July 1964

U.S. FOREST SERVICE
RESEARCH NOTE RM - 22

FOREST SERVICE
U.S. DEPARTMENT OF AGRICULTURE

ROCKY MOUNTAIN FOREST AND RANGE EXPERIMENT STATION

Use of the Grazed-Plant Method for Estimating Utilization of Some Range Grasses in New Mexico

H. W. Springfield[1] and Geraldine Peterson[2]

The grazed-plant method of estimating utilization has stimulated much interest among range managers. Because the method is rapid and easy to use, it could be a valuable tool in managing large range areas. Several investigators have found the grazed-plant method gives reasonably reliable estimates of utilization. The method has been used successfully for estimating the utilization of Idaho fescue (Festuca idahoensis),[3] bearded bluebunch wheatgrass (Agropyron spicatum),[4] and crested wheatgrass (A. desertorum).[5]

Grazed-plant guides for estimating the utilization of blue grama (Bouteloua gracilis), Kentucky bluegrass (Poa pratensis), mountain muhly (Muhlenbergia montana), and Arizona fescue (Festuca arizonica) were developed in New Mexico from studies conducted on National Forest ranges grazed by cattle in 1961 and 1962. The guides give reasonably precise estimates of utilization up to about 40 to 45 percent utilization by weight.

METHODS OF STUDY

Data for the grazed-plant studies were obtained on National Forest grazing allotments representative of a variety of vegetation types and range conditions (table 1). The data were taken on 100-plant paced transects. Number of transects for each species, together with the number of allotments sampled, was as follows:

	Number of 100-plant transects	Number of allotments sampled
Blue grama	168	24
Kentucky bluegrass	174	25
Mountain muhly	126	20
Arizona fescue	108	18

[1] *Range Conservationist, located at the Station's project headquarters at Albuquerque, in cooperation with the University of New Mexico; central headquarters are maintained at Fort Collins in cooperation with Colorado State University.*

[2] *Statistician, located at central headquarters, Fort Collins, in cooperation with Colorado State University.*

[3] *Hurd, Richard M., and Kissinger, Neland A., Jr. Estimating utilization of Idaho fescue (Festuca idahoensis) on cattle range by percent of plants grazed. U. S. Forest Serv. Rocky Mountain Forest and Range Expt. Sta. Sta. Paper 12, 5 pp. 1953.*

[4] *Mattox, James E. A study of percent of plants grazed method of utilization determination and its application. Mont. Agr. Expt. Sta. Mimeo. Cir. 88, 140 pp. 1955.*

[5] *Springfield, H. W. Estimating the utilization of crested wheatgrass from counts of grazed plants. U. S. Forest Serv. Rocky Mountain Forest and Range Expt. Sta. Res. Note 38, 6 pp., illus. 1959.*

Table 1.--Distribution of 100-plant transects by National Forest, vegetation type, and range-condition class, 1961-62

Distribution	Blue grama	Kentucky bluegrass	Mountain muhly	Arizona fescue
	- - - Number of transects - - -			
National Forest:				
Carson	12	42	30	42
Cibola	78	12	48	36
Lincoln	36	54	12	12
Santa Fe	42	66	36	18
Vegetation type:				
Mixed conifer	12	102	36	30
Ponderosa pine	48	72	78	78
Pinyon-juniper	108	0	12	0
Range-condition class:				
Good	12	18	6	12
Fair	96	90	72	42
Poor	60	66	48	54

Selection of study areas was based on information in allotment analyses, discussions with grazing specialists, and field examination. For each study area, the vegetation type, range-condition class, and grazing season were recorded. On most allotments only one area was studied, but on a few allotments two areas were studied. Transects were taken in the summer of 1961, and repeated on the same study areas in the summer of 1962.

Individual plants observed on paced transects were used for the grazed-plant counts and utilization estimates. A transect consisted of 100 individual plants of one species. Utilization was estimated for each plant on every transect. If less than 5 percent of the herbage was missing, the plant was classed as ungrazed. All transects, six on each study area, had random starting points and directions of travel. Study areas, generally 20 to 100 acres in size, were relatively uniform as to vegetation and topography.

The ocular-estimate-by-average-of-plants method[6] was the standard measure of utilization. The estimate of utilization for each transect was the average of the utilization percentages for the 100 plants observed. Before estimates were made for a species on any area, the technician was trained to estimate varying degrees of utilization by clipping and weighing different amounts of herbage from individual plants.

The method was modified wherever blue grama or Kentucky bluegrass formed a sod. Instead of an individual plant, a 3-inch-diameter circle of sod was used as an observation. Supplemental studies conducted in June 1961, showed that 3-, 4-, or 5-inch loops were better than 2- or 6-inch loops for delimiting plant units. Field experience indicated the grazed-plant data could be taken more readily with a 3-inch loop than with the 4- or 5-inch loops. The loop and 30-inch handle were made of 1/4-inch welding rod.

The data were analyzed by regression with the model: $Y = b_1 X_1 + b_2 X_2$, where Y = percent utilization, X_1 = percent number of plants grazed, and $X_2 = X_1^2$. Separate regression analyses were computed by year, vegetation type, and range-condition class for each species. The resulting regression lines were compared by analysis of covariance.

[6] *Pechanec, J. F., and Pickford, G. D. A comparison of some methods used in determining percentage utilization of range grasses. Jour. Agr. Res. 54: 753-765. 1937.*

RESULTS

Comparatively strong relationships were found between number of plants grazed and estimated utilization by weight for the four grasses studied. Statistical analyses reduced the relationships to three curves--one each for blue grama and Kentucky bluegrass, and a combined curve for mountain muhly and Arizona fescue (fig. 1). Multiple regression equations for the three curves are as follows:

	Regression equation	Correlation coefficient
Blue grama	$Y=0.11X+0.0024X^2$	0.99
Kentucky bluegrass	$Y= .08X + .0036X^2$	.98
Mountain muhly-Ariz. fescue	$Y= .11X + .0029X^2$	.98

Statistical analyses showed no differences of practical importance between years, vegetation types, or range-condition classes. Though some statistical differences were found, the differences often amounted to less than 3 percent in utilization.

The curves in figure 1 may be used as guides for estimating utilization of any one of the four grasses on a range area, provided certain procedures are followed. The first step is to select a random starting point and direction of travel. Next, pace off a transect, observe 100 plants of one species, and record the number grazed. Then, using the curve, convert this number of plants grazed to percent utilization. This procedure is repeated for each transect. The final step is to average the utilization percentages for all transects to obtain an estimate of utilization for the area.

Using the curves to convert number of plants grazed to percent utilization for each transect may prove tedious and could introduce personal errors. For these reasons, table 2 was devised to make conversion more convenient, more rapid, and less subject to personal errors.

An example of how to use table 2 follows: Assume 50 random paced transects are taken on a Kentucky bluegrass area. The number of grazed plants and corresponding utilization estimates would be tabulated and averaged as shown below:

Transect number	Grazed plants (Number)	Estimated utilization (Percent)
1	64	19.8
2	46	11.3
3	72	24.3
4	30	5.6
5	80	29.3
6	44	10.5
:	:	:
:	:	:
:	:	:
50	56	15.7
	Total	765.0
	Average	15.3

This average, 15.3 percent, would be the estimate of utilization of bluegrass for the area sampled.

A large number of grazed-plant transects must be taken to arrive at a reliable estimate of utilization for any range area, regardless of whether the area is a small pasture, a site within a pasture, or a fairly large range unit with uniform topography and vegetation. The number of transects needed will depend on the degree of confidence desired in the utilization estimate, and on uniformity of grazing on the area. In the example given above for Kentucky bluegrass, the confidence intervals for different numbers of transects would be as follows:

	Confidence interval 0.95	0.99
12 transects	15.3±5.82	15.3±8.73
24 transects	15.3±4.10	15.3±6.15
48 transects	15.3±2.90	15.3±4.35
60 transects	15.3±2.58	15.3±3.87

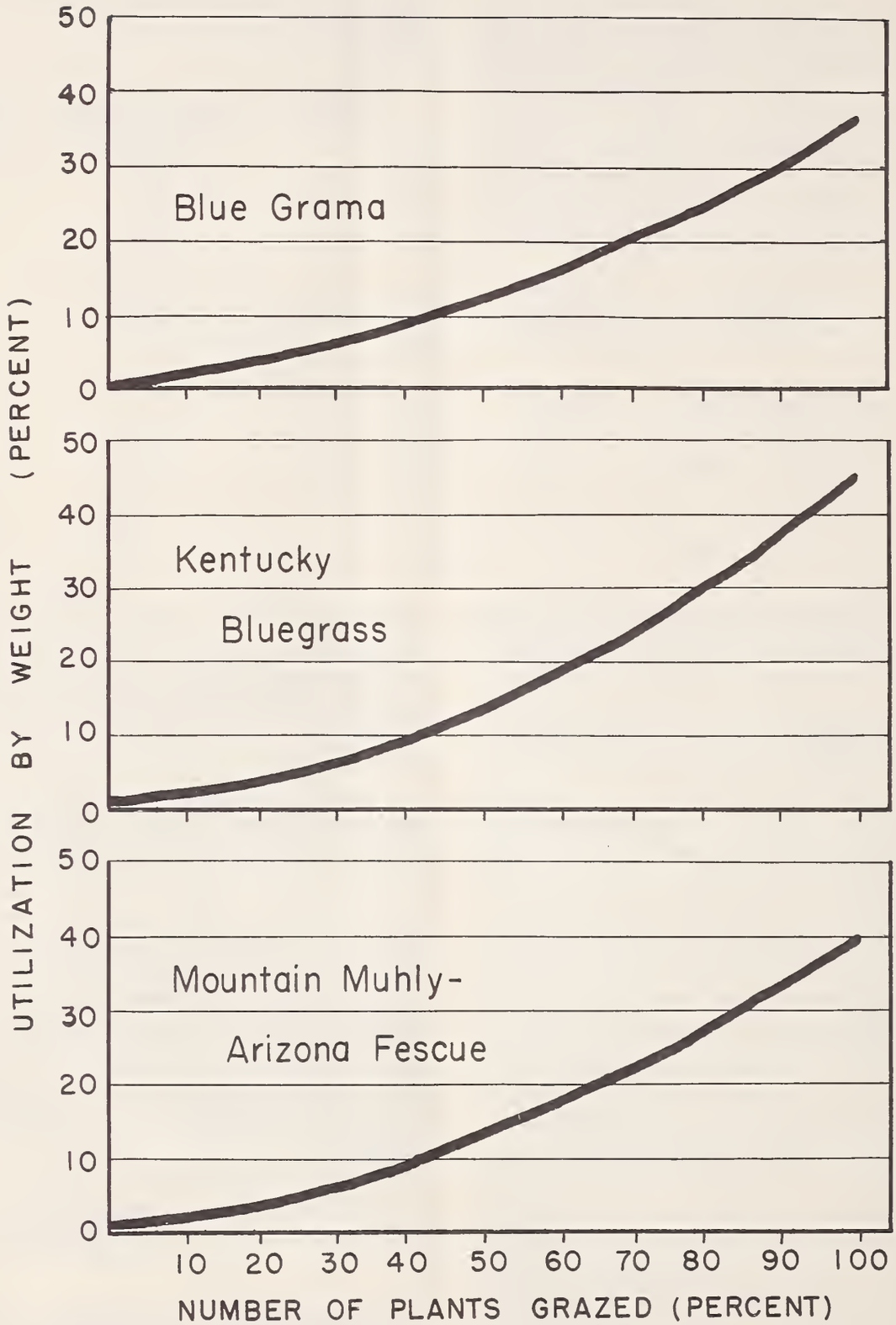

Figure 1.--Grazed-plant utilization curves.

Table 2. --Conversion from number of plants grazed to percent utilization by weight

Number of plants grazed	Blue grama	Kentucky bluegrass	Mountain muhly or Arizona fescue	Number of plants grazed	Blue grama	Kentucky bluegrass	Mountain muhly or Arizona fescue
	Percent				Percent		
2	0.2	0.2	0.2	52	12.5	13.8	13.8
4	.5	.4	.5	54	13.2	14.8	14.6
6	.8	.6	.8	56	14.0	15.7	15.5
8	1.1	.9	1.1	58	14.8	16.7	16.4
10	1.4	1.2	1.4	60	15.6	17.7	17.3
12	1.7	1.5	1.8	62	16.4	18.7	18.2
14	2.1	1.8	2.2	64	17.2	19.8	19.2
16	2.4	2.2	2.6	66	18.1	20.9	20.2
18	2.8	2.6	3.0	68	19.0	22.0	21.2
20	3.2	3.0	3.4	70	19.9	23.1	22.2
22	3.7	3.5	3.9	72	20.8	24.3	23.2
24	4.1	4.0	4.4	74	21.7	25.5	24.3
26	4.6	4.5	4.9	76	22.6	26.8	25.4
28	5.1	5.0	5.4	78	23.6	28.0	26.5
30	5.6	5.6	6.0	80	24.6	29.3	27.7
32	6.1	6.2	6.6	82	25.7	30.6	28.8
34	6.7	6.8	7.2	84	26.7	32.0	30.0
36	7.2	7.5	7.8	86	27.8	33.4	31.3
38	7.8	8.2	8.5	88	28.8	34.8	32.5
40	8.4	8.9	9.2	90	29.9	36.2	33.8
42	9.0	9.7	9.9	92	31.0	37.6	35.1
44	9.7	10.5	10.6	94	32.2	39.1	36.4
46	10.4	11.3	11.4	96	33.3	40.7	37.7
48	11.0	12.1	12.2	98	34.5	42.2	39.0
50	11.7	12.9	13.0	100	35.7	43.8	40.4

These figures clearly show the need for a large number of transects if a high degree of confidence is desired in the utilization estimate. In this example, if 48 transects were used to obtain the average, the true value of percent utilization should lie between 12.4 and 18.2 at the 0.95 confidence level, or between 11.0 and 19.6 at the 0.99 level.

The large number of transects is required because the number of plants grazed per transect on an area may vary from 0 to 100. Fewer transects would be needed if the number of plants grazed per transect varied only from 40 to 60, or 70 to 90. Based on the 1961-62 studies, a variation of from 15 to 95 in number of plants grazed per transect can be expected. With this much variation, 50 transects are needed to give a reasonably reliable estimate of utilization for a range area.

Time records kept for grazed-plant studies on crested wheatgrass indicate that only about 5 minutes are required to observe 100 plants along a paced transect and record the data. At 5 minutes per transect, one man could sample an area with 50 grazed-plant transects in about 4 hours if distances between the transects were not too great.

[7] *See footnote 5, p. 1.*

DISCUSSION AND CONCLUSIONS

The grazed-plant guides may be used for estimating the utilization of blue grama, Kentucky bluegrass, mountain muhly, and Arizona fescue, provided certain limitations of the method are recognized. A number of precautions also must be heeded to avoid biased estimates.

Random sampling of the paced transects is essential for an unbiased estimate. A systematic sample on a grid over the whole area would be satisfactory, but a selected sample based on judgment or chosen for accessibility could lead to very biased results.

Also, a large number of transects should be taken over the range area. Results of these studies suggest 50 transects are needed to give reliable estimate of utilization. If experience with the method shows less variation in the number of grazed plants per transect than found in the 1961-62 studies, fewer transects will be necessary. Degree of confidence desired in the utilization estimate likewise affects the number of transects required. At the 0.99 confidence level, 50 transects are needed for a reasonably precise estimate of utilization. On the other hand, 25 transects give a reasonably good estimate at the lower 0.95 confidence level.

The curves shown in figure 1 may be used for estimating utilization, but table 2 probably will prove more satisfactory. In using either the curves or the table, the main precaution is to convert from number of plants grazed to percent utilization for each transect. Then, average the utilization percentages for all transects to obtain an estimate for the entire area.

A notable limitation of the grazed-plant guides is that they cannot be used on heavily grazed areas. None of the relationships extends beyond 45 percent utilization. For blue grama, the maximum is 36 percent utilization because at this point all plants are grazed. The upper limit is 44 percent for Kentucky bluegrass, and 40 percent for mountain muhly and Arizona fescue. In practice, only range areas with utilization averages substantially less than these upper limits can be sampled satisfactorily. The reason is that, when all plants on a transect are grazed, the utilization could be anywhere from 40 to 100 percent. Therefore, when 100 grazed plants are recorded for one or more transects on an area, the estimated utilization for that area will be in doubt. Consequently, the method can be applied only to areas where all transects have at least one ungrazed plant. As a rule of thumb, the method should not be used where fewer than 5 percent of the plants in the stand are ungrazed.

One further precaution concerns sampling areas where the grass has made considerable regrowth after grazing. During the 1961-62 studies, data were not collected on several areas because the individual grass plants had regrown enough after grazing to obscure the stubble. This problem was encountered with all four species, but especially with Kentucky bluegrass. The method apparently works best on areas where grazing use is current or where very little if any regrowth has taken place since the grass was grazed.

The grazed-plant guides appear to have special value for mid-season utilization checks. Grazing begins in early June on many allotments in New Mexico. A check on utilization often is needed in August to decide when the grazing season should end. The grazed-plant method provides a convenient and practical way of making this mid-season utilization check. When the method is used in August, its shortcomings may be less troublesome than when it is used at the end of the summer season. First, all transects are likely to have at least a few ungrazed plants, and, second, the grazing is more apt to be current, thus avoiding the problem of regrowth obscuring the stubble.

Despite its limitations and the necessary precautions, the grazed-plant method has merit as a relatively rapid way of estimating utilization. The method may be difficult to apply on yearlong ranges, but should work well on summer ranges.