Lesson 3
Cover, frequency, density, point sampling methods

Common parameters from plant community analysis

- Species composition (total species list)
- Cover
- Density
- Frequency
- Basal area

Cover

The area of ground covered by the vertical projection of the aerial parts of plants of one or more species.

- An easily obtained index of plant biomass.
- **Estimates** of cover can be obtained by using cover-abundance scores.
- **Measures** of cover can be made using point sampling methods, line transect method, or photos and planimeter or other direct measure of cover.

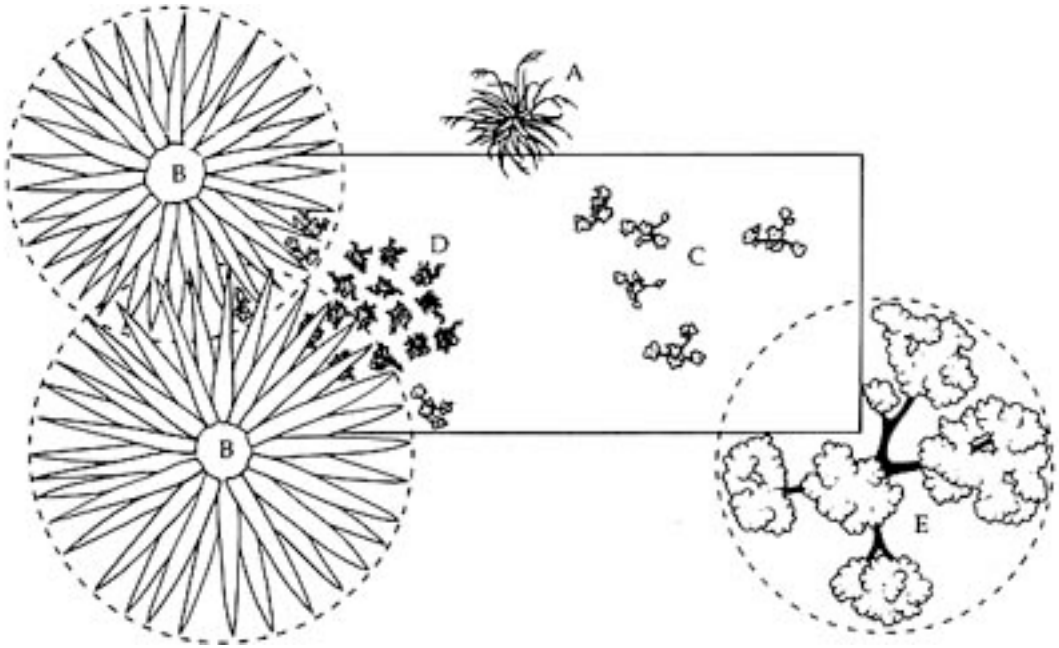
Density

- The number of plants per unit area. Expressed as number/square meter, stems/acre, etc.
- Most often used for trees or large plants.
- An an easy concept to grasp, but very difficult to perform in some types of vegetation because of:
  - (1) the difficulty of defining an individual (e.g. caespitose growth forms, plants with underground rhizomes, plants in peaty landscapes often have complicated stems just beneath the surface of the moss layer)
  - (2) quadrat size affects density size because of problem of counting large individuals near the boundary of the quadrat
  - (3) it is very time-consuming in graminoid dominated systems and low-growing vegetation, or moss or lichen communities.

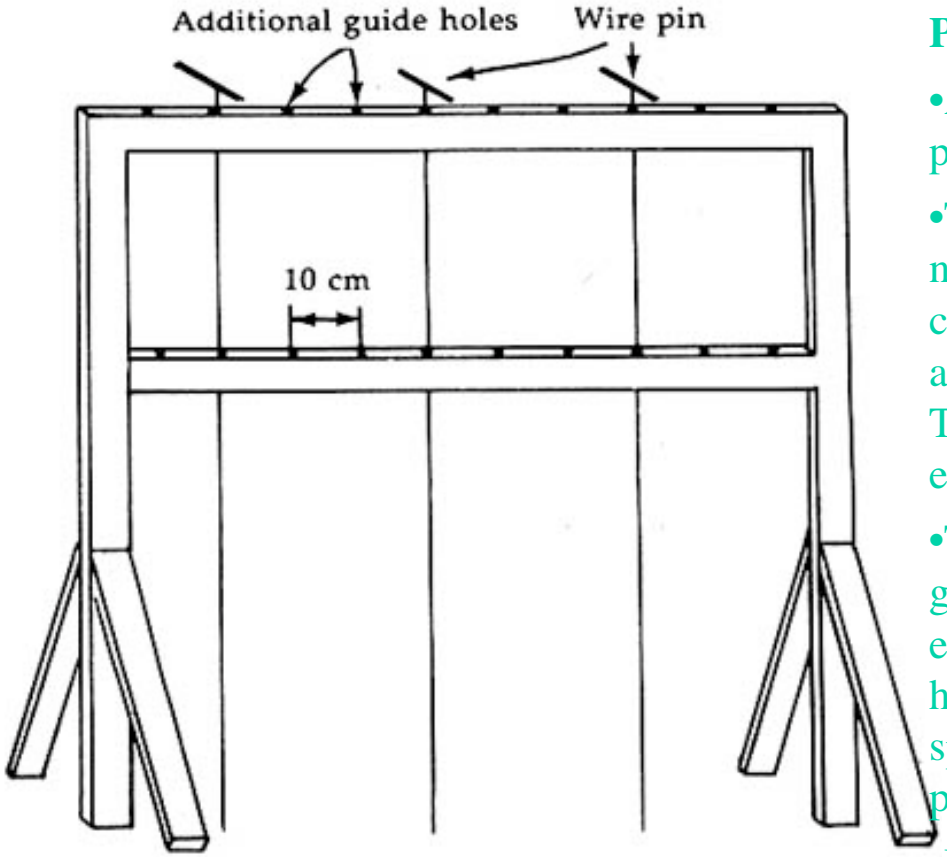
Frequency

- Expressed as a percentage of plots (quadrats) of equal size in which at least one individual of the species occurs in a stand.
- It is a measure of the degree of uniformity with which individuals of a species are distributed in an area, and more specifically a stand.
- Generally frequency quadrats are much smaller than quadrats used to determine species composition in plant communities (relevés). Rule of thumb is that the frequency-plot size should be at least twice the size of the largest individual.

Estimating percentage cover



Point sampling methods to measure percentage cover:
point frame



Point frame

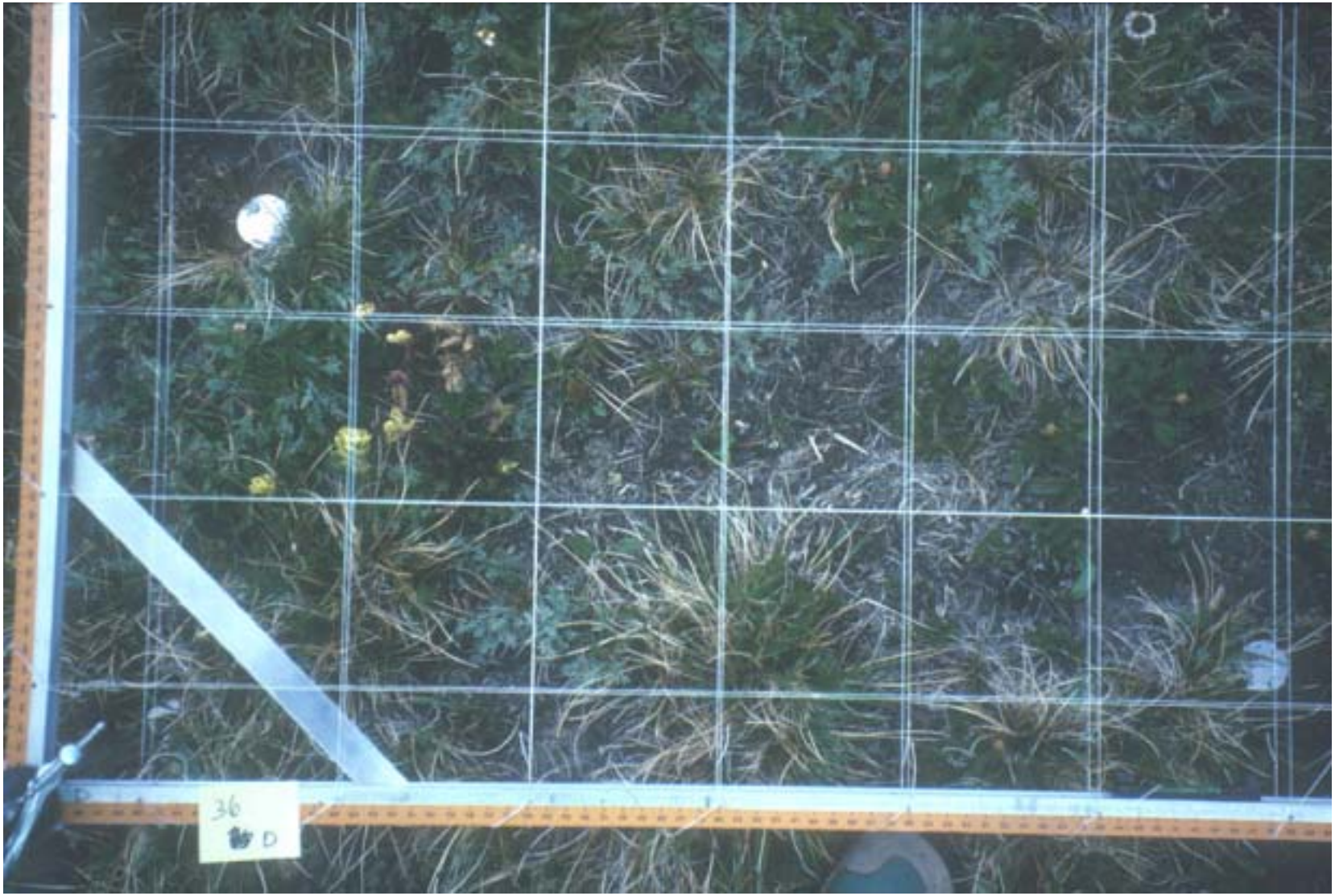
- A point frame is a device that is used to obtain point samples to estimate cover.
- The frame is set up over the vegetation and the needles are lowered down through the plant canopy. Every time the point of a needle touches a plant, a "hit" is recorded with the species name. The needle can touch several plants before it eventually touches the ground surface.
- This is the only point sampling method that can give an accurate estimate of absolute cover of each species in multi-stratose vegetation, and hence an estimate of total leaf area for each species. All other methods give relative percentage cover.
- It is, however, a very time consuming method.

$$\% \text{ cover of species A} = \frac{\text{(No. of points that intercept species A at least once)}}{\text{Total number of points}} \times 100\%$$

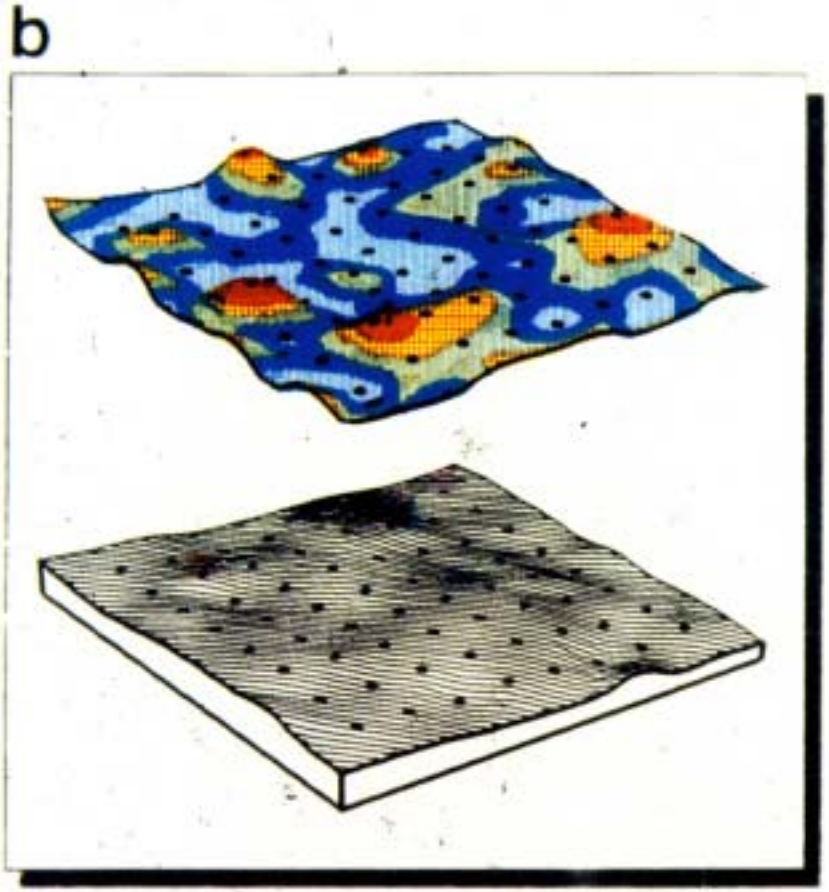
Electronic inclined point frame

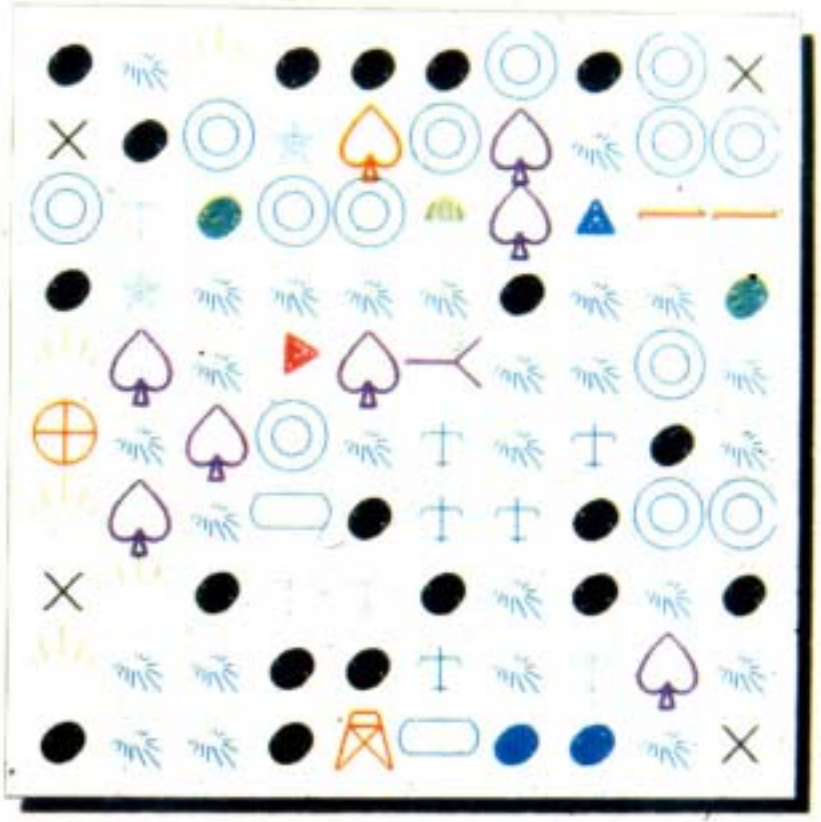
Point quadrat

Point quadrat grid



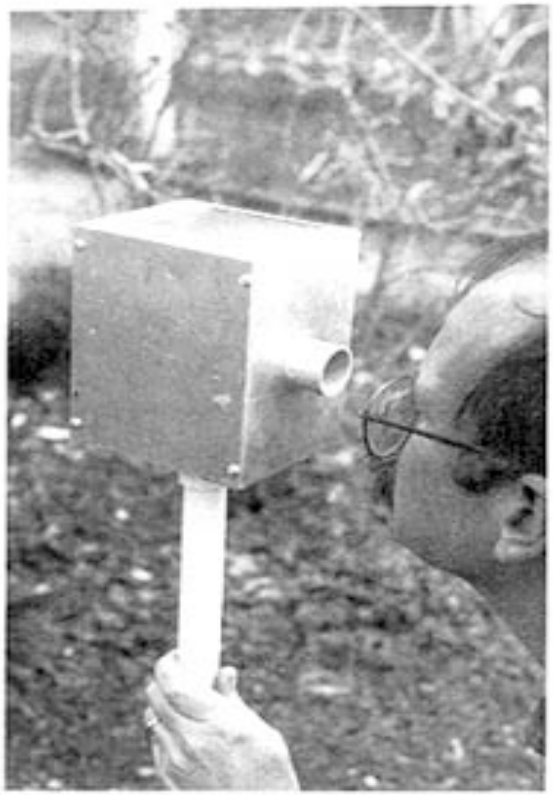
Map from point-quadrat data





Buckner sampler: Optical device for measuring cover

Methods of determining tree-canopy cover



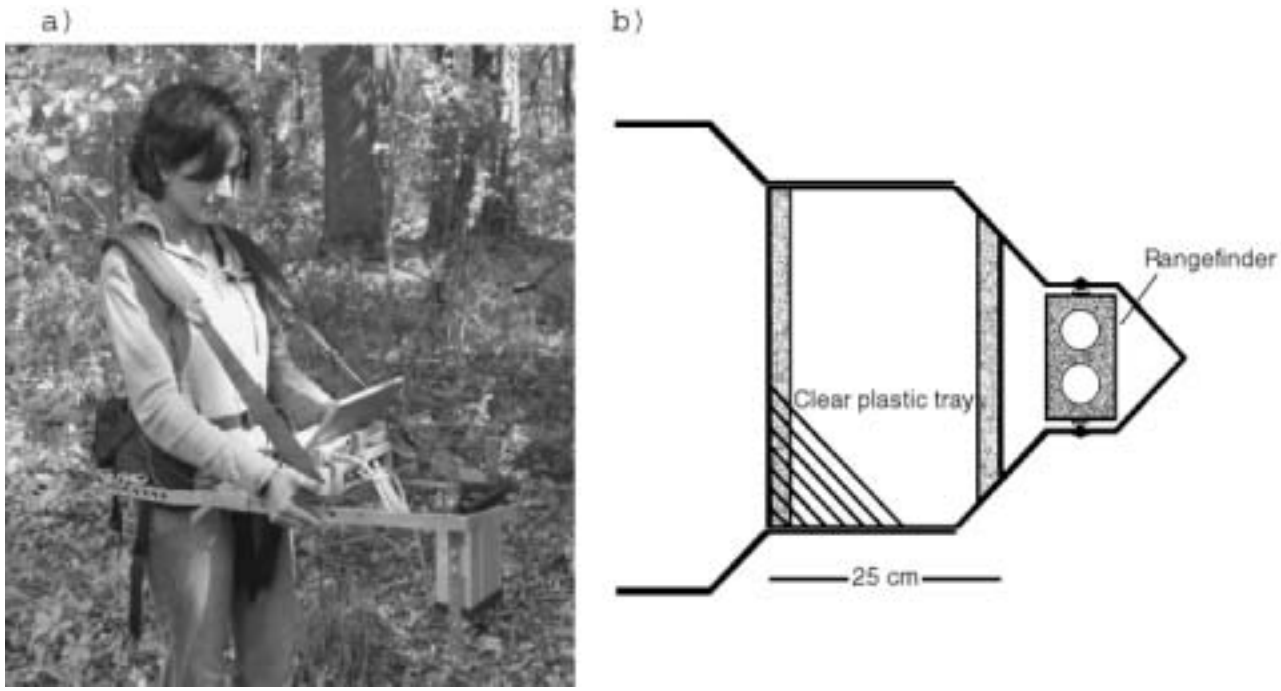
(a) Moosehorn crow-cover estimator

(b) Densitometer with single cross hairs

(c) Spherical densiometer

Figure 9-6 Several devices for estimated overstory tree cover. (a) Crown-closure estimator (moosehorn) with a grid of dots in the view. (b) Densitometer with a single point created by two cross-hairs in the field of view. (c) Spherical densiometer with 24 squares etched into the reflective surface.

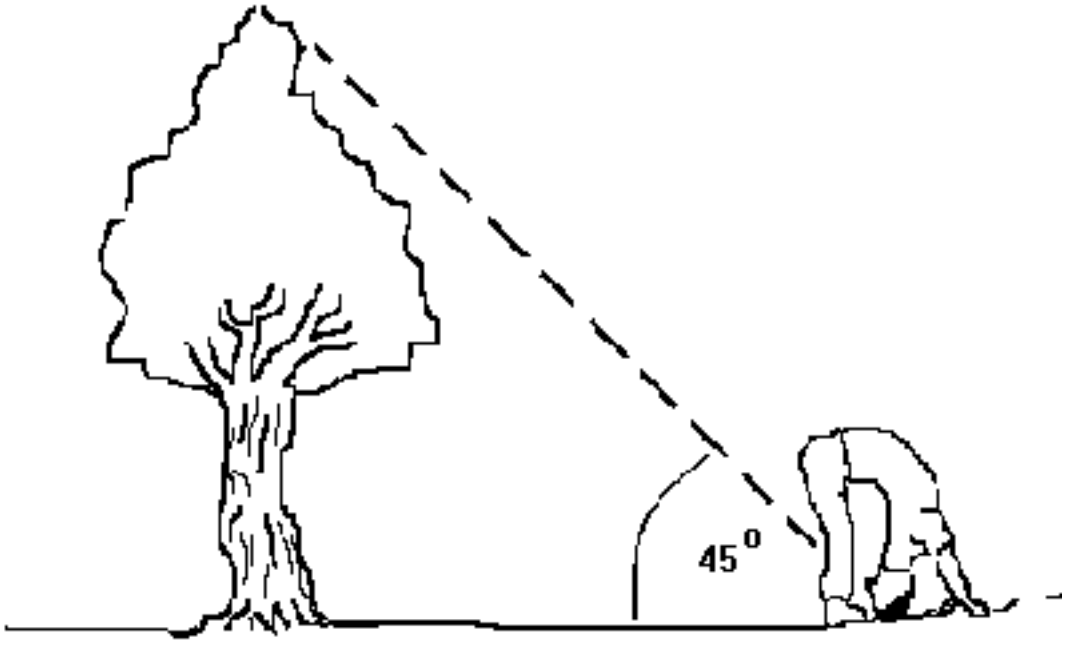
Measuring foliage heights: Portable LIDAR system for rapid determination of forest canopy structure



- A narrow-beam rapidly pulsed first-return laser rangefinder coupled with a data recording system.
- Measures distance to overhead plant surfaces.

Parker, G.G., Harding, D.J. and Berger, M.L. 2004. Journal of Applied Ecology, 41: 755. doi:10.1111/j.0021-8901.2004.00925.x

Measuring tree heights: Native American Indian approach



Find a spot where, looking under their legs (as shown), they could just see the top of the tree. The distance from such a spot to the base of the tree was approximately the height of the tree.

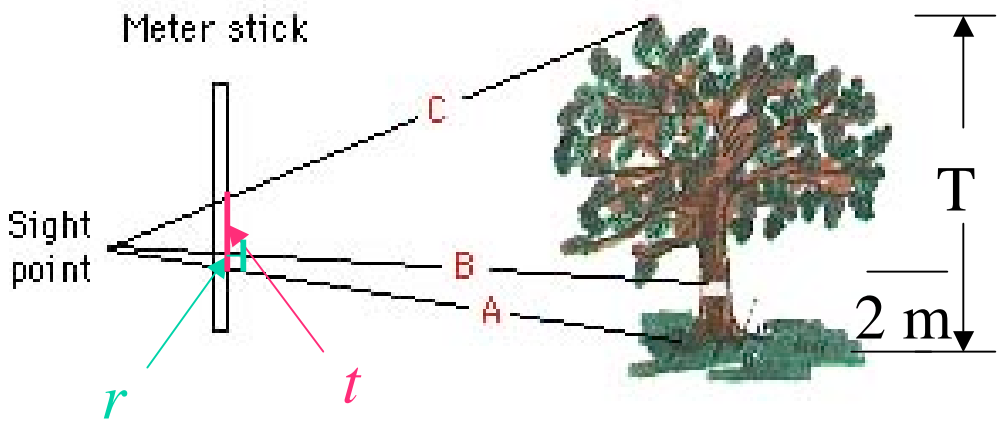
Why does this work? For a normal, healthy (limber) adult, the angle formed by looking under one's legs is approximately 45˚. Hence, the distance to the tree must be around the same as the height of the tree.

Trigonometric methods

Lots of trigonometric methods:

METHOD 1: Use a meter stick to measure the distance from your eye to your outstretched fist (*d*). Hold the meter stick vertically at so the length *d* extends above your fist. Back off from tree holding meter stick vertically in your extended hand, while sighting the top of the tree. When the top of the tree is at the top of the meter stick. Pace the distance to the tree. This distance is the same as the height of the tree.

METHOD 2: Tie a ribbon around tree at 2-m above the ground. Back off from the tree and measure the apparent distance between the base of the tree and ribbon *(r)*. Then measure the apparent distance between the base of the tree and the top of the tree *(t)*. The ratio $r/t = 2/T$.

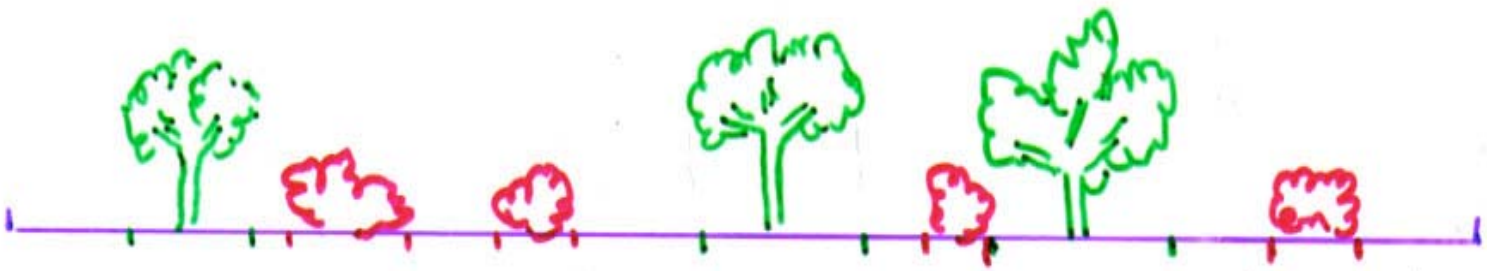


Measuring tree heights: Sunto Clinometer

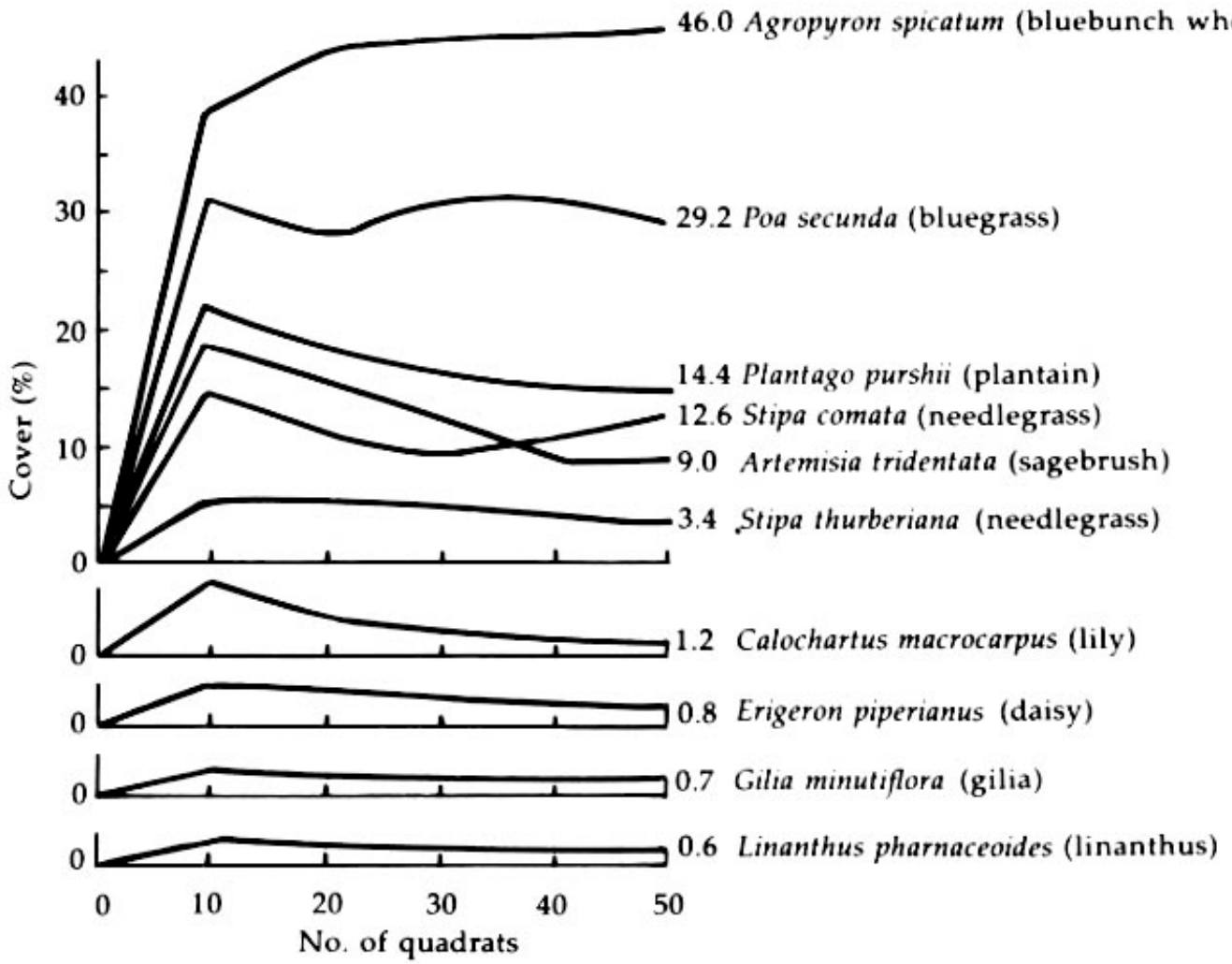
- User measures a given distance (20 or 15 m) from the tree.
- Then sights and aligns a cross hair with the top of the tree. The tree height is then read directly in the viewer (if on level ground).
- If not level, the user then sights the bottom of the tree, and subtracts (if the tree base is above the user) or adds (if the tree base is below the user) the reading to the first determination.

Line intercept method for measuring plant cover

- Generally used for tree and shrub cover or for measuring cover of clearly defined vegetation types
- A line is laid out along the ground and the line segments for each species or vegetation type is recorded.
- Percentage cover for each species is the total length of line segments for each species divided by the total length of the transect.

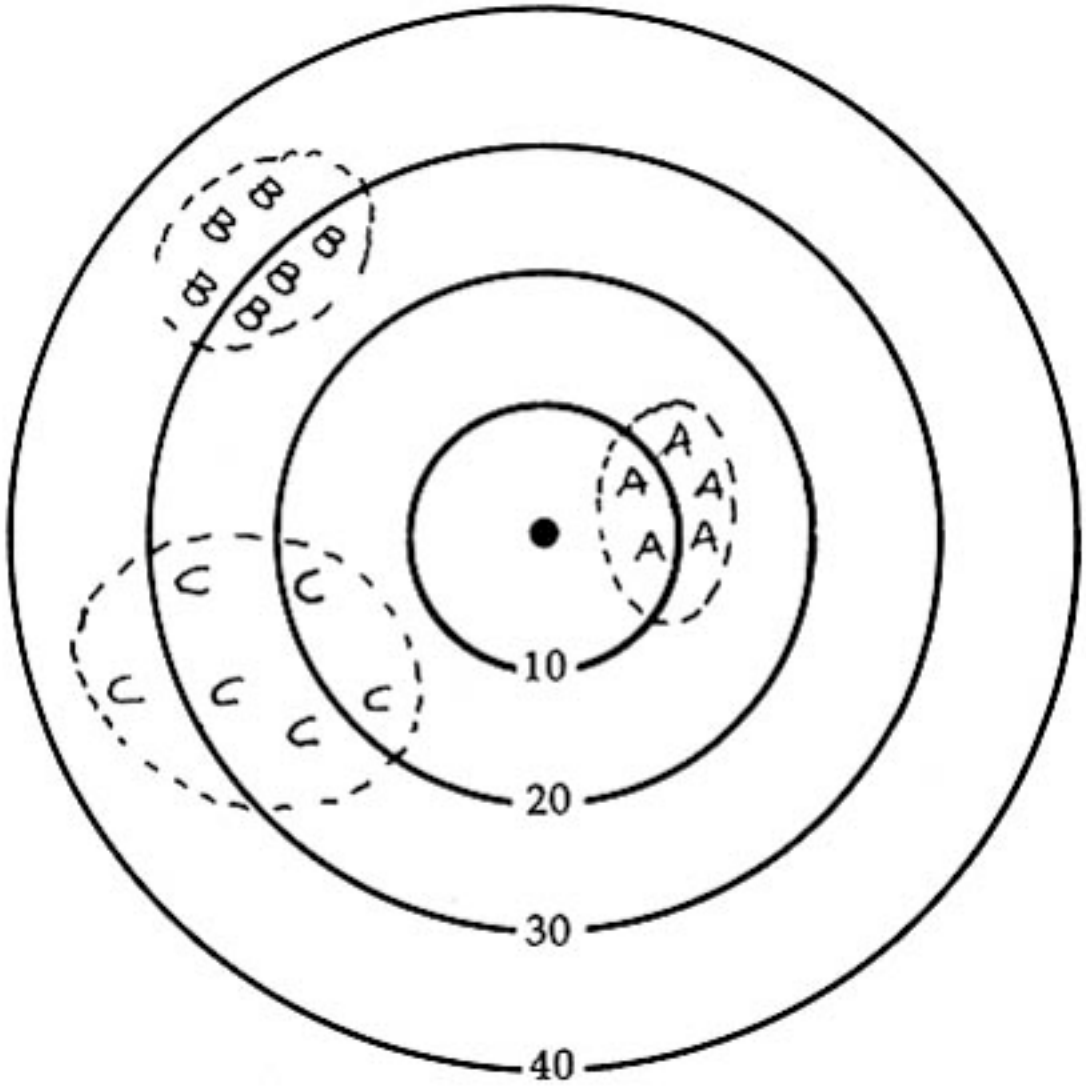


How many sample plots or line transects are needed for an accurate determination of cover?
Running mean method

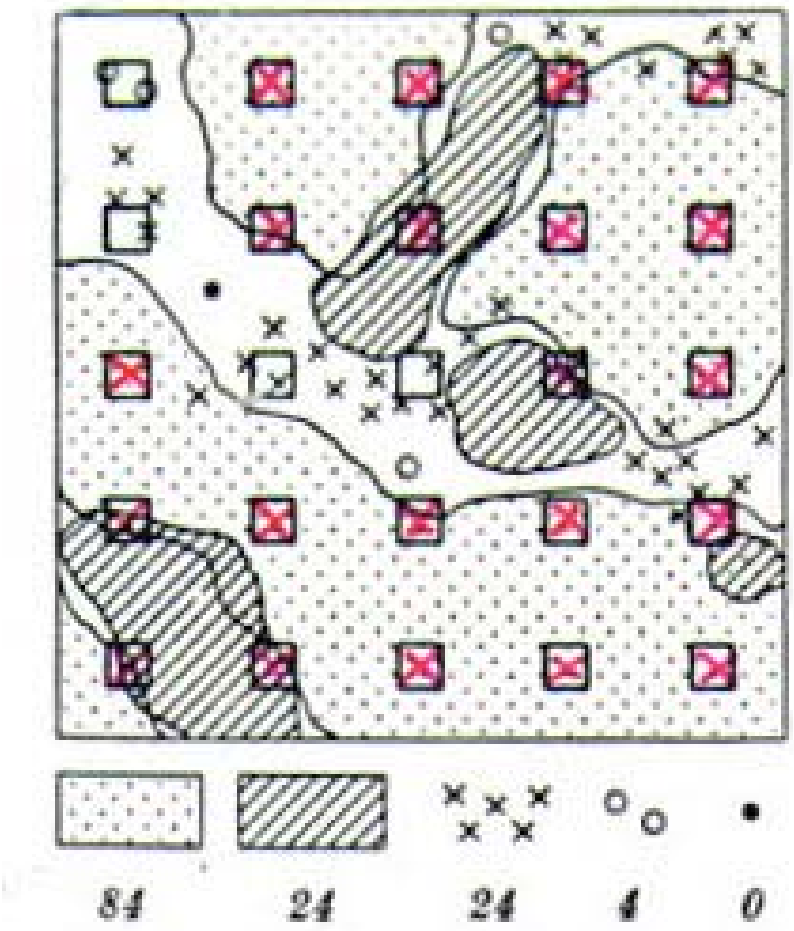


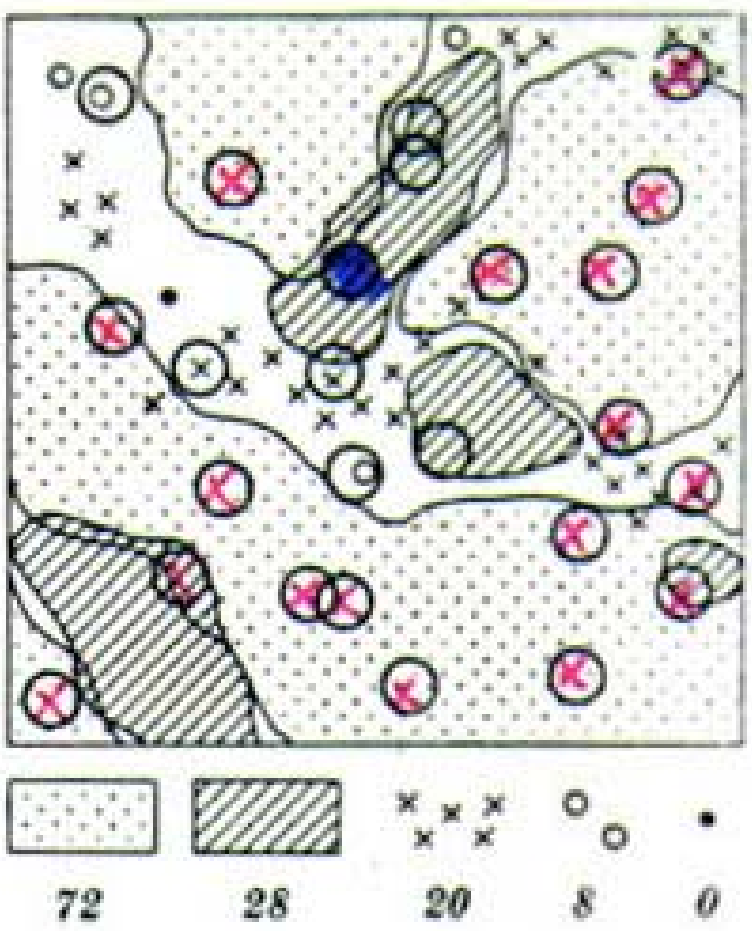
Example at left: Running mean for most species levels off at about 15-20 samples.

Precision vs. Accuracy



Frequency plots





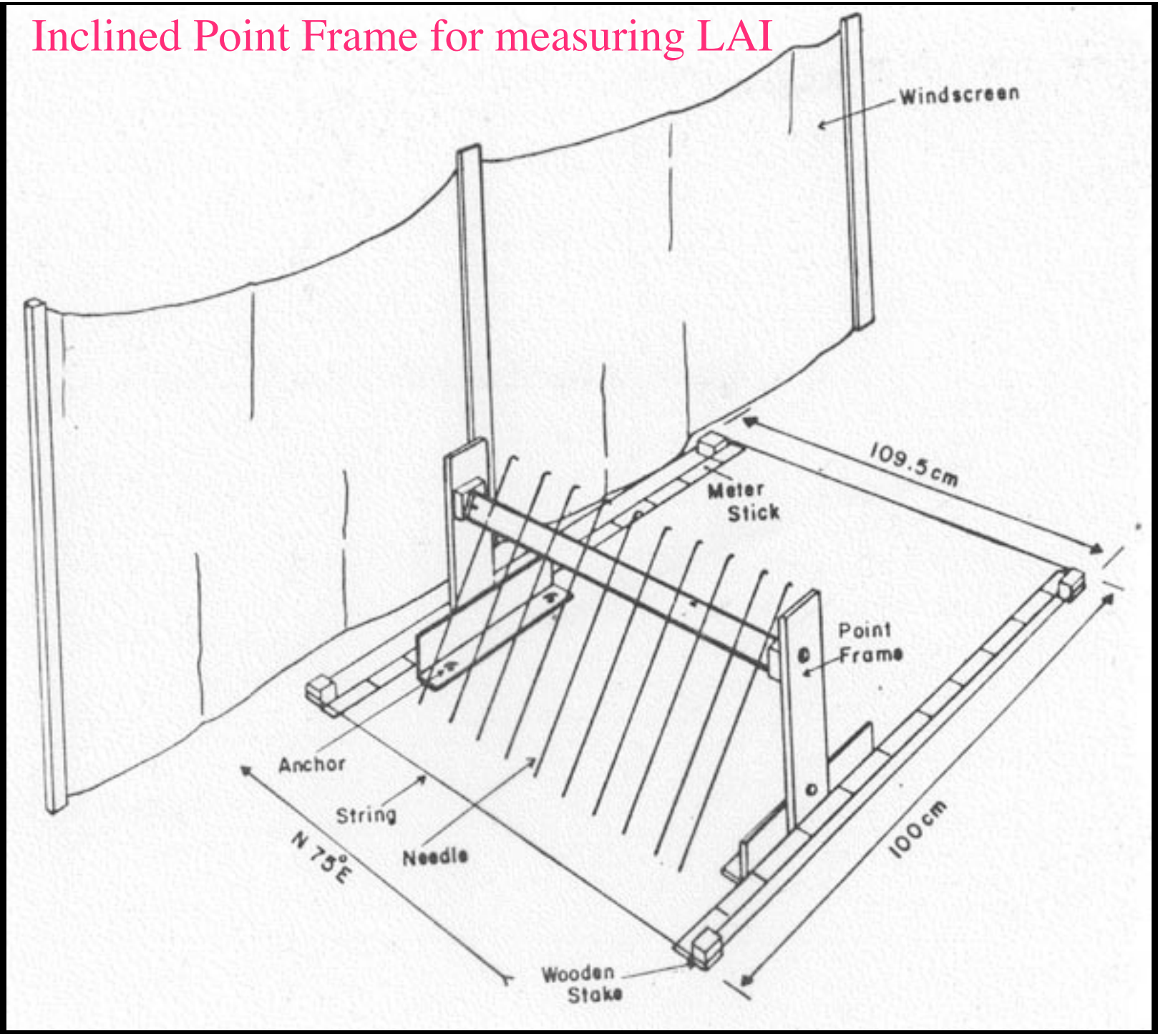
Basal area

- A measure of dominance. Generally used for trees.
- The cross-sectional area of tree stems at breast height per unit of ground area (e.g., m^2/ha)
- Methods of determining basal area
  - Measure tree diameters at breast height with a biltmore stick or diameter tape. Area = $\pi(dbh/2)^2$. This approach is used in count-plot and distance methods (e.g., point-centered quarter method).
  - Bitterlich stick, or angle gauge
- We will discuss basal area more thoroughly when we discuss methods of measuring density and dominance of forest species (point-centered quarter method and count-plot method).

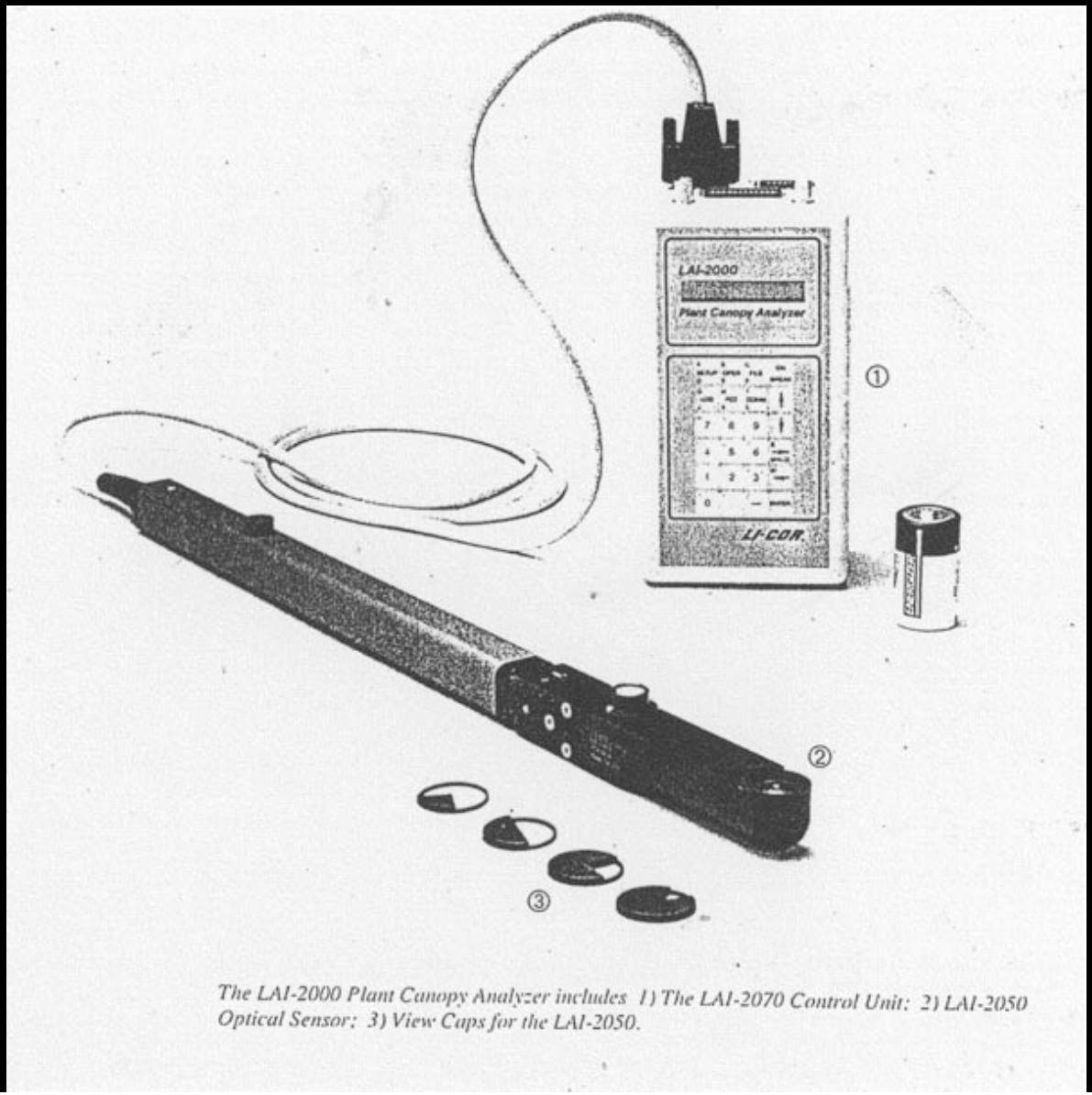
Leaf Area Index

- Leaf area index: The ratio of the total area of photosynthetic leaves to the area of the ground surface.

Inclined Point Frame for measuring LAI



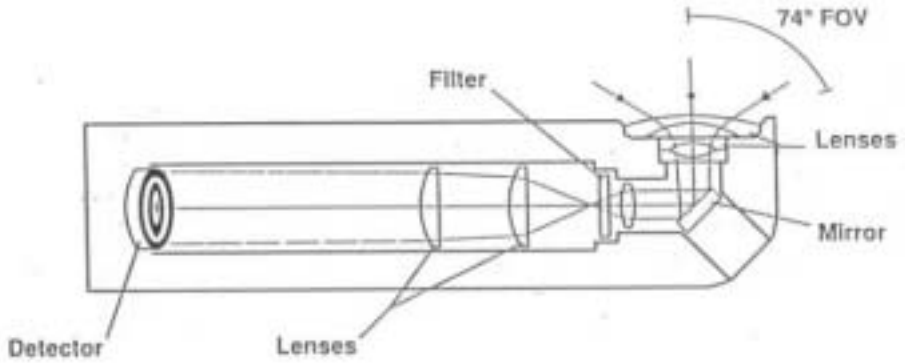
LAI-2000 Plant Canopy Analyzer



The LAI-2000 Plant Canopy Analyzer includes 1) The LAI-2070 Control Unit; 2) LAI-2050 Optical Sensor; 3) View Caps for the LAI-2050.

LAI-2050 Optical Sensor

The heart of the LAI-2000 is the unique design of the LAI-2050 Optical Sensor. The LAI-2050 uses a "fish-eye" lens with a hemispheric field-of-view (zenith cutoff angle = 74°) to project radiation onto the detector. The use of a lens with a "fish-eye" field-of-view assures that LAI calculations are based on a large sample of the foliage canopy.



High precision optics are used to focus radiation onto the detector.

The LAI-2000 Plant Canopy Analyzer

- *Non-destructive measurements of Leaf Area Index (LAI)*
- *Fast measurement times*
- *On-site evaluation of LAI data*

The LAI-2000 calculates Leaf Area Index (LAI) and other canopy structure attributes from radiation measurements made with a "fish-eye" optical sensor (148° field-of-view). Measurements made above the canopy and below the canopy are used to determine canopy light interception at 5 angles, from which LAI is computed using a model of radiative transfer in vegetative canopies.

Above Canopy Measurement

Measurements are made by positioning the optical sensor and pressing a button; data are automatically logged into the control unit for storage and LAI calculations. Multiple below canopy readings and the fish-eye field-of-view assure that LAI calculations are based on a large sample of the foliage canopy.

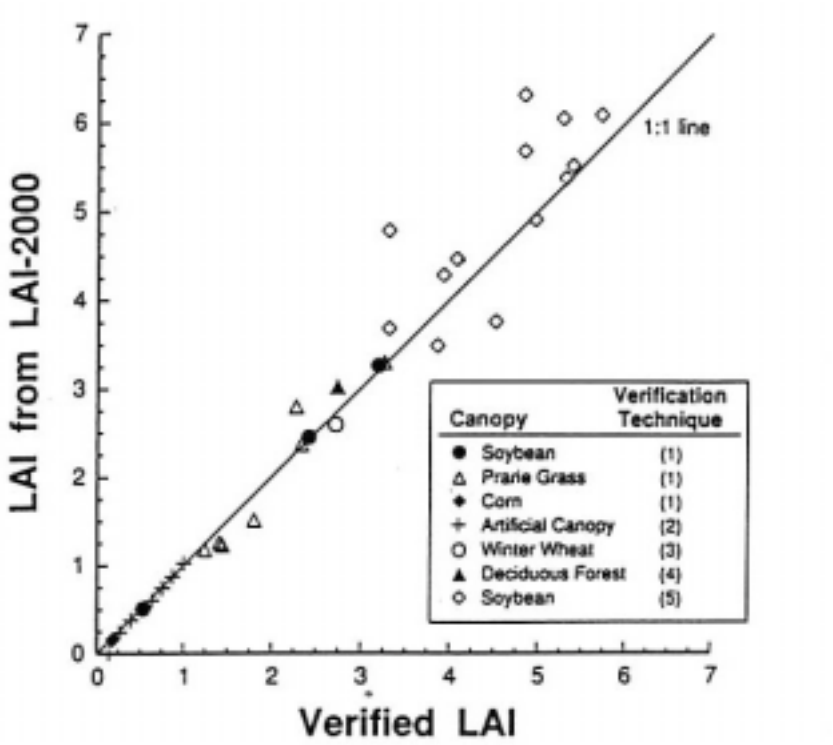
Below Canopy Measurement

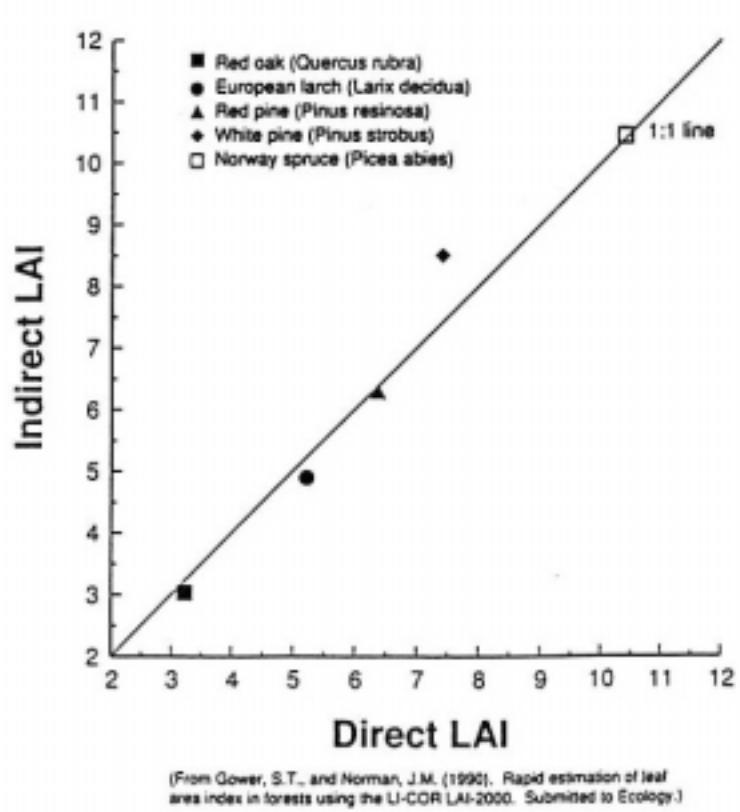
After collecting above canopy and below canopy measurements, the control unit performs all calculations and the results are available for immediate on-site inspection.

The LAI-2000 calculations include:

- Leaf Area Index (LAI) for broad canopies, or foliage density for isolated canopies.
- Mean foliage inclination angle.
- The fraction of the sky visible from beneath the canopy.

Correlation between actual leaf area and LAI measured with the LAI-2000





(From Gower, S.T., and Norman, J.M. (1990). Rapid estimation of leaf area index in forests using the LI-COR LAI-2000. Submitted to Ecology.)