ABSTRACT

Students test local watersheds for possible sources of pollution. Groups of students survey a small watershed in their area, testing the water for specific chemicals including dissolved oxygen, pH, nitrate, ammonia, chlorine, and phosphate. Students determine if there are pollution problems in the watershed, identify the types of pollution, and determine if the pollution originates from point sources or non-point sources. After analyzing data, the class makes recommendations to town or city planners on steps to correct the pollution problems.

TIES TO CURRICULUM

In addition to integrating concepts in social studies, English, mathematics, and technology, this lesson incorporates several *National Science Education Standards* relating to scientific inquiry. Students learn to apply the concepts and processes of inquiry as they explore the local environment and its ecological connections.

LEARNING OBJECTIVES

Students will learn to

- explain pH, dissolved oxygen, point source and non-point source pollution, fertilizer run-off, siltation, and watersheds;
- sample local waterways for various chemicals and interpret results;
- identify possible point sources of pollution;
- find additional testing sites to locate changes in water quality;
- describe wetlands' impacts on water quality;
- research methods to reduce or eliminate point and non-point sources of pollution; and
- make formal presentations to the town/city planners on local water quality.

NUMBER OF LAPTOPS AND GROUP SIZE

Use one laptop for every group of four to six students.

TIME REQUIREMENT

Conduct *Watershed Biology* twice a month for the semester, for a long-term project. Time estimates are as follows:

Task	Time	Location
Introduction	2½ hours	Classroom
Water sampling	2-3 hours	Field
Data analysis	1½ hours	Classroom
Presentations	2 weeks	Classroom/homework

LESSON DESCRIPTION

MATERIALS

- Laptop computers
- Word processing and spreadsheet software
- Probes (PASCO, Vernier, etc.) for dissolved oxygen, pH, nitrate, phosphate, ammonia, chlorine, and turbidity
- Large buckets (approximately 20 liters)
- Liquid fertilizers or cleansers
- Adapter boxes
- Local topographic maps showing streams
- Watertight plastic bags

Teacher Preparation

Prepare a lab activity to use on the last day of the introduction to demonstrate chemical probes and pollution sources. Fill 6–12 20 liter buckets with water and number the buckets. Use liquid fertilizer or liquid cleansers as the pollution. Set up the series of buckets in a row with enough room around each bucket for a group of students to gather. Place a detectable amount of the pollutant in one of the buckets. Make sure a "trail" of the pollutant can be found in diminishing quantities in each subsequent bucket. The further from the point source, the less the amount of pollutant. You may also want to have a background amount of another pollutant in all the buckets to demonstrate a non-point source as well. Never combine an ammonia-containing product with a chlorine based product. This produces toxic vapors!

Introduction

Using local topographic maps, introduce students to the concept of watersheds and different types of pollution. As a class, choose a nearby stream area from a local topographic map. Divide students into groups of four to six students. Ask each group to determine the watershed for the chosen stream and mark the area on a copy of the topo map. Groups should examine land uses in the watershed, and speculate what types of pollution may be found in the stream, as well as any possible sources of that pollution. The groups should sort the items on their lists into "point-source" and "non-point source" types of pollution.

Introduce students to chemical tests of water quality such as pH, dissolved oxygen, phosphate, nitrate, ammonia, chlorine, and turbidity. Discuss the impact of these factors on local aquatic life, including the range of safe and harmful concentrations of each factor. Introduce possible sources for various types of pollution. Students can locate specific point sources of pollution when in the field.

Use the final day of class preparation to demonstrate how to set up and use the various field probes and adapter boxes. Students can practice taking measurements from a series of containers and evaluate the data to locate where in this "stream" of buckets pollution has entered the water system.

Student groups use their probes to take samples of all the buckets, and try to locate the source of the pollution. Have some of the groups work "upstream" and others "downstream." They can sample each bucket, or they can skip a few. One good technique is to measure the beginning, middle, and end of the "stream" and use those results to decide where to test next. Groups should graph their results. Review the results and help students understand what the graphs show.

Suggest that students select starting test locations on the topographic map of the stream area before going into the field. Give the students guidelines on when they may want to go back between sample points to take additional samples. Significant changes in readings indicate that they should backtrack about halfway between sample sites for additional data.

Activity

At the field site, give each group the watershed map. Review the activities and, if possible, arrange for a naturalist to give students a brief orientation to the field site. Give each group a laptop computer, an adapter box, a set of probes, and assign groups to portions of the watershed. One student in each group should be responsible for recording data on the laptop computer, and keeping the laptop clean and dry. Other students will collect data and each will be responsible for the adapter and probes.

LESSON SUGGESTIONS

- After the class determines which stream area to test, contact park rangers or the local Department of Conservation to arrange for a naturalist to give students a brief orientation to the field site.
- During water sampling, students and teachers should be dressed in proper field clothes (old shoes and clothes that can get muddy and wet).
- Keep the laptop dry and clean. The student in each group designated to carry the computer should stay back away from the water's edge and keep the computer in its case until needed. Use the computer on a small drop cloth on flat ground.
- Each group should carry a topographic map of the area in a waterproof plastic bag. Students should be familiar with reading topographic maps and using a compass.

The group will start at the predetermined sampling points, and head out with an adult leader as an observer. Give groups sufficient time (about an hour) to complete a survey of their portion of the waterway, and set a deadline to report back to the meeting place. Groups will take their measurements from the first site and review them on the laptop. Based on the data it obtains, each group can decide if it needs to move a short distance or long distance up or down the waterway for the next sample. Groups will continue moving along the waterway until each has surveyed its entire portion of the stream, or has run out of time. The class should return to sample the stream twice a month for the rest of the semester to collect long-term data on water quality.

Data Analysis and Presentations

Back at school, groups outline results on a master watershed map. The class can then discuss what pollution was found, and the origin of the pollution. How far along the waterway are detectable levels of polluting chemicals found? Do chemical levels change with the weather? Are there any apparent effects of these pollutants, and do students predict other effects on the ecosystem? Any trends or consistent problems will become apparent after several months of data collection. Encourage groups to develop a plan to address pollution problems.

At the end of the semester, each group will develop a brief presentation (5–10 minutes) on a pollution problem, and make recommendations to correct the problem. Groups should also submit a written report of the findings, with introduction, method, materials, data, and conclusions. The final report should identify the type of pollution found, the pollutant's impact on the environment, whether the pollution stems from a point source or non-point source, and the location of any point sources. In instances where no significant pollutants were found, the class should address seasonal concerns about turbidity, water temperature, and oxygen levels.

REFERENCES

Books

Crowder, Jane N., and Joe Cain. *Water Matters, Volume 2*. Arlington, VA: National Science Teachers Association, 1997.

Kaufman, Sue C. *Water Matters, Volume 1*. Arlington, VA: National Science Teachers Association, 1994.

National Research Council. *National Science Education Standards*. Washington DC: National Academy Press, 1996.

Web sites

Global Rivers Environmental Education Network: http://www.econet.org/green/

Give Water a Hand. University of Wisconsin's national watershed education program: http://www.uwex.edu/erc/

Hach Company. Equipment for water quality monitoring: http://www.hach.com/

LaMotte Company. Educational water quality kits: http://www.lamotte.com/

PASCO Scientific: http://www.pasco.com/

Save Our Streams. Sponsored by the Izaak Walton League of America: http://www.iwla.org/sos/

continued on page 5

The class can vote on the best presentations to be given at the local nature center and, if possible, the city or town council.

ASSESSMENT

Assess students on group presentations and final reports. Students should use and interpret graphs and other data collected in presentations. Students will need to understand the source, cause, and impact of the pollution to properly develop a method of correcting the problem. Additional assessment checkpoints during the course of this lesson might include vocabulary testing, a final bucket stream lab practical, graph interpretation tests, or other written simulations.

REFERENCES, cont'd.

USGS's Water Science for Schools: http://wwwga.usgs.gov/edu/indexjs.html

Vernier Software: http://www.vernier.com/