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Dry-weight-rank method assessment in heterogenous communities

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Abstract

Assessment of herbaceous standing crop in heterogeneous range plant communities requires large numbers of samples to account for inherent variability. The dry-weight-rank method (DWR) was developed to eliminate the need for clipping and sorting of herbage to determine relative proportions on a dry weight basis. The technique was assessed for applicability and accuracy in the mixed prairie of the Texas Rolling Plains. Much of the herbage within the communities investigated occurred in monospecific patches that resulted in only 15% of quadrats having 3 species ranked for which DWR was designed. Non-harvest methods of determining grass proportion by species were compared to harvested proportions in mesquite (*Prosopis glandulosa* Torr.) and redberry juniper (*Juniperus pinchotii* Sudw.) communities. Estimation methods evaluated were 1) harvest by species, 2) weight estimation by species, 3) DWR with quadrat weighting, 4) unweighted estimated proportion by species, and 5) unweighted DWR.

Correlations of non-harvest to harvest proportions were improved with quadrat weighting. Weighting improved values more in the juniper than in the mesquite communities. Although cumulative ranking of DWR multipliers was necessary in 85% of sample quadrats, there was a high correlation (r^2>0.995) between weight estimation and weighted DWR and between estimated proportion and unweighted DWR. This indicates that cumulative ranking with the original DWR multipliers was virtually the same as evaluator estimation.

Analysis of variance indicated significant differences in non-harvest methods compared to harvesting. Quadrat weighting with DWR was necessary to draw the same statistical conclusions between means that harvest data provided. Ranks are easier to apply and more likely to be applied similarly by individual evaluators than estimated proportions. For sites with high standing crop variation and patchiness of species that require considerable use of cumulative ranking, DWR with quadrat weighting provides adequate determination of species proportions of biomass.

Key Words: botanical composition, estimation, landscape, standing crop proportion

Resumen

La evaluación de la cosecha en pie de la vegetación herbácea de comunidades de pastizal heterogéneas requiere de un gran número de muestras para contabilizar la variabilidad inherente de estas comunidades. El método de clasificación de peso seco (DWR) se desarrollo para eliminar la necesidad de cortar y ordenar el forraje herbáceo para determinar las proporciones relativas en base a peso seco. La técnica se evaluó para valorar su aplicabilidad y certeza en las praderas mixtas de las planicies onduladas de Texas. Mucho del forraje herbáceo dentro de las comunidades investigadas ocurrió en manchones de una sola especie, resultando en que solo el 15% de los cuadrantes tuvieran 3 de las especies clasificadas para lo que se diseño el DWR. Se compararon métodos no destructivos para determinar la proporción de zacate por especie y se compararon con las proporciones cosechadas en comunidades de "Mezquite" (*Prosopis galndulosa* Torr.) y "Redberry juniper"(*Juniperus pinchotti* Sudw.) Los métodos de estimación evaluados fueron: 1) cosecha por especie, 2) estimación de peso por especie, 3) DWR pesando cuadrantes, 4) la estimación sin pesar de la proporción por especie y 5) DWR si pesar.

Las correlaciones entre las proporciones obtenidas con métodos no destructivos y por cosecha se mejoraron con el peso de cuadrantes. El pesar mejoró más los valores en las comunidades de "Juniper"que en las de "Mezquite". Aunque la clasificación acumulativa de los multiplicadores del DWR fue necesaria en 85% de los cuadrantes de la muestra, hubo una alta correlación (r^2 > 0.995) entre la estimación de peso y la del DWR pesad caudrantes y entre la proporción estimada y el DWR sin pesar.cuadrantes. Esto indica que la clasificación acumulativa con los multiplicadores originales del DWR fue virtualmente la misma que la estimación del evaluador.

El análisis de varianza indicó diferencias significativas entre los métodos de cosecha y no cosecha El peso de cuadrantes en el DWR fue necesario para inferir las mismas conclusiones estadísticas entre las medias que proveyeron los de datos de cosecha. La clasificación es fácil usar y mas probable de ser aplicada en forma similar por evaluadores individuales que las proporciones estimadas. Para sitios con variación alta de cosecha en pie y con especies en manchones que requieren el uso considerable de la clasificación acumulativa, el DWR con peso de cuadrantes provee una determinación adecuada de la proporción de biomasa por especie.

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Assessment of standing crop by species in heterogeneous range plant communities requires numerous samples to account for inherent variability. Often, at the landscape scale, it is logistically untenable to harvest and sort enough samples to adequately account for such variability. The dry-weight-rank (DWR) method was developed (t'Mannetje and Haydock 1963) to eliminate the need for clipping and sorting to assess species proportions of standing crop on a dry weight basis, therefore, saving time and allowing for greater sample sizes. When using DWR, which species occupy first, second and third place in order of their dry weight is judged within a quadrat. Rankings are converted to dry weight species composition by multiplying the proportion of occurrences of each rank for a species by multipliers of 0.70, 0.21, and 0.09 for the first, second, and third ranked species, respectively (t'Mannetje and Haydock 1963). The DWR method aims to eliminate the need to develop predictive models for individual species by using multipliers that apply to a large range of pasture types and species. The DWR multipliers were derived by multiple regression of actual dry weight proportion by species to number of occurrences of that species for rank 1, rank 2, and rank 3. Jones and Hargreaves (1979) derived similar multipliers to t'Mannetje and Haydock (1963) from a broader range of pasture types and climates, but obtained only minor improvements in species proportions by dry weight. Jones and Hargreaves (1979) recommend using rank multipliers derived from larger data sets, because rank multipliers developed from smaller data sets were often illogical (ie. rank 1 < rank 2 or rank 3) or were inconsistent between dates.

The DWR method works best when the number of species per quadrat is low and variation of their proportions is high (Sandland et al. 1982). For pastures that are homogeneous at the quadrat level DWR is less suited, because the same species would receive the same rank and its dry weight proportions would always equal the rank values. Species forming monospecific patches tend to be underestimated. Modifications by Jones and Hargreaves (1979) reduced this problem by assigning first and second rank to the dominant species when it is judged to be 85% or greater of quadrat dry matter, an adjustment referred to as 'cumulative ranking'. A second potential problem with DWR is that a consistent relationship between quadrat standing crop and the order that a species is ranked can result in over- or under-estimation of that species. If a species was always associated with low standing crop patches, its proportion at a site would be overestimated. Jones and Hargreaves (1979) reduced this problem by applying a weighting factor to the DWR multipliers, based on standing crop in each quadrat. A weighting factor or actual quadrat weights can be applied to estimated proportions of species to provide an index or estimate of standing crop by species.

Applicability of DWR has been studied in a variety of rangelands (Jones and Hargreaves 1979). In both tallgrass prairie (Gillen and Smith 1986) and arid rangeland (Friedel et al. 1988), there was no improvement in estimation of standing crop composition using quadrat weighting with DWR. Both t'Mannetje and Haydock (1963) and Jones and Hargreaves (1979) doubt whether DWR is applicable where quadrat size or pasture conditions result in a high incidence of cumulative ranking.

Our region of northwest Texas is semiarid, consisting of plant communities that have a very patchy distribution of species and standing crop with large monospecific patches. As a result, the use of DWR requires the frequent use of cumulative ranking. In this paper, we test the applicability and accuracy of DWR under these conditions. We also assess the effects of applying quadrat weighting and DWR multipliers for improving the estimate of species proportion of standing crop.

Methods

Site Description

The study was conducted on the Y Experimental Ranch, located 25 km southeast of Crowell (33º 52' N, 100º 00' W) in north central Texas. Much of the vegetation is comprised of communities distinguished by dominant shrubs redberry juniper (*Juniperus pinchotii* Sudw.) or mesquite (*Prosopis glandulosa* Torr.). The juniper community occurred on shallow clay-loam soils (Vernon-Weymouth clay-loam complex) which have exposed rock or gypsum areas with sparse herbaceous vegetation as well as deeper soils with much greater herbaceous biomass. The mesquite community occurred on deeper, clay-loam soils (Tillman clay-loam) with a greater spatial continuity of herbaceous vegetation. Both communities had similar herbaceous standing crops with a patchy distribution of species. Patches of single species ranged from 1 m to 10 m in diameter. The herbaceous vegetation in both communities was dominated by tobosa grass [*Hilaria mutica* (Buckl.)Benth.], buffalo grass [*Buchloe dactyloides* (Nutt.)Engelm.], and sideoats grama [*Bouteloua curtipendula* (Michx.)Torr.]. Mesquite communities had a greater annual grass component [primarily *Bromus japonicus* Thunb., *Hordeum pusillum* Nutt., and *Bromus unioloides* (Wild.)H.B.K.] while juniper communities had relatively greater amounts of slim tridens [*Tridens muticus* (Torr.)Nash.]. Texas wintergrass [*Stipa leucotricha* Trin.&Rupr.] was common on sites in both communities. Other short grasses and other midgrasses were recorded individually but grouped for analysis. Forbs were important within these habitats, but were a minor component of cattle diets. Therefore, they were analyzed separately from grasses and were not used in these analyses. A more detailed description of the vegetation can be found in Donges (1994).

Sampling

Each method was evaluated at 3 juniper and 3 mesquite replicate sites (2.5 ha each) sampled on 4 dates (October 1993, January, April, and June 1994) by a single experienced evaluator. Sites were chosen from 3 pastures to represent the variation in forage observed within juniper and mesquite communities that were temporarily fenced (about 1 week in duration, seasonally) for another study. For each site, grasses within 40 quadrats (0.05 m^2) were placed at 15 m intervals along 7 randomly selected line transects. Species were visually weight estimated, dry-weight-ranked (DWR), and harvested by species group. Species were collectively bagged by site, dried and weighed. The 3 most abundant grasses in a quadrat were ranked and ascribed the proportional values of 0.70, 0.21, and 0.09, respectively. If a species contributed 85% or more of standing crop in a quadrat it received ranks 1 and 2 (cumulative ranking). If a species was very minor (<1–2%) the prior ranked species additionally received rank 3. The visually estimated standing crop of each quadrat was used as the weighting factor as recommended by Jones and Hargreaves (1979). Cumulative ranking as well as quadrat weighting was potentially important because numerous samples were dominated by a single species, particularly where tobosa grass was encountered.

Assessment time

Evaluation and harvest of 40 quadrats at each site by species groups were accomplished by 3 people (1 evaluator and 2 harvesters) in about 2 hours. Evaluation and harvest (collectively by site) of 40 quadrats by grass or forb were accomplished by 1 person in about 2 hours. Ranking and weight estimation without harvesting would require a single evaluator and be 2–3 times faster (about 40–60 quadrats hr^{-1}). This compares to 35 quadrats hr^{-1} evaluated in tall-grass prairie (Gillen and Smith 1986) and 45 quadrats hr^{-1} evaluated in arid rangeland (Friedel et al. 1988).

Calculations

The proportion of each species in the total standing crop was determined using the following equations:

Harvest = Σ Sw / Σ Qw	Clipped, sorted, and weighed
ESTw = Σ Se / Σ Qe	Estimated weight
DWRw = Σ [(.70)Sf1+(.21)Sf2+(.09)Sf3)]Qe / Σ Qe	Weighted Dry-Weight-Rank
NRw = Σ [Sf /Qf] Qe / Σ Qe	Weighted, but Not Ranked
ESTu = Σ [Se / Qe] / n	Unweighted Estimated Species Proportion
DWRu = Σ [(.70)Sf1 +(.21)Sf2+(.09)Sf3] / n	Unweighted Dry-Weight-Rank
NRu = Σ Sf / Σ Qf	Unweighted and Not Ranked (relative frequency of ranked species)

Where:
n = number of quadrats
Σ = sum for quadrats 1-n
Sw = dry weight of Species
Qw = dry weight of Quadrat
Se = estimated dry weight of Species
Qe = estimated dry weight of Quadrat
Sf1, Sf2, Sf3 = frequency of rank 1, 2, or 3 for Species, Sf1, Sf2, Sf3 = 1 or 0
Sf = frequency of ranked Species, Sf = 1 or 0
Qf = frequency of species within a Quadrat, Qf = 0, 1, 2, or 3

Harvest was the proportion of species standing crop based on total standing crop and was the check for the study. The ESTw , DWRw, and NRw were non-harvest methods using quadrat weight estimates to determine proportions based on total estimated standing crop. ESTu, DWRu, and NRu were non-harvest methods that give equal weighting to each quadrat. The ESTu and DWRu were averages of proportions of species. The NRu was based on relative number of ranked occurrences of a species. Because of the high degree of cumulative ranking within these sites and biomass differences associated with species, unranked proportions (NRw and NRu) were calculated to assess the relative importance of dry-weight-rank multipliers and quadrat weighting in improving values.

Statistical Analysis

Precision of non-harvest methods were evaluated with no-intercept regressions because intercepts were not significantly different from 0. Arcsine transformations of squareroot of proportions were performed to reduce the non-linear affect of dominant to minor species on goodness of fit determination (after t'Mannetje and Haydock 1963). Regression coefficients and coefficient of determination were squared to account for the effect of transformation. Multiple regression was used to derive rank multipliers for comparison to established DWR values. For all regressions probability of slope = 0 was < 0.0001.

Because the same quadrats were evaluated for Harvest as for non-harvest methods, regressions did not include sampling error associated with quadrat placement. For analysis of variance, sample date was a primary source of variation because of the different quadrat placement over 4 dates. Two methods were compared in each analysis. Analysis of variance of these method pairs was used by species to determine method differences in determining species proportions. Similarity of methods in determining overall species proportions was tested using analysis of variance by method pairs for which the species interactions across methods, communities, sites and dates are compared. Effect sum of squares are presented in ratio to total sum of squares to indicate the magnitude of variation associated with different methods (equivalent to effect r^2 in %). Only one main effect, species, was included because values were proportional resulting in only species and species interaction means differing. Repeated measures of dates were considered in hypothesis test. Sampling units were proportions by species, community, site and date (not quadrats). Analyses were carried out using the SAS statistical package (SAS 1985).

Results and Discussion

Dry-weight-rank (DWR) with cumulative ranking was necessary within quadrats because of the frequent presence of large monospecific patches of a grass species with high standing crop (in particular, tobosa grass) and monospecific patches of other species with low standing crop. Areas devoid of herbaceous vegetation were encountered in sub-canopy positions or because of geological features (ie. rocks, gypsum soils), particularly in juniper sites. About 7% of quadrats had no herbaceous vegetation in the juniper community compared to 1% in the mesquite community. Other vegetation sampling within these communities with 0.25 m^2 quadrats (Parajulee et al. 1997) resulted in a high incidence of cumulative ranking 69% vs. 85% with 0.05 m^2 quadrat used in this study. Standard error of means (n = 40) for standing crop in juniper communities was 9–21% with 0.25 m^2 quadrats and 9–15% with 0.05 m^2 quadrats. Standard error of means for standing crop in mesquite communities were 5–11% with 0.25 m^2 quadrats and 8–12% with 0.05 m^2 quadrats.

Proportions determined by estimate methods

Individual sites within juniper and mesquite communities varied considerably in species proportions of standing crop (Fig. 1). Harvest and non-harvest methods were similar and highly correlated within a site. Analysis of variance by species indicated that proportions of standing crop were similar between weighted methods (ESTw and DWRw) or between unweighted methods (DWRu and ESTu). The weighted methods were more accurate than unweighted methods. All non-harvest methods overestimated buffalo grass ($P < 0.01$) and under-estimated tobosa grass ($P < 0.05$ for weighted methods and $P < 0.01$ for unweighted methods). This indicated a bias towards aerial cover in visual estimation, because for a given cover or volume, tobosa grass was more dense while buffalo grass was less dense than expected. Additionally, for unweighted methods (ESTu and DWRu) annual grasses and Texas wintergrass were statistically different from Harvest proportions ($P < 0.01$ and $P < 0.05$, respectively). Annual grass was the dominant species within a quadrat only when quadrat standing crop was low, thus causing annual grass to be overestimated with unweighted methods. Additional differences between non-harvest methods and Harvest proportions

Table 1. No-intercept regression coefficient of determinations (r^2) of species composition between estimate methods of arcsine of square root transformed proportions.

COMMUNITY	METHOD	ESTw	DWRw	NRw	ESTu	DWRu	NRu
Juniper							
	Harvest	.956	.952	.936	.884	.880	.869
	ESTw		.998	.984	.962	.958	.940
Mesquite							
	Harvest	.979	.975	.909	.932	.929	.831
	ESTw		.999	.945	.967	.966	.878

were detected using regression but were not considered as important because no sampling error due to quadrat placement was incorporated.

Relationships between methods and communities

All non-harvest methods were highly correlated to Harvest standing crop proportions (Table 1). Harvest proportions were more correlated to weighted methods (ESTw and DWRw) than unweighted methods (ESTu and DWRu). Weighting improved values particularly for the juniper community as indicated by the greater difference between r^2 of weighted and unweighted methods. Similarly, Jones and Hargreaves (1979) found that where a consistent relation between quadrat yield and species rank occurs, quadrat weighting can improve DWR composition estimation.

The unweighted, unranked method (NRu) represents the least improved estimates of Harvest proportions. Harvest to NRu r^2s were similar for juniper and mesquite communities. Ranking alone (DWRu) improved values slightly in juniper communities and substantially in mesquite communities. Weighting without ranking (NRw) improved values for both communities. Estimation or ranking with quadrat weighting (ESTw and DWRw) were more highly correlated with Harvest proportions than other methods tested for either community. All non-harvest methods were more highly correlated to ESTw than to Harvest proportion. This may indicate non-harvest methods are sensitive to the degree of evaluator training and that frequently recurring minor species are more likely to be overestimated. Initial training to identify the relative differences in plant dry weight is considered important (t'Mannetje and Haydock 1963, Gillen and Smith. 1986, Friedel et al. 1988).

The lower importance of ranking in the juniper community when compared to the mesquite community was due to all species at juniper sites having equal distribution of the three ranks (t'Mannetje and Haydock 1963, Jones and Hargreaves 1979, Sandland et al. 1982). In mesquite communities the greater importance of ranking was in part because tobosa grass, when present within a quadrat, was almost always the dominant species and annual grass was almost always the minor species.

Multiple regression analysis to provide rank multiplier values (Table 2) for ESTw based on species ranks and quadrat weights, produced similar rank multipliers to those of t'Mannetje and Haydock (1960). However, other multiple regressions resulted in poorer model fit and some illogical negative multipliers. These data indicate that the original multipliers that are derived from a broad range of pasture types were satisfactory for our community types.

species x method interactions are of interest as indices to account for variation ascribed to methods. Without including variation associated with methods, residual error (species x community x site x date) would be 7–8% with 120 degrees of freedom. This indicates powerful tests of the hypothesis are possible. Both the magnitude of effect variation (r^2) and significance of hypothesis test are important in evaluating method differences.

Estimation and DWR produced virtually the same species proportions. Unweighted methods ESTw vs. DWRw were very similar, as were ESTu vs. DWRu, with total method interaction variation of only 0.2% of model r^2. Therefore, Harvest to ESTw and Harvest to ESTu comparisons are not presented. Compared to Harvest, DWRw sum of method interaction r^2 was 2.29% while DWRu was 6.14%. DWRw residual error r^2 (species x community x site x date) was 8.13% while DWRu was 6.88%. For DWRu compared to Harvest, the sum of method variation was approaching that of residual error. Individual sites (species x community x site) and residual error (species x community x site x date) accounted for more variation than non-harvest method (sum of method interaction).

Table 2. Values for species rank multipliers derived with multiple regression and coefficient of determination (r^2). The dependent variable was species proportion with independent variables of frequency of that species with rank 1, 2, and 3; or the dependent variable was species weight with dependent variable of the sum of quadrat estimated weight for that species of rank 1, 2, and 3.

	Rank 1	Rank 2	Rank	r^2
DWR proportion*	0.70	0.21	0.09	.894
Harvest proportion	0.68	0.65	–0.33	.894
Estimated proportion	0.71	0.45	–0.16	.960
Harvest weight	0.67	0.34	–0.01	.962
Estimated weight*	0.68	0.22	0.10	.998

*DWR multipliers derived by t'Mannetje and Haydock (1963).

Differences between methods, communities, sites and dates

Regression analyses are limited to describing paired data which reflects little sampling error. Of more importance is how error associated with a method compares to inherent sampling error. Analysis of variance provides a tool to discern the effects of methods within communities and sites on species proportions (Table 3). Method pair source of variation was for a complete model with r^2 totaling 100%. Significant species differences were expected because dominant species were compared with other species. Other main effects have equal proportions and do not account for more variation. Species interactions and

Species proportions for non-harvest methods were significantly different from Harvest proportions (method x species) (Table 3 and Fig.1). The magnitude of species differences from harvest was greater for DWRu than DWRw. All methods calculated consistent differences in species proportions within sites and communities (species x community x site). This indicated that individual sites were adequately sampled, but likelihood of finding differences at the community level was decreased because this was used as the error term to test for community differences. Unweighted methods (Harvest vs. DWRu and ESTu vs. DWRu) resulted in exaggerated differences in species propor-

Table 3. Sources of variation within analysis of variance comparing method pairs of calculated species proportions. Values are the ratio of effect sum of squares to total sum of squares which are equivalent to effect portions of model r^2 expressed as percent.

	df	Harvest vs DWRw	Harvest vs DWRu	DWRw vs DWRu	ESTw vs DWRw	ESTu DWRu
Sp	7	48.92**	44.06**	44.24**	47.39**	41.40
Sp*C	7	10.81	13.98*	16.63*	12.81	21.14*
Sp*C*S	28	28.02**	26.90**	28.71**	29.66**	29.26**
Sp*D	21	1.83	1.62	1.47	1.73	1.33
Sp*C*S*D	120	8.13	6.88	6.72	8.32	6.80
M*Sp	**7**	**1.18****	**3.10****	**.62***	**.01**	**.01**
M*Sp*C	**7**	**.07**	**.46**	**.24**	**.01**	**.01**
M*Sp*C*S	**28**	**.34**	**1.18**	**.62**	**.01**	**.01**
M*Sp*D	**21**	**.23**	**.28**	**.08**	**.02**	**.01**
M*Sp*C*S*D	**120**	**.47**	**1.12**	**.68**	**.15**	**.14**
Sum of M	**183**	**2.29**	**6.14**	**2.24**	**.20**	**.18**

Sp = species Significance of effect F-value: * = P < 0.05; ** = P < 0.01
M = method
C = community Sp and Sp*C tested with Sp*C*S
S = site Sp*C*S and Sp*D tested with Sp*C*S*D
D = date Method interactions tested with Sp*C*S*D + M*Sp*C*S*D

tions between juniper and mesquite communities. This was indicated by higher r^2 for species x community relative to fairly constant variation of r^2 across methods pairs for species x community x site resulting in significant F-values. Although DWRw species proportions were significantly different from Harvest, these differences were smaller than DWRu and did not exaggerate differences between communities as much as DWRu.

Conclusions

Unlike studies which present dry-weight-rank (DWR) results derived from ideally ranked and weighted data from harvest studies, these calculations are based on visual estimation made in the field prior to clipping, sorting, and weighing. These data are also from sites with high variability in standing crop and high spatial heterogeneity of species resulting in most quadrats being cumulatively ranked. The DWR method was preferred to visual quadrat composition estimates because ranking was easier, quicker, and less-likely to be biased between evaluators. Species proportions using DWR derived by trained evaluators were highly correlated (t'Mannetje and Haydock 1963, Walker 1970, Gillen and Smith 1986, Everson and Clarke 1987, Friedel et al. 1988).

The ability of the published DWR multiplier values of 0.70, 0.21, and 0.09 (t'Mannetje and Haydock 1963) with cumulative ranking to predict dry-weight species proportions was supported in 3 instances. Firstly, correlation of DWRw to ESTw or DWRu to ESTu was high ($r^2 > 0.996$). Secondly, analysis of variance indicated that variation between DWRw and ESTw or between DWRu and ESTu was small, about 0.2% of model r^2. Thirdly, multiple regression analysis to solve for rank multipliers for ESTw based on species ranks and quadrat weights produced similar rank multipliers to those of t'Mannetje and Haydock (1960). The DWR method very nearly predicted species proportions the evaluator estimated to be present.

Deficiencies in DWR with quadrat weighting were relatively minor and were due to misapplication of ranks to certain species because of evaluator error. Although the evaluator was experienced in harvest techniques, tobosa grass and buffalo grass were consistently under- and over-estimated, respectively. A combination of more perfect ranking and quadrat

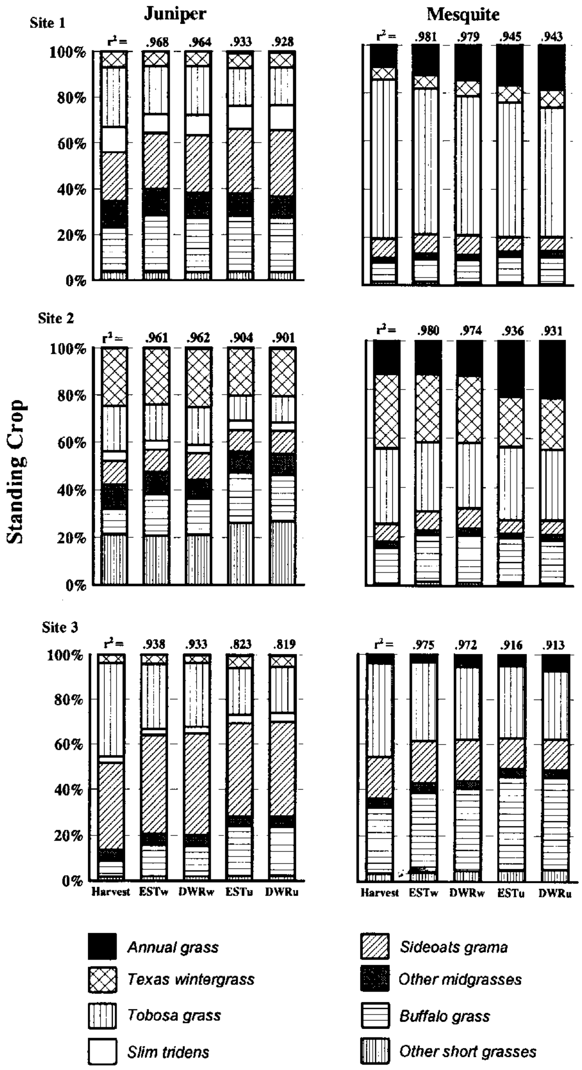

Fig. 1. Standing crop proportions by species at different sites within juniper and mesquite communities as determined by Harvest vs. non-harvest methods. Coefficient of determinations (r^2) were of non-harvest to Harvest method based on no-intercept regression of arcsine of squareroot of proportions over 4 dates.

weighting would potentially improve values particularly for tobosa grass and buffalo grass. Quadrat weighting improved values and, additionally, can be used with species proportions to estimate standing crop by species.

Quadrat weighting of DWR improved species proportions in this study and the studies of Jones and Hargreaves (1979) and Sandland et al. (1982). However, quadrat weighted and unweighted DWR proportions were similar in studies by Gillen and Smith (1986) and Friedel et al (1988). The effect of ranking and quadrat weighting on estimates of species proportions was also different for mesquite and juniper communities. For mesquite communities, ranking and weighting resulted in similar improvement of values towards harvest proportions. For juniper communities weighting was necessary to improve values. When making comparisons between communities using analysis of variance, DWR with quadrat weighting was necessary to draw similar statistical conclusions between means that harvest data provided.

When initially using DWR within a community, we recommend quadrat weighting so that comparisons can be made to insure unweighted values are similar to weighted values. Acceptable estimates of species proportions were obtained with weighted DWR for communities with high spatial variability of species and standing crop. The time taken to estimate standing crop proportions by species using quadrat weight estimates and DWR compared well with use of DWR in other studies. Ranking and weight estimation was considerably faster than any harvest method.

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