Tree Height, Diameter, and Population Density

Accompanying Classroom Worksheets: Tree Height and Diameter (W-F-01), Tree Population Density (W-F-02), Density Effects (W-F-03)

Objective: Students will measure the height and diameter of trees using simple instruments, and use applied geometry to calculate measurements. They will plot their results and discuss correlations between variables.

Considerations:

1. This is a two-part protocol that can encompass both parts or either one individually, though they work best together.
2. You may choose to select a site where at least two species of adult trees are available to enable comparisons across species (in Flagstaff, the Forces of Nature trail has Ponderosa Pines, Oaks, and Alligator Junipers of sufficient size for sampling).
3. Students should have a basic understanding of the geometry needed to determine the diameter of a tree by measuring its circumference. They should also create and be trained in the use of **clinometers (**See protocol E-01 for clinometer construction and use).
4. For the population density activity: generally, population density is measured in trees/hectare, which is 10,000 square meters (100 m x100 m plots). However, this may not be feasible with your site, so we suggest more manageable sizes of ½ hectare(5000 m^2, ~70m x ~70m plots), ¼ hectare (2500 m^2, 50m x 50m plots), or, in extreme cases, 1/16 hectare (625 m^2, 25m x 25m plots). To normalize data, you will extrapolate your results to always report per one hectare (ie, if you measured density in a ¼ hectare plot, multiply your tree counts by 4).

Tree Height and Diameter (T-01)

Required Materials: Worksheet W-F-01, tape measures, clinometers

Calculating Tree Height

1. Each student or group of students should have access to a clinometer, either regular or homemade.
2. Use the clinometers to calculate the approximate height of at least six trees of each chosen species, in centimeters, and record the heights on the worksheet.

Calculating Tree Diameter

1. Use the tape measure to determine the circumference of the tree, again in centimeters, which will then be recorded on the worksheet.
2. Calculate tree diameter by dividing by pi, and again record on the worksheet.

Plotting: this may be done in the field or back at the classroom.

1. Plot tree height on the x-axis and tree diameter on the y-axis.

2. If you chose to evaluate multiple species, plot them on the same graph, using different colors or symbols to denote each species.
3. Draw a line of best fit for each species, and note any correlation.

Tree Population Density (T-02)

Required Materials: Worksheet W-F-02, Surveyor's flags or tape, measuring tape, small piece of cardboard

Determining Population Density

1. Measure out your plot and mark your site using the surveyors tape or flags. You may wish to use string to mark the boundaries to make them clearer.
2. Count the numbers of each species of tree in the plot, and record on the worksheet. Trees that are more than halfway within the boundary are considered "in."
3. Generally, only trees that have a diameter greater than 10 cm are considered, to avoid counting saplings. To ensure accuracy of selection, we suggest cutting a 10 cm wide chunk out of a small piece of cardboard to create a U-shaped piece that can be placed around and compared with tree trunks to determine which category they fall into. You may wish to exclude samplings entirely, or record them in a separate category from adult trees.
4. Remember to normalize your data; if you used half- hectare plots, make sure to multiply your results by two in order to report number of trees per hectare.
5. Repeat at a second site with roughly the same species as the first. This will allow you to see how the density of one species may have affect another. It is best to repeat for at least three sites, though if time allows, of course more is better.

Plotting: this may be done in the field or back at the classroom

1. Record all data from tree counts in the tables provided, creating additional tables if necessary.
2. Create a plot on the graph provided with axes: Species 1 and Species 2. Ie, record one species' density as a function of a second, with points for each site. This can be used to determine if the density of one species affects the density of another. For example, pines prevent much of the sunlight from reaching the forest floor, so a higher density of pines may impact the survival and growth of alligator junipers.
3. You may wish to play around with these plots depending on the trends you witness in the field. You can have students create plots of one species vs total density, or compare various species in regards to one another.

Combining Tree Height, Diameter, and Density

Required Materials: Worksheet W-F-03

Objective: Students will determine if tree density affects tree growth; create and use graphs to make inferences about real-world ecology

Collecting Data:

1. Using the protocols for Tree Height and Diameter and Tree Population Density, gather data from two or more sites on tree height, tree diameter, and population density for at least one species, though two or more is preferable.

Plotting and Discussion:

1. On separate graph paper, create a graph of the average diameter of a species of tree versus the total tree population density, with a point for each site. You may wish to include points for all species studied at each site. Is there a notable trend? Does population density seem to have an effect on tree diameter?
2. You can repeat this, having different graphs for heights and densities (total density or density of a particular species) to answer questions such as: Does the density of Species 1 affect the growth of Species 2? Does the total population density affect the growth of all the species in an area? Do you believe that a higher population density detracts from optimal growth because of competition for resources? What do you believe is the optimal density for these species?