HARVARD FOREST

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HARVARD UNIVERSITY

Harvard LTER Schoolyard Program

Teacher Developed Lessons and Documents that integrate Harvard Forest Schoolyard Ecology Themes into curriculum.

- Lesson Title: 3 Labs to Connect with HF Field Trip
- Teacher/Author: Nicole Forsyth
- School: Norfolk County Agricultural High School
- Level: High School
- Date: November, 2017

ame ____ Section ____________

Plant Community Sampling Lab

In this lab you will sample the species diversity of herbaceous plants between two different plant communities. Before you begin, determine which two different plant communities you will measure.

Examples include: 1) under the canopies of trees vs. in the open, 2) under shrubs vs. under trees, 3) the slope of a steam bank vs. the the top of the stream bank, 4) under two different types trees (i.e. oak vs. pine), 5) mowed vs. not mowed. Many other possibilities exist. Feel free to use your imagination to come up with two different environments to sample.

Question:
Testing two naturalized plots (woodland, fields, meadow etc.) on the Aggie Campus, what are the chances of the plots having a significant difference in the diversity of species represented within each plot?

What factors might play into the species diversity if there is a dramatic difference in species? (i.e plots are in different areas of campus with different site conditions etc.)

Comment [1]: i.e. means in other words, e.g. means for example - I'm not sure which one you prefer to use.

Hypothesis: add your hypothesis below.
An example of how you write a hypothesis might be:
"If a plant receives fertilizer, then they will grow to be bigger than a plant that doesn't receive fertilizer."

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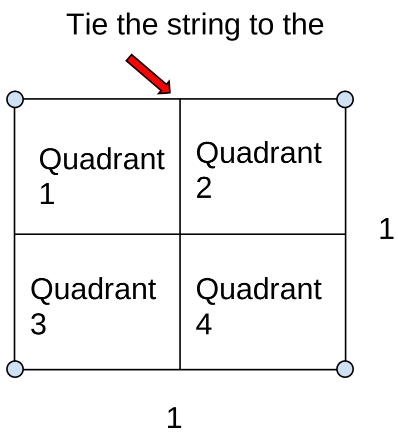
Comment [2]: even though they have had practice writing hypotheses. perhaps given them a starter here. Perhaps something like:
If __________________, then _____________.
Or maybe even more specific examples to help them

<u>Materials:</u>

String
4 sticks
Measuring tape/stick
Pencils
Notebook
Calculator
Tape

<u>Procedures:</u>

- Go out into the field, woods, or any other naturalized area, and bring your materials.
- Measure out a 10’ by 10’ area, and make a square with your string and sticks in each corner. Then put another string through the middle, then another so you have the area broken up into 4 areas.



This will be your sampling area. See:

- These sub-areas will be Quadrant 1, 2, 3, 4
- We will do two large areas like this.
- Follow the questions and steps below to conduct the lab.

VARIABLES:

α-diversity

α-diversity is simply a measure of the **number of species (*species richness*) in a specific plot**. In this manner, α-diversity can be thought of as plot-level diversity. JUST THE PLANTS IN THAT ONE PLOT WITHIN THE WHOLE COMMUNITY.

γ-diversity

γ-diversity is simply the **total number of species recorded in a specific community.** γ-diversity can also be thought of as the *species pool.* OVERALL IN THE WHOLE COMMUNITY.

β-diversity

β-diversity measures the turnover of species between two sites in terms of gain or loss of species. Here ***γ-diversity* is the total species diversity of a landscape, and *α-diversity* is the mean species diversity per habitat**.

In the strictest sense β-diversity is measured as:

$$\beta = \frac{\alpha}{\gamma}$$

In other words, **β-diversity measures the differentiation in species among plots within a single community.** If the mean β-diversity in a community is low (near 0), there is high turnover of species from one plot to another. While if mean β-diversity in a community is high (near 1), many of the plots measured share the same species.

Procedures:

1. Once you have your square laid out, determine the number of unique plant species within each quadrant. This is known as *alpha species diversity* (α-diversity). Record this number in Table 1 under α-diversity for all quadrants.

2. Collect examples of all unique species. Tape them to the piece of paper in your packet titled "species diversity samples" and number them.

3. Identify any species present in the 2nd, 3rd and 4th quadrant, not found in the first quadrant. Collect them, tape them to the piece of paper and number them as well.

4. In Table 1, put the **cumulative diversity**. For example, if you found 4 species in quadrant 1, 3 DIFFERENT species in quadrant 2, 2 different species in quadrant 3, and 1 different species in quadrant 4, than the total diversity for our measured square would be 10 species total. DO NOT COUNT THE SAME SPECIES TWICE.

5. Record data in **Plant Species Diversity Table: Area 1.**

Plant Species Diversity Table: Area 1

PLOT SAMPLING AREA 1	QUADRANT 1	QUADRANT 2	QUADRANT 3	QUADRANT 4
A-DIVERSITY (A)				

Y-DIVERSITY (Y): Total number of species in the whole plot (all 4 quadrants). Remember--do not count the same species twice!

A(Quadrant 1)+A(Quadrant 2)+A(Quadrant 3)+A (Quadrant 4)= Y ____________________

Using your data above, calculate the species diversity for each quadrant: B would be the *differentiation of species* within that one plot (Area 1)

Quadrant 1: $\beta = \frac{\alpha}{\gamma}$

Quadrant 2: $\beta = \frac{\alpha}{\gamma}$

Quadrant 3: $\beta = \frac{\alpha}{\gamma}$

Quadrant 4: $\beta = \frac{\alpha}{\gamma}$

After you complete area one, move your setup to another area that isn't near your first one. Do the same thing you did before!!

Plant Species Diversity Table: Area 2

PLOT SAMPLING AREA 2	QUADRANT 1	QUADRANT 2	QUADRANT 3	QUADRANT 4
A-DIVERSITY				

Y-DIVERSITY (Y): Total number of species in the whole plot (all 4 quadrants).

A(Quadrant 1)+A(Quadrant 2)+A(Quadrant 3)+A (Quadrant 4)= Y ____________________

Using your data above, calculate the species diversity for each quadrant: B would be the differentiation of species within that one plot (Area 1)

Quadrant 1: $\beta = \frac{\alpha}{\gamma}$

Quadrant 2: $\beta = \frac{\alpha}{\gamma}$

Quadrant 3: $\beta = \frac{\alpha}{\gamma}$

Quadrant 4: $\beta = \frac{\alpha}{\gamma}$

Analysis

In order to summarize data of this nature, we use statistics. A common statistic is mean. However, simply calculating the mean of the two groups doesn't tell us whether or not those two groups are "statistically significantly" different. For that we need a statistical test. For this analysis, we will be using a simple test known as an unpaired t test.

Unpaired t test

In our case the unpaired *t* test will compare the means of two groups. Our two groups are "community 1" and "community 2." With this test, we will be able to determine whether or not the difference in the means of diversity metrics of your two different plant communities. In other words, we will be able to determine whether or not there is a difference between the α-diversity of the transects of your two different plant communities.

Protocol

- Go to: http://www.graphpad.com/quickcalcs/ttest1.cfm

- Under "1. Choose data entry format", select "Enter up to 50 rows."
- Under "2. Enter data" you will input your data. (your B-Diversity quantities)
- First change the label to correspond with the plant communities you sampled (i.e. under tree vs. in open field).
- Input the data from those two columns only.
- Under "3. Choose a test", select "Unpaired *t* test."
- Under "4. View the results", click on "Calculate now."

You will see on the results page :

P value and statistical significance:

The two-tailed P value equals 0.1996

By conventional criteria, this difference is considered to be not statistically significant.

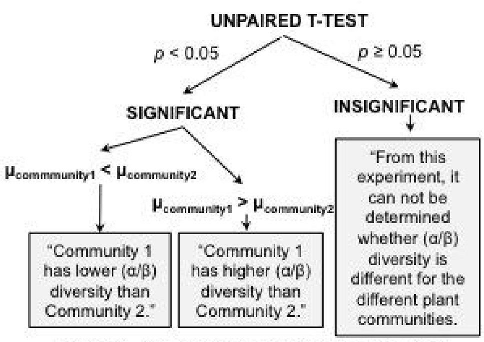


Figure 1. Interpreting the results of the unpaired *t* test.

p **value**

The *p* value allows us to determine whether or not the means of the two samples are "significantly" different.

The *p* value is the probability (ranging from zero to one), that answers whether or not the observed means of two populations (e.g. "under tree" and "open field") are real and not merely a product of chance.

In most biological studies, if the *p* value is less that 0.05 we can state that there is, in fact, a "statistical" difference between the two populations. This is somewhat of an artificial cut off, but it is one that is widely accepted in this field of study. Therefore, in our study if you get a *p* value less than 0.05, you can state that there is a "significant" difference between the two plant communities.

Discussion Questions:

1) What is the "p-value" of the two communities based on the results on the website?

2) Is this number you got >0.05 or <0.05?

3) What do these results mean? Are the two communities you tested dramatically different in their species diversity?

What benefit does it bring to the plant communities to have a diverse population of plant species?

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Conclusion:

Claim-evidence-reasoning rubric

Component	**Score 3**	**Score 2**	**Score 1**
Claim: A conclusion that answers the original question.	Makes an accurate and complete claim using clear language and complete sentences.	Makes an accurate but incomplete claim. Language could be clearer but uses complete sentences.	Makes an inaccurate or unclear claim. Doesn't use complete sentences.
Evidence—Scientific data that supports the claim. The data needs to be appropriate and sufficient to support the claim.	Provides appropriate and sufficient evidence to support claim.	Provides appropriate but insufficient evidence to support claim. May include some inappropriate evidence.	Provides inappropriate evidence (evidence that does not support claim).
Reasoning—A justification that links the claim and evidence. It shows why the data count as evidence by using appropriate and sufficient scientific principles.	Provides reasoning that links evidence to claim. Includes appropriate and sufficient scientific principles.	Provides reasoning that links the claim and evidence. Repeats the evidence and/or includes some—but not sufficient—scientific principles.	Provides reasoning that does not link evidence to claim.

Step 1: State your claim

- Restate your hypothesis and supporting evidence.
    - Your supporting evidence comes from the answers to questions:
        - Testing two naturalized plots (woodland, fields, meadow etc.) on the Aggie Campus, what are the chances of the plots having a significant difference in the diversity of species represented within each plot?
        - What factors might play into the species diversity if there is a dramatic difference in species? (i.e plots are in different areas of campus with different site conditions etc.)

Step 2: Provide evidence to support your claim

- State your data. In this section simply tell me your data do not explain it.
- Provide the data from your *Plant Species Diversity Tables*

Step 3: Explain your findings

- Connect your findings to your claim.
- Explain the meaning of your data, what does it tell you?
    - Provide evidence that explains how the data supports your claim

- If your hypothesis was falsified, explain why and how you would change your hypothesis based on your current data.
- Make sure to explain your p value in this section and it's significance
- What benefit does it bring to the plant communities to have a diverse population of plant species?

This will be turned in as a 1-2 page paper, with these three headings.

Remember:

- ***Your name, class section, title of lab***
- ***1" margins, 12 times new roman font, 1.5 spaced***
- ***Keep paragraphs short and easy to read--4-5 sentences each.***
- ***Attach this paper to this lab and turn in all together. The deadline will be determined in class.***

Name ____ Sec _________

Plant Communities Lab
Part 1B: Observations

1. Canopy/Light.

Does this community have open or closed canopy? (Canopy refers to cover by the highest levels of plants, such as the branches of trees.)

Is the area shaded as in a forest, or open like a meadow?

Describe the canopy at this site.

2. **Soil.** Check the soil. Rub a small amount between forefinger and thumb.

Is it gritty (sandy), or sticky (clay)? A smooth-textured, floury feel between your fingers would suggest an intermediate (silty) soil.

How wet is the soil—is it saturated and muddy, or dry? Do you notice leaf litter at the soil surface?

3. **Water.** Observe if the water is standing (like a pond) or running (like a stream). How can you tell? List some characteristics such as clarity, depth, and size of the water body.

4. Plants. What kind of plants do you observe—trees, shrubs, grasses, or herbaceous plants?

If you can identify any of the plants in this community, write down their names.

5. Animals. List any animals you observe or animal signs such as tracks, scat, spider webs, or a feather. If you don't know an animal's name, try to draw it, or describe it in words. Examples could be ants, moths, earthworms, domestic cats, etc.

Part 2: Questions

1.) What makes each community unique? Base your answer on characteristics such as light, soil, water, plants, and animals.

2.) Which communities had the greatest diversity of plants and animals (composition)? Which seemed to have the best habitat?

3.) Did the communities seem to be made up primarily of animals or plants?

4.) Can you identify which area had the greatest number of native plants?

5.) Can you think of ways to improve the habitat around your school?

Name ______________________________ Section ____________
Group ____

Lab #2: Plant Families Project

1) Your will be assigned one of the 8 plant families which are common, which include the : **Mustard, Mint, Parsley, Pea, Lily, Grass, Rose & Aster families**.

2) Read the handout for your assigned plant family, **underlining any words you do not understand**, or are unfamiliar that you would like to define. Write them here:

WORD	DEFINITION

3) We will **come up with a list and definitions** of these words and define them as a class, so that you may understand the essential parts of plant classification.

4) Make a poster to present to the class!
   - **Include on poster:**
     i) Key characteristics of family drawn and labeled
     ii) At least 5 plants in that family drawn, labeled
     iii) The 5 plants uses and characteristics listed

(See attached rubric, which I will use as a guideline to grade you)

Students (Group) ____

Plant Families Project
Botany & Soils

	Exemplary-4	**Accomplished-3**	**Developing-2**	**Unsatisfactory-1**
Poster has visuals and drawings- (less words)				
Ideas/concepts expressed in project from reading/lectures and research				
All areas of rubric answered (see below)				
Overall effort, neatness and readability of the poster/project				
Presentation (eye contact, voice, reasoning and expression, complete ideas etc.) at least 3 minutes--TEACH THE CLASS				

Include on poster:

- Key characteristics of family drawn and labeled
- At least 5 plants in that family drawn, labeled
- The 5 plants uses and characteristics listed

Grade ____________________