Reminder!
- 1 LITER OF WATER!
- Clothes that can get dirty and are loose (so you don’t over-heat); long pants and sleeves would be best to not get cuts by tall grass and thorny trees
- Close toed shoes (no slippers and no heels!)
- Hat & sunscreen; and/or rain gear
- Read Appendix B before coming to lab

Key Concepts
Field community ecology sampling techniques:
- vegetation (identify and quantify, height)
- quadrats and transects to quantify vegetation
- environment (temperature loggers/iButtons, rain gauge, soil depth)
- terrestrial invertebrates (pitfall & sticky traps)

Student Learning Outcomes
After Lab 6 students will be able to:
1. apply ecological field sampling techniques learned in Lab 4 to survey and characterize the vegetation on Wa‘ahila Ridge.
2. measure environmental parameters such as rainfall, temperature, and soil depth in the field.
3. set sticky and pit fall traps in the field to sample terrestrial invertebrates.

I. INTRODUCTION
Today, we will make another field trip to Wa‘ahila Ridge. We will sample the plant and insect populations on the ridge in order to determine their density, percent cover, and dispersion. We will also be measuring key physical variables such as temperature, soil depth and quality, and rainfall. The data you collect this week will be used to test your hypotheses (homework Lab 4) on what factors affect the vegetation on the ridge, which is the central part of your research project throughout the semester.

Be Prepared
Wa‘ahila Ridge can be extremely hot. Although the temperature rarely reaches 90°F, the strong sun reflecting off rocky surfaces can sometimes make it feel greater than 100°F! You need to come prepared for climbing in hot, dry conditions. It is recommended to wear a hat, hiking shoes, and lightweight, durable clothing. Wear pants and a shirt to avoid being scratched by plants and bring sunscreen. YOU MUST BRING WATER. Make sure that you eat before hiking or bring food with you. Please inform your TA immediately if you feel sick or are injured during our trip. Your TA will be carrying a first aid kit. Coming prepared for hiking will make your experience more enjoyable.

Vegetation on Wa‘ahila Ridge
The vegetation on Wa‘ahila Ridge is not uniform. In general, you will see that the habitat is composed mainly of grasses interspersed with cactoids, shrubs, and small trees. Some of the shrubs are thorny, so be careful! If you look closely, you will see broad-leaved herbs among the grass. As you travel up the ridge, you will see more woody plants, and the grass species change. If you go all the way to the top, the habitat is mostly small trees – a sparse forest.

The majority of plant species you find on Wa‘ahila Ridge are aliens (non-native invaders) introduced from many parts of the world. Alien plants now dominate most lowland habitats in the Hawaiian Islands.

A list of the most common plants at each site on Wa‘ahila Ridge can be found on Page 6-8.

Plots on Wa‘ahila Ridge
An initial observation of the ridge suggests that the climate and vegetation vary across the ridge. Plots (20x20m) have been established across a range of elevations on Wa‘ahila Ridge. Each lab section has been assigned to one of these plots. We will investigate relationships between biotic factors, such as plant and insect species, and abiotic factors, such as temperature, rainfall, and soil depth in the plots. Understanding
relationships between organisms and their environments is an important goal of ecology.

During lab this week you will be working in groups of three or four. Each group is responsible for collecting specific data from five quadrats and one transect within their lab section’s plot. Later, the data from all quadrats in the plot will be pooled to estimate environmental, population, and community parameters for the plot as a whole.

In Lab 8, data from your lab section will be combined with data from the other sections’ plots to get an overall picture of the community ecology on Wa‘ahila Ridge and the factors influencing the distribution and abundance of certain species. This combined data set (as well as the data sets from former years) is what you will use for your individual research projects.

We will focus on the following questions, which we will answer through the use of various sampling techniques:
- What kinds of plant and animal species are present and how abundant are they?
- How do temperature, soil depth, and rainfall differ along the Ridge?
- How do the observed species and ecological communities relate to environmental conditions along the Ridge?

YOUR DATA WILL BE USED BY OTHERS. CAREFUL MEASUREMENTS AND ACCURATE DATA RECORDING ARE IMPERATIVE IF YOU ARE TO MAKE SENSE OF THE COMBINED CLASS DATA.

MAKE ALL MEASUREMENTS IN METERS.

YOU MUST COMPLETE ALL STEPS LISTED WITHIN THIS LAB TODAY.

II. SAMPLING TERRESTRIAL INVERTEBRATES

In addition to sampling vegetation, we will also be sampling the terrestrial invertebrate populations on the ridge. Many methods have been devised to sample mobile populations. We will be setting traps. The trapping methods are rather crude and generally cannot provide good quantitative estimates of animal populations because of the highly variable results. However, these methods are still useful for documenting which mobile species are present at a site and providing a qualitative (rough) estimate of population abundance.

**Pitfall Traps**

Pitfall traps consist of a plastic cup or other container that is sunken into the ground. The opening of the cup is level with the surrounding ground, forming a "pit" into which unsuspecting small animals may fall. The bottom of the jar often contains mineral oil, or other slippery substance that will help prevent the animals (usually insects) from escaping by drowning them. After at least one day, you can pour out the traps and count what you’ve caught. Pitfall traps are a very crude method of sampling invertebrate populations. You will only catch organisms that walk on the ground, particularly those that are active at night.

**Sticky Traps**

Sticky traps consist of pieces of cardboard, or any sturdy material, that have been coated with a sticky substance to trap insects that touch the traps. Often sticky traps are painted a bright yellow color, which helps to attract insects. Sticky traps may be hung from vegetation, or attached to poles. After placing the sticky traps in the field, you can return to them (usually several days later) and count what you caught.

III. METHODS

**Overview:**

On Wa‘ahila Ridge there are a number of 20x20m plots. Each section will be assigned a different plot. Your section will then break into four groups. Each group will be assigned to a 10x10m area (sub-plot) of the 20x20m plot. Each group will sample five 1x1m quadrats within their sub-plot (Figure 1). Each group will also sample a 15m transect within the plot (Figure 4).
You will need to:

- identify and quantify plant species
- estimate percent cover
- set two insect (sticky) traps and two pitfall traps within your sub-plot
- measure soil depth at the bottom left corner of each quadrat
- place an iButton at the center of your 1st quadrat
- measure rainfall in the gauge (in cm), empty the water and add some mineral oil
- measure vegetation height
- fill in data sheets and have them checked by your TA.
- Enter the data into the appropriated spreadsheet on Google doc according to your TAs instructions.
- Finally, your TA will post information and data collected from your plot on Laulima for use in your assignment.

**B. Check Rain Gauge**

A RAIN GAUGE HAS ALREADY BEEN SET IN YOUR SECTION’S PLOT AT THE BEGINNING OF THE SEMESTER. BE SURE TO OBTAIN THE COORDINATES FROM YOUR TA.

Two volunteers from each section will be responsible for reading the rain gauge within their plot. Your TA will inform you of the location of the rain gauge. *Mineral oil has been added to prevent the collected rain from evaporating before it can be recorded. Don’t measure the oil level; measure the water level in cm.*

1. Record the water level (Units = cm).
2. Record the amount of time the gauge has been collecting rain and determine the average rainfall/day (cm/day).
3. Empty the gauge.
4. Fill the rain gauge with mineral oil to reset.

**C. Measure Vegetation Height**

Two volunteers from each section will be responsible for measuring vegetation height for your plot. Within your plot measure the five tallest trees/shrubs (ask your TA if you are unsure) with a 20m transect tape and a clinometer.

1. Decide which are the five tallest trees/shrubs in the plot.
2. Measure 20m (or 15m) distance from tree.
3. Look through the clinometer with both eyes and align cross-hair with the top of tree.
4. Read off tree height (in m) from appropriate scale (20m: left scale, 15m: right scale).
5. First reading gives you just tree height from your eye level. You need to add or subtract tree base depending on the slope you are standing on.
6. Add height of tree base if your eye level is above base of tree OR subtract if your eye level is below (check the figures in the ppt).

---

**A. Locate 20m x 20m Plot**

The TAs will complete this prior to the laboratory. **Orange flags** with corresponding plot numbers will be positioned every 5 meters along the trail within each plot. The y-axis, for the purpose of mapping, is parallel to the trail and is mostly in the center of the plot, dividing the left and right sub-plots.

![Sample plot showing sub-plots within the 20m x 20m plot.](image-url)
D. Locate your Sub-Plot & Delineate your 1st Quadrat

Materials: Measuring Tape, Compass, & Flags

1. In the interest of efficiency, your TA will assign each group to a 10x10m area (sub-plot) of the 20x20m plot. Locate your sub-plot. Orient yourself using the flags placed along the trail of the main plot. Each flag is 5 meters apart and mostly divides the left and right sub-plots (check with your TA).

2. To locate your 1m² sample quadrats within the 10x10m sub-plot, use the random x-y coordinates supplied by your TA.

3. With the help of a compass, turn 90 degrees, and measure off your x-coordinate using the tape measure. Place a flag at the coordinate. This coordinate is the bottom left corner of your first sample quadrat. AVOID TRAMPLE ANY AREA WITHIN YOUR SAMPLE QUADRAT.

4. Place the bottom left corner of a 1m² PVC quadrat on the flagged point.

5. Use your soil probe and measuring tape to measure the soil depth at one corner of the quadrat (measure soil depth in cm).

6. Attach the iButton 1m above the ground (approx. waist height) in the center of the quadrat. Try to attach the iButton not exposed directly to the sun in order to get true air temperature measurements.

7. In your notes, draw a map of your entire 10x10m sub-plot, with your quadrats demarcated. Be sure to include the coordinates of the quadrats. You will need to find them (especially the iButton) again in a few weeks.

8. Repeat steps 2-7 for the remaining quadrats (for a total of 5 quadrats).

E. Sampling Vegetation w/ Quadrats

We are sampling the density and percent cover of plant populations as we practiced last week. It is important that you accurately identify each species. There will multiple groups sampling vegetation across the ridge, and it is important that species are identified correctly so we can compare the data of different groups and sections. The species list included with this lab indicates what species were found at which sites in previous years. In the past, no more than 21 species were found at any one site. Look at the species list to help you narrow down the possibilities. Be careful though; due to yearly variation, you may find species that were not found last year. If you cannot identify a species, collect a specimen (leaf, flower, seed) from outside your quadrat, if possible, and give it an arbitrary name such as Species A (see methods below). Your TA can help to properly identify the species at a later time.

When counting grasses on Wa‘ahila Ridge, realize that a clump of grass is often a single genetic individual and should be counted as 1 individual. When estimating percent cover, view each quadrat from directly above and below (look up for tree cover). Beginners tend to overestimate percent cover. It is very important that you use the picture (Figure 2) to get an idea of what the various cover classes look like. Be consistent in reading cover for different species and quadrats. If two species overlap, be sure to count the full area covered by each species. Don’t deny short species the cover they deserve because they are hidden under the bigger species! Also, don’t forget to record the cover of bare ground. Remember, quadrats may have more than 100% total cover.

1. With the bottom left corner of the PVC quadrat on the flagged point, identify each plant species within the 1m² quadrat.

2. Classify the species as a grass, shrub/tree, or other.

3. Record the number of individuals of each species within the PVC frame. You are recording individuals/m², i.e. density.

4. Estimate the area covered by each plant species using the Braun-Blanquet cover classes (Figure 3).

5. Record the midpoint percent cover corresponding to the cover class (Right column, Figure 3). Don’t forget to look up as well as down!

6. Record the midpoint percent cover of bare ground.
7. Find your next quadrat location and repeat until you have surveyed all five quadrats. Remember to record the soil depth at each quadrat and mark the locations on your map. You should also install a single animal trap (sticky OR pitfall) at the next four quadrats giving a total of 2 sticky traps and 2 pitfall traps.

*IF YOU CAN’T ID A SPECIES, COLLECT A SAMPLE OF THE PLANT AND PLACE IT IN A ZIP LOCK BAG. LABEL THE BAG WITH THE ARBITRARY SPECIES NAME (e.g. SPECIES A), YOUR GROUP #, AND YOUR SECTION #. CONTINUE YOUR SAMPLING, REFERRING TO THAT SPECIES AS ‘SPECIES A’. WHEN THE SPECIMEN IS PROPERLY IDENTIFIED, YOU CAN GO BACK AND REPLACE THE ARBITRARY SPECIES NAME WITH THE PROPER NAME.

F. Temperature Loggers

Each section will have four iButtons. The iButtons measure temperature once every 14 minutes. The logger data will be downloaded, entered in a datasheet, and summarized, leading to a Min, Max and average temperature for each plot.

We are using several temperature loggers per section to get a better representative sample of the temperatures encountered on the ridge. Each site is fairly large (20x20m) and can have a range of temperatures. Thus, hotter areas of the site may have different vegetation than cooler areas.

Each group will position an iButton within their first quadrat. Place the iButton at about 1 meter off the ground, preferably not in direct sunlight, by tying it to a branch with twist-tie. Groups will be responsible for placing and retrieving the iButtons. Your TA be given your downloaded data.

G. Installing Pitfall Traps

In this exercise, each group will install two pitfall traps in the center of two quadrats.

1. **Using a trowel or small shovel, dig a hole slightly larger and deeper than the cup you will be using for the actual trap.**
2. **Place the cup in the hole and fill the space between the cup and the hole with soil. Place a small flag near the trap.**
3. **Smooth the soil out so that the lip of the cup is level with ground level. Be sure to make the area look clean (undisturbed) or the invertebrates will know what you are up to.**
4. Partially fill the trap with a vial of mineral oil. This will smother and kill the invertebrates that fall into the trap and may also serve to preserve the specimens.
5. Record the location of the traps in your notes & on your map!
6. When you return to the site in Lab 8, you will remove the invertebrates trapped in the container in order to count and classify them.

**H. Installing Sticky Traps**

**Materials:** Yellow Cards, Tanglefoot, Twist-ties, knife

The sticky traps we are using are made from 3” x 5” yellow cardstock, with holes at each end. Each group will hang two sticky traps in their quadrats. It is best to hang the trap from a branch, but if your quadrat has no shrubs or trees, hang the trap from any sturdy plant, or a flag.

1. Spread a thin layer of tanglefoot on both sides of each card with the plastic knife.
2. Use two twist-ties to fasten the trap to vegetation in such a way that they won't blow very much in the wind. Be sure not to put the traps right next to each other.
3. You will count and identify what you have caught when you return to your quadrats in Lab 8.

*WARNING -- the traps are sticky!!! Although this sticky material is non-toxic, it can make a BIG MESS on your clothes and your hands. USE MINERAL OIL TO REMOVE THE TANGLEFOOT.*

**I. Sampling Vegetation w/ Transects**

We are also sampling the ridge vegetation using the transect method, as we practiced in class last week.

1. **Groups 1 & 2 should go to the lower boundary of the plot, while groups 3 & 4 should go to the upper boundary of the plot.**
2. Your TA will provide you with a random number for determining the x-axis (perpendicular to the general ridge slope) coordinate at which to start your transect.
3. Use the tape measure to make a line transect beginning at the random coordinate and extend 15 meters towards the center of the plot and perpendicular to the upper or lower boundary of the plot.
4. **Starting at the beginning of the transect, identify each species and the length of each species touching the tape (and those that would touch the tape were it raised or lowered), classify the species (as a grass, shrub/tree, or other) and measure the length of transect touched by each individual (See Figure 4).**

Although it would be ideal to identify your transect position based on two random numbers (x and y coordinates), students have encountered problems trying to do this in the field. Our method involving one random number is nearly as good, as long as plants in your plot don’t grow in linear rows like a vegetable crop (this would be rare in nature).

![Figure 4](image)

**J. Compiling Data**

It is necessary for the groups within a section to combine data in order to complete the assignment. Each group should turn in **one set** of complete and accurate data sheets to the TA at the end of the lab period. Your TA will make copies of this datasheet and return the original to you before you leave. One student per group will enter the data into a spreadsheet on Google docs within 24 hours of the end of your lab according to instructions by your TA. **Data not entered by that time results in points deducted from their homework for all students in that group.** When entering data in this spreadsheet, it is important that you follow instructions carefully. The compiled summary of
your data will then be posted by your TA within 48 hours from the end of your lab. Use this posted summary data to complete the assignment below.

IV. ASSIGNMENTS (35 pts.)

Each individual is required to turn in answers to the following questions at the beginning of your next lab period. All questions are based on the data collected from your entire class, available as a finalized excel file on Laulima (do not use the Google doc):

1. a. Use your section’s quadrat data to plot three column graphs: A) relative density for all species, one column for each species, B) relative cover for all species, one column for each species, and C) relative frequency for all species, one column for each species. (6 pts.)

b. Which species had the highest relative cover? (1 pt.)

Did the species with the highest relative cover also have the highest relative density? (1 pt.)

Why or why not? Explain your reasoning. (5 sentences max) (2 pts.)

2. From your section’s quadrat Data:

a. For each species, was the null hypothesis ($H_0: C_d = 1$) rejected? Remember to check the p-values (2 pts.)

b. What kind of dispersion (clumped, uniform, or random) occurs in these species? Explain your reasoning. (2 pts.)

c. Identify one species that was clumped; using your personal observations from when you were on the ridge, develop a hypothesis to explain why its dispersion pattern is clumped. (2 pts.)

d. If any species had a significant uniform dispersion, develop a hypothesis as to why that species’ dispersion was uniform. If none had a significant uniform dispersion, assume one had and develop a hypothesis as to why that species’ dispersion was uniform. Justify your reasoning. (4 sentences max) (2 pts.)

3. Community ecology theory predicts that a graph of number of individuals of a species vs. species (e.g., species names sorted from most common to least common) will have a log-normal distribution, meaning that we should expect only a few common species and many more rare species in a community.

a. Plot a single column graph of the importance values, arranged from largest to smallest, based on the quadrat data for each species in your section’s plot (20x20m). (2 pts.)

b. Based on your graph of importance values, does your Wa‘ahila ridge community seem to match this theoretical prediction? (2 pts.)

Explain why or why not (5 sentences max). (2 pts.)

4. Use your graphs to write a simple (one paragraph) scientific description of the vegetation at your site that would allow someone who has never been there to visualize the site. Focus on species diversity and distribution from your data and use the terminology you learned in Lab 4 and this lab. (5 sentences max) (4 pts.)

5. Write a cohesive paragraph each discussing the differences, similarities, advantages, and disadvantages of the transect and quadrat methods.

a) Include which method seemed to provide a better picture of the vegetation as you remember it, point out any major disparities and which method you preferred in terms of logistics. Use your data to justify your reasoning. (4 pts.)

b) Describe a situation where a transect (or quadrat) would better characterize your study site. (3 pts.)
This list is not absolute. You may find species in your site that are not on the list. This is a general guide to point you in the right direction when identifying species.

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