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8-4-1, One for All

Eight water users, four common water needs…and one river to serve them all.

Grade Level
Upper Elementary, Middle School, High School

Subject Areas
Social Studies, Environmental Science, Government, Geography, Language Arts

Duration
Preparation time: 45 minutes
Activity time: 45 minutes

Setting
Classroom or open area

Skills
Gathering information; Organizing; Analyzing; Interpreting

Charting the Course
"Seeing Watersheds" defines watersheds, and "Blue River" discusses how river flow is influenced by seasonal variations in precipitation and climate. "Back to the Future" introduces students to the use of hydrologic data to analyze stream flow conditions and extremes. In "Sum of the Parts" students learn that upstream water users make positive and negative choices that impact downstream water users. "Virtual Water" establishes direct and indirect connections between water and water users.

Vocabulary
adaptive, integrated, water user, sustain, earth systems, municipal, indirect water use, direct water use, virtual, watershed, watershed manager, bacteria, virus, toxin, dissolved oxygen, nutrient, contaminant, aquatic, algae, microscopic organism, macroinvertebrate, food chain

Summary
Representing eight different water users, students must safely carry one water container "downstream" and must navigate through four simulated water management challenges to reach the next community of water users on the same "river."

Objectives
Students will:
- identify water users and their water use or product.
- describe major water user categories and how each consumes water.
- list water users' four common water needs.
- demonstrate the complexity of sharing water among all water users in a watershed.
- summarize how water managers use adaptive and integrated strategies to address river basin water challenges.

Materials
Warm Up
- *Eight sticky notes per student*
- *White board or chalkboard*
- *Milk jug filled with water and capped*
- *Ball of string*
- *Materials for students to create a nametag* (either sticky or hung from a lanyard or piece of string)

The Activity
- *Soup can or small coffee can* (three-quarters full of water)
- *Eight pieces of string* (equal length, about five feet [1.5 meters] each)
- *Two or three rubber bands large enough to securely hold the can* (You only need one; the extras are in case one breaks.)
- *Three pieces of rope or string* (each at least six feet [1.8 meters] long)
- *At least four chairs*
- *Several small sticks*
- *Masking tape or chalk*
- *Marker*

Making Connections
Showering, toothbrushing, getting dressed and eating breakfast likely are part of students' daily morning routines. Water is used directly for the shower and is also used to produce the soap, shampoo and towel. From farmers to manufacturers to students, everyone uses water. This activity explores eight categories of water users, four water needs shared by all water users and how water managers, using adaptive and integrated strategies, address the challenges faced when managing a water supply.

Background
We cannot manage a watershed until we know who the water and land users are, what their needs are and how to collectively deal with common water management challenges such as floods, drought, pollution and endangered species.

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The right quantity of water meets the needs of all—including recreationists such as rafters.

PHOTO CREDIT: © Comstock–Thinkstock Photos

The cost of the water used to produce products, such as these rolls of newsprint destined for newspapers, can affect consumer prices.

Water management challenges affect us all, and any decisions to solve a water dilemma must consider everyone in a watershed. Water use in a watershed includes water for agriculture, business and industry, earth systems, energy, fish and wildlife, municipal water supplies, and navigation and recreation.

Each water user consumes water differently. Some consumption is direct, such as when an irrigator applies water to crops to grow food or when individuals wash, bathe or cook. Indirect, or virtual, water use may not be immediately obvious. For example, a person indirectly uses water when eating a piece of bread or riding a bike, because water was used to grow the grain needed to make the bread and in the production of steel and other parts of the bike.

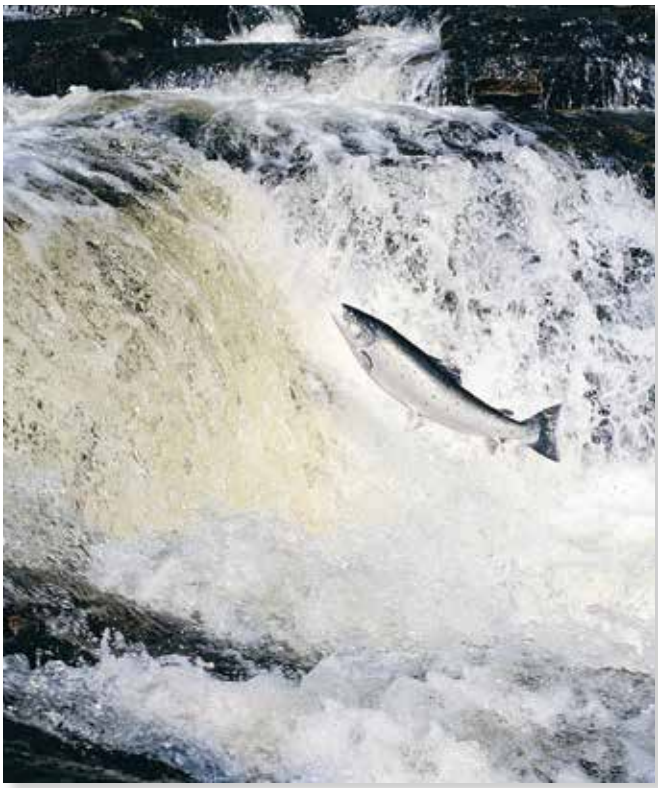
In addition to human uses, fish and wildlife also have critical water needs that must be met for species survival. Alterations in a watershed can seriously impact fish and wildlife.

A shared goal of watershed managers is to meet the water needs of individuals and groups not just some of the time, but all of the time. This goal presents a major challenge to the watershed manager. To satisfy the water needs of any water user, water is needed at:

- the right quantity (not too little but not too much).
- the right cost.
- the right time.
- the right quality.

The **right quantity,** or amount, means enough water to sustain life. For humans, this is about eight glasses of water per day, depending on age, health and activity. Navigation needs enough water in the channel to support boat traffic; agricultural needs vary according to region and crops. Recreationists want enough water to raft, kayak, canoe or fish. Large amounts of water are required to produce manufactured goods, such as paper, cars and food. Energy producers require a steady flow to operate turbines and cool motors. Although the quantity needed by each water user may vary substantially, the interconnections among different users bind them all.

The **right cost** is the expenditure of energy and/or financial resources for a water user to secure and consume water. For industry, it may involve elaborate purification methods to clean and return water to the common allotment. A water-stressed plant closes down the stomata to conserve water; carbon dioxide intake is reduced, limiting photosynthesis



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Water quality has different meanings for different water users—humans need drinking water free of bacteria, viruses and toxins. On the other hand, plants and animals need a balance of dissolved oxygen and nutrients.

PHOTO CREDIT: © Photos.com–Getty Images

People test water to determine its quality and its suitability for use.

and stunting growth. For animals, the cost might be migrating to a new watering hole or weaker animals dying off. All water used has some cost associated with it, whether direct or indirect.

The **right time** means water must be available when it is needed. Humans are unable to store excess water, and dehydration can take place in a few hours during exercise. Salmon need sufficient water to migrate and lay eggs in the fall. Energy demands require consistent availability of water, meaning holding tanks must store seasonal precipitation or energy production will fluctuate throughout the year. Even a small seed demands the right amount of water at the right time: enough to germinate and not too much or it could be washed away.

The **right quality** of water has different meanings for different water users. Navigation, industry and energy often can make use of water that other users cannot. Humans are aware of the need for drinking water free of bacteria, viruses and toxins, but not everyone can turn on the tap and know the water is safe. On the other hand, plants and animals can generally use the water directly available in their environment. If this water contains a healthy balance of dissolved oxygen and nutrients—and few contaminants—it can support abundant and diverse aquatic life, including algae, microscopic organisms and macroinvertebrates. These organisms form the cornerstone of the aquatic food chain, which leads to the larger food chain. All life depends on the right quantity of clean water at the right time and price.

Working together to solve problems and share the river is a goal of watershed managers. Such cooperation could be called having a "good neighbor" attitude. Being a good watershed neighbor means trying to make sure all water users have their water needs met. It is a complex and huge job that requires a lot of money, time and talent. Some people call this integrated (meaning many people are involved in the problem-solving process) and adaptive (meaning new approaches and people may be needed based on changing times, needs and priorities) water resources management.

Common Water Needs

Water User Category	Right time	Right cost	Right quality	Right quantity	Specific users	How water is used
Navigation	When goods need to be shipped	Inexpensive or free	Not as important	Depth of channel depends on river and types of ships that use it	Transportation companies, pipeline owners	Move materials, products or people from one point to another
Fish and Wildlife	Year-round	Free	Medium to high	Depends on species	Mammals, fish, insects	To live in or consume
Agriculture	During growing season	Inexpensive	Fairly clean (not salty)	Depends on crop/ product. Enough to grow crops but not too much.	Sugar cane grower, dairy farmer	To irrigate, to wash and process raw materials, to sanitize equipment, to carry away waste
Business/ Industry	Year-round	Inexpensive	Low to high, depending on what is being produced	Varied	Paper mill, textile manufacturer	Notebook paper, newspaper, T-shirts, hats
Earth Systems	Seasonal, depending on region and system	Free	Medium to high	Lots, although the amount can vary some seasonally	Clouds, ground water	Create precipitation, refill aquifers
Energy	Year-round, but more during hot and cold weather	Inexpensive	Medium	A lot at times of peak electricity demand	Hydropower plant, nuclear power plant	In cooling towers, to turn turbines
Municipal	Year-round	Inexpensive	High, drinkable	Continuous supply; amount depends on population	Restaurant owner, fire department, parks	Cook meals, clean the kitchen, wash dishes, table and floors, extinguish fires, water grass
Recreation	Depends on part of country	Free	Medium to high	Depends on right amount	Water theme park, skier, waterskier	Transporting people on fun rides, providing a surface on which people can ski or skate

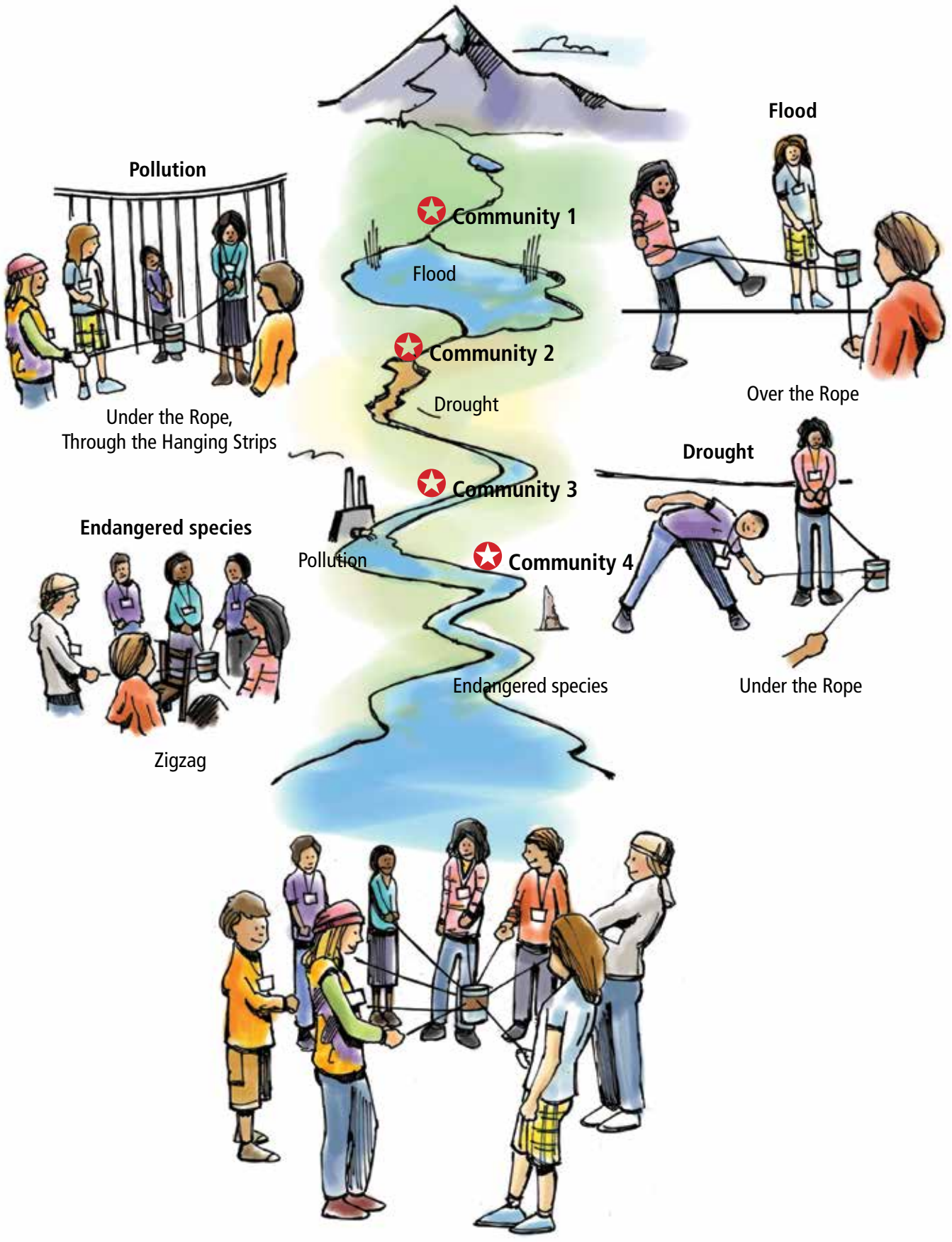
Procedure

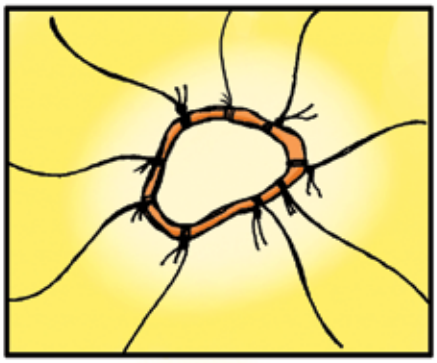
Warm Up

- Give each student eight sticky notes or index cards.
- Explain the difference between direct (uses of water that are apparent, e.g., washing, bathing, cooking) and indirect water use (uses of water that are not immediately apparent to the consumer; for example, a person indirectly uses water when driving a car because water was used in the production process of steel and other parts of the vehicle).
- Give students three minutes to list water users (one per sticky note). Answers may include farmers, firefighters, beverage manufacturers, etc.
- Ask a student to describe or read aloud one of his or her cards. Ask the class if anyone has a similar water user. Collect related cards and tape them in a group on the wall. Repeat the procedure and continue forming groups until all the cards are posted. The number of groups generated depends on the size of the class.
- Draw or tape a circle around each group, and ask students to suggest a category title that describes the common element among the cards in the group (you also can write each category on the board before collecting related cards and taping them on the wall). Write the category title next to the circle. Explain that each category is a separate "idea pool" (a collection of related ideas, topics or concepts). Students may note overlaps among pools.
- Discuss water users missing from the list. Add them to the appropriate pool.
- Discuss right time, right quantity, right quality and right cost related to a specific water user (e.g., farmer or firefighter).
- Then, divide the class into groups and assign each group one of the following eight water user categories: navigation, fish and wildlife, agriculture, business and industry, earth systems, energy, municipal and recreation.
- Have each group create a presentation about their water user category with PowerPoint, Windows Movie Maker or other technology. If computers are unavailable, have students create a flip book. One slide or page should be dedicated to each of the following topics for the assigned water user category:
  - Right time
  - Right quantity
  - Right quality
  - Right cost
  - Examples of water users in your community belonging to the category
  - How the water users in your community consume water
  - Impact of this water consumption on the local water supply
- Have students give their presentation to the class.
- Have each student create a nametag for one of the water users in his or her group's idea pool. Have each student include the category title as well (navigation, fish and wildlife, agriculture, business and industry, earth systems, energy, municipal and recreation). Each student's nametag should reflect a different water user. Nametags can have a sticky back or be fastened to the end of a string or lanyard, allowing the tag to hang around students' necks.

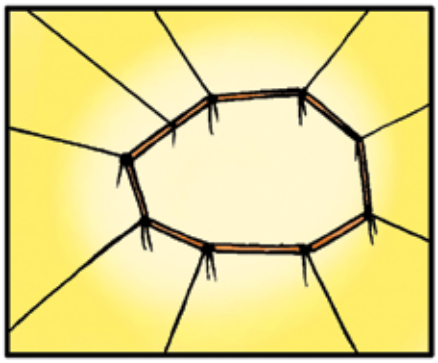
The Activity

1. **Place students into four groups of eight.** One of each of the eight water user categories (navigation, fish and wildlife, agriculture, business and industry, earth systems, energy, municipal and recreation) should be represented in each of the four groups. Each group represents a community.
2. **Give each group a name.** You may number the communities one through four, or you may name them according to communities in your area. If you have too few students, reduce the number of communities, or have one student represent several water users.
3. **Lay out a "river" on the floor or ground using a rope, tape or chalk. Label communities along the river's path.** Students exchange the can at each community.
4. **Tie eight strings to one rubber band. Community One will work together to place the rubber band with strings around the can.** They then will carry the can by holding the strings and gently lifting together.
5. **Test the rubber band to ensure it is the proper tension—too loose and it will not hold the can, too tight and the can will fall, or the rubber band will break.**
6. **Make water management challenges.** The four obstacles are drought, flood, endangered species and pollution. Drought is a rope the water users will pass under. Flood is a rope they must travel over. Endangered species is a zigzag path between chairs they must pass through. Pollution is a rope above their heads with pieces of paper or cloth tied to strings hanging from the rope through which students must pass.

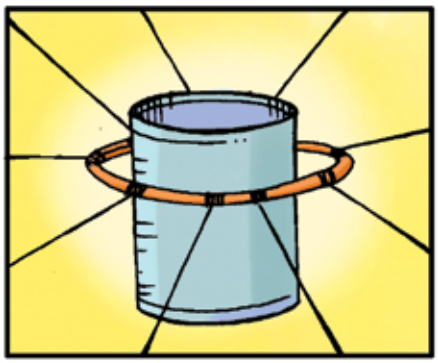




1. Loose



2. Pull to expand opening.



3. Group maneuvers stretched band over can.

7. **Remind students of the four common water needs—right quantity, right cost, right time, right quality.** With one river supporting all water users' needs, teamwork, excellent communication and cooperation are essential. Notify students that in the ***Wrap Up***, they will be asked to consider the four common water needs and their relationships to the river challenges (drought, pollution, endangered species and floods).
8. **Explain the significance of the river and obstacles you have made. Discuss the river in the larger context of a watershed.**
9. **Construct a river channel pathway on the floor in an indoor or outdoor play area, as shown in the illustration.** The river channel will guide the movement of the four groups to and through obstacles.
10. **Place Community One before the first obstacle (flood), Community Two between the first obstacle and the second (drought), Community Three between the second and third (pollution) and Community Four between the third and fourth (endangered species).**
11. **Direct Community One to stand in a circle. Place the can three-quarters full of water on the floor in the middle of the circle, with the strings tied to the rubber band next to the can.** There should be eight strings, one end in front of each water user.
12. **Instruct students to carefully pick up the strings and use teamwork to stretch the rubber band, fit it over the can, slowly release tension on their strings to tighten the rubber band around the can and work together to lift the can.** Remind them that if any water user pulls too hard, the can will fall out of its loop.
13. **Starting at the headwaters, students must work as a team to pass through the flood (over the rope) and hand off the water to the next community downstream.**
14. **Have students from Community One hand off their ropes to Community Two as the water moves downstream through the drought obstacle.** Do not allow the can to touch the floor. Repeat this process for Communities Three and Four, in turn, for pollution and endangered species.
15. **Reinforce the concept that if the water needs of community members are to be consistently met, it will take teamwork, communication and cooperation.**
16. **How did the students adapt to the different water challenges?**
17. **Ask students how water and land use in one community is connected to another. Discuss how communities within your watershed—upstream and downstream—are connected.**
18. **Repeat the activity several times using different levels of complexity.** In round one, make each obstacle easy to maneuver, and then in subsequent rounds make the obstacles more difficult. In each round, have students discuss how they successfully managed the challenge. If the can touches the ground or if the can falls and spills water, the group must start over. This will add excitement to the already challenging activity.

Wrap Up

- Discuss the results of the activity. How much water was left in the can when it reached the last community along the river? Where did they experience the most trouble? What did they learn about the eight water user categories, four common water needs and one river? How were communication, teamwork and cooperation important for delivering the water?

- If community water supply and demand are out of balance, how would they resolve the issue? Would they reduce the supply of one water user or would they find another solution?
- Have students analyze the challenges they faced as they moved the can of water downriver. As a class, discuss the specific challenges of each water user in overcoming each obstacle. Which common water user needs (right amount, right cost, right time or right quality) relate to each obstacle?
- Finish by having each student write a paragraph, tell a story or draw a picture explaining what "8-4-1, One for All" means. They should briefly define each water user category, four common water needs and sharing one river. Ask them to include how communities throughout their watershed can improve the ways they share water.

Project WET Reading Corner

Goodman, Donna L. 2003. *Every Body Counts, Every Drop Matters*. New York, NY: United Nations Department of Public Information.

Learn fun and interesting ways to conserve water.

Project WET Foundation. 1999. *Fish and Fishing KIDs Activity Booklet*. Bozeman, MT: Project WET Foundation.

Students learn about fish and fishing in the wonderfully illustrated book.

Project WET Foundation. 2004. *Water Every Drop Counts*. Bozeman, MT: Project WET Foundation.

Children's illustrated activity booklet that discusses why water is so precious.

Vickers, Amy. 2001. *Handbook of Water Use and Conservation: Homes, Landscapes, Businesses, Industries, Farms*. Amherst, MA: WaterPlow Press.

A water resources professional shares her suggestions on how to conserve water.

Assessment

Have students:

- define the eight water user categories and how each is connected to students' lives (***Warm Up*** and ***Wrap Up***).
- list four common water user needs (***Warm Up*** and ***Wrap Up***).
- demonstrate the complexity of sharing water and the skills needed to successfully manage water (***The Activity***; ***Wrap Up***).
- describe the relationship between water users and a watershed by writing or drawing the definition of "8-4-1, One for All" (***Wrap Up***).

Extensions

Have students select a challenge and then develop a list of careers associated with solving the problem. Just as you do not have a plumber do your dental work, in water management you match the right sequence of people to the problem. Planners interact with people to determine needs and priorities. Hydrologists locate the best sources of water. Engineers design water systems, and microbiologists test water to make sure it meets standards. There are numerous career opportunities in water.

Tell students a bottle of food coloring represents a source of pollution. Place a drop in the can. Have students explain how water quality affects the quantity of water available to water users.

Write the names of the eight water user categories on slips of paper. Have each group draw two to four slips of paper and eliminate those water users from their group. When they make it past the obstacle to the next community, ask them to discuss how carrying water was different with fewer water users. Then ask them to list what products or services the community loses along with the missing water users and discuss the impacts.

Change the length of the string to some water users, indicating a greater distance to the river or that they'll receive a smaller supply of water. Discuss the effect this creates when the team tries to carry the can.

Teacher Resources

Books

SciGuides. 2008. *Resources and Human Impact: Grades 5-8*. Arlington, VA: National Science Teachers Association.

SciGuides. 2008. *Resources and Human Impact: Grades 9-12*. Arlington, VA: National Science Teachers Association.

Journals

Cronin, Amanda and David M. Ostergren. 2007. "Tribal Watershed Management: Culture, Science, Capacity, and Collaboration." *American Indian Quarterly*, 31 (1), 87-109.

Ferreyra, Cecilia, Rob C. de Loe, and Reid D. Kreutzwiser. 2008. "Imagined Communities, Contested Watersheds: Challenges to Integrated Water Resources Management in Agricultural Areas." *Journal of Rural Studies,* 24 (3), 304-321.

Hall, Randy. 2008. "Science Sampler: Water-use Awareness." *Science Scope,* 31 (7), 62-66.

Websites

U.S. Geological Survey. Estimated Use of Water in the United States in 2005. This website provides water use data down to the county level for the United States in 2005. http://pubs.usgs.gov/circ/1344/. Accessed May 19, 2011.