

Herbage Utilization on Pine-Bunchgrass Ranges of Colorado

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TO MANAGE ANY range effectively, the operator needs to know what plants make up the forage supply, their relative value as forage, their ability to withstand grazing, and when and how they are grazed. This paper presents the results of studies to determine how cattle utilize several important species on ponderosa pine-bunchgrass ranges in Colorado.

The studies were made at the Manitou Experimental Forest in central Colorado during 1950 and 1952 on six experimental range pastures that had been grazed at different intensities since 1941. The three grazing intensities had each created different range conditions as reflected in both amount and composition of the vegetation. The study, therefore, gives examples of utilization on areas grazed at three intensities where the conditions are those created by the different levels of grazing. The differences in utilization are not necessarily those expected when ranges in similar condition are grazed at the three levels.

Yearling heifers grazed the pastures from the first of June to the end of September in both years. The study was confined to grassland openings that made up 12 to 32 percent of the pasture areas. These openings were always more heavily grazed than the timbered areas that made up most of the remainder of the pastures.

In 1950, 90 plots were selected at random on areas that past records indicated were grazed consistently at either a heavy, moderate, or light rate of utilization. In the light grazing 10 to 20 percent of the grass and sedge herbage was removed; moderate grazing, 30 to 40 percent; and heavy grazing, 50 percent or more. On each plot

herbage composition was estimated by species, expressed as percentage of total weight of herbage produced. Utilization was estimated on each plot in mid-July, mid-August, and late September. Utilization was expressed as percentage of herbage removed by weight. Utilization estimates were repeated on the same plots in 1952.

Data on utilization and herbage composition were collected for the following species or groups of species: (1) Little bluestem (*Andropogon scoparius* Michx.), (2) Parry danthonia (*Danthonia parryi* Scribn.), (3) Blue grama (*Bouteloua gracilis* [H.B.K.] Lag.), (4) Arizona fescue (*Festuca arizonica* Vasey), (5) Mountain muhly (*Muhlenbergia montana* [Nutt.] Hitchc.) (6) Other grasses. (7) Sedge (*Carex* spp. primarily *C. heliophila* Mack.), (8) Rose pussytoes (*Antennaria rosea* [D. C. Eaton] Greene), (9) Purple milkvetch (*Astragalus agrestis* Dougl.), (10) Trailing fleabane (*Erigeron flagellaris* A. Gray), (11) Other weeds, and (12) Fringed sagebrush (*Artemisia frigida* Willd.).

Composition of the Vegetation

The vegetation on the areas studied consisted of a large number of species. Ranges in good to excellent condition contained as many as 35 different grasses. Forbs too were numerous but they fluctuated in abundance from year to year. A few forbs were fairly stable in the composition, and some are useful indicators of range condition. In general, however, only a few plants were either sufficiently frequent or abundant enough to warrant intensive study.

Only six species were both abundant enough or palatable enough to be important as cattle forage: Little bluestem, blue grama, Arizona fescue, mountain muhly, sedge, and fringed sagebrush. Oth-

er grasses found commonly but in small amounts were Parry danthonia, bluestem wheatgrass (*Agropyron smithii* Rydb.), bearded wheatgrass (*A. subsecundum* [Link] Hitchc.), Canby bluegrass (*Poa canbyi* [Scribn.] Piper), bottlebrush squirreltail (*Sitanion hystrix* [Nutt.] J. G. Smith), pine dropseed (*Blepharoneuron tricholepis* [Torr.] Nash), and prairie Junegrass (*Koeleria cristata* [L.] Pers.).

Among the forbs, purple milkvetch, rose pussytoes, and trailing fleabane were the most common. Other common genera included *Chenopodium*, *Chrysopsis*, *Orthocarpus*, *Thermopsis*, *Potentilla*, *Solidago*, and *Aster*.

At the time of the study, differences in both the amount and composition of the vegetation had resulted from the differences in grazing intensities the study areas had received since 1941. No specific measurements of total herbage production were made on the 90 plots. However, in other sampling of the experimental pastures it was found that the total production of grasses and sedges in 1947 under the three conditions represented, averaged 704, 673, and 249 pounds per acre for the lightly, moderately, and heavily grazed areas, respectively.

As shown in Table 1, 73 percent

TABLE 1.—HERBAGE COMPOSITION ON GRASSLAND AREAS GRAZED AT LIGHT, MODERATE, AND HEAVY RATES AT THE MANITOU EXPERIMENTAL FOREST

Species	Herbage composition based on total weight produced		
	Moderately grazed		
	Lightly grazed	Heavily grazed	
	Percent		
Little bluestem...	2	1	5
Blue grama.....	1	3	21
Arizona fescue....	21	41	11
Mountain muhly...	57	45	38
Sedge	3	4	7
Fringed sagebrush	2	2	11
All others.....	14	4	7
Total	100	100	100

¹With headquarters at Fort Collins, Colo. in cooperation with Colorado State University



FIG. 1.—A typical lightly grazed area in the ponderosa pine-bunchgrass type. Only 20 percent of the herbage has been utilized.

of the herbage composition on the lightly grazed areas was produced by mountain muhly and Arizona fescue. Little bluestem, sedge, blue grama, and fringed sagebrush were of minor importance; the last two made up only 3 percent of the vegetation. A variety of miscellaneous species such as bluestem wheatgrass, bearded wheatgrass, Canby bluegrass, bottlebrush squirreltail, and prairie Junegrass made up 14 percent of the vegetation.

In contrast, on the heavily grazed areas, Arizona fescue and mountain muhly made up only 49 percent of the herbage. Blue grama and fringed sagebrush made up 32 percent. Sedge was somewhat more prominent than on the lightly grazed range. Miscellaneous species constituted 7 percent of the herbage. These were predominantly sleepygrass (*Stipa robusta* [Vasey] Scribn.) and tumblegrass (*Schedonardus paniculatus* [Nutt.] Trel.).

although the more valuable western wheatgrass was usually present.

Moderately grazed areas were predominantly Arizona fescue and mountain muhly. Blue grama and fringed sagebrush were slightly more abundant than on the lightly grazed areas.

Palatability and Forage Composition

On lightly grazed areas mountain muhly, Arizona fescue, little bluestem, and sedge were by far the most palatable of the six species studied (Fig. 1). Mountain muhly and Arizona fescue, being most abundant, made up about 95 percent of the forage (Table 2). Little bluestem and sedge produced about 5 percent of the forage. Although taken quite well by cattle, they were not sufficiently abundant to be important forage producers.

Blue grama was grazed very

lightly and fringed sagebrush not at all at this intensity of grazing.

Parry danthonia, bearded and western wheatgrasses, Canby bluegrass, and prairie Junegrass were palatable but were not abundant enough to be considered among the major forage species. Of the forbs, purple milkvetch was the most palatable.

Utilization on heavily grazed areas was different from that on lightly grazed areas (Fig. 2). Arizona fescue and mountain muhly still received the most use and together furnished most of the forage. As on the lightly grazed range, mountain muhly was the outstanding species. It furnished 53 percent of the forage. However, the increased abundance of blue grama and more intensive grazing of it made it one of the important plants from the standpoint of forage produced—equally as important as Arizona fescue. Blue grama was used to about 25 percent, which was comparatively light use compared with the intensities at which mountain muhly and Arizona fescue were grazed. Both of these species were grazed in excess of 65 percent. Fringed sagebrush was grazed to about the same intensity as blue grama. It was more abundant in the composition and was grazed more than on the lightly grazed areas. Fringed sagebrush produced about 7 percent of the forage consumed. Little bluestem and sedges were grazed well, but were not abundant and, therefore, contributed only 5 to 7 percent to the forage.

The moderate rate of grazing (Fig. 3) is currently considered to be about proper utilization of pine-

TABLE 2.—UTILIZATION OF THE SIX MOST IMPORTANT PLANTS ON RANGE GRAZED AT THREE INTENSITIES, MANITOU EXPERIMENTAL FOREST

Species	Lightly grazed				Moderately grazed				Heavily grazed			
	Herbage use		Forage composition		Herbage use		Forage composition		Herbage use		Forage composition	
	1950	1952	1950	1952	1950	1952	1950	1952	1950	1952	1950	1952
	Percent											
Little bluestem	18	25	3.1	2.9	29	25	0.7	0.6	61	36	6.3	4.7
Blue grama	1	5	0.2	0.4	6	9	0.9	1.4	24	25	11.6	15.5
Arizona fescue	13	28	22.3	34.9	35	40	43.2	45.7	75	73	16.1	14.2
Mountain muhly	16	18	72.3	58.7	38	33	51.6	48.7	72	67	53.1	53.0
Sedge	8	17	2.1	3.1	22	19	3.4	3.4	46	38	7.0	6.0
Fringed sagebrush	0	0	0	0	3	3	0.2	0.2	30	28	5.9	6.6



FIG. 2.—On this area 70 percent of the herbage of native forage plants has been grazed. It is typical of the heavily grazed areas in this study.



FIG. 3.—Moderate use on pine-bunchgrass ranges, with approximately 40 percent utilization. This pasture is typical of moderately grazed areas used in this study.

bunchgrass range. In general, grazing of the various species under this rate differed from that on lightly grazed areas, principally in amount. Arizona fescue and mountain muhly were utilized 33 to 40 percent. These two species made up 90 to 95 percent of the forage, the same as they did on the lightly grazed areas. Blue grama and fringed sagebrush, which together made up less than 5 percent of the herbage consumed, were only lightly utilized. These species were grazed less than 10 percent.

Utilization by Seasons

Utilization of individual forage species varies with seasons as well as with the intensity of grazing (Fig. 4). On heavily grazed areas, 57 percent of the utilization of Arizona fescue was made during the first 48 days of the 117-day grazing period. During the remainder of the season, grazing of it continued, but at a reduced rate. On moderately grazed areas, 64 percent of the total use of Arizona fescue took place during the first 48 days. During the rest of the period the rate of use was much reduced. On areas grazed lightly, Arizona fescue was utilized at an almost uniform rate throughout the season.

Mountain muhly, in contrast to Arizona fescue, was grazed most heavily during the latter part of the grazing season. On heavily grazed areas only 24 percent of the utilization of mountain muhly was made during the first 48 days of

grazing and 54 percent was during the last 41 days of grazing. The lighter the degree of use, the more grazing of mountain muhly tended to be concentrated in the later period. On the moderately grazed areas 66 percent of the grazing was made during the last 41 days, and on the lightly grazed areas 69 percent of the use was made during this period.

Little bluestem and sedge followed the same general trend as Arizona fescue on heavily and moderately grazed areas. They were grazed most during the first 48 days of the season. After that period the rate of use declined, especially on the areas grazed moderately. On lightly grazed areas little bluestem was grazed most during the middle of the summer.

Blue grama and fringed sagebrush were both relatively unpalatable as shown by the comparatively light utilization they received even on heavily grazed areas. There was less consistency than in other species in the way they were utilized under different grazing intensities. Blue grama on lightly and moderately grazed areas received most of its utilization during the middle of the summer. On heavily grazed areas it was most heavily grazed during the last of the period.

Discussion

Several factors seem to affect the time and degree of use each species received. Perhaps most important is the palatability of the plant to the cattle. Lightly grazed areas

give a truer picture of palatability because there was sufficient herbage of all species available. On these areas Arizona fescue, mountain muhly, little bluestem, and sedge were highly palatable; blue grama only slightly palatable; and fringed sagebrush has little or no palatability.

The second factor affecting degree of use is the availability of species for grazing or perhaps availability of the desirable parts of the better species for grazing. The differences in utilization of the fescue, muhly, and sedge were all proportionately about the same for light, moderate, and heavy grazing. The relative differences in the use of little bluestem are somewhat similar but received a higher proportion of use on lightly grazed areas. However, use of blue grama and fringed sagebrush was markedly different. The proportionately heavy grazing of these species on heavily grazed areas indicates that the cattle turned to them for forage on heavily grazed areas. Since one-quarter or more of the herbage of the more palatable species was left both years on the heavily grazed pastures, the cattle apparently preferred the finer parts of the grama to the coarser parts of the more palatable plants. Another possibility is that they grazed it because of its availability.

The growth period of the plant influenced the utilization. Arizona fescue, little bluestem, and sedge grew early and they were grazed best at that time. On the other

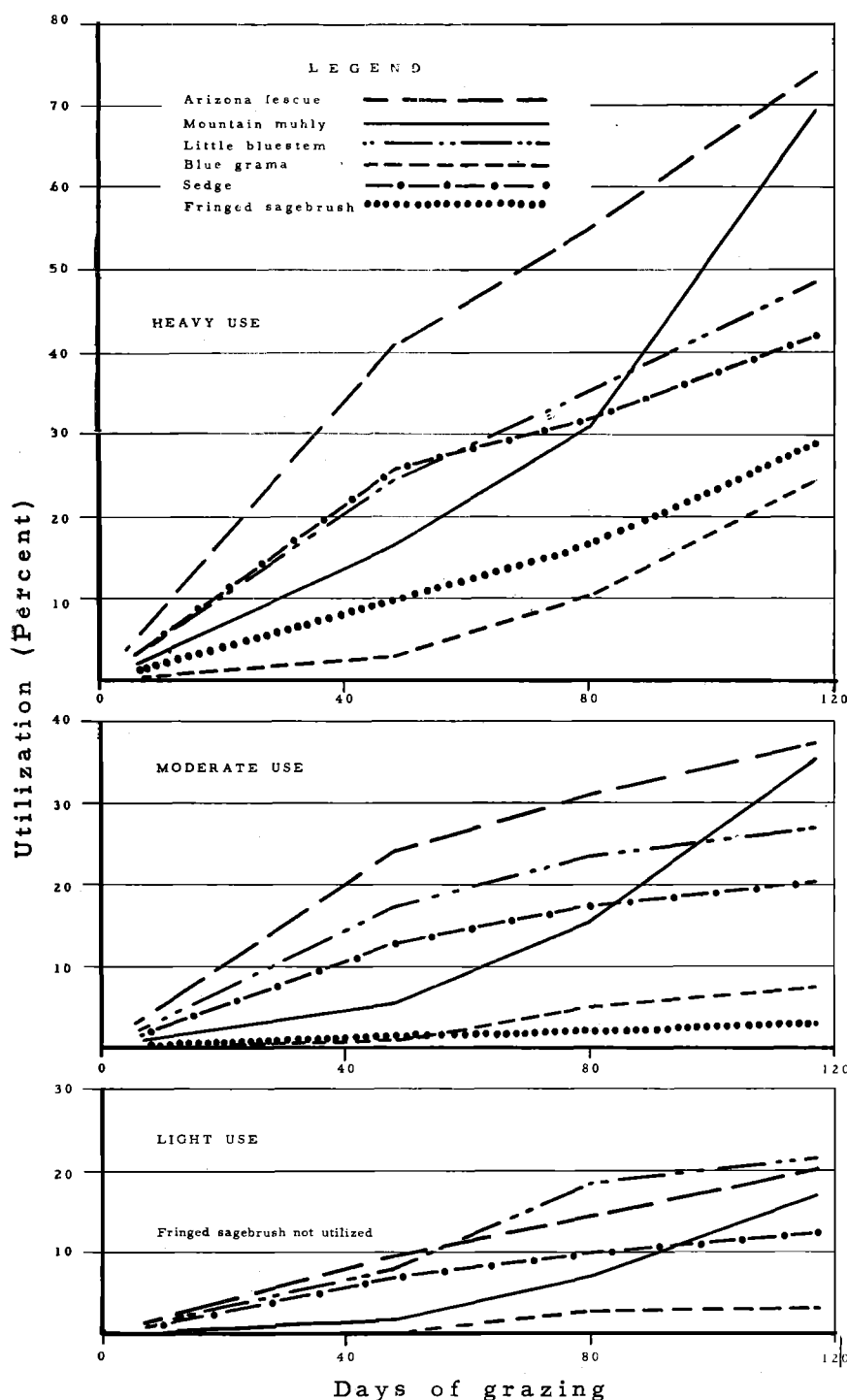


FIG. 4.—Seasonal use of major forage species on pine-bunchgrass ranges. 1950-1952.

hand, the period of rapid growth of mountain muhly and blue grama was later and these species were grazed later. The contrast between the fescue and the muhly is an example. By July 1, Arizona fescue in 1950 had made 90 percent of its leaf growth on moderately grazed areas. By that same date muhly had made only 60 percent of its leaf growth and its period of most

rapid growth was in July. On July 1 cattle had made 72 percent of the total use of Arizona fescue that was to be made by the end of the grazing period, but only 29 percent of the total use of the mountain muhly.

The seasonal aspects of the palatability should be considered when determining the period to graze a range. Summer-long grazing at

proper rates has been shown to have no serious effect on these bunchgrass ranges. A range that is most predominantly Arizona fescue could be used most effectively as late spring and early summer pasture, while one predominantly mountain muhly could be used most efficiently in late summer. In a rotation grazing system where midsummer shift to new pastures is used, the early use would throw the bulk of utilization on Arizona fescue, little bluestem, and sedge. At the same time mountain muhly, which had not made a considerable part of its growth, would be only lightly used. On the areas used later, the bulk of the utilization would be on mountain muhly. Arizona fescue, little bluestem, and sedge would receive the deferment.

The use received by blue grama is of particular interest in view of the value of blue grama on other range areas. In the shortgrass plains of eastern Colorado, blue grama is an important forage plant and furnishes most of the forage on cattle ranges. In the mountain areas it is relatively ungrazed if bunchgrasses are present, and it is not highly productive. On the Manitou Experimental Forest, herbage production on plots of almost pure blue grama averages about 30 pounds per acre in contrast to 650 to 750 pounds of bunchgrass types.

Arizona fescue and mountain muhly are the most productive grasses on the pine-bunchgrass ranges studied. They are highly palatable to cattle and carry the bulk of the grazing load. For these reasons maintenance of good vigorous stands of these species should be the basis of managing ranges where these grasses are important. On ranges grazed during the growing season, grazing that removes 30 to 40 percent of the herbage has been found to maintain both species. For Arizona fescue this means that the height of all plants at the end of the grazing period should average 5 to 6 inches. A sample measurement of plants on a range grazed in this manner

would reveal some plants ungrazed and some plants very closely grazed, but the majority of plants would have about 5 to 6 inches of ungrazed stubble at the end of the season. Corresponding plant heights

for proper use of mountain muhly are 1½ to 2 inches at the end of the season. Since both little blue-stem and sedge are utilized less than Arizona fescue or mountain muhly, they can be expected to

maintain their productivity on ranges grazed in this manner. Utilization of this kind would be expected to maintain conditions similar to those found on the moderately grazed areas.



Dioryctria Cone Moth Attack as Related to Cone Rust of Slash Pine in North Florida

The southern pine cone rust disease has long been known to be destructive to first-year slash and longleaf pine cones. But it is now probable that the rust may also be indirectly responsible for additional heavy losses in second-year cones by providing a favorable breeding place for cone moth larvae, according to a recent preliminary study by forest entomologists at the Lake City Research Center.

During the past year a survey by E. R. Roth of this station indicated that the rust, *Cronartium strobilinum* (Arth.) Hedge. & Hahn, was the direct cause of the loss of about 20 percent of the potential 1958 slash pine cone crop in north Florida and southeast Georgia. Hedgecock and Hahn, in their original description of this cone rust, mention the fact that numerous nectar-loving insects were attracted to the diseased cones in the spring and were observed feeding on the pycnial exudations. *Dioryctria abietella* (D. & S.) was the only insect which was specifically identified and found associated commonly with infected cones.¹

¹Hedgecock, G. G., and G. G. Hahn. Two important pine cone rusts and their new cronartial stages. Part I. *Cronartium strobilinum* (Arthur) Hedgecock and Hahn, *Phytopathology* 12(13):109-116. 1922.

TABLE 1.—INCIDENCE OF BRANCHLETS BEARING SECOND-YEAR CONE CLUSTERS ATTACKED BY DIORYCTRIA CONE MOTHS — JUNE 1957

Tree	Branchlets with diseased first-year cone clusters	Branchlets with healthy first-year cone clusters
	Percent	
A	100	31
B	86	9
C	89	7
D	100	18
Average	89 ¹	13 ²

¹Based on a total of 74 randomly selected branchlets.

²Based on a total of 116 randomly selected branchlets.

Field observations at Lake City have disclosed that rust-infected cones invariably supported populations of larvae of two cone moths, *Dioryctria abietella* (D. & S.) and *D. amatella* (Hulst), as early as April. By this time the diseased cones had become swollen and were covered with bright yellow-orange spores, and appeared to provide an ideal habitat for the cone-destroying insects.

Two months later, in mid-June, attacks on second-year cones by the *Dioryctria* cone moth larvae became noticeable in the field. It was then discovered that insect attacks on these second-year cones were most likely to occur on branchlets where there were first-year cones that had been hit by rust earlier the same season. Ap-

parently the insect populations had built up in the rusted first-year cones, and had then moved down the branch to attack the maturing second-year cones.

Second-year cones on branchlets having healthy, rust-free, first-year cones showed a low incidence of moth infestation.

Data are summarized in Table 1 from nearly 200 branchlets on four open-grown slash pines, averaging 35 feet in height and 8 inches d.b.h.

From our observations it appears that rust-infected slash pine conelets are a highly attractive food for *Dioryctria* larvae in the spring. The data also demonstrate the vulnerability of second-year cones on branches with diseased conelets. However, it should not be concluded that these moths required diseased cones either to survive or to maintain heavy populations, since they also attack branch tips and tree stems.

Further research is needed to evaluate total cone moth damage to cone crops on trees with both high and low cone-rust incidence. Data thus far suggest that controlling the cone rust may also substantially reduce the damage to second-year cones by insects.

E. P. MERKEL

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