MEASURING VEGETATION

Quadrat orientation and construction: Measurements are always begun at Quad 1. A $1m^2$ PVC frame is placed over the fiberglass stakes or rebar that mark the diagonal corners of each quad. Once placed, the square frame should be as close as possible to the vegetation canopy without touching it. If the ground is sloped the frame should be adjusted so that it is parallel to the vegetation, not the ground.

The frame is constructed of ½" PVC. The interior dimensions of the square are 1 m on each side. Each corner coupling is a female-threaded right-angle "T" (threads are for attachment to the adjustable legs). Each PVC frame is divided with nylon string into 100 squares. The dimensions of each square are 10cm X 10cm, representing 1% of total quadrat area.

Additional measuring tools: "niners" and "plexidecs" are additional tools that can be used to determine vegetation cover. A "niner" is a small, hand-held PVC frame used to measure canopy systems or low-growing plants. The "niner" is also made of ½" PVC and nylon string but has no legs. The interior dimensions of the square are 30 cm on each side and the enclosed area is divided into nine 10 cm x 10 cm squares. Each square represents 1% of the total $1m^2$ quadrat cover.

"Plexidecs" are used to measure vegetative units with covers < 1%. They are small, clear, ¼" plexiglass squares that are held over vegetation. A "plexidec" is 0.71 cm on each side, representing a cover of 0.5%. Squares are etched with dimensions of 0.1, 0.22, 0.32, and 0.5 cm. These squares delineate covers of 0.01%, 0.05%, 0.10%, and 0.25% respectively. Hint: to help relocate a "plexidec" dropped into vegetation, tie brightly colored surveyor's tape to a small hole drilled into one corner.

Obtaining measurements: standing plant biomass within a quad is measured in terms of vegetative units, which consist of a specific size class of a particular species. A size class is defined as a unique cover and height for a species within the quad. The cover and height of each vegetative unit that falls within the $1m^2$ quad is measured separately. Height is determined with a tape measure while cover is obtained by counting the number of 10cm X 10cm squares occupied by each vegetative unit. Partially-occupied squares are consolidated and added to the total cover.

When measuring cover it is important to stay centered over the vegetation. If an observer is not directly over the vegetation, the angle of observation (parallax) can result in inaccurate measurements. If the surrounding plants prohibit you from leaning directly over the vegetation, use a tape measure to delineate a vertical column from which to maintain the proper perspective.

CALIBRATION AMONG TECHNICIANS

Prior to measuring quadrats, calibrate cover and height measurements amongst technicians. To calibrate measurements, place a PVC frame over an area of vegetation. It is helpful to choose an area that contains all the vegetation types expected at a site. It may be necessary to choose more than one area to ensure all vegetation types are represented. Each person then measures the cover and height of every plant species in the quadrat without disclosing their results. Measurements are then compared and discussed and adjustments made to bring all technicians into agreement.

If there is a large disparity between technicians this exercise should be repeated until measurements are consistent.

It is extremely important that cover and height measurements remain consistent over time to ensure that regressions based on this data are valid. Below are guidelines on how to make these measurements within specific vegetation types.

MEASURING THE COVER OF SPECIFIC VEGETATION TYPES

Cover and height measurements are made on separate vegetative units that occur within the PVC frame. A vegetative unit consists of a specific size class (as defined by a unique cover and height) of a particular species within the quadrat. This includes vegetation that is rooted outside but has foliage that hangs inside the frame.

Cover is quantified by counting the number of 10cm x 10cm squares encompassed by each vegetative unit. It is possible to obtain a total percent cover greater than 100% for a given quadrat because vegetation often overlaps, particularly shrubs (branches) and cacti (branches or pads).

The smallest cover category is 0.01%. Seedlings often have covers below 0.01%; record seedlings as 0.01%. The next cover increments up to 1.0% are 0.05%, 0.10%, 0.25%, 0.5%, 0.75%. For covers above 1.0% up to 10.0%, the covers are rounded to the nearest 0.5%. Covers above 10.0% are rounded to the nearest 1.0%.

To increase accuracy and to reduce the size of harvested samples (see below), divide the total canopy cover of large individuals into smaller units and measure the cover and heights of each separately. For example, an observation of black grama with a total canopy cover of 80% could be divided into several observations of smaller cover by breaking the total cover into individual clumps or groups of clumps. As a general rule, try not to record cover values that exceed 15%. During really wet years, large perennial grasses can be measured up to 30%, but no higher than that.

Grasses: To determine the cover of a grass clump, envision a perimeter around the central mass or densest portion of the plant, excluding individual long leaves, wispy ends, or more open upper regions. Live tissue is frequently mixed with dead tissue in grass clumps. It is unnecessary to try and separate individual live stems from dead stems as this is accounted for when samples are harvested and sorted. At the same time, the goal is to measure only the plant biomass growth for the current season. As recently dead foliage is yellow and long-dead foliage gray, try to include only yellow or green portions of the plant in cover measurements, excluding gray areas.

Stoloniferous stems of grasses that are not rooted should be ignored. If the stem is rooted in the soil it should be recorded as a separate observation from the parent plant.

Shrubs and Sub-Shrubs: To measure dominant shrubs (e.g., *Larrea tridenta, Atriplex canescens*) and sub-shrubs (*Gutierrezia sorothrae*).

Measure the cover as the perimeter of the green leaves/foliage of the plant, ignoring small open spaces (keeping in mind the 15% guideline stated above). For plants that do not have leaves, such as *Ephedra torreyana*, draw the perimeter around the needles instead of the leaves. For *Gutierrezia sorothrae*, simply measure the cover and height as with any other perennial forb or grass.

Do not measure dead stems or areas of dead foliage. If in doubt about whether a stem is alive, scrape the stem with your fingernail and check for the presence of green cambium.

For shrubs that drop their leaves in winter, lump the branches into canopy systems and record the cover of each.

It is especially important in the case of shrubs and sub-shrubs to remember to record the cover of vegetation rooted outside the quadrat but hanging inside.

Forbs: Forb cover is measured as the perimeter of the densest portion of the plant. Measure all foliage produced in the current season, including any recently dead (yellow). Avoid measuring gray foliage.

During really wet years, KAPA can be measured as a total cover if individuals cannot be idendified.

Cacti: For cacti that consist of a series of pads or jointed stems (i.e., *Cylindropuntia imbricata*, *Opuntia phaeacantha*) measure the average length and width of each pad instead of cover and height. Cacti that occur as a dense ball/clump of stems (*Cylindropuntia leptocaulis*) are measured using the same method as shrubs, which is one total cover. Pincushion or hedgehog cacti (i.e., *Echinocereus fendleri*, *Echinomastus intertextus*, or *Escobaria vivipara, also Grusonia clavata*) that occur as single or clustered cylindrical stems are measured as a single cover.

Yuccas: The leaves and caudices (thick basal stems) of yucca are recorded separately. Break the observations into sections of leaves that are approximately the same height and record the cover as the perimeter of the group of leaf blades. The caudex is measured as a single cover. The thick leaves of yucca make it difficult to measure cover while centered over the caudex. The cover of the caudex may be better estimated by a "niner" or tape measure. For measurements of yucca leaves add "L" to the species code and for yucca caudices add "C" (i.e., 'YUBAL' or 'YUBAC').

Vines: Because vines often grow diffusely, measuring cover can be difficult. Each square that the vine crosses is a 0.5%. Count up the squares that the vine crosses and divide by 2.

Overstory in PJ: (*Quercus, Rhus*, PIED, JUMO) Measure the cover as the perimeter of the green leaves/foliage of the plant above or in the quad. This number will be rough as some of the vegetation will be meters above the quad. Approximate the cover of the tree/shrub and record that value.