Comparison of Herbage Production on Moderately Grazed and Ungrazed Western Ranges

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Abstract

The hypothesis that there is no difference in the total amount of herbage produced on moderately grazed and ungrazed Western ranges was proposed and rejected. It was rejected because published literature shows that annual herbage production averaged 68 ± 46% higher when plots were protected from a moderate level of livestock grazing. Likewise, herbage production of individual plants averaged 59 ± 50% higher when they were protected, rather than clipped at a moderate level of use.

Comparison areas (Fig. 1) occur throughout our Western rangelands. They clearly illustrate that there is more herbage remaining on the protected, rather than on the grazed site. But, because of herbage utilization, the actual affect of livestock grazing on total herbage production is not obvious. For example, Stoddart et al. (1975) conclude that heavy livestock grazing is generally detrimental to herbage production, although they and others (Pearson 1965; Duvall and Linnartz 1967; Marquiss and Lang 1969; and Reardon and Merrill 1976) believe that moderate grazing is beneficial.

The purpose of this paper is to test the hypothesis that there is no difference in herbage production on grazed and ungrazed Western rangelands.

Methods

Herbage production is a good measure of plant vigor (Vogel and Van Dyne 1966; and Willard and McKell 1973) and is the most reliable measure of grazing management procedures (Klipple 1964). Consequently, studies were reviewed to find those which compared herbage production under moderately grazed and ungrazed conditions. Although herbage production is related to range condition class and successional stages, we were unable to quantify these variables. Thus, the review describes only herbage production per se.

We summarized results from 12 studies which report a moderate level of use (40 to 60% of the current year's growth). Our analysis

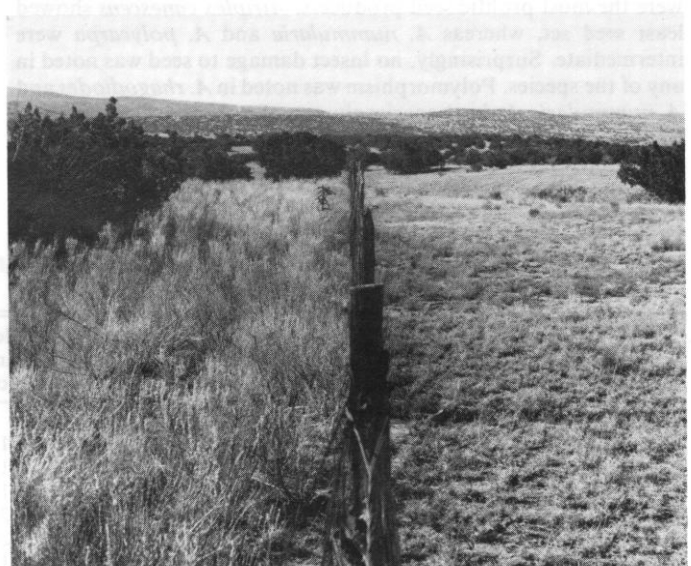

Fig. 1. *More herbage is visible on a New Mexico range that has been protected from livestock grazing for 35 years, than on a similar area that is grazed.*

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also includes production data which Johnson (1956) and Smith (1967) measured under their heavy grazing treatments. Their data were included because utilization of the important forage plants averaged about 50%. Most studies that involved livestock used cages to insure that the herbage was not grazed during the year the measurements were made. Utilization was estimated in one study (Smith 1967) in order to adjust production to ungrazed conditions. Another study (Evanko and Peterson 1955) selected ungrazed plants from their study areas which were being grazed.

The restricted number of studies made it impractical to use only relict area data to analyze ungrazed conditions. Therefore, we have included data from studies where herbage had been protected from livestock grazing for varying lengths of time. Three studies used a clipping technique to simulate moderate grazing on "individual plants." These data were analyzed separately in this review because the response of an individual plant may differ from the total herbage response observed on a clipped plot. It is believed that clipping individual plants enabled the investigator to control a variable (degree of utilization) that is normally difficult to measure. In addition, each of the plant species studied does occur in monotypic stands.

Table 1. Herbage production under no grazing and moderate grazing, and mean difference in production for 20 observations.

Author and study information	Production (kg/ha) Moderate use	No grazing	Percentage difference
Albertson et al. (1953)			
Kansas (5 years protection)	1232	2016	64
Evanko et al. (1955)			
Montana (18 years protection)			
Festuca idahoensis	329	778	136
Agropyron spicatum	46	65	41
Johnson (1956)			
Colorado (10 years protection)	1052	2218	111
Larson et al. (1942)			
South Dakota (described as a relict)	1838	2650	44
Pieper (1968)			
New Mexico (12 years protection)			
Stony hills	526	627	19
Loamy upland	616	728	18
Loamy bottomland	330	683	107
Reardon et al. (1976)			
Texas (20 years protection)	1331	1166	−12
Riegel et al. (1963)			
Kansas (20 years protection)			
Andropogon spp. (mixture)	2432	6188	154
Bouteloua gracilis	2374	2475	4
Agropyron spp.–*Bouteloua* spp.	3358	3852	15
Schwan et al. (1949)			
Colorado (7 years protection)	1318	1817	38
Sims et al. (1978)			
Montana (relatively undisturbed)	899	1519	69
Kansas (60 years protection)	1109	1159	5
Oklahoma (15 years protection)	2399	2698	13
Colorado (31 years protection)	899	1049	17
Smith, (1967)			
Colorado (17 years protection)			
Open grass	336	1810	438
Open timber	224	371	66
Vogel, et al. (1966)			
Montana (4 years protection)	661	739	12
Average for Western ranges (Based on 20 comparisons reported from 7 states)			$\bar{x}$=68, S=99, $S\bar{x}$=22

We used a paired-plot analysis to test the null hypothesis that there was no difference between treatments (Snedecor and Cochran 1973). The first analysis includes 20 comparisons reported in 11 studies which compared herbage production under moderate use to protected conditions. We determined the difference between treatment at each site and calculated an average difference. The second analysis includes eight comparisons reported in three studies which compared herbage production on "clipped" and protected plants. The difference between treatment for each plant was determined and an average difference calculated.

Results and Discussion

Herbage Response to Protection

Herbage production averaged 68 $\pm$ 46% higher on sites protected from livestock grazing, compared to similar areas which were moderately grazed (Table 1). This increase is significant at the 99% level. Individual plants show a similar response when they are clipped at a moderate degree of use (Table 2). The average difference between treatments is 59 $\pm$ 50%. The difference is significant at the 95% level. Therefore, both approaches indicate that the hypothesis must be rejected. In other words, Western ranges produce more herbage under protection than they do under moderate livestock grazing.

Table 1 shows that the grazed plots produced more herbage than the protected plots in only one study area, the Edwards Plateau (Reardon and Merrill 1976). However, two studies (Duvall and Linnartz 1967; and Kelting 1954) that found 12% more herbage production on the grazed plots rather than on the protected plots were omitted from this analysis. The former was treated as an outlier (Bonham 1971) because it was conducted in Louisiana where annual rainfall averages 147 cm. Kelting's (1954) study was omitted because his report does not contain an utilization estimate for the grazed plots, even though they were not protected from livestock grazing during the year the study was conducted. His study was conducted in the tall grass prairie near Norman, Oklahoma.

Weaver and Rowland (1952) and Albertson et al. (1953) suspected that livestock grazing may be beneficial on productive sites because it prevents a detrimental accumulation of mulch. Mulch may have detrimentally influenced Kelting's (1954) protected plots because they contained 9,121 kg of dead material in addition to 3,217 kg of live herbage per ha when they were measured during the summer. However, a more recent study (Sims et al. 1978) in the tall grass prairie measured 13% more herbage production on the pro-

Table 2. Herbage production of individual plants under clipping and protection, and mean difference in production for eight observations.

Author and study information	Production (gm/plant) Moderate use	No grazing	Percentage difference
Julander (1968)			
Utah (10 years protection)			
Geranium richardsoni	20	43	115
Ligusticum porteri	33	52	58
Valeriana edulis	21	28	33
Pond (1957)			
Wyoming (5 years protection)			
Festuca idahoensis			
Granitic soil	.74	2.07	180
Sedimentary soil	1.48	2.09	41
Willard et al. (1973)			
Utah (more than 10 years protection, but only 5 years of clipping treatment)			
Geranium fremontii	13.9	14.5	4
Chrysothamnus viscidiflorus	6.3	8.1	29
Symphoricarpos vaccinioides	13.0	14.4	11
Average based on 8 comparisons			$\bar{x}$=59, S=60, $S\bar{x}$=21

tected rather than on the grazed plots. This latter study measured a less productive site, 8533 kg of above-ground standing crop and litter per acre.

Reardon and Merrill's study area on the Edwards Plateau receives 58 cm of annual rainfall, and the protected plot produced 1,166 kg of herbage per ha. These conditions should not result in a detrimental level of mulch because mulch does not appear detrimental in other study areas (Albertson et al. 1953; and Riegel et al. 1963) that receive as much rainfall and produce more herbage under protection (Table 1). Although plots studied by Albertson et al. had been protected for only 5 years, the protected plots in the other two studies had been protected for 20 years.

Ellison (1960) concluded that although moderate livestock grazing seems to retard production of herbaceous species, grazing may stimulate production of shrubs. This suggests that grazing may affect herbage production on a shrub community differently than it does on a grass community. Differences between plant communities may account for some of the variability in Table 1. Grazing systems, or other management practices, are another factor that cannot be quantified in published literature at this time. These practices do influence herbage production under moderate grazing.

Studies by Schwan et al. (1949), Albertson et al. (1953), Pond (1957), and Vogel and Van Dyne (1966) measured the effects of nonuse treatments that varied from 4 to 7 years in length (Tables 1 and 2). The increase on the protected plots in these studies is similar to the increases measured on plots protected for eight or more years. This suggests that herbage production does not increase indefinitely when it is protected from moderate livestock grazing. On the other hand, Larson and Whitman's (1942) relict area data show that herbage does not necessarily enter a nonproductive state if it is not grazed by livestock.

It is not known how much old herbage material was included as current year's growth in the cited studies. It is expected that the material would be easier to separate when individual plants are clipped. From this standpoint, it is interesting to note that the difference between treatments was nearly as large when individual plants were clipped. Additional insight may be gained from Sims et al. (1978) study because they stressed the importance of separating current year growth from older residue. Herbage production averaged 26% higher on the protected plots at their four study sites.

Management Implications

Data in Table 1 indicate that herbage production on Western ranges would increase 68 ± 46% if livestock grazing was discontinued. It is recognized that this average response will differ by range site (Pieper 1968), by vegetative life form (Ellison 1960), and by plant species (Table 2). But, it is an average response that Land Management Agencies can expect if they implement a no-grazing policy on Western ranges.

Published data suggest that herbage production will not continue to increase if nonuse periods of 4 to 7 years are extended. Thus, from a herbage production standpoint, there is little justification for advocating long periods of nonuse.

The additional herbage produced from a no-grazing policy would not be economically attained. A nonuse policy would be three to many times more costly for livestock operators (Klipple and Bement 1961). Their fixed costs would remain, whereas income would be eliminated. Thus, a no-grazing policy would adversely affect the Western livestock industry. This would be felt at the national level because the importance of livestock production on Western ranges cannot be overlooked (Workman 1975; Box 1978; and Cook 1978).

Conclusions

Published data show that ranges protected from livestock grazing produce 68 ± 46% more herbage than do similar areas which are moderately grazed. Likewise, when individual plants are clipped at a moderate level of use, herbage production (when compared to unclipped plants) decreases by 59 ± 50%. These significant responses caused us to reject the hypothesis that there is no difference in the amount of herbage produced on grazed and ungrazed Western ranges.

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