Effects of Grazing on a Hardland Site in the Southern High Plains[1]

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Highlight

The vegetation and soil characteristics of an ungrazed butte are compared with those of a similar site on an adjacent High Plains area. Woody plant cover was greater and more diverse on the butte while herbaceous vegetation was more productive and of higher quality. Species composition and production was representative of shallow hardlands of the Southern High Plains region. Soil characteristic differences reflected the detrimental influence of continued herbage removal and trampling by livestock on the grazed area.

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An ungrazed isolated butte was studied to learn the effects of grazing on the vegetation and soils of a hardland site on the Southern High Plains. Such relict areas commonly serve as the basis for determining range site potential. The comparison of the relict area with an adjacent area which had received unrestricted grazing by cattle since the late 1800's also let us determine the effects of grazing on the soils and vegetation.

The butte (Flat Top Mountain) is located approximately 20 miles northwest of Snyder, Texas, and 8 miles southeast of Justiceburg on U.S. Highway 84. Flat Top Mountain (Fig. 1), adjacent to the escarpment (Cap Rock) of the Llano Estacado, straddles the line between Garza and Scurry Counties. The grazed area is located in Scurry County and is the nearest point to the isolated butte, which lies approximately 2 miles to the east of the Cap Rock. Elevations of the Cap Rock and the butte are 2,885 ft and 2,865 ft respectively.

The Llano Estacado, or Staked Plains, is the

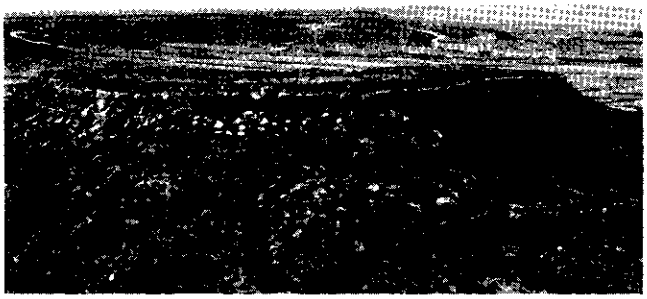

FIG. 1. Flat Top Mountain relict area was once part of the Cap Rock of the Llano Estacado in the background.

southernmost part of the High Plains province. The surface is a nearly flat plain, having an average southeastward slope of only 8 or 10 ft per mile. It is essentially a plateau, bounded on the north by the breaks on the Canadian River, on the east and west by escarpment rising above stream-eroded lower lands, and on the south it merges physiographically with the Edwards Plateau (Evans and Brand, 1956).

Both study areas are capped by cretaceous material of the Fredericksburg formation which overlies the exposed Trinity formation, which is also cretaceous material (Evans and Brand, 1956). The cretaceous deposits consist of rather hard fossiliferous limestone. These deposits are confined to the top of Flat Top Mountain and the adjacent Cap Rock area (Fluvanna Flat) in Scurry County (Templin and Reitch, 1931). The soils on both study areas are clays of the Lea-Slaughter complex series and the Kimbrough series.

Climatic conditions in this area of the High Plains of Texas vary from maximum temperatures greater than 100 F in the summer to readings below zero for short periods in the winter. Variations of 30 to 40 F is one feature of the daily temperature changes in the summer (Lotspeich and Everhart, 1962). Rainfall records from Post, 25 miles north, and Snyder, 20 miles to the south, show that they receive an average of 19.6 inches and 19.9 inches, respectively. The seasonal distribution follows the usual pattern for both towns with peaks in May and September (Hildreth and Thomas, 1956). However, the pattern of rainfall, the high wind velocities, and the high evaporation rates tend to reduce the effectiveness of the precipitation (Lotspeich and Everhart, 1962).

Two distinctly different range sites occurred on both study areas. They are a shallow hardland site (Lea-Slaughter complex) and the very shallow site (Kimbrough series). This study was limited to the shallow hardland site on both areas. This site differs from the deep hardland site commonly recognized in the Southern High Plains mainly in depth, and generally supports a more mesic type vegetation due to better soil moisture relationships.

Methods

Canopy cover of shrubs was measured by the line intercept method using a 100-ft line. Herbage production for each area was determined at the end of the 1967 growing season by the weight-estimate method. Estimates of green plant weights occurring within sixty 2.4 ft^2 plots per area were made. Twelve of the estimated plots from each area were selected at random and clipped. These clipped samples were oven-dried to a constant weight at 160 F. The regression of actual green weights on estimated green weights was used to correct all estimated weights. Wire cages were used to determine utilization on the grazed area. Production estimates on the grazed area were adjusted according to utilization estimates to obtain total production.

Soil samples were taken at 0–4 inches and 6–10 inches on both study areas. Soil pH, organic matter content, phosphorus content, and soluble salts were analyzed by the Texas Agricultural Experiment Station's South Plains Research Center. Bulk densities were determined from core samples of known volume. Soil texture was determined by the hydrometer method. Infiltration and compaction data were collected directly in the field.

A double-ring infiltrometer was used for infiltration data. The process was repeated four times in each area. Soil compaction measurements were taken with a soil penetrometer. One-hundred readings were taken at 1-inch depths on each area.

Herbage production data were statistically analyzed by paired comparison. Differences in infiltration rate, soil compaction, and bulk density were tested by the group comparison method.

Results and Discussion

Vegetation

There was considerable difference in the vegetation between the ungrazed butte and the grazed area, both in quantity and in quality.

The butte supported 14 woody plant species compared with only eight on the grazed area (Table 1). Redberry juniper was the dominant species on the butte, but other plants such as shinnery oak, narrowleaf yucca, mesquite and skeleton goldeneye added considerable cover (Fig. 2). On the other hand, mesquite was the dominant species on the grazed area (Fig. 3).

There was more than twice as much total woody plant cover on the butte as on the grazed area (Table 1). The difference was largely due to the large amount of redberry juniper on the butte and the absence of several species on the grazed area. The absence of palatable species such as skeleton goldeneye, vine ephedra and elbowbush are explainable by grazing pressure. The presence of shinnery oak, feather dalea and narrowleaf yucca

Table 1. Woody plant cover (percent) on an ungrazed butte and the adjacent Cap Rock area, 1967.[1]

Species	Ungrazed Butte	Grazed Cap Rock Area
Redberry juniper *Juniperus pinchoti*	6.3	0.3
Narrowleaf yucca *Yucca angustifolia*	2.3	0
Skeleton goldeneye *Viguiera stenoloba*	1.5	0
Feather dalea *Dalea formosa*	1.4	0
Shinnery oak *Quercus havardii*	1.3	0
Honey mesquite *Prosopis glandulosa*	1.2	5.5
Vine ephedra *Ephedra antisyphilitica*	1.0	0
Elbowbush *Forestiera pubescens*	0.5	0
Skunkbush *Rhus aromatica*	0.2	0
Lotebush *Condalia obtusifolia*	0.2	0.8
Littleleaf sumac *Rhus microphylla*	0.1	0.3
Agarito *Berberia trifoliolata*	0.1	T[2]
Catclaw acacia *Acacia greggii*	T	0
Engelmann pricklypear *Opuntia engelmannii*	T	T
Cholla *Opuntia imbricata*	0	0.3
TOTAL	16.1	7.2

[1] Common and botanical names are according to Gould (1962).
[2] T = Amounts less than 0.1%.

FIG. 2. Jimmy Brown and Jack McClung examine a motte of shinnery oak, one of 14 woody species found growing vigorously on the Flat Top Mountain relict area.

FIG. 3. The grazed shallow hardland site is dominated by mesquite with only scattered juniper and lotebush. Buffalograss and tobosagrass are the most prevalent herbaceous species.

on the ungrazed butte and not on the grazed area is not, however. Since soils and climate are not factors either, some other factor such as the lack of fire on the butte may be involved. Another study (Ellis and Schuster, 1968) indicated that fire might have been instrumental in keeping redberry juniper off the Cap Rock area but not from isolated buttes. This is assumed to be the case on this butte for redberry juniper, but further study is needed to determine the causes of the presence or absence of the other woody species from the two areas. The presence of woody species on the butte indicates that the soils and climate are favorable for growth of these species. Their absence from hardland sites on the Southern High Plains is apparently due to factors other than soils and climate.

The butte produced 706 lbs. more oven-dry herbage per acre than the grazed area (Table 2). Sideoats grama, rough tridens and blue grama were the most productive species on the butte. These species produced 70% of the herbage on the butte, while only one of them, blue grama, was found on the grazed area on the Cap Rock.

Buffalograss was the most productive species on the grazed area, making up 65% of the herbage production. Tobosagrass and vine mesquite, apparently increasers on this site, were the next most productive species. These three species produced 85% of the herbage on this area.

Table 2 presents the classification of the herbaceous species according to their reaction to cattle grazing pressure. The classification is based on their presence or absence on the ungrazed butte and general knowledge of the species' reaction to grazing in this region. We classified the site as shallow because the soils (Lea-Slaughter complex)

Table 2. Herbage yields (lb/acre) and classification of herbaceous species in relation to reaction to grazing.[1]

Species by class	Butte	Grazed
Decreasers		
Sideoats grama *Bouteloua curtipendula*	816	0
Rough tridens *Tridens elongatus*	246	0
Blue grama *Bouteloua gracilis*	163	21
New Mexico feathergrass *Stipa neomexicana*	15	0
Greenthread *Thelesperma filifolium*	42	0
Total decreasers	1282	21
Increasers		
Buffalograss *Buchloe dactyloides*	315	692
Tobosagrass *Hilaria mutica*	112	136
Vine mesquite *Panicum obtusum*	34	100
Halls panicum *Panicum hallii*	17	11
Threeawn *Aristida* sp.	16	15
Sand dropseed *Sporobolus cryptandrus*	10	0
Hairy tridens *Tridens pilosus*	4	3
Hoary euphorbia *Euphorbia lata*	3	0
Green false-nightshade *Chamaesaracha coronopus*	3	0
Purple groundcherry *Physalis lobata*	3	0
Texas skeleton plant *Lygodesmia texana*	1	0
Scarlet globemallow *Sphaeralcea coccinea*	4	6
Fall witchgrass *Leptoloma cognatum*	T	0
Louisiana sagewort *Artemisia ludoviciana*	T	0
Total increasers	522	957
Invaders		
Sand muhly *Muhlenbergia arenicola*	0	50
Leatherweed croton *Croton pottsii*	T	34
Indian rushpea *Hoffmanseggia densiflora*	0	13
Silverleaf nightshade *Solanum elaeagnifolium*	T	4
Sideranthus *Machaeranthera pinnatifida*	0	3
Stinkgrass *Eragrostis megastachya*	0	1
Low milkvetch *Astragalus lotiflorus*	0	1
Texas filaree *Erodium texanum*	0	T
Pigweed *Amaranthus* sp.	T	0
Total invaders	0	106
Total all species	1804	1090

[1] Common and botanical names are according to Gould (1962).

were shallower than 20 inches and the species and composition differed from those found on the deep hardlands of this land resource area. Several of the species found in abundance on the butte are not included as climax species on the current soil conservation service range site condition guide for the deep hardland site. For example, New Mexico feathergrass and rough tridens, both palatable grasses were present in abundance on the butte and should be considered climax decreasers for this site. Similarly, the palatable perennial forb, greenthread should be included as a decreaser for this site. Other perennial forbs such as Texas skeleton plant, purple groundcherry, green false nightshade and hoary euphorbia all found in substantial quantities on the ungrazed butte, are apparently present in the climax. Their reaction to grazing is not known so we tentatively classified them as increasers. Vine mesquite reacted as an increaser and because of its mediocre palatability is classified as an increaser.

The herbaceous vegetation on the butte is representative of climax vegetation of shallow hardland sites of the Southern High Plains. It is dominated by mid- and short grasses but contains several perennial forbs. The five species we consider decreasers (Table 2) produced 71% of the herbage. Sideoats grama is by far the most productive species.

Difference in plant distribution patterns also existed between the grazed and ungrazed areas. On the butte, each species tended to occupy very distinct areas with very little intermixing of species except in narrow transition zones. This colonization was not apparent on the grazed area.

Soil Characteristics

The differences in soil characteristics reflect the influences of herbage removal and trampling by grazing livestock. The infiltration rate was almost

Table 3. Soil characteristics found on grazed and ungrazed shallow hardland sites in the Southern High Plains, 1967.

Characteristic	Ungrazed Butte	Grazed Area
Infiltration Rate*	15.3 in/hr	3.9 in/hr
Soil Compaction*	7.9 lb/in^2	47.7 lb/in^2
pH		
0–4″ depth	7.8	7.7
6–10″ depth	8.0	8.0
Bulk Density*		
0–4″ depth	.996 gms/cc	1.180 gms/cc
6–10″ depth	1.020 gms/cc	1.150 gms/cc
Organic Matter		
0–4″ depth	3.6%	2.8%
6–10″ depth	2.9%	2.5%
Available Phosphorus		
0–4″ depth	35 lb/acre/ft	92 lb/acre/ft
6–10″ depth	18 lb/acre/ft	50 lb/acre/ft
Sodium		
0–4″ depth	140 lb/acre/ft	140 lb/acre/ft
6–10″ depth	240 lb/acre/ft	220 lb/acre/ft
Soil Texture		
A horizon		
sand	18.8%	21.0%
silt	33.2%	37.7%
clay	48.0%	41.3%
B horizon		
sand	14.6%	12.8%
silt	28.3%	31.2%
clay	57.1%	56.0%

* = Differences between areas tested and found significant at the .05 level.

four times as great on the ungrazed butte as on the grazed area (Table 3). This highly significant ($P < 0.01$) difference in infiltration rate was probably due to better soil structure, less compaction by grazing animals, increased organic matter content in the top soil, and increased accumulation of litter on the soil surface on the relict area. Similar differences in infiltration rates have been reported. Hopkins (1954), comparing water absorption of grazed and ungrazed sites on rangelands with a ring-type infiltrometer, found that water was absorbed much faster on ungrazed than on grazed sites. Reed and Peterson (1961) found that grazing reduced infiltration rates by about one-half. Even the lightest intensity of grazing lowered the rate of infiltration in their study. Evidently, continual removal of organic matter and trampling by livestock causes soil conditions that prevent water penetration.

Penetrometer readings indicate about six times as much compaction on the grazed area as on the butte (Table 3). This highly significant difference points out the effect grazing animals have on the physical structure of the soil. Other investigators have found similar effects. Keen and Casheen (1932) used a penetration rod to measure compaction by sheep to a depth of 10 cm. Compaction was greatest in the 3 to 4 cm layer. Kucera (1958) also found the greatest soil compaction by cattle in the surface inch, with no apparent influence below 4 inches. Such conditions are probably also influenced indirectly by decreases in organic matter and soil porosity at the soil surface with continued grazing.

Measurements of soil texture, pH, sodium, organic matter, and available phosphorus for the two areas are shown in Table 3. Although not tested statistically, differences in pH, sodium content, and soil texture do not appear significant. The differences in available phosphorus does appear real, however. A previous study (Lodge, 1954) also reported higher amounts of phosphorus in the 0–4 inch soil layer on grazed sites. The lower amount of organic matter on the grazed area was also expected, and assumed to be a significant decrease due to grazing effects.

Soil bulk densities were significantly ($P < .05$) greater at both levels in the grazed area than on the butte (Table 3). Our findings agree with other studies that found grazing increased bulk density. Alderfer and Robinson (1947) found that bulk densities in the 1-inch surface layer on a variety of pasture sites ranged from 1.54 to 1.91 gms/cc for heavily grazed sites and from 1.09 to 1.51 gms/cc for ungrazed and lightly grazed sites in Pennsylvania. Kucera (1958) also found bulk densities higher under grazed conditions. The loss of organic matter and compaction due to livestock trampling are commonly considered the causes of increases in bulk density on grazed sites.

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ERRATA

In the July 1969 issue of the *Journal of Range Management*, the list of Sciential Committees contains the following error: The committee headed **Native Haylands** mistakenly lists the members of the committee on **Native Pasture Lands of Farms and Forest Climates.** Following are the correct listings of the two Sciential Committees in question:

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Native Pasture Lands of Farms and Forest Climates

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