Relationships Between Visual Obstruction Measurements and Weight of Grassland Vegetation[1]

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Highlight

Visual obstruction measurements were used to determine height and density of vegetation in a Kansas grassland. These visual obstruction measurements were compared with the weight of vegetation collected from each site. The weight of vegetation collected was significantly correlated with the visual obstruction measurements.

As part of a long-term study of greater prairie chicken (*Typanuchus cupido pinnatus*) ecology in northeastern Kansas (Slade et al. 1965; Robel, 1966; Watt, 1969), an attempt was made to correlate movements and locations of prairie chickens with habitat types. In order to accomplish this, the various habitat types on a 2,500-hectare grassland study area had to be described. Species composition alone could not provide all the information necessary to evaluate the habitat potential of a grassland for prairie chickens. Emlen (1956) indicated that vegetation screening efficiency and density were as important as species present in describing avian habitats. Specifically, Hamerstrom et al. (1957) stated that height and density of grass were "clearly more important to the prairie chickens than species composition." Various optical means have been used to measure the height and density of vegetation (Wight, 1938; Webb, 1942; Mossman, 1955).

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However, few studies have correlated the amount of vegetation present at a site with various indices to visual obstruction. To quantify the visual obstruction technique of evaluating the height and density of cover types on our study area, weights of vegetation clipped on sample plots were compared with visual obstruction measurements made on each plot. This paper presents the results of those comparisons.

Study Area

The study was conducted on a grassland area located approximately 13 kilometers east-southeast of Junction City, Kansas in Geary County. Topography of the area consists of a series of gently sloping, rounded hills separated by intermittent streams. There are three major range sites on the study area: limestone breaks, shallow, and claypan (Bidwell, 1960). Each range site has its characteristic soil and vegetative composition (Bidwell, 1960; Briggs, 1968; Silvy, 1968).

Methods and Materials

Thirty 20-meter line transects were established in a north-south direction on areas of homogeneous vegetation on the study area. An effort was made to distribute the transect sites to include the entire range of vegetation densities and heights as well as plant life forms on the study area.

The capacity of the grassland vegetation to obstruct vision was measured in a manner similar to that described by Wight (1938) for forest understory. Alternating decimeters on a round pole (3 × 150 cm) were painted light brown and white. The mid-point of each decimeter was marked with a narrow black stripe making it possible for the observer to distinguish half-decimeters on the pole.

Vegetative measurements were made each 2 meters along a steel tape stretched from the north to the south end of each transect. Beginning at the zero-meter point of each transect, the pole was placed vertically in the vegetation 10 cm west of the tape. The pole was then observed from the south at mid-day at heights of 1.0, 0.8, and 0.5 meters at distances of 4, 3, and 2 meters (Fig. 1). A light bamboo stick marked at 1.0, 0.8, and 0.5 meters was used to standardize the observation heights (Fig. 2). The lowest decimeter or half-decimeter mark visible on the

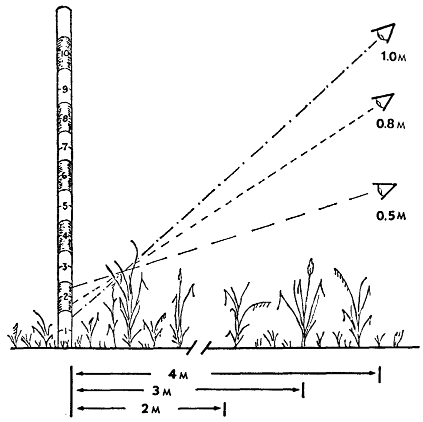

FIG. 1. Diagrammatic sketch of apparatus and technique used in sampling vegetation density. Readings were taken at each of three heights at 2, 3, and 4 meters from the pole.

pole was recorded for each of the three heights and distances, producing nine visual obstruction measurements. Following the visual obstruction measurements, the vegetation on a 20 × 50 cm rectangular plot situated along the transect tape directly in front of the pole was clipped to a height of 0.5 decimeters and collected. The process was repeated every 2 meters along the 20-meter transect. Thus, 90 visual observation measurements and 10 vegetation collections were obtained from each of the 30 transects. All clipped vegetation was immediately dried for 48 hours at 60 C and weighed to 0.1 gm.

Vegetation obstruction and weight of clipped vegetation data were punched on IBM cards and statistical analyses done in a 360/50 IBM system. A multiple linear regression analysis was used to measure the relationship between visual obstruction measurements and the weight of clipped vegetation from each transect. Comparisons were made between the mean of each of the nine visual obstruction measurements for each transect and the total weight of clipped vegetation from the ten 20 × 50 cm plots on that transect. Visual observation measurements (independent variables) were coded in the order they were collected in the field, i.e., variables 1, 2, and 3 are means of 10 visual obstruction measurements taken at 4 meters from heights of 1.0, 0.8, and 0.5 meters, respectively; variables 4, 5, and 6 are means of visual obstruction measurements taken at 3 meters from heights of 1.0, 0.8, and 0.5 meters, respectively; and variables

FIG. 2. Observer making a visual observation measurement in moderately dense vegetation from a height of 1.0 meter, 2 meters from the pole.

7, 8 and 9 are means of visual obstruction measurements taken at 2 meters from heights of 1.0, 0.8, and 0.5 meters, respectively. The weight of the clipped vegetation was the dependent variable and was coded as 10. Variables 1, 2, and 3 (all measurements made from 4 meters distant) were averaged and coded as variable 11, the average of variables 4, 5, and 6 was coded as 12, and the average of variables 7, 8, and 9 was coded as variable 13.

Results and Discussions

Examination of the raw data disclosed a striking relationship between the visual obstruction measurements and the weight of vegetation clipped from each transect. The most obvious relationship was between the mean of all the visual obstruction measurements and the weight of vegetation clipped from each transect (Fig. 3). A highly significant ($P < 0.01$) product moment correlation coefficient ($r = 0.9727$) was detected between the pooled means of each transect and the weight of vegetation collected from that transect. Because the collection of 90 visual obstruction measurements was extremely time consuming, further analyses were conducted to determine if significant correlations could be obtained using fewer observations.

A simple correlation matrix was constructed to detect correlations among all the variables (Table 1). Although the entire matrix is of interest, the focal points of this study were the correlations of the independent variables (1 through 9 and 11 through 13) with the dependent variable (10), weight of clipped vegetation.

When the first nine independent variables (1 through 9) were examined for their stepwise contribution to the multiple correlation coefficient ($R^2 = 0.9727$), visual obstruction measurements taken from a height of 1 meter at a distance of 4 meters plus those taken from a height of 1.0 and 0.5 meters at a distance of 2 meters contributed 0.9634 to the total R^2 value for the nine variables (Table 2). Thus, these three variables (1, 7, and 9) contributed 99.0 percent of the total R^2 value. Variables 1 and 7 contributed 98.6 percent of the total R^2 value while variable 1 by itself had an R^2 value of 0.9550 or 98.2 percent of the total R^2 value.

Using all the visual obstruction measurements stratified by distance classes (variables 11, 12, and 13), the realized R^2 value was 0.9438, with 0.9400 (99.6 percent) of that contributed by the measurements taken from 4 meters (Variable 11).

Obviously all 90 visual observation measurements need not be made to obtain a reliable measure of the amount of vegetation along a transect. The visual obstruction measurement taken from a distance of 4 meters and a height of 1 meter provides an extremely reliable measure of the height and density of the vegetation.

Because the visual obstruction measure is so strongly correlated with the weight of vegetation clipped from the area, it is possible to use this visual index as a measure of total forage production. Since variable 1 (4 meters distant, 1 meter high) contributed 0.9550 to the overall R^2 of 0.9727, a simple linear regression of variable 10 (vegetation weight) on variable 1 gave an estimated regression equation:

$$\text{Variable } 10 = -6.2 + 117.2 \text{ (variable 1)}$$
$$s_{\text{var. } 10 \cdot \text{var. } 1} = 27.2$$

Additional research along these lines may prove fruitful for range managers

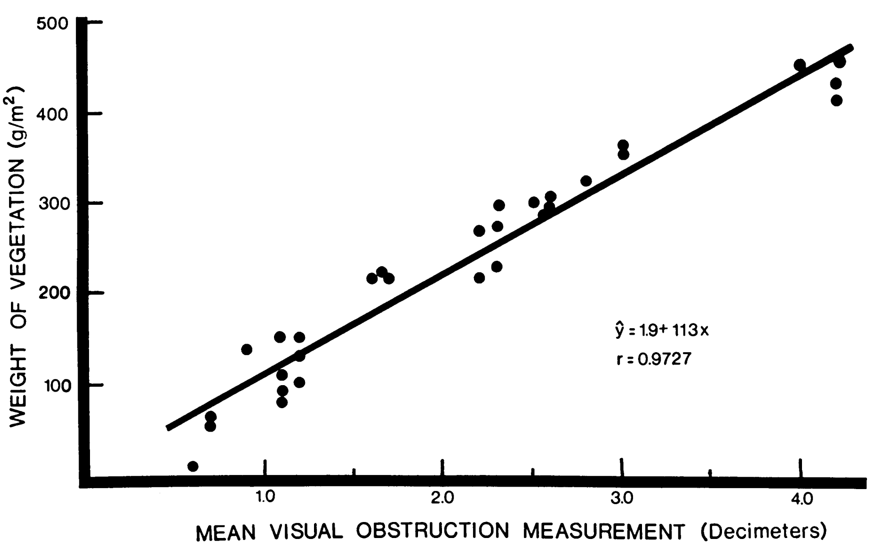

FIG. 3. Relationship between the means of nine visual obstruction measurements and the weight of vegetation clipped from each of 30 transects.

Table 1. Simple correlation matrix showing relationships between 12 independent (1–9 and 11–13) and 1 dependent variable (10). All correlation coefficients are significant ($P < 0.01$).

Variables[a]	1	2	3	4	5	6	7	8	9	10	11	12	13
1	1.0000												
2	0.9950	1.0000											
3	0.9788	0.9817	1.0000										
4	0.9950	0.9880	0.9772	1.0000									
5	0.9955	0.9921	0.9812	0.9987	1.0000								
6	0.9884	0.9889	0.9921	0.9884	0.9915	1.0000							
7	0.4979	0.4923	0.5142	0.5218	0.5071	0.4934	1.0000						
8	0.5410	0.5380	0.5625	0.5658	0.5529	0.5447	0.9942	1.0000					
9	0.6243	0.6228	0.6508	0.6436	0.6322	0.6272	0.9822	0.9890	1.0000				
10	0.9772	0.9771	0.9470	0.9707	0.9725	0.9578	0.5452	0.5823	0.6559	1.0000			
11	0.9947	0.9961	0.9938	0.9905	0.9937	0.9953	0.5058	0.5521	0.6384	0.9695	1.0000		
12	0.9948	0.9922	0.9873	0.9971	0.9985	0.9969	0.5064	0.5542	0.6347	0.9682	0.9961	1.0000	
13	0.5647	0.5615	0.5869	0.5871	0.5743	0.5657	0.9949	0.9978	0.9955	0.6040	0.5761	0.5755	1.0000

[a] See text for explanation of variable coding.

Table 2. Stepwise contribution to the total correlation ($R^2 = 0.9727$) between vegetation weight and the means of each visual obstruction measurement.

Variable[1]	Contribution	Df[2]	F value
1	0.9550	28	593.93
7	0.0046	27	3.05
9	0.0038	26	2.71
2	0.0070	25	5.88
6	0.0014	24	1.17
5	0.0007	22	0.56
4	0.0002	23	0.17
3	0.0001	21	0.07
8	0.0000	20	0.00

[1] See text for explanation of variable coding.
[2] Df = Degrees of freedom.

Table 3. Stepwise contribution to the total correlation ($R^2 = 0.9438$) between vegetation weight and the means of the visual obstruction measurements taken at each of three distances.

Variable[1]	Contribution	Df[2]	F value
11	0.9400	28	438.57
12	0.0031	27	1.46
13	0.0007	26	0.132

[1] See text for explanation of variable coding.
[2] Df = Degrees of freedom.

since the visual obstruction technique is far less time consuming compared with the traditional methods of determining forage production on grassland areas.

Conclusions

1. Visual obstruction measurements were strongly ($P < 0.01$) correlated with the amount of vegetation present. A correlation of 0.9727 was detected between 90 visual obstruction measurements and the weight of vegetation collected from each transect.
2. A visual obstruction measurement taken from a height of 1 meter and a distance of 4 meters constitutes a reliable index ($R^2 = 0.9550$) to the amount of vegetation on a specific site.
3. Use of the visual obstruction measurement may prove valuable in determining a standing crop of vegetation.

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