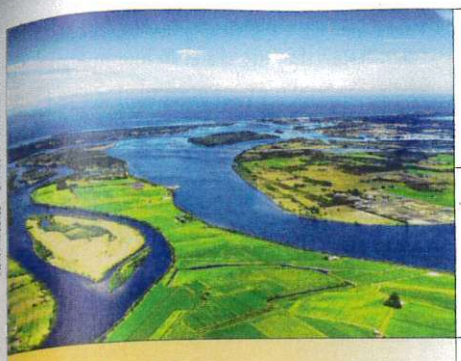


Sum of the Parts

The good news is that you've inherited valuable riverfront property. The bad news is that the beach is polluted! Where did all this stuff come from?

Grade Level
Upper Elementary, Middle School

Subject Areas
Environmental Science, Government

Duration
Preparation time: 50 minutes
Activity time: 50 minutes

Setting
Classroom

Skills
Gathering information (observing); Organizing (arranging); Analyzing (identifying components); Interpreting (identifying cause and effect); Applying (proposing solutions)

Charting the Course
Supplement this activity with activities on runoff ("Just Passing Through," "A-maze-ing Water" and "Rainy-Day Hike), watershed and river flow factors ("Seeing Watersheds" and "Blue River") and water use practices ("Common Water"). Aspects of water quality monitoring are introduced in "Macroinvertebrate Mayhem" and "Water Quality? Ask the Bugs!"

Vocabulary
point source pollution, nonpoint source pollution, Best Management Practices (BMPs), watershed, erosion, erode, sediment, turbidity, vegetative cover, drainage basin, flow, contaminant, policy maker, water manager, runoff

Summary

Students demonstrate how everyone contributes to the pollution of a river as it flows through a watershed and recognize that through individual and group action, the amount of pollution can be reduced.

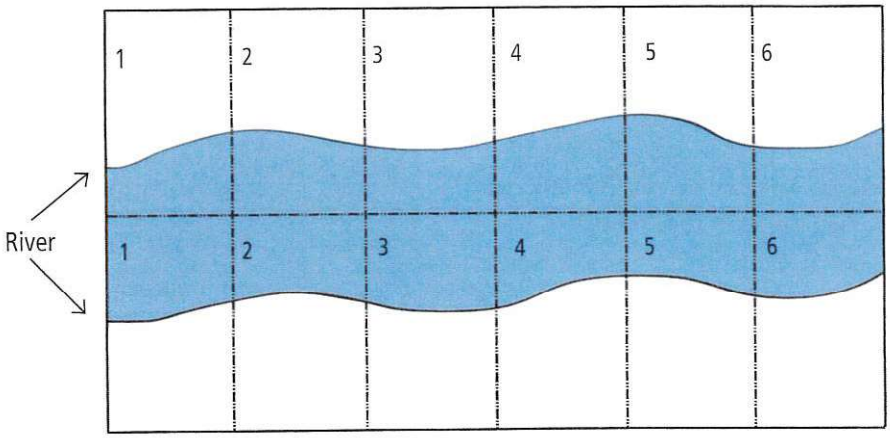
Objectives

Students will:

- differentiate between point and nonpoint source pollution.
- recognize that everyone contributes to and is responsible for a river or lake's water quality.
- identify Best Management Practices to reduce pollution.

Materials

- *Large piece of poster board or newsprint* (Using a blue marker, draw and color a river on the poster board, as shown below. Divide the stream in half down the middle and crosswise into sections. Each section should include a portion of river and some blank space to allow room for student drawings. The number of sections should correspond with the number of students or groups of students working together. Number the sections on both sides of the river identically in sequential order, placing numbers in the upper left-hand corner of each segment—the ones should face each other, with the twos next to them and so forth. Cut out the sections of stream. For durability, sections can be laminated.)
- *Drawing pens and pencils*
- *Items from students' desks (e.g., pencil, paper clip, book)*



Making Connections

In math class, students add a list of figures to obtain a total or "sum" (of the parts). Most students have attended a large gathering such as a concert or sporting event and may have been amazed at the amount of garbage left behind. Each person in attendance probably did not leave much on the ground, but with hundreds of people (or more!) doing the same, the total amount was large. Taking a closer look at how students can positively or negatively contribute to water quality helps them appreciate their role in water quality management.

Background

The quality of water in a river or lake is, to a large extent, a reflection of land uses and natural factors found in its watershed. If soil near a river or lake naturally erodes, chances are the river has sediment and turbidity problems. If the land has stable vegetative cover, erosion is kept in check. When humans settle and develop land, water quality can be affected. Breaking sod, cutting forests, building cities, mining and other ways that we use the land can have an impact on water quality.

Everyone bears responsibility for the health of a watershed and the water systems (rivers, lakes, wetlands, etc.) within a drainage basin. Individual actions, both negative and positive, add up. Understanding a river or lake's water quality and quantity involves investigating the condition of the contributing watershed. If the watershed is polluted, sections of the river will likely be polluted.

Watershed investigations are conducted for many reasons. Some investigations monitor changes in river and stream flows over time to protect fisheries, regulate floods or meet seasonal demands. Other studies determine the best method of protecting a river or lake from pollutants. One aim of a researcher might be to determine which areas of a watershed contribute the highest percentage of contaminants. This information is vital to policy makers and water managers when they make decisions about how best to spend money for improvements. For example, most lake improvement projects address problems in the watershed as well as those in the lake. It would prove fruitless to spend thousands (or even millions) of dollars to clean up a lake if problems in the watershed will only pollute the lake again.

When watershed managers investigate land use practices that might affect the quality of water, they are concerned with two general sources of pollutants: point and nonpoint.

Point source pollution involves pollutants that are discharged from, and can be traced back to, an identifiable point or source, such as a factory's discharge pipe or a sewage ditch. Nonpoint source (NPS) pollution occurs when the source of a contaminant is unidentifiable; that is, the pollutant might have come from one of many places. Examples of nonpoint source pollution include runoff from agricultural fields containing fertilizers and pesticides, motor oil filtering from urban areas and sediments from eroded stream banks.

Surface runoff and ground water can transport both point and nonpoint source pollutants. Since point source pollutants are identifiable, they are easier to monitor, and environmental protection regulations and laws may be enforced.

The protection of surface and ground water resources from NPS pollution presents an enormous challenge because of the widespread and diverse nature of the problem. Land and water managers rely on methods called Best Management Practices, or BMPs, which describe land use measures designed to reduce or eliminate NPS pollution problems. A list of nonpoint source pollution sources and suggested BMPs can be found in the sidebar later in the activity.

In the United States today, laws and regulations on the local, state and federal levels have been developed to help guide development towards environmentally friendly approaches. The days of building a manufacturing plant along a river and dumping untreated waste into that waterway are over. Individuals and organizations that do not adhere to the laws are subject to formal legal action, penalties and restoration costs. America's waterways are better protected now than they were half a century ago, and our understanding and public support for clean water continues to grow.

PHOTO CREDIT: © iStockphoto–Thinkstock Photos

Everyone bears responsibility for the health of a watershed and the water systems within a drainage basin.

Demonstration: Have students form a line. Each student should take one item (for example, a pencil or piece of paper). Starting at the student who is most "upstream," have students pass the items to the "downstream" students. The students near the end of the line will accumulate more and more objects.

Procedure

Warm Up

- Determine student knowledge about watersheds by asking them to name several major North American rivers (e.g., Mississippi, Columbia, Missouri, Hudson, Rio Grande). Where do these rivers originate (where are the headwaters) and end? How many states does each cross or touch?
- Discuss some of the predominant types of land usage along one river as it flows through a single state. Do students think these practices could affect the river? What do students think the attitude of downstream state residents might be about the water they receive from their upstream neighbors?

The Activity

1. **Inform students that they have just inherited a piece of riverfront property and one million dollars. Have them list ways they could use the land and the money.**
2. **Pass out "pieces" of property and drawing pens and pencils. Explain that the blue is water and the blank space is land they own. They have one million dollars to develop their land as they wish.** They can farm or ranch; build resorts, homes, factories or parks; log, mine or plant forests—whatever they like.
3. **When students have completed their drawings, ask them to look in the upper left-hand corner of their property for a number. Explain that each piece is actually a part of a puzzle. Have students assemble their pieces starting with number one.** They will construct the stream pathway and adjacent land area in proper order.
4. **Have students describe how they developed their land and how they used water. They should identify any of their actions that polluted or added materials to the waterway. Have students choose items from their desk (e.g., a book, piece of paper, pen, pencil) to represent each of their contributions to the river.**
5. **Tell students to take their item(s) and line up in the same order as their pieces of riverfront property. They are going to pass their pollution pieces downstream. Have them announce what kind of pollutant they are holding before they pass it on.** The ones will pass their item(s) to the twos; the twos will pass everything to the threes and so on, until the last students are holding all the items.

Wrap Up

- After all the items have reached the final students, discuss the activity. How did those students toward the middle or at the end of the river feel? What about their property use plans? Could a student downstream be affected by the actions of a student upstream? Could upstream users alter the water quality of those downstream?
- Tell students to reclaim their items. Explain that the items easily identifiable as their own symbolize point source pollution. Other items (e.g., pencils, paper clips, notebook paper) may be more difficult to claim, because these kinds of pollutants originated from multiple sources. Tell students these represent nonpoint source pollution.
- As a follow-up, ask students to write a paragraph detailing ways they might reduce the amount of pollution they contributed. (Share the major sources of NPS pollution and the BMPs from the sidebar on the next page.)
- Students can research the regulations governing waterfront property in their communities. If they believe their waterways are being poorly treated, they may want to write letters to local government officials in support of environmentally sound land use legislation.

Project WET Reading Corner

Bial, Raymond. 2000. *A Handful of Dirt.* New York, NY: Walker & Company.

Using outstanding photographs and text, this book presents the nature and importance of soil and the many life forms it supports, emphasizing just how fragile this crucial natural resource is.

Burnie, David and Tony Juniper. 2004. *Endangered Planet.* New York, NY: Kingfisher/ Houghton Mifflin Company.

Burnie and Juniper explore the human impacts on habitats and various natural cycles.

Burns, Loree Griffin. 2007 *Tracking Trash: Flotsam, Jetsam, and the Science of Ocean Motion.* Scientists in the Field Series. Boston, MA: Houghton Mifflin Books for Children.

Learn how human trash ends up in the oceans, and follow it as it is picked up and transported by the currents.

Desonie, Dana. 2008. *Biosphere.* New York, NY: Chelsea House Publishers.

This extensive volume describes the dramatic changes that are happening among Earth's organisms as a result of human activities.

Frost, Helen. 2000. *Keeping Water Clean.* Mankato, MN: Pebble Books.

Text and color photos examine the causes and effects of water pollution.

Grahame, Kenneth. 1908. *The Wind in the Willows.* New York, NY: Signet Classics.^

A classic tale about the adventures of a group of animals who live along a riverbank, in wetland habitats and in other low-lying areas.

Harper, Joel. 2006. *All the Way to the Ocean.* Claremont, CA: Freedom Three Publishing.

This colorful book illustrates how things that go into storm drains often end up in the ocean. Sold through the Project WET Store.

Major Sources of NPS Pollution and BMPs

Source	Best Management Practices
Roads and Streets	• dispose of paints, solvents and petroleum products at approved disposal sites, not in storm drains or street gutters • fix automobile oil and fuel leaks • stop oil dumping on rural roads • use nonchemical deicers (sand and ash) on roads, sidewalks and driveways • construct a sediment catch basin to collect storm water runoff • reduce road construction runoff by building terraces and catch basins and by planting cover crops
Agriculture	• read and follow all labels, and ask for application directions before using chemicals, fertilizers and pesticides • use conservation tillage • use contour farming • use strip cropping • leave filter strips and field borders along wetlands and streams • use a cover crop to protect exposed soil • rotate crops • plant shelter belts and windbreaks • institute pasture management • terrace areas prone to erosion • construct livestock waste collection and treatment ponds for confined livestock • use grassed waterways • seal abandoned wells and waste disposal wells • fence waterways to reduce the impact of livestock on riparian zones
Logging	• monitor water entering and leaving cut areas • prevent sediments from reaching streams and lakes by building terraces, catch basins and natural filters

Source	Best Management Practices
	• leave a vegetative buffer zone in riparian areas • maintain and restore effective watersheds • implement a plan to reduce erosion from roads
Mining	• monitor all water entering and leaving mine sites • intercept and reroute uncontaminated water away from contaminated areas • construct catch basins and terraces and plant cover crops to catch sediment and prevent erosion • catch and treat contaminated water • stabilize stream channels • stabilize mining waste areas to prevent release of materials into streams • maintain buffer strips along streams
Construction	• implement a sediment control plan • plant ground cover to reduce erosion • dispose of solvent, paint and other wastes at approved disposal sites • build temporary, small dikes to slow and catch runoff • build sediment catch basins to collect construction runoff • build earth berms and filter runoff before water enters stream
Residential	• use nonchemical deicers (sand and ash) on residential driveways and sidewalks • read labels prior to using pesticides and fertilizers • consider xeriscaping (landscaping that utilizes indigenous and drought-tolerant plants) • use nonchemical fertilizers (compost) on gardens • dispose of household hazardous waste at approved disposal sites • maintain septic tanks if sewers are not available

Hewitt, Sally. 2008. *Using Water*. New York, NY: Crabtree Publishing Company.

By examining such topics as the water cycle, watersheds, droughts and pollution, Hewitt demonstrates that fresh drinking water can be rare.

Moore, Peter D. 2006. *Wetlands. Biomes of the Earth.* New York, NY: Chelsea House Publishers.

Moore discusses a broad range of topics related to wetland ecology and use, including environmental threats to these ecosystems.

Olien, Rebecca. 2005. *Making Water Clean.* Mankato, MN: Capstone Press.

Learn how water is drawn from a source and rendered clean enough for drinking.

Project WET Foundation. 2003. *Watershed Protection*. Bozeman, MT: Project WET Foundation.

This illustrated booklet explains what watersheds are and how they can be protected.

Project WET Foundation. 2005. *Discover Bays and Estuaries*. Bozeman, MT: Project WET Foundation.

Learn about bays and estuaries and the creatures that live in them, including why they are so important to modern society and how we can protect them.

Project WET Foundation. 2005. *Discover Storm Water*. Bozeman, MT: Project WET Foundation.

If you have ever wondered where the rain or melted snow on your street goes and what effects it might have, you can find out by reading this illustrated children's booklet.

Richardson, Gillian. 2009. *Ecosystems*. New York, NY: Weigl Publishers, Inc.

This book uses a question and answer format to help define ecosystems and their key components.

Solway, Andrew. 2009. *Waste Disposal.* Mankato, MN: Black Rabbit Books.

How do we solve the problems of dealing with the stuff we throw away? And how do the methods of modern and developing nations differ?

Stille, Darlene R. 2005. *Erosion: How Land Forms, How It Changes.* Mankato, MN: Compass Point Books.

Learn about both natural and human-caused erosion and their effects.

Strauss, Rochelle. 2007. *One Well: The Story of Water on Earth.* Tonawanda, NY: Kids Can Press.

A broad look at water today and how Earth can literally be a well from which we all draw the water we need to survive.

Talbott, Hudson. 2009. *River of Dreams: The Story of the Hudson River.* New York, NY: Putnam Juvenile.^

Read about how the Hudson River played an important role in the settling and founding of our nation.

Woods, Michael and Mary B. Woods. 2008. *Environmental Disasters.* Minneapolis, MN: Lerner Publications.

Examine the short- and long-term effects of some of our worst environmental disasters and how science might help prevent these in the future.

^Listed on one or more state reading lists.

Assessment

Have students:

- express their opinions about individual contributions to total water quality (***Wrap Up***).
- write a paragraph identifying what they can do to protect water quality (***Wrap Up***).
- discriminate between point and nonpoint source pollutants (***Wrap Up***).

Upon completing the activity, for further assessment have students:

- design a community that uses Best Management Practices, resulting in minimum contribution of pollutants to their waterways.

Extensions

Have students physically represent a lake system rather than a river. One student acts as a lake. A group of students encircles the student; they are houses around the lake. Other students, standing in lines extending from the lake, can be streams flowing into the lake. Students pass their item(s) downstream and into the lake until all the items are held by the person in the middle.

Have students adapt the activity to represent a river system that includes tributaries flowing into a main channel.

Complete the main activity with students representing real water users within their watershed. Or assign generic roles (farmers, suburban dwellers, etc.) to students and have them develop their land accordingly. How would they manage their land to protect water resources?

Share the BMP list with the students again. Ask them which of the BMPs could be applied to their own actions and those of their household. How can BMPs designed for organizations be adapted for individual and family use?

Teacher Resources

Journals

Farenga, Stephen J. and Daniel Ness. 2007. "After the Bell: Making a Community Information Guide about Nonpoint Source Pollution." *Science Scope*, 30 (5), 12-14.

McDonnell, Janice, Ravit Duncan, C. Sage Lichtenwalner and Laura Dunbar. 2010. "The Hudson River Plume." *Science Teacher*, 77 (9), 42-47.

McEwen, Margaret and Julia Czyz. 2008. "Science Sampler: Environmental Stewardship in Action." *Science Scope*, 31 (8), 55-57.

Schaaf, Sherry. 2005. "How Clean Is the River?" *Science and Children*, 42 (5), 18-22.

Sprangers, Donald. 2004. "Saving the Salmon." *Science Teacher*, 71 (5), 26-27.

Websites

United States. Environmental Protection Agency. Nonpoint Source Pollution: The Nation's Largest Water Quality Problem. This site has up-to-date information on nonpoint source pollution in the United States. http://water.epa.gov. Accessed February 22, 2011.