Factors Affecting Forage Consumption by Cattle in Arizona Ponderosa Pine Forests

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Highlight: Forage consumption was significantly correlated with forage production and tree density, but not with steepness of slope, rockiness of soil, or distance from water. This suggests that good range management practices can effectively distribute livestock use.

Management practices designed to increase multiple use values of ponderosa pine forests are being tested in Arizona (Brown et al. 1974). Some of these practices will increase herbage production (Clary 1975), but there is a question as to what extent cattle will consume the additional forage. Factors related to forage consumption need to be identified in evaluating possible impacts of forest overstory manipulations on grazing values.

An earlier study on the Coconino Plateau in north-central Arizona found that distance to water, steepness and length of slope, access routes, forest density, season of use, range condition, floristic composition, and possibly rockiness influenced the manner in which pine-bunchgrass ranges were grazed (Glendening 1944). Slope steepness and distance upslope were important variables on uniform terrains in Montana, but the amount of rockiness was not (Mueggler 1965). In a Utah study, Cook (1966) concluded that although factors such as slope, distance to water below, percent palatable plants, and thickness of brush were correlated with utilization, no single factor could be used as a reliable index for predicting use. Young et al. (1967) found that forest density and understory vegetation influenced the distribution of forage utilization in northeastern Oregon.

This note summarizes the results of a study conducted to define factors related to forage consumption by cattle on the Beaver Creek Watershed in north-central Arizona, and to provide insight as to how timber management practices will likely affect utilization of the range resource.

The Study

The study was conducted on one-half of a summer-use cattle allotment (13,000 acres) on the Beaver Creek Watershed at the edge of the Coconino Plateau, near Flagstaff, Ariz. Yearling cattle grazed the allotment from June 1 to October 15 under a 4-unit rest-rotation system. Under this system, one range unit was rested for the entire grazing season while each of the other units were grazed 1.5 months per season. Range riding several days each week kept the animals well distributed.

Timber on this allotment is primarily ponderosa pine (*Pinus ponderosa*), with some intermingling Gambel oak (*Quercus gambelii*) and alligator juniper (*Juniperus deppeana*). Although the area had not been commercially logged for 15 years, 17% of it had been uniformly thinned 5 years prior to the study.

Principal grasses and grasslike plants include blue grama (*Bouteloua gracilis*), sedges (*Carex* spp.), spike muhly (*Muhlenbergia wrightii*), mutton bluegrass (*Poa fendleriana*), bottlebrush squirreltail (*Sitanion hystrix*), and black dropseed (*Sporobolus interruptus*). Principal forbs and half-shrubs are western ragweed (*Ambrosia psilostachya*), showy aster (*Aster communtatus*), and broom snakeweed (*Gutierrezia sarothrae*). Total herbage production in the year of the study averaged 200 lb/acre.

Elevations range from 6,600 to 7,400 ft. Soils are volcanic with considerable surface rockiness (Williams and Anderson 1967). Annual precipitation averages 20 to 25 inches.

Methods

Fifty-eight clusters of five 9.6-ft^2 plots were distributed on the study area by a stratified random procedure. Production of green forage was determined by weight estimate (Pechanec and Pickford 1937a). A sixth plot at each cluster was estimated, clipped, and oven-dried to provide a conversion factor to oven-dry weight. Utilization was determined by ocular estimates (Pechanec and Pickford 1937b).

Eight independent variables were empirically related to two dependent variables that expressed forage consumption and utilization. The dependent variables were: forage consumed (Y_1), in lb/acre (calculations included grasses, forbs, and half-shrubs); and utilization of perennial grasses (Y_2), in percent by weight. The independent variables were: perennial grass production (X_1); average preference rating of the grasses present on each sample area (X_2) (Clary and Pearson 1969); ponderosa pine density-basal area per acre (X_3); percent forest crown cover estimated from aerial photographs (X_4); percent slope at the sample area (X_5); distance from nearest water along probable travel route (X_6); elevation difference between the sample area and nearest water (X_7); and soil (X_8).

Multiple regression techniques were used in the analysis. Preliminary analysis suggested that forest variables be expressed both linearly and logarithmically.[1]

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[1] Basic data included values of O. Consequently (*1*) was added to all data values to allow logarithmic transformations.

Table 1. Characteristics of the regression variables.

Variables	Unit of measure	Minimum	Mean	Maximum
Dependent:				
Forage consumed	lb/acre	0	62	569
Utilization of perennial grasses	% of weight	0	34	84
Independent:				
Perennial grass production	lb/acre	0	147	675
Average preference rating of grasses at sample area	Numerical rating	16	21	30
Ponderosa pine density	Ft^2 basal area/acre	0	72	166
Forest crown cover	%	10	43	90
Slope at sample area	%	0	10	30
Distance from water	Ft	500	3,820	11,210
Elevation from water	Ft	0	113	432

Table 2. Correlations of selected variables with two expressions of forage use.

Dependent variable	Independent variable	Simple correlation coefficient	Multiple correlation coefficient
Y_1	X_1	+0.82	
	log (X_3 + 1)	−0.78	
	log (X_4 + 1)	−0.63	
	log (X_3 + 1), X_3		0.85
	log (X_3 + 1), X_3, X_4		0.89
	log (X_3 + 1), X_1, X_3		0.89
Y_2	X_1	+0.34	
	X_5	−0.28	
	log (X_4 + 1)	−0.45	

Dependent variables:
Y_1 = forage consumed (lb/acre).
Y_2 = utilization of perennial grasses (% by weight).
Independent variables:
X_1 = perennial grass production (lb/acre).
X_3 = ponderosa pine density (basal area/acre).
X_4 = forest crown cover (%).
X_5 = slope (%).

Results and Conclusions

Forage consumed by livestock averaged 62 lb/acre (Table 1); 97% of the consumption was perennial grasses. Forage consumption increased as grass production increased and forest density decreased. Two variables—perennial grass production and ponderosa pine density (logarithm of basal area)—accounted for 67 and 61%, respectively, of the variation in pounds of forage consumed (Table 2). Two combinations of variables accounted for over 75% of the variation in forage consumed.

Utilization of perennial grasses averaged 34% by weight. Although percent utilization of perennial grass was associated with perennial grass production, forest crown cover (logarithm), and percent slope, correlations were too low to be of practical value. Combining variables did not improve the correlations.

Most topography and distance variables related to forage consumption in other studies were not significant on Beaver Creek. Poss ible reasons were that the topography is more gentle on the Coconino Plateau than on many western mountain areas and that steep canyons were not sampled in this study, so only limited variability was present. Likewise, the amount of rockiness and average forage preference did not vary greatly.

However, Glendening's earlier (1944) study on similar areas of the Coconino Plateau described noticeable effects on grazing use by physical factors such as distance to water and steepness and length of slope. Why did this result not appear in the present study? In Glendening's study, the allotments ranged from 13,000 to 29,000 acres with no cross fences and a much lower density of developed watering places. The average distance to water in the present study was about one-half that found by Glendening. In addition, the allotment evaluated in the present study was cross-fenced into approximately 6,500-acre units and was under a management system which included rest-rotation and regular range riding. Under this management, cattle were well distributed, utilizing the forage resource wherever it occurred.

Variables most highly correlated with amount of forage consumed were those that would be influenced by timber management practices. Conversely, the factors unaffected by forest management practices, such as topography, surface characteristics, and distance to water, had little relation to forage consumption. These results suggest that, with *proper* livestock management, physical features on areas similar to the Beaver Creek Watershed will not severely restrict cattle movement except possibly on extreme slopes. Therefore, these features should not greatly hinder cattle from utilizing additional forage produced following reductions in forest overstory as a result of timber management practices.

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