An Approach to Plot Sampling for Canopy Volume in Shrub Communities

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Abstract

A method of plot sampling for canopy volume of shrubs in plant communities is described. The method requires a three dimensional plot and an estimation of canopy volume by classes for each species in the plot. Midpoint values for the volume classes are used to calculate averages from an appropriate sample size. The method eliminates the necessity of measuring height and canopy diameters of individual species and provides an acceptable index to species dominace in the vegetation.

Daubenmire (1968) describes canopy volume as a structural parameter which can be used to determine and compare dominance of plant species in plant communities. He suggests that by measuring the heights and diameters of canopies, then calculating volumes by assuming a cylindrical form, an effective measure of dominance can be derived. The method has not been widely applied in synecological studies; however several investigators have used canopy volume measurements as a means of estimating biomass or current year twig production of shrubs (Lyon 1968; Bentley et al. 1970; Peek 1970: Leege and Hickey 1971: Nieman 1977: Rittenhouse and Sneva 1977; Uresk et al. 1977; and Bryant and Kothmann 1979).

The purpose of this paper is to describe a plot sampling method for determining shrub canopy volume as a quantitative index to species dominance and composition. The method was patterned after a procedure proposed by Daubenmire (1959) for measuring canopy coverage using a plot frame and estimating species canopy area by percentage classes. The procedure described herein was developed during a study of clearcut transitory range in grand fir *(Abies grandis)* forests of northcentral Idaho (Zamora 1975). The initial objective in the use of the procedure was to assess the quantity of shrub canopy volume available for deer, elk, and moose browsing in shrub communities. The method proved to be a rapid means of estimating canopy volume by species in dense shrub

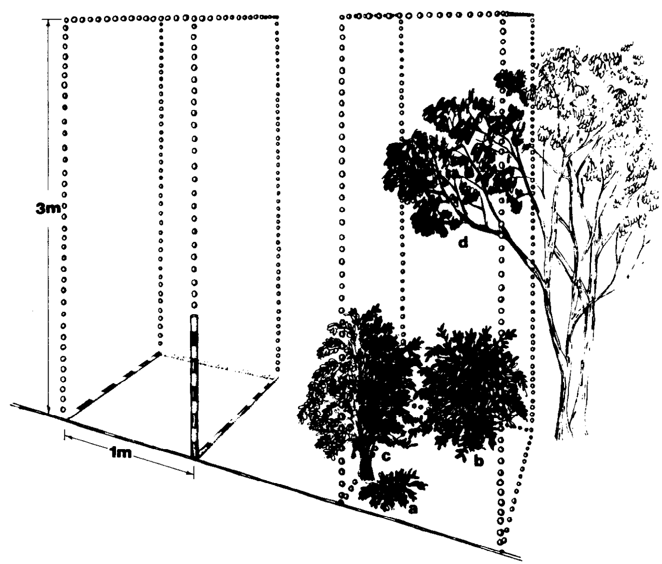

Fig. 1. *A diagrammatic representation of the three-dimensional plot used to sample canopy volume of shrubs. Canopy volume class estimates illustrated are: a =*class 1, b = *class 3, c= class 2, d = class 4. Only that portion of a canopy that falls within the plot is used in making the estimate by volume classes (examples c and d) as illustrated by the darkly shaded area.*

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Table 1. Volume classes and dimensions used to assess shrub canopy volume.

Volume class	Volume class as percentage		Volume class as cubic space[a]		Convenient dimensions used to estimate upper limits of volume classes[a,b]
	Range (%)	Class midpoint (%)	Range (dm^3)	Class midpoint (dm^3)	
1	0–1	0.5	0–30	15	3.1^3 dm
2	1–5	3.0	30–150	90	5.3^3 dm
3	5–10	7.5	150–300	225	6.7^3 dm or 3 × 10 × 10
4	10–25	17.5	300–750	525	10 × 10 × 7.5 dm
5	25–50	37.5	750–1500	1125	10 × 10 × 15 dm
6	50–75	67.5	1500–2250	2025	10 × 10 × 22.5 dm
7	75–95	85.0	2250–2850	2550	10 × 10 × 28.5 dm
8	95–100	97.5	2850–3000	2925	10 × 10 × 30 dm

[a]Based on a plot size of 1 × 1 × 3 meters.
[b]Approximate dimensions.

communities and provided an effective measure of species dominance in the lower strata of vegetation.

The method requires a three dimensional plot. The plot is 1 m^2 in horizontal dimensions with a 3-meter vertical dimension (Fig. 1). The m^2 horizontal dimension of the plot was chosen to insure adequate sampling of widely spaced shrubs and to allow relative ease in observation and maneuverability along transects in dense brush. It is important to point out that the plot size and shape can be adjusted according to the nature of the vegetation and objectives of the study. The plot can be located by any sampling technique, but the one most frequently used by the author was systematic sampling along designated transects. The vertical dimension was set at 3 meters because deer, elk, and moose normally do not browse above this height.

Three separate poles, each 1 meter in length and marked in decimeters, are used to delineate plot boundaries. Experience with the system has demonstrated that if the horizontal dimensions of the plot are carefully located, accuracy and consistency in establishing the vertical plot boundaries can be easily achieved.

Within the boundaries of each plot, total canopy volume is estimated for each shrub species and recorded as one of eight volume classes (Table 1). Each estimate includes not only the canopy of a shrub species rooted within the plot boundaries but also overhanging canopies of that species rooted outside the plot (Fig. 1). Individuals of each species are not recognized but rather lumped into one estimate of canopy volume for that species in each plot. Where the canopies of two or more species are intertwined, the canopies are visually separated for estimation. The upper dimensional limits of each volume class (Table 1) can be simulated with boxes to train technicians in the recognition of volume classes.

To derive an estimate of canopy volume percentage or cubic canopy space per species per 3 m^3, the midpoint for each volume class recorded for the species among the plots is averaged for the entire sample. It is important to recognize that each volume class represents a finite range of cubic space. It is assumed that actual canopy volume values are normally distributed around the midpoint within each class. When midpoint values of observed classes for a species in a sample are averaged to derive a statistical estimate, a high degree of accuracy is maintained in the estimate. To obtain canopy volume per 3 m^3, species averages are summed. Because each species within a plot is considered separately in volume estimates and species with smaller canopies can be included within canopies of other species, the total canopy volume estimate for a plot may exceed 100 percent.

Sample size and the time required to acquire a sample is dependent upon the uniformity, diversity, and structure of the vegetation. Examples of sample sizes required for three contrasting community types based on coefficients of variation are shown in Table 2. The most time consuming situation that the author experienced was a 23-year old clearcut where the stand was highly diverse in composition and complex in structure; 50 plots required three man hours to measure.

Table 2. Number of 3 m^3 plots required to achieve sampling precisions (E) of ± 10, 20, and 30 percent of the mean total canopy volume of shrub populations in three age classes of grand fir clearcuts in Northern Idaho at the 80, 90, and 95 percent confidence levels.[1]

Sampling precision	Confidence level		
	80%	90%	95%
Three-year-old clearcut (CV=168%)[2]			
E± 10%	464	764	1084
20%	116	191	271
30%	52	85	120
Twelve-year-old clearcut (CV=76%)			
E± 10%	95	156	22
20%	24	39	55
30%	11	17	25
Twenty-three-year-old clearcut (CV=63%)			
E± 10%	65	107	152
20%	16	27	38
30%	7	12	17

[1]Sample size formula: $n_o = \frac{t^2\,CV^2}{E^2}$
[2]CV = coefficient of variation

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