Comparison of Cage Methods for Determining Utilization on Pine-Bluestem Range[1]

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Highlight

Plucking herbage from caged quadrats to simulate grazing resulted in lower estimates of yield and utilization than did monthly or yearly clipping of herbage from caged and open quadrats. At the end of the grazing season, estimates of ungrazed herbage did not differ significantly by measurement technique. The overestimate of yield when herbage was clipped once a year was probably caused by greater growth on caged than on open quadrats.

When forage consumption is computed as the difference between herbage weight on protected and grazed plots, greater growth on protected plots may distort the estimate. The longer the period of protection, the greater the discrepancy is likely to become (Joint Committee, 1962). To assess the magnitude of this error, various measurement techniques were compared in a 2-year study on pine-bluestem range.

Procedure

The study was made in 1963-64 on a 570-acre range unit of the Palustris Experimental Forest in central Louisiana. Longleaf pine, *Pinus palustris* Mill., had been clearcut more than 20 years before. The woody cover now consists mainly of scattered second-growth pines, scrub oaks, *Quercus* spp., and southern waxmyrtle, *Myrica cerifera* L. Pinehill bluestem, *Andropogon divergens* (Hack.) Anderss. ex Hitchc., and slender bluestem, *A. tener* (Nees) Kunth, dominate the herbaceous cover. Herbage averages about a ton (oven-dry)/acre/year. Annual rainfall is about 58 inches.

Before the study, ⅓ of the unit was burned each April in a 3-year rotation. A cow herd grazed yearlong, and utilization averaged about 75% on the newly burned portions and 25% on the unburned. For 1963, the study site was a 190-acre area burned in April. To intensify use during

the second year, only 20 acres were burned in April 1964, and the grazing herd was kept constant.

Yield and herbage remaining after grazing were measured by three methods: stationary-cage, transient-cage, and plucked-quadrat. All are variations of what is called the difference method (Joint Committee, 1962) or cage technique (Brown, 1954), whereby herbage weights on protected plots are compared with those on adjacent, unprotected plots. Utilization at the end of the grazing period is computed, in percent, from differences.

Measurement units were replicated 20 times in a randomized block design because a preliminary survey indicated that this sampling intensity would be required for a sampling error of less than 20% on burned, moderately grazed range. All quadrats were 3.1 ft square; ungrazed guadrats were protected by net-wire cages 4 ft square. Original plots were installed immediately after sites were burned. Final measurements were made in the fall, after growth ceased; the growing season lasted slightly more than 7 months in 1963, but only 6 months in 1964. All clipping was to a 1-inch stubble height. Samples were oven-dried at 76 C.

Stationary-cage method.—A cluster of four quadrats, similar in herbage density and composition, constituted the measurement unit. One quadrat, randomly selected, was caged and left undisturbed throughout the growing season. The three remaining quadrats were open to grazing; preliminary sampling indicated that three open quadrats/cluster would minimize weight variation among herbage samples from grazed range. Herbage from open quadrats in each cluster was combined and the average weight subtracted from the weight on the caged quadrat.

This method, with the grazing and growing periods coinciding, is the simplest version of the difference, or cage, technique. Since caged

quadrats are free of grazing influences throughout the growing season, however, growth on them may exceed that on open quadrats. As a result, yield and utilization estimates may be too large.

Transient-cage method. — The measurement unit was a series of quadrat pairs whose members were similar in herbage density and composition. The first pair was established immediately after the fire; one quadrat, randomly selected, was caged, the other left open.

After 30 days, both caged and open quadrats were clipped, and utilization was calculated for that period. Immediately before clipping, a second pair was located in which each member was as similar as possible to the open member of the previous pair. Open quadrats were limited to one/cluster to permit accurate matching. The sampling procedure was repeated monthly, and quantities utilized were totaled to determine utilization for the whole season.

Except for 30-day periods when yield-measurement quadrats were caged, all quadrats were subjected to cropping and trampling. Thus, transient-cage measurements should estimate yield and consumption more accurately than the stationary-cage. Because quadrats must be frequently relocated and adequately paired, however, personal bias in this method may exceed that of other methods.

Plucked-quadrat method. — The measurement unit consisted of three quadrat pairs. One quadrat/pair, randomly selected, was caged throughout the growing season; the other was left open to grazing. Three pairs/set were presumed necessary to sample grazed range adequately. At 30-day intervals, herbage on caged quadrats was hand-plucked to a height judged the same as on corresponding open quadrats. Herbage plucked from the three caged quadrats/set was combined and the weight averaged. After growth ceased for the year, all quadrats were clipped and weights averaged for both open and caged quadrats.

Caged quadrats were not trampled, but periodic plucking simulated cropping by cattle. Precision of this method depends to some degree on the observer's ability to pluck caged

Table 1. Herbage yield and utilization (oven-dry basis), by year and method.

Year and Method	Herbage yield	Herbage util.	
1963	Lb./A	Lb./A	%[1]
Plucked-quadrat	1824	925	50
Stationary-cage	2212	1334	56
Transient-cage	2047	1135	54
1964			
Plucked-quadrat	1851	1154	62
Stationary-cage	2318	1643	69
Transient-cage	2194	1615	74

[1] Mean of 20 values/method.

quadrats to the same height as their grazed models. Most of the immediate error arising from inaccurate plucking should be corrected when quadrats are clipped at the end of the season. Where plucking intensity consistently exceeds grazing intensity, however, growth on caged quadrats may be less than on the open; conversely, insufficient plucking may increase production on caged quadrats.

Because the plucked-quadrat method provided a direct measure of herbage removed by simulated grazing, it was considered the control for this study.

Because techniques differed in subsampling intensity and procedure for measuring yield, production and utilization variances were heterogeneous both years. Hence, a special analysis for comparing means was necessary (Snedecor, 1956, p. 285-288).

Results and Conclusions

In 1963, utilization measurements by the three methods varied from 50% for the plucked-quadrat to 56% for the stationary-cage (Table 1). These differences were not significant at the 0.05 level. Estimates of herbage remaining on open quadrats after grazing were likewise similar. Yield measurements were significantly different; those by the stationary-cage method were highest. Despite similar measures of utilization, therefore, accuracy of the stationary-cage method was questionable.

In 1964, utilization measurements ranged from 62% by plucked-quadrat to 74% by tran-

sient-cage and differences were significant. As in the previous year, the techniques gave similar estimates of herbage remaining on grazed quadrats but measures of yield differed.

The stationary-cage method overestimated yield in both years and utilization in one. Greater growth on caged than on open quadrats probably accounted for the bias. Cassady (1953) found that undisturbed plots produced 33% more herbage than plots harvested at 4-week intervals.

Apparently, exaggeration of utilization by the stationary-cage technique is greatest under very heavy use and diminishes as utilization approaches zero. Findings show, however, that overestimation is not serious even when utilization is about 70%. Therefore, for general use—e.g., determining approximate utilization on lightly or moderately stocked range — this simple, economical method is probably adequate.

The transient-cage method consistently gave higher estimates of yield than did the plucked-quadrat. Moreover, its 1964 estimate of utilization significantly exceeded that by the plucked-quadrat. Measures of residual herbage by the two methods were similar in 1964; therefore, the high estimate of use was probably due to exaggerated yield. Reason for this overestimation is not clear. Since all quadrats were located by one observer, personal bias may have been responsible.

Where periodic and cumulative measures of production and utilization are needed, the transient-cage method or a modification of it must be used. However, its general usefulness is questionable. It was only slightly more reliable than the stationary-cage method and required seven times as much field work and much more computation.

Estimates of herbage remaining at the end of the season did not differ significantly either year. This suggests that the 1:1 ratio of open:caged quadrats sampled residual herbage as precisely as the 3:1 ratio. Thus, subsampling intensity for the stationary-cage and plucked-quadrat methods could have been reduced materially, without loss of accuracy.

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