



# Water Watchers

Grade 4

*‘Ōhi‘a Project / Exploring the Islands*

## Lesson at a Glance

Students play a game that illustrates the increased demand for fresh water and the need for water management in Hawai‘i.

## Key Concepts

- There are many competing demands for fresh water in Hawai‘i. Demands have increased over time.
- The health of watersheds depends on the health of the forests.
- Water resources need to be managed through conservation and protection.
- We must educate others and ourselves on the importance of water conservation and protection.

## Essential Questions

- How has land use affected our fresh water supply over time?
- Why do islands need forested watersheds?

## Hawai‘i Content Performance Standard III, Science

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.4.2.1		Describe how the use of technology has influenced the economy, demography, and environment of Hawaii	
Sample Performance Assessment (SPA)		The student: Describes how a specific technology (e.g., farming, manufacturing, or communication) has influenced the economy, demography, and environment of Hawaii and describes a plan to improve the conditions in the natural environment.	
Rubric			
Advanced	Proficient	Partially Proficient	Novice
Explain how the use of technology has influenced the economy, demography, and environment of Hawai‘i and suggest ways to conserve the environment.	Describe how the use of technology has influenced the economy, demography, and environment of Hawai‘i.	Give examples of how the use of technology has influenced the economy, demography, and environment of Hawai‘i.	Recognize that the use of technology has influenced the economy, demography, and environment of Hawai‘i.

## Objectives:

Student will be able to:

1. identify the major water users in the state;
2. state the relationship between population growth and water demand;
3. list strategies for water conservation; and
4. list strategies for groundwater protection.

## **DOE/MGF *Exploring the Islands* Telecast: “Watershed Watch”**

Students construct a watershed puzzle and predict the winner of a game show contest between “Florence Forest” and “Barry Slopes” where the winner is the biggest collector of precious groundwater.

### **Assessment**

Students create a diagram that summarizes how demands for fresh water use in the islands changed over time. Using the dates listed for the five scenarios above, ask each student the following:

- a. Organize the scenario characters and events into a chronology.
  - b. Explain how the characters and events in each time period affected water supplies.
  - c. Explain how the characters affected one another. For example, how do native plants and animals benefit people? How do sugarcane and *kalo* benefit people?
  - d. Describe ways to conserve water and protect their watershed.
- Students fill in the second half of the *ahupua‘a* diagram started in the previous activity, “Wai Ola: Water of Life” illustrating and/or describing changes in land use since early Hawai‘i.

### **Subjects**

Science, social studies

### **Time**

three class periods

### **Materials**

student reading (provided)  
watershed puzzle pieces (provided)  
construction paper, 3 different colors  
markers or crayons  
scissors  
radio or tape recorder or CD player and recorded music  
masking tape or safety pins

### **Preparation**

Copy the student reading and a set of watershed puzzle pieces for each student. Cut 30 large water drop shapes (about 15 cm, or 6 in.) out of blue construction paper to represent the water supply (or substitute other props). Cut out 16 squares of one color construction paper for identification tags, and label them as follows: 8 people, 4 native plants, 4 native animals. Cut out 8 squares of another color construction paper and label them: 4 sugarcane, 2 *kalo* (taro), 1 aesthetic value, 1 cattle. There should be an identification card for each student. If there are more than 24 students in the class, have the additional students represent people. If there are fewer, alter the scenarios to fit the class size and remove a corresponding number of water drops.

### **Vocabulary**

watershed, ground cover, infiltration, runoff, groundwater, surface water, desalination

### **Prerequisite: “Plunging into the Water Cycle”, Geography, Grade 4**

## Teaching Suggestions

1. Briefly review the water cycle. See “Plunging into the Water Cycle”, Geography, Grade 4. Define surface water, runoff, evaporation and transpiration, groundwater and infiltration. Explain how they are interconnected. Define aesthetic value.
2. Distribute the student reading and review it with the class.
3. Write the term “watershed” on the board and ask students if they know what it means. Record their ideas. Distribute the watershed puzzle piece page and ask students to cut their pieces out in preparation for the “Watershed Watch” program. Show “Watershed Watch” from the *Exploring the Islands* series.

### During the *Exploring the Islands* Telecast “Watershed Watch”

#### **Mystery Minute Question**

They grow on the land, but they help keep streams and reefs healthy. What could they be?

#### **MindPower Minute Questions/Tasks**

- Label your water cycle diagram with these water words and write a definition for them: surface water, runoff, groundwater, infiltration
- In a competition to collect groundwater, which contestant will win—Barry Slopes or Florence Forest?
- Identify at least one way that clearing forest slopes affects you.

#### **Mahalo to...**

Kūhiō Elementary School for assisting with *Exploring the Islands*

Teachers: Diane Sumida and Kathy Lee

Students: Jordan Delo Santos, Camille Gonzales, Brysen Kotaka, Alexia Whirry

4. After the program, “Watershed Watch,” revisit students’ ideas about a watershed.

#### Discussion Questions

- What is a watershed? (*The land area where water drains to a particular body of water.*)
- Where is the watershed for our school area? (*Have students view on-line the maps of each island showing where streams are located. See the links provided on the ‘Ōhi‘a Project web page at mgf-hawaii.com.*)
- Why are watersheds important to people who live in a town? (*Healthy watersheds covered with forest vegetation catch and hold water that is drawn from wells and distributed to population centers. Watersheds with bare ground contribute to runoff, flooding and erosion that affect people in lowland areas where towns are usually located.*)

- Why was “Barry Slopes” a loser in the contest for groundwater? (*Without plant cover, there is increased erosion and less infiltration into the ground.*)

### Water Watchers Game

5. Take the class outside or pull the tables and chairs to one side of the classroom. Arrange the paper water drops in a circle on the ground. Explain that the drops represent surface water resources in Hawai‘i. Pass out identification tags for the water game, and have students tape or pin them on.
6. Review the directions and play the game.

### How to Play

- a) Read a scenario from a period of Hawaiian history.
- b) After each statement ask the characters named in the scenario to form a circle around the water drops.
- c) Turn on the music and have the characters circle the water drops.
- d) When the music stops, characters must each take one water drop from the pile.
- e) Characters stay in the circle, which grows larger as more students are added with each scenario. Water drops are returned to the center after each scenario, since water recycles in nature.
- f) If there are not enough drops to go around, people, agriculture and livestock have the power to take water from native plants and animals and aesthetic value.
- g) If a character does not get a water drop, it cannot survive and must leave the game. The survivors then return their drops to the center and the teacher goes on to the next scenario.



### Scenarios

- a) The year is 200 BC. There are no people in Hawai‘i, but there are lots of plants and animals. Ask the eight native plant and animal characters to circle the water drops.
- b) The year is AD 1000. Polynesians have colonized the Hawaiian Islands, so there are now more uses for fresh water. Ask the *kalo*, the aesthetic value, and two people to join the other characters in the circle.
- c) The year is AD 1800 and Europeans are in the islands. Send in the sugarcane, cattle, and three people.

- d) The year is AD 1910. People want to grow more sugarcane than ever and have dug hundreds of wells to tap groundwater sources. As a result, the water table has dropped, and many surface water sources have gone dry. (Remove five water drops from the circle to represent this loss of surface water.) Two more people approach the circle.
- e) It's now the present time. The population has grown so large that even more water is being pumped from the ground. (Remove three drops to represent the loss of surface water resources.) All remaining people approach the circle. This time, there will not be enough water to go around.
- f) Global warming: Data confirming global warming of temperatures in the air and oceans have risen to affect amount and distribution of rainfall. What can we do about this and what are the causes?

7. Summarize the main points of the game.

### Discussion Questions

- Why did the sugarcane and *kalo* get to keep water, while the native plants and animals could not?
- What effects do cattle have on the water supply?
- Why did the character representing aesthetic value appear when people appeared?
- What places in Hawai'i have aesthetic value, or lost it when water dried up or became polluted?
- When there is not enough water for all the water users, who decides which uses are most important, and how do they decide? (Discuss the State Water Code—see Background.)
- What is more important: aesthetic value, sugarcane, plants and animals, industry (jobs), or recreation? (Stress that there is no correct answer—everyone has his/her own opinions.)
- What can be done to provide more water to meet needs?
- How can pollution affect our groundwater supply?

8. Have students complete the assessment activities.

9. Have students read and do the Kolepa Kai Golf Course activity. Share collected information with the rest of the class.

### **Extended Activities**

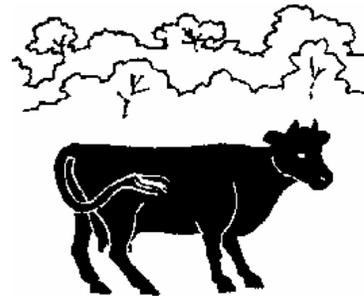
- Play the game again, altering the scenarios or extending them into the future.
- Ask a *kupuna* or grandparent to come in to class to share about the surface water resources they remember enjoying as a child—many can tell of swimming holes, springs and streams that are now dry or polluted.
- Bring in newspaper clippings about current water issues and discuss them with the class. Have students assume the roles of coffee grower, rancher, developer, taro farmer, or other roles, and debate the issues.

- Ask students to write a story about Hawai'i 100 years from now when there will be a much larger population. Will we treat water differently then, or have different water sources?
- Take the class to visit a nearby stream (see "Stream Sojourn," Plants and Animals, Grade 4). Discuss aesthetic and ecological values of streams. Imagine what it would be like if the stream was not there.
- Make posters depicting water conservation or watershed protection. For more information on watersheds see "Watershed Wisdom," Humans and the Environment, Grade 6.
- Assign creative writing exercises, such as "The Day I Was a Water Drop," "A Day in the Life of Derek the Drip," or "Journey of a Water Drop."

The early Polynesian settlers of the Hawaiian Islands identified water with wealth. *Wai* is the Hawaiian word for fresh water; *waiwai* means value or worth. *Kāna* means belonging to or equally sharing, and *kānāwai* was the law of the land.

There were once many more streams and marshes in Hawai‘i than there are now. Whole settlements were built around streams that no longer flow. The underground water supply was once greater, too. It helped feed freshwater springs that are now dry. Areas named for their freshwater springs include Waikīkī and Waialua.

After Captain Cook arrived in 1778, cattle and other hoofed animals were introduced to the islands. These animals polluted the rivers with their wastes and removed so many plants that soil began washing into rivers and out to sea. Many forests were cut to make room for farmland and grazing animals. Soils, laid bare and packed down by animals’ hooves, lost the ability to soak up water. This meant that more water was draining into rivers and the ocean and less into underground water supplies. With forest protection gone, some streams became muddy or turned into raging rivers during heavy storms.



Meanwhile, thousands of acres of land in Hawai‘i were planted in sugarcane. Sugarcane requires a lot of water to grow. The first irrigation ditch was built in Līhu‘e, Kaua‘i in 1857 to carry surface water from the rainy mountains to the dry sugarcane fields. In 1878, the East Maui System, originally called the Hāmākua System, was built 27 km (17 mi) long. Another large system at Olokele on Kaua‘i was built in 1890–1891. On the Big Island, the Kohala Ditch system was built in 1906 and was 22.5 km (14 mi) long. The Upper Hāmākua Ditch System was built in 1907 and was 37 km (23 mi) long. The Lower Hāmākua Ditch was completed in 1910 and extended 40 km (25 mi). On O‘ahu, the Waiāhole Ditch was completed in 1916 and was nearly 43 km (26.5 mi) long.

As additional land was planted in sugarcane and the population in the islands grew, even more water was needed. In 1879, James Campbell drilled a well 68 m (223 ft) deep through the ‘Ewa Plain caprock into the volcanic rock below. The volcanic rock contained small holes (vesicles) and voids that store fresh water. The rock was fully saturated. This was the beginning of deep well drilling for groundwater in Hawai‘i.

People thought Hawai‘i’s water supply would last forever. By 1910, 430 wells had been drilled on O‘ahu alone. As a result of so much water being removed from the ground, the water table on O‘ahu dropped by one-third within 30 years. Springs, streams, and wells near the coast dried up or became brackish (salty). In 1915, the Honolulu Water Commission began asking people to conserve water. The Honolulu Board of Water Supply was formed in 1929 to manage O‘ahu’s water supply. They repaired leaky wells, sealed abandoned wells, standardized fees for water

use, replanted trees along the bare upland slopes of the main Hawaiian Islands, and removed cattle. Watershed areas were also set aside by law as reserves to protect the water supply.

Today, there are more people, more industries, and more uses for Hawai'i's fresh water than ever before. As the population on all islands continues to grow, the demand for fresh water grows too. Unfortunately, the source of all fresh water, precipitation (rain and snow), remains unchanged.

A State Water Code was adopted by the legislature in 1987 (Chapter 174C) to address management of the state's water supplies. The code's Declaration of Policy opens with the following statement:

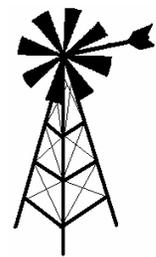
It is recognized that the waters of the state are held for the benefit of the citizens of the state. It is declared that the people of the state are beneficiaries and have a right to have the waters protected for their use.

A later paragraph in the same section continues:

The State Water Code shall be liberally interpreted to obtain maximum beneficial use of the waters of the state for purposes such as domestic uses, aquaculture uses, irrigation and other agricultural uses, power development, and commercial and industrial uses. However, adequate provision shall be made for the protection of traditional and customary Hawaiian rights, the protection and procreation of fish and wildlife, the maintenance of proper ecological balance and scenic beauty, and the preservation and enhancement of water of the state for municipal uses, public recreation, public water supply, agriculture, and navigation. Such objectives are declared to be in the public interest.

Many businesses in our islands have been looking for ways to conserve water. Some have turned to treated waste water, which is treated for recycling, with some nutrients still left in it. This makes a great alternative for irrigating most landscaping, crops, and golf courses. For example, some golf courses are now eco-friendly so that they use less water and save money. The types of grass grown at some golf courses do not require as much water as other kinds of grass. Other golf courses benefit from recycled waste water because most are developed near the coast in sunny areas with little water. Because of its nutrient content, recycled waste water is actually better suited than drinking water for some of the applications where drinking water gets used the most. When recycled waste water is used for irrigation or landscaping, more of our natural supply of drinking water is ultimately conserved. Using recycled waste water also helps preserve fresh water for ecosystems that depend on it.

Another way to conserve drinking water or create new supplies is through desalination. **Desalination** is the process of removing minerals and salts from seawater and brackish water. In other parts of the world where there are water shortages, such as the Middle East, desalinating is an important way for people to get drinking water and water for irrigation. There are different methods for desalinating sea water, such as reverse osmosis. In reverse osmosis, the sea water or brackish water passes through a membrane and comes out separated as salts, minerals, and fresh water. The University of Hawai'i Institute of Marine Biology (HIMB) on Moku o Lo'e off the windward coast of O'ahu has a desalination system that's



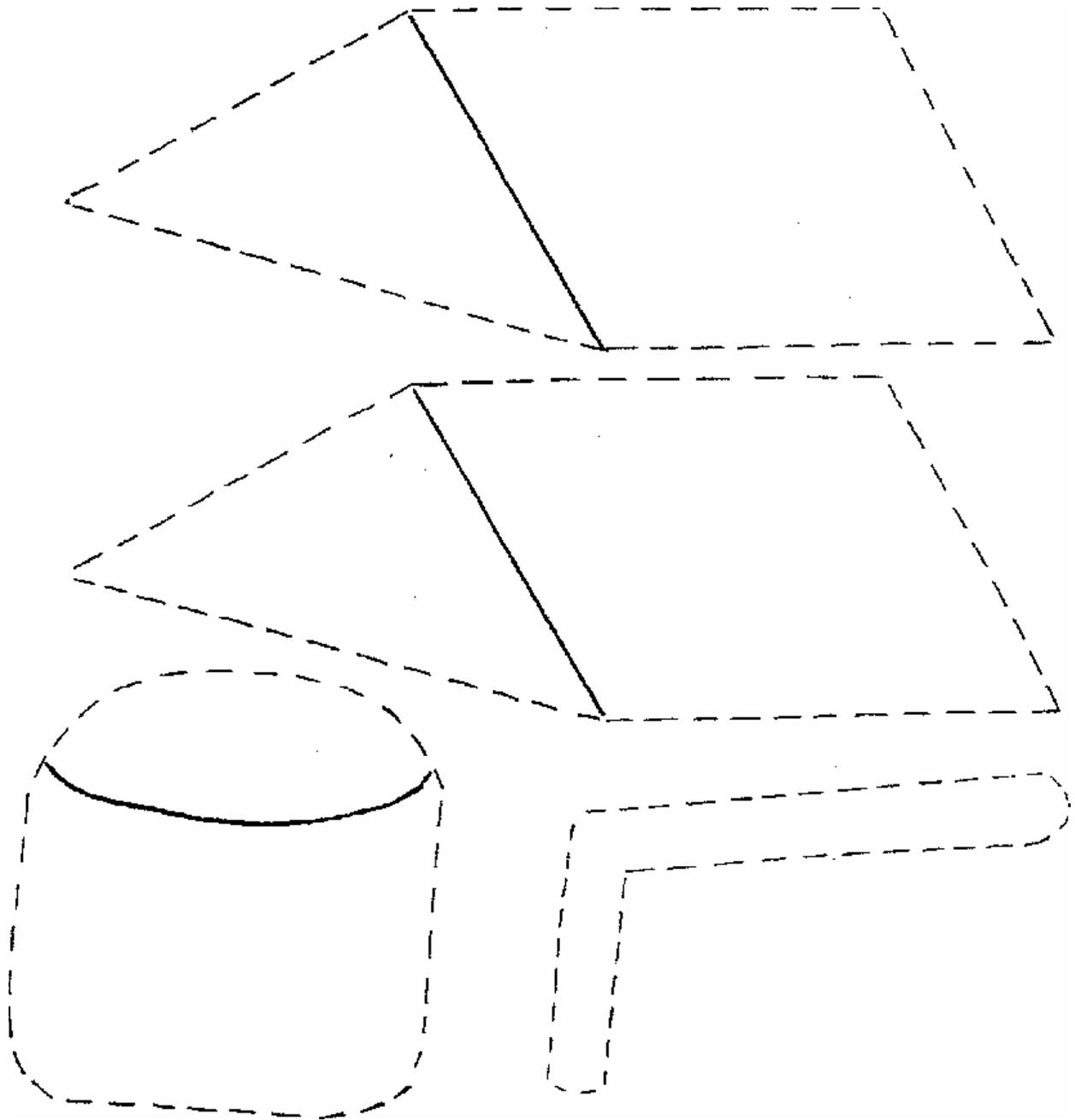
powered by a 30-foot tall windmill. The power of the wind is an alternative, inexpensive, and clean fuel source. On the island of Kaho‘olawe, where water sources are extremely limited, a desalination system was also built. It too relies on sea water and reverse osmosis to provide water for irrigation and drinking. At the end of the year 2004, the Honolulu Board of Water Supply will build a desalination plant at Kalaeloa, O‘ahu. This plant will incorporate the reverse osmosis process but instead of drawing water from the sea, it will rely on sea water from deep groundwater wells. This plant will help supplement the water needs of the ‘Ewa District, a normally dry area on the island. On the Big Island, companies are producing bottled drinking water by desalinating deep ocean water using reverse osmosis.

Water conservation alone is not enough to assure an adequate safe supply of fresh water. Pollution of our environment can affect groundwater quality. Pesticides, herbicides, fertilizers, paint, oil, gas, cleaning solvents, and other contaminants can seep into the ground and reach our groundwater supply. Some pollutants can enter streams via sewer systems, killing stream life. Eventually the pollutants can flow through the streams and enter our ocean to cause massive kills to marine life. Beaches in Hawai‘i are periodically posted warning signs of pollution washed down from the land and into streams after heavy rains. Land and water management need to cooperate if water is to be a renewable resource. It’s very costly to reverse contamination.

Conserving water and preventing its pollution is a global issue. For instance, if a water aquifer lies beneath several countries, which country has control of it? Although there are many water treaties between countries, the issue of aquifer “ownership” is still being addressed. About 4,500 years ago, a war over water rights broke out between the Umma and the Lagash of Sumeria. Eventually the war ended with a peace treaty engraved on a clay-tablet that is now on display in the Louvre in Paris.

By educating ourselves to better manage our water supplies and care for our environment, this valuable resource will adequately provide for all.

- Cut the pieces below on the dotted lines. Color them to add interest as follows: triangular pieces—green, rounded piece—red, “L-shaped” piece—blue.
- Create a fifth puzzle piece by cutting a piece of blue construction paper (or other 8.5 in x 11 in blue colored paper) in half length-wise. Cut the top edge of this blue strip of paper in a wavy line to represent the surface of the ocean. (Another student may use the other half of the paper!)



Hi, I'm Kolepa Kai. I own Kolepa Kai Golf Course in Hawai'i, one of the best champion golf courses in the world. People from all over the globe come here to play 18 holes. My golf course has been featured in magazines, ESPN, calendars, and movies—just everywhere. It's one of the most photographed golf courses in the world and consistently rated in the top 10. Kolepa Kai Golf Course is situated on a valuable piece of land along a gorgeous coastline where the weather is sunny all year long. Doesn't my golf course sound like a place you'd like to experience?

At the beginning, Kolepa Kai Golf Course watered its course using the same kind of water people in our community were drinking. That's what all golf courses did. Water was water. It costs a lot of money to water a golf course. A golf course takes up so much land. The grass is a beautiful shade of green and to maintain that greenery it takes a lot of water. I became concerned with using water wisely so I've made some changes at Kolepa Kai Golf Course. To cut down on costs, I've planted Bermuda grass on the tee and putting areas. Bermuda grass is a great choice because it is drought resistant and salt tolerant. I know of a golf course that uses seashore paspalum. This type of turf grass thrives on brackish water. Even with this change in the type of grass used, a golf course still requires a lot of water.

Several years ago, Hawai'i went through an extended drought. Little rain fell for most of the year. Water levels in the islands' groundwater wells were lower than they should have been. The water company asked everyone, residents and businesses alike, to conserve water. A smart young guy I just hired suggested that we use recycled water from the sewage treatment plant down the street to water the course. It would cost less than using drinking water AND we would be conserving our pure drinking water. We could show the water company and the community that we were doing our part to conserve this precious natural resource. I thought—what a great idea, but I was still unsure. Did I really want to use sewage water? It just didn't sound clean. I discovered that the sewage treatment would treat the water before they gave it to us so that it would be clean. Perfect! Now I have recycled water piped right to my golf course! The employees at Kolepa Kai Golf Course were so pleased with what we discovered.

After our success in using recycled water, we wanted to do more. To help save water, we decided to use drip irrigation rather than the sprinkler system used by some golf courses. The lawn is irrigated on average about 18 inches underground through a drip method. The water is being delivered to the root system where it is most needed. A computer monitors my drip irrigation. My computer will tell me if there's a leak at the 18<sup>th</sup> hole. If so, I can fix the problem right away. How's that for efficiency? Our maintenance workers monitor the water quality daily to ensure that our recycled water supply does not include anything harmful to the environment or people.

Initially it was costly to have a pipe installed from the sewage treatment plant to my golf course and then to assemble the drip irrigation system, but these changes are definitely worthwhile. The money I save from using recycled water is now paying off. Today, Kolepa Kai Golf Course is at the forefront of using recycled water. I noticed my water bill is **50 percent** less for recycled water than it used to be when I was using drinking water. I sure hope other golf courses and businesses can learn from my experience. I just found out that new turf grasses are being developed that will reduce water and pesticide use. Incredible! I'm going to look into that because providing a wonderful golf experience for my customers while caring for the environment is my goal. Bring your 'ohana down for an unbelievable Hawaiian style golf experience.

Mahalo for talking story with me! Kolepa Kai

### Activity

Now that you've read how Kolepa Kai Golf Course saves water, discover how a real business on your island conserves water. Select a business that you think uses a lot of water. Here are some questions you can ask them. Write down the answers.

- How do you use water in your business?
- How much water do you need per day??
- What is the cost comparison of using recycled water and fresh water?
- Do you conserve water? If so, how?
- Do you recycle water? If so, how?
- What is the cost comparison of using recycled water and fresh water?
- Are there any government regulations that you need to conform to in using water/recycled water?
- What are the environmental benefits of practicing water conservation, if any? For instance, some businesses have created wetlands for native water birds.