

# Vegetational Composition and Ground Cover of Two Natural Relict Areas and Their Associated Grazed Areas in the Red Desert of Wyoming<sup>1</sup>

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The Red Desert of Wyoming is a valuable resource because it furnishes winter grazing for a high percentage of the state's sheep. Consequently, proper grazing management of this and other winter range areas is a problem continually confronting the range manager.

The early stages of range deterioration are difficult to detect without a guide to the vegetational composition and production potential to use as a basis for comparison. Natural barriers to grazing resulting in relict areas are few. When they can be found, they are invaluable for the determination of composition and production potential of similar range sites.

Two natural relict areas occurring in Wyoming's Red Desert were utilized in this study in an attempt to determine changes in vegetation which may be attributed to grazing on the shallow-soil range sites common to the area.

## Previous Studies

The range condition class method of study is commonly used in range analysis. It is based upon comparison of relict and grazed areas on the basis of vegetational composition. Beetle (1952), Gardner (1950), Whit-

field and Buetner (1938), and others have used the method as a key to both the past and future in recording functions and changes of plant communities.

Clements (1934) described a relict in an ecological sense, as "a community or fragment of one that has survived some important change, often to become in appearance an integral part of the existing vegetation." He further describes a relict as possessing evidence of "two indicator values of the first importance. These relate to the causes concerned on the one hand and to the original vegetation and its changes on the other. The former may be climatic, edaphic, or human, each exhibiting a more or less distinctive impress." The relict method is a key to both the past and the future and places proper emphasis upon the measurement and record of community functions and changes by means of quadrats and exclosures.

In areas of high precipitation and mature soils, where vegetational composition changes are relatively rapid, exclosures with

short relict histories have been used to determine trends of vegetational changes. In a vegetation survey of the Fort Worth Prairie Dyksterhuis (1946) selected relict areas which had not been grazed for at least five years or longer, giving emphasis to one area which had not been grazed by domestic livestock since barbed wire became generally available. He did not consider any land that had been cultivated or subjected to other types of severe disturbance which leave a relative permanent impress on soil or vegetation.

The earliest records of the vegetational composition of the Red Desert area where this study was conducted were made by Aven Nelson in 1897 (Nelson, 1898). The main objective of his survey was not merely to list plant species, but also to evaluate the forage value of the region.

The findings of Nelson were confirmed by Vass and Lang (1938). In counts of living and dead plants and reproduction of four shrubby species, they found that with few exceptions there was sufficient reproduction to replace the plants which had died in 1936. A comparison of the grazing capacity of the major vegetation type between a controlled grazing area, as represented by the Rock Springs Grazing Association lease, with a non-controlled grazing area, as represented by the land surrounding the lease, showed no significant difference.

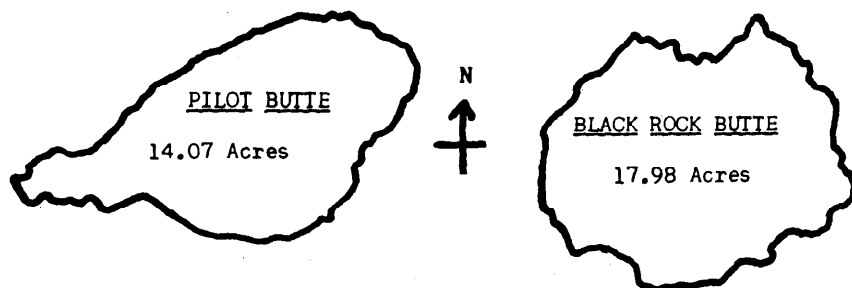


FIGURE 1. Scale diagram and area of the relatively flat summits of the two natural relict areas studied in Sweetwater County, Wyoming. The two areas are separated by a physical distance of about 50 miles.

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**Table 1. Monthly and annual precipitation in inches and annual departure from average for the five years of study\***

Year	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Annual Precipitation	Departure from 20-year mean
1937	.67	1.26	.72	1.01	.73	1.94	3.00	.62	.38	.71	.93	.70	12.67	+6.01
1938	.16	.38	1.24	1.68	1.64	.56	1.42	1.24	1.00	2.23	.54	.09	12.18	+5.52
1939	.55	.82	.17	.98	.65	.33	.45	.03	.84	.74	.00	.07	5.63	-1.03
1940	1.12	.65	.86	.64	.78	.08	.24	.18	1.57	.74	.90	.50	8.26	+1.60
1956	.38	.14	.05	.94	2.20	.01	.27	.56	.35	1.18	.70	.36	7.14	+ .48
20-year mean (1937-1956)													6.66	

\* Average precipitation data from the Farson and Rock Springs weather stations.

### The Study Area

Two relatively flat topped buttes<sup>2</sup> located about 50 miles apart in the northwestern quarter of Sweetwater County, Wyoming, provided the natural relict areas for this study. These buttes, locally known as Black Rock Butte and Pilot Butte, have high perpendicular sides, and their tops could not possibly have been grazed within historic time by any herbivorous animals other than rodents. The grazed areas studied in conjunction with the butte tops were located near the level base of each butte, but still within the shallow-soil range site common to the relict areas.

The vegetation of both the grazed and relict areas studied consisted mainly of desert shrubs as dominants and perennial grasses as subdominants. Various perennial and annual forbs were evident from year to year depending on climatic conditions. The dominant species on both relict and grazed areas was big sagebrush (*Artemisia tridentata*). Other common browse species were: winterfat (*Eurotia lanata*), spiny hopsage (*Grayia spinosa*), shadscale (*Atriplex confertifolia*), low rabbitbrush (*Chrysothamnus viscidiflorus pumilus*) bud sagebrush (*Artemisia spinescens*), and Gardner saltbush (*Atriplex gardneri*).

Grasses most common to this

desert range area were: mutton blue grass (*Poa fendleriana*), bottlebrush squirreltail (*Sitanion hystrix*) Indian ricegrass (*Oryzopsis hymenoides*), bluebunch wheatgrass (*Agropyron spicatum*), needle- and -thread, and thickspike wheatgrass (*Agropyron dasystachyum*).

Although a great variety of forbs were listed from the study plots, those most frequently encountered were: Hoods phlox (*Phlox hoodii*), cushion eriogonum (*Eriogonum ovalifolium*), Hooker sandwort (*Arenaria hookeri*), slenderbush eriogonum (*Eriogonum microthecum*), stemless goldenweed (*Haplopappus acaulis*), fringed sagebrush (*Artemisia frigida*), arrowleaf balsamroot (*Balsamorhiza sagittata*), stickseed (*Lappula* spp.), bluebells (*Mertensia oblongifolia*), and Fremont penstemon (*Penstemon fremontii*).

The elevation of Pilot Butte is 7,923 feet, and it rises some 450 feet above the surrounding area. Black Rock Butte rises 658 feet above the surrounding area to an elevation of 7,558 feet. The size and the outlines of the relatively level tops of both buttes are shown in Figure 1.

A cool climate and low precipitation are characteristic of the Red Desert region where this study was conducted. Average annual precipitation is less than 10 inches and much of the effective moisture comes during March, April, and May in the form of snow and light showers. Generally little precipitation oc-

curs during the summer months, although both 1937 and 1939 were years with abundant summer moisture. (Table 1).

### Methods of Study

The vegetational composition and ground cover of the relicts and surrounding grazed land were studied in June each year by the point-observation plot method as described by Stewart and Hutchings (1936). These studies were conducted in 1937, 1938, 1939, 1940 and 1956. Ten circular plots, each 100 square-feet in area, were studied on each location each year. On the summits of each butte, plots were spaced at random but not at the very edge of the butte. The randomly located plots on the grazed areas were near the level base of the butte but confined to the shallow soil range site similar to that of the summit.

In addition to the listing of species and estimation of ground cover, an actual count of the number of live plants, other than seedlings, dead plants, and seedlings of four shrub species was made on each study plot each year. The species thus counted were big sagebrush, shadscale, Gardner saltbush, and winterfat.

Samples of the top 6 inches of soil were taken from the summits and from near the level base of both buttes in the general area where the vegetation study plots were located. These soil samples were analyzed to determine if differences in texture, pH, soluble salts, or air-water permeability existed be-

<sup>2</sup> Black Rock Butte is located in Sec. 24, T. 22 N., R. 101 W., and Pilot Butte is located in Sec. 9, T. 19 N., R. 106 W.

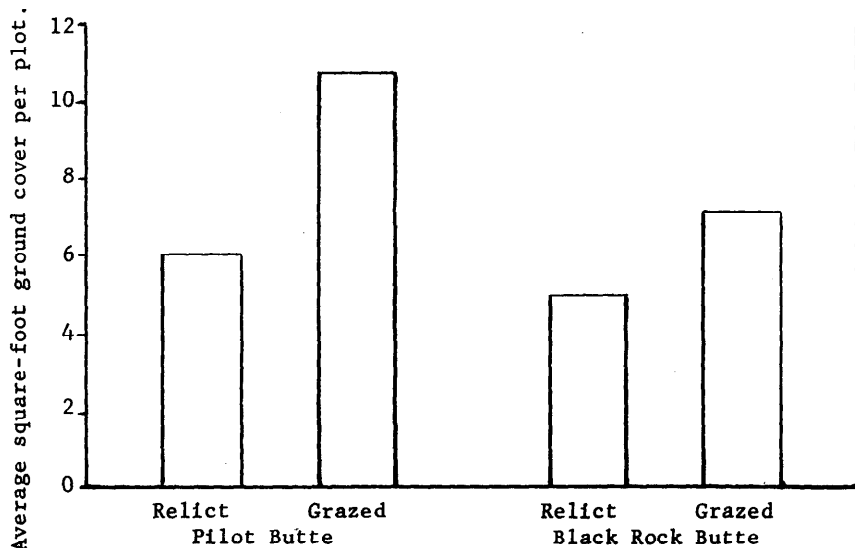


FIGURE 2. Average square-foot ground cover per plot for the Pilot Butte and Black Rock Butte relict and grazed areas.

tween the soil of the relict areas and that of the associated grazed areas.

### Results

#### Total Ground Cover

Total ground cover was greater on each grazed area than on its associated relict. The grazed area surrounding Pilot Butte had the greatest total ground cover with a five-year average of 10.54 percent, compared with 6.02 percent on the summit of the butte. The Black Rock Butte grazed area averaged 6.97 percent total ground cover compared with the top of the butte which averaged 4.84 percent. The average total ground cover per plot on each location is shown in Figure 2, and the average percentage composition by vegetational groups for these same areas is shown in Figure 3.

The average total ground cover per plot on the top of Pilot Butte decreased for each of the five years studied while on Black Rock Butte it decreased from 1937 to 1940 and increased again by 1956 to about the five-year average. The two grazed areas reacted somewhat differently each year from the two relict areas, but the reactions of the grazed areas were similar to each other. Each grazed area in-

creased in total ground cover in 1938 over 1937, decreased in the following 2 years to a low in 1940, but again increased slightly by 1956. These total ground cover fluctuations occurring on the grazed areas were similar to those of the precipitation averages of March through June of the same 5 years. General views of the vegetation on the two relict areas in June 1956 are shown in Figures 4 and 5.

Separate analyses of the ground cover were made of the four most widely distributed species of major importance within the grazed and relict areas. The species with the greatest ground cover, big sage-

brush, contributed 34 percent of the total vegetational composition on the relict plots and 54 percent on the grazed plots. These figures would indicate that big sagebrush is an increaser on these shallow soil range sites. Greatest variation in ground cover of big sagebrush within the five-year period was from 3.87 percent in 1938 to 2.64 percent in 1940. When these data pertaining to ground cover of big sagebrush were analyzed statistically, differences between buttes, locations, years and all of the interactions between these factors were highly significant.

The ground cover of winterfat was found to be considerably lower on the grazed areas than on the relict areas. Black Rock Butte had the greatest ground cover of this species, with an average of 0.60 square-foot per plot, while the grazed area surrounding the butte averaged only 0.04 square-foot per plot. Winterfat contributed 12 percent of the total ground cover on the relict compared to 0.57 percent on the grazed land; under these conditions of shallow-soil range site, it would be considered a decreaser. Pilot Butte had an average ground cover of 0.18 square-foot of winterfat per plot, while the grazed area surrounding the butte averaged 0.12 square-foot per plot. It contrib-

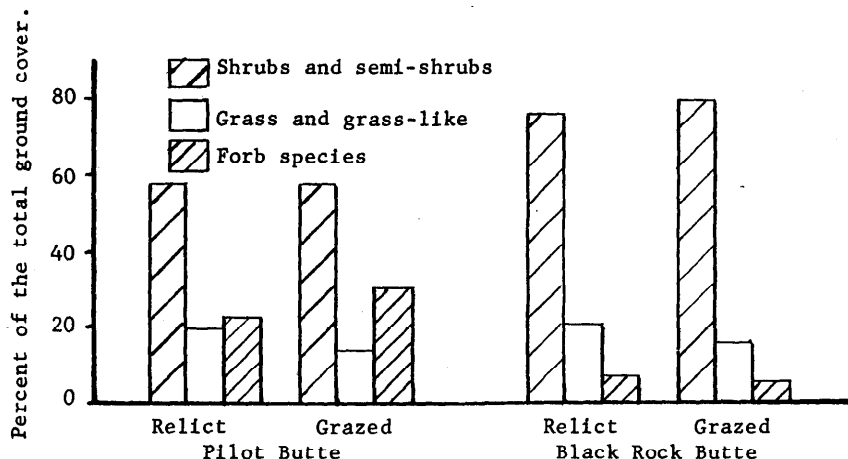


FIGURE 3. Average percentage total ground cover in three vegetational groups for the Pilot Butte and Black Rock relict and grazed areas.

uted 3 percent of the total ground cover on Pilot Butte and only 1 percent on the grazed land. These differences in ground cover of winterfat between buttes, between locations, and among years were highly significant.

The greatest variation in the ground cover of Indian ricegrass was between the Pilot Butte region and the Black Rock Butte region. Little difference existed in ground cover of this species between each relict area and its associated grazed area, and variations among years was small. Differences between the buttes were significant at the 0.01 level. Differences between relict and grazed areas (locations), among years, and interactions of these factors were non-significant.

Needle-and-thread was common on the two grazed areas and contributed about the same ground cover as did Indian ricegrass. It was less common on the two associated relict areas. Black Rock Butte had an average of 0.06 square-foot ground cover per plot, while its surrounding area had 0.20 percent average ground cover of this species. Pilot Butte had only an average of 0.01 square-foot ground cover per plot and its associated grazed area had 0.09 percent. Differences among years, between locations, and between buttes were highly significant. From these data it appears that needle-and-thread would be classified as an increaser under grazing.

Three species, shadscale, Gardner saltbush, and bud sagebrush, were present on Black Rock Butte and the surrounding grazed area, but were not present in the Pilot Butte region. Actually shadscale was the dominant species on the top of Black Rock Butte and big sagebrush was the subdominant. Average ground cover of shadscale was 1.41 percent on the Black Rock Butte relict and only 0.14 percent on the grazed area surrounding the butte.

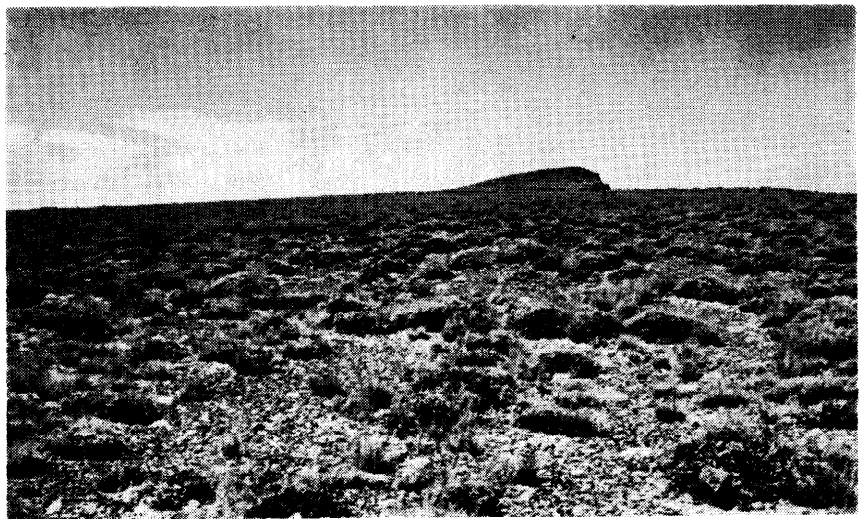


FIGURE 4. Typical vegetation on the Pilot Butte relict area. Photo taken in June 1956.

#### Frequency of Specific Occurrence

There were only 9 species of the total of 50 which occurred on both locations of Pilot Butte and Black Rock Butte. Big sagebrush occurred with 60 percent frequency on the summit of Black Rock Butte and 96 percent on the grazed land of this area. The remaining 8 species found on both locations of the two butte regions consisted of one semi-shrub, five grasses, and two forbs.

Forbs varied the most between the two locations (relict and grazed). Black Rock Butte area had 6 species of forbs occurring on the relict plots and 14 were recorded on the grazed area around this butte. Pilot Butte had 19 species of forbs and its surrounding grazed area had 31.

Wild onion (*Allium textile*) was present only on Pilot Butte, and scarlet globemallow (*Sphaeralcea coccinea*) was present only on Black Rock Butte. These were the only two species found to occur on the relict and not on the grazed plots.

One shrub, gray horsebrush (*Tetradymia canescens*), three grasses, thickspike wheatgrass, slender wheatgrass (*A. trachycaulum*), and subalpine needlegrass (*Stipa columbiana*), one sedge (*Carex eleocharis*), and 13 species of forbs occurred on the two grazed areas studied but not

on their associated relicts. These species were generally of less than 10 percent frequency.

All species present on the two buttes and the two grazed areas which had an average frequency of 10 percent or more are listed in Table 2.

#### Plant Counts of Four Species

Counts of living plants (other than seedlings), dead plants, and seedlings were made of big sagebrush, winterfat, shadscale, and Gardner saltbush. Only two species, big sagebrush and winterfat were frequent on both Black Rock Butte, Pilot Butte, and their adjacent grazed areas.

The average number of living plants of big sagebrush per plot on Black Rock Butte was 2.82. This compared with 6.80 living plants per plot on the surrounding grazed land. Pilot Butte averaged 12.92 plants per plot and its surrounding grazed area averaged 17.72. The number of living plants increased from an average of 5.40 per plot in 1937 to 15.70 per plot in 1956 on the two relict areas. The number of living plants on the grazed areas increased from an average of 11.75 per plot in 1937 to 19.55 per plot in 1956. These differences were highly significant.

The number of dead plants of big sagebrush varied the most

**Table 2. Percentage frequency of plant species occurring on two relict and two grazed areas in Sweetwater County, Wyoming. (Species with average frequency of 10 percent or more.)**

Species	Pilot Butte		Butte Black Rock		Avg. All Relict	Avg. All Grazed	Avg. All Areas
	Relict	Grazed	Relict	Grazed			
<i>Artemisia tridentata</i> .....	100	100	60	96	80	98	89.0
<i>Poa fendleriana</i> .....	88	92	72	80	80	86	83.0
<i>Sitanion hystrix</i> .....	72	80	78	76	75	78	76.5
<i>Oryzopsis hymenoides</i> .....	52	44	92	88	72	66	69.0
<i>Phlox hoodii</i> .....	88	90	20	62	54	76	65.0
<i>Agropyron spicatum</i> .....	96	86	42	6	69	46	57.5
<i>Eurotia lanata</i> .....	80	40	80	8	80	24	52.0
<i>Eriogonum ovalifolium</i> .....	80	90	....	26	40	58	49.0
<i>Arenaria hookeri</i> .....	100	30	48	8	74	19	46.5
<i>Stipa comata</i> .....	8	48	34	48	21	48	34.5
<i>Grayia spinosa</i> .....	56	....	2	62	29	31	30.0
<i>Atriplex confertifolia</i> .....	....	....	92	26	46	13	29.5
<i>Chrysothamnus viscidiflorus</i>							
<i>pumilus</i> .....	6	74	....	30	3	52	27.5
<i>Artemisia spinescens</i> .....	....	....	86	14	43	7	25.0
<i>Eriogonum microthecum</i> .....	2	88	....	2	1	45	23.0
<i>Haplopappus acaulis</i> .....	12	74	2	....	7	37	22.0
<i>Agropyron dasystachyum</i> .....	....	42	....	42	....	42	21.0
<i>Artemisia frigida</i> .....	66	16	....	....	33	8	20.5
<i>Balsamorhiza sagittata</i> .....	2	70	....	....	1	35	18.0
<i>Lappula spp.</i> .....	10	38	....	24	5	31	18.0
<i>Mertensia oblongifolia</i> .....	2	42	....	....	1	21	11.0
<i>Atriplex gardneri</i> .....	....	....	32	8	16	4	10.0
<i>Penstemon fremontii</i> .....	2	34	....	4	1	19	10.0

among years. The number of dead plants on the relict areas averaged 0.15 per plot in 1940 and 2.0 per plot in 1956. Grazed areas had a higher percentage of dead plants than their associated relict areas.

Variations in the number of big sagebrush seedlings were high among years, between buttes, and between locations. Pilot Butte had the greatest average number with 24.26 seedlings per plot. Its associated grazed area averaged 15.62 seedlings per plot. High variations, but in the reverse order, occurred in the Black Rock Butte area. Seedling numbers averaged only 1.18 per plot on the relict and 12.92 per plot on the grazed area. The average number of seedlings for both areas (including the relict and grazed lands) was greatest in 1938 (33.65 per plot) and 1939 (20.92) and averaged 13.50 per 100 square feet for the 5 years of study. There were no seedlings in any of the plots in 1956. When these

data were analyzed statistically there was no significant difference between locations. However, differences between buttes, years, and the interaction between buttes and locations were significantly different at the 0.01 level.

Counts of winterfat showed the greatest variation between locations. The number of living plants was less on each grazed area than on the non-grazed relicts. Differences in numbers of plants varied considerably less than the variations in ground cover for this species on the different buttes. The Black Rock Butte relict area had the greatest average of living winterfat plants per plot (5.86) and the Pilot Butte grazed area had the lowest (1.98). Variations among years ranged from an average of 5.62 living plants per plot in 1939 to 1.95 in 1940. Differences between locations were significant at the 0.05 level, and all other differences were non-significant.

The number of dead winterfat

plants averaged only 1.50 per plot on the four locations. There were fewer dead plants on the grazed than on the relict areas. Variations among years, however, were greater than among locations, with an average from 0.32 dead plants per plot in 1939 to no dead plants recorded in 1956. Differences among years were significant at the 0.01 level. Other variations were not significantly different.

Seedling counts of winterfat showed no significant difference between buttes, between locations, or among years.

The average number of living plants of shadscale on Black Rock Butte was 7.18 per plot. Its associated grazed area had an average of 0.76 living plants per plot. The greatest number of seedlings on the relict areas was recorded in 1938 with an average of 1.50 per plot. Average number of seedlings over the 5 years studied was only 0.04 per plot. This species did not occur in the Pilot Butte region.

#### Soil Analyses

Soil samples were taken from grazed lands of shallow-soil range sites adjoining the relict areas for comparison with soil samples removed from the relicts. These were analyzed for possible factors affecting differences in vegetational composition and ground cover between the two locations.

A mechanical analysis for texture showed that the soil from the grazed areas near Pilot Butte and Black Rock Butte contained a higher percentage of sand and a lower percentage of clay than their associated relict areas. Texture class changed from clay loam on Pilot Butte to loam on the associated land, and from clay loam on Black Rock Butte to sandy clay loam on the surrounding grazed land.

The pH of the soil was slightly lower on all grazed locations, and the amount of soluble salts, although low in the soils from the

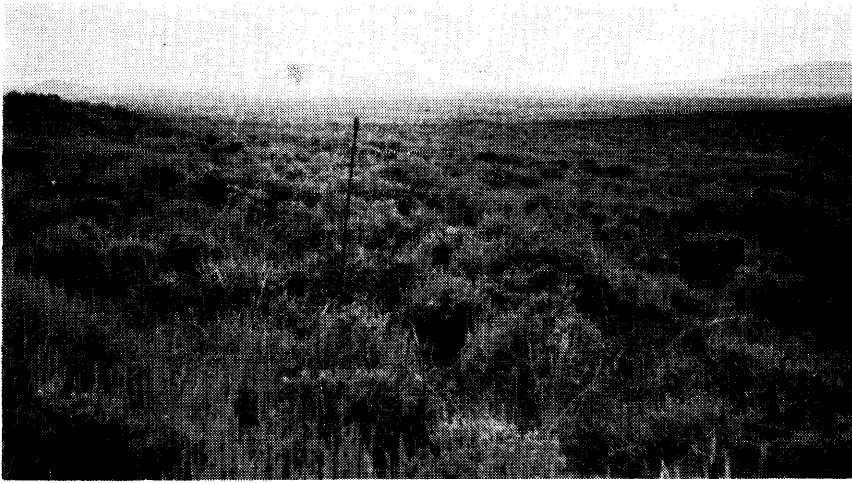


FIGURE 5. A view of the northwestern part of the Black Rock Butte relict area showing the tall shrubby vegetation common to this part of the butte. Photo taken in June 1956.

relict areas, was even lower in samples from the grazed. Air-water permeability tests indicate all soils sampled to be stable in structure.

### Conclusions

Grazing has apparently caused a shift in vegetational composition on the shallow soil sites of Sweetwater County, Wyoming, as evidenced by the greater number of forb species present on grazed areas, greater percentage of ground cover made up of shrubs, and smaller amounts of grass when compared with closely associated relicts.

The use of relict areas as a basis for judging grazed range lands is a common practice. However, this study shows a wide variation in the vegetational composition and ground cover between relicts of similar shallow soil sites separated by approximately 50 miles. This fact emphasizes the importance of using many relicts or protected areas as a basis for judging the condition of grazed lands.

Ground-cover fluctuations on both relict and grazed areas were high among years. Fluctuations in this factor were greater on the grazed areas than on the relicts for different years. These ground-cover changes among years may be largely attributed

to the shrubby vegetation and primarily to big sagebrush. However, ground cover of forbs also varied considerably on some of the grazed plots.

Spring rainfall has considerable effect upon establishment of big sagebrush seedlings. This factor does not operate alone, as no seedlings were evident in 1956, which was a year with more spring precipitation than occurred in 1939 and 1940 when relatively large number of seedlings were recorded.

Under the conditions of this study it must be concluded that big sagebrush and needle-and-thread are increasers, while winterfat is a decreaser under grazing. The reaction of other species to grazing pressure was not sufficiently definite for accurate classification as increasers or decreasers.

### Summary

Black Rock Butte and Pilot Butte in Sweetwater County, Wyoming, were studied as true natural relict areas to compare vegetational composition and ground cover with that of grazed land of similar rangesite characteristics surrounding these buttes. This is an arid area used primarily for winter grazing by sheep.

Average total ground cover

was greater on both grazed areas studied than on their associated relicts. Ground cover of shrubs and semi-shrubs on the grazed land was the main factor accounting for this greater total. Changes in ground cover were greater on the grazed areas than on the relicts for the years of extremes in precipitation.

Shrubs, semi-shrubs, and forbs contributed a greater percentage, and grass and grass-like species made up a smaller percentage of the total ground cover on the grazed area than on the relict areas.

One shrub, three grasses, one sedge, and thirteen forb species occurred on plots of the grazed areas, but were not found on the relict plots. Two forb species occurred on the relicts but not on the associated grazed land.

Soil samples analyzed from each of the relict areas and from the grazed areas varied only slightly between the two locations.

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