A community consists of all of the species living and interacting within a particular location at a particular time. It includes species that interact with each other both directly and indirectly. Numerous parameters affect what species are present and in what abundance. One way to look at communities is to examine guilds of species, where a guild includes those species of a similar life form or a similar way of making a living, for example all the tree species in a forest community. One issue is whether all the species contribute equally to numbers or biomass of a given guild. At one extreme are mono-specific forests and the other highly diverse forests. Most communities of plants and animals are in between these two extremes, but generally thought to have few common species and many rare species (Fisher et al. 1943).

Simple generalizations can rarely explain why certain species commonly occur together in communities or why some communities are more dominated by single species than others. The distributions of most populations in communities are probably affected to some extent by abiotic gradients, interactions with other species, and chance events. The first step in this kind of community study is to determine the number of individuals of each species per unit area. So, we will start by estimating density.

Mean density is a measure of the number of individuals of a species per unit area. Species with higher densities have larger population sizes in a given area and usually control more resources than those with lower densities. In a previous lab we used small quadrats of fixed sizes for estimating density of herbs. Herbs occur at a small spatial scale. Quadrat counts are not a practical solution for organisms that occur over larger spatial scales. In this lab, we will learn how to use the distance from random points to individuals to estimate this important population parameter.

We will also estimate relative abundance and biomass of constituent species.

Relative density measures the importance of an individual species within a community in terms of relative numbers of individuals. Relative density is an important parameter in the dynamics of species interactions. Communities differ in the extent to which individual species dominate numerically, making it an interesting parameter for comparing communities to one another.

Relative dominance measures the importance of an individual species within a community in terms of biomass. Dominant species exert a powerful control over the occurrence and distribution of other species. Communities differ in the extent to which individual species dominate the biomass, making it an interesting parameter for comparing communities to one another. Biomass for trees is estimated by “basal area,” which is estimated from measurements of the diameter of a tree at breast height (dbh). Diameter is twice the radius, 2r. Circumference
is $2\pi r$, and basal area is estimated as $\pi r^2$. Tree ecologists often use a special meter tape which converts the girth or circumference of a tree to its diameter directly.

**Species diversity** is a characteristic unique to the community level of biological organization, and is an expression of community structure. Species diversity is the number of different species in a particular area (**richness**), weighted by some measure of abundance such as number of individuals or biomass. The relative abundance with which each species is represented in an area is called **species evenness**.

**Study site**

Our purpose is to examine the pattern of tree density, dominance, and diversity of the plant community in the simulated tropical hardwood hammock forest of the Taylor Alexander Microbiome. This forest was initiated by planting some native trees typical of this habitat type in the 1970’s; it has been perpetuated largely by natural recruitment and growth, although exotic invasives are periodically removed. In this lab we will learn a field sampling technique commonly utilized for measuring community parameters in a forest setting.

**Materials and Methods**

There are a number of vegetation sampling techniques for describing the structure of terrestrial plant communities and the densities of constituent species as well as the pattern of the relative importance of the constituent species. Plotless methods are useful for plants or sessile animals and have the advantage of not having to demarcate sampling areas of certain size and shape. The most widely used of these are the point-centered quarter or **point-quarter technique** (Cottam et al. 1953).

In the **Point-Quarter Technique**, a series of random points are first located within the stand to be sampled. In most cases, it is satisfactory to pick random points along a series of line transects passing through the stand. The students in class will be divided into five groups. The whole class will lay down one 25 m transect and choose five random points along this transect. Each group will be equipped with a compass, one 25 m tape, several flagged stakes, and a shorter measuring tape, and will work at one of the five random points.

The area around each point should be divided into four quadrants, using the point as the center of each quadrant (i.e. upper right, lower right, lower left, upper left). Quadrants may be formed by the transect line and a second line perpendicular to the transect at the sampling point. Point-quarter sampling procedure is shown diagrammatically in Figure 1. Once quadrants are delineated, locate the closest large tree ($\geq 2$ cm in diameter at 1.5 m above the ground; this is the standard height for recording diameter at breast height, “dbh”) in each quadrant. Record the point-to-plant distance (m) of the tree, the circumference (cm) or the diameter (cm), and the species (use Data sheet 1). Diameter can be directly obtained in the field by use of a “dbh tape,” a tape measure that automatically converts the distance around the tree to diameter. The TA will help you identify the tree species and ensure that all teams are doing so consistently. Point-to-plant distances should be measured to the center of the crown or to the center of the rooted base rather than to the edge of the crown. For each point there should be data for four trees, one in each quadrant.
Data and calculations

Back in the lab, each team will enter the data for the trees at their sample point on a class data sheet in an excel file and we will determine the following for the composite data from all teams. We may make copies of the data file to divide the work of doing these calculations and of making the figures among the teams and then pool all the work together so that everyone can have access to all the results to answer the study questions.

1) Absolute density of species $x$

For each species, compile all the point-to-plant distances, convert the distances from cm to m and square them. Then find the mean of these squared distances for that species, $(\text{mean } d^2)_x$. Then,

\[\text{Density of species } x = \frac{1}{(\text{mean } d^2)_x}\text{ individuals per square meter}\]

OR

\[\text{Density of species } x = \frac{\# \text{ of individuals of species } x}{\text{sum of distance squared of species } x (m^2)}\]

2) Relative density for species $x$

\[\text{relative density of species } x = \frac{\# \text{ of individuals of species } x}{\text{total } \# \text{ individuals of all species}} \times 100\]

3) Relative dominance for species $x$

\[\text{relative dominance of species } = \frac{\text{total basal area of species } x}{\text{total basal area of all species}} \times 100\]
4) Species diversity (Shannon diversity index, $H'$):

$$H' = - \sum p_i \ln p_i$$

$$p_i = \frac{\text{# of individuals of species } x}{\text{total # of individuals of all species}}$$

Study questions

1. Make a graph with species listed on the $x$ axis and absolute density on the $y$ axis. List the species in order from highest density to lowest density. How many high density species are there and how many low density species are there?

2. Make two more similar graphs; one with species listed on the $x$ axis and relative density on the $y$ axis, and the other one with species listed on the $x$ axis and relative dominance on the $y$ axis. How many species do you need to include to get to 50% of the total number of individuals in the community? How many species do you need to include to get to 50% of the biomass of the community?

3. Make another graph with species listed on the $x$ axis and $p_i$ on the $y$ axis. List the species in order from highest $p_i$ to lowest $p_i$. How different is your observed community from one in which all species would have the same $p_i$. What would the value of $H'$ be if you had observed a community with the same number of species as the one we did observe, but with equal proportions of all species?

4. What species had the highest relative density and the highest relative dominance? What biological characteristics might be making this/these species to be more dense and/or more dominant?

References


**Data Sheet 1.** Tabulation of raw data from point-quarter plant sampling

Date: ______________________________________________________

Team members: _______________________________________________

<table>
<thead>
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<th>Point number</th>
<th>Quadrant number</th>
<th>Species</th>
<th>Diameter (cm)</th>
<th>Point-to-plant distance</th>
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