Unit 3

Biotic Sampling Methods

Introduction: Ecological Measurements

A number of basic measurements are used in describing populations and communities. Among these are density, frequency, coverage, and biomass. From them other important ecological measures are determined, such as population distribution, species diversity, and productivity. The most critical ecological measurements are introduced below, and methods for obtaining them will be discussed throughout Unit 3.

Ecologists call the total count of all individuals in a population or other group of interest a **census.** It is seldom possible to count every individual in a population or other large group, however; but a relatively small part (a sample) of the whole can be studied. Then inferences may be made from this sample about the entire population or community (see Section 1A.1). If a sampling method tends to underestimate or overestimate a characteristic of a population or community, it is **biased.** Bias inherent in biotic sampling will be discussed in the appropriate sections of Unit 3.

All measurements are to be in metric units; any English measurements encountered should be converted to metric equivalents (see Appendix B).

1. Density

In ecological population studies, numbers of individuals are basic information. **Abundance** (N) is the number of individuals in a given area, and **density** (D) is that number expressed per unit area or unit volume. For example, a species may have an abundance of 100 individuals in a particular area. If the total area is 2.5 hectares (ha), then the density of this species would be 40 per hectare (40/ha).

While density (often called **absolute density**) is the number of organisms per unit area or unit volume, much of the area may be habitat unsuitable for that species. Therefore, it may be more meaningful to speak of the number per unit of habitable area. Thus, in the above example of 100 individuals in 2.5 ha, if only half the area provides suitable habitat for the species in question, then the species would have an **ecological density** of 80/ha. (Appendix B.2 gives various units of area and their equivalents).

A problem sometimes encountered in plant sampling is the determination of individuals. Counting trees and many herbaceous plants poses little trouble, but when plants are growing in clumps or are reproducing vegetatively from underground rhizomes, the common concept of the individual falters. Then you must count individual shoots or stems; or, if the plants are growing in distinct clumps, count the whole clump and treat it as an individual. The counting of clumps is recommended when measuring aerial coverage or basal coverage for this type of vegetation. In these situations, coverage or biomass has more ecological significance than does density.

In many kinds of faunal sampling, accurate, absolute density determinations often are difficult or impossible to obtain. However, if a standardized sampling procedure is used, then at least an **index of density** (ID) may be calculated and used for comparative purposes. Such an index might be the number of individuals per unit of habitat or the number per unit effort of sampling, rather than the number per unit area. Sometimes this is called **population intensity.** For example, the number per unit of habitat might be the number of beetles per leaf or the number of parasites per host organism. Density expressed per unit of sampling effort might be the number of fish caught per hour, the number of birds seen per kilometer of walking, or the number of mice caught per trap per night.

In comparative studies, one generally wants to know the number of individuals relative to other populations or relative to the same population at other times. As will be seen in Section 5A, **relative species density** (*RD*) is important in community studies. Relative species density is the total number of individuals of a species expressed as a proportion (or percentage) of the total number of individuals of all species. If, for example, there are 50 trees in a given area and 30 of them are sugar maple, then the relative species density of sugar maple is 30/50 = 0.60, or 60%.

Relative population density is the number of individuals of a given species from one location or time expressed as a proportion of the total number of individuals of that species for all locations or times sampled. For example, if one caught 10 locusts with 100 sweeps of a collecting net in July of one year and 70 locusts in the same location and with the identical sweeping effort in September, the relative density for July would be 10/80, or 0.125, and for September it would be 70/80, or 0.875.

2. Frequency

Frequency (f) is the number of times a given event occurs. Thus an ecologist might speak of the frequency of measuring water temperature, or the frequency with which an animal feeds. In many studies, the term frequency indicates the number of samples in which a species occurs. This is expressed as the proportion of the total number of samples taken that contains the species in question. Thus, if a species were found in 7 out of 10 samples taken, it would have a frequency of 7/10, or 0.7. This is the same as saying that the probability of finding that species in a sample is 0.7. Since frequency is sensitive to distribution patterns of individuals, it is also useful in describing and testing such patterns (see Section 4C). The **relative frequency** (*Rf*) of a species is the frequency of that species divided by the sum of the frequencies of all species in the community.

3. Biomass

Biomass (B) is the weight of the individuals of a population or group of populations and often is expressed per unit area or volume. For example, we might speak of kilograms of a species per hectare of forest, or of milligrams of a species per liter of pond water. Biomass is useful in visualizing the trophic structure of a community. In terrestrial communities, for instance, species having large biomass often strongly influence the flow of energy and materials through their trophic levels. Where there are large differences in the sizes of species, biomass data often are more useful than density measurements and some ecologists prefer the use of energy over biomass. Special considerations required in the estimation of biomass are discussed in Section 6A.

4. Coverage

Coverage (C) is the proportion of the ground occupied by a perpendicular projection to the ground from the outline of the aerial parts of the members of a plant species. (This can be visualized as expressing the proportion of ground covered by the species as the habitat is viewed from above.) As will be seen, coverage is calculated as the area covered by the species divided by the total habitat area; for example, a species' coverage might be 180 m^2/ha.

In measuring **foliage cover,** the diameter of the crown of foliage is taken at its densest portion, and the coverage area is determined by assuming a circular outline. **Basal coverage** is generally used in a field or prairie situation and consists of measuring the circumference or the diameter of a clump of grass 2 cm to 3 cm above the ground and calculating the circular area for the foliage. **Basal areas** of trees are determined from trunk circumferences measured 1.5 m ("breast height") above the ground. A direct measurement of foliage coverage is difficult in trees, but the basal area generally is proportional to coverage and hence a useful index of the latter. The **relative coverage** (*RC*) of a species is the proportion of its coverage compared to that of all species in the community combined. Table 3.1 can be used to convert diameters and circumferences to circular coverage areas.

The degree of cover is sometimes considered as a measure of **dominance** in a community. However, dominance may include additional factors, so the term coverage is preferred.