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View Point

Daubenmire Versus Line-Point Intercept: A Response to Thacker et al. (2015)

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On the Ground

- Thacker et al. compared two common techniques for assessing greater sage-grouse habitat: Daubenmire quadrats and line-point intercept sampling.
- Sampling only 16 Daubenmire quadrats may not have been adequate to support Thacker et al.'s assertion that line-point sampling yields higher cover values and that the two methods are not comparable.
- Using data from sagebrush ecosystems in Montana, we show that mean percent cover changes depending on the number of Daubenmire quadrats sampled and that 16 Daubenmire quadrats may not be sufficient to accurately characterize sagebrush vegetation.
- Assessing the appropriate sampling effort for the method and study is a crucial part of designing sampling protocols and has implications for greater sage-grouse management and conservation.

Keywords: *Artemisia tridentata*, Daubenmire quadrats, habitat assessment, line-point intercept, greater sage-grouse, sampling methodology.

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Evaluating and comparing habitat assessment techniques is important for successful and efficient habitat management and conservation. We applaud Thacker et al.[1] for comparing the two most common assessment techniques for greater sage-grouse (*Centrocercus urophasianus*) habitats: Daubenmire quadrats and line-point intercept. This comparison is especially timely in light of the widespread concern about degradation and loss of greater sage-grouse habitat, which has resulted in greater sage-grouse population declines.[2] As a result, the greater sage-grouse is currently being considered by the U.S. Fish and Wildlife Service for listing on the Endangered Species Act, and thus assessing the validity of habitat assessment methods has become even more important.

Methods Used for Greater Sage-Grouse Habitat Quality Assessment

Determining the best and most efficient technique to assess the vegetation component of the greater sage-grouse habitat will aide in both identifying high-quality greater sage-grouse habitat and will inform restoration on degraded habitat patches. Thacker et al.'s[1] results showed that the line-point intercept method consistently produced higher cover values compared with Daubenmire quadrats for each of the plant functional groups analyzed (perennial grasses, annual grasses, and forbs). This suggests that the two common methods for quantifying vegetation cover in sagebrush ecosystems are not equivalent and may lead to different conclusions regarding the quality of the greater sage-grouse habitat. Thacker et al.[1] suggested that greater sage-grouse researchers should use both sampling strategies because the majority of studies used Daubenmire quadrats and utilizing both will allow for comparisons with previous studies.

There is no easy way to quantify the actual cover value of functional groups in the field without systematically mapping the size and location of each individual plant. Therefore, methods that are rapid and easily replicated, such as Daubenmire quadrats and line-point intercept, have been used to quantify vegetation, with the caveat that these methods require large sample sizes.[2–4] Thacker et al.[1] sampled 200 points (every 20 cm along four 10 m transects) at each location and 16 Daubenmire quadrats (0.1 m^2) per location. However, Connelly et al.[2] suggested 50 Daubenmire quadrats, and Stiver et al.[5] recommended 100 to assess herbaceous vegetation within the greater sage-grouse habitat. In our estimation, Thacker et al.[1] may not have achieved an adequate number of quadrats for a meaningful comparison of methods. Therefore, we pose this question: Are 16 Daubenmire quadrats enough to estimate the mean cover for perennial grasses, annual grasses, and forbs within sagebrush ecosystems?

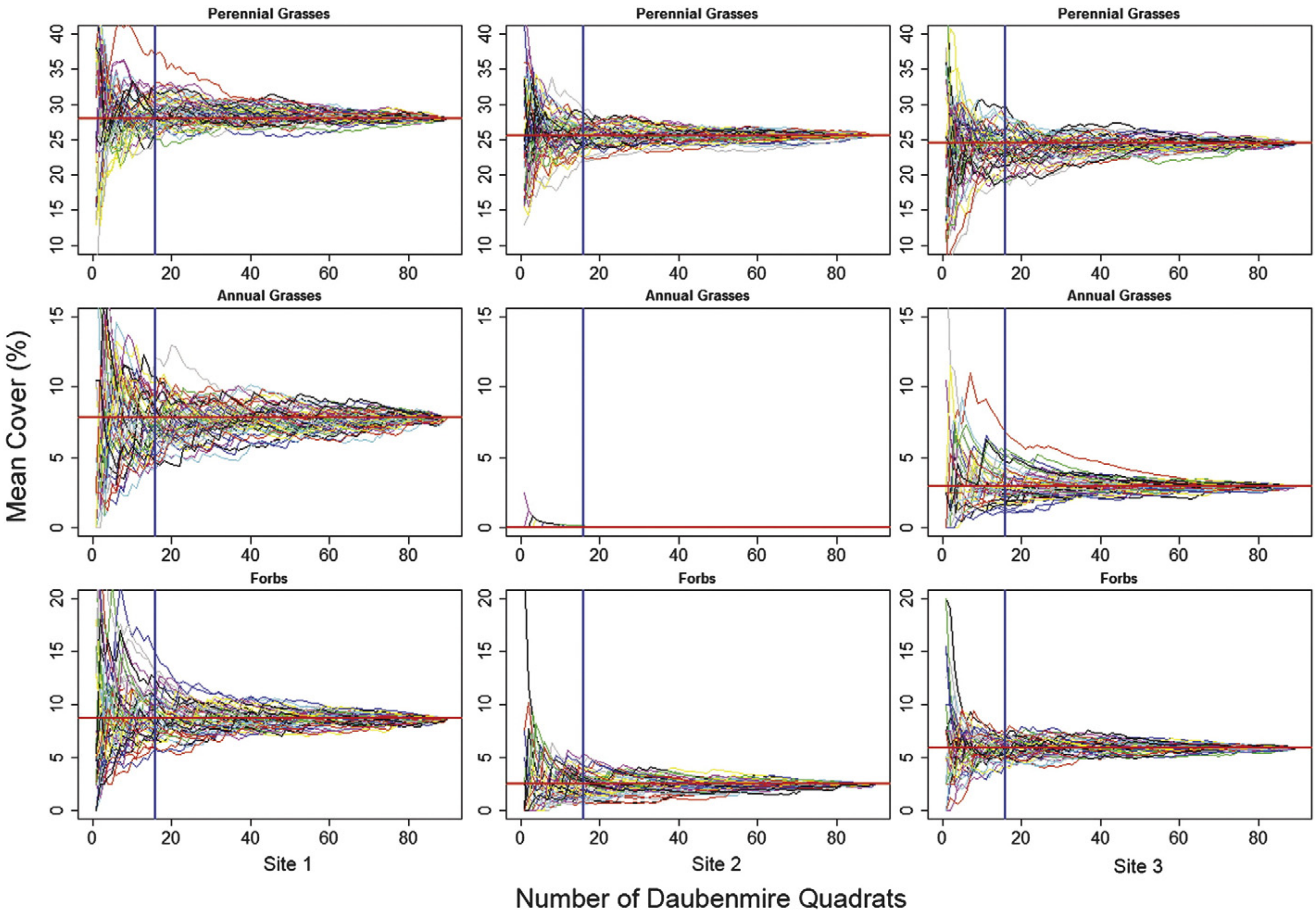

Figure 1. Mean cover (%) as a function of the number Daubenmire quadrats used to estimate those values. Values shown are for 50 iterations and 90 Daubenmire quadrats per site. The red horizontal line is the mean for each site, and the blue vertical line indicates 16 Daubenmire quadrats. Represented are the mean cover (*y* axis) for all functional groups (Perennial Grasses, Annual Grasses, and Forbs) (ordered from top to bottom in each panel) and sites (1, 2, 3) versus number of Daubenmire quadrats (190 quadrats).

How Many Daubenmire Quadrats Are Enough?

To address this question, we analyzed data from three big sagebrush (*Artemisia tridentata*) sites in northeastern Montana in the United States. At each site, we established three 10 × 10 m plots, and within each plot, we randomly placed 30 Daubenmire quadrats to characterize the vegetation, for a total of 90 quadrats per site. We assigned each species a canopy cover class (1 = 1–5%; 2 = 6–15%; 3 = 16–25%; 4 = 26–40%; 5 = 41–60%; 6 = 60–100%) and used the midpoint of the cover class for our analysis.[4] We assigned each species to a functional group used in Thacker

Table 1. Comparison of percent cover for each functional group (perennial grasses, annual grasses, and forbs) at 16 Daubenmire quadrats within each site (Sites 13)

	Functional groups			
	Perennial grasses			
Site	**$Mean_{16}$ Low**	**$Mean_{16}$ High**	**$Mean_{90}$**	**$Mean_{16}$ Difference**
1	25	37	27	12
2	21	29	25	8
3	18	29	24	11

$Mean_{16}$ Low indicates lowest mean at 16 Daubenmire quadrats across 50 iterations within each site and plant functional group (the lowest value at blue line in Fig. 1); $Mean_{16}$ Highest, highest mean at 16 Daubenmire quadrats across 50 iterations within each site and plant functional group (the highest value at blue line in Fig. 1); $Mean_{90}$, the mean calculated using all 90 Daubenmire quadrats for each site and plant functional group; and $Mean_{16}$ Difference, the difference in percent cover between $Mean_{16}$ High and $Mean_{16}$ Low.

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et al.[5] and then analyzed the change in mean cover value for each functional group as the number of quadrats increased.

Specifically for each site, a random Daubenmire quadrat was selected without replacement from our dataset of 90 quadrats. We calculated a mean cover value for each functional group and then randomly selected another quadrat from the dataset and recalculated the mean value. This process was repeated until all 90 Daubenmire quadrats from the site were included in the calculation. We repeated this analysis for 50 iterations and graphed the functional group mean cover for each iteration as a function of the number of quadrats (Fig. 1). We then extracted the mean cover for each site, functional group, and iteration at 16 Daubenmire quadrats to assess the range in cover values and calculated the difference in cover values between the lowest and highest iterations at 16 quadrats (Table 1).

The Percent CoverQuadrat Number Relationship

For all sites, cover converged around the mean value at a similar rate (see Fig. 1). At 16 Daubenmire quadrats, the mean cover value and difference in cover across iterations for annual grasses, perennial grasses, and forbs were 5 (± 4)%, 10 (± 3)%, and 6 (± 3)%, respectively (see Table 1). These values are similar to the differences Thacker et al.[1] found between line-point intercept and Daubenmire quadrats, approximately 3%, 9%, and 7%, for annual grasses, perennial grasses, and forbs, respectively. This suggests that differences in cover values between the two sampling methods could have been a result of random sampling effects.

Our analysis was not able to identify which of the two methods—line-point intercept or Daubenmire quadrats—is more accurate at quantifying functional group cover values in sagebrush ecosystems. Here, we showed that cover values for Daubenmire quadrat sampling in three sagebrush plant communities are sensitive to the number of quadrats sampled. We have no data for the line-point intercept method, so we cannot assess whether Thacker et al.'s[1] number of points (n = 200) was adequate. However, Abrahamson et al.[3] used 2656 points and 800 quadrats in six different plots in their comparison of methods for sampling understory vegetation. We suggest a follow-up study to compare both methods with more samples to assess if these two methods produce similar results.

When designing sampling protocols it is crucial to assess the appropriate sampling effort for the method, study, ecosystem, scale, or organism in question. Furthermore, it may also be necessary to identify if differences detected between sampling methods/efforts are statistically significant and whether they would affect the conclusions of the study.

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Functional groups							
Annual grasses				Forbs			
Mean$_{16}$ Low	Mean$_{16}$ High	Mean$_{90}$	Mean$_{16}$ Difference	Mean$_{16}$ Low	Mean$_{16}$ High	Mean$_{90}$	Mean$_{16}$ Difference
5	13	8	8	6	15	9	7
0	0	0	0	0	5	3	5
3	9	3	6	5	9	6	4