How Heavy Grazing and Protection Affect Sagebrush-Grass Ranges

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Highlight

Heavy late-fall grazing by sheep following spring deferment improves deteriorated sagebrush-grass ranges by reducing sagebrush and increasing the production of grasses and forbs. Fall grazing as a method for range improvement is more effective and practical than complete protection from grazing and is less expensive than mechanical or chemical means of sagebrush control. Heavy spring grazing damages good-condition ranges by increasing sagebrush and reducing herbaceous production.

Since 1924, researchers at the U.S. Sheep Experiment Station[2] near Dubois, Idaho, have been studying the sagebrush-grass ranges which provide the primary source of forage for sheep in both spring and fall on the Upper Snake River plains of southeastern Idaho. As they have reported previously, heavy spring grazing by sheep followed by fall grazing results in dense stands of sagebrush and low production of palatable grasses and forbs. Craddock and Forsling (1938) reported results of this study through 1932; Mueggler (1950) continued the report through 1949, and Laycock (1961) summarized results through 1957. All these reports showed that grazing only in the late fall maintains an open stand of sagebrush. This paper reports continuation of these studies through 1964; objectives of this continuation were to determine the effects on good and poor sagebrush-grass range of (1) complete protection, (2) heavy grazing in the spring only, and (3) heavy grazing in the late fall only.

[1] *At Forestry Sciences Laboratory, maintained in cooperation with Utah State University.*

[2] *Cooperative research by the Intermountain Forest and Range Experiment Station, Forest Service; Animal Husbandry Research Division, Agricultural Research Service; and the University of Idaho.*

The Study

This study was conducted in two 80-acre native range pastures. From 1924 to 1949 the two pastures were grazed at different seasons—one in the fall only, the other in both spring and fall. Stocking rates for the fall-grazed pasture averaged 43 sheep-days/acre; stocking rates for the spring-fall pasture averaged 19 sheep-days/acre in the spring and an additional 10 in the fall.

In 1924, both pastures were in good condition when rated by the standards published by Pechanec and Stewart (1949). Both pastures had open stands of threetip sagebrush (*Artemisia tripartita*)[3] and were producing abundant grasses and forbs. In 1949, the pasture grazed in the fall was still in good condition. The spring-fall pasture, however, dropped from good to poor condition during this period; sagebrush increased and grasses and forbs decreased. This deterioration was attributed primarily to the heavy spring use during the first few years of the study when

[3] *Nomenclature follows Hitchcock et al. (1955-1964) for dicotyledons and Hitchcock (1951) for grasses.*

the spring stocking rates were as high as 34 sheep-days/acre. Because of the combined seasons of use, however, the separate effects of spring and fall grazing could not be determined. The pasture arrangement and the study therefore were changed somewhat in 1950.

First, 10 acres of the spring-fall pasture were fenced off so that their rate of recovery could be compared with that of an exclosure in the fall-grazed pasture that had been protected from grazing since 1941. Then the remainders of both the spring-fall and fall-grazed pastures were bisected with a fence. The former grazing practices, with some modification (Fig. 1), were continued in one half of each of the original pastures. The two remaining halves, however, were put to new use. One was grazed in the spring only (May) at the heavy stocking rate of 40 sheep-days/acre, and the other was grazed in the fall only (November and December) at the heavy stocking rate of 60 sheep-days. Craddock and Forsling (1938) and Laycock (1962) all show that moderate grazing rates for fair to good ranges in this area would be 10 to 20 sheep-days/acre in the spring and again in the fall.

These modifications, made in 1950, have enabled us to determine whether heavy grazing solely in the spring damages the range as much as the heavy spring-fall grazing did prior to 1950. Similarly, the addition of the exclosures has provided for a comparison between fall grazing and protection as methods for improving range in poor condition and for maintaining range in good condition.

Fig. 1 shows the layout and grazing history of the pastures and exclosures. For convenience of discussion, the following terms are used to describe the grazing treatments:

Continued Fall — fall grazing 1924-1949; fall grazing continued 1950-1963.

Continued Spring — spring-fall grazing from 1924-1949; spring grazing continued 1950-1963.

New Fall — spring-fall grazing from 1924-1949; use changed to fall only 1950-1963.

New Spring — fall grazing 1924-1949; use changed to spring only 1950-1963.

Old Exclosure—fall grazing 1924-1941; protected from grazing 1941-1963.

New Exclosure — spring-fall grazing 1924-1949; protected from grazing 1950-1963.

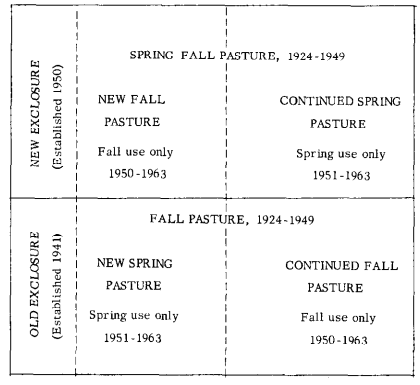

FIG. 1. Layout and grazing history of the pastures and exclosures, U.S. Sheep Station Experimental Range, Dubois, Idaho, 1924-1963.

Vegetation Sampling. — Each pasture contains 30 permanent 100-square-foot plots located on a grid. In the exclosures, the number and size of plots vary. The new exclosure contains fifteen 100-square-foot plots; the old exclosure contains fifty 50-square-foot plots.

Vegetation on the plots in each area was sampled by the weight estimate method (Pechanec and Pickford, 1937a) in 1950, 1957, and 1964. The pastures were not grazed in the spring during these years to permit sampling at the end of the spring growing season. The pastures were also sampled in 1953 and 1960 without interrupting the planned grazing treatments. In 1964, additional information on plant density was obtained from the sample plots by counting the number of plants in the following categories: arrowleaf balsamroot (*Balsamorhiza sagittata*), mature threetip sagebrush (6 in. or taller), and sagebrush seedlings and young plants (less than 6 in.).

Utilization of the major species was estimated on the plots after spring grazing every year from 1951 to 1956, and in 1958. Estimates of fall utilization of the grasses and shrubs were made only in 1955 and 1956. Estimates were made by the ocular estimate-by-plot method (Pechanec and Pickford, 1937b).

Results and Discussion

Trends Under Spring Grazing, 1950-1964.—The range condition of the continued spring pasture, poor to begin with, declined further between 1950 and 1964. Sagebrush production increased more than 60%, and cheatgrass brome (*Bromus tectorum*) also increased (Table 1). Production of perennial grasses and forbs remained about the same.

In the new spring pasture, where the heavy grazing treatment was changed from fall to spring, the range condition declined from good to poor just as Mueggler (1950) reported it previously had declined in response to use in both spring and fall. Sagebrush production increased 78%, and cheatgrass brome increased more in this pasture than in any other. Total grass production decreased 22%; bluebunch wheatgrass (*Agropyron spicatum*) decreased 48%. Total forb production decreased 73%. The forbs most palatable to sheep—arrowleaf balsamroot, common comandra (*Comandra umbellata*), tapertip hawksbeard (*Crepis acuminata*), and eriogonum (*Eriogonum heracleoides* and *E. ovalifolium*) — decreased more than 85%.

The response of comandra is interesting because increases in comandra on overgrazed ranges

have been cited as a possible cause of increased incidence of rust in lodgepole pine (Mielke, 1961). At the Sheep Station, comandra decreased rather than increased on overgrazed ranges because sheep eat it heavily in the spring (see Table 1; also Mueggler, 1950).

The downward trend in the new spring pasture could be seen and measured 3 years after the treatment was changed from fall to spring grazing. Fig. 2 shows some of the changes that took place during the study on one of the plots in this pasture.

Trends under Fall Grazing and under Complete Protection. —The pasture in which fall grazing was continued remained in good condition from 1950 through 1964 just as it had during the previous 25 years (Mueggler, 1950). Production of sagebrush, grasses, and most forbs remained about the same. Production of annuals, mainly cheatgrass brome, was higher in both fall-grazed pastures and in both exclosures in 1964 than in 1950—presumably in response to precipitation; but the differences

Table 1. Herbage production (lb/acre, air-dry) in spring- and fall-grazed pastures and in exclosures, U. S. Sheep Experiment Station, 1950 and 1964.

Species	Good condition in 1950 (Fall-grazed, 1924-1949)						Poor condition in 1950 (Spring-fall grazed, 1924-1949)					
	Continued fall-grazed		New spring-grazed		Old exclosure		Continued spring-grazed		New fall-grazed		New exclosure	
	1950	1964	1950	1964	1950	1964	1950	1964	1950	1964	1950	1964
Perennial grasses												
Agropyron spicatum	127	124	93	48	72	87	88	67	77	110	72	127
Koeleria cristata	22	11	27	5	22	10	10	4	8	6	12	8
Oryzopsis hymenoides	26	17	14	6	27	8	17	13	14	9	13	2
Poa secunda and *P. nevadensis*	31	81	23	68	23	80	22	77	25	80	20	70
Stipa comata	32	26	18	12	64	24	18	13	13	9	16	8
Other grasses	23	16	24	16	27	7	31	22	17	12	27	8
Total perennial grasses	261	275	199	155	235	216	186	196	154	226	160	223
Perennial forbs												
Balsamorhiza sagittata	164	226	176	9	132	167	1	1	1	9	5	25
Comandra umbellata	18	18	20	1	10	10	1	0	0	1	1	1
Crepis acuminata	28	25	24	3	25	16	2	2	3	11	6	12
Erigeron spp.	11	19	11	20	9	14	5	21	5	10	11	10
Eriogonum spp.	12	14	20	2	18	10	7	1	7	4	4	5
Penstemon spp.	7	6	5	1	5	5	3	2	3	4	3	3
Phlox hoodii	10	12	12	19	20	24	10	17	11	8	7	8
Other forbs	44	38	53	32	63	39	36	24	38	29	39	24
Total perennial forbs	294	358	321	87	282	285	65	68	68	76	76	88
Shrubs												
Artemisia tripartita	94	84	126	224	158	127	152	248	137	107	204	166
Chrysothamnus viscidiflorus var. *puberulus*	45	24	17	6	33	16	24	6	31	26	58	27
Gutierrezia sarothrae	4	3	6	4	7	8	19	17	13	8	6	6
Leptodactylon pungens	7	2	6	4	9	4	8	7	12	5	9	5
Purshia tridentata	17	3	52	5	15	4	28	9	39	3	64	13
Tetradymia canescens	33	16	18	14	15	9	26	11	21	12	19	19
Other shrubs	3	2	2	1	6	19	6	5	6	3	9	5
Total shrubs	203	134	227	258	243	187	263	303	259	164	369	241
Annuals												
Bromus tectorum	2	9	2	53	2	10	3	33	7	12	2	7
Annual forbs	2	4	2	6	4	6	4	7	3	8	3	6
Total annuals	4	13	4	59	6	16	7	40	10	20	5	13
Cactus												
Opuntia polyacantha	75	31	13	19	33	17	22	30	62	31	36	9
TOTAL VEGETATION	837	811	764	578	799	721	543	637	553	517	646	574

FIG. 2. This plot in the new spring pasture shows the damaging effects of heavy spring grazing by sheep on native sagebrush-grass range. Upper left, 1952, Arrowleaf balsamroot plants were vigorous following the favorable fall-grazing treatment before 1951. Upper right, 1955, The balsamroot plants are less vigorous, and more bare soil is evident. Lower left, 1958, The balsamroot plants have died, and the sagebrush plants have grown larger. Lower right, 1964, Sagebrush has obscured the plot stake. The bitterbrush plant in the upper left was killed by tent caterpillar defoliation, not by grazing. Much of the grass is cheatgrass brome.

were comparatively smaller than those in the spring-grazed pastures.

Significantly, the deteriorated pasture improved under fall grazing (the new fall pasture—Fig. 3) and under protection (the new exclosure). The increase in total grass production, expressed mainly as increases in bluebunch wheatgrass and bluegrass (*Poa secunda* and *P. nevadensis*), was 47% in the new fall pasture and 39% in the new exclosure. Sagebrush production decreased about 20% in both areas (Table 1). Total forb production increased only slightly. After palatable forbs have been reduced or removed by heavy spring grazing, they recover slowly, even under favorable conditions.

Some forbs, such as tapertip hawksbeard, increased fairly uniformly throughout the new fall pasture. This species becomes established quickly because it has a light, wind-carried seed. In contrast, almost all the increase of arrowleaf balsamroot occurred in the south end of the new fall pasture. Balsamroot has a comparatively heavy seed, which is not dispersed over a very wide area. Most plants in the south end of the new fall pasture probably started from seeds produced in the adjacent new spring pasture (Fig. 1), which had an abundance of balsamroot in 1950. Seeds could have been carried short distances by the prevailing southwesterly winds or possibly by rodents. This seed source has been largely elimi-

FIG. 3. These two photographs on a plot in the new fall pasture show the increase in production of grasses and forbs and the decrease in sagebrush from 1952 (left) to 1964 (right) as a result of heavy fall grazing.

nated because few of the remaining balsamroot plants in the new spring pasture now produce flowers or seed. However, balsamroot plants now present in the new fall pasture should insure further increases as long as the favorable fall-grazing treatment is continued.

Number and Average Weight of Plants, 1964.—The number of arrowleaf balsamroot plants was not correlated with production in the new spring and new fall pastures in 1964. Production was 9 lb/acre in both pastures (Table 1), but the new spring pasture had 8 times as many plants (Table 2). The air-dry weight of plants in both spring-grazed pastures averaged 2 to 4 g compared with 13 to 17 g for the plants in the fall-grazed pastures and the exclosures.

Plant numbers and productivity of mature sagebrush were highest in the two spring-grazed pastures and lowest in the continued fall-grazed pasture. The mature sagebrush plants in the continued fall pasture also had the lowest average weight. The number of sagebrush seedlings and small plants (less than 6 in. tall) was not affected by grazing treatment.

Table 2. Average number and weight of arrowleaf balsamroot and mature (taller than 6 in) sagebrush plants in 1964.

Item	Fall-grazed, 1924-1949			Spring-fall grazed, 1924-1949		
	Continued fall	New spring	Old exclosure	Continued spring	New fall	New exclosure
Ave. no. plants/100/ft^2						
Balsamroot	14.5	5.8	13.1	0.2	0.7	1.5
Sagebrush	7.7	15.4	10.8	19.3	10.0	11.0
Ave. plant weight (g. airdry)						
Balsamroot	16.2	1.6	13.3	3.6	13.9	17.5
Sagebrush	11.5	15.1	12.3	13.3	11.2	15.8

Statistical Analysis.—Analysis of variance was used to compare changes in production from 1950 through 1964 for bluebunch wheatgrass, arrowleaf balsamroot, threetip sagebrush, and total perennial grasses and forbs. Counts of the number of balsamroot and sagebrush plants in 1964 were also analyzed. Each of these categories was analyzed separately using the six pastures and exclosures as six treatments in a completely randomized design with the individual sample plots as subplots within each treatment. In each analysis, the treatment sum of squares was subdivided into various single degree of freedom comparisons between pastures or groups of pastures. The three comparisons of greatest value in interpreting results are shown in Table 3.

In the overall analysis for each category, the "F" test for "Treatment" was highly significant ($P < .01$). As might be expected, a large part of the treatment sums of squares for each category resulted from the difference between the average of the spring-grazed areas on the one hand, and the average of the fall-grazed and protected areas on the other (Comparison A, Table 3). The main comparisons of interest were those between fall grazing and protection from grazing on range initially in good condition (continued fall pasture vs. old exclosure—Comparison B, Table 3) and on range initially in poor condition (new fall pasture vs. new exclosure—Comparison C, Table 3). In general, only two

Table 3. Comparisons between pastures and exclosures of change in production from 1950 through 1964 and number of plants in 1964.

Item	A			B			C		
	Spring grazing	Fall grazing & protection	F	Continued fall	Old exclosure	F	New fall	New exclosure	F
Average change in prod. (lb/acre), 1950-1964									
Agropyron spicatum	−33	+25	**19.2	− 3	+15	ns	+33	+55	ns
Balsamorhiza sagittata	−84	+31	**48.5	+62	+35	ns	+ 8	+20	ns
All grasses and forbs	−132	+54	**19.7	+78	−16	*5.8	+80	+75	ns
Artemisia tripartita	+97	−27	**77.5	−10	−31	ns	−30	−38	ns
Ave. no. of plants (per 100 ft.²) in 1964									
Balsamorhiza sagittata	3.0	7.0	**12.6	14.5	13.1	ns	0.7	1.5	ns
Artemisia tripartita	17.4	9.9	**70.8	7.7	10.8	*5.6	10.0	11.0	ns

* Difference significant at the 5% probability level.
** Difference significant at the 1% probability level.
ns Difference not significant at the 5% probability level.

of these comparisons were significant. First, from 1950 through 1964 production of all grasses and forbs increased in the continued fall-grazed pasture; however, it decreased slightly in the protected old exclosure. Moreover, the continued fall pasture contained significantly fewer sagebrush plants in 1964 than did the old exclosure.

Vegetation Changes not Related to Grazing Treatment.— Results discussed thus far were for the major species and those that showed definite responses to the experimental treatments. Precipitation may have had a greater effect than treatment upon some of the other species. Precipitation in 1950 and 1964 was:

	1950	1964
Before the growing season (July-March)	7.16	7.14
Growing season (April-June)	3.20	7.52

Blaisdell (1958) found that *total* production of grasses and forbs at the Sheep Station was most closely correlated with precipitation prior to the growing season. However, precipitation during the growing season also affected the production of some individual species in this study. Cheatgrass brome and other annuals, for example, were scarce in 1950; but they were relatively common in all areas in 1964 as a result of the abundant spring moisture.

The perennials most obviously affected by variations in precipitation were the Nevada and Sandburg bluegrasses; in 1964 they produced two to three times more in all pastures and exclosures than they had in 1950. These grasses generally start growth, mature, and become dry earlier than most other grasses. In 1964, the abundant and prolonged spring moisture evidently favored extended growth and therefore relatively high production. The large decrease in the production of antelope bitterbrush *(Purshia tridentata)* in all areas was probably caused by damage from tent caterpillars in 1958-1960. When several pastures were sampled in 1960, almost all bitterbrush plants were completely defoliated. By 1964 many were partly or completely dead (Fig. 2).

Utilization. — In the spring, grasses and forbs made up the bulk of the diet of the sheep. Average use of the highest producing grass, bluebunch wheatgrass, ranged from 20 to 40% of the current year's growth in the new spring pasture and from 40 to 60% in the continued spring pasture. Most other grasses were consumed in about the same quantity, or slightly less, as bluebunch wheatgrass; however, Indian ricegrass *(Oryzopsis hymenoides)* and needle-and-thread *(Stipa comata)* were usually grazed more heavily.

The average spring use of tapertip hawksbeard and arrowleaf balsamroot ranged from 40 to more than 90%. Use of other forbs usually was less and varied considerably from year to year. Antelope bitterbrush was the main shrub utilized in the spring, with use ranging up to 60% of the growth at the time of grazing. Other shrubs received only light use in the new spring pasture, but up to 40% of the downy rabbitbrush *(Chrysothamnus viscidiflorus* var. *puberulus)* and the broom snakeweed *(Gutierrezia sarothrae)* was used in the continued spring pasture. Evidently, the low production of palatable grasses and forbs in the continued spring pasture caused heavier use of the shrubs.

In the fall, the amount of sagebrush and other shrubs eaten by the sheep varied considerably from year to year. In 1955 and 1956, the only years for which

fall utilization data are available, the sheep consumed the following percentages of the current year's growth of threetip sagebrush:

	Continued fall pasture	New fall pasture
1955	26	19
1956	7	6

The greater utilization in 1955 probably was the result of deeper snow cover. Little snow was present at any time in 1956, and in that year the use of sagebrush and other shrubs was light. In 1955, 5 to 8 inches of snow covered the ground during the last month of fall grazing. Thus many of the grasses and forbs were buried, and heavier use of sagebrush and other shrubs resulted.

Continuous snow cover of 5 inches or more during the last half of the fall grazing period occurred in 6 of the 14 years of the study. In 1951, the sheep were removed from the fall-grazed pasture about 10 days earlier than had been planned because the snow was about 15 inches deep. Portions of sagebrush and other shrubs above the snow were used heavily, but accurate estimates of total utilization could not be made because of the deep snow.

Causes of Varied Response.— As Mueggler (1950) previously reported, heavy spring grazing followed by fall grazing caused sagebrush-grass range in good condition to deteriorate quickly. During the present study, heavy grazing only in the spring had the same result: sagebrush increased, and the more desirable grasses and forbs decreased. By contrast, late fall grazing improved range in poor condition; it reduced sagebrush and increased the production of grasses and forbs.

Why does spring grazing damage the range while heavy fall grazing improves it?

The best answers seem to be that the spring grazing period is also the active growing period for the native grasses and forbs. Grazing during this period, and particularly heavy grazing, removes photosynthetic material from grasses and forbs at just the time when it is needed for the repair of winter damage and for renewed growth. When protected in the spring, however, the grasses and forbs can reach full maturity unhindered and increase in vigor. Then in the fall, when their root systems are well established and their foliage is dry, they can be grazed without significant damage. Sagebrush, on the other hand, is not dormant in the fall; so utilization by sheep results in a decline in vigor. The established grasses and forbs, vigorous as a result of spring deferment, can then increase while the sagebrush decreases.

Moreover, fall grazing probably helps to promote the establishment of additional grass and forb seedlings during the following spring. The sheep scatter the newly shed seed and often cover it by trampling (Pechanec and Stewart, 1949). Then, if the area is again protected in the spring, many of these grass and forb seedlings become established.

An area containing an open stand of sagebrush resulting from heavy fall grazing is probably better sheep range than an area from which sagebrush has been eliminated. Sagebrush and other shrubs constitute an important part of the diet of sheep in the fall because they supply much more crude protein and phosphorus at that time than do the native grasses and forbs (Blaisdell et al., 1952). The shrubs also provide emergency feed when early snows bury herbaceous vegetation.

Thus, both fall grazing and protection improved range in poor condition. However, fall grazing probably reduces sagebrush more than protection from grazing: (1) after prolonged fall grazing, there were significantly fewer sagebrush plants in the continued fall pasture than in the old exclosure (Table 3), and (2) the average weight of sagebrush plants was lower in the new fall pasture than in the new exclosure (Table 2).

Application of Results. — The results of this study indicate that depleted sagebrush-grass ranges can be improved by use of a properly planned grazing program. The commonly used methods of reducing dense stands of sagebrush (burning, spraying, or mechanical treatment) are costly and eliminate grazing for one or more years following treatment. A program of spring deferment combined with heavy fall grazing offers an alternative method of improvement. Its advantage is that it requires only management of the sheep and not costly cultural practices.

Fall grazing should be an effective method of improving sagebrush-grass ranges if:

(1) The sagebrush has a good understory of herbaceous perennials, especially grasses. (If the native grasses and forbs have been replaced by annuals, little improvement can be expected.)

(2) The sagebrush is grazed in the late fall when snow is on the ground so that utilization is as heavy as possible. On fairly level ground, the condition of the sheep should determine the time of removal in the fall rather than any certain level of utilization. (Sheep were not weighed in this study, but fall grazing caused no observable decline in weight or condition.) On steep slopes, however, grazing rates should be lower than on level ground to prevent excessive soil disturbance by

sheep and the resulting acceleration in erosion.

During this study, heavy fall grazing had noticeably improved the new fall pasture by 1953, only 3 years after the treatment was started. Such a rapid rate of improvement indicates that the combination of spring deferment and heavy fall grazing is a very practical method for range restoration. Because only 2 or 3 years are necessary to effect marked improvement, this program could be applied on a rotation basis to one range unit at a time, and it should thus upgrade the entire range over a period of years.

Whether this system could be used on a given range without reducing the number of sheep grazed in the spring would depend upon the condition of the range and the present grazing intensity. If the present grazing rate is quite heavy, deferment of one unit and thereby increasing the spring grazing pressure on the remainder of the range might cause considerable damage. In such a situation, additional spring range or supplemental feed might be necessary until the carrying capacity of part of the range is increased. If the present grazing rate is moderate, the system might be used without serious damage, especially if the spring-grazed units were rotated so that a given unit would be grazed at a different time each spring (Laycock, 1962).

The only known test of fall grazing as a method of range improvement is being conducted on the Benmore Experimental Area in Utah, where heavy fall grazing by sheep appears to have reduced the amount of big sagebrush *(Artemisia tridentata)* in seeded cattle pastures.[4]

[4] *Personal communication, Neil C. Frischknecht, Intermountain Forest and Range Experiment Station, Provo, Utah.*

Summary

At the U.S. Sheep Experiment Station near Dubois, Idaho, one pasture, grazed only in late fall from 1924 to 1949, remained in good condition with an open stand of threetip sagebrush and a good understory of perennial grasses and forbs. An adjacent pasture, grazed in both spring and fall, deteriorated to poor condition as grasses and forbs decreased markedly and sagebrush increased.

In 1950 additional fences were erected and grazing treatments were applied from 1950 through 1963 to determine the effects of spring grazing only, fall grazing only, and protection from grazing on some range in good condition and some in poor.

Heavy spring grazing caused rapid deterioration of good-condition range; production of sagebrush increased 78% and production of grasses and forbs decreased more than 50%. Arrowleaf balsamroot and some of the palatable forbs decreased more than 85%. Heavy spring grazing on range already in poor condition maintained the low productivity of palatable forage species and further increased sagebrush.

Heavy late-fall grazing and complete protection maintained the range in good condition with an abundance of balsamroot, other forbs, and grasses. Likewise, both heavy fall grazing and protection improved poor-condition range; production of the desirable forage species increased more than 30% while sagebrush decreased 20%. Fall grazing, however, reduced sagebrush more than protection because the sheep browsed on the sagebrush in the fall. Grasses and forbs were not damaged by fall utilization because they are essentially dormant at that time.

Thus sagebrush-grass ranges can be improved by proper grazing rather than by costly spraying, burning, or mechanical treatments. Spring deferment combined with heavy grazing in the late fall offers an alternative method of improvement. The loss of grazing in the spring is more than offset by the increased grazing rate allowable in the fall.

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