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Research Note

The Influence of Gap Size on Sagebrush Cover Estimates With the Use of Line Intercept Technique

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Abstract

Sagebrush cover is often estimated with the use of the line intercept method. However, a lack of standardized protocols may lead to variable estimates of sagebrush canopy cover. Our objectives were to determine the influence of gap size on 1) sagebrush canopy cover estimates, 2) time needed to read a transect, and 3) among-observer variability in sagebrush canopy cover estimates. We utilized 5-, 10-, and 15-cm gaps, and defined a *gap* as a lack of continuous live or dead shrub canopy. In instances where a segment of dead cover was less than the gap size and adjoined live cover, the dead cover was measured as live. We evaluated canopy cover at 6 Wyoming big sagebrush (*Artemisia tridentata* Nutt. ssp. *Wyomingensis* Beetle & A. Young) sites in southeast Oregon. At each site, four 2-person teams measured sagebrush canopy intercept along 50-m transects. Each transect was read by multiple teams to allow for assessment of among-observer variability. Intercept values were converted to percent canopy cover and we used analysis of variance to determine the influence of site and gap size on measurement time and cover estimates. Observer variability was highest at the intermediate gap size (i.e., 10 cm). Transect measurement time was longest with the use of a 5-cm gap ($P < 0.001$). Total cover estimates were not related to gap size ($P = 0.270$). Live canopy cover estimates increased ($P < 0.001$) from 12.1% to 14.5% with increasing gap size, and cover of dead material decreased ($P = 0.015$) from 4.4% to 3.2%. These differences are small in magnitude and would not likely change a gross assessment of vegetation status. However, use of a standardized gap size will enhance comparability of canopy cover estimates among studies and will decrease between-year sampling error for repeat monitoring.

Resumen

La cobertura de “Sagebrush” a menudo es estimada usando el método de línea de intercepción, sin embargo, la falta de protocolos estandarizados puede conducir a estimaciones variables de la cobertura de copa del “Sagebrush.” Nuestros objetivos fueron determinar la influencia del tamaño del hueco en: 1) las estimaciones de la cobertura de copa del “Sagebrush,” 2) el tiempo necesitado para leer el transecto, y 3) la variabilidad entre observadores en la estimación de la cobertura de copa del “Sagebrush.” Utilizamos huecos de 5, 10, y 15 cm y definimos un “hueco” como la falta de continuidad de la copa, viva o muerta, del “Sagebrush.” En los casos donde un segmento de cobertura muerta, adyacente a cobertura viva, era de menor tamaño que el hueco este se midió como cobertura viva. Evaluamos la cobertura de copa en seis sitios de “Wyoming big sagebrush” (*Artemisia tridentata* Nutt. ssp. *Wyomingensis* Beetle & A. Young) en el sudeste de Oregon. En cada sitio, cuatro equipos de dos personas midieron la intercepción de la copa del “Sagebrush” a lo largo de transectos de 50 m. Cada transecto fue leído por los diferentes equipos para evaluar la variabilidad entre observadores. Los valores de intercepción fueron convertidos a % de cobertura de copa y usamos el análisis de varianza para determinar la influencia del sitio y tamaño del hueco en el tiempo de medición requerido y las estimaciones de cobertura. La mayor variabilidad entre observadores se dio en huecos de tamaño intermedio (10 cm). El mayor tiempo para medir el transecto se obtuvo usando huecos de 5 cm ($P < 0.001$). Las estimaciones de cobertura total no estuvieron relacionados con el tamaño del hueco ($P = 0.270$). Las estimaciones de cobertura viva aumentaron ($P < 0.001$) de 12.1 a 14.5% al incrementar el tamaño del hueco y la cobertura de copa muerta disminuyó ($P = 0.015$) de 4.4 a 3.2%. Estas diferencias son pequeñas en magnitud y probablemente no cambiarían la evaluación total del estado de la vegetación. Sin embargo, el uso de un tamaño de hueco estandarizado mejoraría la capacidad de comparación de las estimaciones de cobertura de copa entre estudios y disminuiría el error de muestreo entre años para repetir el monitoreo.

Key Words: Vegetation inventory, wildlife habitat, sage-grouse, sagebrush obligate

INTRODUCTION

Measuring abundance of woody plant species has often proven difficult in the field because of observer variability (Hall and Max 1999), irregular shrub morphology (Bryant and Kothmann 1979), and a lack of standardized techniques (Harniss and Murray 1976). Greater sage-grouse (*Centrocercus urophasianus*), a sagebrush (*Artemisia* spp. Nutt.) obligate

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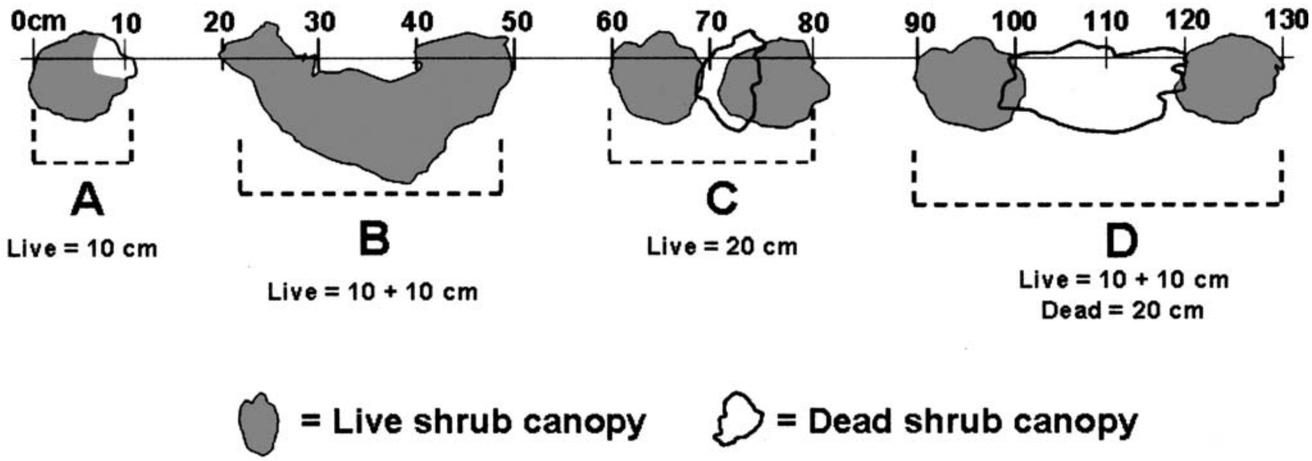

Figure 1. Hypothetical line intercept measurement of shrubs with the use of a 10-cm gap size illustrating the various gap rules incorporated in this study. In scenario A both the live and dead shrub canopy intercept would be measured collectively, because the gap in live canopy is $<$ 10 cm. In scenario B, intercept would include separate measurements for both shrub segments. The area in between these segments would not be measured, because the gap is $>$ 10 cm. In scenario C, a single intercept measurement is recorded across both live shrubs because the gap between live shrub canopy is $<$ 10 cm; the dead canopy is not recorded for the same reason. In scenario D the intercept of dead canopy is recorded because live shrubs are $>$ 10 cm apart; live shrubs are measured separately for the same reason.

inhabiting portions of most western US states, have experienced marked decline in recent years (Connelly and Braun 1997). This species depends on sagebrush as both a source of cover (Gregg et al. 1994) and forage (Patterson 1952; Barnett and Crawford 1994). Line-intercept–based techniques (Canfield 1941; Hanley 1978; Bonham 1988) are frequently used to estimate cover in sage-grouse habitat to assess habitat suitability (e.g. Klebenow 1969; Sveum et al. 1998) and these values may in turn be used for developing habitat management guidelines (e.g., Connelly et al. 2000). At present there has been little effort to standardize techniques for line intercept measurement. Variability in technique could influence perceptions of the habitat requirements for sage-grouse and other sagebrush obligates, as well as comparability of results from different studies. The present literature reflects a wide variety of line intercept field protocols to characterize sage-grouse habitat, including variable transect length and transect layout. A gap refers to a break in contiguous shrub cover. Ideally, gaps smaller than a predetermined size are ignored, and larger gaps are excluded from the measurement of canopy cover. Wambolt et al. (2006) compared line intercept results between a 3-cm gap and no gap (i.e., intercept of entire plant canopies), but to date, there are no published articles that characterize how different gap sizes impact canopy cover estimates along a line intercept transect. Our objectives were to determine if varied gap sizes influence 1) sagebrush canopy cover estimates, 2) time necessary to measure sagebrush canopy cover, and 3) observer variation in sagebrush canopy cover estimates along 50-m transects.

METHODS

All data were collected in Wyoming big sagebrush (*Artemisia tridentata* Nutt. ssp. *Wyomingensis* Beetle & Young) communities located within the 6 500-ha Northern Great Basin Experimental Range in Harney County, Oregon. Data were collected on 27 August 2003 after ephemeral leaf drop. We selected 6 sites that were representative of the continuum of shrub canopy cover present in Wyoming big sagebrush communities at the experimental range. At each site we ran 4 parallel 50-m transects spaced 15 m apart. Transects were marked with 50-m plastic tapes, pulled taut, and staked on both ends. Four teams of 2 persons were then randomly assigned 2 transects per site to measure shrub canopy cover. Observers measured canopy intercept from the plastic tape, or with a smaller handheld metal tape. Within a team, 1 person always read canopy cover at all sites/transects, and the second recorded data and kept track of the time it took to complete the cover readings on each transect.

Gaps were defined by a lack of continuous live or dead shrub canopy within or between (i.e., interspace) canopies of individual shrubs. Breaks in cover larger than a specific gap size were excluded from canopy measurement (Fig. 1). In instances where a segment of dead cover was less then the gap size and adjoined live cover, the dead cover was measured as live (e.g., Fig. 1, scenarios A and C). Each team measured live and dead sagebrush canopy intercept using 5-, 10-, and 15-cm gap sizes along each measured transect. Starting and ending times were recorded for each transect/gap size combination.

Summed shrub intercept data were converted to percent canopy cover prior to analysis by dividing measured intercept in centimeters by total transect length (cm). In our sample design, each transect was measured by 2 teams. We examined distribution of residuals for response variables for departures from normality and tested for homogeneous variances among treatment groups using Levene's test (PROC GLM, SAS 1999). We used analysis of variance (PROC GLM, SAS 1999) to determine the influence of gap size on shrub canopy cover estimates and measurement time using the model: $y =$ gap size + site + gap size $\times$ site, where $y =$ % live, dead, and total shrub canopy cover (i.e., live + dead) or measurement time in minutes. When significant main effects were detected, differences in treatment means were assessed using the LS MEANS (SAS 1999) procedure. Differences were considered significant at $\alpha = 0.05$. Canopy cover values for sites were derived by averaging across transects within site, observers, and gap sizes. Cover values and measurement times for gap sizes were averaged across sites and observers. We indexed among-observer variability in cover estimates by averaging the 2 estimates of total sagebrush cover within a gap size (i.e., each transect was measured by 2 teams), and dividing the difference between these estimates by the mean value; the result was expressed in percent format. All means are reported with the associated standard error.

RESULTS

Data for all response variables did not exhibit large departures from normal distribution, and variances were homogeneous ($P > 0.05$) among treatment groups. Total sagebrush canopy cover ranged from 15% to 22% across sites. Percent live ($P < 0.001$), dead ($P = 0.003$) and total ($P < 0.001$) canopy cover values varied among sites. Live canopy cover was about 3 times greater than dead at most sites. Transect measurement time was similar for 10- and 15-cm gap sizes and was longest for the 5-cm gap size ($P < 0.001$, Fig. 2A); values ranged from 4.1 (±0.2) minutes for a 15-cm gap to 5.6 (±0.3) minutes for a 5-cm gap. Gap size influenced estimates of percent live ($P < 0.001$) and dead ($P = 0.015$) shrub canopy cover (Fig. 2B and 2C), but not total shrub canopy cover ($P = 0.270$, Fig. 2D). Live canopy cover estimates increased from 12.1% to 14.5% with increasing gap size; conversely dead cover estimates decreased from 4.4% to 3.2% with increasing gap size. Among-observer variability in cover estimates was highest with a 10-cm gap (12.5% ± 1.9) as compared to the 5- (8.5% ± 1.3) and 15-cm (9.0% ± 1.7) gap sizes.

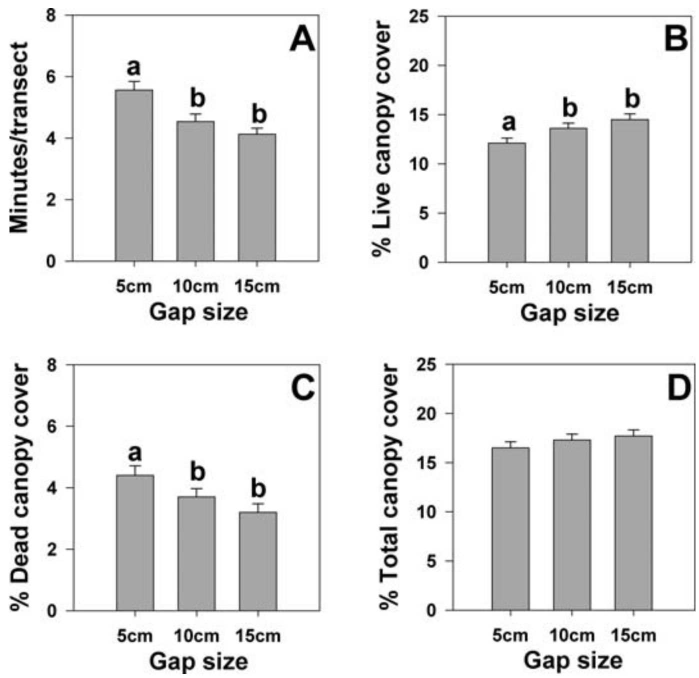

Figure 2. The effects of gap size on **A**, time per transect; and **B**, percent live; **C**, dead; and **D**, total sagebrush canopy cover for Wyoming big sagebrush communities in southeastern Oregon. Values within panels for bars without common letters are different at $\alpha = 0.05$. Bars represent averages across sites and observers. Error bars are ± 1 standard error.

DISCUSSION

The range of sagebrush canopy cover values at our sites is within that reported by others for Wyoming big sagebrush communities in eastern Oregon (Davies 2005). Although we did find differences in live and dead canopy cover estimates among gap sizes, the magnitude of differences (2.4% and 1.3% difference for live and dead cover, respectively) would likely not impact assessments of vegetation status relative to broad management objectives. Our data suggest that variation due to gap size is similar to among-observer error. However, for research purposes, or when determining compliance with management guidelines (e.g., cover requirements for wildlife species), a difference of over 2% live canopy cover among gap sizes may be sufficient to warrant concern. In these cases, gap size should be clearly defined in measurement procedures and the initial gap size retained in future measurements. In addition to the size of gap used, rules for deciding gaps may affect canopy measurements. Rules should specify if gaps apply to both individual shrub canopies and interspaces, and under what circumstances gaps are associated with live or dead aerial cover. Further, standardizing gap sizes will enhance comparability of canopy cover estimates among various studies.

The inverse behavior of live and dead canopy cover estimates with increasing gap size (i.e., live cover increased and dead cover decreased) is related to the fact that our gap sizes were primarily defined by the absence of live cover. For example, if a 6-cm patch of dead canopy was present within an otherwise contiguous live canopy, that dead patch would be measured separately with the use of a 5-cm gap, but would be included in the measurement of live canopy with a 10- or 15-cm gap (see Fig. 1). We also found that among-observer variability in cover estimates was highest with an "intermediate" gap size. This trend may have been related to greater difficulty in recognizing an intermediate gap size relative to larger or smaller gap sizes.

MANAGEMENT IMPLICATIONS

In summary, growing concern over sagebrush habitats has increased the need for accurate measures of sagebrush cover (Crawford et al. 2004). Our results indicate that variable gap size (from 5 to 15 cm) is not a major source of variation in total sagebrush canopy cover estimates with the use of the line intercept technique. Intermediate gap sizes (e.g., 10- vs. 5- or 15-cm gap) may generate higher among-observer variability in cover estimates. Although monitoring efforts using 5-, 10-, or 15-cm gaps should be generally comparable for measurement of total sagebrush canopy cover, live and dead sagebrush cover estimates were affected by gap size in our study, suggesting that a specific gap size be set and maintained throughout data collection efforts. The impetus for this study was sage-grouse; however, our general findings may have applicability to measurement of other shrub species [e.g., bitterbrush (*Purshia* *tridentata* (Pursh) DC)] as well as to measurement of habitat parameters for other shrub-dependent wildlife species [e.g., mule deer (*Odocoileus hemionus*) or sage sparrow (*Amphispiza belli*)].

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