

Name _____ Other Group Members _____

COMMUNITY DIVERSITY OF TREES+SHRUBS

LAB #1 FOREST COMPOSITION

Purpose:

To study some features of community organization by sampling and comparing biotic features (species composition and diversity) of forest communities. To consider some of the abiotic factors influencing development of forest communities.

Introduction:

Communities are naturally occurring, interacting assemblages of plant and animal populations. Adaptations of these populations to the physical environment (soil, temperature, moisture, light, nutrients) and interactions between populations (predation, competition, symbiosis) determine the structure, dominance, species diversity, and niches in a community.

Communities are often too large or complex to be completely studied in one visit, but some features of community structure and function can be examined relatively quickly. For example, we can look at just plants and animals inhabiting a rotting log rather than the entire forest community.

In forests, trees are the dominant vegetation. They influence microclimate, light reaching the forest floor, and soil conditions. They also provide protection, feeding, and nesting sites for animals. We will examine forest plant communities and make observations about their composition and structure, and discuss site potential as wildlife habitat. We will use measures of community structure (species diversity and richness) to examine 3 sites and a measure of community similarity to compare the sites.

Calculating species diversity (such as through the Shannon Diversity Index equation) requires knowledge of species richness (**number of species in a community**) and **number of individuals within each species**. A community with many equally abundant species is considered to have high species diversity. For example, in a community of 10 species with 100 individuals, maximum possible diversity would occur if there were 10 individuals in each of the 10 species. Least possible diversity would occur if there were 91 individuals of 1 species and 1 individual in each of the other 9 species. Equitability in the second example is lower because individuals are not evenly distributed among the 10 species.

High species diversity usually indicates a complex community because the greater variety of species allows more interactions among species. Population interactions involving predation, competition, and energy transfer are more complex and varied. There is not always a simple relationship between diversity and stability however.

After determining the species composition in multiple communities, you may want to see how similar or dissimilar they are. You can do this by using a community similarity index. (These indices can also be used to compare the same community at 2 different times.) Although there are several indices, we'll use **the percent similarity index**.

On-Site Activity:

We'll visit 3 sites within TESC campus forest: 1) a western redcedar stand, 2) a mixed hardwood stand, and 3) a Douglas-fir dominated stand. At each site we'll break into groups (4-5 students per group) and examine the plant community. We will spend approximately 1 hour at each site.

At each site we will collect:

1. Qualitative information: Collect spatial information (topography), describe the community type, moisture classification, historical events that have influenced community type, and biotic features information. (See data collection sheet)

2. Quantitative information:

a. Select a plot that is **representative** of the forest around you (do not use exceptionally dense or sparsely vegetated sites unless this truly represents your forest site). **Sample trees using a 8-m radius circular plot** ($0.02 \text{ ha} = 201 \text{ m}^2$) and **sample shrubs and saplings using a 1.8-m radius circular plot** ($0.001 \text{ ha} = 10 \text{ m}^2$).

Tree = any woody plant with a single main stem that is $> 4 \text{ m}$ (about 15 ft) tall
Shrub or sapling = 1 or multiple woody stems, but $\leq 4 \text{ m}$ tall. *We will also include sword fern as a shrub for this study.

Measure out and mark your plots (shrub plot can be within the tree plot), identify each species, and count number of individuals of each species (enter on data collection sheet that follows). If you are uncertain of species identification, collect a sample and label as Species 1, 2, etc but **be sure and identify the species before leaving your plot!** You can use the Tree and Shrub ID book to help you identify the species.

Post-Site Calculations:

b. Combine data from all groups for each of the three sites. Sum the number of individuals in each tree & shrub species for the first site (for example, the western redcedar stand). Calculate density (number of individuals in each species per unit area) - use #/ha. Repeat for the other two sites. You'll use these data to calculate species diversity and community similarity. Keep in mind that when you sum tree or shrub data, you're also summing the area sampled. If you sum tree data from 3 groups, for example, the total area sampled is $3 \times 200 \text{ m}^2$ or 600 m^2 ($= 0.06 \text{ ha}$). Therefore you would need to multiply by ($1/0.06 = 16.6$) to calculate a density of trees per hectare. Summing data from 3 shrub groups gives you a sampling size of $3 \times 10 \text{ m}^2$ or 30 m^2 . You need to make sure that both the shrub and tree data are using the same units before you combine them, so be sure and have both your tree and shrub data on a per hectare basis. *Show your calculations.*

*A hectare (ha) is a unit of area that is $10,000 \text{ m}^2$

Calculating Species Diversity and Community Similarity

1. Shannon Diversity Index (H') to Calculate Species Diversity

$$H' = - \sum p_i \ln p_i \quad \text{where } p_i = n_i/N.$$

P_i is the proportion of individuals for species i . It is calculated by dividing the total number of individuals for a species by the total number of individuals in the community.

The units of H' are unimportant; the values of H' are used in a relative fashion, to determine which species assemblages are more or less diverse than others. The higher the H' value, the more diverse.

EXAMPLE:

<u>Community A</u>		
<u>Species</u>	<u>abundance</u>	<u>proportion (p_i)</u>
Douglas-fir	3	$3/4 = 0.75$
Western redcedar	1	$1/4 = 0.25$

for Community A:

$$H' = -[(0.75 \ln 0.75) + (0.25 \ln 0.25)]$$

$$H' = -[0.75(-0.29) + 0.25(-1.39)]$$

$$H' = \mathbf{0.56}$$

<u>Community B</u>		
<u>Species</u>	<u>abundance</u>	<u>proportion (p_i)</u>
Douglas-fir	2	$2/4 = 0.50$
Western redcedar	2	$2/4 = 0.50$

for Community B:

$$H' = -[(0.50 \ln(0.50)) + (0.50 \ln(0.50))]$$

$$H' = -[0.50(-0.69) + 0.50(-0.69)]$$

$$H' = \mathbf{0.69}$$

In this comparison, **Community B is more diverse** (because it's value of H' is higher).

Measures of Evenness

The maximum Shannon-Wiener index for a given number of species can be calculated as:

$$H'_{\max} = \ln(\#\text{Species})$$

The minimum Shannon-Wiener index for a given data set can be calculated as:

$$H'_{\min} = \ln(N-S+1)$$

Where:

S is the number of categories or species

N is the total number of observations.

2. Community Percent Similarity (PS)

Percent similarity is calculated by summing the **lowest** proportion of each species in 2 communities. Communities that are exactly the same will have 100% similarity. Dissimilar communities will have low percent similarity values.

EXAMPLE:

<u>Species</u>	<u>Community A</u>		<u>Community B</u>	
	<u>abundance</u>	<u>proportion</u>	<u>abundance</u>	<u>proportion</u>
Douglas-fir	5	$5/7 = 0.71 = 71\%$	2	$2/5 = 0.40 = 40\%^*$
grand fir	1	$1/7 = 0.14 = 14\%^*$	3	$3/5 = 0.60 = 60\%$
big-leaf maple	1	$1/7 = 0.14 = 14\%$	0	$0/5 = 0 = 0\%^*$

* The lower of the two percentages for each species among the communities.

$$PS = \Sigma [\text{lowest proportion or percentage for the species}]$$

$$PS = 0.40 + 0.14 + 0$$

$$PS = 0.54 = 54\%$$

ASSIGNMENT TO BE HANDED IN:

Write up a technical lab report summarizing the activities, sampling, and results of this exercise. Please write so someone who was not along on the laboratory would understand where you went, what you did, why you were there, and what you learned or found. Your report should be typed, double-spaced, double-sided and 2-3 pages in length. **The report is due at the beginning of your next lab period (August 3).**

Included in your report should be:

Introduction:

Describe the purpose of this lab and the sites we visited (why were we there?)

Site Description:

Describe each site that we visited and sampled. Address the following questions adding additional information as appropriate: Where is the study site? What is the dominant vegetation form? What types of over and understory vegetation did you observe? What are the major topographic characteristics of the sample site?

Methods:

Succinctly state the objectives of the lab. Describe what information you collected and how you collected it. Identify and briefly explain the indices used to compare the two communities. Attach your spreadsheet calculations to the back of the report to show how you calculated the index values for the three stands.

Site Comparisons (Quantitative):

Discuss the results of the site comparisons, using the relative H' and PS values of each site. Include your spreadsheet or show your work on additional sheets added to the end of your report.

Address how your individual group data compared with the data from the entire class. Why might it be different? What are your thoughts on sampling techniques based on this experience?

Conclusion:

How did the diversity and similarity indices help to compare the 3 sites? What different conclusions might you have reached without the quantitative comparisons? Do you think the results would have been different if you only considered tree species diversity, rather than tree and shrub diversity combined?

Qualitative Information

1. Spatial Information

	<u>Western redcedar Site</u>	<u>Hardwood Site</u>	<u>Douglas-fir Site</u>
Slope (%)			
Aspect			
Position (ridge, upper-slope, mid-slope, lower slope, bench, stream bottom)			

2. Community Type

	<u>Western redcedar Site</u>	<u>Hardwood Site</u>	<u>Douglas-fir Site</u>
community type*			
dominant plant species			
moisture classification**			
Known historical events***			

* tundra, grassland, field, meadow, marsh, swamp, bog, deciduous forest, coniferous forest, broad-leaf forest, scrub, shrub, woodland, savanna, desert

**moisture classification: rainy, humid, dry

***any known historical events that have influenced community type (e.g., recent burning, flooding, evidence of previous timber harvest, grazing)

3. Biotic Features

	<u>Western redcedar Site</u>	<u>Hardwood Site</u>	<u>Douglas-fir Site</u>
<u>Overstory</u> Species present in the overstory			
<u>Mid-Canopy</u> Species present in the mid-canopy			
How vigorous are they and what are causes of mortality?			
<u>Understory</u> What type of vegetation dominates (shrubs, grasses, herbs)?			
Are there areas of exposed soil? What are principle causes?			
<u>Wildlife</u> List any signs of wildlife activity in the area.			
What parts of the forest are being used by wildlife?			
<u>Human Influences</u> Are there signs of human activity in the area? What is the evidence?			

Quantitative Information

5. Tree Species > 4 m tall (8-m radius, 200 m² plot)

	<u>Western redcedar Site</u> <u># individuals</u>	<u>Hardwood Site</u> <u># individuals</u>	<u>Douglas-fir Site</u> <u># individuals</u>
<u>Tree Plot</u>			
bigleaf maple			
Douglas-fir			
Pacific yew			
red alder			
western hemlock			
western redcedar			
other species:			
_____.			
_____.			

6. Shrub and Sapling Species ≤ 4 m tall (1.8-m radius plot; 10 m² or 0.001 ha)

<u>Shrub Plot</u>	<u>Western redcedar Site</u> <u># individuals</u>	<u>Hardwood Site</u> <u># individuals</u>	<u>Douglas-fir Site</u> <u># individuals</u>
Douglas-fir sapling			
Bigleaf maple sapling			
Blackberry			
Hazel			
Holly			
Huckleberry - red - evergreen			
Indian plum			
Ocean spray			
Oregon grape			
Salal			
Salmonberry			
Sword fern*			
Thimbleberry			
Other species: _____ _____ _____			

* Even though sword fern isn't a shrub, we will treat it as a shrub for the purposes of this study.

