From the Sea to the Mountains

Grade 4

‘Ōhi‘a Project / Exploring the Islands

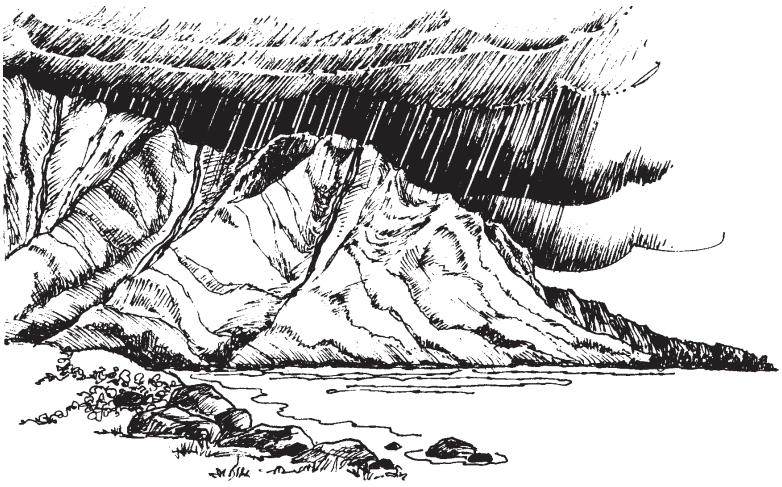
Essential Questions

- What key factors affect the zonation of natural communities in Hawai‘i?
- What makes one vegetation zone different from another?
- How does the Hawaiian zonation system differ from the vegetation zonation system?

Hawai‘i D.O.E. Content Standards and Performance Indicators

Social Studies—Geography: World in Spatial Terms

- Collect, organize, and analyze data to interpret and construct geographic representations.



Social Studies: Physical Systems

- Explain how physical process affects formation, and distribution of climates, natural resources, and ecosystems.

Science–Habits of Mind: Using Unifying Concepts and Themes

- MODEL–Use geometric figures, number sequence, graphs, diagrams, sketches, number lines, maps, or stories, to represent corresponding features of objects, events, and processes in the real world.

Key Concepts

- The Earth’s surface is divided into natural communities.
- The variation in temperature and rainfall results in the zonation of natural communities.
- There are different ways of representing natural communities in Hawai‘i.
- Plants and animals are adapted to a particular zone.

Activity at a Glance

Students create drawings or models of a typical Hawaiian island, using a variety of materials to illustrate major vegetation zones. Students also illustrate a plant or animal that lives in one of the zones and describe its adaptations.

Exploring the Islands Telecast: "Exploring Mountain Zones"

Students from Pū'ōhala Elementary School explore why we have so many different vegetation zones in the Islands and take a "magical" whirlwind tour from sea level to mountaintop on the windward and leeward sides of an island. Near the end of the program, a riddle game gives students the opportunity to test their knowledge of natural communities.

Assessment

Students:

- Draw a diagram or make a model of a mountain showing each of the vegetation zones with average rainfall and temperature for each zone. Pair up with another student and construct a Venn Diagram comparing diagrams.
- Write a summary describing the physical factors that affect the zonation of natural communities.

Time

four–five class periods

Materials/Resources

activity sheet (provided)
construction paper measuring 12 by 18 in. for each student
colored pens or pencils
map of your island
glue
scissors
sand or glitter
cotton balls (optional)

A kōlea bird leads the way on a magical whirlwind tour of Hawaiian mountain zones on Exploring the Islands.

During the *Exploring the Islands* telecast
color pencils or pens
paper
rainfall and elevation map for your island (provided, *'Ōhi'a Project* Appendix A-21—A30)
book: *Call of Kōlea* (optional)
video: "In the Middle of the Sea" (optional)

Preparation

If you don't have projection capability from your computer, make a transparency of the vegetation zonation sheet to use on an overhead projector. Make one copy of the Hawaiian zonation sheet for each student.

Vocabulary

zonation, natural community, coastal strand, leeward savanna, rainforest, dryland forest, subalpine, alpine, desert, microclimate

Teacher Background Information

Historically, people have divided the surface of the Earth into smaller units to make it easier to understand. There are two fundamental ways to make these divisions: political and natural. World maps and globes illustrate this well—some show the political divisions between countries, while others focus on natural relief, such as deserts, cold areas, and wet areas. Such divisions work at almost any scale. In the Hawaiian Islands, maps are drawn to show political boundaries such as tax boundaries or land ownership, or natural boundaries such as elevation, temperature, or rainfall. Different natural areas are often referred to as zones.

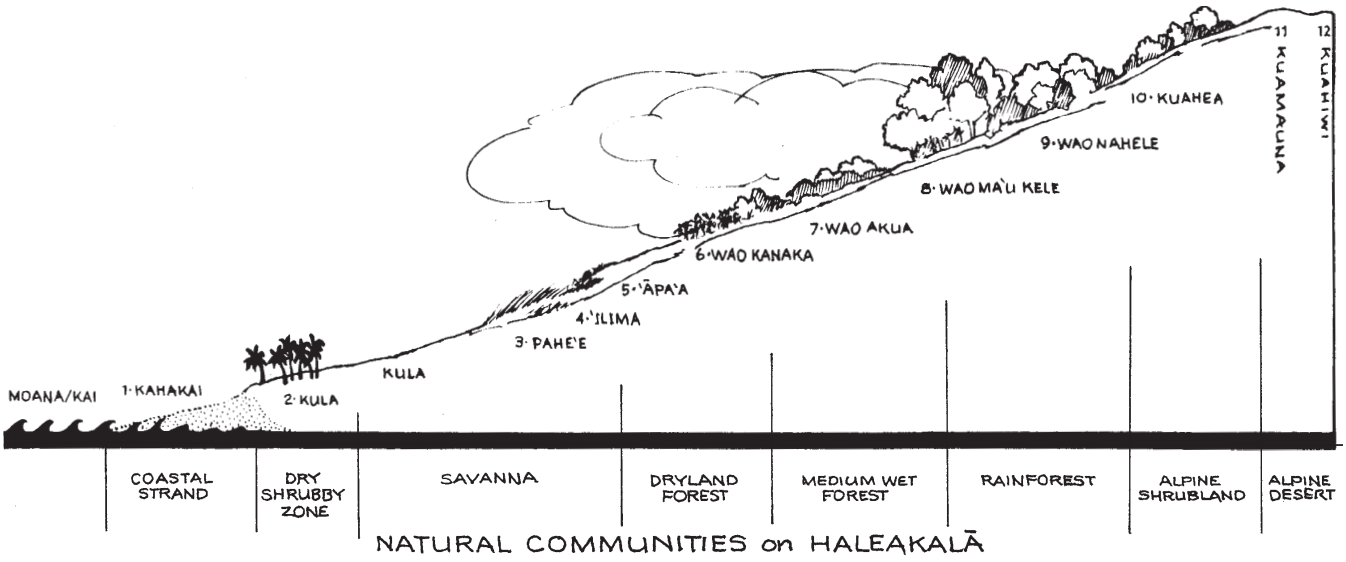
Although **zonation** results from natural divisions, people decide where to draw the boundary lines. Which system of zonation is most appropriate depends upon the area concerned and the people using the system. Popular systems tend to be simple, and use either climate (temperature, rainfall) or vegetation patterns as their base. Of course, these two are interrelated. Although some systems are more widespread than others, there is no universally accepted "right" way to make zonation boundaries.

Two zonation systems for Hawai‘i are presented here as examples. The first is a general outline of vegetation zones based primarily upon elevation and rainfall. (For further information on these zones, see "Island Puzzle Pieces," Geography, Grade 5.) The second is a Hawaiian system (adapted from David Malo) used to delineate different zones within an ***ahupua‘a***. An *ahupua‘a* is typically a land division stretching from the mountains to the sea or reef. It should be noted that this system is relative, not absolute. The top of a mountain on one island will be at a different elevation than the top of a mountain on a different island. Also, Hawaiian language experts question the strict definitions presented, and suggest that there may be some regional differences among the islands.

The tallest peaks on the major Hawaiian Islands are as follows:

Island	Meters	Feet
Hawai‘i	4,206	13,796
Maui	3,056	10,023
Kaua‘i	1,597	5,240
Moloka‘i	1,515	4,970
O‘ahu	1,232	4,040
Lāna‘i	1,027	3,370

Natural communities form 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. From place to place, the greatest temperature differences in the Islands are due to elevation. As a general rule, the air temperature decreases approximately 5.5° C/km rise in elevation (3° F/1,000 ft). This rate increases slightly in dry areas and decreases in wet areas. Below 1,800 m (6,000 ft), moisture is a major factor of zonation. Above this elevation, the air is very dry and temperature is a more important factor.



NATURAL COMMUNITIES on HALEAKALĀ

On wet windward slopes, zonation from sea level to mountain crest generally proceeds from coastal strand to ʻōhiʻa 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 forest, alpine shrubland, and alpine desert. The alpine communities are only found on the younger and higher islands of Maui and Hawaiʻi. All of the other main Hawaiian Islands support rainforest or medium-wet (mesic) to dry forest at their summits depending on their elevation and location in relation to other islands. Bogs and ponds occur in rainy area where drainage is poor.

Within each of the island zones, physical and natural factors, such as rainfall and groundcover, combine to create distinct **microclimates**, which are climates within small areas. For example, in forested cloud belt areas, trees and shrubs add to the total precipitation as their leaves collect moisture (fog drip) carried through the air. Although fewer than a dozen vegetation zones are described in the *ʻŌhiʻa Project* materials, scientists have identified more than 150 distinct natural communities in Hawaiʻi.

Each of these communities represents a unique composition of plants and animals, especially adapted to the variety of growing conditions in the islands. Following is a description of the major vegetation zones described in this activity.

Coastal Strand Community

This is the Hawaiian zone called *kahakai*. The hardy plants that grow here, such as hala, pōhuehue, and naupaka kahakai, are tolerant of the harsh growing conditions. These plants are adapted to intense sunlight, wind, high temperatures, salt spray and brackish water. Rainfall on leeward shores is generally less than 76 cm (30 in.) per year and on windward shores, up to 305 cm (120 in.) per year. Coastal ecosystems vary depending on rainfall, the shape of the land, and type of soil or rock present.

Rainforest

This natural community includes the Hawaiian zones of *wao ma‘u kele* where the largest trees grow and *wao nahele*, where large trees grow. The ‘ōhi‘a and koa rainforest stretches from just above the coasts to approximately 1,830 m (6,000 ft) on the wet, windward slopes of most islands where annual rainfall is between 200–1,016 cm (80–400 in). A wide variety of plants, including mosses, vines, ferns, shrubs and trees grow amidst the ‘ōhi‘a and koa in this lush community.

Leeward Savanna

The leeward savanna encompasses the Hawaiian zones of *kula* (plains) and *pahe‘e*, where one can slide on the grass. It also includes the regions known as *‘ilima*, named after the flower that grows here; and the dry, baked zone called *‘āpa‘a*. This dry savanna zone extends to approximately 915 m (3,000 ft) and is dominated by shrubs and grasses. Formerly, much of this zone above 305 m (1,000 ft) was dryland forest, but grazing, fires, and development have converted the vegetation to grass and shrubs. Rainfall is generally less than 50 cm (20 in.) per year.

Leeward kula *areas were named by Hawaiians for the ‘ilima that grew there.*

Dryland Forest

The Hawaiian zones of *wao kanaka*—the area where ‘ama‘u fern and small trees grow, and *wao akua*—the zone of the spirits, are in the area of the dryland forest. This zone occurs on the higher leeward slopes from approximately 915–1,830 m (3,000–6,000 ft) where annual rainfall is between 50–200 cm (20–80 in). ‘Ōhi‘a, wiliwili and ‘ohe are among the many trees growing in dry forests. Sandalwood (*‘iliahi*) was once common here along with a diverse community of native species, many of which are now rare.

Subalpine Forest

The Hawaiian *kuahea*—a cold and misty zone where only smaller trees will grow, encompasses the subalpine forest and the alpine shrubland. This zone is located between 1,830–2,745 m (6,000–9,000 ft) elevation on Maui and the Big Island, where drifting clouds create a wet, cool environment. Māmane and naio are the dominant tree species. Rainfall is between 50–130 cm (20–50 in.).

Alpine Shrubland

Above the tree line at approximately 2,745 m (9,000 ft), where it is so cold and dry that only a few stunted trees survive, is the zone known as the alpine shrubland. Hardy shrubs, such as

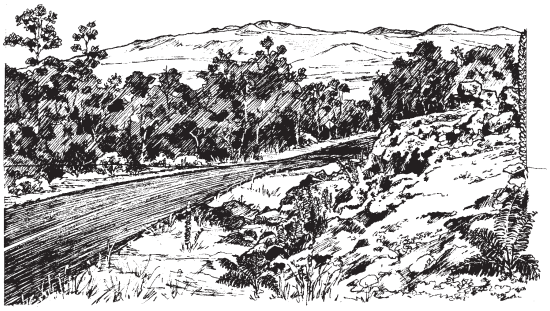
the silversword, pūkiawe, and pilo kuahiwi are the dominant species. Annual rainfall is often less than 50 cm (20 in).

Alpine Desert

The Hawaiian *kuahiwi* is the uppermost mountain zone. (*Kuahiwi* also refers to summits of older islands that only reach to the *wao nahele*.) The alpine desert is found above 3,355 m (11,000 ft) elevation, where frost occurs and only lichens and some mosses grow. The wēkiu bug that survives on "freeze-dried" insects carried by the wind from lower elevations, is one of the few animals found at this high elevation in Hawai'i.

Some of the plants of the alpine shrubland include the stiff, upright 'ae fern (left foreground), creeping kūkaenēnē (behind it), 'ama'u fern (right foreground) and small 'ōhi'a trees.

For teachers interested, a highly detailed and thorough explanation of the classification of Hawaiian plant communities can be found in Warren L. Wagner, Derral R. Herbst and S.H. Sohmer, 1990, *Manual of Flowering Plants of Hawai'i*, Volume 1, pp. 45–114, Honolulu, University of Hawai'i Press and Bishop Museum Press.



Moanalua Gardens Foundation's "Saddle Sojourn" Field Site Packet for Teachers describes a trip along the Saddle Road from Hilo to Hale Pōhaku at 9,000 ft elevation. Field trip activities in the packet help students observe and appreciate variation in plant communities growing under different environmental conditions.

Pictures and a brief summary of vegetation zones can also be found at: http://www.nationalgeographic.com/xpeditions/hall/**.**

Teaching Suggestions

1. Ask students to take an imaginary trip from the beach to the highest point on their island and predict how conditions like rainfall and temperature, and types of natural communities, might change as they go up.

2. Make a K-W-L chart on the board. Discuss students' ideas and predictions and record what

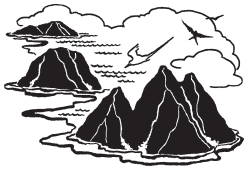
they know (K), and what they would like to know (W). Explain that after the *Exploring the Islands* program and other additional activities, students will add what they have learned to the (L) category on your chart.

Discussion Questions

- When you travel from the sea to the mountaintop, which two environmental factors change the most? (temperature and rainfall)
- How do you predict temperature and rainfall will change as you go up to the top of your island?
- Why do you think conditions change as you go higher in elevation?
- How are natural communities of plants and animals different from the windward to the leeward side? How are they different from beaches to high mountain forests? Why are they different?

3. Distribute the materials students will need for *Exploring the Islands* and watch the telecast. Refer to the box below for more information about the telecast.

During the *Exploring the Islands* Telecast "Exploring Hawaiian Mountain Zones"



Mystery Minute Question for This Week

On a hot still day in the tropics, how could you get cooler without using shade, water, electricity, or fans?

MindPower Minute Question

- What vegetation zone would occur naturally around your school?

Student Activities

Students draw and label a diagram of a mountain and use it to compete with *kōlea* bird in a "Riddle Game" about vegetation zones on our high islands.

To determine what vegetation zone would occur naturally around their school, students use rainfall and elevation maps for their island and apply what they have learned in the telecast. (See *'Ōhi'a Project* Grades 4–6 guidebook, Appendix (pp. A-21 through A-30 for maps.)

Mahalo to . . .

Pū'ōhala Elementary School for assisting with *Exploring the Islands*!
Teacher: Torry Montes
Students: Marcus Afoia, Louise Pagaduan, Kolakea Sherwood, Paul Tong

4. Project the vegetation zonation sheet and ask students to compare it to the diagrams they created during the telecast. Revisit the questions posed to students before the telecast and compare their predictions to what they have learned. Record their answers under the L on your K-W-L chart.

5. Distribute copies of the Hawaiian zonation sheet and review it with students.

   Discussion Questions

   - How are the two zonation systems similar? How are they different?
   - In which zone would early Hawaiians have lived? Why?
   - Where do most people live today?
   - In which Hawaiian zone is your school located?

6. Ask students to choose the Hawaiian or the vegetation zonation system and create a drawing or model to illustrate the zones. Their depictions should include each vegetation zone with physical conditions recorded. (Drawings could be on large sheets of construction paper. Models could be constructed of play dough or out of a large cardboard box with sides bent to form a long slope. To illustrate the zones, use craft materials such as glitter, construction paper, and cotton balls.)

Students create drawings or models of a Hawaiian island, using a variety of materials to illustrate major vegetation zones.

7. Have students pair up with another student and construct a Venn Diagram comparing their diagrams or models.

8. Ask students to write a summary describing the physical factors that affect the zonation of natural communities in Hawai‘i.

Plants and Animals Discovered on the Magical Tour of Island Zones

Vegetation Zone	Featured or Mentioned Plants and/or Animals
windward coast	bird’s nest fern, hala trees, hau trees
rainforest	carnivorous caterpillar, ‘ōhi‘a trees
subalpine forest	māmane trees, palila birds
alpine shrubland	‘āhinahina (silversword), kūpaoa (*Dubautia scabra*)
alpine desert	wēkiu bug
dryland forest	‘iliahi (sandalwood), ‘a‘ali‘i, wiliwili trees
leeward coast	pā‘ū o Hi‘iaka (beach morning glory), hinahina (beach heliotrope)
all zones	kōlea (Pacific golden plover)

Extended Activities

- Take your class on a field trip to one of the vegetation zones on your island. See the *ʻŌhiʻa Project* Field Sites Appendix for more information.

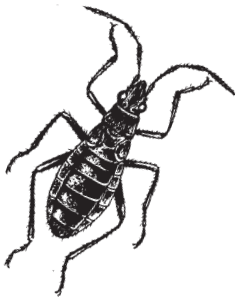
- As a class, read aloud the book *Call of Kōlea*, which depicts students on a magical tour of island zones, and view the companion video "In the Middle of the Sea." (See Unit Resources.)

- Have students examine globes or maps and identify those that show divisions based on natural features and those that show political boundaries. Point out that political boundaries tend to be very clearly defined (the country ends here), while natural boundaries tend to shift gradually from one type to another. Have students compare a map of the Earth's biomes with the vegetation zonation sheet. How many of the biomes are represented in the Hawaiian Islands' natural communities?

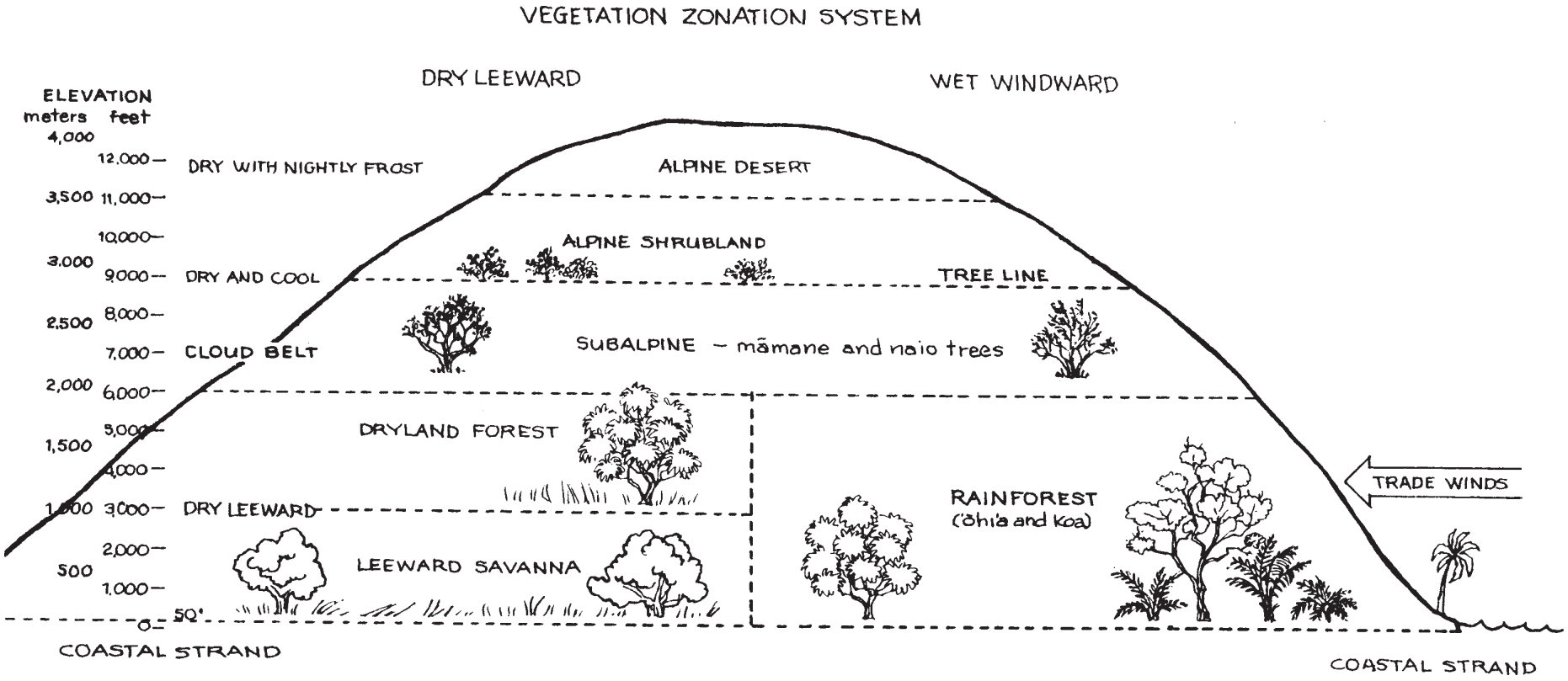
- As a homework assignment, assign students a plant or animal that was discovered on the magical tour of island zones in the *Exploring Mountain Zones* telecast. (See list of species on the previous page.) Ask students to illustrate the plant or animal and write a description of its environmental needs and how it is adapted to the zone where it lives.

- Build a three-dimensional model of a Hawaiian island out of new casting gauze, clay, papier mache or plasticine. Use tempera paint to represent the different zones and craft materials to illustrate key features. Be sure that the models are shield-shaped and wider than they are tall.

- Initiate a discussion about the environmental factors that influence where people live. Plot cities and towns or elementary schools on your island. Use the elevation maps in the *ʻŌhiʻa Project* Guidebook Appendix A. Analyze where the human population is most concentrated and infer why it's most concentrated there. Compare that to where natural communities are found. Finally, summarize what impact human population has on the natural communities.



The wēkiu bug is adapted to the harsh conditions of the alpine desert.



1) *Kahakai* is the beach/shore region.
2) *Kula* is the plain region. It can be subdivided into the sea plain region (*kula kai*), the midland plain region (*kula waena*), and the upland plain region (kula uka).
3) *Pahe'e* is the area where one can slide on the grass.
4) *'Ilima* is named after the plant that flourishes in this zone.
5) *'Āpa'a* is a dry, baked region.
6) *Wao kanaka* is the area where the 'ama'u fern and small trees grow and where some crops were grown.
7) *Wao akua* is the zone of the spirits.
8) *Wao ma'u kele* is the area where the largest trees grow.
9) *Wao nāhele* is the area where the large trees grow.
10) *Kuahea* is a cold and misty zone where only smaller trees will grow.
11) *Kuamauna* is the rounded swell of a mountain.
12) *Kuahiwi* is the uppermost mountain zone. It is also used to refer to the summit area on islands that only reach to the *wao nahele*.