



College of Tropical Agriculture and Human Resources
University of Hawai'i at Mānoa

School Garden Basics Workshop For Educators



The Natural Environment of Hawai'i

by O'ahu Master Gardeners in cooperation with Kōkua Hawai'i Foundation

The Natural Environment of Hawai'i

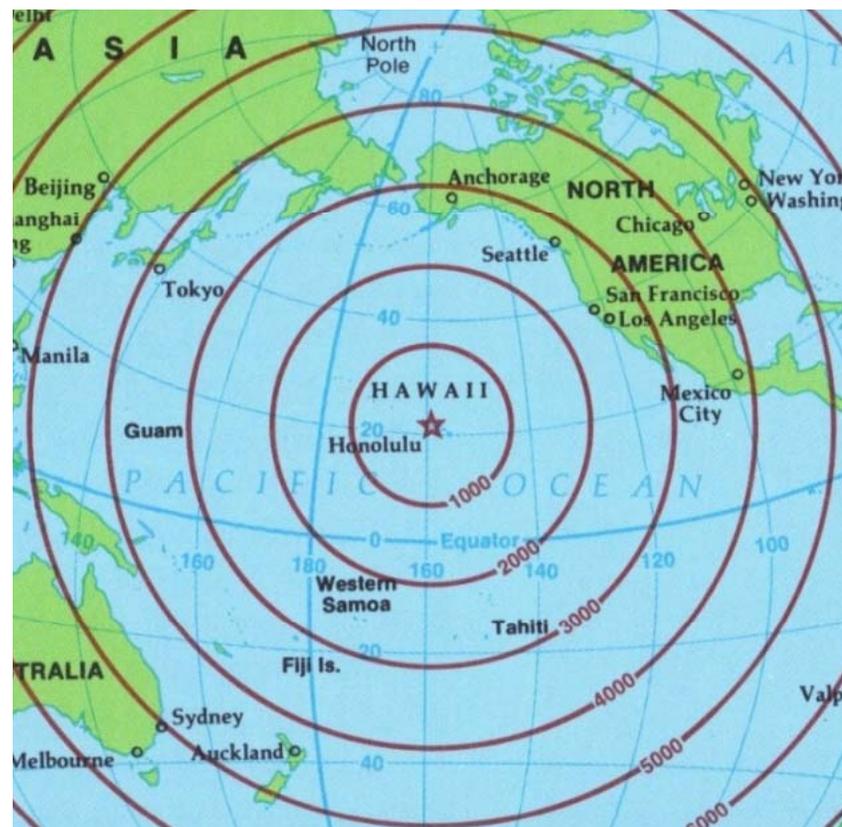
Learning Objectives

- How did we get here?
- Land and culture shaped by water
- Our precious water supply
- Native plants of Hawai'i



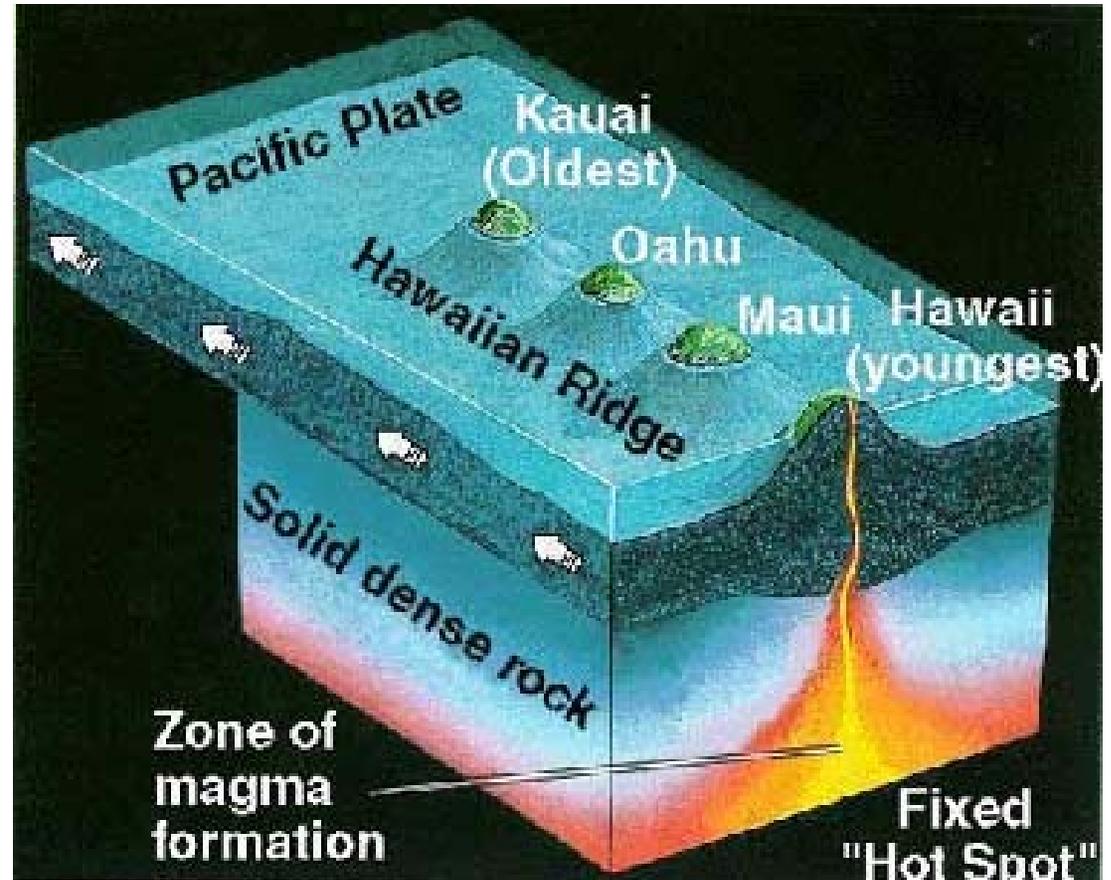
Hawai'i – the most remote landmass

- 2,000 mile chain of volcanic islands
- Over 2,100 miles from any continent.
- 10 of the 12 world climate zones.
- Mostly within zone 12 of the USDA Plant Hardiness Zone Map.
- No known human contact until about 1,500 years ago.



How did the islands get here?

- Island formed over stationary “hot spot”
- Earth’s moving crust carries the islands toward the northwest
- Kure Island is oldest in chain at 30 million years
- O’ahu formed 2 – 3 million years ago.
- The newest Hawai’ian island is building up from the sea floor



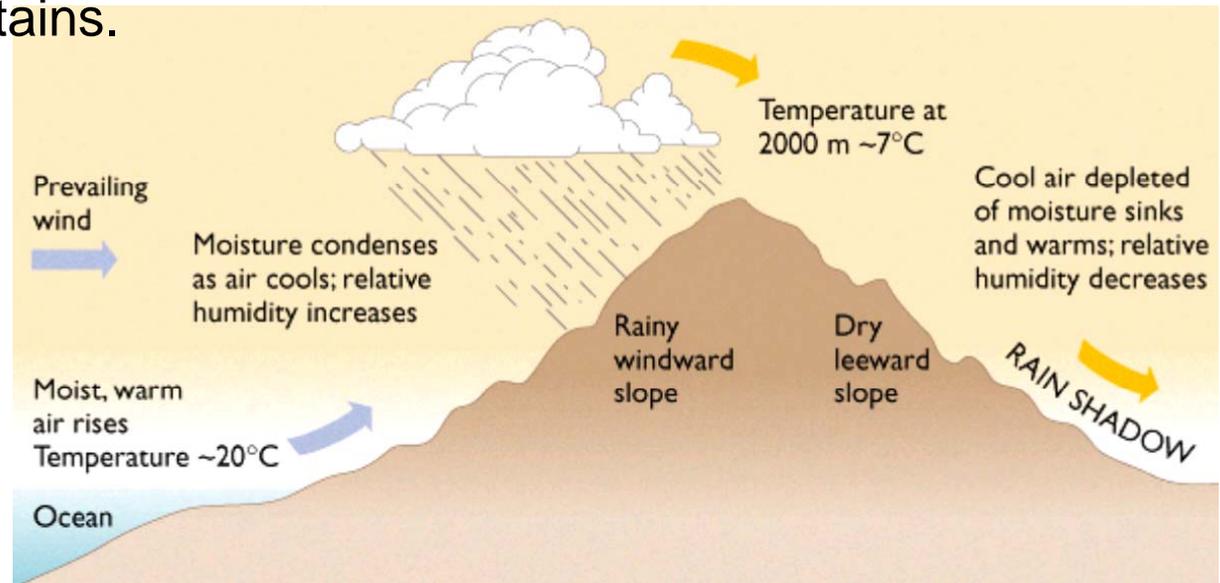
Hawai'ian trade wind flow

- Heating at the equator and rotation of the earth results in windflow from northeast to southwest
- Warm surrounding sea water keeps average sea level temperature between 73° and 80° F.
- Kau – Hawai'ian name for warm season from May through September with prevailing northeasterly trade winds
- Ho'oilō from October through April, is cooler with high rainfall from storm systems and more variable winds.



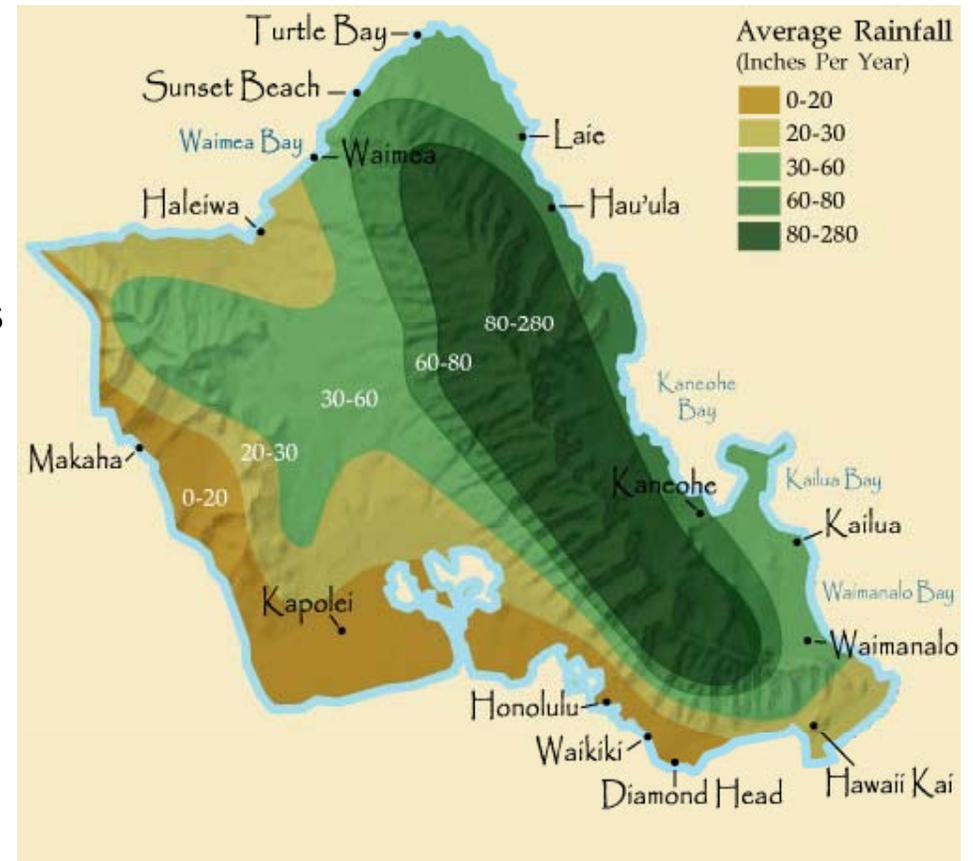
O'ahu rain systems

- Mountains and winds together shape our weather patterns
- Warm moist air rises over windward coasts and turns to rain as it cools, creating areas of high rainfall
- Warm, dry air descends into leeward areas after being depleted of moisture over the mountains.
- Winter storms bring heavy rains to leeward as well as windward regions.



Climatic Regions

- Windward Lowlands and Mountain slopes - Moderately rainy with frequent trade wind showers, even temperatures
- Leeward Lowlands – Dry weather prevails except for light trade wind showers and major storms, warmer days and cooler nights.
- Leeward Mountain slopes – rainfall greater than on leeward lowlands, greater temperature extremes
- Interior Lowlands - Sometimes intense local afternoon showers because of local heating.

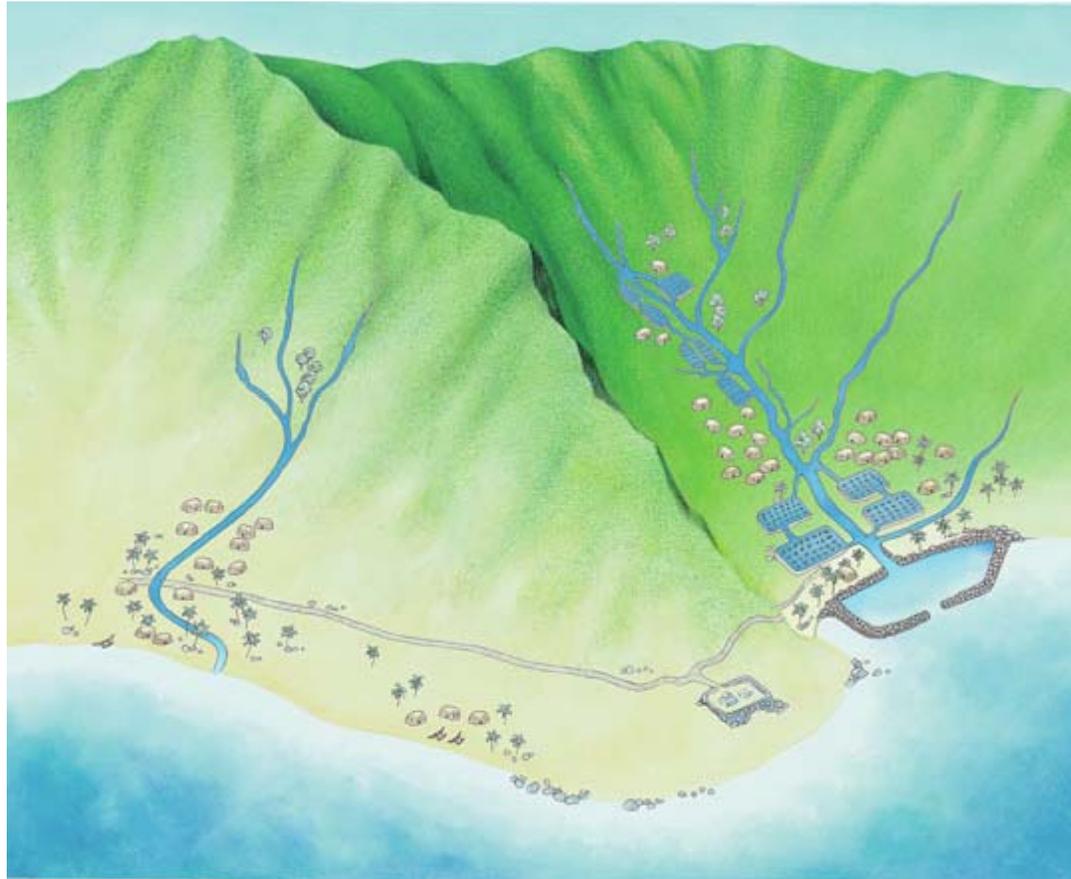


Water shapes the land

- O'ahu is shaped by volcanism, wave action, rain patterns, and erosion.
- Northeast trade winds batter the northeast coasts and create steep, high, vertical slopes.
- Stream erosion cuts gulches which expand into valleys
- As rain-depleted trade winds pass the Ko'olau summit, erosion diminishes and slopes are more gradual.
- Sediment collects where coral has built fringing reefs forming the dry flat plains of Honolulu and Ewa.



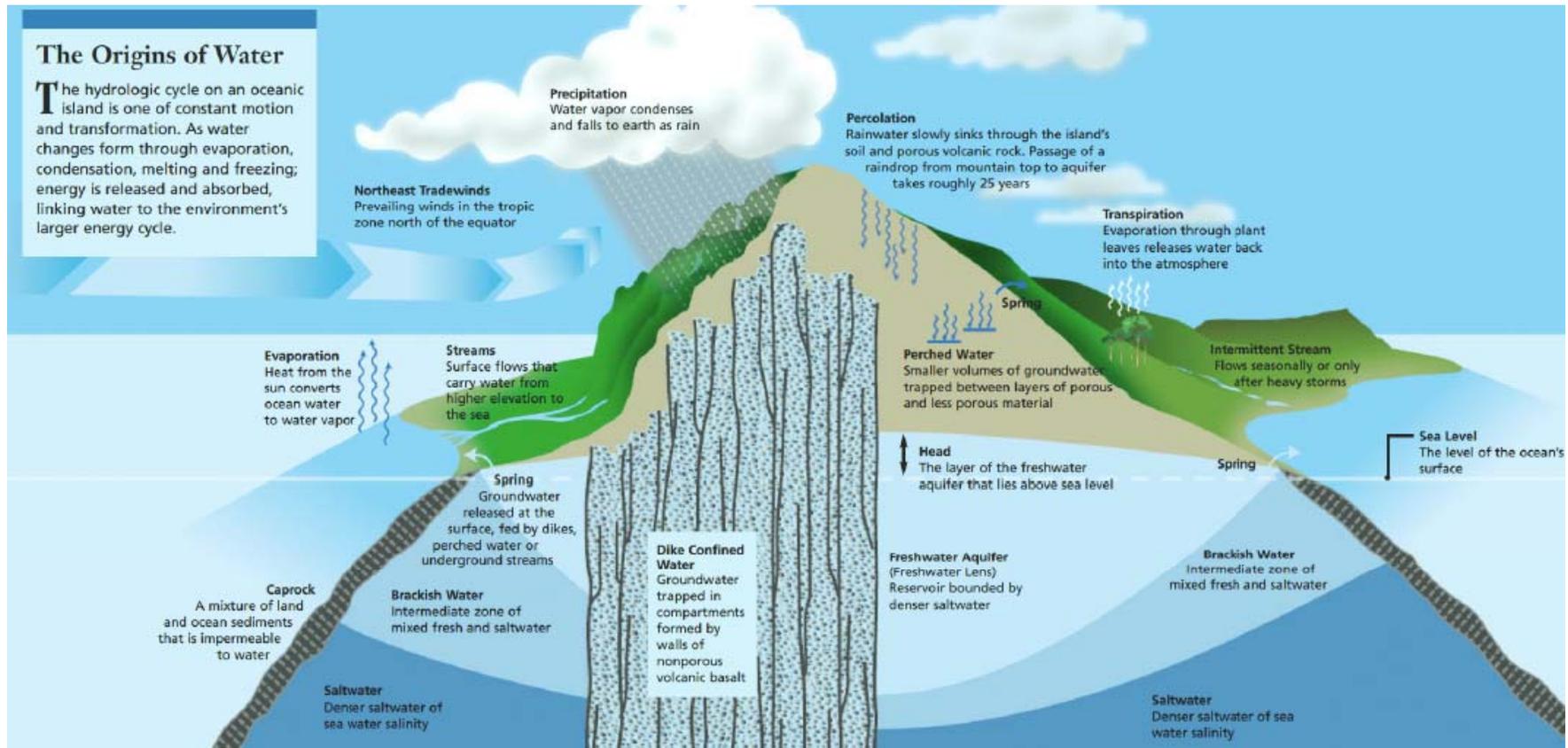
The land shapes the culture



The land shaping forces of wind and water informed the land divisions essential to early Hawai'ian cultural and economic organization known as the ahupua'a system.



Where does our drinking water come from?



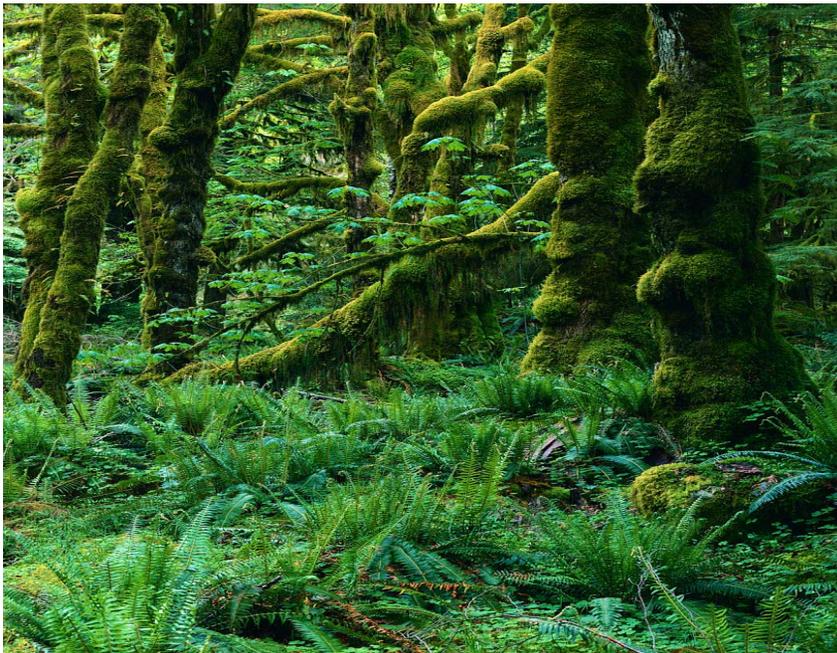
- Rain is stored in natural underground storage compartments called aquifers.
- Volcanic soils filter rainwater water as it replenishes the aquifers
- Oahu is the ONLY island that relies SOLELY on underground water
- From clouds to aquifers to your tap= 25 YEARS!



Healthy forests help to maintain water reserves

HEALTHY

Multi-story canopy absorbs water like sponge.
Aquifers are replenished.



UNHEALTHY

Loss of vegetation layers
Soil cannot absorb water quickly
Water runs off and causes erosion



Our aquifers are fragile systems!

- Invaders like strawberry guava crowd out native forest with its rich understory growth
- Foreign animals like pigs, goats and sheep uproot native plants which increase erosion and create more room for invasive species.
- Human construction results in decreased groundwater absorption and increased runoff.
- Increased runoff decreases marine water quality by adding sediment, nutrients, pesticides, hydrocarbons, and high temperatures to near shore environments.



WHATEVER YOU PUT ON THE GROUND ENDS UP IN OUR WATER



WATER CONSERVATION

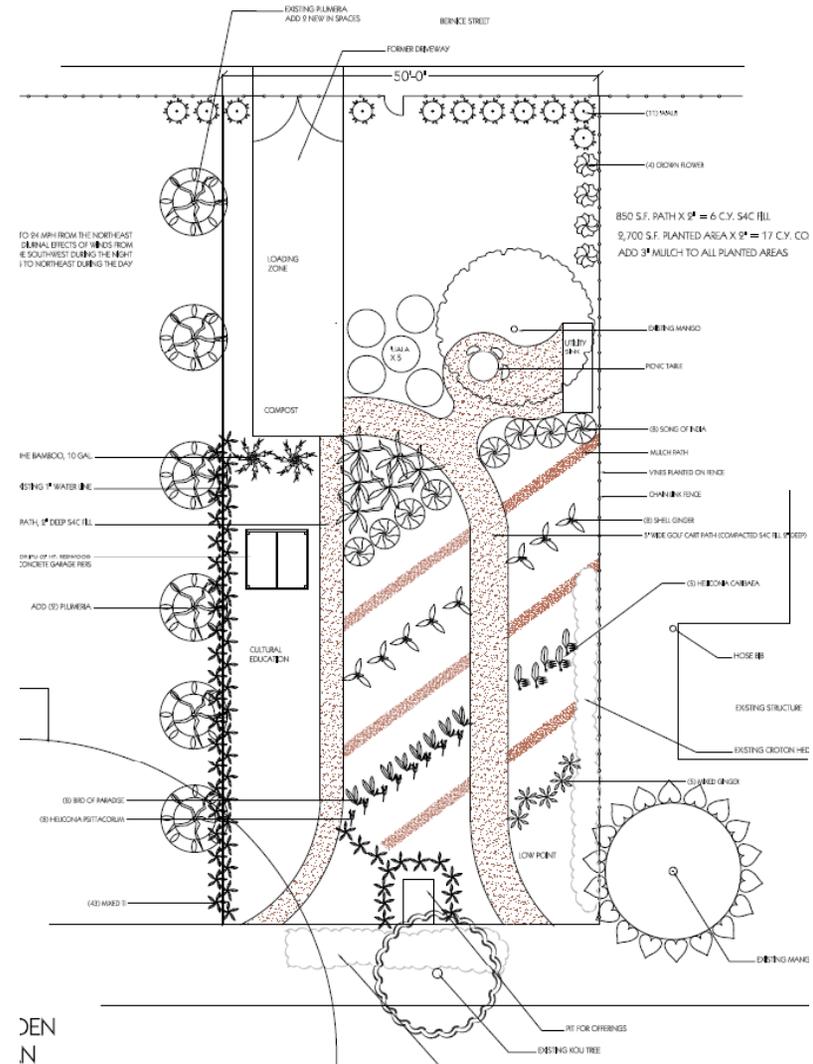
7 XERISCAPE PRINCIPLES



1) Planning & Design

Create a master plan

- Build in phases
- Manage expenses
- Manage water use



2) Limit and separate turf areas

- Grass requires high water use.
- Replace lawn with mulch, rocks, or drought tolerant plants.



3) Choose your irrigation system

- **Less** water (drip system) - drought tolerant herbs and natives
- Medium** water (hand water / microsprinkler) - flowers & veggies
- High** water (spray system) - lawn



Drip emitters



Rain Barrel / hand water
Rain barrel info & drilling available
at the UGC



Micro sprinklers



4) Soil improvement

- Grading & soil improvements should be done before you plant or install an irrigation system
- Compost increases the water holding capacity of soil



5) Mulch

- Mulch consists of either:
 - Organic material – shredded bark
 - Rock, gravel or cinder
- Mulch will help your garden:
 - keep soil cool & covered
 - reduce weed growth
 - help prevent erosion
 - limit evaporation
 - beautify



6) Drought-tolerant planting

There are many plants that thrive on rainfall; especially native Hawai'ians



Milo

Naupaka

Pohinahina



7) Maintenance

- Proper weeding, fertilization, pruning, and irrigation will save you time, water and money in the long run



WATER CONSERVATION GAMES FOR KIDS



Visit Waiola and Kulu at:

<http://www.hbws.org/cssweb/display.cfm?sid=1358>

:

Play water saving games with “Flo” at
EPA Water Sense for Kids:

<http://www.epa.gov/watersense/kids/simpleways.html>



Native Plants of Hawai'i



A'ali'i
Dodonaea viscosa



Ilima
Sida fallax



Loulu
Pritchardia spp.



Koki'o ke'oke'o
Hibiscus waimeae



Naio
Myoporum sandwicense



How did plants get here before people?

The three W's

➤ WINGS



➤ WIND



➤ WATER



What is a native Hawai'ian plant?

NATIVE

Arrived without human help

ENDEMIC - Found ONLY in Hawai'i

Arrived by 3 W's, evolved on site



MAIAPILO
Capparis sandwichiana

INDIGENOUS - found in Hawai'i AND elsewhere, arrived by 3 W's



NAUPAKA KAHAKAI
Scaevola sericea

EXOTIC

Brought to Hawai'i by humans

POLYNESIAN - prior to European contact



KUKUI
Aleurites moluccana

RECENT - brought to Hawai'i since 1776

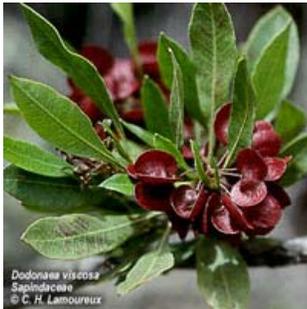


LILIKOI
Passiflora edulis



STUDENT EXERCISE - THE 3 W'S

Provide array of seeds from native plants and ask students to guess how they might have arrived - wind? Waves? Wings?



A'ali'i



Ilie'e



Uki uki



Naupaka



Nanea



'Ohia lehua



Hawai'i -Endangered species capital of the world

- Hawai'i has the highest percentage of endemic flora in the world (plants found only in Hawai'i),
- Hawai'i has already lost half of its native plant species and 10% or more go extinct every year.
- Hawai'ian plants on the U.S. Fish & wildlife endangered species list make up almost half of all endangered species in the United States

<http://www.plantpono.org/>



Clermontia peleana subsp. *peleana*



Why are Hawai'ian native plants so endangered?

Sensitive island ecosystems cannot cope with the loss of habitat resulting from invasion by exotic species, both plant and animal.

The extinction of even one plant or animal species has a huge impact on others, resulting in decline of entire ecosystems



Bare soil under strawberry guava promotes loss of habitat and uncontrolled erosion.



HOW CAN YOU HELP?

PLANT THE RIGHT PLANT IN THE RIGHT PLACE
& PLANT NATIVE!



How do you know what natives to plant?

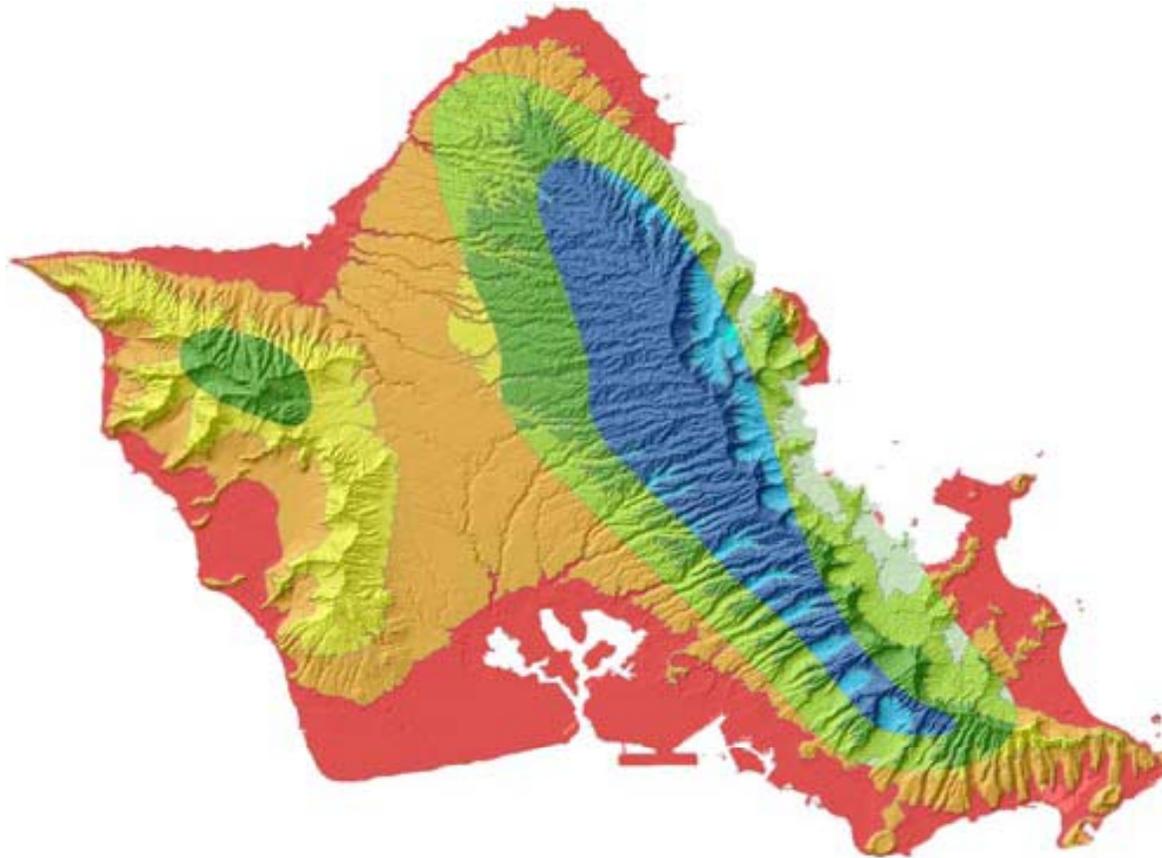


Native Hawai'ian plant garden at UH Manoa Shidler College of Business

- Visit native gardens in your area to see what grows well
- Include Polynesian imports for food and medicinal plants
- Check the BWS Oahu Planting Guide for plants native to your elevation and rainfall



What Hawai'ian plants are native to your area?



Zone Number	Zone Description
Zone 1	Dry (0-47" annual rainfall) Elevation <150ft
Zone 2	Dry (0-47" annual rainfall) Elevation 150-1000ft
Zone 3	Dry (0-47" annual rainfall) Elevation 1000-3000ft
Zone 4	Mesic (48-98" annual rainfall) Elevation < 150ft
Zone 5	Mesic (48-98" annual rainfall) Elevation 150-1000ft
Zone 6	Mesic (48-98" annual rainfall) Elevation 1000-3000ft
Zone 7	Wet (>98" annual rainfall) Elevation <150ft
Zone 8	Wet (>98" annual rainfall) Elevation 150-1000ft
Zone 9	Wet (>98" annual rainfall) Elevation 1000-3000ft

Board of Water Supply Oahu Planting Guide

<http://www.boardofwatersupply.com/cssweb/display.cfm?sid=1360>



Zone 1: Fern

-  Zone 1: Grass
-  Zone 1: Fern
-  Zone 1: Herbaceous Plant
-  Zone 1: Sub-Shrub
-  Zone 1: Shrub
-  Zone 1: Shrub-Tree
-  Zone 1: Tree
-  Zone 1: Vine-Liana
-  Zone 1: PDF Text Only

Click on plant photo for specific plant information.

PHOTO	SPECIES	COMMON NAME	END/IND/POL	HEIGHT(FT)	SPREAD(FT)	E*
	<i>Adiantum capillus-veneris</i>	'Iwa'iwa, 'iwa'iwa hāwai, 'iwa'iwa kahakaha, Venus' hair fern, maidenhair fern	I	1 TO 2	1	
	<i>Asplenium nidus</i>	'Ēkaha, 'Ēkaha kuahiwi, 'Ēkahakaha, bird's nest fern	I	4 TO 6	6	
	<i>Doryopteris decipiens</i>	'Iwa'iwa, manawahua, kumuniu	E	1	1	
	<i>Nephrolepis exaltata</i> spp. <i>Hawaiensis</i>	Ni'an'au, 'ōkupukupu, pāmoho, kupukupu, palapalai, sword fern	E	1 TO 4	8	

Sample page BWS Oahu Planting Guide

<http://nativeplants.hawaii.edu/>





See the “Hawai’i’s Unique Environment” section of the UHMG website for publications: <http://www.ctahr.Hawaii.edu/UHMG/environment.asp>



Visit the Hawai'i Environmental Education Alliance website – heea.org - for a wealth of Environmental Education resources, including teaching tools and funding opportunities.



School Gardens as models of sustainability



By understanding the natural systems that create and sustain our islands, students can learn to model sustainable practices at school, at home and in their communities.



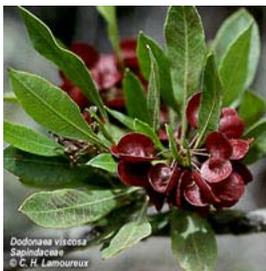
THE NATURAL ENVIRONMENT OF HAWAI'I
SCHOOL GARDEN BASICS FOR EDUCATORS

STUDENT EXERCISE

PROVIDE ARRAY OF SEEDS FROM NATIVE PLANTS AND ASK STUDENTS TO GUESS HOW THEY MIGHT
HAVE ARRIVED - WIND? WAVES? WINGS?

ARE THEY ENDEMIC OR INDIGENOUS

A'ali'i



Ilie'e



Uki uki



Naupaka



Nanea



Ohia lehua



THE NATURAL ENVIRONMENT OF HAWAII
 SCHOOL GARDEN BASICS FOR EDUCATORS - NATIVE HAWAIIAN SCAVENGER HUNT

	Common Name	Botanical name	Native/Poly	Sun/shade	Wet/dry	Vine/shrub/tree
	A'ali'i					
	'Akia					
	'Akulikuli					
	Alahe'e					
	'Awapuhi					
	Carex wahuensis					

Common Name	Botanical name	Native/other	Sun/shade	Wet/dry	Vine/shrub/tree
 <p>Kokio ke'oke'o</p>					
 <p>Moa</p>					
 <p>Kupukupu</p>					
 <p>Pohinahina</p>					
 <p>'Uki 'uki</p>					
 <p>Ulei</p>					

THE NATURAL ENVIRONMENT OF HAWAII

REFERENCE SHEET

8/8/12

1. NATURAL ENVIRONMENT - Climate of Hawaii –
<http://www.wrcc.dri.edu/narratives/HAWAII.htm>

2. OAHU WATER CYCLE:
<http://www.hbws.org/cssweb/display.cfm?sid=2178>
http://www.boardofwatersupply.com/files/Wfl_Website.pdf

3. HAWAIIAN NATIVE PLANTS AND INVASIVE SPECIES
 - a. How did native species evolve and why are invasive species dangerous to our environment:
<http://www.invasivespeciesinfo.gov/docs/council/HISC%20Presentation.pdf>
<http://landscapehawaii.org/invasive-species.asp> - list of invasive species

4. WHICH NATIVE PLANT IS THE RIGHT PLANT IN THE RIGHT PLACE:
 - a. Native Hawaiian plants for landscaping, conservation, and reforestation -
<http://www.ctahr.hawaii.edu/oc/freepubs/pdf/OF-30.pdf>
 - b. BWS Oahu Planting Guide – Island mapped out by rainfall / elevation and corresponding native plants:
<http://www.hbws.org/cssweb/display.cfm?sid=1360>
<http://www.hbws.org/cssweb/display.cfm?sid=1155>
 - c. How to Plant a Native Hawaiian Garden:
http://oegc.doh.hawaii.gov/shared%20documents/misc_documents/1992_how_to_plant_a_native_hawaiian_garden.pdf

 - c. To view healthy real life native gardens:
 1. Papahana Kuaola: Kaneohe, Hi 447-7694
 2. Bishop Museum: 1525 Bernice St. Honolulu, Hi 847-3511
 3. Lyon Arboretum: 3860 Manoa Rd. Honolulu, Hi 988-0456
 4. Halawa Xeriscape Garden: 99-1268 Iwaena St., Aiea 748-5041
 5. UH Manoa Shidler College of Business
 6. UH Manoa East-West Center
 7. Kawaiaha'o Plaza, Kaka'ako
 8. Leeward Community College, Pearl City
 9. Queen Kapiolani Garden, Kapiolani Park, Honolulu, HI

5. WATER MANAGEMENT
 - a. BWS Principles of “Xeriscaping”: <http://www.hbws.org/cssweb/display.cfm?sid=1086>
 - b. Landscape Industry Council of Hawaii (LICH) Irrigation tips:
<http://landscapehawaii.org/waterconservation.asp>
 - c. Rain barrel catchment : <http://www.hbws.org/cssweb/display.cfm?sid=2091>
 - d. “Irrigating (Watering) Your Vegetable Garden” UN cooperative extension
www.unce.unr.edu/publications/files/ho/2010/fs1016.pdf
 - e. “Watering Vegetable Gardens” OSU Extension Service
<http://extension.oregonstate.edu/catalog/html/grow/grow/water.html>

**THE UNTHIRSTY NATIVE HAWAIIAN GARDEN
PLANT LIST**

GROUND COVERS

FULL SUN

- 'Ilima papa – *Sida fallax* (full sun)
- Naio papa – *Myoporum sandwicense*
- Pohuehue – *Ipomoea pes-caprae* sub. *Brasiliensis*

SOME SHADE

- 'Ākulikuli – *Sesuvium portulacastrum* (full sun, some shade)
- Nehe – *Melanthera integrifolia* / *Lipochaeta integrifolia* (full sun, some shade)
- Pā'ū o Hi'iaka – *Jacquemontia ovalifolia*
- 'Ae'ae – *Bacopa monnieri*
- Nanea – *Vigna marina*
- 'Uala – *Ipomoea batatas*

SMALL SHRUBS

FULL SUN

- Pohinahina – *Vitex rotundifolia*
- 'Ākia – *Wikstroemia uva-ursi*
- 'Ohai – *Sesbania tomentosa*

SOME SHADE

- Carex wahuensis*
- 'Ilie'e – *Plumbago zeylanica*
- 'Ūlei – *Osteomeles anthyllidifolia*
- 'Uki'uki – *Dianella sandwicensis*
- Kupukupu – *Nephrolepis cordifolia*

LARGE SHRUBS

FULL SUN

- 'A'ali'i – *Dodonaea viscosa*
 - Naupaka kahakai – *Scaevola sericea*
 - Koki'o 'ula – *Hibiscus kokio* or *Hibiscus clayi*
- SOME SHADE
- Kulu'i – *Notrotrichium sandwicense*
 - Koki'o ke'oke'o – *Hibiscus arnottianus*
 - Nā'ū – *Gardenia brighamii*

TREES

FULL SUN

- Hala – *Pandanus tectorius*
 - Kou – *Cordia subcordata*
- SOME SHADE
- Loulu – *Pritchardia* sp.
 - Milo – *Thespesia populnea*
 - Koai'a – *Acacia koaia*
 - Alahe'e – *Psydrax odorata*