

Life Expectancy of a Sagebrush Control in Central Wyoming

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Highlight

On grazed range in the Beaver Rim Area of Wyoming the density of young and mature sagebrush plants began to increase within 5 years after spraying and within 14 years there were more plants present than on adjoining unsprayed areas. On ungrazed ranges 17 years after spraying the number of mature and young plants was about the same as on adjoining unsprayed ranges. Increased herbage production on ungrazed ranges was nullified within 6 years after spraying. During the 17 years after spraying, there was a reversal in the relative composition of bunchgrasses vs. sod grasses in ungrazed exclosures.

Chemical control of big sagebrush (*Artemisia tridentata* Nutt.) is an accepted range improvement practice in Wyoming. Kearl (1965) estimates that more than one-half million acres of sagebrush range were sprayed in Wyoming from 1952 to 1964. The beneficial effects—increased herbage production—have been well documented (Alley et al., 1956; Bohmont, 1954; Kissinger et al., 1952). One important aspect that has not been well documented is the life expectancy of the sagebrush control derived from spraying.

In 1949 the U.S. Forest Service, in cooperation with the Bureau of Land Management, initiated studies of sagebrush control in the Beaver Rim area of central Wyoming (Fig. 1). Additional control studies were made in 1950, 1951, and 1952. Different herbicides were applied at different rates of application, at different times, and by different methods (Hull and Vaughn, 1951; Hull et al., 1952; and Kissinger et al., 1952).

In 1952 the value of these plots for additional information on long-time changes in the stand of sagebrush in relation to initial kill was recognized. From the original control plots, specific plots representing different levels of sagebrush kill were selected for study. Exclosures were constructed to compare grazed and ungrazed conditions. Data were collected in 1953, 1954, and 1956 on numbers of sagebrush seedlings, young plants, and mature plants, and on yield of bunchgrasses and sod grasses (Johnson, 1958).

Observations were continued, and by 1965, re-establishment of sagebrush had become pronounced on many of the plots (Fig. 2). In 1966 the two exclosure areas and the grazed portions of the same treatment plots were reexamined. Treatment responses were reevaluated by the same methods and, whenever possible, on the same sample plots used in the original study. Since this paper includes some of the results from three separate studies of the treatment areas, the data for all criteria for all years reported were not always available. For the same reason statistical interpretation was not possible, but the sampling was considered adequate and the differences between the means were in some cases large enough to be meaningful. The paper discusses the vegetational changes that have occurred since the areas were sprayed.

¹ U.S. Dept. of Agriculture, Forest Service, with headquarters at Fort Collins, Colorado, in cooperation with Colorado State University. Research was done in cooperation with the University of Wyoming while the author was stationed at Laramie, Wyoming. Ms. received July 28, 1968; accepted for publication October 21, 1968.

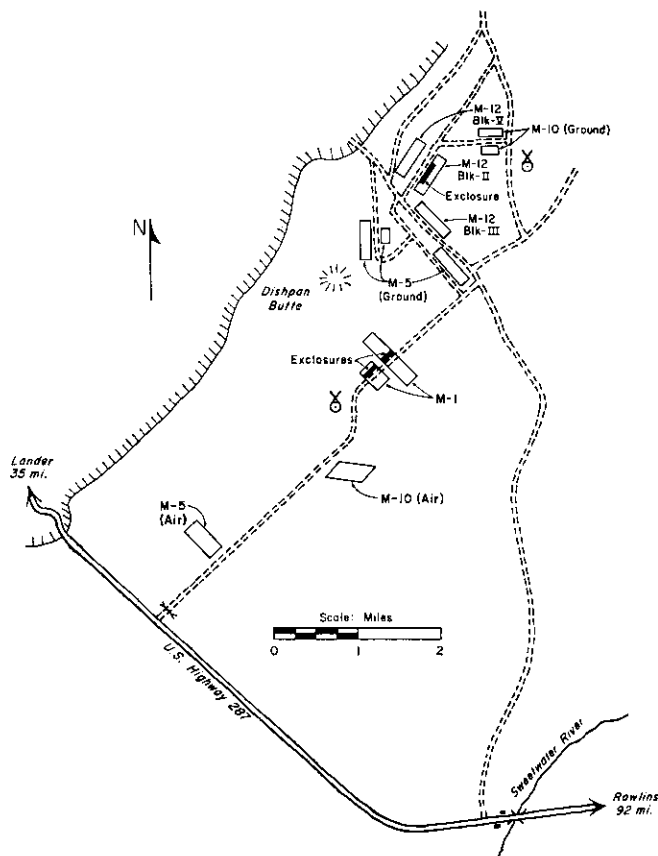


FIG. 1. Location of study areas at Beaver Rim. Results in this paper are based on studies of the M-1 and M-12 areas.

Study Area and Methods

The study area is 36 miles southeast of Lander, Wyoming. Elevation is 6,800 ft, and annual precipitation is estimated to be 7 to 9 inches.

The striking feature of the landscape in the study area is the apparent uniformity of the sagebrush-grass vegetation on the level to gently rolling topography. The sagebrush, except along some drainages, is short (12 inches), multiple

stemmed, and round topped. This growth form of sagebrush is common throughout the high plains of Wyoming, and tentatively has been called the plains type to distinguish it from the tall, single-(sometimes more) stemmed, flat-topped foothill-mountain form. Other woody species include very scattered individuals of gray horsebrush (*Tetradymia canescens* DC.) and irregularly occurring amounts of Douglas rabbitbrush (*Chrysothamnus viscidiflorus* (Hook.) Nutt.)—about three plants/50 ft².

Herbaceous vegetation is largely grass; of particular importance are the rhizomatous thickspike wheatgrass (*Agropyron dasystachyum* (Hook.) Scribn.), cusick bluegrass (*Poa cusickii* Vasey), and Sandberg bluegrass (*P. secunda* Presl.). Forbs are usually perennial, and except for Hoods phlox (*Phlox hoodii* Rich.) are not particularly noticeable. In addition, occasional plants of shooting star (*Dodecatheon* sp.), hoary balsamroot (*Balsamorhiza incana* Nutt.), grassy deathcamas (*Zygadenus gramineus* Rydb.), and the annual bushy birdbeak (*Cordylanthus ramosus* Nutt.) have been seen throughout the area in small amounts.

Soils are residual and derived from shales, limestones, and sandstones. No chemical or mechanical analysis has been made, but the general appearance suggests a clay loam with a lime layer at 12 to 20 inches. Rocks are infrequent, and when present are usually as bedrock outcrops on small knolls. Bluebunch wheatgrass (*Agropyron spicatum* (Pursh) Scribn. & Smith) is customarily found on these knolls.

The entire study area is located on a stock driveway. It is used by several bands of sheep trailing through both spring and fall. Additional cattle and sheep graze the area during the summer from May 1 (May 15 beginning in 1963) to October 31. The immediate study area is serviced by two stock water wells. Early unpublished progress reports indicate that from 1953 to 1956 the average utilization of perennial grasses in the M-1 area was about 20% and in the M-12 area was about 12%. Observations in 1966 indicated considerably heavier use on both areas.

There were several items or changes in management which might influence or account for a dramatic increase in utilization. A ranch in the Dishpan Butte area, with a license equivalent of 650 cattle, was not used most of the 1950's. This ranch was leased and activated by another party in 1960–61.

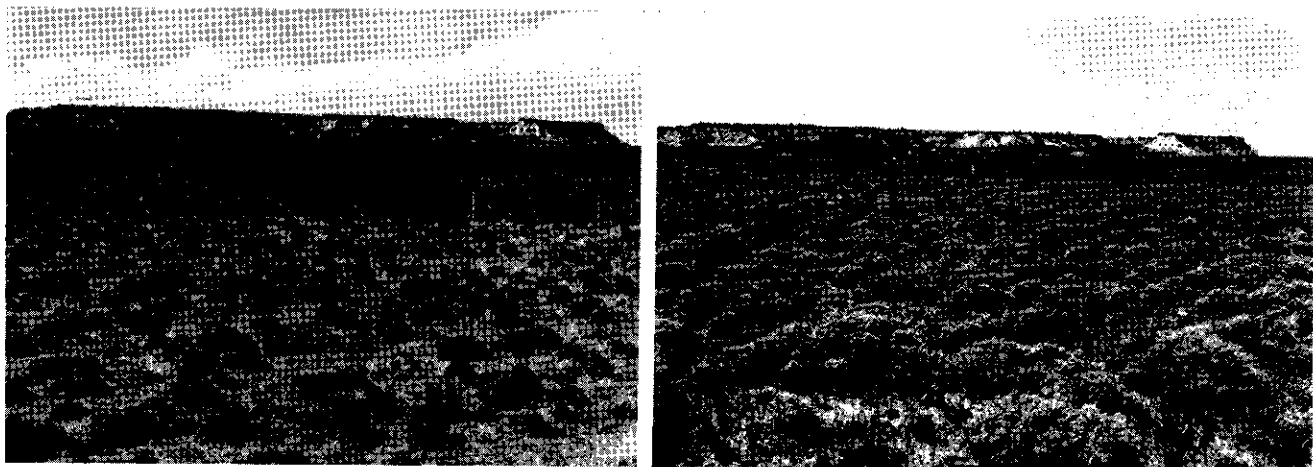


FIG. 2. Sprayed sagebrush plots at Beaver Rim. Left: 1951, two years after spraying (the dark strips are sprayed), and Right: the same plot in 1968 (M-1 Study Area).

Table 1. Number of sagebrush plants and square feet of live crown area per 50-square-foot plot on grazed and ungrazed ranges.

Size of sagebrush and year of analysis	1949 treatment (M-1)				1952 treatment (M-12)			
	Unsprayed area		Sprayed area		Unsprayed area		Sprayed area	
	Ungrazed	Grazed	Ungrazed	Grazed	Ungrazed	Grazed	Ungrazed	Grazed
SEEDLINGS:								
1953	0	0.7	0	27.4	0		0	0
1958	0.3	0.3	2.8	3.8	0		0.3	5.2
1966	0	0	1.4	0.4	0	0	2.4	1.8
YOUNG PLANTS:¹								
1953	2.4	7.3	0.9	0.7	10.3		2.5	0.4
1958	0.9	0.6	0.6	9.0	1.7		0.4	4.3
1966	2.0	3.6	4.5	20.7	3.3	3.6	1.9	9.4
MATURE PLANTS:²								
1953	11.0	8.4	2.8	2.2	8.4		5.6	2.2
1958	7.5	6.8	3.2	9.2	11.7		5.0	4.0
1966	8.1	8.5	6.0	12.5	11.4	10.5	5.5	9.0
LIVE CROWN AREA:								
1953	3.6		0.6		3.2		0.5	
1958	8.0		2.5		7.6		2.8	
1966	6.2	5.9	2.7	4.6	3.9	4.7	2.6	3.2

¹ Less than 4 inches high exclusive of seedlings.² 4 inches high and over.

A total of six stockwater wells were developed in the general area during the period 1959–63. While these developments were not in the immediate vicinity of the study, they did tend to draw grazing use from the north and east into the general area.

The extent of stock trailing through the area varied considerably from year to year. Changes in leased operations sent more stock through the general area some years than it did others. Also, there was considerable variation from year to year in the number of livestock trucked through the area versus the number trailed. The spring of 1966 was one of comparatively heavy trailing use.

The original study of sagebrush control involved numerous 1-acre plots. The plots were 726 × 60 ft, and separated by a 30-ft unsprayed buffer strip. The two exclosures used in the present evaluation were located on a portion of the original M-1 study plots (sprayed in 1949) and the M-12 study plots (sprayed in 1952). The M-1 exclosure covered 8 of the original treatment plots with resultant sagebrush kills ranging from 62% to 95%. Unsprayed buffer strips were used as control plots. The M-12 exclosure covered 10 original spray plots plus an unsprayed control plot. The original sagebrush kill on the sprayed plots ranged from 45% to 87%.

Ten 50 ft² sample plots had been established both inside and outside the exclosure on each of the selected treatment plots and in unsprayed buffer strips in 1953. These same plots were reexamined in 1958 and 1966. All sagebrush plants were counted and segregated into height classes—under 4 inches, 4 inches plus, and seedlings of the current year. The square feet of live sagebrush crown was estimated.

On the area sprayed in 1949, herbage yield of grasses was measured on ten 1 × 2 ft subplots on each treated plot and on the unsprayed strips within the exclosures. All grass and sedge herbage was clipped and segregated on the basis of "bunch" or "sod" growth form. Thickspike, western wheatgrass (*Agropyron smithii* Rydb.), plains reedgrass

(*Calamagrostis montanensis* (Scribn.) Scribn.), and needle-leaf sedge (*Carex obtusata* Lilj.) were grouped as "sod grasses," and bluebunch wheatgrass, prairie junegrass (*Koeleria cristata* (L.) Pers.), Indian ricegrass (*Oryzopsis hymenoides* (R. & S.) Ricker), cusick and Sandberg bluegrasses, and needle-and-thread (*Stipa comata* Trin. & Rupr.) were grouped as "bunchgrasses." Cusick bluegrass was the principal bunchgrass and thickspike wheatgrass was the principle sodgrass.

Results

By 1966 sagebrush density was not related to the original percent kill of sagebrush. For this reason, and because this paper is primarily concerned with long-time trends, the 1966 and earlier data have been recomputed and are presented only on the basis of sprayed and unsprayed conditions.

Sagebrush seedlings.—Early in the study, sagebrush seedlings were more numerous on grazed range than inside the exclosures (Johnson, 1958). By 1966, however, there was no appreciable difference between numbers of seedlings inside and outside the exclosures (Table 1). There were more seedlings on sprayed than unsprayed areas. Abundance of sagebrush seedlings over the years has been highly erratic, and does not seem to be related to the percent of sagebrush kill, at least insofar as the plots reexamined in 1966 were concerned. Rather, it would appear that microclimatic effects were possibly more important than either grazing or percent kill of sagebrush. In some instances all of the seedlings counted were found within one sample plot, so the distribution was not uniform over the treatment area. This was not true for the other factors measured. In the early years of the study

when observations were made in consecutive years, it was found that mortality among the seedlings was very high. Some survived, however, and were undoubtedly responsible for the later increases in both young and mature sagebrush plants.

Young sagebrush plants.—Changes in the population of young sagebrush plants less than 4 inches in height (exclusive of seedlings) have been dramatic (Fig. 2), particularly on grazed range. In 1966, young plants on areas sprayed in 1949 were nearly five times more numerous on the grazed than on the protected portions of the plots (Table 1). The difference has been large since 1954, or 5 years after the plots were sprayed (Johnson, 1958). The large number of seedlings that became established soon after the sagebrush was sprayed was responsible for the increase. Fourteen years after the M-12 area was sprayed, young sagebrush plants were also about five times more numerous on the grazed range. Much of this increase occurred as early as 1958, 6 years after the plots were sprayed.

Young sagebrush on the unsprayed areas inside both exclosures in 1966 averaged 2.7 plants/50 ft². On unsprayed areas outside the exclosures, the average was 3.6 young plants/plot. This difference is not large, but it is in general agreement with the above findings that grazing does favor the establishment of young sagebrush plants.

Perhaps more important is the influence of spraying on subsequent populations of young plants. In 1966, 17 years after spraying, the number of young plants on all sprayed areas inside the exclosure in area M-1 was more than twice the number on the unsprayed plots. Outside this exclosure the number of young plants on sprayed plots was more than five times the number on the plots not sprayed.

Fourteen years after spraying, young plants on sprayed plots inside the exclosure in area M-12 were less than on unsprayed areas, but on grazed range the relationship was reversed and the difference was greater.

Mature sagebrush plants.—The number of mature sagebrush plants remained about the same on unsprayed plots from 1953 to 1966 on both study areas, and grazing, at least on the M-1 area, seemed to have little effect (Table 1). Numbers decreased slightly in the M-1 exclosure, but this was offset by an increase on the M-12 exclosure.

Seventeen years after spraying, the number of mature plants on the sprayed areas inside the M-1 exclosure had more than doubled. Because of this increase the difference in number of plants on sprayed and unsprayed areas in 1966 was not large. Mature plants on sprayed plots outside this exclosure in 1966 were almost 50% more abundant than on unsprayed plots, and more than twice as abundant as on sprayed plots inside the exclosure.

Inside the exclosure on the M-12 areas, sprayed in 1952, there was no change in the population of

mature plants. Outside the exclosure, however, the number of plants had increased almost fourfold by 1966 and was almost the same as on the unsprayed areas. This indicates that the population of plants on grazed areas was about back to original levels.

These results also indicate that, in general, the longevity of the beneficial effects of spraying sagebrush is closely related to grazing use by livestock. On grazed range 17 years after spraying, there were more mature plants than were present in the original stand (as measured in 1953). Fourteen years after spraying, the number of plants on grazed ranges was about equal to the original stand.

Area of live sagebrush crown.—Seventeen years after spraying, the area of live sagebrush crown on plots inside the M-1 exclosure had increased about fivefold during the period from 1953 to 1966 (Table 1). It was almost equal to the 1953 crown cover on the unsprayed plots. Outside, the area of live crown on the sprayed plots was almost equal to that on the unsprayed plots. On the unsprayed plots inside the exclosure, live crown area more than doubled from 1953 to 1958, but had decreased again by 1966.

Similar trends were observed on the M-12 area sprayed in 1952. Live crown on the sprayed areas inside the exclosure increased fivefold from 1953 to 1966. This was still less than the area of live crown on the unsprayed and ungrazed plots, however. The area of live crown was greater on the sprayed plots outside the exclosure than inside the exclosure, but still less than on the unsprayed plots.

These increases in live sagebrush crown show that (1) on the sprayed and protected plots the crown areas of sagebrush have almost returned to conditions existing in 1953; and (2) on grazed ranges the area of live crown exceeds that measured inside the exclosures in 1953 on both sprayed and unsprayed areas.

Herbage production.—Herbage production inside the M-1 exclosure has been measured intermittently since 1951, 2 years after spraying. In 1951 the areas in which sagebrush had been sprayed were producing slightly more grass and sedge herbage than the unsprayed areas:

	Unsprayed	Sprayed
	(lb/acre)	
1951	222	276
1952	221	230
1953	178	191
1955	221	182
1956	199	191
1958	337	294
1966	403	280

The increase was not as great as has been reported for other areas (Kearl, 1965). By 1955 herbage production on sprayed areas was below that on unsprayed areas, and by 1966 the sprayed areas were

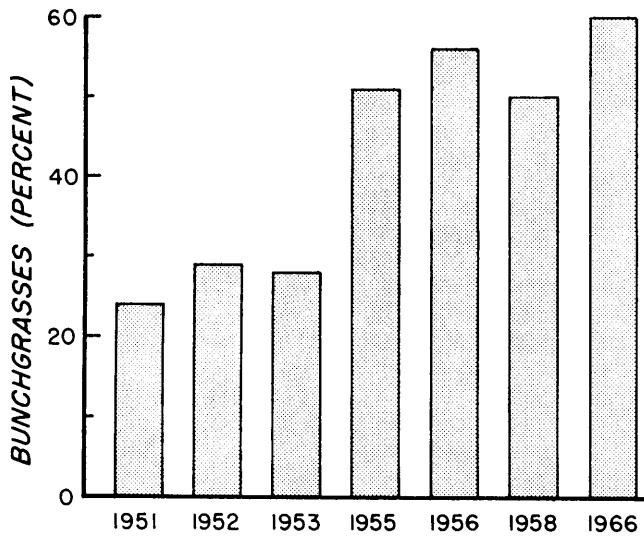


FIG. 3. Change in composition of grass and sedge herbage from 1951 to 1966 inside enclosure M-1 (1b/acre airdry).

producing only 70% as much herbage as the unsprayed areas. This decline is undoubtedly related to the increase in sagebrush on sprayed areas.

One of the most interesting aspects of this study is the change in composition of the vegetation inside the enclosures. In the M-1 enclosure in 1951, bunchgrasses made up only 24% of the total grass and sedge herbage. In 1966 bunchgrasses made up 60% of the total (Figs. 3 and 4). Since the composition changed on both sprayed and unsprayed areas, it would appear that the response was due more to control of grazing than to control of sagebrush.

Discussion

This study indicates clearly the importance of grazing management following sagebrush spraying. Furthermore, it raises questions regarding the eco-

nomie feasibility of a single spraying of sagebrush, at least at lower elevations with semiarid climate.

Although the abundance of sagebrush seedlings on grazed range immediately following spraying was closely related to percentage kill of original plants, their abundance thereafter apparently was dependent upon climatic, microclimatic, and/or site factors.

In this study, the life expectancy of sagebrush control from chemical spraying was between 14 and 17 years on areas not grazed by livestock. Seventeen years after sagebrush was controlled the number of young sagebrush plants on sprayed areas exceeded the number on unsprayed areas. Fourteen years after spraying the number of young plants was still about 30% below the numbers on unsprayed check areas. The number of mature sagebrush plants 17 years after spraying was slightly more than 50% of the number on the unsprayed areas. Fourteen years after spraying, the area of live sagebrush crowns was equal to that at the time of spraying but, because of increases in crown cover on the unsprayed areas, live crown in 1966 was still less on the sprayed plots than on the unsprayed plots.

The influence of grazing of the type practiced in the Beaver Rim country is quite pronounced. On the M-1 study area, the number of young plants on sprayed and grazed plots after 17 years was greatly in excess of the number of plants on both unsprayed but grazed areas and on areas protected from grazing. This relationship first appeared in 1954, only 5 years after the spraying was done. By 1958, 9 years after spraying, the number of mature sagebrush plants on sprayed and grazed plots exceeded the number on grazed range that was not sprayed. Grazing appeared to have little effect on the area of live sagebrush crown.



FIG. 4. Close up of the understory vegetation on the Beaver Rim study area: Left, 1952, three years after spraying (mostly *Agropyron dasystachyum*) and Right, 1968 (mostly *Poa cusickii* and *P. secunda*).

In substance, then, the initial benefits of sagebrush spraying on ranges grazed by livestock in the Beaver Rim area began to decrease within 5 years after spraying, and within 14 years they were nullified. Seventeen years after being sprayed, sagebrush stands were denser than before spraying.

Increased production of herbage was nullified within 6 years after spraying.

The change in composition of the grass and sedge herbage on the Beaver Rim area points toward bunchgrasses as the "climax" forage species.

It should be pointed out that the original design of the treatment plots could have contributed to the results obtained in this evaluation. The narrow plots with unsprayed sagebrush on each side could have contributed to more rapid reinvasion than if the spraying were done in large blocks. There are always some plants or portions of plants left alive to produce seed. It is also possible that grazing use was heavier on the sprayed than on the unsprayed strips. This preference for sprayed areas has been observed on other areas, and narrow-strip sprayings would be more susceptible to this pressure than large-block sprayings. Nevertheless, the results from this evaluation indicate that careful thought

should be given to plans for future spraying on low-altitude, semiarid sagebrush ranges such as those at Beaver Rim.

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