

Lesson at a Glance: Students compare maps showing ecosystems before and after human habitation and create a timeline that tells the story of the decline of their island’s native ecosystems.

Key Concepts: Island ecosystems have been drastically altered by the invasion of non-native species. This invasion poses the single greatest threat to the native ecosystems of Hawai‘i.

Objectives: Students will be able to:

- 1) Compare native ecosystems on their island before and after human habitation.
- 2) Present ways that their island ecosystems have been altered by human activities.
- 3) Identify ways that invasive alien species have changed their island and steps that people can take to stop the invasion.

Time: four–five class periods

Subject Areas: science, social studies, language arts

- Materials:
- 20 feet of string
 - color markers
 - drawing paper
 - *Timeline Cards*/student reading (provided)
 - ecosystem maps (provided)
 - *Stop the Alien Invasion* handout (provided)
 - reference materials (see list at the end of this activity)

Preparation: Make six copies of the two island ecosystem maps for your island and one copy of each timeline card. Alternatively, copy a set of cards for each student to read. Copy the *Stop the Alien Invasion* handout for each student. Post the remaining ecosystem maps in the classroom for students to see.

Teacher Background: There are approximately 150 different types of natural communities in the Hawaiian Islands. These communities formed as a result of the combined interaction of elevation, temperature, rainfall and soil type. Temperature and moisture are the dominant factors determining vegetation zones in Hawai‘i. On wet, windward slopes, zonation from sea level to mountain crest generally proceeds from coastal strand to *‘ōhi‘a* and *koa* rainforest, subalpine forest, alpine shrubland and alpine desert.

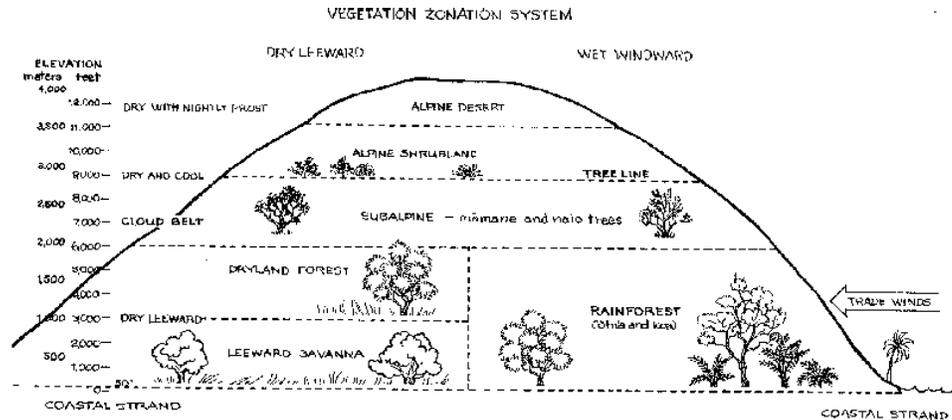
On drier leeward slopes, natural communities generally range from coastal strand to leeward savanna, dryland forest, subalpine cloud forest, alpine shrubland and alpine desert. In this activity these communities are presented in broad categories:

Dry: dryland forest, shrubland and grassland

Mesic: semi-wet forest and shrubland

Wet: rainforest, shrubland, and bog

Alpine: subalpine forest, shrubland, and alpine desert



Typical Cross-Section Through a High Island

The maps presented here show at least 1,500 years of human activity have drastically altered native ecosystems in Hawai‘i. Today, nearly two-thirds of the native forests of Hawai‘i, including 90 percent of the dryland forest and 50 percent of the rainforest, have been replaced with non-native species and most of the native coastal strand and shrubland are gone. Changes to our native environments are inevitable as people alter the landscape to meet their needs for survival. But when such large-scale changes lead to the loss or degradation of much of our native habitats, finding a balance between human needs and the needs of native species is critical if we are to protect the best of what remains of the natural and cultural heritage of Hawai‘i.

In the last 200 years, people have introduced plants and animals at a rate that far exceeds the natural rate of dispersal of species to the islands. Species that arrived here naturally had millions of years to settle in. Today we are flooding the islands with non-native species at an alarming rate (*approximately a million times greater than the natural rate of dispersal*). This invasion poses the single greatest threat to the survival of remaining native ecosystems.

Species in the Hawaiian Islands

Group	Native * (Evolved over at least 30 million years)	Introduced & Naturalized ** (over 200 years)
Flowering plants.....	957.....	800 ***
Land birds	110.....	38
Mammals.....	2.....	18
Arthropods	6,000+.....	2,500
Mollusks.....	1,064.....	33
Terrestrial reptiles & Amphibians	0.....	27

* Estimates of native species pre-human contact (includes known extinct species).

** Naturalized: introduced species that have established themselves in Hawai‘i.

*** Some botanists estimate this number to be as high as 2,000 species.

Primary Source: Stone, Charles P. and Danielle B. Stone, Eds., *Conservation Biology in Hawai‘i*, 1989. *Biological Diversity and its Loss*, by Lloyd L. Loope and Samuel M. Gon, III. Honolulu: University of Hawai‘i Cooperative National Park Resources Studies Unit.

Loss of Native Ecosystems in the Hawaiian Islands

Factors:	Type of Ecosystems Affected:			
	<i>Dry</i>	<i>Mesic</i>	<i>Wet</i>	<i>Alpine</i>
Vulnerable native species	X	X	X	X
Polynesian introductions: pigs, dogs, chickens, rats, snails, skinks & 32 plant species.....	X	X	X	
Fire—land clearing for planting in old Hawai‘i: <i>kalo</i> , <i>‘uala</i> ; today: military maneuvers, arson, accidental/natural	X	X		
European introductions: cattle, goats, pigs, sheep, rats.....	X	X	X	X
Ranching	X	X	X	
Plantation agriculture: sugar cane, pineapple	X	X	X	
Introduced deer, sheep for hunting	X	X		X
Introduced plants, birds and invertebrates	X	X	X	X
Introduced plant and animal diseases	X	X	X	X
Reforestation of watersheds with non-native trees.....		X	X	
Urbanization.....	X	X	X	

4. List the four main types of ecosystems (*dry, mesic, wet and alpine*) on the board and begin developing a chart with the labels “Factors” and “Types of Ecosystem Affected.” As students come up with additional factors that have contributed to the loss of native ecosystems, add these to the chart and discuss students’ reactions. Display maps of other islands so students can compare them with their island maps.

Discussion Questions:

- Which native ecosystem has been changed the most since humans arrived on your island?
- What might have caused the loss of this ecosystem?
- Which native ecosystem has been the least disturbed? Why?

5. Give a different *Timeline Card* to each of the six student groups. Ask groups to read their cards and develop a way to visually present the information in a timeline to be developed by the class. Following are some suggestions for tasks that students could assume for creating the timeline:

- Have students in each group create timeline labels to represent their time period.
- Develop a scale to visually represent the time periods and have students mark a long string where each timeline label will be attached. For example, if one foot equals 100 years, the timeline would be 20 ft long. Note that in order to make the scale manageable,

the first timeline card begins in the year 1 A.D. even though native ecosystems have probably been evolving in the islands for 30 million years.

- Students could conduct research (see references for books and web sites at the end of this activity) and interview community elders and resource managers such as from the Department of Land and Natural Resources or The Nature Conservancy to supplement the information on their timeline cards.
- Some students could create computer graphics to help tell their portion of the story. Others could create illustrations to convey the information.

6. When students have completed their timeline sections, ask each group to present its story to the class. Tape the timeline string to a wall and have students attach their label and any other graphics or illustrations they have developed. Encourage them to be creative and use raps, drama, riddles, quizzes or other ways to share their information with one another.

7. After each group's presentation, ask students to review the ideas from the initial question posed in this activity and use the new information to fill in the chart. They can add factors that have led to the endangerment of so many Hawaiian species and check off the type of ecosystem affected.

8. When all presentations are completed, review the list and summarize with a discussion:

Discussion Questions:

- Which factors involved alien plants and animals?
- Which ecosystem has been most affected by alien species?
- Why are alien species considered the number one threat to native species today?
- What can individuals do to prevent more damage from invasive alien species?

9. Ask each group to come up with a list of what people can do to stop the invasion of alien pests and share their ideas. Distribute the *Stop the Alien Invasion* handout for students to review.

10. Have students add information about stopping the invasion to the timeline. Post the display in the school library or cafeteria to spread the word.



Before—pristine, native ecosystem

After—invaded by alien species.

Extended Activities:

- Take students into the field to see examples of native ecosystems and compare these with disturbed areas. See the *‘Ōhi‘a Project*, Grades 7–8 “Coastal Cruisin’” activity and Field Sites Appendix for more information on sites and student investigations.
- Have students create a web site that tells the story of change on their island and add the steps we can take to prevent additional alien invasions.
- Take the timeline on the road and see if it can be displayed at the local library and/or shopping center.
- Invite a *kupuna* or other elder to visit and talk story with the class about their memories of the island before there were so many changes.
- Ask students to choose one ecosystem on your island and write a paper that contrasts that environment before and after human habitation. Their papers should discuss why there has or has not been significant change in their chosen ecosystem.
- Have students compile and edit their papers into a single document to share with others. Students could take on roles as editors, typists, photographers, cartoonists, cover designers, and collators to complete the task. Some students could edit the classes’ research for addition to the school's web site so that others can learn from their studies.

References:

The following books provide colorful images of native Hawaiian ecosystems:

Daws, Gavan and Samuel M. Gon III. *Hawai‘i: The Islands of Life*. The Nature Conservancy of Hawaii. Signature Publishing, 1988. (Includes beautiful color photographs of native ecosystems.)

Sohmer, Seymour H. and Robert Gustafson. *Plants and Flowers of Hawai'i*. University of Hawai'i Press, 1987. (Pages 1-57 have good background information on natural communities and some photographs.)

Kepler, Angela Kay. *Hawaiian Heritage Plants*. The Oriental Publishing Company, 1983. (Includes color photographs of the following natural communities: coastal strand, p.3; subalpine *māmane* forest, p.86; alpine shrubland, pp.88 and 118; and 'ōhi'a rainforest, p.109.)

These references will provide students with additional information and images for their timelines:

Berger, Andrew J. *The Exotic Birds of Hawaii*. Island Heritage Press, 1977.

Cuddihy, Linda W. & Charles P. Stone, *Alteration of Native Hawaiian Vegetation: Effects of Humans, Their Activities and Introductions*. University of Hawai'i Cooperative National Park Resources Studies Unit, 1990.

Culliney, John L. *Islands in a Far Sea*. Sierra Club Books, 1980.

National Geographic. *Hawai'i's Vanishing Species*. September 1995.

Pratt, H. Douglas. *Hawai'i's Beautiful Birds*. Mutual Publishing, 1997.

Stone, Charles P. and J. Michael Scott, eds. *Hawai'i's Terrestrial Ecosystems, Preservation and Management*. Cooperative National Park Resources Studies Unit, University of Hawai'i, 1985.

Stone, Charles P. and Danielle B., ed., *Conservation Biology in Hawai'i*. University of Hawai'i Cooperative National Park Resources Studies Unit, 1989.

Ivan Riper III, Charles and Sandra G. *A Field Guide to the Mammals in Hawaii*. The Oriental Publishing Co., 1982.

World Wide Web Sites:

Hawai'i Department of Agriculture
<http://www.mic.hawaii.edu/hawaiiag>

Hawai'i Department of Land and Natural Resources
<http://www.htdc.org/~dlnr>

Hawai'i Ecosystems at Risk (HEAR), University of Hawai'i
<http://www.hawaii.edu/~halesci/AlienSpeciesInHawaii>

Hawai'i Natural Heritage Program (of The Nature Conservancy)
<http://www.aloha.net/hinhp>

Moanalua Gardens Foundation
<http://www.mgf-hawaii.com>

The Nature Conservancy of Hawai‘i
<http://www.tnc.org/infield/state/hawaii>

SOS—Save Our Special Hawaiian Flora, Leeward Community College
<http://alaike.lcc.hawaii.edu/sos>

UH Botany Navigation
<http://www.botany.hawaii.edu>
(conservation, research and support)