Lab 2: Field sampling

I. Introduction to ecological systems

Ecologists frequently refer to their subject of study as a *system* that they investigate (O'Neill 2001). A group of potentially interbreeding individuals of the same organism (a population) is a system; an assemblage of different species in a given area (a community) is a system; and a large area of land containing many populations of organisms arranged in different local communities over areas with unique abiotic environments is also a system (an ecosystem). All ecological systems share two important traits, **structure** and **function**. The structure of a system is defined by its measurable traits at a single point in time and can include living (biotic) and non-living (abiotic) components (e.g. plant height, soil depth, water temperature). The functions of an ecological system involve the various processes that occur as the component parts exchange energy through time (e.g. oxygen consumption, biomass production, decomposition).

A good example changes in ecosystem structure and function can be seen in a pine rockland plant community following a fire (Figure 1). Structural features such as vegetation height, the number of species and their relative abundances, and the soil chemical properties (e.g., nutrient content and pH) can be measured over time to gain insight into how fire affects the structural aspects of the system. Functional aspects of the system, such as plant productivity and leaf litter decomposition rates could also be measured over time to determine how fire affects the functioning of the system.

For example, studies have shown that following a fire initial plant biomass will be low, then rise slowly for next three years and rise quickly through years four and five, after which it will remain stable for as many as fifteen years. The number of species in the community will be low for two years following a fire but will rise precipitously to its highest point after four years and subsequently, species number in the pine rockland will decline to a few species that remain present until the next fire (Figure 2). Soil nutrient content and pH are also changing over time, as are the productivity levels and rates of decomposition.

![Figure 1: Pine rockland community in the Florida](image1)

![Figure 2: Plant biomass and species richness in a pine rockland following fire (example data from A. Edwards)](image2)
II. Organizing an ecological study

Any ecological study that is to be conducted must first take into account the following:

- The main aim of the study
- The main question/s being asked
- The main hypotheses to be tested

In order to test a hypothesis, you must design appropriate experiments and sampling methods. Making inferences (i.e., deciding whether or not to reject a hypothesis) requires experiments designed with statistical tests in mind. Keep in mind that there are many different experimental and sampling designs, and your selection of the appropriate design depends on the objective(s) of the experiment.

Once the experimental design has been determined, then the practical aspects of the study can be conducted. The first part of this involves the collection of appropriate data. For this you must first determine what data is to be collected and then determine the sampling techniques that will be used to collect the data.

III. Types of data

To gain information about any system, an ecologist can collect two basic types of data: Physico-chemical data and biological data.

**Physico-chemical data** include information about the physical and chemical characteristics of the system. The type of information collected depends largely on the system being studied and the aim of the study. As such this may involve the collection of information such as water depth, soil depth, water flow rate, temperature, pH, conductivity, salinity, dissolved oxygen content, wind speed, light intensity and cloud cover to name a few.

**Biological data** include information specific to the biota within the system. Again, the type of information collected depends largely on the organism/s being studied and the aim of the study. Some examples of biological data include:

- (for plants): Species diversity, plant height, number of leaves, internode length, root biomass, shoot biomass, root:shoot ratio, number of fruits and/or seeds produced and primary productivity rates
- (for animals): Species diversity, weight, length and/or height of the animal, number of offspring produced and average life span.

Keep in mind that some types of biological information can be estimated in a variety of ways and the techniques used to collect these data depend on the specific requirements of the study as well as the resources available to the researcher. Two types of biological information that you will be collecting within each system you study will include:

(i) Relative abundance of species
(ii) Biomass measurements.
**Relative abundance of species**

**Braun-Blanquet method:** Relative species abundance is often determined using the Braun-Blanquet method. This method involves delineating a specific area (the plot or quadrat), identifying all species in that area, and then assigning a code to each species based on its contribution to the total area. An example of Braun-Blanquet codes is:

- 0: species not present
- 1: species <5% of total
- 2: species 5-10% of total
- 3: species 10-25% of total
- 4: species 25-50% of total
- 5: species 50-90% of total
- 6: species >90% of total

![Study plot](image)

In the example above, species A could be estimated to have a percentage coverage of 25 – 50%, and as such would be assigned the code 4, while species B could be estimated at 5 – 10% coverage and assigned the code 2. Clearly, these are subjective classifications, so it is important that the same observer make code classifications whenever possible.

**Count method:** Another method for estimating relative species abundance within in a community is to identify a specific area and then count the total number of individuals of each species within that area. While this method is more accurate and objective than the Braun-Blanquet method, it is also much more time consuming.

The researcher has to decide how accurate a measure is required for the specific study being done. If a rough estimate is adequate, then the Braun-Blanquet method would suffice. However, more accurate measurements may be required for detailed quantitative analysis and in such a case, counts of the species present would be necessary.

**Biomass**

Plant species biomass may be measured destructively (e.g. with harvest methods) or non-destructively. **Destructive** techniques for measuring plant biomass involve establishing a plot, clipping all aboveground vegetation within the plot, sorting this vegetation by species, drying it, and, finally, weighing it. There are many ecological situations where it is against the best interest of either your ecosystem or your study to destructively sample plants. In these cases, you must think of ways to estimate plant biomass without actually harvesting your plants. In such cases **Non-destructive** sampling methods are used. These methods vary widely, but all involve measures of biomass which do not require the killing of the organism being studied. Non-destructive methods generally may determine the amount of growth of individual organisms over time or at one point in time. For example, a researcher may measure the length of plant stems or count the number of leaves or stems on the same plant over a specific period of time to calculate the growth rate or rate of biomass accumulation.
IV. Field sampling techniques

Ecologists are often interested in being able to understand the structure and function of the systems that they study. It is usually not feasible to collect information from the entire system and so samples from the system are collected, analyzed and used to estimate what would be seen in the entire system.

For example, if an ecologist was interested in determining the average height of pine trees within the Everglades National Park, it would not be feasible to go out into the park and measure the height of each pine tree. However, it is possible to select five sites within the park and at each site measure the heights of 100 trees. The measurements collected would be considered samples and would be used to estimate the average height of plants throughout the entire system.

In this lab you will learn and employ field sampling techniques that are widely used in ecology. Not surprisingly, there can be large differences in the methods used to sample plants and animals or even different communities of plants or animals. However, there are several techniques that can be used in a wide variety of situations and so it is important to keep in mind that you must pick the best sampling technique for a given ecological system, and that not every method will work in every situation.

The following is a review of the basic sampling techniques that you will employ in this course. The main techniques that will be described include (i) the Quadrat sampling method, (ii) the Point to plant method, (iii) the Transect method and (iv) Capture methods.

**Quadrat sampling method**

Quadrat sampling is a method used to intensively sample a subset of a system, so as to obtain a representative sample. The technique involves randomly selecting square areas (quadrats) of a specific size within a study site and collecting data of interest within these quadrats. For example, you might randomly place ten 1m² quadrats within a grassland area and collect biological and physical data from within the quadrats. These data would then be used as estimates of the larger grassland area.

Multiple quadrats which act as replicates are placed in a random way, to ensure that the data represent an unbiased picture of the system. When true randomness cannot be obtained, haphazardly selecting plot locations is often used. Determining where to place a sample of plots is critical to a good study, and there are a variety of techniques available. Some of these include “over the shoulder tosses,” randomly generated positions, and stratified samples.

Quadrat sampling is commonly used to sample communities of plant species in marine and aquatic ecosystems, wetlands, grasslands, and forests (for understory vegetation), as well as to sample sessile invertebrate communities in marine ecosystems. This technique is not appropriate for large trees or mobile animals.
**Point-quarter sampling**

Point-quarter sampling is more complex than quadrat sampling but expands on the same concept in an attempt to reduce the amount of intensive labor involved in quadrat sampling. Rather than quantify the exact make-up of a specific plot, point-quarter sampling involves generating a random number of points in an area and then for each point, the nearest plant species in each of the four quadrants surrounding the point is noted. The distance from each random point to the nearest plant can also be measured and used as an indicator of the dispersion of the species. Replicate samples (points) are also necessary for the point-quarter sampling method.

This technique is most appropriate for sampling in forests with large trees, where the quadrat technique would not be adequate.

**Transect sampling**

Transect sampling is one of the most widespread ecological techniques for sampling both plants and animals. To implement this technique, the investigator establishes a line (i.e. the transect line) between two points. There are several ways to conduct a transect sample. All individuals on the transect line may be counted and their position along the transect recorded, or, all individuals may be counted within a given distance of the transect line and their distances along and to the side of the line recorded. It is also common to place quadrats at specific distances along the transect and collect data within each quadrat. As with plot and point-quarter samples, it is usually important to have replicate transects within the same area.

The line transect technique is used primarily to collect data along a gradient of some sort. For example, a line transect may be placed running from the shore of a lake, extending out into the lake to see changes with distance from the shore. Similarly, a line transect may be placed to run across multiple habitats (e.g. from a freshwater marsh to a mangrove swamp to a seagrass bed) to examine changes throughout multiple systems.

**Capture techniques**

Capture techniques are useful for many species of mobile animals that are elusive or live in an environment that is hard to access (e.g. many marine environments). Capture techniques may include nets, traps, snares, or settlement substrates. When using capture techniques, it is very important to have clearly defined hypotheses that you are testing since many capture techniques have serious biases (e.g. they capture different species at different efficiencies).
V. Accuracy and Precision of data collection

When collecting data for any ecological study, it is important to consider both the **precision** and **accuracy** of the data being collected. Precision refers to the degree of repeatability of a single measurement. Imprecise measurements are made, for example, when someone does not consistently read a ruler correctly. Accuracy refers to the degree to which single measurements reflect the true value of the object being measured. Figure 3 provides examples of precision and accuracy and depicts the relationship between them. The best investigative methods are both precise and accurate.

Figure 3: Examples of accuracy and precision

VI. Objectives

In this lab, we will use two field sampling methods to measure the composition, distribution and abundance of plant species in a small area within the FIU preserve. The objectives are:

1) To compare and contrast two field sampling methods
2) To compare two methods of determining relative species abundance within a given area

VII. Instructions

Before you leave the lab to go to your field site for today’s exercise, be sure to do the following.

1. Generate several hypotheses as a class that you can test with today’s exercise **(Hint: the objectives, above, may help with this)**.
2. Discuss how to keep track of the data that you record at your field site and set up data sheets.
3. Gather all the equipment that you will need for the lab exercise(s).
We will be going to the FIU preserve on campus and conducting two types of sampling: Quadrat and Transect sampling. We will then use two techniques to estimate relative species abundance: Counting and the Braun Blanquet method.

1) Organize yourselves into groups of 4 to 5 people
2) Collect the equipment needed for the exercises:
   1) 1m² quadrat, 1 ¼ m² quadrat, 1 meter ruler, 1 tape measure, 1 compass, Tape, 1 random numbers table, Braun Blanquet table (you will have to design your own table), Note book to record data, Pen or pencil to write information.
3) Trek over to the FIU preserve
4) We will perform two tasks:
   a) Quadrat sampling:
      • One person in the group must stand at a random spot in the area outside of the preserve and toss the ¼ m² quadrat onto the grassy area.
      • Look within the quadrat and record the following information:
        • Species present
        • % cover of each species (using Braun Blanquet technique)
        • Number of individuals of each species present (using the Count technique)
      • Repeat this process of tossing the quadrat and recording data 3 times.
   b) Transect sampling:
      • Secure the tape measure to a tree at a starting point along the edge of the forest (your TA will show you where this should be done) and then extend the tape in a straight line parallel to the forest edge for 30m.
      • Starting at the “0m” mark place a 1m² quadrat on the RIGHT side of the transect line so that one side of the quadrat is in line with the “0m” mark
      • Look within the quadrat and record the following information:
        • Species present
        • % cover of each species (using Braun Blanquet technique)
        • Number of individuals of each species present (using the Count technique)
      • Move along the LEFT side of the transect line until you reach the “5m” mark. (This will prevent you from trampling on areas that will be sampled)
      • At this point place a quadrat on the RIGHT side of the line so that one side of the quadrat is in line with the “5m” mark and record the same data as before.
      • Repeat this process at 5m intervals until you reach the end of the transect.
5) Return to the lab classroom and organize your data within your group and with the lab as a whole.
Literature Cited


Further Reading

