# Biology 208 Ecology – Vegetation Community Structure – Lab 6 and 7

## Biology 208 Lab 6 – Introduction to Vegetation Sampling in the Field

### Overview

This lab will train you on how to **obtain quantitative data** in the field that can be used to characterize the **vegetation structure** of selected disturbed and undisturbed forest ecosystems. The lab will be coupled with a subsequent data analysis, interpretation and presentation lab.

Ecological studies often require quantitative data for the description and analysis of patterns and processes. Because it is usually not feasible to describe or count every organism in a community, some kind of **sampling** is required. Sampling techniques vary depending on the nature of the organisms being studied and the kinds of questions being asked, but in all cases the goal is to obtain samples that are **free from bias and representative of the system** being studied.

Several things to consider when designing a sampling study are:

- The placement of sample sites;
- The techniques used to sample different types of organisms (e.g. trees vs. herbaceous plants);
- The data that will be collected;
- The kinds of analyses the data will be used for.

## Learning Outcomes

- **Identify common plants of BC**
- **Design study sampling methods to obtain replicated and unbiased quantitative data**
- **Implement a vegetative sampling protocol under field conditions**
- **Accurately record field data and enter this into databases.**

### Timeline

- (30 mins) Travel from CapU

- (5 mins) Sample site orientation at study site 1
- (45 mins) Vegetative sampling at study site 1
- (20 mins) Travel from Study site 1 to study site 2 (TBD)
- (45 mins) Vegetative sampling at study site 2 (TBD)
- (15 mins) Travel to CapU

### Materials

- Clipboards x 7
- Lab handouts
- Data collection sheets
- Long Tape Measures x 7
- DBH tapes / trunk measurement tapes
- Flagging tape
- Ponchos
- Plant ID guides x 7 (max)

## Sample Site Selection

There are two main ways to select sites for sampling, random and non-random (systematic).

In random sampling points are located randomly throughout the entire study area, usually with the use of a random number table. Random means that all points within the study area have the same chance of being selected, and that they are independent – the selection of any sample point is not influenced by the position of other points. Note that this is not the same as haphazard sampling, in which the selection of points is entirely subjective. Data collected by random sampling is ideal for statistical analysis. The disadvantage of random sampling is that it can be complicated and time-consuming to apply in the field.

In non-random sampling the sample points are located at regular intervals, or according to some pre-determined criteria. A regular sampling grid ensures that sample sites are evenly spread throughout the study area, but the points are not independent of one another, and all points within the area do not have the same probability of being sampled, so it is more difficult to apply statistical analysis to data collected this way.

Regular sampling is still useful because it is simple and easy to do in the field. We will use a regular design in this study.

There are also more complicated designs that combine aspects of random and non-random sampling, but we will not be concerned with them for this lab.

## Sampling Methods and Data Types

At each sample site within the study area, we will sample the vegetation within **circular quadrats** (quadrat originally meant a square sampling area, but now it is common to use round quadrats). The size of the quadrats and the kind of data collected depend on the life forms being studied. Standard quadrat sizes are 100 $m^2$ for trees, 10 $m^2$ for shrubs, and 1 $m^2$ for herbs. We will establish circular quadrats for trees. Shrubs will be sampled using a line-intercept method within the quadrats used for trees.

| Life form | Quadrat size | Radius | Quadrat size in hectares (ha) | Multiplier to get plants/ha |
|---|---|---|---|---|
| Trees | 100 $m^2$ | 5.64 m | 0.01 | 100 |
| Shrubs | 10 $m^2$ | 1.78 m | 0.001 | 1000 |
| Herbs | 1 $m^2$ | 0.56 m | 0.0001 | 10000 |

Different life forms sometimes require different sampling methods. For this lab, use the methods described below.

<u>Trees</u>

For the purpose of this lab a tree will be defined as any woody plant with diameter at breast height (DBH) of 10 cm or greater. You will sample trees within a 100 square metre quadrat. All trees within the quadrat should be identified to species and their DBH should be measured. You will be given instructions on how to measure DBH before going into the field.

<u>Saplings</u>

Saplings are young trees with a DBH between 2.5 cm and 10 cm. Saplings should be counted and identified, but we will not measure DBH for saplings.

<u>Shrubs and Ferns</u>

Shrubs and ferns will be sampled using a line-intercept method. Extend a 10 metre measuring tape through your quadrat and record how much of the line is intercepted by each shrub species.  Detailed instructions will be provided before going into the field.

## Instructions

We will use a regular grid sampling design. Follow the directions below to establish your quadrats and line transects.

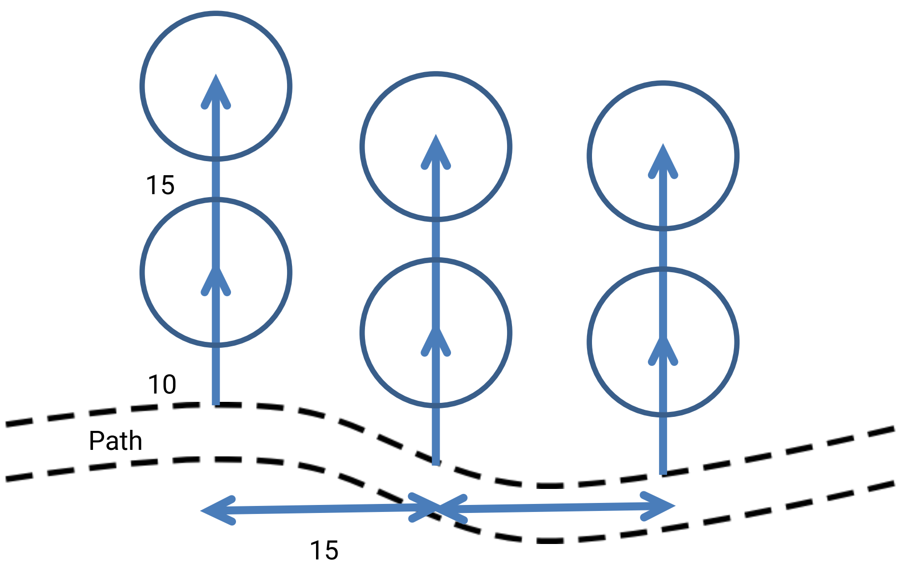
1. Work in groups of 3-4 students.

2. Groups should be spaced at 15 metre intervals along a path.

3. Establish your first quadrat. Measure 10 metres perpendicular to the edge of the path (or as directed). This marks the centre of the quadrat. See Figure 1.

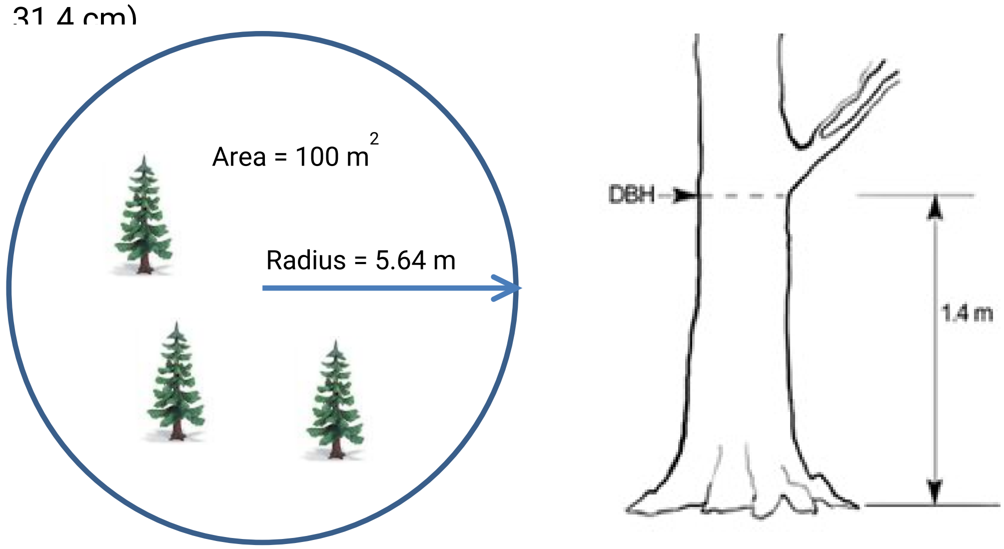
4. Use the marked ropes to establish a 5.64 metre radius from the centre of the quadrat. This defines an area of 100 $m^2$. See Figure 1.

Figure 1. Vegetation Sampling Design (Not to Scale)



5. Identify to species all trees with a diameter at breast height (DBH) of more than 10 cm. Measure the circumference or DBH of all trees within your quadrat. See Figure 2.

Figure 2. Measuring Diameter at Breast Height (DBH
Measure DBH for all trees with DBH > 10 cm (circumference > 31.4 cm)
Count saplings with 2.5 cm < DBH < 10 cm (7.9 cm < circumference < 31.4 cm)




6. Identify and count all tree saplings with DBH between 2.5 and 10 cm. Do not measure their sizes.

7. Sample shrubs and ferns using the line intercept method. Centre a 10 metre tape along the centre line of your quadrat, perpendicular to the edge of the path (along the same line you used to find the centre of the quadrat). Identify all shrubs and ferns to species and record where they intercept the tape. See Figure 3.

Note: the cover of a plant can be defined as its Zone of influence as shown in Figure 4, one technique is to measure across this area along your transect line wherever it falls. Also note that plants may be under other plants; they must both be measured separately.

Figure 3. Line Intercept Method for Shrubs and Ferns
Measure how much of the line is intercepted by each shrub or fern

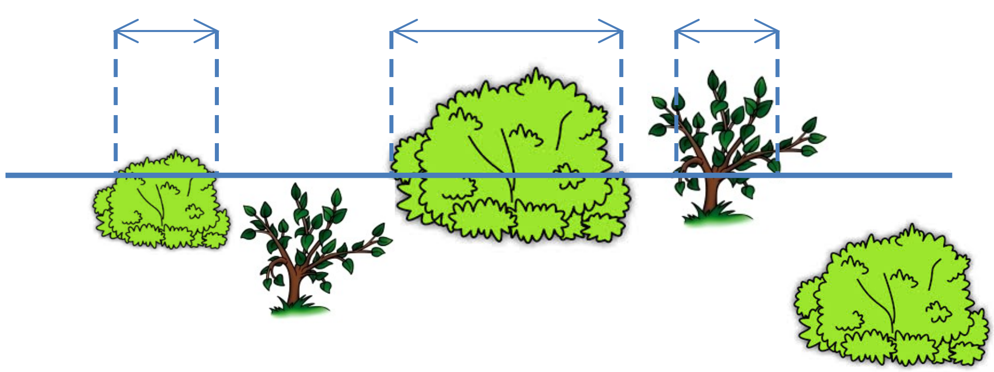
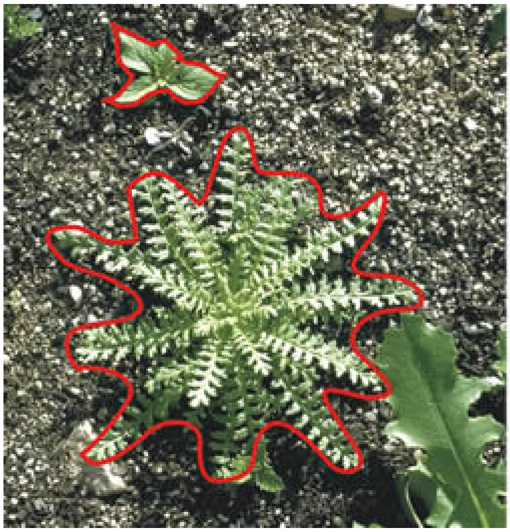


Figure 4. Zone of influence for a shrub



8. Establish your second quadrat. Measure 15 metres from the centre of the first quadrat, along the same line perpendicular to the path edge. This marks the centre of the second quadrat.

9. Repeat steps 4-7 above. Complete three quadrats.

# Biology 208 Lab 7 - Quantitative Analysis of Vegetation Data

You will complete this data analysis lab during the lab session following your field data collection (or at the instructor's direction).

## Overview

The structure of an ecological community is defined by the identity, number, and relative abundance of the species it contains. In this lab you will learn how to use quantitative data to analyse community structure. The quantitative measures used here may then be used to compare different communities, or to guide investigations into the processes that structure communities.

You will be working with the data you collected at the Lower Seymour Conservation Reserve (LSCR) to describe and compare the tree and shrub communities in areas with different levels of disturbance.

## Learning Outcomes

- Calculate species importance using data on species richness, abundance (density/coverage) and frequency (presence/absence in sampling sites)
- Plot rank importance curves to visually analyze vegetation communities
- Calculate Simpson's and Shannon's Diversity Indices to assess community richness and evenness
- Calculate Sorenson's Coefficient to compare community species composition
- Describe patterns in diversity data to characterise vegetation structure
- Compare vegetation structure between communities and explain potential causes of variation

## Exercise 1. Community Structure of Trees

Begin by using the worksheet labelled **trees** for this exercise. **Trees** shows our **raw data** from the field with several additional columns which have been used to calculate: (i) **Diameter at breast height**, (ii) **Basal Area**, and (iii) **Basal Area per Hectare** as follows.

**Diameter at breast height** (DBH) was measured for all trees (> 10 cm DBH). If a DBH tape was not available, circumference was measured and DBH was calculated using DBH = circumference/$\pi$.

**Basal area,** is a measure of the area of ground covered by the base of a tree and can be calculated using DBH. Basal area is usually expressed in square meters per hectare ($m^2$), so DBH measurements were first converted to meters. Basal area was then calculated using the formula: **Basal Area =** $\pi * 0.5 * DBH^2$

**Basal area per hectare** was calculated by multiplying basal area by 10 (because we sampled 0.1 hectare at each quadrat site).

We can use our raw data and our newly calculated basal area per hectare to sum basal area per tree species per quadrat. In addition to basal area, we will also look at the total number of trees for each species per quadrat. Finally, we will consider the number of quadrats in which each species was present within our study area. Recall that we sampled in different study areas (e.g. forest / clearcut) so we'll sum data for these areas separately

This data is summarised in the **Trees Data** worksheet. We'll use this for our exploration of the data. Note that the Basal area per hectare is an average across the quadrats which was calculated using the '**Trees pivot table 1 & 2**' worksheets by your instructor

### Exercise 1.A

Fill in the remaining columns in the worksheet. Do this for all communities.

Use the following formulas:

$$\text{Relative Basal Area} = \frac{\text{Basal Area per Hectare}}{\text{Total Basal Area per Hectare for all Species}}$$

$$\text{Density} = \frac{\text{Number of Individuals}}{\text{Total Area Sampled}}$$

$$\text{Relative Density} = \frac{\text{Density for a Species}}{\text{Total Density for all Species}}$$

$$\text{Frequency} = \frac{\text{Number of Quadrats in Which Species was Recorded}}{\text{Total Number of Quadrats Sampled}}$$

$$\text{Relative Frequency} = \frac{\text{Frequency for a Species}}{\text{Total Frequency for all Species}}$$

$$\text{Importance} = (\text{Relative Basal Area} + \text{Relative Density} + \text{Relative Frequency})$$

$$\text{Relative Importance} = \frac{\text{Importance of a Species}}{\text{Total Importance of all Species}}$$

## Exercise 1.B

Make a bar graph for each community with bars for Relative Basal Area, Relative Density, Relative Frequency, and Relative Importance for each species.

*Question 1: Define basal area, density, frequency, and importance in your own words.*

*Question 2: Compare the different measures of species importance.  Does the same species always rank highest on all measures?  Why or why not?*

*Question 3: Describe any differences among the tree communities that you can infer from this*

*Question 4: Suggest why the tree communities differ and what adaptations abundant community members have.*

## Exercise 2. Species Diversity of Forest Trees

Use the **tree diversity** worksheet for this exercise.

Enter the Importance of Tree species at the communities we sampled into the worksheet.

### Exercise 2.A

Simpson's Diversity Index is a measure of **species richness** and **species evenness**, where the maximum value is set by the total number of species and the value is closer to this maximum when the species have more even abundance. Use the data to calculate Simpson's Diversity Index for the communities. Use the following formulas:

Proportion of species i: $p_i$ = Relative importance of species i

Simpson's Diversity: $$D = \frac{1}{\Sigma(p_i^2)}$$

*Question 5: Compare the communities in terms of species richness and diversity. Which community is most diverse? What does Simpson's Diversity Index tell you about the structures of the tree communities?*

*Question 6: Calculate Simpsons Diversity for a community that has five species, all of which are equally important. How do the communities you sampled differ from this hypothetical community?*

## Exercise 3. Rank Importance of Forest Trees

Enter the relative importance ($p_i$) values for the trees at both site in to the table in the **Rank importance** worksheet. Now sort the values so the most important species is ranked first (make sure to sort both species and importance data together), the next most important species is ranked second, and so on. In the table, fill in the rank importance column for the trees in the communities sampled.

Make a scatter plot with rank-importance curves for both communities on the same graph. Typically this is a plot of relative importance (y axis) against rank (x axis). You can also plot relative importance against tree species to compare the communities.

*Question 7: How and why do the slopes of the rank-importance curves vary with species evenness? Compare these results with the values for Simpson's Diversity. Do they give you the same information about community structure?*

(Note: it may be easier to visualize the slopes if the y-axis is changed to a log scale).

## Exercise 4. Community Structure of Forest Shrubs

Use the **shrubs data** worksheet for this exercise. You may view the original shrub data in the **shrubs** worksheet.

This exercise will show you that similar analyses can be performed using data that were collected using different methods. Shrubs were sampled using a **line-intercept method** (transects). The average total distance intercepted by each shrub species (average across transects) and the number of transects in which it was found have been entered into the worksheet.

### Exercise 4.A

*Fill in the remaining columns in the* ***Shrubs data*** *worksheet. Do this for all communities.*

Use the following formulas:

$$\text{Percent Cover} = \frac{\text{Total Length Covered}}{\text{Total Length Sampled}}$$

$$\text{Relative Percent Cover} = \frac{\text{Percent Cover for a Species}}{\text{Total Percent Cover for all Species}}$$

Frequency = <u>Number of Lines in Which Species Recorded</u>

Total Number of Lines Sampled

Relative Frequency = Frequency for a Species / Total Frequency for all Species

Importance = Relative Percent Cover + Relative Frequency

Relative Importance = Importance of a Species / Total Importance of all Species

Exercise 4.B

*Make a bar graph for each community with bars for Relative Percent Cover, Relative Frequency, and Importance for each species.*

*Question 8: Define percent cover in your own words. How is percent cover similar to the measure of basal area that was used for trees?*

*Question 9: Describe any differences between the shrub communities.*

*Question 10: Suggest why the shrub communities differ and what adaptations abundant community members have.*

## Exercise 5. Species Diversity Indexes for Forest Shrubs

Use the **shrubs diversity** worksheet for this exercise. You will calculate two different diversity Indices and compare them.

*Enter the importance of shrub species at the communities sampled into the worksheet.*

### Exercise 5.A

*Use the data to calculate both **Simpson's Diversity Index** and **Shannon's diversity index** for both communities. Use the following formulas:*

Simpson's Diversity: $D = \frac{1}{\Sigma(P_i^2)}$

Shannon's Diversity Index: $H = \Sigma(P_i \ln P_i)$

Relative importance of species = $P_i$
*ln* = Natural log
Σ = sum for all species

In the Simpson index, p is the proportion (n/N) of individuals of one particular species found (n) divided by the total number of individuals found (N), Σ is the sum of the calculations, and s is the number of species.

In the Shannon index, p is the proportion (n/N) of individuals of one particular species found (n) divided by the total number of individuals found (N), *ln* is the natural log, Σ is the sum of the calculations, and s is the number of species.

*Question 11: The Simpson index is a dominance index because it gives more weight to common or dominant species. In this case, a few rare species with only a few representatives will not affect the diversity. Can you point out any problems in these assumptions?*

*Question 12: The Shannon index is an information statistic index, which means it assumes all species are represented in a sample and that they are randomly sampled. Can you point out any problems in these assumptions?*

*Question 13: Compare the communities in terms of species richness and both Simpson's and Shannon's diversity. Which community is most diverse? What do the Diversity Indices tell you about the structures of the shrub communities?*

## Exercise 6. Comparing species diversity between communities

Comparison of community species informs us of whether we are comparing similar or distinct communities. High dissimilarity indicates that they support different species.

Sorenson's Coefficient (CC) is a simple comparison metric for communities calculated as follows:

$$CC = 2C / S1 + S2$$

C = the number of species two communities have in common

S1 = Total number of species in community 1

S2 = Total number of species in community 2

Logically a value of *CC* = 1, indicates complete overlap of species; a value of *CC* = 0, indicates no overlap of species.

### Exercise 6A

*Calculate Sorenson's Coefficient (CC) for the* communities you sampled.

*Question 14: What does your value for Sorenson's Coefficient (CC) indicate about the communities you sampled and why might they show this similarity?*