Seasonal and Livestock Influences in Estimating Foliage Density of Vegetation[1]

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Highlight

A knowledge of the influence of advance in season and activity of grazing animals on foliage-density estimates is necessary to properly assess trends or evaluate range treatments. Foliage-density estimates were made at 14-day intervals from June 20 through August 17 of the years 1964 and 1965 at the Scotts Bluff Experimental Range. Significant differences were found in foliage densities of various species among dates of sampling. These differences varied between years of the study. Grazing and trampling of livestock had little effect on foliage-density estimates. Optimum time for estimating foliage density of mixed-prairie vegetation was established as being the period one week prior to and one week following July 20. Grazing influences did not alter these dates.

In order to study trend in botanical composition within a range area over a period of years, some knowledge of the influence of advance in season and/or livestock disturbance by trampling or grazing on foliage density estimates is desirable.

Tosun (1961) recorded foliage cover early and late in the growing season on a true prairie range. Trends in his data indicated that further study throughout the growing season was needed. Spedding and Large (1957), studying cocksfoot and ryegrass swards, recorded large differences in foliage density within a height increment above the ground on five successive dates. Winkworth (1955) and Wilson (1959) showed that a geometrical change in leaf angle as the plant developed changed the foliage area measured.

Surveys taken during the growing season or even at the end of the growing season to make comparisons between areas, treatments, or years are subject to much criticism. Owing to the complex interactions of the edaphoclimatic cycles, the relative proportion of plant species at any time during the growing season may vary widely.

Crocker and Tiver (1948) suggest that since all species do not occur at the same stage of maturity within the edaphoclimatic cycle on a given date, one must record stages of maturity of the various species at the time the survey is taken. However, data from numerous sources (Henson and Hein, 1941; Spedding and Large, 1957; Sant, 1964) sug-

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gest that stage of maturity may not always be positively correlated with foliage density.

Influences of grazing pressure and trampling by livestock on foliage-density estimates have been recorded indirectly by several investigators (Spedding and Large, 1957; Norman, 1957; Henson and Hein, 1941; Sant, 1964).

This study was initiated to measure the effect of advance in season and livestock disturbance on foliage density in order to ascertain the best time within the growing season to make vegetation surveys.

Study Area and Procedures

The study was conducted at the Scotts Bluff Experimental Range, 10 miles north of Scottsbluff, Nebraska. The area supports a mixed-prairie vegetation. The dominant grasses are needleandthread grass (*Stipa comata*), prairie sandreed (*Calamovilfa longifolia*), and blue grama (*Bouteloua gracilis*). Various perennial forbs and two shrubs (*Artemisia filifolia* and *frigida*) are present. Annual forb populations fluctuate widely, depending on weather conditions.

Average annual precipitation at the Scotts Bluff Experiment Station, six miles south of the study area, is 12.88 inches. Precipitation during the growing season (April 15 to September 1) measured at the study area was 5.19 inches in 1964 and 12.66 inches in 1965. The long-term average precipitation for this period is 10.27 inches.[2]

Surface textures of soils in the study area range from loamy very fine to fine sands. These soils are characteristically low in organic matter and water-holding capacity.

Two adjacent locations, representing differences in range condition, were selected. Two grazing treatments, i.e. grazed vs. nongrazed, were established within each location on similar sites. Each treatment plot was subdivided systematically to give 100 sampling stations. The stocking rate for locations under grazing influences was 0.73 AUM/acre.

Twenty randomly-selected points were recorded at 20 randomly-selected stations using the focal point technique described by Burzlaff (1966). Only first hits were recorded. A hit was recorded as the species encountered, litter, or bare soil.[3] Species hits were defined as a point intercept with any material originating from the current year's forage production. Terminology for cover characteristics follows that suggested by the National Academy of Sciences–National Research Council (1962).

Repeated readings were made on each plot at 14-day intervals, beginning the third week in June and continuing through the third week in August.[4]

Because of the large number of species of low abundance which contributed only a minor portion to the total foliage density, some species were grouped into categories according to their life history. Various perennial grasses of very low abundance will not be discussed.

Treatments were evaluated by an analysis of variance of the mean foliage density of plots. The main effect of advance in season (dates) was analyzed by using data from the nongrazed plots. Since the main objective of this study was to study the effect of sampling dates, emphasis was placed on the interpretation of dates and its interaction with the grazing main effect. Therefore, grazing treatments were evaluated by their failure to respond the same between grazed and nongrazed sites with advance in season. The interaction of dates and grazing treatments was determined using all the data.

Reduction sums of squares for linear, quadratic, cubic, and quartic response surfaces indicated that there was not enough consistency in response of a given species to advance in season or livestock disturbance between years to establish regression equations. Therefore, Duncan's multiple range test was used to determine on which consecutive dates foliage density remained the same within the .05 level of probability with advance in season and livestock disturbance.

Results and Discussion

Advance in Season

Significant differences ($P < .05$) in foliage density were found among date means during both years for needleandthread grass. Significant differences were also found among date means in 1964 for the category of perennial forbs and shrubs and in 1965 for prairie sandreed, sand dropseed (*Sporobolus crytandrus*) and the category annual forbs and grasses. No significant differences were found among date means for blue grama in either year.

Greater fluctuations in foliage density of needleandthread grass were found between years than within a growing season because of a severe drought in 1964 which resulted in high death loss and the inability of the surviving plants to produce flowering culms in 1965. The significant difference in date means between June 20 and July 5 in 1964 (Table 1) can be attributed to the increased exposed vegetation due to the emergence of the flowering culm. The linear increase in foliage density after July 20, 1965, resulting in a significant difference in date means between July 20 and August 3, may be attributed to a gradual recovery from the 1964 drought.

The drought of 1964 had little effect on the foliage density of prairie sandreed in 1965, however, growth characteristics were altered. In 1964 no differences among date means were found because vegetative growth was limited, but in 1965 normal growth resumed resulting in a significant difference in date means between July 20 and August 3 (Table 1). This period corresponds to the maximum rate of jointing stage of growth.

Because of the low abundance of blue grama, sand dropseed, and perennial forbs and shrubs, sampling was inadequate to fully evaluate their

[2] Measured at the Scotts Bluff Experiment Station.

[3] Litter cover and bare soil percentages will not be discussed in this article.

[4] The authors recognize that in using this procedure the errors are no longer independently associated, but since stations within a plot were rerandomized on each date, it is assumed that for the purpose of this study, this violation of the assumptions of the analysis of variance does not introduce bias.

Table 1. Date within the sampling period at which significant differences in foliage density of various species or categories was found in 1964 and 1965 under nongrazed conditions.[a]

Species or category	S. E. of a date mean	Foliage-density percentage					
		6/20	7/5	7/20	8/3	8/17	Mean
1964							
Needleandthread	.802	18.3	21.2	19.7	22.2	20.5	20.4
Prairie sandreed	.427	3.8	4.0	3.8	4.5	3.8	4.0
Blue grama	.465	2.9	1.3	1.6	1.5	1.4	1.8
Sand dropseed	.320	2.6	2.3	1.7	1.7	1.7	2.0
Perennial forbs & shrubs	.199	.5	.5	.7	.4	.2	.5
Annual forbs & grasses	.220	1.8	1.4	1.5	1.2	.8	1.3
1965							
Needleandthread	.757	6.5	5.8	6.3	8.2	9.1	7.2
Prairie sandreed	.639	3.4	3.5	3.3	5.9	4.8	4.2
Blue grama	.524	1.6	1.5	1.7	2.0	2.3	1.8
Sand dropseed	.296	.9	1.0	.5	1.9	1.5	1.2
Perennial forbs & shrubs	.364	.7	1.9	1.7	1.5	1.2	1.4
Annual forbs & grasses	1.173	14.0	13.8	14.7	18.5	16.5	15.5

[a] Lines, either solid or broken, connect means for consecutive sampling dates at which foliage density was significantly different ($P > .05$) from those not underlined or connected with solid or broken lines.

response to advance in season. No explanation can be offered for the significant differences among date means for the category perennial forbs and shrubs in 1965 (Table 1). Many of the established plants of sand dropseed succumbed to the 1964 drought. The significant difference in date means between July 20 and August 3, 1965, can be attributed to seedlings initiating growth the latter part of July.

Annuals, being opportunist plants, showed wide fluctuating foliage density between years. In 1964 most annual species had either reached maturity or had ceased growth by the time vegetation inventories were initiated on June 20. No significant differences in foliage density were found among date means. In 1965 most species of forbs were in the initial flowering stage on June 20. No significant differences were observed between the first three and the last two sampling dates (Table 1). Maximum cover of annual forbs and grasses, occuring on August 3, was a result of the rapid growth of two prostrate growing *Euphorbia* spp. (*E. geyeri* and *E. petaloidea*) between July 20 and August 3. In 1965 lambsquarter (*Chenopodium pratericola*) made up more than 50% of the annual forbs and grasses category. A significant decline in foliage density of lambsquarter was observed throughout the season.

Livestock Disturbance

It appears that livestock disturbance by grazing and/or trampling had little influence on foliage density estimates. No significant interaction ($P > .05$) of grazing treatments and dates was found in either year for any species or category.

Changes in foliage density of needleandthread grass were of about equal magnitude between any two dates regardless of grazing treatment. Data collected by Streeter (1966) in an adjacent pasture showed that animals utilized little or no needleandthread between June 20 and August 17; however, trampling damage was severe on the low-condition sites.

In 1964 maximum utilization of prairie sandreed occurred between July 1 and July 20 (Streeter, 1966). Foliage density declined significantly between July 5 and July 20 (Table 2). Since moisture was inadequate for continued growth, less foliage density was measured from July 20 through August 17 than from June 20 through July 5, resulting in a significant difference in these two periods of time. In 1965 the effect of grazing on foliage density of prairie sandreed was masked by growth to the point that there was no significant interaction between grazing treatments and dates. Maximum utilization occurred after August 1. This accounts for the significant decline in foliage density by August 17 (Table 2).

Foliage densities of the remaining species or categories, i.e. blue grama, sand dropseed and the categories perennial forbs and shrubs and annual forbs and grasses (except for the latter in 1965) were too low to fully evaluate their response to livestock disturbance.

Selecting a Sampling Time

Because of morphological and phenological variations among and within species, it is difficult to determine an adequate date for sampling foliage density. If a common date over all species or categories, years, and use could be established when no progressive or regressive changes in fo-

Table 2. Date within the sampling period at which significant differences in foliage density of various species or categories was found in 1964 and 1965 under grazed conditions.[a]

Species or category	S. E. of a date mean	Foliage-density percentage					
		6/20	7/5	7/20	8/3	8/17	Mean
1964							
Needleandthread	.802	15.1	20.0	15.5	17.9	17.4	17.2
Prairie sandreed	.427	4.7	5.5	3.8	3.8	4.5	4.4
Blue grama	.465	2.1	1.2	1.3	1.8	1.8	1.6
Sand dropseed	.320	2.3	2.3	1.8	1.9	1.3	1.9
Perennial forbs & shrubs	.199	.8	.7	1.2	.9	.7	.9
Annual forbs & grasses	.220	2.1	1.3	1.8	1.6	.8	1.5
1965							
Needleandthread	.757	5.3	7.0	7.7	8.4	8.2	7.3
Prairie sandreed	.639	4.2	4.3	5.1	5.5	3.5	4.5
Blue grama	.524	1.3	2.4	2.0	2.5	2.0	2.1
Sand dropseed	.296	1.4	1.3	.7	2.7	1.7	1.6
Perennial forbs & shrubs	.364	1.2	2.6	1.8	2.3	.8	1.7
Annual forbs & grasses	1.173	12.2	13.2	11.8	12.3	11.5	12.2

[a] Lines, either solid or broken, connect means for consecutive sampling dates at which foliage density was significantly different ($P > .05$) from those not underlined or connected with solid or broken lines.

liage density occur between any two sampling dates, this date would be the ideal date for inventorying mixed-prairie vegetation. It is further logical to assume that if a change in foliage density between two dates is of sufficient magnitude to be significant (.05 level), at some point in time between these two dates the foliage densities would not be significantly different from that determined for either the preceding or following date.

Based on this assumption, the most reliable sampling time for measuring year to year changes in foliage density under grazed (Table 2) or nongrazed (Table 1) conditions on a mixed-prairie vegetation would be a week prior to and immediately following July 20.

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