



## Dry Forest

### Concepts

Modern technology has affected the forest.

### HCPS III Benchmarks

SC 6.2.1

### Duration

2 hours

### Source Material

PRISM

### Vocabulary

native  
endemic  
endangered  
invasive  
fountain grass  
wiliwili  
uhiuhi  
lama  
deciduous

## Lesson 1: What is a Dry Forest?

### Summary

The students will learn about the history of the dry forest and the traditional importance of plants in the dry forest. They will also learn how the dry forest has changed as a result of the effects of humans and technology.

### Objectives

- Students will learn the difference between native and invasive species.
- Student will learn problems native Hawaiian ecosystems face.

### Materials

#### Activity 1: Discussion Series

Map of Hawaii  
Map of dry forests  
Invasive species images  
Images of native plants  
Plant ID Cards  
Worksheets (guided notes on discussion)  
KWL Worksheets

#### Activity 2: Map Quest

Map with historic range and current range  
Paper  
Tracing paper  
Pencil  
Colored pencils/markers/crayons

#### Optional work:

Vocabulary word search

### Teacher Prep for Activity

Read the background information and become familiar with some of the native plants, especially wiliwili (*Erythrina sandwicensis*), uhiuhi (*Caesalpinia kavaiensis*), and lama (*Diospyros sandwicensis*). More information can be found at <http://www.botany.hawaii.edu>. Make sure all worksheets are copied and that the maps are in a form that can be easily displayed to the class.



## Background

A Hawaiian dry forest consists of small trees, shrubs, and grasses and receives less than 127 cm (50 in) of rain per year. In Hawaii, 90% of the plant species are **native** plants, and nearly 25% of them are found in the dry forest. On the island of Hawai'i, dry forests are found on the leeward side of the island. There are protected areas and natural reserves set up at different locations as attempts to save this highly **endangered** forest.

Hawaiian dry forests are one of the most critically endangered habitats in the world. The forest is highly degraded and its range has been reduced by 90%. The biggest problems for dry forests are fires and **invasive** grass. One grass that native Hawaiian plants cannot compete with after fires is **fountain grass**. Fountain grass is fire adapted and easily regenerates after wild fires, which native plants did not historically experience. Fountain grass also competes with native plants for light and water, and crowds out native seedlings. It provides a lot of fuel for wild fires because of the large clumps and bunches that form at the base of the grass. The most common way of controlling fountain grass is the use of herbicide as well as pulling it out of the ground, roots and all.

There are many threatened and endangered plants found in Hawaiian dry forests. **Uhiuhi**, a medium size tree up to 10 m (35ft) tall, has dark, rough bark. Hawaiians used the wood from uhiuhi to make fishing supplies that sink rather than float because the wood is so dense. There are about 100 wild Uhiuhi left in the Hawaiian Islands. **Lama** is a small, slow growing tree that grows up to 35 feet tall and 10 feet wide. It grows on all of the Hawaiian Islands, mostly in dry forests, up to elevations of 4000 ft. Traditionally, lama was used for medicine as well as for its wood, known as the Hawaiian ebony. Kokia is a small tree that is 4-10 m (13-35 ft) tall. It has showy flowers and star shaped leaves, and is commonly used as a garden or ornamental plant. Traditionally, the sap of this tree was used to dye fishing nets red. There are only 3 wild kokia left, all in the North Kona district, and they are not naturally reproducing. **Wiliwili** grows 35-45 ft tall and has about the same width. The trunk and braches have a few short spines growing on them. It is one of Hawaii's few **deciduous** trees, shedding its leaves in the summer in order to conserve water. Wiliwili blooms in the summer after it sheds its leaves and can flower through November. It has large, showy flowers that are curved and claw-shaped. They grow 2-5 cm (1-2 in) long and are usually orange, but can be different colors like red, peach, salmon, green, yellow, or white. Wiliwili wood was traditionally used for buoys for fishing and for the ama of a canoe. The seeds can also be used in leis.



## Vocabulary

Native: historically found in a location, native species in Hawaii are species that are historically found in Hawaii and were not introduced.

Endemic: found only in one location, endemic species of Hawaii are found only in Hawaii

Endangered: low numbers, a threat of losing a species permanently

Invasive: a species that is non-native and overtakes habitats, becoming much more common than it does in its native range

Fountain grass: an invasive grass species in the dry forest, causes fires

Wiliwili: an endangered native tree species of the dry forest

Uhiuhi: an endangered native tree species of the dry forest

Lama: a rare tree species of Hawaiian dry forests

Deciduous: trees that lose all of their leaves

## Procedure

1. Hand out KWL worksheets and have the students fill out the first two parts.
2. Display the map of the Hawaiian Islands.

### ACTIVITY 1: Group Discussion Series

1. Discussion 1: Talk about the types of forests found in Hawaii (wet and dry forests).

*Question 1:* Where are wet forests found?

*Answer:* Wet forests are found on the eastern half of the island. These forests can be found at low, middle, and high elevations.

*Question 2:* Where are the dry forests found?

*Answer:* Dry forests are found on the western side of the island. These forests are found at low and middle elevations.

*Question 3:* How are dry forests different from wet forests?

*Answer:* Wet forests get much more rain than dry forests. The plants found in each type of forest are very different from each other. Animals that inhabit both types of forest are different from each other.

2. Use the map to show where types of forests are located.
3. Show where the dry forests are found on Hawaii Island (next map).
4. Discussion 2: Rainfall Differences

*Question 1:* How much rain does a dry forest get each year?

*Answer:* A dry forest is a forest that gets less than 50 inches of rain per year.

What is a Dry Forest?



*Question 2:* How much rain does your town get a year?

*Answer:* have the students look it up and share.

*Question 3:* How much rain does Hilo get a year?

*Answer:* Hilo gets more than 100 inches of rain per year.

5. Discussion 3: Native plants

*Question 1:* What is a native plant?

*Answer:* A native plant is a plant that is traditionally found in Hawaii.

*Question 2:* What is an endemic plant?

*Answer:* An endemic plant is a native plant that is found only in Hawaii.

*Question 3:* How many species of plants in Hawaii are native plants?

*Answer:* 90% of the plants found in Hawaii are native plants.

*Question 4:* How many of the native plants in Hawaii are found only in the dry forest?

*Answer:* 25% of native plant species in Hawaii are found only in dry forests.

*Question 5:* What does this (the answer to question 4) mean?

*Answer:* There is high amount of native plant diversity found in the dry forests.

6. Discussion 4: Importance of dry forest

*Question 1:* Are the dry forests important? Why or why not?

*Answer:* There isn't a "correct" answer, just a question for the class to think about. Talk about the traditional uses of dry forest plants.

7. Discussion 5: E Malama ai`Aina

*Question 1:* What does E Malama ai`Aina mean?

*Answer:* It means to take care of the land.



*Question 2:* How could you E Malama ai `Aina?

*Answer:* They could grow native plants to plant in the dry forest (which we are doing in class), they could grow native plants in their gardens and plant native plants around their yards, they could help their community get rid of invasive plants, they could talk to their family and/or their friends about the importance of the dry forest, etc.

8. Discussion 6: Dry forest habitat

*Question 1:* How endangered is the dry forest?

*Answer:* The Hawaiian dry forest is one of the most critically endangered habitats in the world.

*Question 2:* How much of the original dry forest is left?

*Answer:* Only 10% of the original forest is left. A good way to visualize this is to have the students think of a football field, and then think of only 10 yards of the football field.

9. Introduce some of the dry forest plants (see plant ID cards)

10. Discussion 7: Problems for the dry forest

*Question 1:* What problems do plants in the dry forest have?

*Answer:* The dry forest has problems with fires. They also face problems due to invasive species. Two of the better known/more problematic invasive species in the dry forest are fountain grass and a gall wasp that lays eggs on wiliwili leaves which cause them to die, impacting the trees' health.

11. Collect their worksheets.

ACTIVITY 2: Map Quest

1. Give each student a map of the island and tracing paper of the same size. Have them trace the island. Then, have them trace the historical range of the dry forest (the dark black line) and the current range of the dry forest (shaded 10, 11, 14, 15, and 16).
2. Provide each student with a blank sheet of paper for them to trace the map onto by flipping over the tracing paper and re-tracing on the other side. Have them darken in their outlines.
3. After they have gotten their map onto a sheet of paper, have them color it in with the difference in ranges in different colors. These colors should be complimentary to help



illustrated the difference. Make sure they draw in all five volcanoes. Have the students complete the worksheet on the dry forest.

4. To end the session, have students finish filling out KWL sheet and collect. If more work is needed, assign the vocabulary word search.

#### INTRODUCE BROCHURE PROJECT:

1. Give a brief introduction of the goal of creating the educational brochures. (These brochures can eventually be handed out to the community as an educational resource.)
2. Hand-out the project guidelines and the rubric to the students. (A brochure “check” will occur in week 5 to see how the students are progressing.)

### Assessments

Notes and worksheets

### Resources

#### UH Manoa Dept. of Botany

<http://www.botany.hawaii.edu>

- includes picture library of plants and background information
- a great article of work being done today to restoring dry forest of West Hawaii available at

[http://www.botany.hawaii.edu/Bot351/Saving Hawaii dry forests.pdf](http://www.botany.hawaii.edu/Bot351/Saving_Hawaii_dry_forests.pdf)

#### Nāhelehele Dryland Forest Non-profit

<http://drylandforest.org/>

- A great local example of dry forest restoration and education
- 60 acre restoration area of dry forest with interpretive trail
- Possible field trip and service project

#### Amy B.H. Greenwell Ethnobotanical Garden

<http://www.bishopmuseum.org/exhibits/greenwell/greenwell.html>

- Garden available for field trips

#### Hawaii Forest Industry Association Dryland Forest Restoration

<http://www.hawaiiforest.org/reports/dryland.html>

- Background information on restoration

#### UCLA Tropical Dryland Forests of the Pacific Research Center

<http://www.geog.ucla.edu/tdfpacific/home.html>

- Great background information on these important forests
- Excellent online documentary about Pacific Island dry forest—including West Hawaii
- Also, great poster of dry forest plants that can be printed



## **Extension Activities**

Have students create dry forest maps of the other Hawaiian Islands



### **Traditional uses and description of dry forest plants**

Kokia (*Kokia drynarioides*)-highly endangered tree found only in North Kona. Grows to be about 25 feet tall. There are only three left in the wild and the sap has been used to dye fishing nets red.

Wiliwili (*Erythrina sandwicensis*)-grows 35-45 ft tall and about as wide. Deciduous, losing its leaves late summer to conserve water. Its flowers and seeds can be used for leis. The wood can be used for buoys and amas of canoes.

Uhiuhi (*Caesalpinia kawaiensis*)- grows 12-30 feet tall, with long compound leaves. Its flowers and seeds can be used in leis.

Lama (*Diospyros sandwicensis*)- a small slow growing tree, less than 35 feet tall. Its traditionally used for wood and medicine.

Ohi`a (*Metrosideros polymorpha*)-a highly variable tree, can be shrubby to more than 100 feet tall. Its flowers and seeds can be used in leis. It has traditionally been used in medicine and used for its wood.

`Aiea (*Nothocestrum latifolium*)-a small tree, growing up to 30 feet tall. Its flowers and seeds can be used in leis and was traditionally used for wood.

`Ilima (*Sida fallax*)-highly variable shrub usually less than 5 feet tall. Can be used in leis and traditionally used for medicine.

`Iliahi or Sandalwood (*Santalum freycinetianum*)-can be a 3 ft shrub to 40 ft tree. Used for its wood.

Naio or False Sandalwood (*Myoporum sandwicense*)-shrub to tall tree. Used for wood.

Mamane (*Sophora chrysophylla*)- a large shrub to tree. Serves as the main food source of the native Palila. Traditionally used for wood. Its flowers and seeds can be used in leis.



Name: \_\_\_\_\_

Date: \_\_\_\_\_

### Dry Forest Word Search

Find the vocabulary words based on the clues. Follow the directions for each clue.

a e n d c g d y t l p w c d w g  
u b a t a p i n v a s i v e n a  
r f t e t h j m k I w l d c p I  
g f i a b l z u o r t i l i h n  
r a v t y u j n d e r w a d b s  
g p e e b u l o a c v i v u a g  
l n n q u t p p a x a l a o b r  
a a i o j r n m s j b i c u q d  
w s r p k w f b g t e l d s w e  
s g s l r m g e b r a k g z c v  
g r g a t n h d e e h p w l g c  
y e h w r a j s g u j h n k n a  
h w c c o g d a j k w e q f c l  
i q v d w s n h a m q c u e o o  
k o o e e o c i k n a j i b f o  
l l p r y p e a a a b b o n a r  
e n d e m i c w m t c g l c w o  
q x e g b s s e o i n a q e e p  
r v r n m x h t j m j u a a h d  
s w x a k n g e k c i w o b j s  
v d b d j b j m l x o a x f k a  
e o n n w q u b a h w l c i l l  
i c o e s g r l w n d k h u q k  
k e p b a h e k d v r j w q e m  
o r a t r e a j u a u c u w r i  
j t s s t f x h h i f a r u t u  
h f t a u s c g i o w e e h a h  
h u u i p d j e u u n g e n s g  
s t q n o e k s h q m b g p q a  
p g n a a e w s i i t s o g r e  
l w p a s b t n m a i l k u v e

Vocabulary words:
-native
-endemic
-endangered
-invasive
-fountain grass
-wiliwili
-uhiuhi
-sap
-deciduous

1. something found only in Hawaii, enclose in a circle
2. trees that lose their leaves, enclose in single box
3. plant that competes with native plants, enclose with a squiggly circle
4. something traditionally found in Hawaii and other places, enclose in two circles
5. native tree with narrow trunk, place single line through
6. native tree with wide trunk, place two lines through
7. a dry adapted plant that competes with native plants, scribble out
8. sticky substance that comes out of a tree, place a large X through
9. a plant that is protected because it is rare, enclose in a regular circle and a squiggly circle

What is a Dry Forest?



**Name:** \_\_\_\_\_

**Date:** \_\_\_\_\_

**KWL-Hawaiian Dry Forests**

**What do you know about Hawaiian dry forests?**

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**What do you want to know about Hawaiian dry forests?**

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**What did you learn about Hawaiian dry forests?**

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**Name:** \_\_\_\_\_

**Date:** \_\_\_\_\_

### **Introduction to native plants**

- 1) What is a native plant?
  
- 2) What is an endemic plant?
  
- 3) How many species of plants in Hawaii are native plants?
  
- 4) How many of the native plants in Hawaii are found only in the dry forest?
  
- 5) What does your answer to question 4 mean?

### **Importance of the dry forest**

- 1) Are dry forests important? Why or why not?



**Name:** \_\_\_\_\_

**Date:** \_\_\_\_\_

**E malama ai `Aina**

- 1) What does “E malama ai `Aina” mean?
  
  
  
  
  
  
  
  
  
  
- 2) How could you E malama ai `Aina?

Dry forest habitat

- 1) How endangered is the dry forest?
  
  
  
  
  
  
  
  
  
  
- 2) How much of the original dry forest is left?
  
  
  
  
  
  
  
  
  
  
- 3) What problems do plants in the dry forest have?



**Name:** \_\_\_\_\_

**Date:** \_\_\_\_\_

**Dry forest mapping activity**

- 1) Where do you live compared to the current range of the dry forest?
  
  
  
  
  
  
  
  
  
  
- 2) Which side of the island is the dry forest found on?
  
  
  
  
  
  
  
  
  
  
- 3) Compared to the original range of the dry forest, how much is left?



## Hawaii Island Annual Rainfall Data

Communities are listed as they appear clockwise around the island.

Map Key	Community	Annual Rainfall (inches)
1	Hawi	50
2	Waimea	80
3	Haina	75
4	Honokaa	100
5	Ookala	125
6	Hakalau	300
7	Hilo	150
8	Kaumana	225
9	Kapoho	100
10	Keaau	125
11	Mountain View	175
12	Volcano Village	100
13	Hawaii National Park (Crater)	80
14	Kulani Mauka	50
15	Pahala	40
16	Naalehu	40
17	Manuka	60
18	Pohakuloa	20
19	Mauna Loa Observatory	30
20	Kainaliu	75
21	Kailua-Kona	30
22	Holualoa mauka	75
23	Puu Waawaa	25
24	Waikoloa	20
25	Puako	10
26	Kawaihae	10

Source: Atlas of Hawaii, Second Edition.