choke the waterway, using up the large amounts of oxygen and causing many aquatic organisms to die.

The phosphate cycle is said to be "imperfect" because not all phosphates are recycled. Some simply drain into lakes and oceans and become lost in sediments. Phosphate loss is not serious because new phosphates continually enter the environment from other sources.

Phosphates are used in fertilizers, pesticides, industry, and cleaning compounds. Natural sources of phosphates are phosphate-containing rocks and solid or liquid wastes. Phosphates enter waterways through human and animal wastes (the human body releases about a pound of phosphates per year - or billions of pounds per year from the world's population), phosphate-rich rocks, wastes from laundries, cleaning and industrial processes, and use of farm fertilizers and pesticides. Phosphates also are used widely in power plant boilers to prevent corrosion and the formation of scale.

Phosphates will not hurt people or animals directly unless they are present in very high concentrations. Even then, they will probably do little more than interfere with digestion. It is doubtful that humans or animals will encounter enough phosphate in natural waters to cause any health problem.

Total phosphate consists of organic and inorganic phosphates. The organic phosphate is formed in living or dead plant and animal tissue. Organic phosphates are important in nature and also may result from the breakdown of organic pesticides containing phosphates. Inorganic phosphate is found in soil, water, and human-produced materials (detergents). Other forms of phosphate are produced by natural processes and are found in wastewater. Poly forms are used for treating boiler water and in detergents and can break down into simpler forms in water.

A certain amount of phosphate released into a stream or river is immediately taken up by algae and plants. Too much phosphate results in excessive growth of plants and causes algal blooms. When plants die, bacteria and other microbes increase in order to break down the organic material. These microorganisms consume available oxygen that, in turn, results in the death of larger aerobic organisms such as fish. This process is called eutrophication. If eutrophication continues, the aquatic system becomes anaerobic, which gives off the rotten egg odor produced by hydrogen sulfide gases. Eutrophication occurs naturally at a very slow pace. Human interference can speed the process by introducing improperly treated sewage, industrial waste, or runoff from feed lots and farmland into receiving waters..

This activity concentrates on the phosphates in detergents. In recent years, some detergents have added to their advertising claims comments such as, "Contains no phosphates" or "Low in phosphates." What are these phosphates, and what is all the fuss about? If they are so bad, then why have they been used in detergents? If they are or were in detergents, then how can they lead to water pollution? Compounds containing phosphate ions are usually associated with the need for high energy substances such as detergents and fertilizers. Phosphates have been used to improve the cleaning power and sudsing ability of detergents. We have culturally associated "lots of suds" with ability to clean, but this is not necessarily true. Now the makers of detergents are trying to sell their product based on their low or lack of phosphate content.

This activity will allow students to research the sources of these phosphates, survey consumer knowledge, and evaluate the impact on our waterways.

Terms

algal bloom: a sudden increase in the amount of algae, usually causing large, floating masses to form. Algal blooms can affect water quality by lowering DO content and decreasing sunlight penetration, are usually caused by excessive nutrient addition, and can be characteristic of a eutrophic lake.

eutrophication: the process in which a body of water becomes oxygen deficient, nutrient-rich, and supports an abundant growth of surface aquatic plants and algae; natural aging cycle of lakes, normally taking centuries, but it can be rapidly accelerated when outside sources of nutrients are added, such as wastewater, fertilizer, or feed lot runoff.

phosphate: an ion composed of a phosphorus atom with 4 oxygen atoms attached (PO_4^{-3}). It is an important plant nutrient.

ADVANCE PREPARATION

A. List terms and definitions on the board.

B. Copy and discuss Background Information with students.

C. Have students bring in labels from detergent products.

PROCEDURE

I. Setting the stage

A. Assign students to work in groups. Have them compile data on different detergents, including cost, phosphate content, and phosphate-related advertising claims (e.g., "free of phosphates" and/or ability to create suds).

B. Students should collect data from all types of cleaning products, such as laundry detergents and dishwasher detergents. Predetermine the minimal number they must examine.

C. Students should then compile data in table form and, if possible, graph form. (A bar graph would work well .)

D. Have students determine if there are any local or regional phosphate-detergent bans in place. What do they prohibit? Get state/local environmental officials to discuss the ban's effectiveness. Wastewater treatment plant data should show the effect of the ban if phosphate (or total phosphorus) concentrations before and after the ban are evaluated.

E. Have students design a survey form or questionnaire asking 25 people (different families):

1. Their choice of laundry detergent and dishwasher detergent.

2. Why they use that detergent. (List top three reasons.)

3. If they are aware of the effect of excessive use of phosphates.

4. Would they change detergents if their current choice were high in phosphates? Students can survey their own family and one neighbor. Do they consider cost, phosphate content and/or other factors when choosing a detergent?

F. Students will share survey results with the group and then with the class. Have groups or the entire class analyze the compiled data and draw conclusions.

G. Compare the consumer data and determine if any relationship exists among choice and cost, phosphate content, and/or other factors.

III. Follow-up

Students can analyze local rivers or lakes within the watershed for phosphate content and algal growth using a water testing kit from a supply company. This data can be compared with choice of detergents and conclusions should be drawn. Be sure to ask students if the phosphates could be coming from anywhere else.

A. Each group will turn in a report of data and conclusions.

B. Students may bring in samples of surface waters and add different detergents to each and see if there is an algal growth difference between the different detergents.

IV. Extensions

Students might want to analyze the wastewater treatment systems of upstream and downstream communities to see if there are specific processes used to reduce phosphorus. If so, they should see small phosphorus increase downstream of effluent discharge. If no phosphorus removal, they may see significant increase in stream phosphorus concentration (depending on flow of plant and flow of stream).

RESOURCES

Arms, Karen, Environmental Science, Holt, Rinehart, and Winston, Inc., Austin, TX, 1996.

Chiras, Daniel D., Environmental Science, High School Edition, Addison-Wesley, Menlo Park, CA, 1989.

Water Analysis Kit, page F-69, Water Testing Fact Sheet