

Vegetation Measurement Methods Comparison

The primary vegetation measurements methods used by Army Installations are presented in the following table. Major vegetation attributes measured include cover, density, frequency, structure, and biomass. To help evaluate the applicability of each method to different monitoring goals and resource situations, the matrix describes sampling methods and provides information such as intended application, strengths, weakness, and technical references. These method descriptions are intended as a resource for LCTA program managers and others involved in the evaluation and selection of sampling methods. A list of general vegetation sampling references are provided following the references cited in the table.

Matrix Comparison of Vegetation Measurement Methods

References Cited in Methods Matrix

General References for Vegetation Measurements and Monitoring

Please submit questions or comments related to this article to :

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A Comparison of the Most Commonly Employed Vegetation Data Collection Methods on Army Installations

	Point-Intercept (original LCTA¹)	Line-Intercept	Daubenmire	Cover Quadrats/ Nested Cover Quadrats
Description	A 1m rod is lowered at 1m intervals along a 100m transect. The contact at ground surface is recorded, i.e. species, litter, etc. Canopy intercepts are recorded by the designated classes from ground level to 8.5 m. See density quadrats for a description of the belt transect methodology.	A measuring tape is stretched between two stakes or points and can be of any length. The intercept distance is recorded for each plant/species that intercepts the line. The accumulated length for any species divided by the length of the transect (tape) multiplied by 100 is expressed as percent cover for that species.	A 20cm x 50cm quadrat is used to estimate percent ground cover. Canopy cover is visually estimated as a vertical projection of a polygon drawn around the extremities of each plant. The projections are summed and recorded in a corresponding cover class. Six cover classes are used and converted to class midpoints for data analysis.	Initially a small quadrat (i.e. 10 x 10 cm) is designated and visual estimates are made of the percentage of the quadrat occupied or covered by a vertical projection to the ground. The area is progressively doubled to twice the area, 4 times, 8 times, etc. The smaller quadrat is nested within the larger quadrat. Cover is estimated relative to the quadrat size with each enlargement.
Intended Application	Ground and canopy cover	Canopy cover	Canopy cover	Canopy cover
Other Potential Uses	Frequency, species composition, vegetation condition and trend	Frequency, basal diameter of species, density (Bonham 1989, p. 177), species composition, vegetation condition and trend	Frequency, species composition, vegetation condition and trend	Frequency, species composition, vegetation condition and trend
Strengths	Objective, rapid and easily taught. Few surveyor decisions.	Canopy cover of different vertical strata can easily be estimated. Equally adaptable to small and large areas. Basal diameter of grasses is commonly employed for monitoring.	Suitable to estimate cover for small shrubs, rhizomatous grasses and bunchgrasses. Cover classes enable repeatable results among surveyors.	Cover estimates are relative to quadrat size.
Limitations	Canopy intercepts are sensitive to wind and surveyor differences. Not recommended for cover less than 5% or greater than 35%. Field sampling design may not be appropriate for all vegetation types in U.S. Difficult to pick up minor species unless a high number of points are used.	Not suitable for dense intermingled herbaceous species. This method is only appropriate for species with a relatively large basal area (i.e. bunchgrasses, shrubs) or small gaps in the canopy.	Not intended for plants greater than 1m in height. Estimates are subject to surveyor bias and requires training to standardize observer estimates.	Cover estimates requires extensive training and repeated comparisons with measured data or between surveyors. Difficult to estimate cover in large quadrats.
Additional Comments	Requires a large number of points to meet sample size adequacy. Focus is on dominant plant species. Use of sharpened pins and pin guide helps to minimize observer bias.	Suitable in sparse vegetation where the plants are distinct and shrub communities, such as the Western U.S.	Data are summarized using the midpoints for the cover class; this results in low precision over time.	In general, cover estimates are desirable when individuals cannot be distinguished.
References	Diersing et al. 1992; Tazik et al. 1992.	Canfield 1941; Bonham 1989.	Daubenmire 1959.	Bonham 1989.

¹ Land Condition-Trend Analysis

Methods Matrix Cont.

	Braun-Blanquet	Density Quadrats (including belt transect)	Modification of the Modified Step-Point	Nested Frequency
Description	A surveyor deliberately and carefully selects a non-random sample location. A detailed description of the sample location is made, which may include information on slope, aspect, soil depth and type. A species list is made. Sites are classified by grouping locations that have a number of species in common. Groups are usually arranged by a computer program and provide a classification from associations.	The number of individual species are counted in each quadrat. Density is expressed as the number of individuals per unit area.	The nearest species to the point in a forward direction, 180° arc along a transect is recorded. Occurrences for each species are summed and divided by the total number of points.	To determine frame size, a small area (i.e. 10 x 10 cm) is designated and all species present are listed. The area is progressively increased to twice its original size, 4 times, 8 times, etc. and with each enlargement any new species encountered are listed. Quadrats are located side by side, with a smaller quadrat located within a large quadrat. Frequency is the percentage of quadrats in which a species is recorded. The optimum frame size for each species should provide a frequency value between 0.2 and 0.8.
Intended Application	Classification of plant communities	Density	Frequency	Frequency - used to determine vegetation condition and trend.
Other Potential Uses	Canopy cover and abundance estimated by seven classes, species composition	Species composition, frequency, monitor population dynamics, including TES	Species composition, vegetation condition and trend	Species composition
Strengths	Detailed description of the area.	Provides a direct count of individuals per unit area.	Quick estimate of species composition. Reduces surveyor bias from pin placement.	Simple to obtain, rapid and objective. Nested frequency is an effective technique to estimate frequency for a number of species. Reduces surveyor bias compared to other techniques.
Limitations	Subjective and dependent upon the experience and knowledge of the vegetation type by the surveyor.	Quadrat size is important. If the quadrat is too small the variation will be high and conversely a large quadrat will be too time consuming.	Unable to conduct statistical analysis for change over time because of the bias. Tend to over estimate frequency if a species is recorded at every point.	Frequency is dependent on the spatial distribution of the species and plant size. Desire frequency estimates between 20% - 80% within a given quadrat size to best detect changes.
Additional Comments	Quadrat size should be no larger than 10m x 10m when numerous species are present for cover estimates. May not detect a change because of decreased precision associated with cover classes.	Surveyor defines what constitutes an individual. Defining an individual can often be difficult for some species, such as sodforming grasses and clonal shrubs. <u>The LCTA belt transect</u> is a form of a density quadrat for estimating density of woody species.	Vegetation condition is based exclusively on vegetation presence/absence and not environmental parameters such as soil stability.	Provides information on the distribution of the species.
References	Braun-Blanquet 1932; Shimwell 1971, Mueller-Dombois and Ellenberg 1974.	Curtis and McIntosh 1950.	Owensby 1973.	Winward and Martinez 1983; Curtis and McIntosh 1950.

Methods Matrix Cont.

	Densiometer	Photographic Monitoring	Forage/Biomass Clipping or Harvest Method
Description	A concave or convex spherical densiometer is held at elbow height. A grid is etched on the surface of the spherical densiometer and the grid intersections (points) are tallied where the canopy is open. Four estimates at the cardinal directions are averaged for each sampling point.	Permanent locations are described and marked. Identical photographic scenes are taken over time. A 28mm or 35mm lens is typically used. <u>Photopoints</u> (qualitative) are general view photographs taken from a permanent reference point to portray dominant vegetation and site conditions. Reference points are noted and marked to ensure replication over time. <u>Photoplots</u> (qualitative or quantitative) are close-up pictures designed to show soil surface characteristics and the amount of ground surface covered by vegetation and litter. Frame size is typically 1m ² . These are analyzed using a slide projector or digital means.	A random transect location and azimuth is established. At a random starting point and at specified intervals, record weights by clipping and weighing all vegetative matter for each species occurring in the quadrat. Bag samples and save for air-dry weighing. Oven-dry samples at 60 °C for 24 hrs. to determine air-dry weight. Pilot studies are necessary to determine the number of samples and the number and size of quadrats to comprise a sample.
Intended Application	Canopy cover (usually for forest)	Visual estimates of changes in vegetation cover, structure, and soil surface conditions. Useful for documenting changes over time	Measuring peak standing crop (above-ground annual production) of each plant species. Best suited for grasslands and desert shrublands
Other Potential Uses			Species composition by weight
Strengths	Most effective in stands of trees taller than 10m.	Effective visual tools synthesize site information. Inexpensive, repeatable. Should be coupled with field observations or quantitative measurements when possible.	May provide continuity with historic data, provides data used in assigning "range condition",
Limitations	Weather conditions may impact the accuracy of the cover estimates, such as bright sun reflecting in the mirror and wind moving the overstory foliage.	Photo plots are more time intensive than photo points, and require analysis in the office.	Seasonal and annual fluctuations in climate can influence plant biomass. Sampling can be time consuming. May be difficult to separate current year growth from previous year. Large numbers of quadrats may be necessary to detect changes.
Additional Comments	Tend to over estimate canopy cover if the understory vegetation is greater than 1m.	Important to conduct photomonitoring during the same season(s) each year.	Requires drying oven and scales. Permanent transects or quadrats are not recommended due to the destructive nature of sampling.
References	Lemmon 1956, Vora 1988.	Bureau of Land Management 1996, Borman 1995, Magill 1989	Bonham 1989, Bureau of Land Management 1996

Methods Matrix Cont.

	Prism Sampling	USDA Forest Health Monitoring (FHM)	Visual Obstruction (Robel Pole) and Cover Board Methods
Description	The surveyor pivots a glass prism 360° over the sampling point. All tree stems that are not completely offset when viewed are tallied. The diameter at breast height (DBH) of each tree is often measured.	FHM is a cooperative, multi-agency program using a multi-layered approach consisting of : Detection Monitoring ; a system of permanent ground plots assessed annually, and aerial surveys of forest pests and other stressors. Plots based on EPA EMAP grid (approx. 4600 forest plots nationally - approx. 27 km apart). Each plot consists of 4 circular subplots (1/60 ha.) placed 36 m apart. Each subplot includes a 1/750 ha. microplot. Tree data and understory vegetation data, area information, and point information are collected. Indicators used to measure condition or change include: lichen communities, ozone bioindicator plants, tree damage, tree mortality, vegetation structure, plant diversity, tree crown condition, tree growth, and tree regeneration. Included in the survey component are symptoms of stress including defoliation, foliage discoloration, tree dieback, main stem and branch breakage, and tree mortality. Evaluation Monitoring : more intensive and specific assessments of changes in forest conditions identified by detection monitoring. Intensive Site Ecosystem Monitoring : a small number of sites (nationally) that represent important forest types are monitored.	Visual Obstruction : Establish the number of vertical cover classes and height limits based on objectives. Select random points along a transect. Two obstruction measurements are made at each point by determining the highest band totally or partially visible and recording the height. Cover Board : A profile or density board is used to estimate the vertical area of a board covered by vegetation from a specified distance away. Transects are often used. Four measurements (offset 90°) are recorded at each observation point.
Intended Application	Basal areas, volumes or numbers of trees per unit area can be computed from the tallied trees.	To monitor, make assessments, and report on the long-term status, changes, and trends in the health of forest ecosystems. Data are intended to assist with national and regional assessments of forest condition. The goal is to integrate plot and survey data to provide a more complete picture of forest conditions. Not intended for detecting small to medium changes at stand to watershed scales.	Vertical cover, vegetation structure - as index of wildlife cover or concealment <u>Visual Obstruction</u> - most effective in upland and riparian areas where perennial grasses, forbs, and shrubs <1 m tall dominate. <u>Cover Board</u> - applicable to wide variety of vegetation types, especially those where significant changes are anticipated (i.e, woody riparian vegetation).
Other Potential Uses		Higher plot densities could provide some information at the management unit level.	Visual obstruction (Robel pole) - estimation of production.
Strengths	Ability to estimate timber parameters for large area. Cost-efficient and precise estimate of volumes.	Provides standard protocols and reporting procedures across states, and long-term continuity. Uses numerous indicators to assess condition.	Measurements are simple, quick and accurate. Training required in laying out transects and determining cover classes/percent cover.
Limitations	Sighting difficulties in dense stands; angle gauge would be more suitable. Does not provide a good estimate of stand structure, such as regeneration (trees/ac).	Sampling density is very low (FMH plot density = 1 plot per 63,942 ha.), therefore, little power to extrapolate beyond the specific plot areas. Most useful for high level information reporting. Information needs to be integrated with other data sources.	Visual obstruction: infrequent application in a wide variety of rangeland ecosystems.
Additional Comments	Also referred to as probability proportional to size (PPS) sampling. Larger trees have a higher probability of selection. Requires training in selecting the appropriate prism and correcting for slope.		
References	Avery and Burkhardt 1995.	Burkman 1992, USDA Forest Service 1997.	Bureau of Land Management 1996, Mitchell and Hughes 1985, Nudds 1997.

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