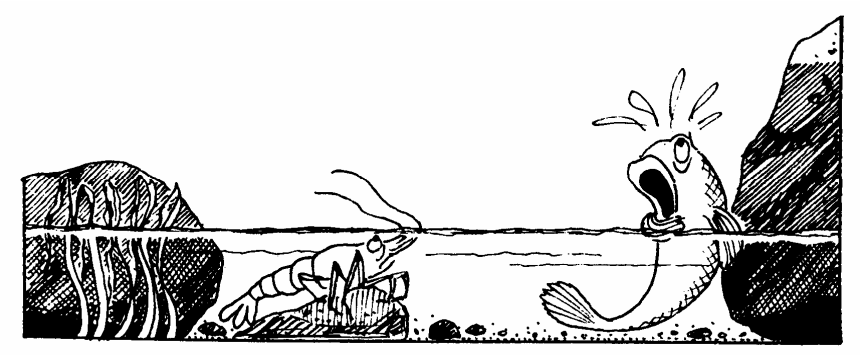
SAVE OUR WATER!

Grades 6–8



Lesson at a Glance

Students analyze environmental issues related to surface and groundwater on their island and undertake an action project to help care for freshwater resources.

Focus Question

What can individuals do to help maintain or improve the quality of groundwater and surface water in the Hawaiian Islands?

Key Concepts

Hawaiians valued water and used it wisely. Hawaiians regarded themselves as stewards of the land. They diverted streams in *'auwai* for their *lo'i kalo* and *loko i'a*. The quality of streams has been affected by channelization, the introduction of non-native species, pollution and diversion. The quality of groundwater has been affected by pollution and overuse. Everyone can become involved in water management through their actions to keep water clean, conserve water use and prevent introductions of non-native species.

Hawai'i Content Performance Standard III, Science, Grade 8

Strand		The Scientific Process	
Standard 2: The Scientific Process: NATURE OF SCIENCE—Understand that science, technology, and society are interrelated.			
Topic		Science, Technology, and Society	
Benchmark SC.8.2.1		Describe significant relationships among society, science, and technology and how one impacts the other.	
Sample Performance Assessment (SPA)		The student: Provides earth and space examples of how science, technology, and society have impacted each other.	
Rubric			
Advanced	Proficient	Partially Proficient	Novice
Evaluate and describe the relationships among society, science, and technology and how one impacts the other.	Describe significant relationships among society, science, and technology and how one impacts the other.	List a few relationships between society, science, or technology.	Recognize relationships among society, science, and technology.

Time
three class periods with additional time to conduct research and implement action plans

Subject Areas
social studies, science, language arts

Materials
issue cards (provided)
student information sheets (provided)
1 sheet of acetate and overhead projector (if computer projection not available)
video: "*Ka Wai*: Water, Source of Life," *Nā Ki'i Hana No'eau Hawai'i*, No. 12. (optional)

Preparation
Copy the "Save Our Water" chart onto transparency sheet to be used with an overhead projector. Alternatively, if you have projection capability from your computer, project the chart during the class discussion. Duplicate one copy of each water issue card and a set of stream life information sheets.

Teacher Background

Stream Diversion

Most of the perennial streams (those that flow year-round) in the main Hawaiian Islands have been altered by human actions. Fewer than 50 percent of the streams flow freely to the sea without some kind of water diversion or alteration of the streambed. Water from more than half of the perennial streams has been diverted for other uses, particularly for growing sugarcane and other crops that have since replaced sugar. **Surface water** is often taken from streams in wet mountain areas and diverted to dry leeward areas where most crops are grown. Diverting water from a stream reduces the stream flow, often causing the stream below the diversion to flow only during and after heavy rainfall. This affects farmers downstream, eliminates habitat, and prevents the migration of native stream animals upstream. These native species—the goby fishes *('o'opu)*, snails *(hīhīwai)* and prawns *('ōpae)*—rely on a connection to the sea to complete their life cycles. These organisms spend part of their larval stages in the ocean before returning to a stream.

Hawaiians valued water and used it wisely. Hawaiians regarded themselves as stewards of the land. They diverted streams using *'auwai* for their *lo'i kalo* and *loko i'a*. No more than half of the stream was diverted and only the amount of water needed was diverted. There was no loss of connection to sea needed by native stream animals, no loss of stream life

Channelization

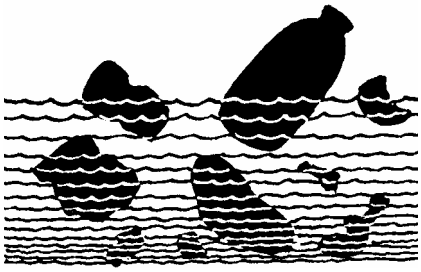
When streams are channelized they are lined with concrete and often realigned. Changing a meandering stream into a straight channel makes sense from the standpoint of an engineer or urban planner because it maximizes the volume of water the stream can convey to the sea and increases the land area

available for human development. However, **channelization** destroys the beauty of streams and has a significant impact on native stream life. The runs, riffles, pools and eddies, which provide a variety of habitats in an unaltered stream, are replaced by a flat featureless environment. The shallow water in straightened channels and the loss of stream bank plant cover raises water temperatures and creates conditions to which native stream animals are not adapted**.** For more information on native and introduced stream animals, see the student information sheets provided with this activity.

Effects of Non-native Species

Excessive grazing by feral animals such as cattle and goats, and rooting by pigs in forested watersheds destroys ground cover and accelerates soil erosion into streams. Disturbance to ground cover reduces the capacity of the forest floor to soak up water and slowly recharge **groundwater**, and results in increased peak stream flow during storms. Soil runoff directly affects stream animals and eventually may smother a reef when the stream empties into the sea. Non-native animals such as tilapia, Tahitian prawns, crayfish and frogs have been introduced to streams where they prey on or compete with native stream animals for habitat and food. In a three-year survey, researchers found 25 species of fishes and crustaceans in streams around the state. Only eight of these species were native, and these were restricted to areas that were free of human development and pollution.

Pollution



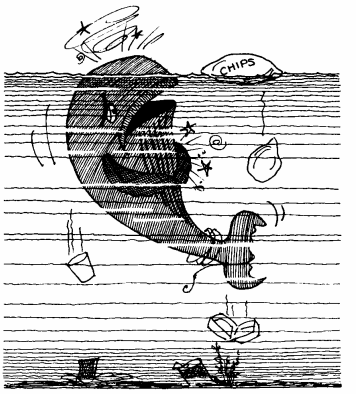
Pollutants are generally classified into two broad categories; one comes from an identifiable source, such as a particular sewage treatment plant or farm. This is known as **point source pollution**. The other, **non-point source pollution**, is more difficult to trace. The Environmental Protection Agency and other groups have made great strides toward regulating and minimizing pollution from identifiable sources. However, some pollutants from pesticides applied to farms and to homes for termite-control have percolated into groundwater. Pollution from non-point sources, such as herbicides and pesticides applied to lawns, paint, oil, gasoline, and cleaning solvents from homes, is very difficult to control. Some of it is litter, such as plastic bags, polystyrene cups, bottles, cans and old appliances.

Much of this pollution is left on lawns, driveways or roadsides to wash down the street and into the gutter. Once in the gutter, this household debris washes through a storm drain and is deposited into a stream. Some of the pollutants, particularly **biodegradable** garbage, will decay. If too much material decays at once, it can consume all the oxygen in the water and kill stream life. Some of the chemicals may percolate beyond the streambed and contaminate the groundwater below. Remediation of our groundwater is costly. After a heavy rain, most materials will be carried out to sea, and much will wash up on our beaches.

In 1972, Congress passed the Clean Water Act (CWA) to restore and maintain our waters free of pollution due to industrial pollution of rivers and streams. In 1977 and 1987, it was amended to

regulate the discharge of pollutants into our waters. The goal was to return all our waterways to their original levels of cleanliness suitable for fishing and swimming. Under the CWA, all sources of water pollution are subject to state effluent and water quality standards.

Beaches in Hawai‘i have been closed periodically due to pollution washed down from streams, or from sewage spills and boaters. Plastics are especially dangerous to wildlife. Many marine animals, such as the threatened green sea turtle, mistake bits of plastic for edible jellyfish or seaweed. These animals have been found washed up on beaches, with their stomachs gorged with plastic. Seals, seabirds and other marine animals sometimes become trapped in plastic, especially nets and plastic soda can rings, which can cause the animals to starve or choke to death.



In Hawai‘i, pollution from general non-point sources is believed to contribute up to ten times as much pollution to streams and beaches as all our factories and industries combined. Unfortunately, it is virtually impossible for officials to identify or regulate the source of all these pollutants. As the population grows and population density increases, this pollution will become an increasingly serious problem for people and wildlife. The burden of recognizing the environmental consequences of one's actions and making the effort to control pollution rests with each individual.

Conservation

Since relatively few high-quality freshwater streams remain in Hawai‘i and since populations of our unique native stream animals are decreasing with disturbances to stream habitats, many individuals and organizations are recognizing the need to take conservation action now. Some high-quality streams are administered by the Department of Land and Natural Resources on conservation lands and in areas managed by The Nature Conservancy of Hawai‘i. However, most high-quality streams are unprotected. High-quality streams can still be found on most of the Islands. Lumaha‘i, Kalalau and Hanalei on Kaua‘i; Kahana, Kōloa and Kaluanui on O‘ahu; Hālawa, Wailau and Pelekunu on Moloka‘i; Hanawī, ‘Ohe‘o and Kahakuloa on Maui; and Kolekole and Waimanu on Hawai‘i are some of the high-quality, free-flowing streams where native stream life still thrives.

Conservation of groundwater is also critical as our growing human population places more demands on this vital resource. According to a draft version of the State Water Projects Plan (2000), by the year 2018, our freshwater sources will meet only 57 percent of the state’s projected demands. In some areas, wells are becoming brackish as too much fresh water is extracted from the aquifer. See “Water We Losing?” for additional background on this issue.

Teaching Suggestions

1. Ask students how they would describe the quality of Hawaiian streams (surface water) and the quality of groundwater. What types of streams do they see? Are most of the streams

natural, free-flowing courses or channelized waterways? What do they see in the streams? Do they think the streams and groundwater are polluted?

2. Divide the class into five groups and give each group a water issue card. Ask students to review the cards and identify the key concerns, questions they would like to answer, and any potential solutions.

3. Ask groups to report their ideas to the group and make a list of class questions. Project the "Save Our Water" transparency and summarize the various ways that people have altered streams and impacted groundwater. Discuss students' ideas for some potential solutions to these problems.

4. Discuss ways that students could collect information to answer their questions. See the ʻŌhiʻa Project links on the MGF Web site at mgf-hawaii.org for resource agencies, GIS maps of streams and other information about water issues.

5. Ask students with similar interests to work together to select an issue, propose a solution, develop an action plan, and carry it out.

   Sample Action Plans

   - Participate in a stream-monitoring project to collect data on non-native species. See http://www2.hawaii.edu/hsrc/home/volunter.htm - the Hawaiʻi Stream Research Center for information on volunteer stream monitoring projects.
   - Conduct storm-drain stenciling to help prevent non-point source pollution.
   - Develop an educational display and place it in a highly visible location like a local library or shopping center. (See sample displays and demonstrations under the Extended Activities.)
   - Write letters to politicians and local newspapers to express concerns and suggest solutions.
   - Implement a water conservation plan at home and/or at school.
   - Volunteer to help maintain a forest trail, planting trees, or other watershed activities.

6. Discuss potential solutions that students propose. Ask students to consider how they might evaluate the effectiveness of their actions. What will be the benefit of their actions and how might they help resolve the issue?

7. When they've completed their projects, ask each group of students to orally present their issue and the solution they've implemented. Encourage them to use visuals (either story boards or computer programs) to support their presentations. Ask each student to submit a written paper that includes the following:
   - a statement of the issue addressed
   - information and/or data collected with documented references
   - an analysis of the data
   - a description of the solution and action plan that was carried out
   - an evaluation of the effectiveness of the action plan

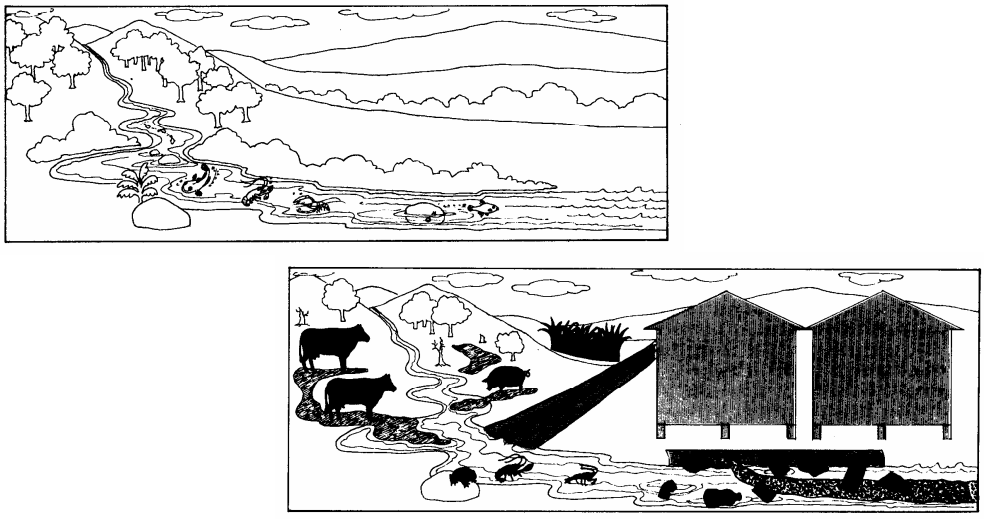
Extended Activities

- Adopt a stream on your island. Take a field trip to the stream and have students study the stream life and pick up litter in the area. Have students write letters to the editor of the local newspaper to inform the community that they have adopted the stream and how they intend to care for it.

  Caution: Leptospirosis is a disease that can be contracted in Hawaiian streams. The bacterium that causes this disease enters the body through openings, cuts and scratches. While not common, there is a chance of infection so students should not be allowed to enter the stream if they have open cuts. Check with the Department of Education regarding guidelines for stream field trips and with the State Department of Health for additional information about leptospirosis.

- Create a class mural of a healthy free-flowing stream compared to a stream that has been impacted by channelization, diversion, introduction of alien species and non-point source pollution.

- Create a mural depicting water usage in an *ahupua'a*.



Sample mural designs showing changes to a healthy stream environment

- Conduct a demonstration to show how pollutants can percolate through soil and rock to end up in our groundwater supply. Place some gravel in a clear plastic or glass container to represent layers of lava. Place some moistened soil on top of the rocks and a sponge over it to represent vegetation. Use food coloring to dye some water blue and pour it onto the sponge to represent rainwater. Have students observe how it percolates down through the rocks to become groundwater. Now add red food coloring to the water to represent chemical pollution. Pour this water onto the sponge and watch it percolate down to the "groundwater."

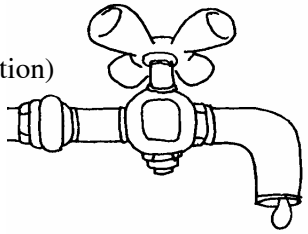
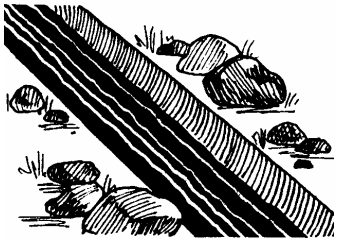
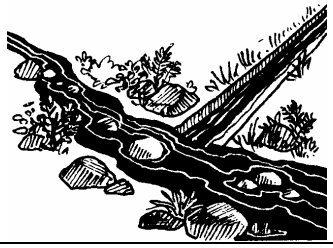
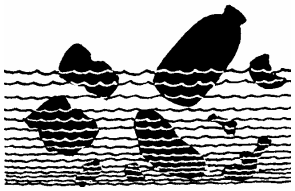
  Compare this to pouring pollutants such as used motor oil on the ground and explain that some gas stations will recycle old oil. Other chemicals, such as paints, insecticides and

cleaning solvents are periodically collected by the State Health Department for safe disposal. Ask students to contact this agency for more information.

- Have students create a hands-on model using cardboard and marbles to show how pollutants washed from lawns and driveways end up in streams. Use a small cardboard box to represent a street gutter. Cut a hole in the top of the box at one end to be the storm drain. Place a cardboard tube (from paper towels or toilet tissue) into a hole on the side of the box beneath the storm drain. Angle this tube down and lead it to a long narrow box representing the stream. Have the marble represent pollution and roll it along the gutter, through the storm drain and into the stream. Another box or a pan could be added to the model to represent the ocean. A block may need to be placed on the gutter end of the model to elevate it and keep the marble moving. Add cutouts of marine animals and plastic litter to the ocean.

- Sea Life Park on O'ahu suggests having a student put a rubber band stretching from baby finger to thumb across the back of the hand, and try to remove it using only that hand! This can be compared to a seabird trying to remove a plastic six-pack ring from around its neck.

- If possible, visit an *'auwai*, *lo'i kalo*, or a *loko i'a* to see how Hawaiians managed, and still manage, water.

Changes to Water	Impact
Freshwater supply (depletion and pollution) 	Increased use causes wells to become brackish Increased use threatens future supply Pollutants threaten water safety
Channelization (straightening and lining with concrete) 	Loss of streambed habitat Increased water temperature in shallow water of channel, especially where plants are removed Increased stream flow during heavy rain
Diversion (removing water for other uses) 	Reduced stream flow Loss of recreational opportunities Loss of connection to sea needed by native stream animals, resulting in loss of stream life
Diversion (*'auwai*)	No more than half of the stream was diverted Only the amount of water needed was diverted No loss of connection to sea needed by native stream animals, no loss of stream life
Pollution 	Reduces water quality; may kill stream life; may pollute groundwater, causing people to become ill Plastics harm marine life (even causing death)

Scenario: The water supply on the island on which you live has been on the decline over many years. More water is being used than is being replenished. Streams and springs have dried out. The economy in Hawai'i is down, especially in the travel industry. Unemployment is high. A resort company wants to build a golf course on the dry coastal side of your island, which is an ideal environment for golf courses. However, golf courses use a lot of water and there is no readily available water source for the golf course. The resort company wants to drill a well on the windward side and transport some of the water to the golf course. ***Should the resort company be allowed to drill the well so it can develop its golf course and provide jobs or should the idea be scrapped to help save water?*** You and your classmates can help to resolve this dilemma.

How to Play: Students break up into the various interest groups listed below. Each group has an interest in the island's water supply, yet they can be in conflict with the needs and desires of other groups. Have students discuss the water issue as it relates to their groups. Reconvene the groups to discuss their ideas to solve the problem. Will they be successful?

Interest Groups:

- Resort company: wants to build golf course
- Unemployed residents: need jobs
- Environmental organizations: protect the ecosystem and all its native plants and animals
- Kalo farmers: need water for growing kalo
- Water commission: state agency responsible for protecting our water resources
- County Water Board: island freshwater supply largely comes from groundwater recharge through watershed in each county

Students should gather facts then plan a strategy to resolve the problem. Students should keep the roles they are playing in their minds and attempt to tailor their responses and strategies to their particular roles. To help with their strategy planning, each interest group should answer the questions below.

1. How does this situation relate to my interest group and the water supply?
2. What are the positive impacts that my interest group has on the environment?
3. What are the negative impacts that my interest group has on the environment?
4. List three actions your interest group could take to help restore and protect the water supply on your island.

When it is time for reconvening, the class seating should be divided according to the different interest groups. Each group should have a spokesman to present their strategy. The teacher will be the mediator and will ensure that the meeting is run fairly and that all sides have a chance to present. A chart should be kept to show the different stances of the different interest groups. The class should come up with a realistic action plan that incorporates the ideas presented.

For more information on water usage at golf courses, see the Student Reading and Activity for "Kolepa Kai Golf Course" in *Water Watchers*, Grade 4.