Quantitative Effects of Twenty-three Years of Controlled Use on Mountain Range

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In 1926 a forest allotment which had been heavily used was made available to the Montana Agricultural Experiment Station. At that time—"vegetation on many of the steep, non-timbered slopes had largely disappeared as a result of overuse. Accelerated erosion had developed on these slopes and in the drainage channels extending from them. Bed grounds were barren except for a scattered cover of mustard, knotweed, niggerhead, and other weeds of low value. The vegetation surrounding the bed grounds was greatly reduced as a result of grazing and trampling by the band as it left and returned on successive days." (Heady *et al.*, 1947).

In 1929 the following management practices were put into effect on the allotment:

1. Grazing was delayed until July 1 each year to permit the forage plants to reach a stage that would minimize damage from grazing.
2. The range was divided into camp units that permitted efficient use of the available forage and regulation of time of grazing with plant development at different elevations.
3. Once-over and twice-over grazing systems were tried and the twice-over system abandoned in 1936.
4. Open herding was used at all times.
5. The one-night bed-ground system of grazing with sheep was used.

The following is a report on some of the effects of these management practices on vegetation.

Description of Area

The area, known as the "College Allotment", consists of 3,788 acres of which about 2,900 are usable for grazing. The allotment is on the east slope of the Bridger Mountains about 15 miles northeast of Bozeman, Montana. The range is rolling to steep with an elevation of about 6,000 feet at the eastern edge to about 8,500 feet at the western edge. The range is characterized by alternating grassland parks and timber. Timber, mostly lodgepole pine and douglas fir, is most abundant on north-facing slopes, with the area dominated by timber being far greater than that occupied by herbaceous vegetation (Fig. 1).

Climatic data from a station a few miles from the allotment (elevation 5,980 feet, with four years of complete records) show an average annual precipitation of 30.7 inches. There was an average of 63 days with temperatures above freezing during the year and an average annual temperature of 39 degrees Fahrenheit. Extremes of temperature were 39 degrees below zero to 90 degrees above zero.

Unfortunately, climatic data were not recorded at the weather station near the College Allotment during the years previous to or immediately following 1932 when the study was initiated. In an attempt to estimate the precipitation pattern immediately preceding 1932 (Table 1), data for the five years at the weather station near the College Allotment were compared with several stations in southwestern Montana. The precipitation data of Loweth, Montana, were most nearly correlated with the station near the College Allotment.

By graphing the data for the two stations for the years 1951 through 1955 it was possible to estimate precipitation on the College Allotment for earlier years from the available Loweth record. The graph was used to estimate the precipitation for the five years (1928 through 1932) preceeding the initiation of the study. June, the month of greatest precipitation and probably the segment of the annual pre-

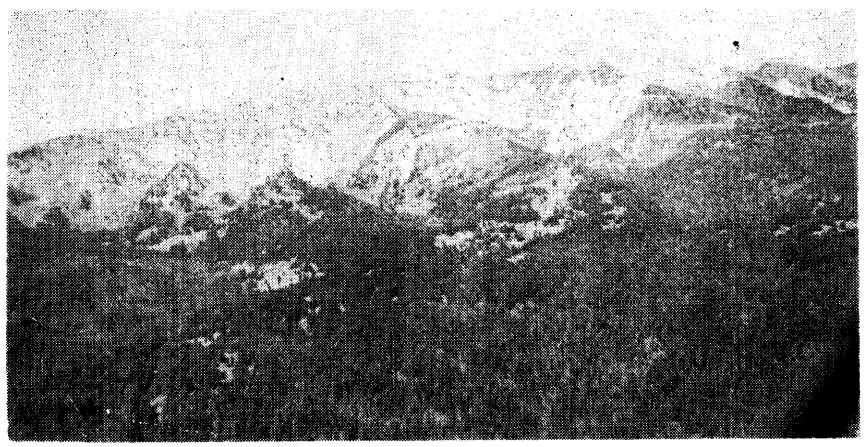

FIGURE 1. An aerial photo of the College Allotment showing the predominant timber cover and interspersed grassland. Sacajawea Peak is in the background.

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Table 1. Precipitation for the month of June at the weather station near the study area and at Loweth, Montana.

Year	College Allotment*	Loweth	Year	Loweth	Estimated College Allotment
1951	3.13	1.10	1928	3.21	6.7
1952	3.97**	1.97	1929	2.40	5.3
1953	6.49	3.10	1930	0.40	1.6
1954	7.78	3.46	1931	1.54	3.6
1955	6.29	3.02	1932	1.94	4.4
Total	27.66	12.65		9.49	21.6
Average	5.53	2.53		1.90	4.3

* Data from weather station 12 miles northeast of Bozeman or about 3 miles from the College Allotment.

** Estimated value entered in U. S. Weather Bureau records.

cipitation having the most effect on yearly plant production on the study area, was selected for the analysis. The estimated precipitation for the College Allotment for the years preceding the 1932 sampling was somewhat lower than that which occurred previous to the 1955 vegetational sampling.

Methods

In 1932 four study plots were established on the College Allotment. One of these was established at the lower edge of the allotment at about 6,100 feet, one at the upper edge at 7,500 feet, and two at intermediate elevations on the allotment (at 6,500 and 7,000 feet). All four areas were in grassland or in grass-forb types. At each location two 1/640 acre plots were clipped, dried, and the amounts of each species present determined by weight. In 1955 the same procedure was followed except that 10 plots, each containing 9.6 square feet, were clipped and species bagged separately at each location.

Exclosures made with poles and woven wire were constructed in 1932. These deteriorated over the years. To avoid effect of protection and of the scattered poles and fence, the temporary exclosures in 1955 were placed outside the old exclosures. Snow fences were used to exclude sheep from plots sampled in 1955. Samples in 1932 and 1955 were collected during the month of August. Samples were air-dried in 1932 and oven-dried in 1955. The 1955 yields were increased by 5 percent to give data more comparable with the 1932 air-dry weights.

Results and Discussion

Total yields on the three plots at lower elevations increased greatly during the 23 years but yields decreased slightly on the plot at 7,500 feet (Table 2). The plot at 7,500 feet was on relatively unstable soil, and near a spring used by the herder when the sheep were on that camp unit. Yields of the plots at 6,100 and 6,500 feet were more than twice as great in 1955 as in 1932. Total yields on the plots at 7,000 feet in 1955 were about 182 percent of the 1932 yield. A part of this increase in yield should be attributed to the more favorable moisture conditions during and preceding 1955 (Table 1). Undoubtedly much of the increase in plant production was due to the improved range management practices used during the 23 years.

Grasses increased greatly on the three plots at lower elevations during the 23 years. On the highest plot, grasses and forbs contributed about the same percentages to the total yield in both 1932 and 1955 (Fig. 2). These results indicate that vegetation at the higher elevations was a forb-grass type while that at lower elevations undoubtedly was originally grassland.

The only grass that occurred on all plots in substantial amounts was slender wheatgrass. Yields of slender wheatgrass decreased on all plots except the one at 6,500 feet elevation. Mountain brome increased on all plots except the one at 6,100 feet. On the lowest plot (6,100 feet) Kentucky bluegrass showed a marked increase over the 23 years. Idaho fescue was abundant on all plots except the plot at 7,500 feet elevation. Idaho

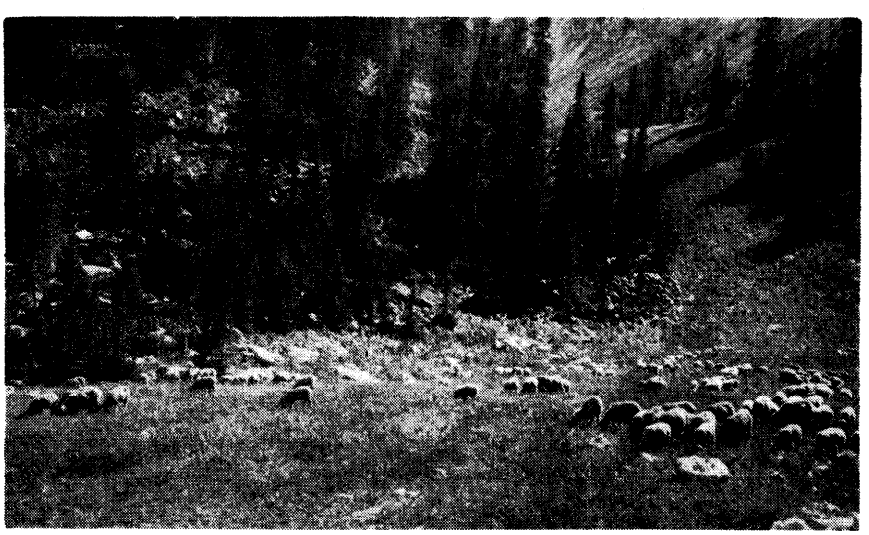

FIGURE 2. The forb-grass type at 7,500 feet, near the upper edge of the College Allotment.

Table 2. Yields in pounds per acre and botanical composition in percent based on average weights of species found on each plot.

	Plot Numbers and Elevation of Plots							
	No. 1 (6100 ft.)		No. 2 (6500 ft.)		No. 3 (7000 ft.)		No. 4 (7500 ft.)	
Grasses	1932	1955	1932	1955	1932	1955	1932	1955
	%	%	%	%	%	%	%	%
Bearded wheatgrass *(Agropyron subsecundum)*	—	T	—	1.7	—	—	—	.2
Slender wheatgrass *(Agropron trachycaulum)*	1.7	2.4	11.5	2.9	1.3	1.2	6.6	.4
Mountain brome *(Bromus marginatus)*	12.2	12.5	—	15.1	—	3.3	3.2	6.1
Sedge *(Carex* sp.)	—	.2	2.1	.4	2.6	2.4	—	—
Timber danthonia *(Danthonia intermedia)*	—	.8	—	4.3	—	—	—	—
Onespike danthonia *(Danthonia unispicata)*	—	—	—	—	11.6	—	—	—
Idaho fescue *(Festuca idahoensis)*	2.2	1.7	34.4	14.0	20.6	.6	—	—
Prairie junegrass *(Koeleria cristata)*	.3	.4	—	.3	—	—	—	—
Showy oniongrass *(Melica spectabilis)*	—	—	—	—	—	.7	3.4	6.3
Timothy *(Phleum pratense)*	—	.1	—	22.4	—	11.7	—	.2
Nevada bluegrass *(Poa nevadensis)*	—	1.3	—	—	—	—	—	—
Fowl bluegrass *(Poa palustris)*	—	—	—	.2	1.7	—	—	—
Kentucky bluegrass *(Poa pratensis)*	10.1	45.1	—	9.3	—	17.5	—	—
Subalpine needlegrass *(Stipa columbiana)*	.3	2.2	—	.8	—	.2	—	—
Others*	.6	.2	—	.3	—	—	—	—
Total grasses %	27.3	66.9	48.0	71.6	37.8	37.6	13.2	13.2
Average yields lbs./A.	244.0	438.0	460.0	1646.9	440.0	793.9	290.0	267.3
Forbs								
Western yarrow *(Achillea lanulosa)*	10.1	11.1	14.6	8.9	10.6	15.9	1.6	—
Pale agroseris *(Agroseris glauca)*	—	—	—	.2	—	1.0	—	—
Common pearleverlasting *(Anaphalis margaritacea)*	—	—	—	T	—	1.3	—	—
Lyall angelica *(Angelica lyallii)*	—	—	—	—	—	—	2.7	—
Sandwort *(Arenaria* sp.)	—	—	5.2	—	.2	—	—	—
Aster *(Aster* sp.)	1.7	2.0	—	—	.9	—	11.3	2.4
Bluebells *(Campanula rotundifolia)*	—	.2	1.0	T	—	.1	—	—
Starry cerastium *(Cerastium arvense)*	20.2	.1	4.2	—	8.6	.2	—	—
Canada thistle *(Cirsium arvense)*	—	—	—	—	—	—	—	11.1
Glia *(Collomia linearis)*	13.5	3.7	—	.2	—	1.3	—	—
Duncecap larkspur *(Delphinium occidentale)*	2.2	—	—	—	3.4	5.5	—	3.5
Northern bedstraw *(Galium boreale)*	.3	2.2	6.2	2.1	—	1.8	—	—
Richardson geranium *(Geranium richardsonii)*	—	—	—	—	—	—	—	4.6
Sticky geranium *(Geranium viscosissimum)*	9.3	3.7	9.4	7.6	20.6	14.0	5.4	1.6
Hackelia *(Hackelia cineria)*	—	—	—	—	—	—	—	4.7
Oneflower helianthella *(Helianthella uniflora)*	—	—	—	—	—	—	5.9	1.7
Rocky Mountain iris *(Iris missouriensis)*	—	—	—	—	—	1.3	—	—
Flax *(Linum* sp.)	—	1.5	—	—	—	.4	—	—
Lupine *(Lupinus* sp.)	—	—	6.8	1.9	2.6	—	—	—
Mountain bluebells *(Mertensia ciliata)*	—	—	—	—	—	2.2	9.1	7.6
Mintleaf beebalm *(Monarda menthaefolia)*	—	—	—	—	2.2	3.7	—	—
Sweetanise sweetroot *(Osmorrhiza occidentale)*	—	—	—	—	—	—	26.8	22.4
Cinquefoil *(Potentilla gracilis)*	6.7	1.1	2.1	.6	10.3	4.2	.9	.2
Douglas knotweed *(Polygonum douglasii)*	4.5	T	—	—	—	2.6	.4	.3
Niggerhead *(Rudbeckia occidentalis)*	—	—	—	—	—	3.9	18.1	19.9
Arrowleaf groundsel *(Senecio triangularis)*	—	—	—	—	—	—	1.4	3.7
Prairiesmoke sieversia *(Sieversia ciliata)*	1.1	T	—	—	1.7	T	—	—
Common dandelion *(Taraxicum officinale)*	2.6	2.5	2.1	4.9	—	T	3.2	1.1
Others*	—	1.3	.4	1.9	1.1	3.0	—	2.3
Total forbs %	72.8	29.2	52.1	28.4	62.0	62.6	86.8	86.8
Average yield lbs./A.	642.5	629.2	500.0	654.1	722.5	1321.7	1915.0	1759.6
Shrubs								
Big sagebrush *(Artemsia tridentata)*	.6	3.8	—	—	—	—	—	—
Total shrubs %	.6	3.8	—	—	—	—	—	—
Average yields lbs./A.	5.0	82.2	—	—	—	—	—	—
Average total yields lbs./plot/acre	891.5	2149.7	960.0	2301.0	1162.5	2115.6	2205.0	2026.9

* Includes species contributing less than 1 percent to any plot average: *Bromus ciliata, Danthonia californica, Phleum alpinum, Poa ampla.*

** Includes species contributing less than 1 percent to any plot average: *Arabis drummondii, Arnica sororia, Astragalus* sp., *Brodiaea grandiflora, Capsella bursa pastoris, Carum gardneri, Castelleja cervina, Epilobium angustifolium, Equisetum* sp., *Frageria virginiana, Frasera speciosa, Gaillardia aristata, Hieracleum lanatum, Hiracium gracile, Myosotis alpestris, Orthocarpus luteus, Pediluclaris* sp., *Polygonum bistortoides, Pulsatilla hirsutissima, Dodecatheon* sp., *Tragopogon pratense, Zygadenus* sp., and three unidentified forbs.

fescue was the most prominent species on the plot at 6,500 feet in 1932 but produced less of the total yield in 1955 than timothy. Prairie Junegrass was found only on the two lower plots, while showy oniongrass occurred only on the two plots at higher elevations.

The increase in timothy over the 23 years was most striking. This introduced grass was not found on the plots in 1932, but occurred on all plots in 1955. Timothy was most abundant on the plot at 6,500 feet elevation. Kentucky bluegrass, another introduced grass, occurred only on the plot at 6,100 feet in 1932, but was also present in considerable quantities on the plots at 6,500 and 7,000 feet in 1955. On the lowest plot (6,100 feet) Kentucky bluegrass showed a marked increase over the 23 years.

The total yield of forbs did not change greatly during the 23 years. There was a slight decrease on the lowest and highest plots; a slight increase on the plot at 6,500 feet, and a marked increase on the plot at 7,000 feet.

Western yarrow was abundant on all plots except the one at 7,500 feet. There was no apparent trend in the abundance of this species due to management practices. Starry cerastium, a plant listed as poor forage by the U. S. Forest Service (Heady *et al.*, 1947), decreased considerably during the 23 years of controlled management. However, Canada thistle, an introduced weed was present in appreciable quantities in 1955 on the plot at 7,500 feet, where it had not occurred in 1932. Gilia, a plant of little forage value, showed a marked decrease on the plot at 6,100 feet but increased slightly on the two plots at intermediate elevations. Tall larkspur, a plant poisonous to cattle but seldom affecting sheep, decreased at lower elevations but increased on the higher plots. Sticky geranium, a plant frequently grazed by sheep, decreased on all plots. Lupine decreased on the two plots at 6,500 feet and 7,000 feet and did not occur on the lowest and highest plots. A study by Teigen (1949) indicated that sheep show a high degree of preference for lupines of this area. Mountain bluebells, choice feed for sheep, increased slightly on the plot at 7,000 feet but decreased slightly on the plot at 7,500 feet. Cinquefoil occurred on all plots and decreased on all plots. Sheep preferentially graze cinquefoil (Teigen, 1949). Arrowleaf groundsel occurred only on the highest plot. It is considered choice sheep feed but showed a slight increase over the 23-year period. Common dandelion occurred on all plots but trends in abundance of this plant apparently were not related to grazing management or elevation.

The only shrub of importance found on the plots was big sagebrush. Its occurrence was limited to the plot at 6,100 feet. Its average yield increased from 5 pounds per acre in 1932 to 78 pounds per acre in 1955. This plot was located near the northeast corner of the College Allotment where it is grazed by sheep and by cattle from the adjacent cattle range.

Summary

Yields of species (determined by clipping and weighing separately for each plot) were determined on a mountain range near Bozeman, Montana in 1932 and in 1955. Previous to 1926 this range had been heavily grazed by sheep and cattle. In 1928 controlled use including proper stocking, open herding, one-night bed grounds, and uniform distribution of grazing, was started on the forest allotment and continued through 1955.

Yields increased greatly on the lowest plot and the two at intermediate elevations but decreased slightly on the highest of the study area. These higher areas where slopes are steep and soils are relatively unstable need careful management to bring about desired improvement in production. The data clearly show that over most of the area, forage production had increased. High precipitation in the years previous to 1955 and low precipitation in years previous to 1932 partially explain this marked increase in total yields, but some of the increase must be attributed to better management practices.

Species that increased, decreased, or invaded the range during the 23-year period are discussed.

LITERATURE CITED

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TEIGEN, M. L. 1949. Forage Preferences of range sheep. Montana State College, unpublshed M. S. thesis.

Special to the Editor:

The Secretary's office recently received 15 new student memberships and two regular memberships in one day from DR. R. MERTON LOVE of the University of California, Davis. This is one of the largest group memberships ever received at one time. Plans are underway to form a student chapter of the California Section.—*John G. Clouston, Executive Secretary*