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Rest-Rotation Grazing . . .

A New Management System for Perennial Bunchgrass Ranges

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Introduction

Following establishment of the national-forest system soon after the turn of the century, the Forest Service became directly concerned with the management of mountain rangelands. Through its forest and range experiment stations, the Forest Service has continually sought grazing methods that will improve the range and increase livestock and wildlife production.

A study carried out on the Burgess Spring Experimental Range in northeastern California during a 16-year period (1936–51), and reported here, led to the design of a rest-rotation grazing system. While the idea of incorporating rest in grazing management is not new (*2, 3, 6, 8, 9, 10, 11*),[2] the concept of longer rest periods than heretofore recommended, at least for mountain bunchgrass ranges, and of closer correlation of resting and grazing with plant growth requirements, is new. Even though the rest periods under this system are longer than heretofore recommended, they are flexible. Their length is determined by the growth requirements of the vegetation and the condition of the range. Rest-rotation grazing holds great promise of improving and maintaining perennial bunchgrass range, the principal type of range in the West, and it may be applicable to any type of range.

Rest-rotation is now being tested on the Harvey Valley cattle allotment on Lassen National Forest in northeastern California. This allotment encompasses about 25,000 acres of suitable livestock range, and it is grazed by 515 head of cattle for a 4-month summer season. The test was started in 1952 and is scheduled to run for 23 years. Results will be reported periodically as sufficient data are accumulated to allow proper evaluation. In the meantime, this publication has been prepared to describe the study on which rest-rotation grazing is based, and to present the design of the system for the benefit of those who wish to try it.

Description of Study Region

The most productive bunchgrass ranges in California are located in the northeast corner of the State. The region is mountainous and of volcanic origin. Numerous lava flows and cinder cones and a few high peaks including Mt. Lassen and Mt. Shasta top an extensive plateau that ranges from 3,500 to 8,000 feet in altitude. Interspersed among the mountains are many plains and valleys. Some of the latter are closed or poorly drained. The region is wet, cold, and snowy in the winter, and comparatively dry and warm in the summer.

[1] Mr. Talbot retired in May 1955.

[2] Italic numbers in parentheses refer to Literature Cited, p. 43.

Livestock summer ranges in this region are located mainly at altitudes above 4,000 feet. They are important to livestock producers because they furnish nutritious forage for both beef cattle and sheep during a 4- or 5-month period when vegetation at lower elevations is dry and deficient in nutritive value. Unfortunately, forage production on many of these summer ranges has been reduced by grazing and other factors. Some are now producing half or less of their potential yield of forage and livestock.

On 97 percent of the range, forage is furnished primarily by bunchgrasses and other perennial plants that depend on seed for reproduction; on less than 3 percent, it is furnished by species that reproduce or spread vegetatively rather than from seed. The principal problems of grazing management in the region therefore center around the bunchgrasses.

Of eight cover types, the grassland, sagebrush, juniper, and pine types (fig. 1) occupy 63 percent of the total area and furnish most of the forage used by the livestock:

Type	*Percent of area*
Pine-fir	28
Pine	25
Juniper	20
Sagebrush	15
Shrubs [1]	5
Grassland	3
Barren or rock	3
Broad-leaved trees [2]	1

[1] Antelope bitterbrush, Sierra evergreenchinkapin, curlleaf mountain mahogany, greenleaf manzanita, snowbrush ceanothus.

[2] Quaking aspen, alder, oak, willow.

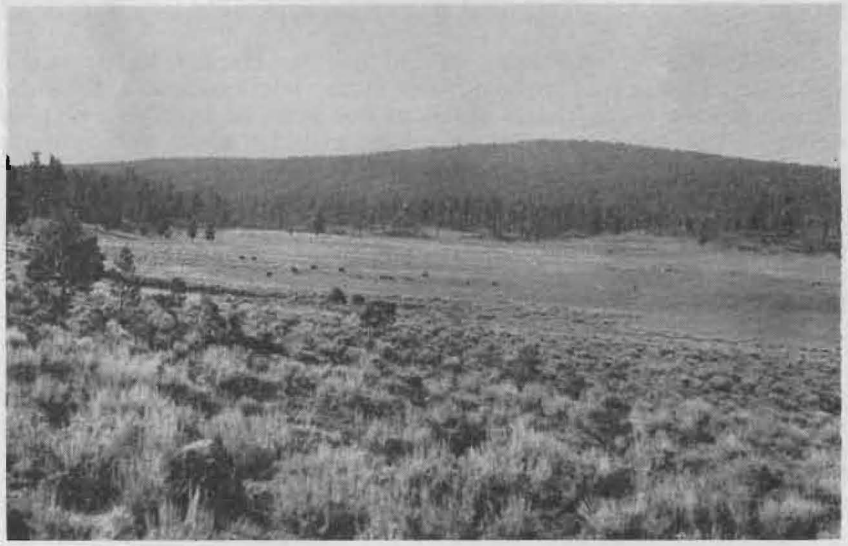

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FIGURE 1.—Northeastern California mountain summer ranges support a composite of types—usually grasslands in valley bottoms, big sagebrush on surrounding gentle slopes, and open pine timber on the mountainsides.

The pine-fir type usually has little grazing value, because not much herbage grows in the understory. The shrub type is composed mainly of manzanita, snowbrush, and chinkapin. This type too has little grazing value for livestock. Because the acreage of the broad-leaved tree type is small, its contribution to the grazing capacity of most ranges is negligible.

Grassland Type

Wet Meadow Sites

Wet meadow sites have the highest grazing capacity per acre of any in the grassland type (fig. 2, *A*). They are kept moist nearly all summer by fresh moving water from springs or streams. In good condition they yield between 1,500 and 2,800 pounds of dry herbage per acre. From 0.5 to 1.0 acre is often sufficient to carry a cow or four or more sheep for 1 month. Meadows are usually heavily grazed, and consequently on many areas the vegetation has been thinned and changed in composition and the soils eroded (fig. 2, *B*).

Plant species on sites in good condition include tufted hairgrass, Nevada bluegrass, Kentucky bluegrass, thin bentgrass, mat muhly, chamisso sedge, silver sedge, Oregon checkermallow, northwest cinquefoil, and longstalk clover. Species commonly growing on deteriorated sites are biscuitroot, plantainleaf buttercup, western buttercup, low pussytoes, aster, water groundsel, cluster tarweed, common camas, and shrubs such as big sagebrush, black sagebrush, and silver sagebrush.

Wet meadow soils usually consist of brown or gray alluvial loams and clay loams. They lie on impervious unrelated substrata and vary from 17 to 60 inches deep.

Closed Basin Sites

Many valleys in northeastern California lack drainage. Water stands up to 36 inches deep on the soil surface of these sites for several weeks in the spring, and sometimes they may be inundated throughout the summer. The vegetation consists mainly of dense stands of rhizome-forming species: common spikesedge, silver sedge, wire rush, common arrowhead, and hoaryleaf arnica. Soils vary from 36 to 60 inches deep and are dark gray alluvial loams, clay loams, and clays that lie on impervious unrelated substrata.

These sites are grazed moderately to heavily by cattle, but they remain in relatively good condition because of the strong regenerative habit of the plant species. From 1 to 3 or 4 acres are usually sufficient to carry a cow for 1 month. Many of these sites could be improved for grazing by better drainage.

Drained Basin Sites

Drained basin sites are similar to the closed basin sites, except that they have some drainage. Here desirable bunchgrasses, such as tufted hairgrass, Nevada bluegrass, meadow barley, and bottlebrush squirreltail, grow together with sod species. In many places grazing has reduced or killed these grasses and decreased forage production. Silver sagebrush often invades deteriorated parts of these sites (fig. 3). Grazing capacity is about the same as that of closed basin sites.

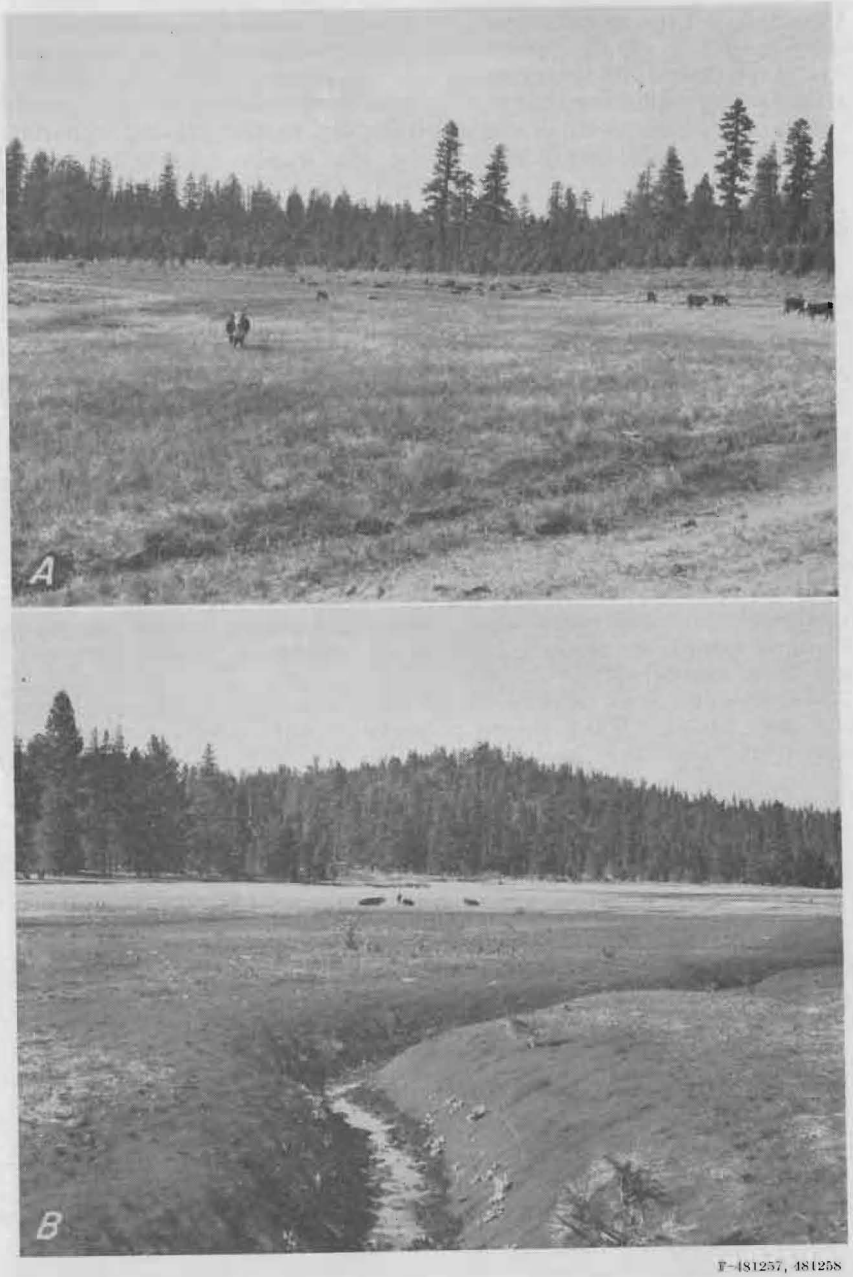

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FIGURE 2.—*A*, The wet meadow is the most productive of the sites in the grassland type, and it is especially valuable for cattle grazing. *B*, A wet meadow site where the vegetation has been greatly thinned and gully erosion started as a result of continuous close grazing by livestock.

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FIGURE 3.—A deteriorated, drained basin site that has been invaded by silver sagebrush. Wire rush and common spikesedge make up most of the cover in the shrub interspaces, but a light stand of desirable and previously more abundant forage species—including Nevada bluegrass and bottlebrush squirreltail—still grows under the protecting shrub crowns.

Terrace Sites

Dense stands of shorthair sedge cover some of the terraces and low benchlands in the region. These stands include some Idaho fescue and Sandberg bluegrass. Shorthair sedge in this region is not particularly palatable to cattle and dries early in the season, so it is not very desirable as a forage species.

Grazing capacity is generally between 4 and 6 acres per cow month. Heavy grazing in the past depleted the stands of shorthair sedge in many places, and areas were left bare or have been invaded by even less desirable species (fig. 4).

Soils on terrace sites generally consist of brown or dark gravelly or stony loams and clay loams which are usually underlain by an impervious clay pan or concretion layer. These soils vary in depth from 12 to 35 inches. They are wet in spring, but they dry out rapidly in summer because of shallowness.

Sagebrush Type

Silver sagebrush, black sagebrush, and big sagebrush grow widely on summer ranges in northeastern California. Silver sagebrush is generally found on poorly drained bottom-land sites (fig. 3). Black sagebrush occupies somewhat better drained, shallower, lighter soils (fig. 5). Big sagebrush, on the other hand, grows on well-drained upland sites (fig. 1).

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FIGURE 4.—A deteriorating shorthair sedge stand. Here tarweed and other inferior annuals have invaded areas of exposed soil. Plantainleaf buttercup is frequently found on such eroded sites.

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FIGURE 5.—Black sagebrush is usually found on shallow soils with impaired drainage in the transition zone between the wetter bottom land and open timber on the mountainsides.

Desirable forage species commonly associated with silver sagebrush are Nevada bluegrass and bottlebrush squirreltail. Sandberg bluegrass, bottlebrush squirreltail, and prairie junegrass are prominent in the black sagebrush stands. Species commonly associated with big sagebrush are Idaho fescue, bottlebrush squirreltail, western needlegrass, woolly wyethia, arrowleaf balsamroot, rabbitbrush goldenweed, and antelope bitterbrush.

This type is grazed closely by cattle where water is available. Its grazing capacity is between 3 and 8 acres per cow month, depending on the condition and productivity of the site.

Juniper Type

Altitudinally, the juniper type lies between the sagebrush and pine types. Western juniper, which characterizes the type, usually grows with black sagebrush and big sagebrush. Where water is available for livestock, the type is utilized closely. Its grazing capacity is between 5 and 10 acres per cow month.

Pine Type

The pine type consists mainly of ponderosa and Jeffrey pines. Locally, white fir, California red fir, and incense-cedar are associated species. Typically, the pine forest is relatively open (fig. 6), and it supports considerable herbaceous vegetation of high grazing value in the understory.

Some of the more abundant forage species are Idaho fescue, bottlebrush squirreltail, western needlegrass, Elmer needlegrass, Lemmon needlegrass, Sandberg bluegrass, Ross sedge, woolly wyethia, longspur

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FIGURE 6.—Characteristic open structure of the pine forest. Idaho fescue is usually prominent in the understory.

lupine, and antelope bitterbrush. Squawcarpet ceanothus and big sagebrush, both inferior grazing species, are prominent in the type in many places.

Grazing capacity of the type generally increases after the timber is logged. The openings that are created usually thicken up with forage plants for a period of years before timber growth takes over. Such openings also make the type more accessible to grazing. The grazing capacity of the virgin pine type is 12 acres or more per cow month, whereas the capacity of the cutover type is 8 acres or more per cow month.

The type generally occupies well-drained, reddish-brown stony and sandy loams derived from underlying lava rock. These soils vary from 6 to 60 inches deep.

Most of the pine type occupies timber sites III and IV, measured on a scale in which site I is the best and site V the poorest. Dominant trees on site III reach an average height of 125 feet, and those on site IV 100 feet, at 300 years of age. The yield of merchantable timber from site III averages about 13,000 board feet per acre; from site IV, about 7,000.

Experimental Layout and Studies

The studies were carried out on the Burgess Spring Experimental Range in Lassen County approximately 40 miles northwest of Susanville. Cattle were grazed in three fenced units (fig. 7); one unit was on a representative area of cutover pine type, and two were on a representative area of grassland type. The timber unit stretches across the lower southeast slopes of Harvey Mountain. The grassland units are in Squaw Valley, a small drainage basin that joins the timber unit at the southeast corner.

The timber unit was logged with tractors in 1934, and about 80 percent of the merchantable trees, mainly ponderosa and Jeffrey pine, were cut. About 24 percent of the area remained covered by trees 16 inches and larger in diameter, and 28 percent by pole-size and smaller reproduction. Nearly half (48 percent) of the area is made up of natural openings and openings created by logging. The grassland units encompass wet meadow, closed basin, drained basin, and terrace grassland sites.

Data were collected on the character and growth of the vegetation, the response of the vegetation to both grazing and clipping, the weather, and the grazing habits and weight responses of the cattle for the main purpose of getting as clear a picture as possible of how bunchgrass ranges are affected by grazing.

Vegetation Records

Growth and development were measured on staked plants of some of the more abundant species in both timber and grassland types. Also, at the end of each grazing season ocular estimates were made of the grazing use of these species in both types.

The effect of cattle grazing on the vegetation was measured only in the timber type. Changes in numbers of plants of important forage species were recorded on 855 one-fourth-milacre quadrats laid out in a grid over the experimental unit. The quadrats were spaced 2.5 chains apart. Every other one was protected from grazing by

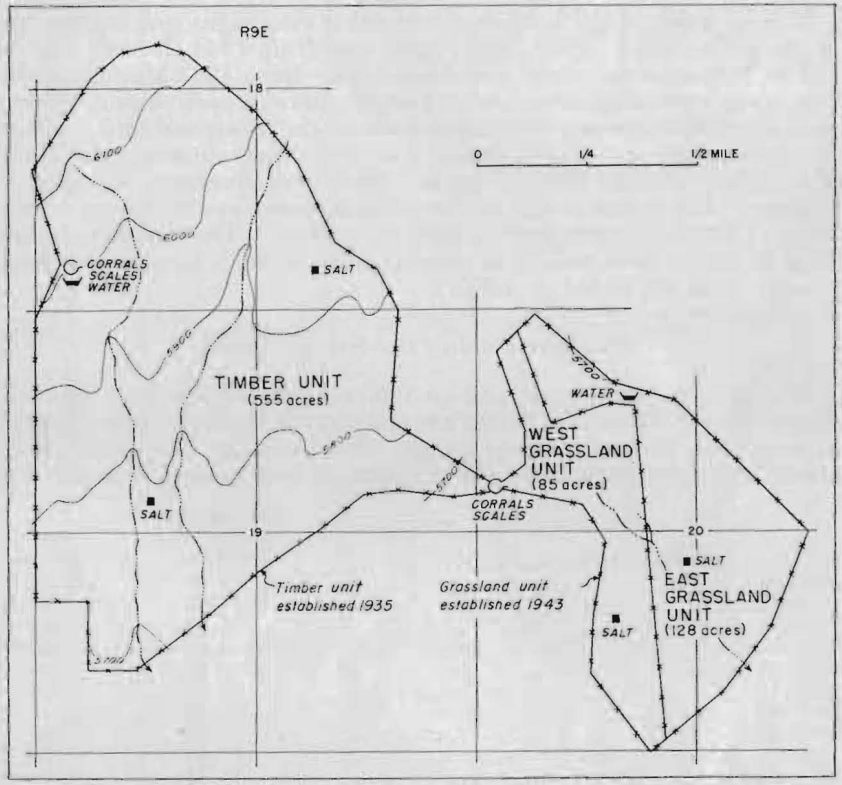

FIGURE 7.—Experimental units at the Burgess Spring Experimental Range.

a rod-square, 4-strand barbed-wire exclosure. The effect of grazing was determined by comparing vegetation changes on quadrats located inside and outside these exclosures.

The amount of vegetation on quadrats was recorded in terms of numbers of large and small plants, and fascicles. These plant units were defined as follows: large plant—basal area 1 square inch or more; small plant—basal area less than 1 square inch; fascicle—a group of leaves or leaves and flower stalks that originate from a single bud. A fascicle rather than the entire plant was used for species such as woolly wyethia and longspur lupine.

Yield of herbage of forage species in the units was determined by clipping and by direct estimation. The reaction of Idaho fescue, bottlebrush squirreltail, longspur lupine, and woolly wyethia to clipping was studied to help interpret the effects of livestock grazing on the vegetation.

Livestock Grazing and Weight Records

For 3 years, 1936–38, records were made of the way cattle grazed the vegetation in the timber type. Selected, individual animals were followed on foot during daylight hours for 2 or 3 days each week, and records were made of the number of bites taken of the various plant species.

Weight gains of cattle were measured during eight grazing seasons in the timber type—1936, 1937, 1938, and from 1944 through 1948—and in five seasons in the grassland type—from 1944 through 1948. The cattle were weighed at about 2-week intervals each season. They were corralled between 4 and 6 o'clock in the afternoon and weighed the next morning between 7 and 9 o'clock after an overnight stand of 15 hours without food or water. This procedure was followed to minimize differences in fill in the animals from one weighing to the next. Different cattle were grazed each year. The number, breed, class of cattle, and season of grazing used in each fenced unit from 1936 to 1948 are shown in table 1.

Weather During the Study Period

Precipitation, snowpack, and air-temperature records were obtained at the Blacks Mountain Experimental Forest headquarters 12 miles west of the Burgess Spring range. Precipitation for a 12-month season averaged 18.06 inches during the 19-year period 1935–54:

Season (Sept. 1–Aug. 31)	*Total seasonal precipitation (inches)*	*Percent of average*
1935–36	16. 50	91
1936–37	14. 32	79
1937–38	29. 24	162
1938–39	9. 09	50
1939–40	18. 91	105
1840–41	21. 28	118
1941–42	20. 13	111
1942–43	16. 26	90
1943–44	13. 69	76
1944–45	17. 35	96
1945–46	15. 42	85
1946–47	13. 18	73
1947–48	23. 95	133
1948–49	16. 37	91
1949–50	17. 28	96
1950–51	19. 30	107
1951–52	24. 86	138
1952–53	19. 94	110
1953–54	16. 06	84
Average	18. 06	100

On the average, 74 percent of the total seasonal precipitation occurred during the 6 months from October 1 to April 1, mainly as snow. Twenty-one percent (3.82 inches) fell during the active growing season, April 1 through June. Only 5 percent fell during July, August, and September (fig. 8).

The lowest seasonal precipitation was 9.09 inches in 1939, and the highest 29.24 inches in 1938. Winter snowpack averaged about 1.5 feet deep, with a maximum pack of 6 feet in 1951. The coldest and wettest period during the year was from January through March; the warmest and driest, from July through September.

Average daily air temperatures were below freezing from early December until mid-March, and up to 61° F. in July. The lowest temperature recorded was −27° in January 1937; the highest, 98° in July 1946.

TABLE 1.—*Number, class and breed of cattle, and season of grazing, the Burgess Spring Experimental Range, 1936–48*

Year [1]	Season of grazing: Period	Season of grazing: Days	Unit grazed	Class and breed of cattle	Head	Age	Weight at beginning of season
		No.			*No.*	*Years*	*Pounds*
1936	June 19–Sept. 25	98	Timber	Steers:			
				Hereford	5	----	----
				Shorthorn	5	----	----
				Angus	5	----	----
					15	2	713
1937	June 14–Oct. 3	111	do	Steers, Hereford	4	1	----
				do	4	2	----
				Heifers, Hereford	4	1	----
				Dry cows, Hereford	4	3	----
					16	----	574
1938	June 24–Sept. 23	91	do	Steers, Hereford	30	2.5	870
1939	Aug. 10–Sept. 21	42	do	Cows, Hereford	14	3	1, 057
1943	July 9–Sept. 28	81	Timber	Heifers, Hereford	9	1	567
			East Grassland	do	8	1	585
1944	June 2–Oct. 31	151	Timber	do	10	1	443
			West Grassland	do	9	1	443
1945	May 23–Oct. 26	156	Timber	do	14	1	450
			East Grassland	do	15	1	446
1946	May 12–Oct. 17	158	Timber	do	12	1	390
			West Grassland	do	12	1	385
1947	May 7–Oct. 20	166	Timber	do	9	1	380
			East Grassland	do	9	1	380
1948	June 9–Oct. 10	123	Timber	do	9	1	444
			West Grassland	do	9	1	448

[1] 1940–42, no livestock grazed.

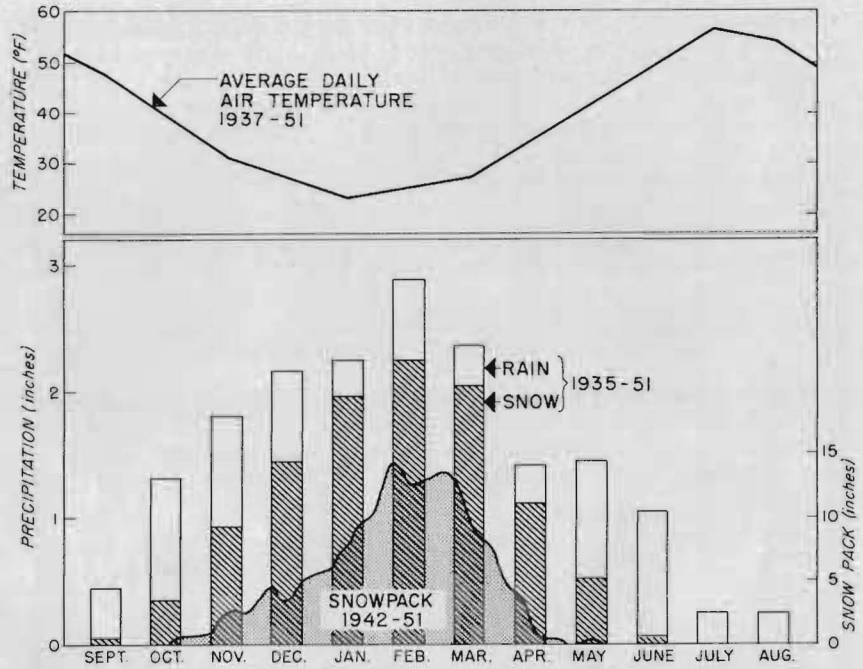

FIGURE 8.—Precipitation and temperature at the Blacks Mountain Experimental Forest headquarters.

A comparison of the record at the Blacks Mountain headquarters with a longtime record at Susanville, which is located 40 miles to the southeast, indicates that approximate extremes in precipitation were experienced during the study period.

Growth and Development of Vegetation

Timber Type

The average seasonal development of herbaceous vegetation in the timber type can be illustrated with Idaho fescue. Growth began about April 1 immediately after the winter snowpack melted, and ended about 120 days later in early August when seed ripened (fig. 9). This growth was sustained mainly by moisture accumulated in the soil up to the start of growth.

Flower stalks started to show above the basal leaves of the plants near the end of May. Half the total seasonal yield of herbage was produced by this time. The plants grew rapidly during the next 4 weeks. They flowered and reached full height early in July. Maximum herbage yield occurred at seed-ripening time about a month later.

The plants started to lose moisture and greenness in June, a little before flowering time. They dried rapidly during the first half of August. By October, both greenness and moisture content reached a minimum. In drying, the plants lost weight because of disintegration of leaves and stems and shedding of seed. Idaho fescue lost about 20 percent of its maximum weight by October 1.

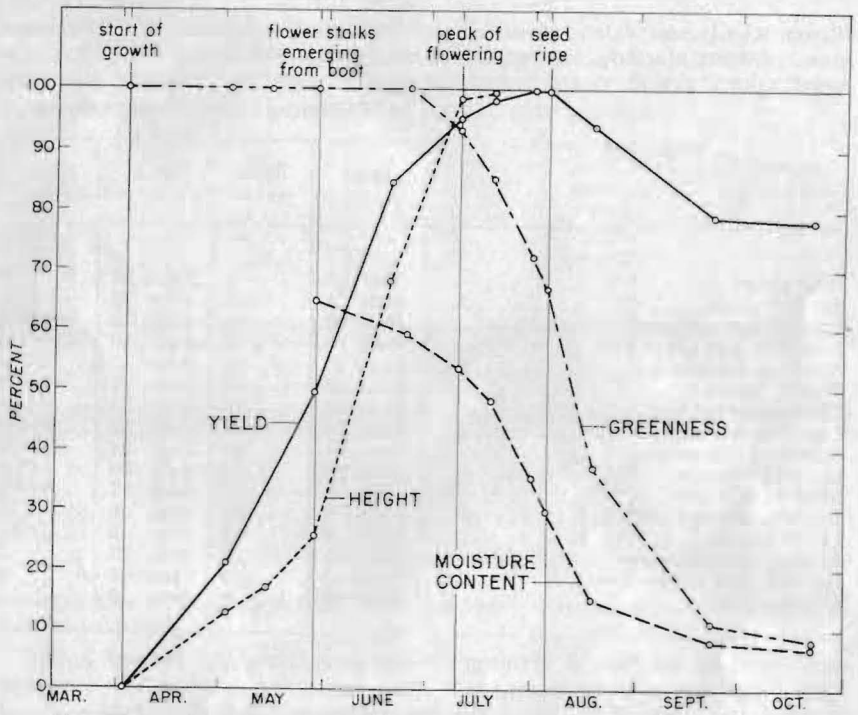

FIGURE 9.—Average seasonal growth and development of Idaho fescue.

Species Differences

The various plant species developed at different rates during the season. For example, Ross sedge flowered about May 15 and ripened seed about June 24 (table 2). Big sagebrush, on the other hand, flowered about September 8 and ripened seed about October 6.

Cheatgrass brome, an annual, and Sandberg bluegrass, a perennial, dried in July, whereas Ross sedge, Idaho fescue, and woolly wyethia dried about a month later. The first two species dried completely, but the latter three retained some greenness even at the end of the summer. Antelope bitterbrush dried during September and October. Big sagebrush remained green throughout the year.

Yearly Differences

The growth and development of individual species and of the vegetation as a whole also varied from year to year. For example, start of growth of Idaho fescue varied as much as 33 days in successive years from 1936 to 1951; date of the flower-stalk-emerging stage varied 25 days; flowering, 25 days; and seed ripening, 19 days (fig. 10).

Herbage production of the principal forage species varied also. In 1938, the best growth year, it was estimated to be about three times greater than in 1939, the poorest year. In 1938, it was 43 percent above average, and in 1939, 51 percent below average.

Flower-stalk production varied more than herbage production. In Idaho fescue, for example, an average of only 0.7 of a flower stalk was produced per plant in 1949 on a measured series of 10 plants. In 1951, 106 flower stalks were produced per plant in the same series.

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TABLE 2.—*Average date of flowering and seed ripening of some abundant plant species, pine type, the Burgess Spring Experimental Range, 1936–54*

Species	Flowering		Seed ripening	
	Date	Basis, years	Date	Basis, years
		No.		*No.*
Ross sedge	May 15	5	June 24	7
Slender phlox	June 1	3	July 2	2
Littleflower collinsia	June 2	2	July 2	2
Lambstongue groundsel	June 6	4	July 10	4
Antelope bitterbrush	June 10	12	Aug. 5	5
Woolly wyethia	June 18	13	Aug. 1	6
Cheatgrass brome	June 19	10	July 24	8
Lemmon needlegrass	June 19	9	July 23	8
Sandberg bluegrass	June 21	10	July 24	7
Longspur lupine	June 25	14	July 29	6
Mountain brome	July 3	5	Aug. 7	5
Bottlebrush squirreltail	July 4	12	Aug. 6	6
Idaho fescue	July 9	13	Aug. 5	11
Flatpod groundsmoke	July 11	3	Aug. 27	2
Rabbitbrush goldenweed	Sept. 5	12	Oct. 5	6
Big sagebrush	Sept. 8	8	Oct. 6	4

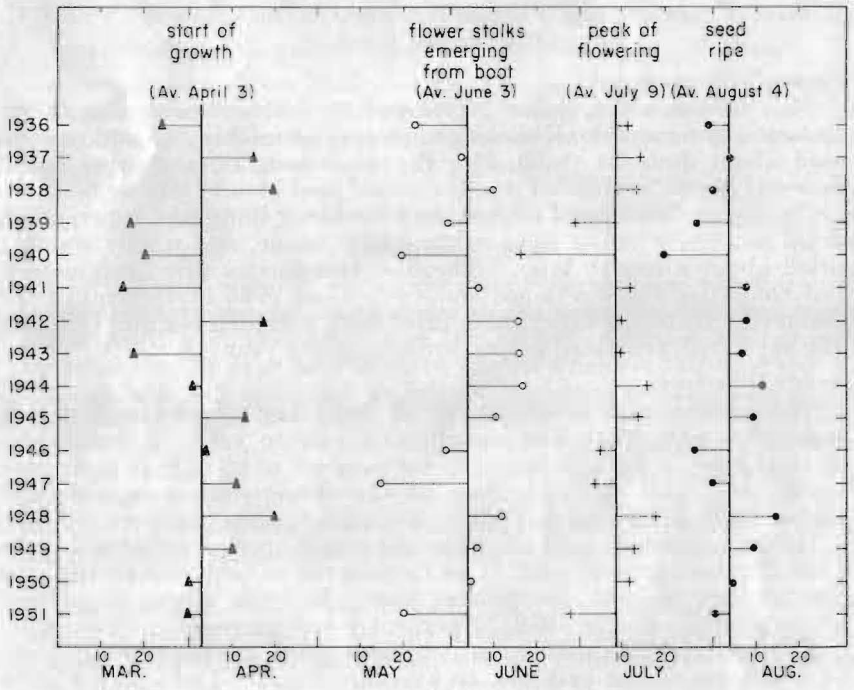

FIGURE 10.—Yearly variations in four main plant-growth stages, Idaho fescue, 1936–51.

Growing conditions that resulted in numerous flower stalks in one species did not necessarily result in a large number in other species. In some years when Idaho fescue produced many flower stalks, longspur lupine produced only few or a moderate number.

Year	*Forage production per acre* [1] *(pounds)*	*Percent of average*
1936	343	104
1937	290	88
1938	472	143
1939	162	49
1940	399	121
1941	472	143
1942	399	121
1943	218	66
1944	327	99
1945	343	104
1946	182	55
1947	290	88
1948	452	137
1949	198	60
1950	290	88
1951	436	132
Average	330	100

[1] Measured by clipping in 1936, 1947, and 1948. Estimated in other years from field observations.

Some species produced seed more regularly from year to year than others. Western needlegrass and cheatgrass brome produced seed most consistently, followed in approximate order by bottlebrush squirreltail, mountain brome, Idaho fescue, Lemmon needlegrass, Sandberg bluegrass, longspur lupine, Ross sedge, antelope bitterbrush, and woolly wyethia. Drying of the soil early in the season, or freezing temperatures at flowering time, reduced or prevented seed formation in some species in some years.

Grassland Type

Vegetation development in the grassland type followed the same general trend as that in the timber type. The vegetation grew more slowly in the grassland for a time after growth started, probably because the site was colder, but, judging by the date of flowering, some species developed early in the season (table 3). Therefore an appreciable amount of herbage of high nutritive value became available for grazing earlier in the season in the grassland type than in the timber type. This is reflected in the higher rate of weight gains made by cattle in the grassland type than in the timber type early in the season.

Herbage production in the grassland type was estimated to be five or six times greater in good growth years than in poor ones. This variation is about twice as great as that in the timber type.

How the Vegetation Was Grazed

In both the timber and grassland types, cattle grazed certain plant species and certain areas more consistently and more closely than others, resulting in very uneven utilization of the range. Though complex, the pattern of use was similar from season to season. Some species and some parts of the range were grazed closely and others

lightly each season even under light or moderate stocking of the range as a whole.

TABLE 3.—*Average date of flowering of some abundant plant species, grassland type, the Burgess Spring Experimental Range, 1944–52*

Species	Date	Basis, years
		No.
Shorthair sedge	May 9	5
Plantainleaf buttercup	May 15	7
Biscuitroot	May 30	7
Longstalk clover	June 6	8
Nebraska sedge	June 9	5
American bistort	June 12	7
Sandberg bluegrass	June 17	4
Wire rush	June 19	5
Water groundsel	June 21	8
Hairy California danthonia	June 24	2
Meadow barley	June 30	2
Northwest cinquefoil	July 1	8
Low pussytoes	July 6	4
Nevada bluegrass	July 11	9
Mat muhly	July 12	5
Aster	July 18	2
Tufted hairgrass	July 20	4
Oregon checkermallow	July 24	8
Black sagebrush	Aug. 1	6
Silver sagebrush	Sept. 9	5

Utilization in Timber Type

Species

Practically every one of the 100 or more plant species in the timber type was grazed to some extent at one time or another during any given season. Twelve species supplied 95 percent of herbage taken by the cattle (table 4). Grasses supplied 61 percent, forbs 27 percent, and shrubs 12 percent.

Twenty-nine percent of the total herbage eaten during the average season consisted of Idaho fescue. This species ranked first, second, or third in daily herbage volume eaten during the season. Bottlebrush squirreltail ranked second to Idaho fescue in volume grazed. Together, these two species made up 42 percent of the diet of the cattle during the season.

Of the abundant species, six were grazed more consistently throughout the season than the others (table 5). These were Idaho fescue, bottlebrush squirreltail, mountain brome, woolly wyethia, longspur lupine, and antelope bitterbrush.

Squawcarpet ceanothus, big sagebrush, greenleaf manzanita, and many forbs, such as flatpod groundsmoke, tapertip hawksbeard, and barestem eriogonum, were grazed but contributed comparatively little forage. Little flower collinsia and slender phlox, both annuals, were not grazed at all.

The degree of use of a species was affected by its abundance and distribution as well as by other factors. For example, cheatgrass brome, considered much less palatable than Idaho fescue, was utilized more heavily than Idaho fescue by the end of the season, probably because cheatgrass brome occurred in small amounts on the range and grew around a stock watering place where it was readily available to

the cattle. Antelope bitterbrush, mountain brome, and longspur lupine were also grazed more heavily than Idaho fescue, apparently because they occurred in smaller amounts on the range. For example, antelope bitterbrush, because of limited abundance, was utilized almost completely by midseason.

Most species were grazed more heavily at one time of the season than another, because of changes in palatability as the plants developed. Longspur lupine was not grazed at all until about flowering time. Thereafter, the entire plant was grazed heavily until it dried. Rabbitbrush goldenweed, too, was not grazed until flowering time, and then mainly flower stalks were taken. Woolly wyethia was grazed lightly during early growth and somewhat more heavily after the plants started to dry.

TABLE 4.—*Average production and utilization of forage species per acre in timber unit, the Burgess Spring Experimental Range, 1936–38 and 1944–48*

Species	Production [1]		Utilization		Proportion of diet
	Pounds	*Percent*	*Pounds*	*Percent*	*Percent*
Grasses and sedges:					
Idaho fescue	77.6	24	23.1	30	29
Bottlebrush squirreltail	34.0	11	10.0	29	13
Needlegrasses	12.1	4	3.7	31	5
Sandberg bluegrass	6.5	2	2.3	35	3
Ross sedge	9.5	3	2.6	27	3
Mountain brome	5.4	2	3.0	56	4
Cheatgrass brome	5.0	1	3.4	68	4
Others	(2)	(2)	0	0	0
Total	150.1	47	48.1		61
Average				32	
Forbs:					
Woolly wyethia	103.6	32	9.3	9	12
Longspur lupine	24.0	8	8.1	34	10
Arrowleaf balsamroot	3.7	1	.7	19	1
Others	22.9	7	3.4	15	4
Total	154.2	48	21.5		27
Average				14	
Shrubs:					
Antelope bitterbrush	10.0	3	8.9	89	11
Rabbitbrush goldenweed	2.6	1	.2	8	(2)
Others	2.1	1	.3	14	1
Total	14.7	5	9.4		12
Average				64	
Total, all species	319.0	100	79.0		100
Average, all species				25	

[1] Based on air-dry weight of herbage above a stubble height of 1½ inches for grasses and forbs, and on twig growth of current season for shrubs. Production was determined from clippings in 1936, 1947, and 1948, and from estimates in the other years.

[2] Trace.

TABLE 5.—*Estimated daily and seasonal use of specified plants by cattle in timber unit, the Burgess Spring Experimental Range, 1936–38* [1]

Species and degree of stocking	Species composition	Proportion of species in daily diet during 2-week period— June 18 to July 6	July 7 to July 21	July 22 to Aug. 5	Aug. 6 to Aug. 20	Aug. 21 to Sept. 4	Sept. 5 to Sept. 19	Sept. 20 to Sept. 30	Utilization at end of grazing season [2]
Grasses and sedges	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*
Idaho fescue	19.2								
Light stocking		5	21	7	8	22	50	59	5
Moderate stocking		15	10	9	10	39	61	78	11
Heavy stocking		(3)	39	27	23	26	38	(3)	30
Bottlebrush squirreltail	3.0								
Light stocking		11	4	4	3	8	13	15	9
Moderate stocking		46	11	6	7	13	12	2	16
Heavy stocking		(3)	6	9	18	16	12	(3)	31
Needlegrasses	2.7								
Light stocking		2	2	1	(4)	(4)	1	(4)	7
Moderate stocking		1	3	3	4	4	3	2	13
Heavy stocking		(3)	3	3	2	2	0	(3)	18
Sandberg bluegrass	1.1								
Light stocking		1	1	(4)	(4)	4	1	0	6
Moderate stocking		(4)	1	1	0	1	(4)	(4)	26
Heavy stocking		(3)	1	1	0	0	0	(3)	34
Ross sedge	1.0								
Light stocking		18	9	2	3	2	1	3	1
Moderate stocking		2	3	1	(4)	1	2	4	13
Heavy stocking		(3)	10	6	8	7	4	(3)	38
Cheatgrass brome	.7								
Light stocking		0	0	11	21	4	0	0	70
Moderate stocking		0	2	(4)	4	5	1	0	65
Heavy stocking		(3)	0	0	(4)	0	4	(3)	60
Mountain brome	.2								
Light stocking		12	7	2	3	5	6	6	9
Moderate stocking		6	11	1	17	5	2	0	45
Heavy stocking		(3)	(4)	(4)	13	13	5	(3)	45
Other [4]	.1								
Total	28.0								
Forbs									
Wooly wyethia	17.6								
Light stocking		0	1	(4)	1	6	6	9	1
Moderate stocking		4	(4)	(4)	4	11	4	3	1
Heavy stocking		(3)	12	8	7	14	17	(3)	5
Longspur lupine	5.2								
Light stocking		0	1	41	36	25	4	(4)	18
Moderate stocking		0	4	42	41	17	8	(4)	36
Heavy stocking		(3)	6	24	17	11	4	(3)	50
Arrowleaf balsamroot	.7								
Light stocking		3	7	1	0	1	1	0	7
Moderate stocking		1	2	3	1	(4)	1	(4)	16
Heavy stocking		(3)	3	4	2	(4)	2	(3)	12
Other [4]	5.9								
Total	29.4								
Shrubs									
Squawcarpet ceanothus	34.6								
Light stocking		0	0	0	0	0	0	2	(4)
Moderate		0	2	2	2	1	(4)	(4)	(4)
Heavy stocking		(3)	1	(4)	3	3	11	(4)	(4)
Big sagebrush	3.9								
Light stocking		0	0	0	0	(4)	1	0	(4)
Moderate stocking		0	0	0	0	0	(4)	0	(4)
Heavy stocking		(3)	0	0	0	0	(4)	(3)	(3)
Antelope bitterbrush	1.5								
Light stocking		0	21	15	15	8	6	(4)	90
Moderate stocking		2	32	18	2	1	2	4	89
Heavy stocking		(3)	13	8	1	(4)	0	(3)	87
Greenleaf manzanita	.9								
Light stocking		0	0	8	1	2	0	3	2
Moderate stocking		0	1	(4)	(4)	0	0	0	1
Heavy stocking		(3)	(4)	(4)	(4)	(4)	(4)	(3)	1
Rabbitbrush goldenweed	.7								
Light stocking		0	0	0	(4)	3	5	1	5
Moderate stocking		0	0	0	0	(4)	1	6	3
Heavy stocking		(3)	0	0	0	4	0	(3)	2
Other [4]	1.0								
Total	42.6								
All species	100.0								
Light stocking									12
Moderate stocking									15
Heavy stocking									26

[1] Light stocking in 1936; moderate in 1937; heavy in 1938.
[2] Estimates based on ocular inspection of pasture. In grasses and forbs, percentage use based on herbage removed above a 1.5-inch stubble, and in shrubs on use of current year's twig growth.
[3] Pasture grazed for only part of period. Use record inadequate.

Areas

Some areas in the timber unit were consistently grazed closely, some moderately, and some lightly or not ar all. Vegetation was grazed more closely in timber openings than under crowns of trees even though the composition and amount of vegetation on these sites did not differ greatly. When use of Idaho fescue in timber openings averaged 45 percent, use under large trees was only 12 percent, and in tree thickets less than 5 percent. One timber opening located away from the direct influence of fences, water, and salt was grazed completely after only 6 weeks, although utilization of the timber unit as a whole was very light (fig. 11).

The area of light use under large trees coincided with the area on which pine needles fell. A similar utilization pattern has been reported for the pine type in northern Arizona (*4*). At Burgess Spring, plants laden with pine needles were avoided by cattle most of the time. Heaviest accumulations of needles were in the basal leaves of grasses, especially Idaho fescue. Broad-leaved species, such as woolly wyethia and longspur lupine which held fewer needles, were grazed more fully. Heavy stocking, as in 1938, failed to force appreciably heavier use under trees.

Utilization was by no means uniform from plant to plant even in one species. For example, in 1947 about 43 percent of the herbage of Idaho fescue in timber openings was utilized by the end of the grazing season. At this time the remaining stubble and ungrazed growth averaged about 4 inches high. The average height of ungrazed plants was 17 inches. But averages do not tell the whole story. Forty percent of the stand was grazed to a 1-inch stubble, 29 percent to a 2-inch stubble, 13 percent to a 3-inch stubble, and 3 percent to a 4-inch or taller stubble. Fifteen percent of the stand was not grazed at all.

Different parts of the range were grazed one after another in about the same order during the season from year to year. Ravine bottoms were usually grazed first. Next in order were openings in timber stands on gentle slopes, areas near water, areas along fences and ridgetops, salt grounds, accessible openings in timber on steeper slopes, areas under large trees, and finally areas covered by tree thickets.

In cattle grazing studies on ponderosa pine-bunchgrass ranges in Colorado, Johnson (*7*) found that "Under all grazing intensities, irregular patterns of use developed. Even in the lightly grazed pastures, areas of moderate and heavy grazing occurred." Woolfolk (*15*), working with sheep in range pastures on comparatively gentle terrain in the northern Great Plains, reported that "The important forage plants were grazed to a low stubble height in all pastures, even though more range acreage and forage were available for each sheep under conservative and light stocking than under heavy stocking."

Utilization in Grassland Type

In the grassland type, as in the timber type, plant species and areas were selectively grazed. The principal species eaten were rushes, sedges, Nevada bluegrass, Sandberg bluegrass, aster, mat muhly, hairy California danthonia, bottlebrush squirreltail, and black sagebrush (table 6). Species that were eaten lightly, apparently because thay were relatively unpalatable, included biscuitroot, plantainleaf buttercup, American bistort, and big sagebrush.

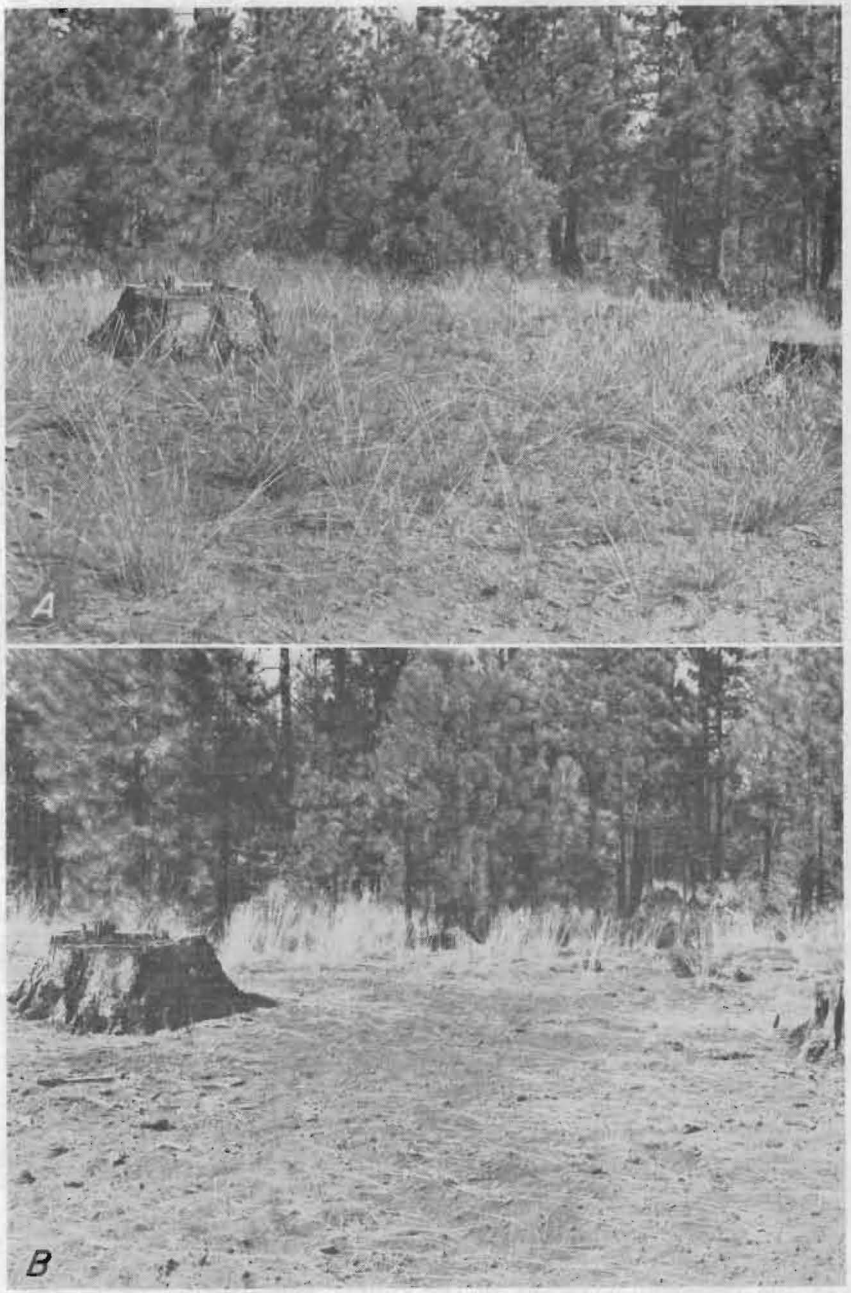

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FIGURE 11.—*A*, An ungrazed stand of western needlegrass on a favored grazing site in the timber unit. *B*, The same site 6 weeks later, showing very close utilization. The ungrazed grass under the trees in the background is Idaho fescue.

TABLE 6.—*Average composition and utilization of vegetation in grassland units, the Burgess Spring Experimeniat Range, 1943–51*

Species	Composition	Use	Proportion of diet
	Percent	*Percent*	*Percent*
Tufted grasses:			
Nevada bluegrass	6	70	10
Sandberg bluegrass	4	79	8
Hairy California danthonia	3	59	5
Idaho fescue	2	73	3
Bottlebrush squirreltail	2	70	3
Tufted hairgrass	(1)	30	(1)
Prairie Junegrass	(1)	50	(1)
Needlegrasses	(1)	70	(1)
Total	17		29
Sod grasses, sedges and rushes:			
Wire rush	22	35	18
Nebraska sedge	3	50	4
Spikesedge	3	60	5
Mat muhly	3	71	5
Shorthair sedge	3	15	1
Rush spp	2	37	2
Sedge spp	1	30	1
Thin bentgrass	(1)	20	(1)
Total	37		36
Tufted forbs:			
Biscuitroot	8	5	1
Plantainleaf buttercup	7	(1)	(1)
Eryngo	1	90	2
Water groundsel	1	60	1
American bistort	(1)	5	(1)
Northwest cinquefoil	(1)	70	1
Oregon checkermallow	(1)	70	(1)
Total	17		5
Sod forbs:			
Aster	4	60	6
Pussytoes	3	28	2
Longstalk clover	1	70	2
Total	8		10
Shrubs:			
Black sagebrush	7	15	3
Silver sagebrush	3	20	1
Big sagebrush	2	5	(1)
Total	12		4
Other species	9		16
All species	100		100

[1] Trace.

The closed basin site was grazed most closely, and then, in decreasing order, the wet meadow, drained basin, and terrace sites. One reason why the closed basin site was grazed closely was that it made up only a small part, 9 percent, of the range. Margins of wet meadow sites were usually grazed first in order of time; they were grazed more closely at the end of the grazing season that other meadow areas. The reason probably is that these areas usually support a large proportion of palatable grasses such as Nevada bluegrass and mat muhly, and forbs such as longstalk clover, but comparatively small amounts of the less palatable sedges and rushes.

Both timber and grassland types therefore, were selectively and unevenly grazed. This complexity of the use pattern was much the same in all seasons even though different cattle were used each season. It was determined by topography; soils; vegetation types; species composition, abundance, growth stage, growth form, and palatability; location of fences, water places, and salt grounds; stocking rate; season of grazing; and strong preferences of the cattle.

Effect of Clipping on Vegetation

Groups of 10 plants of Idaho fescue, bottlebrush squirreltail, woolly wyethia, and longspur lupine were cut with a knife to a 1.5-inch stubble at different growth stages, starting when the plants were about 3 inches tall and ending about the time of seed ripening. Each group of plants was clipped once during the season except where regrowth was produced. Regrowth was clipped when full grown. Some plants therefore were clipped twice during a season.

Herbage Production

Plants of all four species produced some regrowth after clipping at early growth stages and up until the time they reached the seed-in-milk stage. Virtually no regrowth was produced thereafter. Amount of initial growth increased and regrowth decreased, with lateness of clipping (table 7). The total combined weight of initial growth and regrowth increased with lateness of clipping (table 8). Clipping when the plants were growing actively reduced the total herbage yield during the season of clipping.

Basal Area

A single season of clipping materially reduced the basal area of the four species the next year. The basal area of Idaho fescue was reduced 49 percent, longspur lupine 59 percent, bottlebrush squirreltail 21 percent, and woolly wyethia 8 percent (table 9). In Idaho fescue, clipping when the plant was growing rapidly caused the greatest reduction in basal area. Even late in the season when the plants were dry and apparently dormant, clipping reduced basal area (table 10).

TABLE 7.—*Production of initial growth and regrowth per square inch of basal area by Idaho fescue clipped to a 1.5-inch stubble at various growth stages, the Burgess Spring Experimental Range, 1946, 1947, 1948, and 1951*

Average date and growth stage at time of initial clipping	Initial growth	Regrowth[1]	Initial growth and regrowth combined	
	Grams	*Grams*	*Grams*	*Percent*[2]
May 1. Leaves about 3 inches tall	0. 78	0. 70	1. 48	60
May 13. Flower stalks low in boot	1. 09	. 29	1. 38	56
May 27. Flower stalks surpassing basal leaves	1. 42	. 20	1. 62	66
June 17. Flower stalks two-thirds grown	2. 16	. 05	2. 21	90
July 6. Peak of flowering	2. 39	. 01	2. 40	98
July 9. Flower stalks full grown	2. 41	. 01	2. 42	99
July 18. Seed in milk	2. 45	0	2. 45	100

[1] Regrowth from all plants was clipped on July 22.
[2] Comparison with full-grown plants, July 18.

TABLE 8.—*Total production of initial growth and regrowth of forage species clipped to a 1.5-inch stubble at various growth stages, the Burgess Spring Experimental Range, 1946*

Average date and growth stage at time of initial clipping	Per sq. in. basal area		Per fascicle[1]	
	Idaho fescue	Bottlebrush squirreltail	Longspur lupine	Woolly wyethia
	Grams	*Grams*	*Grams*	*Grams*
May 1. Leaves about 3 inches tall	0. 59			
May 15. Flower stalks evident (in grasses low in boot)	. 81	1. 22	0. 45	5. 09
May 26. Flower stalks one-third grown (in grasses surpassing basal leaves)	1. 02	1. 79	. 43	6. 92
June 16. Flower stalks two-thirds grown	2. 28	2. 42	. 70	18. 09
July 3. Peak of flowering	2. 41	2. 72	. 82	13. 00
July 6. Flower stalks full grown	2. 44	3. 02	. 77	15. 93
July 17. Seed in milk	[2] 2. 46	[2] 2. 98	[2] . 84	[2] 16. 00

[1] A fascicle is a group of leaves or leaves and flower stalks that originate from a single bud.
[2] Extrapolated.

TABLE 9.—*Basal area and fascicles [1] of forage species when clipped in 1946, and 1 year after clipping, 1947, the Burgess Spring Experimental Range*

Average date and growth stage at time of initial clipping	Basal area				Fascicles			
	Idaho fescue		Bottlebrush squirreltail		Longspur lupine		Woolly wyethia	
	1946	1947	1946	1947	1946	1947	1946	1947
	Sq. in.	*Sq. in.*	*Sq. in.*	*Sq. in.*	*No.*	*No.*	*No.*	*No.*
May 16. Flower stalks evident (in grasses low in boot)	4.20	1.43	2.25	1.44	8.8	3.2	6.9	5.3
May 26. Flower stalks one-third grown	3.56	2.12	2.23	1.64	12	6.4	7.8	7
June 13. Flower stalks two-thirds grown	3.44	1.82	2.15	1.75	19.4	7.7	3.8	4.5
July 2. Plants flowering	4.16	2.16	2.01	2	16.2	5.6	6.5	6.3
Average	3.84	1.88	2.16	1.71	14.1	5.7	6.3	5.8
Basal area reduction		*Percent* 49		*Percent* 21		*Percent* 59		*Percent* 8

[1] The number of fascicles in the base of the plants is correlated with the area covered by the base. Thus change in number of fascicles reflects change in basal area.

TABLE 10.—*Basal area of Idaho fescue plants when clipped, and one year afterward the Burgess Spring Experimental Range*

Average date and growth stage at time of clipping [1]	Basal area—					
	When clipped in 1948	1949	Reduction	When chipped in 1951	1952	Reduction
	Sq. in.	*Sq. in.*	*Pct.*	*Sq. in.*	*Sq. in.*	*Pct.*
April 25. Leaves about 3 inches tall	4.30	1.23	71	5.60	2.00	64
May 13. Stems low in boot	4.71	.76	84	6.10	1.50	75
May 27. Stems emerging from boot	4.79	.45	90	5.21	.95	82
June 17. Stems two-thirds grown	4.87	.08	98	4.20	.30	93
July 6. Peak of flowering	4.42	.57	87	4.20	.47	89
July 21. Seed in milk	4.88	1.45	70	4.20	.57	86
August 8. Seed ripe	5.05	1.94	62	4.71	1.28	73
August 19. Plant 80 percent dry	4.20	1.65	61	4.82	1.45	70
September 1. Plant 90 percent dry	4.30	2.16	50	5.10	1.89	65
September 29. Plant 95 percent dry	4.38	2.51	43	3.20	1.20	62
Average	4.59	1.28	72	4.73	1.16	75

[1] 10 plants clipped at each growth stage in each series.

Four consecutive years of clipping at the seed-in-milk stage reduced basal area of Idaho fescue 80 percent, bottlebrush squirreltail 62 percent, longspur lupine 91 percent, and woolly wyethia 16 percent (table 11). Two of ten Idaho fescue plants were killed, and 6 of 10 longspur lupine plants. None of the squirreltail or woolly wyethia plants was killed.

TABLE 11.—*Change in basal area or number of fascicles of forage species clipped 4 years at the seed-in-milk stage,[1] the Burgess Spring Experimental Range, 1946–49*

Year	Basal area				Fascicles			
	Idaho fescue		Bottlebrush squirreltail		Longspur lupine		Woolly wyethia	
	Sq. in.	*Pct.*	*Sq. in.*	*Pct.*	*No.*	*Pct.*	*No.*	*Pct.*
1946	4.16	100	1.88	100	15.4	100	8.2	100
1947	2.16	52	2.22	118	5.0	32	7.7	94
1948	1.67	40	2.25	120	6.5	42	8.8	107
1949	1.39	33	.69	37	2.4	16	7.9	96
1950	.83	20	.71	38	1.4	9	6.9	84

[1] Clipping was started in 1946 and ended in 1949 in all 4 species. The effect of a particular clipping is reflected in growth the year after clipping. Thus the effect of clipping in 1946 is reflected in the figures for 1947; the effect of clipping in the fourth year, 1949, is reflected in 1950.

Flower-Stalk Production

Clipping to a 1.5-inch stubble during the active growing season reduced the number and height of Idaho fescue flower stalks in the regrowth:

	Flower stalks in regrowth [1]	
	Per square inch of basal area (number)	*Height (inches)*
Average date and growth stage at time of clipping:		
May 1. Leaves about 3 inches tall	2. 62	14. 50
May 13. Flower stalks low in boot	. 79	10. 82
May 27. Flower stalks surpassing basal leaves	. 30	6. 82
June 17. Flower stalks two-thirds grown	. 04	. 65
July 6. Peak of flowering	[2]	[2]
July 9. Flower stalks full grown	0	0
Check plants, unclipped	13. 09	23. 62

[1] Average 1946, 1947, 1948, and 1951.
[2] Trace.

The stunted flower stalks that were produced in the regrowth had little or no seed. Flower stalk production 1 year after clipping was severely reduced. Average reductions for 4 years ranged from 94 to 100 percent:

Average number of flower stalks per square inch of basal area one year after clipping	
Average date and growth stage at time of clipping: [1]	
April 25. Leaves about 3 inches tall	0. 35
May 13. Flower stalks low in boot	0
May 27. Flower stalks surpassing basal leaves	. 33
June 17. Flower stalks two-thirds grown	. 20
July 6. Peak of flowering	. 28
Check plants, unclipped	5. 67

[1] Clipped in 1946, 1947, 1948, and 1951.

These results are similar to those reported by Blaisdell and Pechanec (*1*) from studies with bearded bluebunch wheatgrass and arrowleaf balsamroot clipped at eight different growth stages.

Studies by Grandfield (*5*), McCarty (*8*), McCarty and Price (*9*), Sampson and McCarty (*12*), Weinmann (*14*), and others on carbohydrate storage in perennial plants explain some of the present clipping results. Apparently food for future growth is stored in the roots and stems of the plants mainly after the growth rate slackens. The amount of stored food is greatest about the time the plant ripens seed. The plant draws on these food reserves after it becomes dormant, throughout the winter, and also in the spring to start new growth. Mountain brome uses about 75 percent of the food reserves by the time 10 percent of the new season's growth is produced (*8*). Most of the food manufactured by the plant while it is growing rapidly is used to produce new tissue.

Thus defoliation at almost any time of the season is harmful to the plant, but it is especially harmful during rapid growth. At that time, stored foods are at a minimum; defoliation prevents further food storage. The present studies show that defoliation is harmful even after seed ripening when the plants are dry and apparently dormant.

Effect of Rest on Vegetation

Basal Area

Four years of rest after 4 years of continuous clipping at the seed-in-milk stage resulted in little or no recovery of original basal area of the four species studied (table 12). Apparently the soil space released by the clipped plants was encroached upon by adjoining unclipped plants, and this encroachment prevented material recovery of basal area of the clipped plants during the rest period.

TABLE 12.—*Basal area and fascicles of plant species after 4 years of clipping at the seed-in-milk stage and 4 years of rest, the Burgess Spring Experimental Range*

Date and treatment	Basal area		Fascicles	
	Idaho fescue	Bottlebrush squirreltail	Longspur lupine	Woolly wyethia
	Sq. in.	*Sq. in.*	*No.*	*No.*
1946. Start of clipping	4. 16	1. 88	15. 4	8. 2
1949. End of clipping	1. 39	. 69	2. 4	7. 9
1950. End of 1 year of rest	. 83	. 71	1. 4	6. 9
1951. End of 2 years of rest	. 68	1. 42	2. 1	6. 7
1952. End of 3 years of rest	. 71	. 92	2	6. 7
1953. End of 4 years of rest	1. 04	. 61	2. 4	6. 9

Flower-Stalk Production and Plant Vigor

Responses in flower-stalk production to resting were measured only in Idaho fescue. No flower stalks were produced during the first year of rest. This indicated that the plants were low in vigor. Moderate to high production in comparison with unclipped plants was obtained in the second year, and full production in the third year (table 13). Yearly variation in flower-stalk production due to differences in growth conditions is evident from the data on unclipped plants. Apparently Idaho fescue will produce few if any flower stalks, and therefore little or no seed the first year after close grazing even

TABLE 13.—*Flower-stalk production per square inch of basal area in Idaho fescue when rested one to four seasons after clipping, the Burgess Spring Experimental Range*

Seasons rest after clipping (number)	Flower stalks from plants clipped—			Unclipped check plants
	4 years 1946–49	3 years 1947–49	2 years 1948–49	
	No.	*No.*	*No.*	*No.*
1	0		0	1. 12
2	6. 29	16. 39	17. 03	23. 57
3	1. 97	1. 17	. 31	. 61
4	5	3. 07	. 86	3. 91

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FIGURE 12.—Idaho fescue is usually grazed closely in openings in the timber type and gradually killed out.

though the plants are rested from grazing. Reasonably vigorous plants and adequate flower-stalk and seed production can be expected in the second season.

Effect of Grazing on Forage Production

Records on grazed and ungrazed quadrats in 1936 and 1946 provided a picture of vegetation changes in the timber unit under cattle

TABLE 14.—*Estimated utilization by cattle of herbage of Idaho fescue and all forage species in openings in the pine type, by specified year, the Burgess Spring Experimental Range*

Year [1]	Grazing season	Utilization		
		Days	Idaho fescue	All forage species
		No.	*Pct.*	*Pct.*
1936	June 19–Sept. 25	98	7	18
1937	June 14–Oct. 3	111	17	22
1938	June 24–Sept. 23	91	45	39
1939	Aug. 10–Sept. 21	42	11	7
1943	July 9–Sept. 28	81	23	19
1944	June 2–Oct. 31	151	11	22
1945	May 23–Oct. 26	156	65	56
1946	May 12–Oct. 17	158	80	56
	Average, June 18–Oct. 7	111	32	30

[1] No grazing in 1940, 1941, and 1942.

grazing. For reasons beyond control, the unit was grazed only eight seasons during this 11-year period (table 14). But forage production was reduced appreciably even in this short time.

Loss in production resulted mainly from reduction of Idaho fescue in timber openings where grazing is normally concentrated on particular plants and areas (fig. 12). Use of Idaho fescue during the 8 years of grazing averaged only 32 percent (table 14). However, in 1946, grazed areas had 21 percent fewer Idaho fescue plants than comparable areas protected from grazing. Also, the plants on grazed areas were 42 percent smaller and produced 31 percent less herbage per unit of live basal area. These effects combined represent a 68 percent reduction in yield of Idaho fescue in open areas, or 21.4 pounds per acre. This reduction was statistically significant. The total loss in yield of Idaho fescue and four other important forage species—bottlebrush squirreltail, needlegrasses, longspur lupine and Ross sedge—was calculated at 25.9 pounds per acre which represents a loss of 8.2 percent of the grazing capacity of the entire unit.

Cattle Weights in Timber and Grassland Types

Because livestock weight information is of value in determining season of grazing and stocking rate, weight records were kept for cattle grazed in both the timber and grassland types. Yearling heifers were used each year. These young cattle had high capacity to gain weight, and they responded to differences in the nutritional value of the vegetation.

Each season from 1944 to 1948, one group of heifers was grazed in the timber type and a second comparable group in the grassland type. The average grazing season during the 5 years began May 23 and ended October 21. During this period, the heifers in the timber type gained 217 pounds per head; those in the grassland type, 227 pounds, or 10 pounds more (table 15).

Gains continued for 136 days in the timber type, until October 6; then the cattle started to lose weight. The losses averaged 10 pounds per head up to October 21. In the grassland type, gains continued only 131 days, until October 1. From then until the end of the season, losses averaged 17 pounds per head. The average daily weight gains of the cattle in the timber type during the period of gain was 1.61 pounds per head; in the grassland type, 1.74 pounds per head.

The difference in average seasonal weight gains by the cattle in the two types was small, and it varied from no difference in 1944 to a 23-pound greater gain in the grassland type in 1948. The difference in gains between types was probably due partly to a difference in the nutritive value of the vegetation and partly to a difference in energy expended by the animals in grazing. The cattle in the timber type gained less probably because they covered a larger area and steeper ground in grazing.

In both types, the rate of animal gain changed continuously as the vegetation developed during the season. The relation between the weight trend of heifers grazed in the timber type and the growth and development of Idaho fescue is shown in figure 13. Daily weight gains of 1.14 pounds per head were made the first 2 weeks on the range when the vegetation was about 4 inches tall. By the time flower

stalks on the plants were about half developed, rate of gain had increased to 1.93 pounds per day. A maximum rate of 2.29 pounds per day was reached just before flowering time in early July, but a gradual decrease followed until early October. Thereafter, weight losses occurred.

TABLE 15.—*Weight gains of yearling Hereford heifers in timber and grassland types, the Burgess Spring Experimental Range, 1944–48*

Year	Heifers	Grazing season		Beginning weight	End weight	Gain per head	Gain per head per day
		Dates	Days				
	Number			*Pounds*	*Pounds*	*Pounds*	*Pounds*
TIMBER TYPE—MAXIMUM SEASONAL GAINS [1]							
1944	10	June 2–Oct. 20	140	443	656	213	1. 53
1945	14	May 23–Oct. 7	137	450	670	220	1. 62
1946	12	May 12–Sept. 21	132	390	609	219	1. 66
1947	9	May 7–Oct. 1	147	380	608	228	1. 55
1948	9	June 9–Oct. 10	123	444	651	207	1. 68
Av	11	May 23–Oct. 6	136	421	639	217	1. 61
TIMBER TYPE—TOTAL SEASONAL GAINS [2]							
1944	10	June 2–Oct. 31	151	443	649	206	1. 36
1945	14	May 23–Oct. 26	156	450	645	195	1. 25
1946	12	May 12–Oct. 17	158	390	593	203	1. 28
1947	9	May 7–Oct. 20	166	380	603	223	1. 34
1948	9	June 9–Oct. 10	123	444	651	207	1. 68
Av	11	May 23–Oct. 21	151	421	628	207	1. 38
GRASSLAND TYPE [3]—MAXIMUM SEASONAL GAINS [1]							
1944	9	June 2–Oct. 6	126	443	656	213	1. 70
1945	15	May 23–Oct. 2	132	446	670	224	1. 70
1946	12	May 12–Sept. 25	136	385	616	231	1. 70
1947	9	May 7–Sept. 21	138	380	619	239	1. 73
1948	9	June 9–Oct. 10	123	448	678	230	1. 87
Av	11	May 23–Oct. 1	131	420	648	227	1. 74
GRASSLAND TYPE [3]—TOTAL SEASONAL GAINS [2]							
1944	9	June 2–Oct. 31	151	443	629	186	1. 23
1945	15	May 23–Oct. 26	156	446	636	190	1. 22
1946	12	May 12–Oct. 17	158	385	603	218	1. 38
1947	9	May 7–Oct. 20	166	380	608	228	1. 37
1948	9	June 9–Oct. 10	123	448	678	230	1. 87
Av	11	May 23–Oct. 21	151	420	631	210	1. 41

[1] Gains made from the beginning of the grazing season to the time the animals started to lose weight.

[2] Gains made between the beginning and end of the grazing season.

[3] See table 1, p. 11, for unit grazed each year.

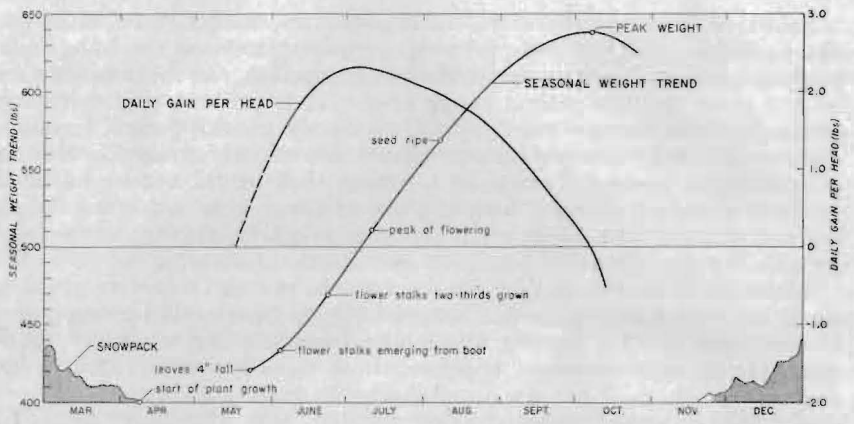

FIGURE 13.—Weights of yearling heifers in relation to growth of Idaho fescue. Average 1944–48, timber type, the Burgess Spring Experimental Range.

This trend bears out the general conclusions drawn by many investigators from chemical analyses and livestock digestion trials; the nutritive value of herbage is highest when the plants are green and growing rapidly. The plant is most ideally balanced in minerals, vitamins, proteins, carbohydrates, roughage, and moisture for livestock when approaching the flowering stage. Before this stage, the plant is high in proteins, minerals, vitamins, and other nutritional essentials, but it is usually deficient in carbohydrates and roughage. After this stage, the plant becomes overbalanced in carbohydrates and roughage and deficient in other nutrients.

The seasonal weight trends were similar in the timber and grassland types. However, in the grassland type early gains were higher and fall losses occurred a little earlier. In other words, production per head was nearly as good in timber as in the grassland types.

Conclusions From Studies

The present studies have reaffirmed previous observations that cattle prefer some plant species and range areas to others and graze them closely, which causes uneven utilization. The pattern of use is very complex, not only because of selective grazing, but also because the range is so variable. However, in spite of this, the pattern of use is much the same from year to year under the same management. The same plants and areas grazed closely one year tend to be grazed closely the next. Thus under continuous seasonal grazing, some plants are repeatedly cropped closely and in time killed, and the production of the area is lowered.

As the better plants are destroyed, livestock graze on less palatable species and are forced into less accessible areas. This leads progressively to ever-enlarging areas of deterioration. In some instances the soil is left bare and exposed to erosion. In others, inferior or worthless forage species invade the site. Range breakdown is spotty because of selective grazing and also because some sites deteriorate more rapidly than others under the same grazing pressure.

Selective grazing, therefore, is one of the main causes of range deterioration, and the basic problem in management is to change the grazing pattern so that palatable forage species can be maintained on the most heavily grazed range area. It is evident that selective grazing cannot be prevented by adjusting the stocking rate, because even under light stocking some plants are closely grazed. Nor is it possible to graze the range at a season that would not be harmful to the vegetation without forgoing use of the vegetation when it has highest grazing value. And, of course, selective grazing cannot be avoided by any practical livestock distribution measure.

Although little if anything can be done to prevent selective grazing while the range is grazed, the harmful effects of selective grazing can be counteracted by resting the range from grazing at appropriate intervals so that all plant species—those usually heavily grazed as well as all others—have an opportunity to grow and reproduce normally. The rest-rotation grazing system was therefore designed to make this possible and thereby increase forage and livestock production.

Design and Application of Rest-Rotation Grazing

Improvement of ranges depends on restoration of vigor of the desirable forage species and establishment of new plants from these species. The need for reproduction of desirable species is of special importance in rehabilitating perennial bunchgrass ranges. As shown by the present study, even one season of close clipping reduces vigor, flower-stalk production, and basal area of Idaho fescue and other forage species. Under rest-rotation grazing heavy emphasis is placed on restoration of vigor to the point where seed can be produced and where conditions are systematically created for establishment of seedlings of desirable forage plants.

To obtain reproduction it is necessary to rest the range from grazing at three critical times for three main purposes; first, to restore plant vigor, second, to insure development and ripening of seed, and third, to insure establishment of seedlings. The general form of rest-rotation grazing, therefore, consists of four basic steps in the following sequence:

Step	*Symbol*
1. Graze the range for maximum livestock production	GL
2. Rest the range until plant vigor is restored	RV
3. Rest the range until seed ripens, then graze for maximum livestock production	RS
4. Rest the range until reproduction becomes firmly established	RR

The number of years required to apply these steps depends on the growth requirements of the key species on the range, the one species most desired for forage and plant cover. The key species is usually one of the most palatable on the range and one easily destroyed by grazing. All other forage species on the range having growth requirements equal to or less exacting than those of the key species will also be maintained by the amount of rest that satisfies the key species.

The first step (grazing) is usually one season long. The second may take one or more seasons, or may be less than a full season,

depending on how much time it takes to restore vigor of the key species on the particular range. In the present studies at least one full season of rest was indicated as needed to restore vigor of Idaho fescue.

The third step, which calls for resting the range until seed ripens and then grazing the remainder of the season, takes one full season. Provision for this third step is exceedingly important not only because it insures seed, but also because the trampling associated with grazing after seed-fall is needed to get as much seed as possible worked into the soil. Seeds buried in the soil have a much better chance of germinating and producing strong, well-rooted seedlings than seeds lodged on the soil surface. Deteriorated sites are particularly unfavorable for seedling establishment, because the soil surface is hard and bare of litter and organic matter. On such sites, covering of the seed by trampling is most important.

The fourth step, which makes sure that seedlings are well established, may take 1, 2, or even 3 years to complete, again depending on the requirements of the key species and the condition of the range, particularly the soil.

Thus the four basic steps may take 4, 5, 6, or more years to apply. The practice or practices applied in one year comprise a yearly treatment. To illustrate, a range requiring one season of rest for restoration of plant vigor and two seasons of rest for establishment of reproduction would require five yearly treatments:

Year	*Treatment*	*Symbol*
1st	Graze the range for maximum livestock production	GL
2d	Rest the range until plant vigor is restored	RV
3d	Rest the range until seed ripens, then graze for maximum livestock production	RS
4th	Rest for establishment of reproduction	RR
5th	Continue rest for establishment of reproduction	RR

Completion of the yearly treatments culminating in establishment of reproduction constitutes a grazing cycle. The cycle is repeated over and over until the range is restored to satisfactory condition. Then, the range may be rested less and grazed more to make fuller use of the vegetation and produce more livestock.

To apply the yearly treatments, the range has to be divided into the same number of units as the number of treatments used. The units should be about equal in grazing capacity. During a grazing cycle each unit is given the prescribed yearly treatment. In any given year each unit receives a different yearly treatment, so some units are rested while others are grazed. Thus, the distribution of treatments among units during a grazing cycle for the five-unit plan described above is as follows:

	Treatments				
Year	*Unit 1*	*Unit 2*	*Unit 3*	*Unit 4*	*Unit 5*
1st	GL	RV	RS	RR	RR
2d	RV	RS	RR	RR	GL
3d	RS	RR	RR	GL	RV
4th	RR	RR	GL	RV	RS
5th	RR	GL	RV	RS	RR

In this example all the livestock grazed on the range in a particular year are placed in the unit receiving treatment GL at the beginning

of the grazing season. Then after seed ripens they are moved to the unit receiving treatment RS and left there the remainder of the season. The unit receiving treatment RV and the two receiving RR are not grazed.

A table like this can be set up for grazing plans involving any number of yearly treatments. Notice the regular pattern of the plan; treatments run from the first to the last in order down column one and across the first line (1st year). The remainder of the treatments in the body of the plan follow in regular order. Treatments are properly allocated to units when the same treatment symbol appears in a diagonal line from lower left to upper right.

Good results from rest-rotation grazing, therefore, depend on resting portions of the range for the proper period and at the right time so the vegetation can complete its normal life cycle. The rate at which a range improves when given proper rest depends on the condition of the range and the weather. Ranges in poor condition will respond slowly and produce rather low yields of forage and livestock. Ranges in fair to good condition can be expected to improve more rapidly and produce more nearly normal yields. Although the number of treatments needed for good results will vary from range to range, a five-treatment plan will probably satisfy the requirements of most bunchgrass ranges in the West.

There are several inherent features of rest-rotation grazing that should be pointed out:

1. Plant material left on the ground during rest period helps build soil fertility, reduces soil erosion, and speeds range improvement.
2. The vegetation in the rested units also constitutes a forage reserve that can be used in emergencies, such as drought years when forage production is below average. When additional forage is needed, the unit being rested to restore plant vigor should be used first, and then the other units. This allows seedlings to be protected from grazing as long as possible.
3. Introduced forage species can be seeded on deteriorated sites within the range units and managed together with the native species without being protected by fencing. Seed of these species can be planted in the unit in which grazing has been delayed until the seed of native species has ripened (treatment 3). In this way both introduced and native species are "planted" at the same time and managed together thereafter. Weed control, drainage improvement, and other similar practices can also be carried out in the units without additional fencing for grazing control. Furthermore, these practices can be applied any time suitable for the work. Only seeding practices have to be fitted into the grazing schedule at a particular time.

Stocking

Under rest-rotation grazing, stocking is based on the production and use of herbage from all the available forage species and not on the key species alone. Under this system, degree of use of plants does not have the same importance as under continuous seasonal grazing, because grazing is limited to a comparatively short time and is always followed by rest planned to be long enough to overcome the harmful effects of grazing.

Further, under rest-rotation grazing little attention is paid to classifying plants according to palatability to determine forage production and stocking. The relationship between palatability ratings and utilization is often not very close. Species rated low in palatability are often grazed as closely as species rated high. So in this system, plants are classified simply as forage or nonforage species, and stocking rate is calculated on the basis of production from all forage species.

Stocking resulting in satisfactory range condition and livestock production cannot be determined accurately prior to actual experience on the range. However, it can be estimated from forage production, as indicated above, or on the basis of actual use elsewhere on a similar type range. After stocking is set on this basis, it can be adjusted upward or downward depending on the responses observed in the range and livestock.

Fairly heavy stocking is desirable in rest-rotation grazing. On the Harvey Valley cattle allotment where a 5-unit design is being tested, a 66-percent use of all available forage in the most heavily grazed units was prescribed. This is an arbitrary use level; it will be changed upward or downward depending on the results obtained.

A fairly high stocking rate forces greater use of the less palatable forage species and the less accessible grazing areas, and this results in intensive trampling in places where reproduction is most needed. Close cropping and trampling can be tolerated because the range is rested at critical times. Were it not for soil erosion, practically all of the vegetation in grazed units could be utilized.

Season of Grazing

The clipping studies showed that seasonal herbage yield is reduced by defoliation during the growing season when the vegetation is growing and green (table 8, p. 23). On the other hand, cattle made greatest weight gains during this period (fig. 13). The grazing season yielding maximum livestock production under any given stocking, therefore, is the one that strikes the optimum balance between herbage yield and nutritive value.

To provide a general guide for selecting a suitable grazing season, the yield of forage and livestock for various length grazing seasons was calculated from data obtained at Burgess Spring on plant growth and development (fig. 9), effect of clipping on herbage yield (table 7) (assuming the vegetation as a whole to behave like Idaho fescue), and rate of livestock weight gains during the season (fig. 13). The results of these calculations are shown in table 16.

The figures for the different seasons are all related to plant growth and development and thus to one another. The absolute values are significant only at Burgess Spring. The relationship between seasons can be used elsewhere on similar ranges when interpreted in terms of plant growth stages rather than calendar date.

TABLE 16.—*Estimated forage and cattle production from various grazing seasons and stocking rates for 66-percent forage use,*[1] *pine timber type, the Burgess Spring Experimental Range*

Beginning of grazing season and average growth stage of vegetation [2]	End of season	Cattle per section	Weight gain per animal	Cattle production per acre	Forage production per acre
		No.	*Pounds*	*Pounds*	*Pounds*
1-MONTH SEASON					
May 12. Flower stalks low in boot	June 10	168	48	12. 6	165
May 22. Flower stalks in mid-boot	June 20	194	58	17. 6	191
June 1. Flower stalks emerging from boot	June 30	220	64	22	216
June 11. Flower stalks one-third grown	July 10	236	68	25. 1	233
June 21. Flower stalks two-thirds grown	**July 20**	**246**	**71**	**27. 3**	**242**
July 1. Near flowering	July 30	250	69	27	246
July 11. Just past peak of flowering	Aug. 9	252	62	24. 4	249
July 21. Seed in milk	Aug. 19	252	54	21. 3	248
July 31. Seed in dough	Aug. 29	247	46	17. 8	243
Aug. 10. Seed ripe	Sept. 8	239	31	11. 6	236
2-MONTH SEASON					
May 12. Flower stalks low in boot	July 10	98	116	17. 8	193
May 22. Flower stalks in mid-boot	July 20	108	127	21. 4	215
June 1. Flower stalks emerging from boot	July 30	117	131	23. 9	231
June 11. Flower stalks one-third grown	**Aug. 9**	**123**	**130**	**25**	**241**
June 21. Flower stalks two-thirds grown	Aug. 19	125	124	24. 2	245
July 1. Near flowering	Aug. 29	125	114	22. 3	245
July 11. Just past peak of flowering	Sept. 8	123	100	19. 2	244
July 21. Seed in milk	Sept. 18	122	84	16	240
3-MONTH SEASON					
April 22. Leaves about 2 inches tall	July 20	58	147	13. 3	154
May 2. Leaves about 3 inches tall	July 30	65	166	16. 9	172
May 12. Flower stalks low in boot	Aug. 9	71	178	19. 7	190
May 22. Flower stalks in mid-boot	Aug. 19	76	182	21. 6	203
June 1. Flower stalks emerging from boot	**Aug. 29**	**79**	**177**	**21. 8**	**213**
June 11. Flower stalks one-third grown	Sept. 8	81	168	21. 3	216
June 21. Flower stalks two-thirds grown	Sept. 18	81	155	19. 6	217
July 1. Near flowering	Sept. 28	81	134	17	215

TABLE 16.—*Estimated forage and cattle production from various grazing seasons and stocking rates for 66-percent forage use,*[1] *pine timber type, the Burgess Spring Experimental Range*—Continued

Beginning of grazing season and average growth stage of vegetation [2]	End of season	Cattle per section	Weight gain per animal	Cattle production per acre	Forage production per acre
		No.	*Pounds*	*Pounds*	*Pounds*
4-MONTH SEASON					
April 22. Leaves about 2 inches tall	Aug. 19	48	201	15. 1	185
May 2. Leaves about 3 inches tall	Aug. 29	51	212	16. 9	203
May 12. Flower stalks low in boot	Sept. 8	55	216	18. 6	217
May 22. Flower stalks in mid-boot	**Sept. 18**	**58**	**212**	**19. 2**	**228**
June 1. Flower stalks emerging from boot	Sept. 28	59	198	18. 3	234
June 11. Flower stalks one-third grown	Oct. 8	60	178	16. 7	236
June 21. Flower stalks two-thirds grown	Oct. 18	60	152	14. 3	237
5-MONTH SEASON					
April 22. Leaves about 2 inches tall	Sept. 18	39	232	14. 1	192
May 2. Leaves about 3 inches tall	Sept. 28	42	234	15. 4	206
May 12. Flower stalks low in boot	**Oct. 8**	**44**	**227**	**15. 6**	**216**
May 22. Flower stalks in mid-boot	Oct. 18	45	210	14. 8	223

[1] Utilization assumed measured on October 18 for all seasons. Figures in bold face type indicate optimum seasons.
[2] In terms of Idaho fescue.

Generally the figures indicate that high livestock production per acre and low total seasonal gains per animal are obtained with the shorter seasons—low production and high total seasonal gains with the longer ones. On the other hand, livestock production per acre is 25.0 pounds for the 2-month season and only 19.2 for the 4-month season. Under the optimum 2-month season, for example, cattle gains average 130 pounds; under the optimum 4-month season, 212 pounds.

The grazing season best suited to a particular situation is determined not only by the livestock-producing potentialities of the season but by other considerations, such as the time the particular range is needed in the ranching operation as a whole and the condition and weight gains desired in the livestock. For example, the longest practical grazing season in the Burgess Spring locality is about 5 months, starting May 12 when flower stalks of Idaho fescue are in low boot, and ending October 8 when cattle start losing weight. This season would produce 227 pounds gain per animal or 15.6 pounds gain per

acre. A 4-month grazing season starting on May 22 when the flower stalks of Idaho fescue are in midboot (fig. 14) would produce only 212 pounds gain per animal but 19.2 pounds per acre. Thus, although the seasonal weight gain of the average animal is 7 percent less under the 4-month season than under the 5-month season, livestock production per acre is 23 percent greater. Since rest-rotation grazing allows range maintenance regardless of the time of beginning and ending of the grazing season, the choice of seasons is up to the livestock operator.

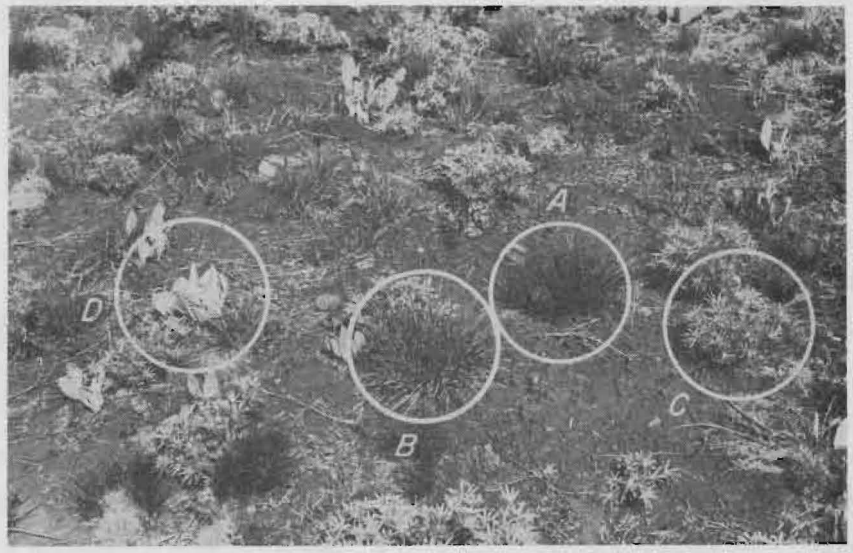

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FIGURE 14.—Stage of development of the vegetation in the pine timber type at the beginning of the optimum 4-month grazing season. Flower stalks in the grasses are in the midboot stage. Species evident in the photo are *A*, Idaho fescue—dark tufts right center; *B*, bottlebrush squirreltail—gray tuft lower center; *C*, longspur lupine; and *D*, woolly wyethia.

Livestock Distribution

The need for subdividing the range into units and restricting animals to a part of the range under rest-rotation grazing generally results in better livestock distribution and more complete use of the available forage. However, there may still be a need for additional control of animal distribution with water developments, judicious placement of salt, and riding or herding.

Fences are required on most cattle ranges for adequate control of grazing, but are unnecessary on sheep ranges where the animals are herded. On ranges where the cost of fencing is prohibitive and where water is supplied by tanks, springs, and wells, the range manager should consider the possibility of obtaining desired distribution by closing water on areas to be rested, leaving water open on areas to be grazed, and placing salt in strategic locations. If the aim is to get the cattle to stay in a given locality, place the salt near water. If it is to get the animals distributed widely, place the salt away from water, but always within easy grazing distance.

How To Judge Effectiveness of Management

The establishment of new seedlings of desirable forage species is often the most important single criterion that can be used to judge whether a rest-rotation grazing system is improving the range. Numerous 2- and 3-year-old seedlings in the spaces between vigorous older plants (fig. 15) indicate that parent plants are producing abundant viable seed, and that forage cover is thickening and grazing capacity increasing. Under these circumstances, litter and soil conditions can be expected to improve and erosion slowed down or arrested. Absence of seedlings may indicate that the range is in top condition; on the other hand it may indicate that the range is so densely covered with worthless plants that there is little or no room for additional plants to grow. Absence of new plants may also indicate that the range has already been so eroded that new plants of desirable forage species are very slow to become established, or that the range is now actively deteriorating.

The place to look for new seedlings is on closely grazed areas. If seedlings are becoming established here, then they are probably becoming established on less heavily grazed areas also.

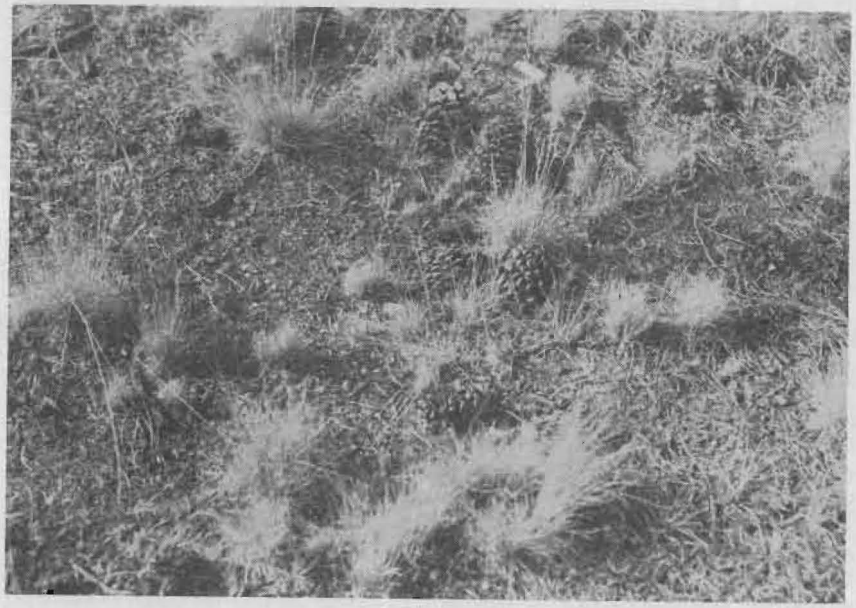

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FIGURE 15.—The presence of small, young plants of desirable forage species on the range indicates that the range is improving. Here young plants of Idaho fescue are evident among older and larger plants.

Such factors as soil stability and composition and vigor of the established vegetation are also important in judging effectiveness of management. Repeat observations and measurements on permanently marked areas are usually necessary to positively establish trend in the condition of the range.

The rate of range improvement will vary from site to site, depending on the character of the soil and vegetation and the condition of the range. Where much topsoil has been lost or where weed species dominate the site, improvement will be slow.

In effect, grazing is eliminated as an environmental factor under rest-rotation grazing. During rest periods, plants that are usually heavily grazed as well as all others are given an opportunity to develop full vigor and compete freely with each other. The species best adapted to prevailing site conditions regenerate first and become dominant, and as the site improves, other species become established in normal successional patterns. Fortunately, desirable forage species increase, and undesirable ones decrease under these conditions on most ranges.

Invaluable information on the adequacy of grazing management is provided by reliable records of animal weight gains, condition, mortality by causes, and calf crop. Much of this information can be obtained by observation. However, the only satisfactory way of getting weight information is to weigh the animals. One of the most valuable tools a stockman can have is a set of livestock scales. In many cases, a portable set of scales is desirable for determining performance of animals on various parts of the range or ranch without unnecessarily long drives to the scale.

Summary

Many mountain bunchgrass ranges in northeastern California have been severely damaged by excessive livestock use, and better methods of managing grazing are needed to restore and maintain them in a high state of productivity. Studies were carried out with cattle at the Burgess Spring Experimental Range in northeastern California by the Pacific Southwest Forest and Range Experiment Station during a 16-year period from 1936 through 1951.

It was concluded from these studies that selective grazing could not be avoided so long as the range was grazed, but that the harmful effects of selective grazing could be counteracted by resting the range from grazing at suitable intervals. A system of grazing incorporating resting was formulated on this premise. The main purpose of rest is to allow the grazed plants to recover vigor, produce seed, and establish new reproduction. The timing and duration of rest is based on the growth requirements of the key forage species on the range.

The system is called rest-rotation grazing. A practical test of the system is now in progress on the Harvey Valley cattle allotment of the Lassen National Forest. Since results from this test are not available, the merits of rest-rotation grazing cannot be fully evaluated at this time. However, the present publication describes the system and the studies on which it is based.

Common and Botanical Names of Species Mentioned

Trees

Alder	*Alnus* spp.
California red fir	*Abies magnifica*
Jeffrey pine	*Pinus jeffreyi*
Oak	*Quercus* spp.
Ponderosa pine	*Pinus ponderosa*
Quaking aspen	*Populus tremuloides*
Western juniper	*Juniperus occidentalis*
White fir	*Abies concolor*
Incense-cedar	*Libocedrus decurrens*
Willow	*Salix* spp.

Grasses

Bearded bluebunch wheatgrass.	*Agropyron spicatum*
Bottlebrush squirreltail	*Sitanion hystrix*
Cheatgrass brome	*Bromus tectorum*
Elmer needlegrass	*Stipa elmeri*
Hairy California danthonia	*Danthonia californica* var. *americana*
Idaho fescue	*Festuca idahoensis*
Kentucky bluegrass	*Poa pratensis*
Mat muhly	*Muhlenbergia squarrosa*
Lemmon needlegrass	*Stipa lemmoni*
Meadow barley	*Hordeum nodosum*
Mountain brome	*Bromus carinatus*
Nevada bluegrass	*Poa nevadensis*
Prairie junegrass	*Koeleria cristata*
Sandberg bluegrass	*Poa secunda*
Thin bentgrass	*Agrostis diegoensis*
Tufted hairgrass	*Deschampsia caespitosa*
Western needlegrass	*Stipa occidentalis*

Sedges and Rushes

Chamisso sedge	*Carex pachystachya*
Common spikesedge	*Eleocharis palustris*
Nebraska sedge	*Carex nebraskensis*
Ross sedge	*C. rossi*
Shorthair sedge	*C. exserta*
Silver sedge	*C. paucicostata*
Wire rush (Baltic rush)	*Juncus balticus*

Forbs

American bistort	*Polygonum bistortoides*
Arrowleaf balsamroot	*Balsamorhiza sagittata*
Aster	*Aster shastensis*
Barestem eriogonum	*Eriogonum nudum*
Biscuitroot	*Lomatium leptocarpum*
Eryngo	*Eryngium alismaefolium*
Cluster tarweed (meadow)	*Madia glomerata*
Common arrowhead	*Sagittaria latifolia*

Forbs—Continued

Common camas	*Camassia quamash*
Flatpod groundsmoke	*Gayophytum humile*
Hoaryleaf arnica	*Arnica foliosa* var. *incana*
Lambstongue groundsel	*Senicio integerrimus*
Littleflower collinsia	*Collinsia parviflora*
Longspur lupine	*Lupinus laxiflorus calcaratus*
Longstalk clover	*Trifolium longipes*
Low pussytoes	*Antennaria dimorpha*
Northwest cinquefoil	*Potentilla gracilis*
Oregon checkermallow	*Sidalcea oregana*
Plantainleaf buttercup	*Ranunculus alismaefolius*
Pussytoes	*Antennaria argentea*
Slender phlox	*Phlox gracilis*
Tapertip hawksbeard	*Crepis acuminata*
Water groundsel	*Senecio hydrophilus*
Western buttercup	*Ranunculus occidentalis*
Wooly wyethia	*Wyethia mollis*

Shrubs

Antelope bitterbrush	*Purshia tridentata*
Big sagebrush	*Artemisia tridentata*
Black sagebrush	*A. arbuscula*
Snowbrush ceanothus	*Ceanothus velutinus*
Sierra evergreenchinkapin	*Castanopsis sempervirens*
Curlleaf mountainmahogany	*Cercocarpus ledifolius*
Greenleaf manzanita	*Arctostaphylos patula*
Rabbitbrush goldenweed	*Aplopappus bloomeri*
Silver sagebrush	*Artemisia cana*
Squawcarpet ceanothus	*Ceanothus prostratus*

Literature Cited

(1) Blaisdell, James P., and Pechanec, Joseph F.
1949. effects of herbage removal at various dates on vigor of bluebunch wheatgrass and arrowleaf balsamroot. Ecology 30: 298–305.

(2) Craddock, G. W., and Forsling, C. L.
1938. the influence of climate and grazing on spring-fall sheep range in southern idaho. U.S. Dept. Agr. Tech. Bul. 600, 44 pp., illus.

(3) Frandsen, Waldo R.
1950. management of reseeded ranges. Jour. Range Mangt. 3: 125–129, illus.

(4) Glendening, George E.
1944. some factors affecting cattle use of northern arizona pine-bunchgrass ranges. U.S. Forest Serv. Southwest. Forest and Range Expt. Sta. Res. Rpt. 6, 9 pp., illus. (Processed.)

(5) Grandfield, C. O.
1930. the relation of organic food reserves to the effect of cutting pasture weeds at different stages of growth. Amer. Soc. Agron. Jour. 22: 709–713.

(6) Hutchings, Selar S., and Stewart, George.
1953. increasing forage yields and sheep production on intermountain winter ranges. U.S. Dept. Agr. Cir. 925, 63 pp., illus.

(7) Johnson, W. M.
1953. effect of grazing intensity upon vegetation and cattle gains on ponderosa pine-bunchgrass ranges of the front range of colorado. U.S. Dept. Agr. Cir. 929, 36 pp., illus.

(8) McCarty, Edward C.
1938. the relation of growth to the varying carbohydrate content in mountain brome. U.S. Dept. Agr. Tech. Bul. 598, 24 pp., illus.

(9) ——— and Price, Raymond.
1942. growth and carbohydrate content of important mountain forage plants in central utah as affected by clipping and grazing. U.S. Dept. Agr. Tech. Bul. 818, 51 pp., illus.

(10) Reid, Elbert H., and Pickford, G. D.
1946. judging mountain meadow range condition in eastern oregon and eastern washington. U.S. Dept. Agr. Cir. 748, 31 pp., illus.

(11) Sampson, A. W.
1914. natural revegetation of range lands based upon growth requirements and life history of the vegetation. Jour. Agr. Res. 3: 93–147.

(12) ——— and McCarty, E. C.
1930. the carbohydrate metabolism of stipa pulchra. Hilgardia 5: 61–100.

(13) Smith, Jared C.
1899. grazing problems in the southwest and how to meet them. U.S. Dept. Agr. Div. Agrost. Bul. 16, 47 pp.

(14) Weinmann, H.
1948. investigations on the underground reserves of south african grasses. So. African Jour. Sci. 2: 12–15.

(15) Woolfolk, E. J.
1949. stocking northern great plains sheep range for sustained high production. U.S. Dept. Agr. Cir. 804, 33 pp., illus.

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