A. L. HORMAY, Center Leader

R-CAL-PUBLICATIONS, Hormay, A. L., Rest Rotation Grazing

Following up on your oral request while I was in Berkeley during the year-end holidays, I have prepared a draft of a Research Note or Miscellaneous Paper on rest-rotation grazing based on the Burgess Spring work. A copy is attached. The paper can stand shortening, pointing up and editing, and I'd appreciate suggestions by Joe Woolfolk, Clyde Walker and you.

Early last year Reg De Mic of the R.C. asked Joe Woolfolk and me if the Station could put out a somewhat different kind of handout for Harvey Valley than had been issued up to that time. He visualized a well-illustrated publication, covering the application of rest-rotation grazing on the Harvey Valley Allotment, for use primarily by men of the class of rangers and staff men. Joe and I thought it was a good idea. Reg assigned Tony Evanko to work with me in preparing the manuscript. However, for various reasons neither of us had time to get at it. It is still on the agenda and I will rough it out as soon as I can.

I believe the attached proposed publication will fill some of Reg's needs and should be sent to his office for comments and suggestions.

Attach.
REST ROTATION GRAZING

A MANAGEMENT SYSTEM FOR BUNCHGRASS RANGES

By
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Susanville Research Center

FOR PUBLICATION
CALIFORNIA FOREST AND RANGE EXPERIMENT STATION
FOREST SERVICE, U.S. DEPARTMENT OF AGRICULTURE
<table>
<thead>
<tr>
<th>CONTENTS</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Introduction</td>
<td>1</td>
</tr>
<tr>
<td>Importance of management of grazing</td>
<td>3</td>
</tr>
<tr>
<td>Condition of northeastern California bunchgrass ranges</td>
<td>3</td>
</tr>
<tr>
<td>Importance of livestock grazing on mountain ranges</td>
<td>4</td>
</tr>
<tr>
<td>The experimental area and studies</td>
<td>4</td>
</tr>
<tr>
<td>Weather</td>
<td>5</td>
</tr>
<tr>
<td>Vegetation</td>
<td>5</td>
</tr>
<tr>
<td>Livestock grazing and weights</td>
<td>8</td>
</tr>
<tr>
<td>Why rest is essential in management of grazing</td>
<td>8</td>
</tr>
<tr>
<td>Application of rest in management of grazing</td>
<td>15</td>
</tr>
<tr>
<td>Subdivision of range necessary</td>
<td>18</td>
</tr>
<tr>
<td>Resting and grazing schedule</td>
<td>18</td>
</tr>
<tr>
<td>Provision for years of low forage production</td>
<td>21</td>
</tr>
<tr>
<td>Introduced species</td>
<td>23</td>
</tr>
<tr>
<td>How to judge effectiveness of grazing system</td>
<td>23</td>
</tr>
<tr>
<td>Maximum livestock production</td>
<td>24</td>
</tr>
<tr>
<td>Livestock distribution</td>
<td>24</td>
</tr>
<tr>
<td>Season of grazing and stocking rate</td>
<td>26</td>
</tr>
<tr>
<td>Summary</td>
<td>31</td>
</tr>
<tr>
<td>Literature Cited</td>
<td>33</td>
</tr>
</tbody>
</table>
A MANAGEMENT SYSTEM FOR BUNCHGRASS RANGES

By August L. Hormay, Foresten

Susanville Research Center

Sincere thanks are extended to the many persons who helped carry out the present studies. Valuable technical assistance in the field and in the office was provided by J. R. Bentley, T. W. Daniel, R. W. Gardner, L. R. Short, and others from 1936 through 1939, by E. Ares and C. Graham from 1946 to 1951, and by W. Emrie in 1953 and 1954. The Lassen County Farm Advisor, T. S. Brown, helped with the livestock phases of the study. Most of the experimental facilities were constructed by the Civilian Conservation Corps. Experimental cattle were furnished by forest grazing permittees as follows: Cone Range Company, Red Bluff, 1935-36; P. Updike, Hat Creek, 1939; P. McClelland, Standish, 1945-47; I. Jefcoat, Manton, 1948-49; and T. Clayton, Vina, 1951.

INTRODUCTION

Rest is needed by most living organisms to restore energy and production capacity. The range is essentially a living organism and too needs rest - rest from grazing which is damaging to the range. As in the case of the human body rest is needed by the range at regular intervals and in certain amounts to fulfill growth and maintenance requirements. Maintenance of a full density of vigorous vegetation on the range minimizes soil erosion, maintains soil fertility and is
the basis for maximum livestock production.

The need for rest by ranges is the principal finding from 16 years of research at the Burgess Spring Experimental Range in Lassen County in Northeastern California from 1936 to 1951. A grazing system, which incorporates resting, was developed on the basis of these studies and is being tested at the present time on a pilot plant basis on the Harvey Valley cattle allotment on the Lassen National Forest. This range is about 32,000 acres in size. The system called the rest-rotation grazing system is yielding promising results. Its design and application to bunchgrass ranges is described in this research note.

In 1914 Sampson (7) designed the deferred and rotation system of grazing which includes some resting. Many other range investigators including Craddock and Forsling (1), Frandsen (2), Hutchings and Stewart (3), McCarty (4), McCarty and Price (5), and Reid and Pickford (6), concluded that some deferment of grazing is necessary for range improvement. The present studies indicate the need for longer rest periods than have been recommended heretofore.
IMPORTANCE OF MANAGEMENT OF GRAZING

Improvement of range grazing capacity can be brought about in two principal ways (1) by management of grazing and (2) by use of cultural methods like artificial reseeding, weed and brush control, water spreading and similar practices. Although ranges can be improved by these means, the acreage that can be treated economically is relatively small on the average range. Furthermore, the vegetation produced by these means as well as by natural regeneration on untreated areas can be maintained only through proper management of grazing. Thus proper management of grazing is vital to all range forage and livestock production.

CONDITION OF NORTHEASTERN CALIFORNIA BUNCHGRASS RANGES

Bunchgrass ranges in Northeastern California are producing considerably below potential capacity of forage and livestock because of deterioration brought about by many causes, among them livestock grazing. The density of the vegetation has been reduced. Soil has been exposed to the elements and is being eroded, reducing soil fertility. Desirable forage plants have been decreased and on some areas killed out. Undesirable species have increased. For example extensive areas that at one time supported thick stands of perennial bunchgrass or other desirable forage plants are now dominated by sagebrush and rabbitbrush.

For many years need has existed for grazing systems that would restore the grazing capacity of these and similar ranges in California and elsewhere in the West. Rest-rotation grazing offers much promise of doing this.
IMPORTANCE OF LIVESTOCK GRAZING ON MOUNTAIN RANGES

In California bunchgrass ranges lie mainly in the mountains in the timber zone (except in a portion of the region east of the Sierra-Cascade divide) at elevations above about 2500 feet. In this zone over 95 percent of the vegetation is of the bunchgrass type and depends on seed for reproduction. Less than 5 percent which consists of sedor rhizome forming species spread by vegetative means. Bunchgrass vegetation pose the major problems of grazing management in mountain areas in the State. Improvement of these mountain ranges would benefit not only livestock producers, but most of the people in the State. For besides livestock, these ranges yield important products and values like water, wildlife and recreation. These resources could be increased or enhanced by thickening and improving the vegetation for grazing. The ever increasing demands by the human population of the State for these wildland resources point up the need for developing mountain range lands to full capacity at the earliest possible date.

THE EXPERIMENTAL AREA AND STUDIES

The present studies were carried out in a fenced range unit on a representative area of cutover pine type at an altitude of about 6000 feet some 40 miles northwest of Susanville on the Lassen National Forest. The timber type provided good conditions for studying bunchgrass vegetation and several mountain range problems. Major emphasis in the studies was placed on getting information on the character of the range,
the grazing habits of cattle, the reaction of the range to grazing and to artificial clipping, and measuring the weight gains of the cattle throughout the grazing season as a basis for planning a desirable grazing system.

WEATHER

The climate of the locality is characterized by warm dry summers and cold snowy winters. From 1935 to 1951 precipitation for the 12 month season September 1 to August 31 averaged 17.64 inches.

Seventy-four percent of the total precipitation fell during the 7 months from September 1 to April 1, mainly as snow. Twenty-two percent (3.90 inches) fell during the active vegetative growing season from April 1 through June. Less than 1 inch fell during July, August, and September.

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

VEGETATION

Mountain ranges in the vicinity of Burgess Spring and in Northeastern California are usually covered by three main vegetation types - grasslands in valley bottoms, sagebrush on benchlands and gentle slopes surrounding valleys, and conifer timber - dominantly ponderosa and Jeffrey pine - on mountain sides.
The composition, yield and utilization of the principal forage plants on the study area are shown in Table 1. All these species depend on seed for reproduction. Idaho fescue (*Festuca idahoensis*) was grazed in greater amounts and more consistently throughout the season than any other species and was considered the key forage species on the range.

The seasonal growth and development of the vegetation can be illustrated with Idaho fescue. Plant growth begins about April 1, immediately after the winter snow pack melts, and ends about 120 days later in early August with ripening of seed. Flower stalks start to show above the basal leaves of the plants near the end of May. Half the total seasonal yield of herbage is produced by this time. The plants grow rapidly during the next 4 weeks. They flower and reach full height early in July. Maximum herbage yield is produced at seed-ripening time about a month later.

The plants start to lose moisture and green color in June, a little before flowering time. They dry rapidly during the first half of August. By October, both greenness and moisture content reached a minimum of about 10 percent.
Table 1.—Average yield and utilization of forage species in timber pasture, Burgess Spring Experimental Range, eight years — 1936 to 1938 and 1944 to 1946.

<table>
<thead>
<tr>
<th>Species</th>
<th>Yield*</th>
<th>Utilization</th>
<th>Proportion of Diet</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Pounds</td>
<td>Percent</td>
<td>Founds</td>
</tr>
<tr>
<td></td>
<td>Per Acre</td>
<td>of Total</td>
<td>Per Acre</td>
</tr>
<tr>
<td>Grasses and sedges</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Idaho fescue</td>
<td>77.6</td>
<td>24</td>
<td>23.1</td>
</tr>
<tr>
<td>Bottlebrush squirreltail</td>
<td>34.0</td>
<td>11</td>
<td>10.0</td>
</tr>
<tr>
<td>Needlegrasses</td>
<td>12.1</td>
<td>4</td>
<td>3.7</td>
</tr>
<tr>
<td>Sandberg bluegrass</td>
<td>6.5</td>
<td>2</td>
<td>2.3</td>
</tr>
<tr>
<td>Ross sedge</td>
<td>9.5</td>
<td>3</td>
<td>2.8</td>
</tr>
<tr>
<td>Mountain bromegrass</td>
<td>5.4</td>
<td>2</td>
<td>3.0</td>
</tr>
<tr>
<td>Cheatgrass</td>
<td>5.0</td>
<td>1</td>
<td>3.4</td>
</tr>
<tr>
<td>Others</td>
<td>T</td>
<td>T</td>
<td>0</td>
</tr>
<tr>
<td>Total</td>
<td>150.1</td>
<td>47</td>
<td>48.1</td>
</tr>
<tr>
<td>Average</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Forbs</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Woolly mules-ears</td>
<td>103.6</td>
<td>32</td>
<td>9.3</td>
</tr>
<tr>
<td>Longspur lupine</td>
<td>24.0</td>
<td>8</td>
<td>6.1</td>
</tr>
<tr>
<td>Arrowleaf balsamroot</td>
<td>3.7</td>
<td>1</td>
<td>0.7</td>
</tr>
<tr>
<td>Others</td>
<td>22.9</td>
<td>7</td>
<td>3.4</td>
</tr>
<tr>
<td>Total</td>
<td>154.2</td>
<td>49</td>
<td>21.5</td>
</tr>
<tr>
<td>Average</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Shrubs</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Antelope bitterbrush</td>
<td>10.0</td>
<td>3</td>
<td>8.9</td>
</tr>
<tr>
<td>Bloomer rabbitbrush</td>
<td>2.6</td>
<td>1</td>
<td>0.2</td>
</tr>
<tr>
<td>Others</td>
<td>2.1</td>
<td>1</td>
<td>0.3</td>
</tr>
<tr>
<td>Total</td>
<td>14.7</td>
<td>5</td>
<td>9.4</td>
</tr>
<tr>
<td>Average</td>
<td></td>
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<tr>
<td>Total all species</td>
<td>319.0</td>
<td>100</td>
<td>79.0</td>
</tr>
<tr>
<td>Average all species</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*Based on herbage above a stubble height of 1½ inches for grasses and forbs and on twig growth of current season for shrubs.

The species yields were determined from clippings in 1936, 1947, and 1948 and were estimated in the other years.
WHY REST IS ESSENTIAL IN MANAGEMENT OF GRAZING

It is a commonly known fact that plants can be killed if kept defoliated for a long enough period of time. Without top growth the plant is deprived of means of making food for itself.

Clipping studies with Idaho fescue showed that in a good growth year a single defoliation to a 1.5 inch stubble when the flower stalks were growing most rapidly was sufficient to kill the plant. Although less damaging clipping proved harmful at other growth stages, particularly during the growing period. Four years of continuous clipping at the seed-in-milk stage reduced the basal area of 10 marked plants 80 percent. These clipping results indicate that persistent defoliation to a 1.5 inch (or closer stubble) is destructive to Idaho fescue.

Now the questions may be raised - Is an appreciable number of the more desirable forage plants grazed this closely on the range under "normal" grazing - under moderate stocking, for example? If there are does it effect grazing capacity and if so is there any way of preventing such close use while livestock are grazing the range?

Answers to these questions were obtained from observations on the grazing habits of cattle during 1936, 1937 and 1938 and from more general observations on the pattern of use on the experimental area and adjoining ranges.
Cattle grazed the range selectively. They grazed particular forage species on particularly areas more closely and more consistently than others resulting in very uneven use of the range (Fig. 1). The pattern of use was governed by many factors like the palatability, abundance and growth stage of the plants, the location of the areas with respect to vegetation types, topography, water, fences, natural barriers, and other fixed factors of the environment, and stocking rate.

Figure 1.—Some areas on the range like that shown in the foreground here are cropped consistently closely year after year, while other areas like that in the background are only moderately or lightly grazed because of the grazing habits of cattle. This selective grazing is a prime factor in deterioration of the range.

Idaho fescue was utilized closely on some areas under conditions where the average use of the forage on the range as a whole was only 18 percent. The principal difference in the grazing pattern between heavy and light stocking was that more plants were grazed closely under heavy stocking than under light stocking. Under all levels of use some plants were grazed closely (Fig. 2), others moderately or lightly and some were not grazed at all.

Figure 2.—Some plants and areas on the range are grazed closely and destructively although the average utilization of the available forage species on the range as a whole may be light. Unfortunately plants on areas grazed closely one year tend to be grazed closely the next and ultimately killed. Most of the plants shown here are Idaho fescue.
Figure 1.—Some areas on the range like that shown in the foreground here are cropped consistently closely year after year, while other areas like that in the background are only moderately or lightly grazed because of the grazing habits of cattle. This selective grazing is a prime factor in deterioration of the range.
Figure 2.--Some plants and areas on the range are grazed closely and destructively although the average utilization of the available forage species on the range as a whole may be light. Unfortunately plants on areas grazed closely one year tend to be grazed closely the next and ultimately killed. Most of the plants shown here are Idaho fescue.
In 1949 Idaho fescue was grazed to average level of 43 percent (4 inch average stubble) in opening areas in the timber stand - when the average utilizations of all Idaho fescue on the range area - under trees as well as in openings - averaged 23 percent. This indicates the general preference of cattle for open areas in this type.

In the openings 40 percent of the Idaho fescue plants were 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 stubble. 15 percent of the plants were not grazed. Thus about 65 percent of the plants were grazed to a 1.5 inch or closer stubble. Furthermore, this close use was concentrated on particular areas that were preferred by the cattle or were most accessible to them. With some variation, the pattern of grazing was the essentially the same from year to year and even though different cattle were used each year.

Eight years of grazing by cattle on the experimental area during the eleven year period from 1936 to 1946 reduced the number of Idaho fescue plants in timber openings 21 percent. This amounted to a calculated 15-pound per acre loss of herbage production. The average level of utilization of all available forage in timber openings during the grazing periods was 31 percent.

-12-
Thus it is evident that there is a tendency for some plants on the range to be grazed closely year after year under continuous seasonal grazing and gradually killed out. If these plants are destroyed soil is left bare and exposed to erosion (Fig. 3) or is invaded by less desirable species. Livestock are then forced to graze less desirable forage plants or move on to less accessible areas. This process leads progressively to a poorer forage cover and to ever-enlarging areas of deterioration. Range breakdown is spotty, not only because of selective grazing, but also because some sites deteriorate more rapidly than others under the same grazing pressure. Evidence that ranges deteriorate in this general manner is stumped on practically every mountain range in northeastern California.

Figure 3.—Cutover pine timber land in poor range condition. Most of the desirable forage plants in this opening in the timber stand were killed out by close continuous grazing by cattle.

There is no apparent way of preventing selective grazing so long as the range is grazed. However, it appears that the harmful effects of selective grazing could be overcome by resting the range from grazing for sufficient periods to allow grazed plants to recover vigor and reproduce. Therefore, in addition to proper regulation of stocking rate, season of grazing and livestock distribution, there appears to be a need for resting ranges from grazing at certain times.
Figure 3.—Cutover pine timber land in poor range condition.
Most of the desirable forage plants in this opening in the timber stand were killed out by close continuous grazing by cattle.
APPLICATION OF REST IN MANAGEMENT OF GRAZING

The main immediate goal of resting ranges from grazing is to establish reproduction of the important forage species (Fig. 4). In reaching this goal it is necessary to step-by-step reestablish plant vigor, insure production of seed, and provide conditions favoring the establishment of new seedlings. (Fig. 5).

Figure 4.--Here numerous seedlings of Western Needlegrass (Stipa occidentalis) are germinating around a parent plant.

Establishment of reproduction of desirable forage species should be a prime objective in management of grazing, because establishment of reproduction over the range generally indicates that vigor of forage species has been reestablished, abundant seed produced, soil conditions improved and the production capacity of the range increased generally.

Figure 5.--Shown is an area in the cutover pine type that has been rested from grazing and is in good productive condition from a range standpoint. Rest from grazing reestablishes vigor of desirable forage species, encourages maximum herbage and seed production and provides for accumulation of litter and organic matter which prevent erosion and increase soil fertility.

Each of these steps can be assured, weather and the condition of the range permitting, by resting the range from grazing at the proper time.

The proper time and length of resting is determined by the growth requirements of the key forage species, - the species that is most desired on the range for forage and ground cover. All other forage species that have equal or less exacting growth requirements than the key species will be maintained by the amount of rest that satisfies the growth requirements of the key species.
Figure 4.--Here numerous seedlings of Western Needlegrass (*Stipa occidentalis*) are germinating around a parent plant. Establishment of reproduction of desirable forage species should be a prime objective in management of grazing, because establishment of reproduction over the range generally indicates that vigor of forage species has been reestablished, abundant seed produced, soil conditions improved and the production capacity of the range increased generally.
Figure 5.—Shown is an area in the cutover pine type that has been rested from grazing and is in good productive condition from a range standpoint. Rest from grazing reestablishes vigor of desirable forage species, encourages maximum herbage and seed production and provides for accumulation of litter and organic matter which prevent erosion and increase soil fertility.
Application of resting in management of grazing can be illustrated for a case where Idaho fescue is the key species. The clipping studies conducted here indicate the need for about two seasons of rest from grazing to restore plant vigor and insure ripening of seed of Idaho fescue. A minimum of an additional season of rest is indicated for establishment of seedlings.

SUBDIVISION OF RANGE NECESSARY

To apply rest at the proper time and to make it possible to graze the range each year the range has to be divided into units. The number of units is determined by the number of grazing and resting periods needed in a sequence of treatments that are aimed at establishment of reproduction. In a rest-rotation system based on the minimum growth requirements of Idaho fescue, four yearly resting and grazing treatments and therefore, four units are needed. In other situations depending on the growth requirements of the key species two or even three seasons of resting may be required for seedling establishment in which case a total of 5 or 6 units would be needed. In fact, observations on light rooting of Idaho fescue seedlings during the first year of growth suggest that two seasons of rest rather than one would be better for firm establishment of seedlings of Idaho fescue. The units should be about equal in grazing capacity.

RESTING AND GRAZING SCHEDULE

In a system based on the minimum requirements of Idaho fescue four resting and grazing treatments would be applied to each range unit over a four-year period in the sequence shown in Table 2.
Table 2. --Basic treatment schedule for a range unit.

<table>
<thead>
<tr>
<th>Year</th>
<th>Grazing treatment</th>
</tr>
</thead>
<tbody>
<tr>
<td>1st</td>
<td>A. Graze closely first half of season for maximum forage use.</td>
</tr>
<tr>
<td>2nd</td>
<td>B. Rest entire season to restore vigor of grazed plants.</td>
</tr>
<tr>
<td>3rd</td>
<td>C. Rest during first half of season to protect developing seed crop from being grazed. Graze closely during second half of season for maximum forage use and to get seed trampled in the soil.</td>
</tr>
<tr>
<td>4th</td>
<td>D. Rest entire season to insure establishment of seedlings.</td>
</tr>
</tbody>
</table>
Close grazing is desired in the first half of the first year so full use can be made of the available forage in the unit. This is followed by a season of resting to restore the vigor of the vegetation. Still another half season of rest is needed during the first half of the third season to protect the developing seed crop from being grazed. Close grazing is desirable in the second half of the third season to make full use of the available forage and to get seed trampled in the soil. Observations have shown that seeds worked into the soil have a much better chance of germinating and producing strong, well rooted, vigorous seedlings than seeds that lodge on the soil surface. Also, depressions in the soil caused by hoof prints collect seeds, litter and extra moisture and form favorable sites for seedling establishment.

A full season of rest is needed in the fourth year to protect the young tender seedlings from grazing and trampling. With this sequence of treatments the entire herbage growth of two seasons out of four is returned to the soil to maintain soil fertility and prevent erosion. Litter is deposited on all areas on the range—those usually grazed closely as well as on all others.

Close grazing in the present illustration has been arbitrarily defined as 66 percent use. In a four-unit system 66 percent use in two units means that the equivalent of 33 percent use is made on the forage on the entire range. In this system stocking of the range is based on the yield of herbage from all forage species on the range and not the key species alone.
The schedule of treatments for all four units during a four-year period is shown in Table 3. The cycle of treatments is started over again at the end of the fourth year and continued indefinitely. This sequence of treatments encourages establishment of reproduction in a different unit each year, weather permitting. One unit is always in a position to benefit from favorable growth years.

All the animals to be grazed on the range during any given season are placed in one unit at the beginning of the season and then shifted to another unit in mid-season for the remainder of the season. For example, in the first year in the schedule shown in Table 3 all the animals are placed in unit 1 the first half of the season and then moved to unit 3 in the second half of the season.

**PROVISION FOR YEARS OF LOW FORAGE PRODUCTION**

During years when herbage production is below average, one or all of the rested units can be opened to grazing, if necessary, in order to carry the livestock through the season. In a four-unit system, grazing could be continued with usual livestock number in years when herbage production is only half of normal.

In years when only part of the reserve vegetation is needed, the unit being rested season-long to restore plant vigor should be used first. If more reserve forage is needed, then the unit being rested to protect new seedlings can be used next. In this way reproduction is protected from grazing for as long a time as possible.

-21-
Table 3.—Schedule of grazing treatments for four units for four years in a four-unit rest-rotation grazing system.

<table>
<thead>
<tr>
<th>Year</th>
<th>Range Unit</th>
<th></th>
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<tbody>
<tr>
<td></td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>1st</td>
<td>1/2 graze</td>
<td>Rest</td>
<td>1/2 rest</td>
<td>Rest</td>
</tr>
<tr>
<td></td>
<td>1/2 rest</td>
<td></td>
<td>1/2 graze</td>
<td></td>
</tr>
<tr>
<td>2nd</td>
<td>Rest</td>
<td>1/2 rest</td>
<td>Rest</td>
<td>1/2 graze</td>
</tr>
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<td></td>
<td></td>
<td>1/2 graze</td>
<td></td>
<td>1/2 rest</td>
</tr>
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<td>3rd</td>
<td>1/2 rest</td>
<td>Rest</td>
<td>1/2 graze</td>
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<td>4th</td>
<td>Rest</td>
<td>1/2 graze</td>
<td>Rest</td>
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<tr>
<td></td>
<td></td>
<td>1/2 rest</td>
<td></td>
<td>1/2 graze</td>
</tr>
</tbody>
</table>
INTRODUCED SPECIES

There is no apparent reason why introduced forage species cannot be established and managed along with native species in a rest-rotation system without additional fences or other special management facilities provided the introduced species are adapted to the site and have about the same growth development as the key forage species. In a given year, seed of introduced species can be planted in the unit that is grazed the second half of the season.

HOW TO JUDGE EFFECTIVENESS OF GRAZING SYSTEM

From these studies it appears that establishment of new seedlings of forage species, particularly the key species, is the most important single criterion that can be used to judge whether or not a rest-rotation grazing system is effective in improving and maintaining bunchgrass type range. Numerous 2 and 3-year old seedlings in the spaces between older plants show that the range is improving, that adequate and properly timed rest is being provided and stocking is not too high. So long as reproduction of the main forage species, particularly the key species is becoming established, grazing capacity is increasing — or holding up to maximum if the range is in excellent condition. Conversely, the absence of seedlings shows that the range is static or deteriorating and that insufficient or improperly timed rest is being provided or stocking is too high.

The place to look for new seedlings is on areas that are moderately to closely grazed. For if seedlings are becoming established on these areas then likely they are becoming established on...
less heavily grazed areas.

After the range is reseeded with as dense a plant cover as the soil is capable of supporting in its current condition, one or all of the range units normally rested season long can be grazed to some extent from time to time for more efficient use of the vegetation. The amount of grazing that can be tolerated has to be determined by local conditions.

MAXIMUM LIVESTOCK PRODUCTION

The grazing system described in the preceding pages is designed to encourage maximum forage production on the range, which is the basis for maximum livestock production (Fig. 6). Within the limitations of the requirements of such a system maximum livestock production is obtained primarily by efficient utilization of the vegetation - through good distribution of livestock over the range, a desirable season of grazing and proper stocking.

| ALH-733 |

Figure 6.--Maximum livestock production is dependent on maximum forage production. A full cover of desirable forage species like that in the timber opening shown here, can be encouraged through proper management of grazing - particularly rest-rotation grazing.

LIVESTOCK DISTRIBUTION

Problems of livestock distribution are so closely tied to the specific range that it is not possible to generalize on the measures to use. In Northeastern California fencing, water, salting and riding are the principal measures used to get good distribution of livestock on cattle ranges. The need for subdividing the range into units in a rest-rotation grazing system
Figure 6.—Maximum livestock production is dependent on maximum forage production. A full cover of desirable forage species like that in the timber opening shown here, can be encouraged through proper management of grazing—particularly rest-rotation grazing.
restricts the movement of livestock on the range and narrows the problems of distribution down to areas within units.

**SEASON OF GRAZING AND STOCKING RATE**

The grazing season that is best suited to a particular situation is determined not only by the livestock-production potentialities of the season, but also by other considerations like: The time the particular area is used in the ranching operation, the condition and weight gains desired in the livestock and the livestock production desired per acre.

Knowledge of the rate of weight gains of livestock at various times during the season is the principal basis for determining a grazing season for a particular range. Information on the relation between the weight trend of yearling heifers grazed in the timber type and the growth and development of Idaho fescue is shown in Figure 7.

---

**Figure 7.** Cattle weight in relation to growth of Idaho fescue. *Average 1944-48, timber type, Burgess Spring Experimental Range.*

The cattle gained weight at a rate of 1.14 pounds per head per day the first 2 weeks after they were placed in the pasture on May 23. At that time the vegetation was about 4 inches tall. Judging from the weight trend, the cattle probably would have gained weight even earlier had they been placed in the pasture earlier. The rate of gain increased to 1.93 pounds per day when the flower stalks on the plants were about half developed. A maximum
Figure 7.—Cattle weights in relation to growth of Idaho fescue. Average 1944 to 1948 inclusive.

Timber pasture

Burgess Spring Experimental Range.

(One copy only. Attached to original)
rate of 2.29 pounds per day was reached just before flowering time in early July. Thereafter, the rate of gain decreased gradually until early October. Then the cattle started to lose weight. The rate of weight loss after peak weight was about the same as the rate of gain up to peak weight for a comparable period of time.

The average weight gains made by these yearling heifers during 5 seasons from 1944 to 1948 was 217 pounds per head or 1.61 pounds per head per day. The average grazing season spanned a period of 136 days from May 23 to October 6. The initial weight of the cattle was 421 pounds.

This trend bears out the general conclusion drawn by many investigators from chemical analyses and livestock digestion trials that the nutritive value of range herbage for livestock is highest when the plants are green and growing rapidly and decreases as the plants mature and dry.

It is apparent from the weight trend that the amount of weight gained by cattle during the season and the livestock production per acre depend both on the length of the season and the particular period of the vegetative growing season encompassed in the grazing season. To illustrate the longest practical period that ranges can be grazed in the Burgess Spring locality is about 5 months, starting May 2 when the vegetation is 3 inches tall and ending September 20 when cattle start losing weight. It has been calculated that this season would produce 234 pounds gain per animal and 8.0 pounds of livestock per acre in the timber type. A 4-month grazing season
starting on May 22 when the flower stalks of Idaho fescue are in mid-boot would produce 212 pounds gain per animal and 9.6 pounds of livestock per acre. Thus although the seasonal weight gain of the individual animal is 9 percent less under the 4-month season than under the 5-month season, livestock production per acre is 17 percent greater. The choice of seasons is up to the range operator.

The amount of herbage and livestock that could be produced under optimum 1-, 2-, 3-, 4-, and 5-month-long grazing seasons and correlated stocking rates were calculated from data collected in the timber type (Table 4). These figures can serve as a general guide for selecting grazing seasons for Northeastern California bunchgrass ranges, if the beginning and ending dates of the growing seasons are interpreted on terms of plant growth stages.

The upper limit of stocking for any grazing season is determined by the heaviest utilization that the range can stand without deterioration. This upper limit cannot be specified very accurately nor checked prior to actual utilization of the specific range. If, within the framework of a sound rest-rotation system establishment of reproduction of the better forage species is being prevented over the range generally then the range can be considered over stocked. If reproduction is becoming established on all areas on the range the range can be considered under stocked or properly stocked.

In a rest-rotation grazing system sixty-five to seventy percent utilization of grazed units appears to be a reasonable upper limit of use for Northeastern California bunchgrass ranges. This level
of grazing use is possible because it is not sustained for any extended period of time but is followed after one season by resting. Lacking more specific information, stocking of a range can be planned on this basis. Adjustments can be made later on the basis of range and livestock responses. Weight records should be obtained on livestock, if at all possible, so as to leave no doubt of the yield of the final salable product from the range.

In a rest-rotation grazing system therefore, maintenance of the range is dependent mainly on rest from grazing. The amount and timing of rest are based on the growth requirements of the key forage species on the range and are controlled by subdivisions of the range. Efficient forage utilization and maximum livestock production within the framework of this system are governed primarily by proper stocking, the right season of grazing and good livestock distribution.
SUMMARY

A livestock grazing system applicable to mountain bunchgrass ranges was developed from studies conducted at the Burgess Spring Experimental Range in Lassen County, Northeastern California, over a 16 year period from 1936 to 1951. The system was developed on cattle range.

This system called the rest-rotation grazing system takes the factor of rest from grazing into consideration in management of grazing in addition to the conventional factors of stocking rate, season of grazing and livestock distribution. The need for rest was indicated by observations on the grazing habits of cattle. Cattle grazed certain species of plants on certain areas closely whether stocking of the range as a whole was heavy or light. Furthermore, the pattern of use was about the same from one year to the next. Under this kind of use the better forage plants tended to be weakened and gradually killed out, resulting in deterioration of the range and loss of grazing capacity.

It was concluded that selective grazing cannot be avoided so long as the range is grazed, but that the harmful effects of selective grazing could be counteracted by resting the range from grazing at suitable intervals. A system of rest-rotation grazing was formulated on this basic premise. The timing and duration of rest in this system is based on the growth requirements of the
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It was concluded that selective grazing cannot be avoided so long as the range is grazed, but that the harmful effects of selective grazing could be counteracted by resting the range from grazing at suitable intervals. A system of rest-rotation grazing was formulated on this basic premise. The timing and duration of rest in this system is based on the growth requirements of the
vegetation - in fact on the requirements of the one species on the 
range most desired for forage and soil cover. The main purpose of 
the rest periods is to allow the plants to recover vigor after a 
period of grazing, produce seed and establish new reproduction. 

To provide the needed rest at the proper time, it is necessary 
to subdivide the range into units, some of which are rested and others 
grazed each year. Different units are grazed and rested in rotation 
in different years. The basis for determining the number of units 
needed, the timing of resting and grazing and other details of the 
system are described in the text. A practical scale test of the 
proposed rest-rotation grazing system is under way at the present 
time on the Harvey Valley cattle allotment on the Lassen National 
Forest.
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-33-
A. L. HORMAY

R-CAL-PUBLICATIONS, Hormay, A. L., Rest Rotation Grazing ---

CLYDE:

Attached is a "quick shrunk" job on the Burgess Spring miscellaneous paper. Your comments on the first draft were very helpful. I got your general idea and agree with it but find it difficult to put in words. The same old trouble — it's sure hard to write with or without distractions. But I think I can make headway more rapidly if I redraft quickly and get reaction like yours to the over-all structure and content, leaving refinement of wording till later. Perhaps with no more than another exchange, this manuscript should go. I'll appreciate your comments on the attached as soon as you can get to it.

Attach.
REST ROTATION GRAZING — — —

A MANAGEMENT SYSTEM FOR BUNCHGRASS RANGES

By

August L. Hormay, Forester
Sueville Research Center

FOR PUBLICATION

CALIFORNIA FOREST AND RANGE EXPERIMENT STATION
FOREST SERVICE, U.S. DEPARTMENT OF AGRICULTURE
REST ROTATION GRAZING — —

A MANAGEMENT SYSTEM FOR BUNCHGRASS RANGES

By August L. Horsay, Forester

Susanville Research Center

1/ The writer wishes to thank the many persons who helped carry out the studies that form the basis of this report, particularly T. S. Brown, the Lassen County Farm Advisor, who assisted with livestock phases; the Cone Range Company, Red Bluff, 1935-38; F. Updike, Hat Creek, 1939; F. McClelland, Standish, 1943-47; L. Jefcoat, Manton, 1948-49; and T. Clayton, Vina, 1951, all Lassen Forest permittees who furnished the cattle and cooperated in other ways; the Lassen National Forest, and many co-workers.

INTRODUCTION

Profitable range livestock production depends on production of maximum native forage on the range. Knowledge of how this forage can be increased and maintained is essential to the stockmen and range managers. The sustained production of natural forage on ranges depends almost entirely on proper management of grazing.

Fifteen years of research at the Burgess Spring Experimental Range in Lassen County in Northeastern California from 1936 to 1951 has yielded a new grazing system which offers much promise of increasing and maintaining forage production on mountain bunchgrass ranges. This system — called rest-rotation grazing — is described in this publication. The basis for it/ from detailed small-scale studies. It is now being tested on a pilot basis on a 32,000 acre cattle range — the Harvey Valley allotment — on the

-1-
Lassen National Forest. The test is in the seventh year and is yielding encouraging results. The system was worked out on cattle ranges but its principles can be applied to sheep ranges as well.

**RESTING - MAIN FEATURE OF GRAZING SYSTEM**

The factor in the system which more than any other is designed to increase forage production and improve the condition of the range is **rest** - rest from grazing. The idea of resting ranges from grazing is not new. It has been provided for in other grazing systems. Sampson,² in 1914, developed the deferred-rotation grazing system, which include some rest and is applicable to range lands. The present system however calls for longer rest periods than have been recommended heretofore and closer correlation of resting with growth requirements of the vegetation.

**GRAZING SYSTEM DEVELOPED FOR ROUGH RANGES**

Rest-rotation grazing was designed especially for rough mountain ranges where uniform grazing is out of question. The studies that form the basis of the system were carried out on an area of cut-over pine type at an elevation of 6,000 feet, some 40 miles north of Susanville. Ranges in this locality are mountainous and are covered by three main vegetation types.

² Sampson, A. W., 1914
grasslands, located usually in valley bottoms, sagebrush and juniper on benchlands and gentle slopes and conifer timber - principally ponderosa and Jeffrey pine (Pinus ponderosa, P. jeffreyi) on mountain sides. Idaho fescue (Festuca idahoensis) is the key forage species in the pine type. It is a typical bunchgrass and reproduces from seed. Over 95 percent of the vegetation suitable for livestock grazing on mountain ranges in Northeastern California depends on seed for reproduction.

Precipitation in this region averages between 17 and 18 inches a year. Most of it falls as snow from November to April. The summers are warm and dry. Less than one inch of precipitation falls during July, August and September. The vegetation growing season spans the period from the beginning of April to the beginning of August. The vegetation grows most rapidly in June, ripens seed in early August and dries rapidly thereafter. These ranges are used by livestock mainly between June 1 and October 1.

WHY REST IS NEEDED

Ranges need rest from grazing because grazing in almost any practical amounts is damaging to the vegetation. It is a commonly known fact that plants can be killed if kept defoliated for a long enough period of time because without top growth the plant is deprived of means of making food for itself. Clipping studies with Idaho fescue, for example, showed that persistent
defoliation to a 1.5 inch stubble was destructive to this species. In a particular kind of growth year a single defoliation to a 1.5 inch stubble when the plant was growing rapidly was sufficient to kill the plant. Although less damaging clipping was harmful at other growth stages, particularly during the growing period. Four years of continuous clipping at the seed-in-milk stage reduced the basal area of a group of plants 60 percent. Such close persistent cropping occurs on the range so the question may be asked, How does it occur? Is it harmful? and if so, Can it be avoided?

Answers to these questions were obtained from observations on the grazing habits of cattle and the effect of cattle grazing on the vegetation.

**HOW CATTLE GRAZE THE RANGE**

Cattle were found to graze the range very selectively. They grazed particular forage species on particular areas in preference to others resulting in very uneven use of the vegetation. (Fig. 1). There was great variation in utilization even of one species on a given site. In one year for example, 40 percent of the Idaho fescue plants in timber openings were 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 stubble. 15 percent of the plants were not grazed.

Figure 1.--Some areas on the range like that shown in the foreground here are cropped consistently closely year after year, while other areas like that in the background are only moderately or lightly grazed because of the grazing habits of cattle. This selective grazing is a prime factor in deterioration of the range.
Figure 1.---Some areas on the range like that shown in the foreground here are cropped consistently closely year after year, while other areas like that in the background are only moderately or lightly grazed because of the grazing habits of cattle. This selective grazing is a prime factor in deterioration of the range.
Plants on some readily accessible or preferred areas were grazed closely whether stocking on the range was light or heavy. Openings in the timber stand, for example, were grazed consistently more closely than areas under trees and some openings were grazed more closely than others. Use in some openings was destructively close when the range as a whole was utilized only 18 percent. The broad pattern of use stemming from selective grazing was similar from one year to the next even though different cattle were grazed on the range each year.

Thus because of the inherent grazing habits of cattle, plants on some areas on the range are grazed closely even under moderate or light stocking of the range as a whole. Continuous grazing of this kind results in loss of forage production.

**EFFECT OF SELECTIVE GRAZING ON FORAGE PRODUCTION**

Eight years of comparatively moderate utilization (averaging 31 percent) of the available forage in open areas in the timber stand, reduced the density of Idaho fescue in openings 21 percent. (Fig. 2.) This amounted to a loss of about 25 pounds of forage production per acre. The reduction in stand occurred principally on the more accessible, preferred grazing areas.

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Figure 2.—A large portion of the Idaho fescue tufts shown on this area have been killed by cattle grazing. Cattle prefer certain areas like this and graze them closely almost every year. Such persistent close grazing kills out the better forage species.
Figure 2.—A large portion of the Idaho fescue tufts shown on this area have been killed by cattle grazing. Cattle prefer certain areas like this and graze them closely almost every year. Such persistent close cropping kills out the better forage species.
Selective grazing leads to ever enlarging areas of deterioration because, as the better forage plants are destroyed on preferred grazing areas, livestock are forced to graze on less desirable forage plants or move on to less accessible areas. That ranges deteriorate in this manner is evident on practically every mountain range in northeastern California.

**SOLUTION TO PROBLEM OF RANGE IMPROVEMENT**

The heart of the solution of the problem of range improvement lies in preventing the first step in range deterioration - namely, preventing the destruction of choice forage species on preferred grazing areas. From the foregoing it is quite evident that there is no way of preventing selective grazing or controlling it sufficiently to prevent damage to the ranges so long as the range is grazed. However, the harmful effects of grazing can be overcome by resting the range from grazing for sufficient periods to allow plants - all plants on all areas - to recover vigor and reproduce. In addition to proper stocking, proper season of grazing and good livestock distribution, periodic resting of the range from grazing, therefore, appears essential for range improvement.

**APPLICATION OF REST IN MANAGEMENT OF GRAZING**

On bunchgrass ranges, increased forage production and range improvement generally, are dependent on continuous establishment of new reproduction of the better forage species. To get this reproduction, vigor must be restored in grazed plants so they can
produce abundant viable seeds. The seed crop must be protected from grazing until ripe. Similarly, the young seedlings must be protected from grazing until they can withstand the grazing and trampling to which they are to be subjected. To accomplish these things, the range must be rested from grazing at particular times and for particular periods.

The duration and timing of resting is determined by the growth requirements of the key forage species, the one species that is most desired on the range for forage and ground cover. All other forage species that have equal or less exacting growth requirements than the key species will be maintained by the amount of rest that satisfies the growth requirements of the key species.

ILLUSTRATION OF GRAZING SYSTEM

A grazing plan based on growth requirements of Idaho fescue is outlined in the following pages to illustrate the principals in a rest-rotation grazing system.

Resting and Plant Requirements

The clipping studies and range observations indicated that two full growing seasons of rest from grazing are needed by Idaho fescue to recover vigor and produce seed. A minimum of still another season of rest is needed to insure firm establishment of seedlings. In this case, four yearly grazing and resting treatments applied in the order shown in Table I are needed to get reproduction started.
Table 1.--Treatment schedule for a range unit.

<table>
<thead>
<tr>
<th>Year</th>
<th>Treatment</th>
</tr>
</thead>
<tbody>
<tr>
<td>1st</td>
<td>Graze closely first half of season for maximum forage use. Rest from grazing second half of season.</td>
</tr>
<tr>
<td>2nd</td>
<td>Rest entire season to restore vigor of grazed plants.</td>
</tr>
<tr>
<td>3rd</td>
<td>Rest during first half of season to protect developing seed crop from grazing. Graze closely during second half of season for maximum forage use and to get seed trampled in the soil.</td>
</tr>
<tr>
<td>4th</td>
<td>Rest entire season to insure establishment of seedlings.</td>
</tr>
</tbody>
</table>
Intensity and duration of grazing as well as rest periods are significant in this schedule. They bear both on the improvement and efficient use of the range.

The range is grazed closely the first half of the first year so full use can be made of the available forage. Rest is needed the entire second year to restore the vigor of the vegetation. Still another half season of rest is needed during the first half of the third season to protect the developing seed crop from grazing. The range is grazed closely in the second half of the third season so full use can again be made of the available forage. The comparatively heavy trampling associated with close grazing during this period is desired because trampling is a means of getting seed worked into the soil. Observations have shown that seeds that are buried in the soil have a much better chance of germinating and producing well rooted, vigorous seedlings than seeds that lodge on the soil surface. A full season of rest is needed in the fourth year to protect the young seedlings from grazing and trampling.

In this schedule the entire herbage production of two seasons out of four is returned to the range - on areas usually closely grazed as well as all others - to build soil fertility and prevent erosion.

**Subdivision of Range Necessary**

To provide rest at the proper time and to make it possible to graze the range with a given number of livestock each year the range has to be divided into units. The number of units is
determined by the number yearly treatments applied to the range. In the plan based on Idaho fescue for example, four yearly treatments are needed (Table 2), so four units are needed.

Five, 6 or even 7 units may be required in a plan based on another species. The units should be about equal in grazing capacity.

**Coordination of Grazing Among Units**

The treatments called for in different units during a four year cycle in a plan based on Idaho fescue is shown in Table 2. All the animals to be grazed on the range during any given season are placed in one unit at the beginning of the season and then shifted to another unit in mid-season for the remainder of the season. For example, in the first year in the schedule shown in Table 2, all the animals are placed in unit 1 the first half of the season and then moved to unit 3 in the second half of the season. The cycle of treatments is started over again at the end of the fourth year and continued indefinitely. Each year the stage is set for the establishment of reproduction in one unit, weather and site conditions permitting.

**Flexibility of System**

During the years when herbage production is below average, one or all of the rested units can be opened to grazing, if necessary, in order to carry the livestock through the season. The unit rested to protect new seedlings should be used only as a last resort. In a four-unit plan, grazing could be continued with usual livestock numbers in years when herbage production is only half of normal.
Table 2.--Schedule of grazing treatments for four years for a four-unit rest-rotation grazing plan based on Idaho fascia.

<table>
<thead>
<tr>
<th>Year</th>
<th>Range Unit 1</th>
<th>Range Unit 2</th>
<th>Range Unit 3</th>
<th>Range Unit 4</th>
</tr>
</thead>
<tbody>
<tr>
<td>1st</td>
<td>1/2 graze</td>
<td>Rest</td>
<td>1/2 rest</td>
<td>Rest</td>
</tr>
<tr>
<td></td>
<td>1/2 rest</td>
<td></td>
<td>1/2 graze</td>
<td></td>
</tr>
<tr>
<td>2nd</td>
<td>Rest</td>
<td>1/2 rest</td>
<td>Rest</td>
<td>1/2 graze</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1/2 graze</td>
<td></td>
<td>1/2 rest</td>
</tr>
<tr>
<td>3rd</td>
<td>1/2 rest</td>
<td>Rest</td>
<td>1/2 graze</td>
<td>Rest</td>
</tr>
<tr>
<td></td>
<td>1/2 graze</td>
<td></td>
<td>1/2 rest</td>
<td></td>
</tr>
<tr>
<td>4th</td>
<td>Rest</td>
<td>1/2 graze</td>
<td>Rest</td>
<td>1/2 rest</td>
</tr>
<tr>
<td></td>
<td>1/2 rest</td>
<td></td>
<td>1/2 graze</td>
<td></td>
</tr>
</tbody>
</table>
Also, after the range is revegetated with as dense a cover as the soil is capable of supporting in its current condition, one or all of the units usually rested can be grazed to some extent from time to time for greater use of the vegetation. The amount of grazing that can be tolerated has to be determined by local conditions.

There is no apparent reason why introduced forage species cannot be established and managed along with native species in a rest-rotation system without additional management facilities. In the above plan, seed of introduced species can be planted in the unit that is grazed the second half of the season.

**MAXIMUM LIVESTOCK PRODUCTION**

It should be reemphasized that the rest-rotation grazing system outlined in the preceding pages is designed to increase and maintain forage production. Within the framework of this system maximum livestock production is obtained through use of a suitable grazing season, judicious stocking and good livestock distribution.

**SEASON OF GRAZING**

Between the time the vegetation is tall enough for grazing in spring and livestock start losing weight in the fall, mountain ranges can be used during many different seasons. The range can be grazed with comparatively large numbers of animals for short seasons or with small numbers for long seasons.
The season that is best suited to a given situation depends not only on the livestock production potentialities of the season and on other considerations like when the range can be used to best advantage in relation to the whole ranching operation. Information obtained at the Burgess Spring Experimental Range on the relationship between cattle weight gains and plant development during the season provides a basis for making a choice of season.

The average seasonal weight trend of yearling heifers grazed in the timber type in 5 different years in relation to the development of the vegetation is shown in Figure 3.

Figure 3.--Cattle weights in relation to growth of Idaho fescue. Average 1944 to 1948 inclusive. Timber pasture, Burgess Spring Experimental Range.

The cattle gained 1.14 pounds per head per day the first two weeks after they were placed on the range. At that time the vegetation was in the leaf stage and about 4 inches tall. The rate of gain increased to 1.95 pounds per day when flower stalks were half developed and to a maximum of 2.29 pounds per day just before flowering time. The rate of gain decreased gradually thereafter as the vegetation matured and dried. The cattle stopped gaining weight early in October and lost weight at an accelerated rate thereafter until removed from the range.

This curve shows that the rate of cattle weight gain changes continuously throughout the season with the development of the vegetation, and that the nutritive value of the vegetation is
Figure 3.—Cattle weights in relation to growth of Idaho fescue. Average 1944 to 1946 inclusive. Timber pasture, Burgess Spring Experimental Range.

(One copy only. Attached to original)
highest when the vegetation is green and growing rapidly and 
decreases as the vegetation matures and dries. The relative 
weight producing value of the vegetation therefore can be judged 
in relation to the growth stage of the vegetation.

The weight of livestock that could be produced under 
optimum 1-, 2-, 3-, 4-, and 5-month-long grazing seasons and 
correlated stocking rates were calculated from data collected 
in the timber type (Table 3). These figures can serve as a general 
guide for selecting grazing seasons for Northeastern California 
bunchgrass ranges, if the beginning and ending dates of the 
growing seasons are interpreted on terms of plant growth stages.

STOCKING

The upper limit of stocking for any grazing season is 
determined by the heaviest utilization that the range can stand 
without deterioration. This upper limit cannot be determined 
readily by any method prior to actual use of the range.

In a rest-rotation grazing system sixty-five to seventy 
percent utilization of all the available forage in the units to be 
grazed appears to be a reasonable upper limit of use for Northeastern 
California bunchgrass ranges. This comparatively high level of use 
can be tolerated because it is not sustained for any long period of 
time but is interrupted by rest periods. Lacking more specific 
information, stocking of a range can be planned on this level of 
utilization at the end of the grazing season and adjusted later 
after range and livestock responses can be observed.
<table>
<thead>
<tr>
<th>Month</th>
<th>Date</th>
<th>Length</th>
<th>Par value</th>
<th>No. of Growth Stages</th>
<th>Purity of Gene Pool</th>
<th>Gene Pool Length</th>
</tr>
</thead>
<tbody>
<tr>
<td>June 21</td>
<td>July 7</td>
<td>2</td>
<td>4.2</td>
<td>4.5</td>
<td>4.5</td>
<td>4.5</td>
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<td>June 22</td>
<td>July 8</td>
<td>2</td>
<td>4.2</td>
<td>4.5</td>
<td>4.5</td>
<td>4.5</td>
</tr>
<tr>
<td>June 23</td>
<td>July 9</td>
<td>2</td>
<td>4.2</td>
<td>4.5</td>
<td>4.5</td>
<td>4.5</td>
</tr>
</tbody>
</table>

For the purpose of breeding, the first stage of growth, as determined by the number of gene pools and the purity of the gene pool, is 70 percent of the total growth stage. For the purpose of production, the first stage of growth, as determined by the number of gene pools and the purity of the gene pool, is 70 percent of the total growth stage.
LIVESTOCK DISTRIBUTION

Problems of livestock distribution tie so closely to the specific range that it is not possible to generalize on measures to use. In Northeastern California, fencing, water, salt ing and riding are the principal methods used to get good distribution of cattle on ranges.

The distribution problem on cattle ranges is reduced with the use of a rest-rotation grazing system because the range has to be subdivided into units. Distribution problems narrow down to areas within units. Where the units are small the problems may be inconsequential.

HOW TO JUDGE EFFECTIVENESS OF GRAZING SYSTEM

A rest-rotation grazing system should be judged in

two steps - first by whether it is increasing forage and
grazing capacity and second, by whether it is producing acceptable livestock weight gains and production per acre. The most important single criterion that can be used to judge whether the system is increasing grazing capacity is establishment of reproduction of forage species (Fig. 4). Establishment of reproduction reflects recovery of vigor of established plants, improvement of soil and an upward trend in the condition of the range.

Figure 4.—Here numerous seedlings of Western Needlegrass (Stipa occidentalis) are germinating around a parent plant. Establishment of reproduction of desirable forage species is the principal criterion that can be used to judge the effectiveness of a rest-rotation grazing system in increasing forage production and grazing capacity.
Figure 4.—Here numerous seedlings of Western Needlegrass (Stipa occidentalis) are germinating around a parent plant. Establishment of reproduction of desirable forage species is the principal criterion that can be used to judge the effectiveness of a rest-rotation grazing system in increasing forage production and grazing capacity.
Numerous 2 and 3-year old and larger seedlings in the spaces between older plants over the range generally show that the range is improving, that adequate and properly timed rest is being provided and that stocking is not too high. Conversely, absence of seedlings shows that the range is static or deteriorating and that insufficient or improperly timed rest is being provided or stocking is too high. The place to look for new seedlings is on areas that are moderately to closely grazed. If seedlings are becoming established on these areas then likely they are becoming established on less heavily grazed areas.

In appraising livestock production, weight gain and condition of the animals, and production per acre should all be taken into consideration. Reliable information on weight gains can be obtained only by weighing the animals.
SUMMARY

A livestock grazing system applicable to mountain bunchgrass ranges was developed from studies conducted at the Burgess Spring Experimental Range in Lassen County, Northeastern California from 1936 to 1951. The system was developed on cattle range, but can also be applied to sheep ranges.

This system is called rest-rotation grazing. Its main feature is the inclusion of the factor of rest in management of grazing in addition to the conventional factors of stocking rate, season of grazing and livestock distribution. The need for rest stems from the selective grazing habits of cattle which is destructive to the range. Cattle grazed certain species of plants on certain areas closely whether stocking of the range as a whole was heavy or light. The pattern of use was about the same from one year to the next. Under this kind of use the better forage plants tended to be weakened and killed out, resulting in loss of grazing capacity.

It was concluded that selective grazing cannot be avoided so long as the range is grazed, but that the harmful effects of such grazing could be counteracted by resting the range from grazing at suitable intervals. A system of rest-rotation grazing was formulated on this premise. The timing and duration of rest is based on the growth requirements of the key forage species on the range—the one species most desired for forage and soil cover. The main purpose of resting is to allow plants to recover
vigor after a period of grazing, produce seed and establish new reproduction.

To provide the needed rest at the proper time, it is necessary to subdivide the range into units, some of which are rested and others grazed each year. Different units are grazed and rested in rotation in different years. The basis for determining the number of units needed, the timing of resting and grazing and other details of the system are described in the text.

A method of appraising the effectiveness of the grazing system in increasing grazing and of getting maximum livestock production within the requirements of the system are also described. A practical scale test of the grazing system is under way at the present time on the Harvey Valley cattle allotment on the Lassen National Forest, and is yielding encouraging results.