

# WATERSHED WISDOM



Grades 6–8

## Lesson at a Glance

The class conducts experiments comparing runoff and groundwater recharge on simple models of vegetated and barren mountain slopes.\* Watershed alliances are explored and researched in the extended activity.

## Key Concepts

Forests protect watersheds by preventing soil erosion and maintaining the quality of surface water by reducing sediment and other water pollutants. Forests absorb water, which is released slowly to plants, streams and groundwater supplies. The health of our islands’ near-shore waters, beaches, and fisheries are dependent on the health of our forests.



## Hawai‘i Content Performance Standards III, Language Arts

Grade 6			
Strand		Reading	
Standard 1: Reading: CONVENTION AND SKILLS: Use knowledge of the conventions of language and texts to construct meaning for a range of literary and informational texts for a variety of purposes.			
Topic		Locating Sources/Gathering Information	
Benchmark LA.6.1.2		Use grade-appropriate online and print sources to research a topic.	
Sample Performance Assessment (SPA)		The student: Finds and reads online (e.g., CD-ROM, internet, intranet, newsgroups) and traditional sources (e.g., encyclopedia, books, periodicals) to answer an inquiry arising from class or personal activities.	
Rubric			
Advanced	Proficient	Partially Proficient	Novice
Use substantive information from an extensive variety of grade-appropriate print and online resources to thoroughly research a topic.	Use relevant information from a variety of grade-appropriate print and online resources to research a topic.	Use some relevant information from a selection of grade-appropriate print and online resources to research a topic.	Use very little relevant information from grade-appropriate print and online resources to research a topic.

\* Adapted from an activity by Keoma Tanaka, from Moanalua Gardens Foundation Teacher’s Workshop, July 1987.

<b>Grade 7</b>			
Strand		Reading	
Standard 1: Reading: CONVENTION AND SKILLS: Use knowledge of the conventions of language and texts to construct meaning for a range of literary and informational		texts for a variety of purposes.	
Topic		Locating Sources/Gathering Information	
Benchmark LA.7.1.2		Use a variety of grade-appropriate print and online sources to research an inquiry question.	
Sample Performance Assessment (SPA)		The student: Finds and reads online (e.g., CD-ROM, internet, intranet, newsgroups) and print sources (e.g., encyclopedia, books, periodicals) to answer a question or inquiry arising from class or personal activities.	
Rubric			
Advanced	Proficient	Partially Proficient	Novice
Use substantive information from an extensive variety of grade-appropriate print and online resources to thoroughly research an inquiry question.	Use relevant information from a variety of grade-appropriate print and online resources to research an inquiry question.	Use some relevant information from a selection of grade-appropriate print and online resources to research an inquiry question.	Use very little relevant information from grade-appropriate print or online resources to research an inquiry question.

<b>Grade 8</b>			
Strand		Reading	
Standard 1: Reading: CONVENTION AND SKILLS: Use knowledge of the conventions of language and texts to construct meaning for a range of literary and informational		texts for a variety of purposes.	
Topic		Locating Sources/Gathering Information	
Benchmark LA.8.1.2		Select appropriate information after evaluating the usefulness of print and online resources to investigate a theme, answer a question, or test a hypothesis.	
Sample Performance Assessment (SPA)		The student: Conducts research and evaluates information for validity, appropriateness, content, and use by asking questions (e.g., What makes the author an expert? Is the information found in multiple sources? What is the author saying and not saying?).	
Rubric			
Advanced	Proficient	Partially Proficient	Novice
Insightfully select highly effective and appropriate information after evaluating the usefulness of print and online resources to investigate a theme, answer a question, or test a hypothesis.	Select appropriate information after evaluating the usefulness of print and online resources to investigate a theme, answer a question, or test a hypothesis.	Select some trivial information after evaluating the usefulness of print and online resources to investigate a theme, answer a question, or test a hypothesis.	Select irrelevant information after evaluating the usefulness of print and online resources that do not help to investigate a theme, answer a question, or test a hypothesis.

## HCPS III, Science

Grade 7			
Strand		Life and Environmental Sciences	
Standard 3: Life and Environmental Sciences: ORGANISMS AND THE ENVIRONMENT—Understand the unity, diversity, and interrelationships of organisms, including their relationships to cycles of matter and energy in the environment.			
Topic		Interdependence	
Benchmark SC.7.3.2		Explain the interaction and dependence of organisms on one another.	
Sample Performance Assessment (SPA)		The student: Explains how organisms in a biological community interact (e.g., predatory/prey, producer/consumer, parasitism, mutualism, competition, cooperation, niche).	
Rubric			
Advanced	Proficient	Partially Proficient	Novice
Evaluate and explain how organisms interact with and depend on one another.	Explain how organisms interact with and depend on one another.	Identify how organisms interact with and depend on one another.	Recognize that organisms interact with and depend on one another.
Topic		Interdependence	
Benchmark SC.7.3.3		Explain how biotic and abiotic factors affect the carrying capacity and sustainability of an ecosystem.	
Sample Performance Assessment (SPA)		The student: Explains how organisms in a biological community interact.	
Rubric			
Advanced	Proficient	Partially Proficient	Novice
Analyze and explain the biotic and abiotic factors that affect the carrying capacity and sustainability of an ecosystem based on evidence.	Explain how biotic and abiotic factors affect the carrying capacity and sustainability of an ecosystem.	Describe that biotic or a abiotic factors affect the carrying capacity and sustainability of an ecosystem.	Recognize that biotic and abiotic factors affect the carrying capacity and sustainability of an ecosystem.

There are no benchmarks for this standard and course for Grades 6 and 8.

### Objectives

Students will:

- 1) predict the amount of runoff and groundwater recharge on models of vegetated and non-vegetated mountain slopes;
- 2) measure the amount of water collected in the experiment and compare it with their predictions;
- 3) draw pictures and write captions contrasting the effects of rainfall on a forested and on a barren slope in Hawai‘i;
- 4) research Hawai‘i’s watershed alliances; and
- 5) conserve and protect our watersheds.

### Time

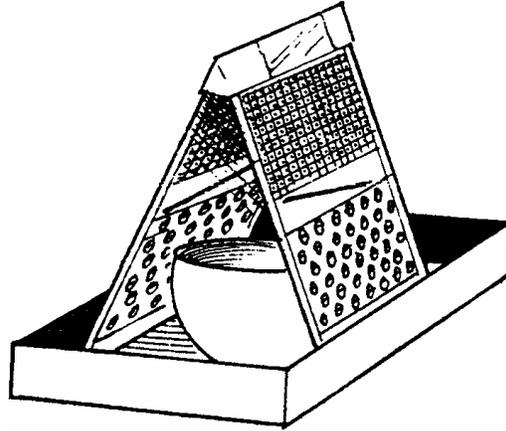
Four to five class periods

### Subject Areas

science, language arts

## Materials

9 x 13 in foil tray or pan  
2 sponges  
4 rubber bands  
2 rectangular, flat vegetable graters  
glass or clear plastic measuring cup  
small bowl (to fit inside foil tray)  
spray mist bottle full of water  
blue food coloring  
old towel or newspapers  
masking tape



## Preparation

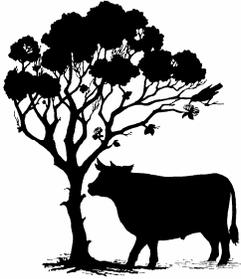
Use the graters to make an A-frame with the small holes on the top. Bend one of the handles so that the two graters will fit securely together or tape them together. Cover the long, wide holes with masking tape. Put the foil tray on an old towel or newspapers, and then place the small bowl between the graters in the center of the tray. Add a few drops of blue food coloring to the water in the spray mist bottle. Wet the sponges and wring them out in preparation for the demonstration.

## Teacher Background

**Watersheds** are land areas that drain to a particular body of water. For instance, a watershed can be our islands' forests with rainwater draining down streams and finally out into the Pacific Ocean. It could also be a small land area where water drains into a river. Watersheds can include people's lawns, parking lots, and streets. Sometimes small watersheds join together to form even larger watersheds.

Watersheds in Hawai'i include our rainforests. Rainforests act like sponges. Tall trees capture drifting rain and clouds in their leaves and branches. The water drips down to the lower forest layers where it evaporates and drains into the soil. Roots of plants absorb the water which is later **transpired** from their leaves. Some of the water **percolates** through the soil and seeps into the water table below.

Some water drain into streams. Most streams in Hawai'i are intermittent with little or no flow during dry periods. A few streams are perennial, such as those on Kaua'i. Hawaiian streams begin from steep mountains and valley walls. They are usually short in length and have small drainage basins. Whether perennial or intermittent, their characteristics make them "flash" streams. Flash floods occur during intense heavy rainfall. Water rises rapidly in shallow streams. From mountain tops, the water quickly flows out to sea over a short distance. The fast rise and rush of water in streams make flash floods a natural hazard. To be safe, it's best to avoid streams in situations, such as in hiking, where flash floods may occur. Interestingly enough, native fauna actually benefit from flash floods. Flash floods empty streams of litter, debris, and sedimentation. The rush of the floods opens up streams to the ocean to allow young adult native fauna to enter and complete their life cycles upstream.



The floor of a rainforest is covered with decaying organic material, ferns and mosses. It is so spongy that even hours after a rain it is still very wet. Water absorbed by this spongy layer during heavy rains is available to streams during dry times. This guarantees a constant, pure water supply for stream plants and animals. Hoofed animals like cattle, sheep or pigs can significantly damage the forest floor by removing vegetation through grazing or rooting and compacting of the soil. They also pollute the water supply with their wastes. Without the forest cover, heavy rains cause soil **erosion** in addition to flash floods. The eroded soil and pollution are carried into streams and to the ocean where they can smother reefs and kill marine life. Therefore, the health of our near-shore waters, fisheries, and beaches are related to the health of our forests. When there is no rain, streams may become completely dry. As vegetation becomes dry it becomes vulnerable to wild fires. Rainforests that are no longer sustainable cannot support all life within its ecosystem.

Forestry in the Hawaiian Islands began in the mid-nineteenth century when King Kamehameha III declared “forests and timber growing therein shall be considered government property, and under the special care of the Minister of the Interior.” In the next half of the century, various private and governmental efforts were made to encourage reforestation. All this was in response to the general decline of native forests due to uncontrolled grazing, fires, cutting for firewood, clearing for farming, and the invasion of introduced insects, plants, and eucalyptus forest diseases.

The Hawaii Sugar Planters’ Association (HSPA) was a leading proponent of good forest management once it recognized the impact poor management had on the water supply. Sugarcane requires vast amounts of water for irrigation, and most of this water came from mountain streams. Trees were cleared to allow cane to grow. Also, fuel in the form of wood was needed to help boil cane juice into sugar. The decline of forests was associated with a sharp drop in the quality and quantity of water downstream. It was during this period that the importance of forests as watershed reserves became apparent.

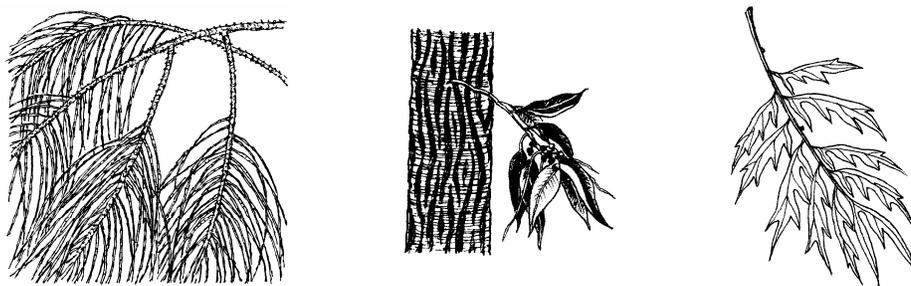
In the early 1900s, the Territorial Board of Agriculture and Forestry was created to protect watersheds. They fenced off forest reserves, eliminated feral animals, and planted ‘ōhi‘a and koa. However, these native trees grew too slowly so introduced trees such as eucalyptus, ironwood, silk oak and Norfolk pine were planted instead.



Eucalyptus forest



*koa and 'ōhi'a*



ironwood, eucalyptus, and silk oak

The Civilian Conservation Corps (CCC) began a massive reforestation effort in Hawai‘i. Thousands of trees were planted on barren hills and eroded slopes throughout the state as a watershed protection measure. When reforesting the watersheds, foresters tried to use introduced species that were not valuable for timber so that later generations would not be tempted to cut the trees. They also experimentally planted many species from other parts of Asia and the Pacific. As a result, native forests are now found only in the most remote mountain areas.

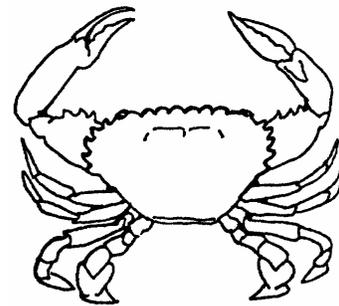
Two of the most widely planted trees, Cook pine (which resembles Norfolk Island pine) and eucalyptus, are now common throughout the lower reaches of the forest. Unfortunately, there tends to be no **understory** (the lowest layer of plant life in the forest) associated with these trees. While they are a major improvement over bare soil, these introduced trees don’t provide adequate habitat for native plants and animals, and are less satisfactory than native forests in watershed protection and groundwater replenishment.

Watersheds are vital in replenishing our fresh water supply. We should make every effort possible to preserve them. Lands in watershed areas are either under public or private control. Conservation of these areas is more effective when public and private entities work together cooperatively. The Hawai‘i Alliance of Watershed Partnerships was established in 2003 to promote coordination among the state’s watershed partnerships. Altogether there are eight watersheds: three on Maui and one each on O‘ahu, Moloka‘i, Lāna‘i, Kaua‘i, and Hawai‘i Island. A critical watershed partnership was organized to protect the watershed in the Kohala Mountains. This watershed feeds streams in the *ahupua‘a* of Hāmākua, North Kohala, South Kohala, and Waimea. The streams provide water for domestic use, cattle, and agriculture. Partnerships work together to ensure that there is a healthy forest watershed by controlling

invasive alien plant species and non-native animals, the two biggest threats. Major control of introduced animals is accomplished by building fences and removing them from the area. Invasive alien plant species like miconia promote runoff by shading out the understory vegetation in wet forests.

Maintaining healthy watersheds is a global issue. Conservation of watershed land is critical; however, as the world population continues to grow at phenomenal rates, all resources are taxed. People need wood for fuel, furnishings, and houses. Land is cleared for crops. The Amazon basin is home to one of the largest tropical rainforests in the world—nearly the size of the continent of Europe! The Amazon River extends through the rainforest for about 3,000 miles. That is a distance longer than any other river in the world except the Nile. The Amazon rainforest supplies 20 percent of the world’s water and contains the greatest biological diversity in the world. Much of the medicine we use today originated from plants found only in tropical rainforests. However, many rainforests have been logged at alarming rates for wood products, farming, and cattle ranching. Some governments, agencies, environmental organizations, and local people are now working to preserve global rainforests. Scientists are hoping that by focusing on saving the rainforest, we will help curb global warming. For more information on rainforests, see our Global Interactions unit for Grades 6–8.

As with the rest of the world, watersheds in America also face significant challenges. The Chesapeake Bay watershed encompasses parts of New York, Pennsylvania, West Virginia, Delaware, Maryland, and Virginia and the entire District of Columbia. It is also North America’s largest estuary and is home to the world’s largest natural oyster bed. The bay is renowned for its blue crab and striped bass. Chesapeake Bay is one of the most unique ecosystems in the world, full of a variety of plants and wildlife. Unfortunately, development of the bay has been extensive and the resulting impact is great. The watershed’s forests have been cut down for timber, fuel, agriculture, and development. Its waters are polluted, tainting the seafood that **everyone loves to eat**. This watershed is no longer the productive ecosystem it once was.



blue crab

The Mississippi Basin watershed, which includes the Ohio River, the Missouri River and Mark Twain’s Mississippi River, drains all or parts of 31 states into the Gulf of Mexico. Over many years, the river’s meandering flow has been altered to allow industries, agriculture, and recreation to thrive. Wetlands were drained and development ran rampant. This watershed has lost its ability to absorb, resulting in torrential floods that reek havoc on surrounding lands.

Long-term watershed protection is a key global issue affecting the quality of our lives today and in the future.

### Teaching Suggestions

- 1) Explain what a watershed is. Ask students to visualize a mountain range divided into a series of connecting bathtubs (valleys). When rain falls on a ridgeline, it will run into one “bathtub” or another, and then drain to a stream at the bottom. Each “bathtub” or valley is a separate watershed.

- 2) Compare a barren mountain with the roof on a house. When it rains, most of the water washes right down the roof, flows through the gutter, and splashes onto the ground. Very little water remains on the roof, and the gutter (like a stream) becomes dry soon after the rain stops. The roof is the “watershed” for the gutter. Identify watersheds in your school’s community.
- 3) Interpret the watershed model for the class. The two graters represent mountain slopes separating two different watersheds and the holes are the pores in the ground. The small bowl is inside the mountain and represents the groundwater lens. The large pan is the ocean, and the blue water coming from the mist bottle is rain.
- 4) Explain that the grater “mountain” is not forested. Ask the class to predict where most of the rain falling on this mountain will end up—as groundwater in the bowl or as surface water in the ocean? Take a vote and record their predictions on the board.
- 5) Pump the mist bottle over the mountain about 80 times to simulate rainfall. Allow a few moments for the water to drain, and then pour the “groundwater” collected in the small bowl into the measuring cup. Ask a volunteer to read the amount collected and record the figure on the board. Then pour the water out and repeat the procedure with the “ocean” water that collected in the tray. Compare the amounts measured with the original predictions.
- 6) Discuss the results and ask students what they think will happen if the spongy forest cover is added to the mountain. Attach sponges to the graters with rubber bands and repeat the experiment. Before measuring the amount of “groundwater” collected, squeeze the sponges into the “groundwater lens” or bowl to speed up the process of water percolating into the water table.
- 7) Again, compare the amounts of “seawater” and “groundwater” with the students’ predictions. Emphasize the importance of forest cover in watershed management. Explain that in a real forest, plants will use some of the stored water.
- 8) Remind students that while forested watersheds will help provide a steady water supply, only wise water use and conservation will insure that the water supply continues to meet the needs of our growing population.
- ✓9) Have students draw a picture comparing rainfall on a forested slope and on a barren slope in Hawai‘i and write captions for the pictures based on the results of the watershed experiment.
- 10) After participating in the Watershed Alliances Student Activity at the end of this lesson, ask students to study the watersheds on their island. Time spent on this activity will vary depending on how well students are able to research, work cooperatively and formulate a plan to resolve the problem of a water shortage.

### **Extended Activities**

- Students can study the watersheds in their neighborhood by using a map to locate various streets, streams, and other geographical features to determine the flow of rainwater across the land.
- Have students work in groups to create their own models of forested and barren watersheds. Shag carpet, towels, or moss can be used to represent the forest, while metal, plastic, or clay can represent barren slopes.
- Generate a discussion about environmental responsibility. Point out that our water supply today is largely due to the foresight of people generations ago. Ask students how their attitudes and actions toward the environment today may affect the lives of their grandchildren in the next century.
- Conduct a long-range experiment to see if there is much potential for fog drip in your area. Place two sturdy posts about 2 m long approximately 1 m apart in an elevated, vegetated area exposed to the wind. Pound the posts 0.5 m into the ground, or until they feel stable. Stretch mosquito screen between the posts and staple it in place. Monitor how long it takes for a line of grass below the screen to appear greener due to greater water availability. Trees, of course, do a much better job of catching moisture in the air because they are fatter, wider, sturdier, and multi-layered.
- Conduct research on a watershed located outside of Hawai‘i. Be sure to identify the positive and negative impacts associated with this watershed.
- On Arbor Day (in Hawai‘i, the third Friday in November) lead the class on a tree-planting expedition. Trees can be planted on the school grounds, or in other community areas with the appropriate permission. Be careful about which tree species you plant. Native trees have many ecological advantages, but some are difficult to establish. See the Plants and Animals Appendix for more information on growing native plants. If you choose an introduced species, make sure it is not a pest species (contact the State Department of Agriculture if you’re not sure).
- Take a class hike through a forested area and compare and contrast moisture, temperature, and other environmental conditions inside and outside the forest.
- Hold a school-wide paper drive. Explain how recycling paper saves trees. Donate money earned to a local, national or international organization that is working to save tropical rainforests, or use it to purchase seedlings and gardening tools for your own reforestation project.
- Ask students to interpret how the following four props represent beneficial effects of forests: a pump or spray mist bottle (cooling effects of transpiration from leaves), an umbrella (forest canopy intercepting water and protecting soil), a sponge (waterholding capacity contributing to groundwater supply), and an anchor (tree roots holding soil).

**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. The watershed is slowly being destroyed by development and the impact of people and feral mammals. Streams and springs are drying up. Residents are concerned about the state of the environment and the lack of sufficient water. What can people on the island do? This problem needs to be tackled and a resolution immediately suggested. 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 depends on the island's watersheds to meet their particular needs, 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 group. Reconvene the groups to discuss their ideas to solve the problem. Will they be successful?

### Interest Groups:

- ✓ Loggers: grow and harvest wood
- ✓ Ranchers: their cattles graze on pasture lands
- ✓ Golf course and hotel resort: needs water for landscaping and golf course
- ✓ Agriculture: farmers are heavy users of water
- ✓ Government entities: Department of Land and Natural Resources, Department of Agriculture, Environmental Protection Agency, and the Department of Health help enforce and regulate laws to protect the environment and our health
- ✓ Environmental organizations: protect the ecosystem and all its native plants and animals
- ✓ Hunters: hunt wild pigs in rainforests for food
- ✓ Scientists: study native and invasive species, need access to land and threatened and endangered species through protection of land
- ✓ County Water Board: manages island freshwater supply, which comes largely from groundwater recharge through watershed in each county

Students need to gather facts to support the stance of their interest group, then plan a strategy to resolve the problem. Responses should be tailored to each group's particular roles. To help with their strategy planning, each interest group should answer the questions below.

1. How does my interest group use the watershed?
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 my interest group could take to help restore and protect the watersheds on our island.

When it is time to reconvene, the class seating should be divided according to the different interest groups. Each group should have a spokesperson 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 stances of the different interest groups. The amount of time it takes to achieve a resolution will depend upon the parties; however, it might be easier to establish a time limit such as two class periods. The class should come up with a realistic action plan that incorporates the ideas presented.