

LEAF IT ALONE!



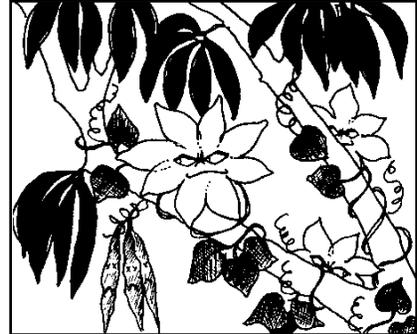
Grade 5

Lesson at a Glance

Groups of students adopt one of four different forest communities and design new adaptations for a native plant so that it may successfully compete with or repel an introduced pest species.

Key Concepts

Having evolved in the absence of large grazing and browsing mammals, a number of Hawaiian plants lack defenses, such as thorns or poisons, necessary to repel such animals. When a new plant or animal is introduced without its natural controls, such as diseases or insects, native ecosystems can suffer.



Objectives

Students will be able to:

- 1) Design an adaptation for a native plant that would help it to repel a particular introduced plant or animal.
- 2) Develop a story to describe how the new adaptation works.

Time

two to three class periods

Subject Areas

science, art, language arts, Hawaiian studies

Materials

student activity sheets (provided)
large sheets of paper
colored markers

Prerequisite

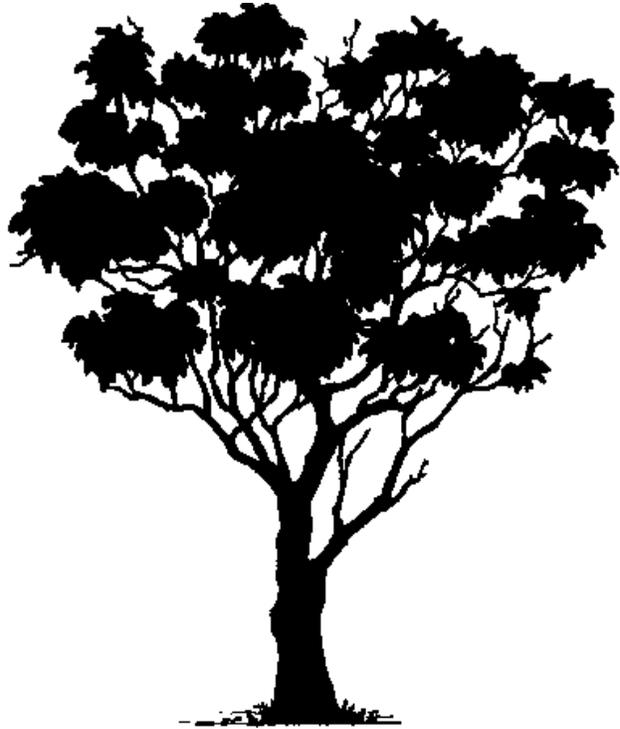
“Island Puzzle Pieces,” Geography, Grade 5

Teacher Background

The range of temperature and moisture conditions from sea level to mountaintops and from windward to leeward sides of the Islands creates a number of zones where different **natural communities** exist. Scientists have described at least 150 different natural communities in Hawai‘i. Four general types of forests in the Islands are: **rainforests**, **dryland forests**, upland moist forests and **subalpine forests**. These forests are home to a diverse array of plants and animals that are **adapted** to specific living and/or growing conditions. One remarkable tree that has adapted to almost every zone is the ‘ōhi ‘a.

Rainforest

The 'ōhi'a rainforest once existed from just above the coasts to approximately 1,800 m (6,000 ft) on the wet, windward slopes of most islands. Today, most native rainforests occur in remote interior upland regions far from our cities and towns. Rainfall in these forests ranges from 3,750–7,500 mm (150–300 in) per year. In many areas between 900–1,500 m (3,000–5,000 ft) elevation, where there are deep soils, tall *koa* trees are found growing amidst the 'ōhi'a.



The cool moist rainforest has many layers of plant growth. The upper layer or canopy is dominated by 'ōhi'a trees. Beneath this layer are smaller trees, such as 'ōlapa, *pilo* and *manono*. In most rainforests, a layer of tall tree ferns grows beneath the trees. Beneath the tree ferns is a layer of scattered shrubs including 'ōhi'a, *pūkiawe* and lobelias. The forest floor is covered with decaying leaves, branches and other **organic** matter and low-growing mosses, ferns, and sedges. Festooning the branches and trunks of the trees are mosses and **lichens**. Lichens are made up of **fungi** and **algae** growing in close association. Algae produce food and fungi provide protection from adverse conditions such as drought. Lichens are commonly found growing on rock walls, where they resemble round spongy masses of gray, white or green moss. Throughout the forest are **epiphytes**, which are plants that grow on other plants and derive moisture and nutrients from the air and rain.

Dryland Forest

Dryland forests once occurred on leeward slopes from approximately 300–1,800 m (1,000–6,000 ft) where rainfall is usually less than 1,250 mm (50 in) per year. A typical dryland forest has trees such as *wiliwili*, 'ōhe, *lama* and 'ōhi'a. The *wiliwili* and 'ōhe drop their leaves in the summer. Growing beneath these trees are shrubs such as *a'ali'i* and *pūkiawe*. Beneath the shrubs are small ferns and grasses, such as the **indigenous** *pili* grass. Unlike the rainforest, the dryland forest is somewhat open, so that patches of sunlight penetrate to the forest floor. There is no layer of tree ferns, and epiphytes are usually not abundant. However, these forests were rich in species and are slow to recover from disturbances. Due to the impacts of fire, goats, cattle and land clearing for human development, very few of these forests remain.

Upland Moist Forest

In the transition from rainforest to subalpine zones on Maui and Hawai'i, there is an area where moist forests grow. In the upper reaches of this upland moist forest zone, *koa* trees grow in open woodland. Growing beneath the *koa* are shrubs and bunchgrasses. Rainfall averages 1,900 mm (75 in) per year. These moist forests usually do not have a tree fern layer or the epiphytes

common to rainforests. Cattle grazing in some areas have prevented regrowth of *koa* in these forests and introduced grasses are replacing native plants.

Subalpine Forest

Subalpine forests grow between 1,800–2,700 m (6,000–9,000 ft) elevation on the windward and leeward sides of Maui and Hawai‘i. *Māmane* and *naio* are the dominant trees in these open, shrubby forests. These trees are adapted to the cool, dry environment in this zone. The mean monthly temperature is less than 10°C (50°F) and the average annual rainfall is only 500–1,300 mm (10–50 in). Growing beneath the trees are shrubs such as *pūkiawe* or *‘ōhelo* and native bunchgrasses. The plants are slow-growing, and on younger rocky soils, the forest floor may consist of only small ferns and lichens growing on cinder or rock. Many subalpine forests have been severely altered by the browsing of **feral** goats and sheep.

Introduced Plants and Animals

Large areas in each of these forest environments have been degraded by the introduction of non-native plants and animals. Native plants, whose ancestors may have had thorns or poisons, evolved and survived without defenses since there were originally no large browsing mammals in the Islands. These plants were vulnerable to grazing by mammals such as pigs, goats, sheep and cattle, which were introduced later by people.

Introduced plants have invaded native forests as well.

Approximately 900 species of ornamental plants have become naturalized or able to maintain populations without human assistance. Of these, approximately 80 species pose a threat to native plants and animals. One species, the banana poka, was introduced to the island of Hawai‘i in 1930. Fifty years later it covered more than 39,000 ha (97,000 ac) on the islands of Hawai‘i, Kaua‘i and Maui. Although an attractive ornamental plant, banana poka is capable of smothering 23-m (70-ft) trees with its vines.



Since an insect or fungus that would control banana poka might also harm the related commercially-grown passion fruit, no natural controls for this pest plant were introduced to the Islands until recently. Researchers have released an iridescent blue moth (*Cyanotricha necyria*) on the island of Hawai‘i and are determining its effectiveness in controlling banana poka. Some non-native plants defend against vines such as banana poka by periodically shedding their bark.

Scientists estimate that before the arrival of people, approximately one plant or animal successfully colonized the Hawaiian Islands every 200,000 years. Changes to existing ecosystems by colonizing plants and animals are nothing new. Today, however, such change (or *ho‘ololi*) is occurring too quickly for native ecosystems to adjust and many species may become endangered or extinct as a result. In this activity, we speed up the evolutionary process to see what kinds of **adaptations** might help native species to survive recent changes.

Teaching Suggestions

1. Review the main vegetation zones in Hawai‘i (see Prerequisite).

2. Discuss ways that plants and animals have adapted to live in certain vegetation zones.
3. Divide the class into small groups and distribute one student activity sheet to each group.
4. Distribute large sheets of drawing paper and colored markers. Challenge students to design a plant adaptation that will allow it to compete with or repel the introduced plant or animal described.
- ✓ 5. Ask each group to present its newly adapted species to the class. The group should describe the forest environment and explain how the plant has adapted to survive.
6. Discuss reasons for the vulnerability of native plants.
- ✓ 7. Ask students to write a story to accompany the picture their group has drawn. Display the drawings and stories for other classes in the school.

Extended Activities

- Have students create three-dimensional models of their newly adapted species using cardboard, clay or papier mache.
- Use cardboard, oak tag and construction paper to create a three-dimensional representation of one of the forest environments in the classroom. See References listed in "Island Puzzle Pieces," Geography, Grade 5, for sources of pictures of the various zones.
- Take a field trip to visit one of the forest zones. See the Field Sites Appendix for suggested sites on each island.
- Involve your class in a service project to remove banana poka, blackberry, gorse, or other pest species from natural areas. Contact The Nature Conservancy of Hawai'i or your local Sierra Club office for more information.

RAINFORESTDescription

Located at 900 m (3,000 ft) elevation on the wet, windward slope of a Hawaiian island, this rainforest has four layers of plants. The tallest layer is formed by 'ōhi'a *lehua* trees. The beautiful red 'i'iwi birds match the *lehua* blossoms where they drink nectar. Beneath the 'ōhi'a is a layer of smaller trees, like *pilo*, which provide berries for birds. The songs of the birds drift through the misty forest. A layer of tree ferns, or *hāpu'u*, and shrubs grows beneath the smaller trees. Many insects and snails live in this layer. The lowest layer is made up of mosses and small ferns that form a soft green carpet on the forest floor. Plants grow on top of plants in this rich forest. Mosses and ferns hold water like sponges. The forest receives more than 3,750 mm (150 in) of rain each year. There is a rich earthy smell in this cool, dark and damp forest.

Problem

Wild pigs are knocking over native *hāpu'u* and eating the starchy inner cores. Rainwater collects in the plants once the starch has been eaten. This leaves a place for mosquitoes to breed. Mosquitoes spread diseases from introduced birds to native birds.

Task

Design adaptations for the *hāpu'u* to protect it from pigs.



DRYLAND FORESTDescription

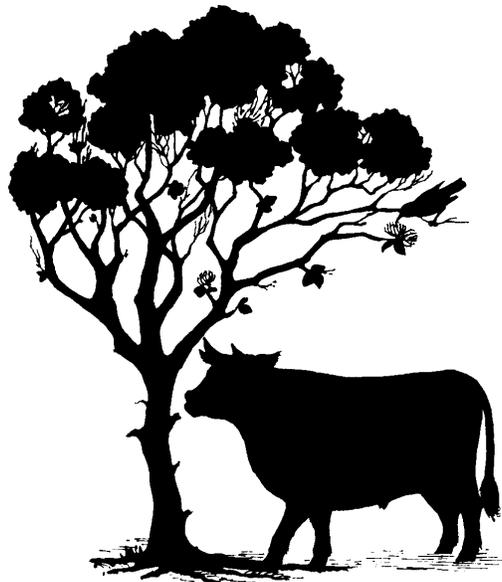
This dryland forest grows on a leeward slope of a Hawaiian island at 900 m (3,000 ft) elevation. Rainfall in this forest is usually less than 1,250 mm (50 in) per year. Some of the trees, such as *wiliwili* and *'ohe*, drop their leaves in the summer and grow them back in the winter. The trees are not growing close together so sunlight reaches the forest floor. Growing beneath the trees are shrubs and grasses, such as *pili* grass, which the Hawaiians used to thatch their houses. The dry forest is home to many rare plants and animals, such as the tiny colorful land snails that crawl over leaves. The calls of birds are carried on the wind as it whistles among the branches of *'ōhi'a lehua* trees. The birds visit the trees to drink nectar from the lehua blossoms.

Problem

Cattle are trampling on the tiny seedlings of *'ōhi'a* trees. As a result, no new trees are growing in the forest. Cattle are also trampling and damaging the roots of older trees. Tree roots grow close to the surface of the soil and cattle not only trample roots, but also compact the soil and squeeze out the oxygen that the plants need.

Task

Design an *'ōhi'a* tree that cattle cannot trample.



UPLAND MOIST FORESTDescription

This moist forest grows on mountain slopes at 1,950 m (6,500 ft) elevation between rainforest and subalpine forest zones. In the upper reaches of this zone, *koa* trees grow in an open woodland. Growing beneath the *koa* are shrubs, ferns and bunchgrasses. It is usually cool, damp and cloudy in this forest. Rainfall averages 1,900 mm (75 in) per year. Tiny yellow, green and red birds whistle and call in the *koa* trees as they search for insects among the lichen-covered branches.

Problem

Koa trees are being smothered by an introduced plant called banana poka. This plant forms a vine that grows over trees and blocks the sun so that the trees eventually die. Banana poka was brought to Hawai‘i from South America. None of the insects or diseases that control it in South America were brought to Hawai‘i, so the plant is out of control. It covers approximately 39,300 ha (97,000 ac) of land on the islands of Kaua‘i, Hawai‘i and Maui combined.

Task

Design an adaptation for the *koa* tree that would keep banana poka from smothering it.

SUBAPLINE FORESTDescription

It is cool and dry in this subalpine forest at 2,400 m (8,000 ft) elevation on the island of Hawai‘i. *Māmane* and *naio* are the main trees growing high on this mountain. Bright yellow-headed *palila* birds search for seeds in the *māmane* trees. Their heads match the trees’ brilliant yellow flowers. The trees are adapted to the cool, dry environment in this zone. It is often less than 10°C (50°F) and the average annual rainfall is only 500–1,300 mm (20–50 in). The trees in this forest are not very tall or spaced very close together. Growing beneath the trees are shrubs such as *‘ōhelo*, with its bright red, delicious berries. Growing with the shrubs are native bunchgrasses and lichens.

Problem

Goats and sheep are browsing on the *māmane* and *naio* trees and eating all of the young trees. This damages the *palila*’s habitat by preventing new trees from growing in the forest.

Task

Design an adaptation for the *māmane* tree that keeps goats from grazing on it and eating its seedlings.

