Learning Objectives:

1. Describe the three types of species distributions and infer the abiotic and biotic interactions that may influence why species exhibit each distribution type
2. Calculate the spatial distribution of southern live oaks *(Quercus virginiana)* using two different field-sampling technique and matching statistical analyses.
3. Compare the field-sampling and analysis techniques to using advanced spatial analysis tools like ArcMap
4. Determine how spatial scale influences dispersion patterns when using field-sampling techniques and spatial analysis tools.

Background:

To date, we have examined population structure and how it changes over time. However, we have yet to examine how populations are distributed spatially, or their **dispersion**. Examining the spatial arrangement of individuals in a population provides another layer of information on how the population is structured, but it can also allude to what abiotic and biotic factors might be influencing the population. For example, we will see that the spacing of individuals within a population can be used to infer whether **abiotic** factors (i.e., non-biological, environmental) or **biotic** interactions between individuals of the same species (e.g., competition, behavior, etc.) might be controlling population density in a given area. For the purpose of this lab, we will focus on the spatial dispersion of a common tree species here in Florida, the southern live oak (*Quercus virginiana*), in USF's GeoPark. Southern live oaks grow quickly and average around 50 feet in height. They are found in almost every habitat type in Florida from sandhills to wetland hammocks. They are typically the dominant species in a community and reproduce annually in large quantities in the spring.

Three idealized patterns of dispersion are used to describe the arrangement of individuals within a population per area – **random**, **uniform**, or **clumped** (Fig. 1). All three patterns can apply to any type of organism, and there is a large variety of potential explanations that can create these patterns. Note that dispersion patterns may change over time and by size of the study area (see below).

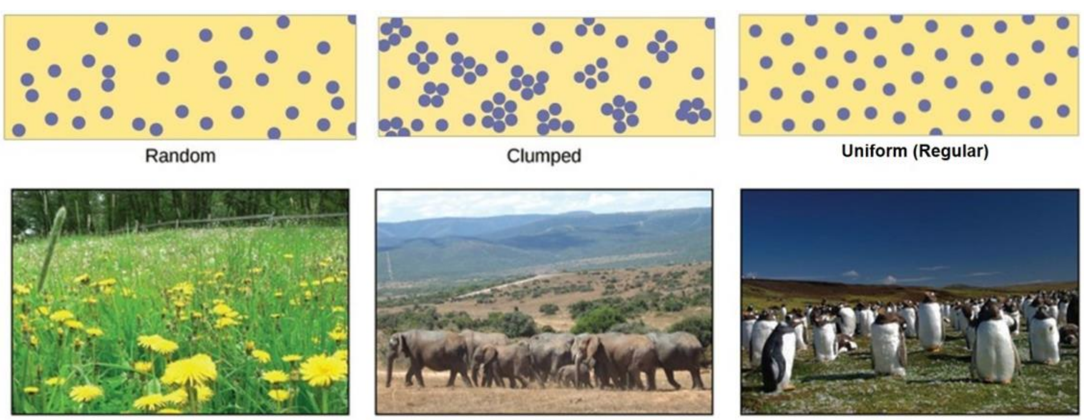

Figure 1. Three main types of spatial dispersion patterns

The Importance of Spatial Scale

Dispersion patterns of individuals within a population can be assessed at different spatial scales. **Spatial scale** is the size of the area over which observations occur and varies depending upon the question of the researcher. For example, the appropriate spatial scale to assess the density of the endangered Florida Panther will be much larger than the area needed to estimate the density of Florida's endangered beach mouse!

Although the appropriate spatial scale is more obvious in the example above, it often becomes much more complicated in more realistic scenarios. For instance, one may find that the distribution of organisms is clumped at a local level, but that those same individuals are regularly dispersed at a larger spatial scale. So, which dispersion pattern is the "correct" one for the population? Ultimately, the answer to this question goes back to what question be asked. If we were examining how individual organisms interact with one another, we might favor the local scale. However, if the question involved how regional climate altered the dispersion of individuals, perhaps the larger spatial scale would be more appropriate.

Thought Questions

1. How do you think the life history of southern live oaks may influence its spatial distribution?
2. What about the surrounding abiotic, biotic, or anthropogenic factors in the USF Geopark?
3. Predict which spatial distribution pattern the southern live oaks will exhibit: random, clumped, or uniform?

Data Collection Instructions

Obtain the following materials from your TA:

1. Transect tape (1)
2. Diameter tape (1)
3. $1m^2$ Quadrat (1)
4. Survey flags (20)
5. Clipboard (1)

I. Plot-Based Field Technique – Density

Plot- or **quadrat- based sampling techniques** involve the establishment of a grid within the area to be surveyed. The scale (e.g., size) of the grid and each individual cell is determined by the researcher and may vary by organism and study site. Follow the steps below to complete and sample your grid:

1. Your group will be assigned to one of four 25x25m plots that comprise one quadrant of a larger 50x50m area. Your individual plot will be subdivided into a 5x5m sampling grid. To do this, use a transect tape to measure out 25 m on each side of your grid and then mark each 5m with a survey flag until the every 5m has flag on the <u>OUTSIDE</u> of your grid only.
2. Next, within your 25x25 m grid, record the number of southern oak trees within each $1m^2$ cell. Use your 1x1 m quadrat to help determine the location of each tree by flipping it along the edge of your quadrat closest to a tree.
3. As you count each tree, measure its diameter at breast height (DBH). DBH is conventionally measured at 4.5 ft (or 1.4 m) above the ground (see figure below). Find where 1.4m is on you, and then use that as your point of reference for all measurements. We will use this measure as an estimate of tree "age" since size and age are positively correlated with one another.
4. A diameter tape has an inch scale and a diameter scale printed on each side of the tape. The diameter scale side is determined by the formula, circumference divided by π (or 3.1416). Wrap the tape around a tree's trunk at 1.4 m high and read the diameter side of the tape for the tree diameter determination. You don't have to convert the circumference!

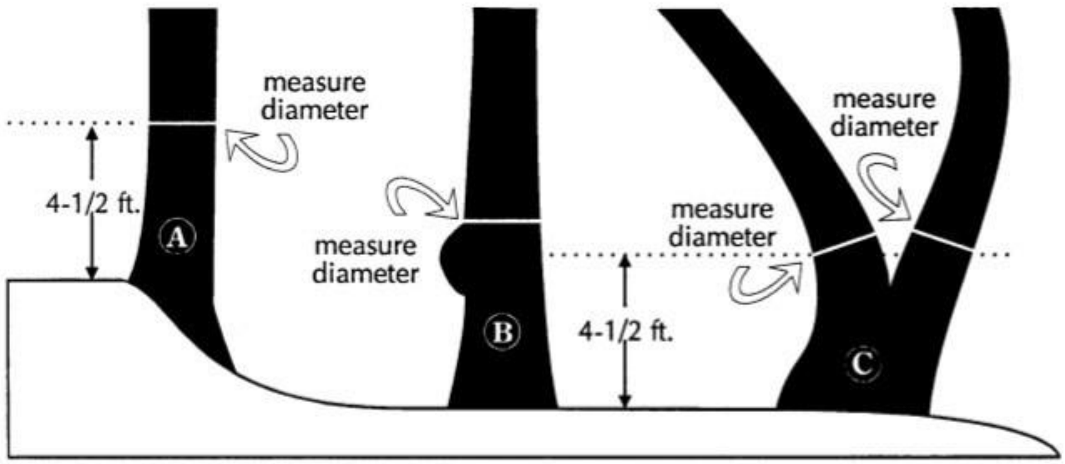

Figure 2-1. Measure stem diameter at breast height (DBH)

II. Plotless Sampling Technique – The T-Square Method

Another approach to estimating spatial dispersion is to use a "plotless" sampling method, which does not require establishing some pre-defined sampling area. Note that this method is inherently *scale-independent*, where the plot-based method required you to define a scale before use (e.g., 50x50 m). Minimal equipment is needed for plotless sampling methods, typically making these a faster method than quadrats or transects. However, plotless sampling methods can be more time-consuming if species studied are at a very low density, or if measuring multiple species in an area of high species diversity.

One of the most common plotless sampling methods is the **T-Square method** (*from Hill et al. 2005*). The T-square sampling method combines both the **nearest-neighbor** method, which overestimates tree density when clumped and underestimates it when regularly dispersed, and **point-to-object**, where the opposite is true. The bias of each of these two methods is effectively neutralized in the T-square method. Complete the following steps to sample the southern live oaks using this method:

1. Within the same 25x25m grid you already outlined above, find the random points that were generated for you by your TA. Estimations are appropriate if needed.
2. Next, for each random point, measure the distance (d_1) between the random sampling point (O) to the nearest southern live oak individual (P). This can be in any direction surrounding point O (see figure below). **Note that you are no longer restricted to your 25x25m plot. If the closest individual is outside of your original plot-based area that is completely okay!**
3. After you measure d_1, imagine that there is a perpendicular line drawn at d_1 (hence the T in T-square). This imaginary line should be perpendicular to line between your nearest neighbor and your random point. The distance (d_2) to the nearest individual (Q) on the other side of that line must then be measured. Individuals *behind* that line (on the same

side as random sampling point *O*) are ignored.

4. Repeat Steps 1 – 3 for a total of 25 *d1* and *d2* measurements.
5. Record your *d1* and *d2* in the table provided.

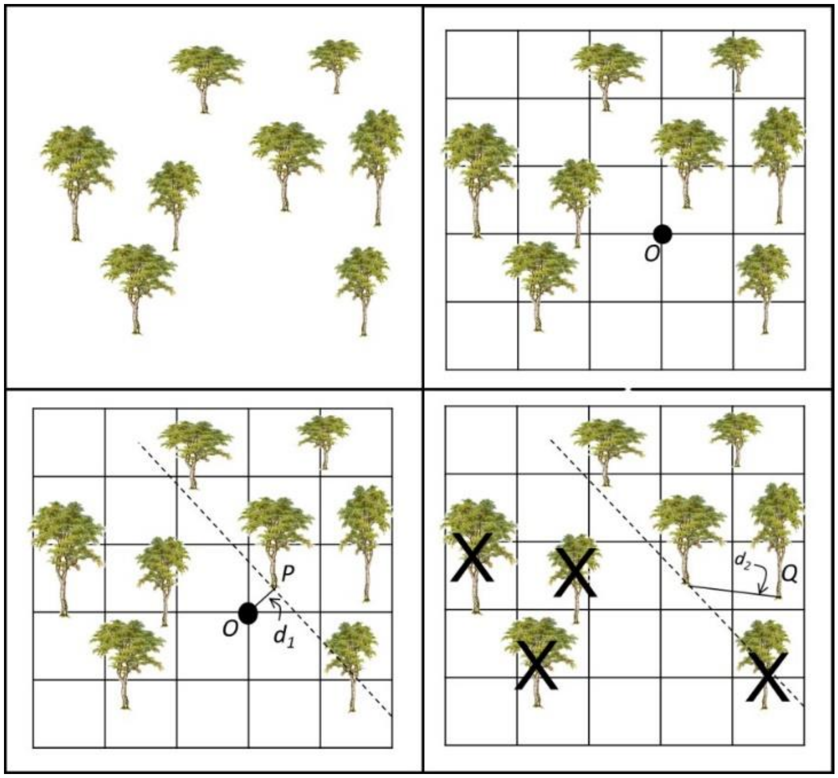

***Figure 1**: Graphic illustrating the T-square method.*