Technical Notes

Evaluation of the Dry-weight-rank Method for Determining Species Composition in Tallgrass Prairie

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Abstract

The dry-weight-rank (DWR) method for determining species composition of tallgrass prairie vegetation was compared to hand clipping. Species composition estimates for the 2 methods were similar in 3 of 4 trials when true ranking and previously published multipliers were used. Weighting the DWR estimates by plot total weight did not consistently improve the accuracy of the method. Observer errors reduced the accuracy of DWR, emphasizing the need for observer training. DWR estimates were generally less precise than hand clipped estimates for a given sample size but the speed of DWR would allow more samples to be taken resulting in more precise estimates in practice.

Measurement of the species composition of vegetation is fundamental to range research and monitoring. Studies of successional trends, vegetation manipulation practices, and disturbed land reclamation all depend on some estimate of species composition. Measures of species composition most often used include density, frequency, cover, and dry weight. Of these methods, composition based on dry weight is considered to be the best indicator of species importance and impact within the plant community (Daubenmire 1968). However, dry weight sampling is also the most time consuming of the species composition measures because the standard procedure is to hand clip and separate plant species or species groups. Double sampling procedures have been developed to speed up the sampling process although these methods often require additional training and more complex statistical treatment (Reese et al. 1980, Anderson and Kothmann 1982).

A relatively simple method involving the use of ranks for determining the proportion of total herbage weight contributed by each species was developed by Mannetje and Haydock (1963) and further refined by other Australian workers (Jones and Hargreaves 1979, Sandland et al. 1982). In the dry-weight-rank method, the 3 most abundant species in each plot are given a rank of 1, 2, or 3 (1 indicating most abundant). A series of multipliers are then used to calculate percent composition from the rankings. Multipliers were calculated from ranked and clipped plots using a series of linear equations. Because the multipliers were empirically developed for improved pasture vegetation, it has been suggested a new set of multipliers should be developed for each vegetation type (Hughes 1969). Calculation of new multipliers would reduce the simplicity of the method and procedures have been developed to adapt the original multipliers to a wider range of vegetation types (Jones and Hargreaves 1979). The objective of this study was to test the accuracy and precision of the dry-weight-rank method for sampling species composition of tall grass prairie using the modified procedures of Jones and Hargreaves (1979).

Materials and Methods

Four trials were run to compare the dry-weight-rank method with hand clipping and separation of species. All trials were run on tallgrass prairie range sites. In excellent condition these sites are dominated by the grasses *Andropogon gerardii, Schizachyrium scoparium, Panicum virgatum,* and *Sorghastrum nutans.* As range condition declines, grasses such as *Bouteloua curtipendula, Sporobolus asper, Bothriochloa saccharoides,* and *Buchloe dactyloides* increase along with forbs such as *Xanthocephlaum dracunculoides* and *Ambrosia psilostachya.* Sites A and B had not been grazed for several years and were in good-excellent condition. Site C was an abandoned field which had naturally revegetated to good condition. Site D was in poor condition as a result of heavy livestock grazing. Site A was a claypan prairie, sites B and D were loamy prairies, and site C was an eroded prairie.

In each trial, a series of randomly located plots were ranked by dry-weight-rank procedures by 2 or 3 observers and then clipped and hand separated in the field. All observers ranked all plots. The number of plots ranked and clipped on each site was either 40 or 50 and plot size was 0.1 m² or 0.25 m². The vegetation was oven-dried and weighed to the nearest 0.1 gm. True species ranks were then assigned to the known weights. Ranking procedures followed Jones and Hargreaves (1979). Only the 3 most abundant species in each plot were ranked. If one species contributed more than 85% of the standing crop in a plot, that species was given both rank 1 and 2 and the second most abundant species was given rank 3. When a plot did not contain 3 species, all ranks were still assigned with the dominant species usually receiving rank 1 and the second species ranks 2 and 3.

Species composition was calculated using the following formula modified from Mannetje and Haydock (1963):

$$C_i = \frac{\sum_{j=1}^{3} (r_{ij})(M_j)}{N}$$

Where:

C_i = % composition of species i
r = number of plots in which species i received rank j
M_j = multiplier for rank j
N = total number of plots

Multipliers used for ranks 1, 2, and 3 were 70, 21, and 9, respectively (Sandland et al. 1982, Mannetje and Haydock 1963).

Composition estimates from the above formula assume equal standing crop across all plots. Since vegetation standing crop is never uniformly distributed, composition estimates that are not weighted by plot standing crop would be biased in a way similar to unweighted utilization estimates (Smith 1968). Weighted species composition was calculated as follows:

$$WC_i = \frac{\sum_{j=1}^{3} (W_{ij})(M_j)}{W_T}$$

Where:

WC_i = weighted % composition of species i
W_{ij} = summed weight of all plots in which species i received rank j
W_T = summed weight of all plots

This formula uses total plot standing crop as a weighting factor and

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has been reported to improve the accuracy of the dry-weight rank procedures (Jones and Hargreaves 1979).

Weighted and unweighted composition estimates based on the dry-weight-rank procedure using true specie ranks (ranks were assigned after clipping and hand separation) were compared to composition estimates from hand separation using paired t-tests. To calculate the differences between paired observations for the t-tests, the ranks were replaced by their respective multipliers (1 = 70%, 2 = 21%, 3 = 9%) and subtracted from the percent estimates by plot from hand separation. The weighting factor for the weighted estimates was the respective total plot weight divided by the average plot weight for the trial.

Sample variances for the unweighted dry-weight-rank estimates were calculated from the following formula (Sandland et al. 1982).

$$s_i^2 = \sum_{j=1}^{3} M_j^2 P_{ij}(1-P_{ij}) - 2 \sum_{j<k} M_j M_k P_{ij} P_{ik}$$

where:

s_i^2 = sample variance for ith species

P_{ij} = proportion of plots in which species i received rank j

From the sample variances, standard errors based on sample sizes of 20 and 50 were calculated for hand clipped and unweighted true rank estimates to compare the relative precision of the two methods.

Results and Discussion

The dry-weight-rank method and hand clipping gave very similar estimates of species composition in 3 out of 4 trials (Table 1). The largest difference occurred in Trial D where dry-weight-rank estimates were significantly different from hand clipped estimates for several components. Site D was dominated by a uniform stand of *Xanthocephalum dracunculoides* and this species received rank 1 in 90% of the plots. One assumption of the dry-weight-rank method is the presence of variability in the ranking of species between plots (Jones and Hargreaves 1979). When this assumption is violated the sensitivity of the method is decreased because the dominant species is always given a value of 70%. Trial D was an example of such a situation. The dry-weight-rank method generally overestimated more abundant species and underestimated less abundant species in all trials. The use of 70, 21, and 9 as multipliers for ranks 1, 2, and 3, respectively, was adequate for sampling sites A, B, and C. Acceptable results would be expected on other sites with similar botanical composition.

Weighting the dry-weight-rank estimates by plot total weight did not consistently improve the accuracy of the method. For instance, weighting improved the estimate for forbs on Site B but worsened the estimate for *Bouteloua curtipendula* on Site. D. In general, the weighted and unweighted estimates were quite similar. Apparently a second assumption of the dry-weight-rank method, that there is no correlation between plot yield and dominance of any one species (Jones and Hargreaves 1979) was satisfied. Weighting would be most useful when this assumption is violated. Otherwise, the more simple unweighted method was adequate.

Results presented to this point have been based on perfect ranking and represent an upper limit on the accuracy of the dry-weight-rank method. Observer error in assigning ranks generally increased the discrepancies between dry-weight-ranking and hand clipping (data not presented). However, observer error did not significantly increase the error in the method in most cases. The amount of observer error was dependant on observer experience. Vegetation components consisting of several species such as miscellaneous grasses were often underestimated by observers. This was due to a failure to adequately lump the weights of the several species together when making comparisons with a single species such as *Andropogon gerardii* or *Schizachyrium scoparium*. These results are similar to those reported by Mannetje and Haydock (1963) and reinforce the fact that any estimation procedure requires careful systematic observer training. However, training to estimate ranks should be easier and require less time than training to estimate actual percentages or weights.

The dry-weight-rank method with true ranks generally gave estimates with larger standard deviations (and larger standard errors *for a given sample size*) than hand clipping on Site A (Table

Table 2. Botanical composition (%), standard deviations, and standard errors determined by hand clipping (Clip) and unweighted dry-weight-rank (DWR) for Site A.

Species	Method	Mean	Standard deviation	Standard error 20 plots	Standard error 50 plots
Andropogon gerardii	Clip	17	18.4	4.1	2.6
	DWR	17	22.8	5.1	3.2
Schizachyrium scoparium	Clip	30	23.4	5.2	3.3
	DWR	32	29.1	6.5	4.1
Panicum virgatum	Clip	15	17.2	3.8	2.4
	DWR	14	23.0	5.2	3.3
Sorghastrum nutans	Clip	5	10.8	2.4	1.5
	DWR	3	10.9	2.4	1.5
Miscellaneous Grasses	Clip	29	16.7	3.7	2.4
	DWR	32	29.0	6.5	4.1
Total Forbs	Clip	4	6.7	1.5	0.9
	DWR	2	4.9	1.1	0.7

Table 1. Botanical composition (%) determined by hand clipping (Clip), weighted dry-weight-rank (DWRw), and unweighted dry-weight-rank DWRu) on four sites in tallgrass prairie vegetation.

	Trial A			Trial B			Trial C			Trial D		
	Clip	DWRw	DWRU	Clip	DWRw	DWRu	Clip	DWRw	DWRu	Clip	DWRw	DWRu
Andropogon gerardii	17	17	17	26	26	24	—	—	—	—	—	—
Schizachyrium scoparium	30	31	32	14	11	13	52	56*[1]	56	—	—	—
Panicum virgatum	15	15	14	16	17	19	—	—	—	—	—	—
Sorghastrum nutans	5	3	3	—	—	—	19	20	20	—	—	—
Total Decreasers	—	—	—	—	—	—	—	—	—	11	8**	8*
Bouteloua curtipendula	—	—	—	—	—	—	—	—	—	12	10	11
Sporobolus asper	—	—	—	—	—	—	5	4	3	—	—	—
Miscellaneous grasses	29	32	32	33	35	36	20	19	19	16	12*	13
Xanthocephalum dracunculoides	—	—	—	—	—	—	—	—	—	52	65**	64*
Forbs	4	2**	2**	11	10	9*	3	1**	2**	8	5*	3**
Standing crop (Kg/ha±SE)		4060 ± 140			4480 ± 245			1750 ± 97			2530 ± 150	

[1]Significantly different from hand clipped samples, *$P<.05$, **$P<.01$

2). Higher standard deviations are not unexpected with dry-weight-ranking since each species can essentially only be assigned 70, 21, 9, or 0% per plot versus the continuous scale with hand clipping. However, dry-weight-ranking required much less time per plot, 1.6 minutes versus 28 minutes for hand clipping, so many more plots could be ranked than clipped for a given time period. A more realistic comparison of precision between the two methods would be hand clipping 20 plots against ranking 50 plots or more. In other words, using the standard deviations estimated from the full samples, clipping 20 plots would give a standard error of 4.1 for *Andropogon gerardii* versus a standard error of 3.2 obtained from ranking 50 plots. Dry-weight-ranking yielded more precise estimates for all species except miscellaneous grasses on Site A. Over all sites and species, dry-weight-ranking 50 plots yielded smaller standard errors than clipping 20 plots in 19 of 21 comparisons. Standard errors under dry-weighted-ranking averaged 19% less than standard errors under clipping.

The dry-weight-rank method gave acceptable estimates of species composition on these tallgrass range sites even though the multipliers were derived from a quite different ecosystem. Jones and Hargreaves (1979) also found that the multipliers could be used satisfactorally in ecosystems other than the one for which they were originally calculated. The need for observer training and adherence to the assumptions of the method were also emphasized in this study. It should be pointed out that the dry-weight-rank method only gives percentage estimates of species composition. If actual species weights are required, total standing crop would have to be measured and multiplied by the percentage estimates for each species. Total standing crop would be much easier to measure, either by clipping, estimation, or capacitance meter, than standing crop by species. The dry-weight-rank method should be a valuable tool in both research and management monitoring activities.

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