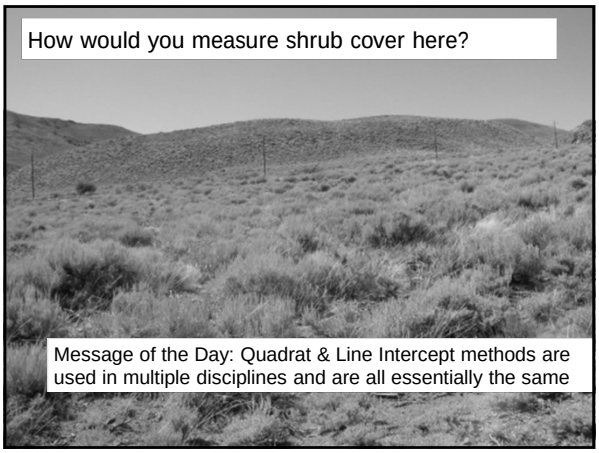
How would you measure shrub cover here?



Message of the Day: Quadrat & Line Intercept methods are used in multiple disciplines and are all essentially the same

FOR 274: Forest Measurements and Inventory

Shrub, Grasses, Litter, and Duff

- Density, Frequency, Cover
- Quadrats
- Line Intercepts
- Litter and Duff Measurements
- Herbaceous Fuel Loadings
- Shrub Fuel Loadings

Density: What is it?

Density: The number of objects present in a container of a given size

The size can be a Length (line), an area (plot, stand), or a volume

Examples:

- Shrubs/m (length)
- Plants/acre (area)
- Crown Bulk Density (mass/volume)

A Reminder: Frequency and Cover

Frequency: The rate (or chance) of finding a given feature when a particular sample is located in an area (such as a quadrat)

Cover: The horizontal extent of trees, shrubs, grass, etc when viewed from above

Source: Bonham 1989

Photo: A Hudak (USFS)

Density: When is it used?

Why is Density Used:

- Monitor species responses over time to a silvacultural prescription: such as increase or loss in seedlings.

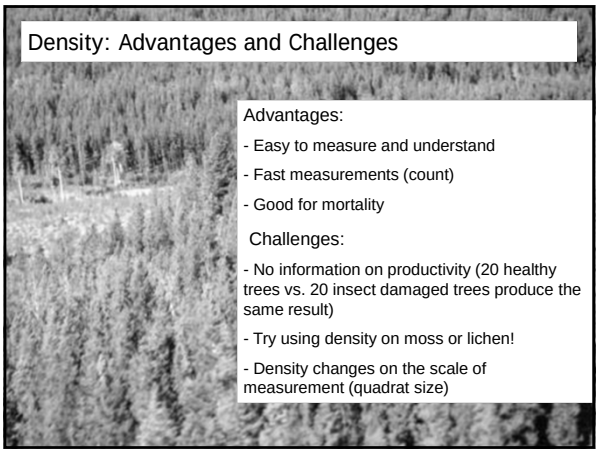
Stocking Rate (average number of survived trees per unit area)

Density: Is it a Good Measure of Biomass or Cover?

Density is not a measure of biomass: A few scattered large trees could easily exceed the biomass of these tightly packed shrubs

Density is not a measure of cover: Could relate to cover if only monitoring changes in plants that remain roughly the same size – so just change in stem count.

Density: Advantages and Challenges



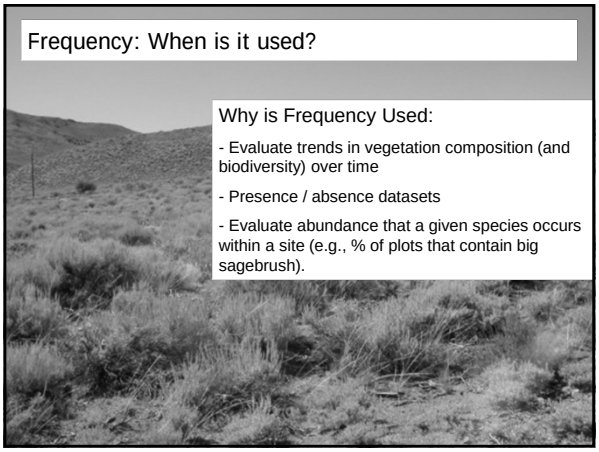
Advantages:

- Easy to measure and understand
- Fast measurements (count)
- Good for mortality

Challenges:

- No information on productivity (20 healthy trees vs. 20 insect damaged trees produce the same result)
- Try using density on moss or lichen!
- Density changes on the scale of measurement (quadrat size)

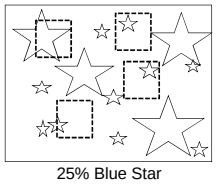
Frequency: When is it used?



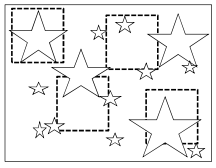
Why is Frequency Used:

- Evaluate trends in vegetation composition (and biodiversity) over time
- Presence / absence datasets
- Evaluate abundance that a given species occurs within a site (e.g., % of plots that contain big sagebrush).

Frequency: Advantages and Challenges



25% Blue Star



100% Blue Star

Advantages:

- Fast / easy measurements (single measure of presence/absence per plot)

Challenges:

- Presence / absence data is dependent on size of quadrat (larger = more likely to be present)
- Each “tally” of a certain species does not tell you how much of the species is there (i.e. just because 25% contained BLUE and 75% contained RED does not mean that over the site there is more RED than BLUE)
- Change in frequency could be due to change in size, abundance, distribution

Cover: What is it?

Basal Cover: % of plant intersecting with soil or at a fixed height

Trees: DBH

Willow, shrubs: DRC

Grasses/forbs: Basal area is usually defined at the soil surface.

Basal cover is easy to re-measure at same heights in future years leading to accurate rates of growth change

Cover: What is it?

Crown Cover: A measure of the area of influence of the plant (ignoring canopy gaps). Canopy cover usually refers to a stand measure (e.g., like canopy base height). Total canopy cover is 100% but total crown cover can exceed 100% as crowns overlap.

Foliar Cover: A measure of the exposed leaf area, such as Leaf Area Index.

Highly sensitive to climatic and biotic factors.

Ground / Soil Cover: A measure of the percentage of the ground / soil that is covered.

Measurements: Quadrats

The Art of Quadrats:
- Density (number of objects per quadrat)
- Biomass (via clipping and weighing)
- Cover (all measures via ocular assessment)
- Frequency (proportion of quadrats that contained a given species)

Choose an appropriate quadrat size:
• 25x25cm grass clippings can fill large bags!
• Bonham (1989) suggests that a quadrat should be large enough to contain at least one plant of interest but small enough to have only a reasonable amount to count.
• PVC pipes are great as they detach at corners!

Measurements: Quadrats

Shapes:
Quadrats are essentially very small Fixed Area Plots and thus can be circular, square, or rectangles

Observations:
When measuring density with quadrats you need a minimum of 7 individuals (stats minimum), but should make the size such that the standard error of the mean is minimized:

$$SE = \sqrt{\frac{s^2}{n}}$$

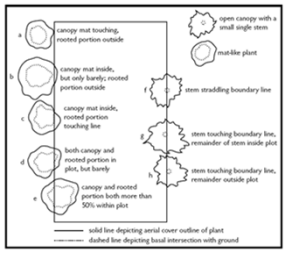
Equation for standard error with replacement

Assuming you can't change the variability, increasing the sample size will reduce SE.

Measurements: Quadrats

As with large plots, your SOPs will determine what to do when plants occur at the boundaries of the quadrats.

Elzinga (1998) SOPs:
1. Alternate counting / discounting boundary plants to produce an unbiased estimate
2. Plants are in if >50% of the crown area is within the quadrat
3. Plants are in if the root collar is within the quadrat

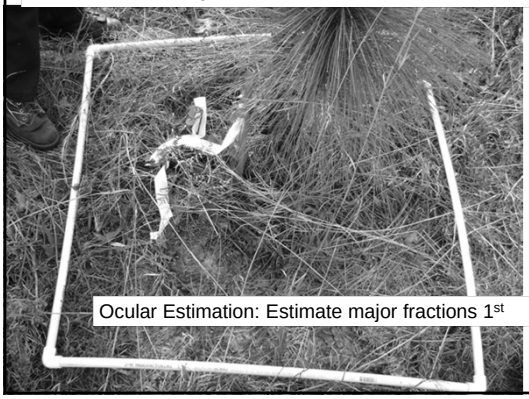


Disadvantages of Quadrats:

- Time consuming, especially if either large of if clipping is involved (e.g., fuel assessments)

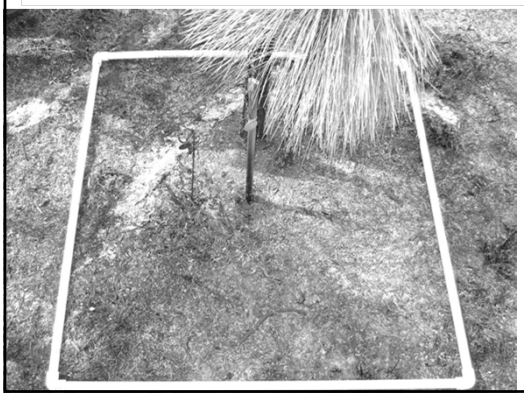
Source: Elzinga, C.L., et al.. 1998. *Measuring and Monitoring Plant Populations*. [Free version on course website]

Measurements: Quadrats



Ocular Estimation: Estimate major fractions 1st

Measurements: Quadrats

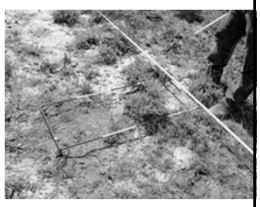


Measurements: Quadrats

The Daubenmire method places a 20x50 cm quadrat along a tape on a permanently located transect.

Usage:

- Hold frame from above and estimate cover class for all plants
- Cover is estimated by imagining how a shape drawn that connects all the leaf tips of the plant would appear on the ground
- The marks on the 20" side are then used to estimate cover
- Total cover is 100%



Cover Class	Range of Coverage
1	0 - 5%
2	5 - 25%
3	25 - 50%
4	50 - 75%
5	75 - 95%
6	95 - 100%

Measurements: Distance Measures

Density can be estimated using the wandering quarter distance method (Catana, 1963). This approach works for non-random plant populations, which mostly occur in nature.

Density = A / MA

A = Area enclosed by four transects

MA = "mean area" of plants = average distance between plants squared

$$MA = d_m^2 = \left[\Sigma\left(d_1 + d_2 + d_3 + \ldots d_N\right) / N\right]^2$$

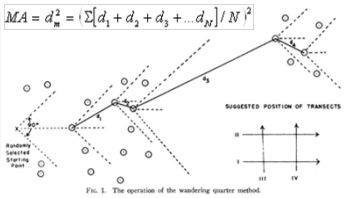
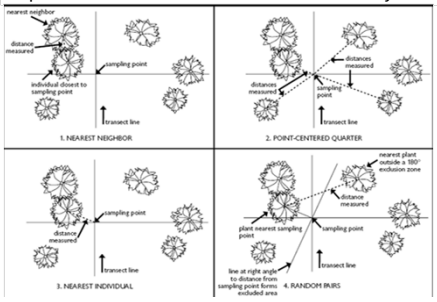


FIG. 1. The operation of the wandering quarter method.

Source: Catana, Ecology (1963)

Measurements: Distance Measures

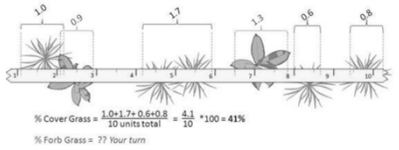
Random population methods should be avoided, as the conditions required for these methods to be accurate rarely occur in nature.



Source: Elzinga, C.L., et al.. 1998. *Measuring and Monitoring Plant Populations*

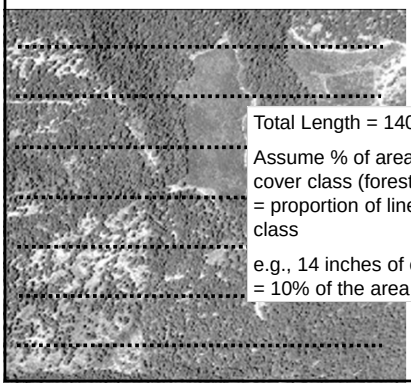
Measurements: Line Intercept

Cover by Line Intercept:
- Lay transect of fixed Length
- Measure % of line intersected by plants
- Ignore instances If same individuals overlap
- If two species overlap – count the total length of each species



Source: Cranfield (1941)

Measurements: Line Intercept



Total Length = 140 inches

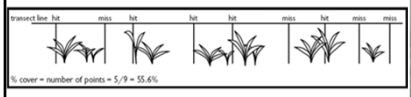
Assume % of area of each land cover class (forest, clearcut, ag, etc) = proportion of line intercepting that class

e.g., 14 inches of clearcut = 14/140 = 10% of the area

Measurements: Point Intercept Methods

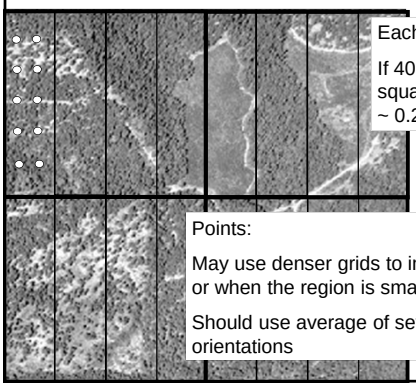
Use point frames to calculate cover via the proportion of pins that hit plants of interest over a defined length or area

Two applications:
- Evaluate a single layer of cover by recording only the first item the pin hits (max 100%)
- Evaluate multiple layers by recording all the vegetation the pins hit until they touch the ground (total can exceed 100%)



Source: Elzinga, C.L., et al.. 1998. *Measuring and Monitoring Plant Populations*

Measurements: Point Intercept Methods



Each block = 8 ac

If 40 dots per block square then each dot ~ 0.2 acres

Points:

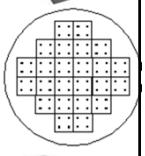
May use denser grids to increase precision or when the region is small

Should use average of several random orientations

Measurements: Densiometers

Steps for Low Canopy Cover:
- Hold level in front of you
- Imagine 4 equally spaced dots per square that represent each quarter
- Count the number of quarters that are filled with canopy
- Record number for calculation later

Steps for high canopy cover:
- Count gaps instead and subtract from 96



Litter and Duff: Common Measurements

When measuring litter and duff we often estimate the weight, bulk density, and depth.

We often estimate the bulk density from with Direct (drying and weighing) or Indirect (FCCS, Fuel Photo Guides, Published Report – c.f. Brown 1981) measurements.

Depth is easy to measure (using an opaque ruler) and biomass (or loading) can be estimated by multiplying bulk density by the depth.

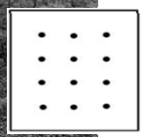
Litter and Duff: Depth

Figure FL-11. Use you boot to carefully pull the litter and duff layers away, until you are down to mineral soil.

Figure FL-12. Use a plastic ruler to estimate duff and litter depth. Place the zero end at the intersection of the mineral soil and duff layer, then mark top of the litter layer using your thumb or finger. In this illustration the duff/litter depth is 2 in. (5 cm). and the proportion of that depth that is litter is about 50 percent.

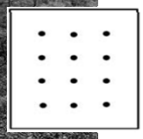
Litter: Direct Measurement of the Bulk Density

1. Insert a 1x1 foot steel square flush with mineral soil
2. Insert 12 x 6” nails within the steel square flush with the litter layer
3. Remove the litter and measure the depth of each nail revealed then push the nails down so flush with duff layer
4. Repeat for duff layer until mineral soil is reached



Litter: Direct Measurement of the Bulk Density

5. Calculate averages for litter and duff heights
6. Oven dry the litter and duff (48 hrs at 70°C, 100°C)
7. Divide oven dry mass by Sample Area (144 sq in) and then by Depth (average



Herbaceous: Fuel Loadings

There exist several methods to estimate the loading and bulk density of herbaceous fuel layers:

- Fuel Photo Guides (already seen these)
- Direct Estimation by Clipping
- Relative Weight Method
- Disc Pasture Meter

Herbaceous Fuel Loading: Clipping and Weighing

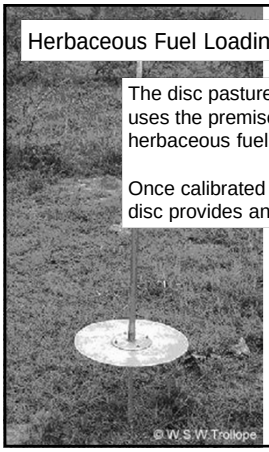
Using a quadrat method, clip (and weigh) all fuels within a known area. Loading is the oven dry mass / Quadrat Area.

Herbaceous Fuel Loading: Relative Weight Method

The premise is that its often easier to compare weights than estimate more weights. Select quadrat with most visible biomass and clip – then estimate other plot weights based on visual estimate of fraction.

This approach is easy and fast but is low in accuracy.

Herbaceous Fuel Loading: Disc Pasture Meter



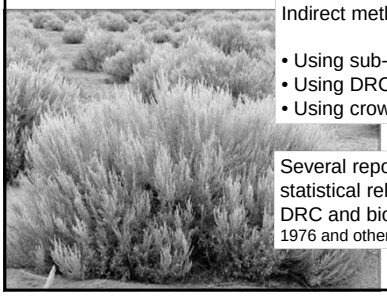
The disc pasture meter (or weighted disc meter) uses the premise that the compaction of the herbaceous fuel is proportional to the fuel loading

Once calibrated for a given fuel the height of the disc provides an accurate estimate of the load.

Bransby, D.I., A.G. Matches and G.F. Krause. 1977. *Disk meter for rapid estimation of herbage yield in grazing trials. Agronomy Journal. 69:393-396.*

Shrub Fuel Loading: Methods

As with grasses, shrub fuel loading can be estimated using direct (clip whole plant or sample) or indirect methods



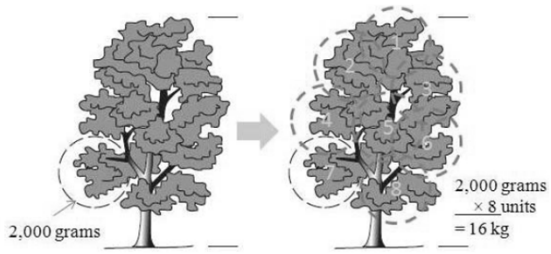
Indirect methods include:

- Using sub-sample of shrub
- Using DRC / Basal diameter
- Using crown volume

Several reports have calculated statistical relationships between DRC and biomass (c.f. Brown 1976 and others)

Shrub Fuel Loading: Sub-Sample (semi-direct)

Divide the shrub into representative samples and calculate biomass of sub-sample. Multiple out by how many “units” are apparent in the plant.



Extra Credit: Describe how you would measure biodiversity in this landscape?

Hint: see http://www.cnr.uidaho.edu/veg_measure/