UNITED STATES DEPARTMENT OF AGRICULTURE

# FOREST SERVICE

STUDY PLAN

HARVEY VALLEY EXPERIMENTAL RANGE

A. L. HORMAY

4/23/56

M—5123 U. S. GOVERNMENT PRINTING OFFICE 8—7417

CONTENTS

NR-CAL
RESEARCH PROGRAM
General

A. L. Hormay
8/4/51 Rev. 4/23/56

# STUDY PLAN
# HARVEY VALLEY EXPERIMENTAL RANGE

## PURPOSE AND SCOPE OF STUDY

Range deterioration is a major problem on mountain summer ranges in northeastern California . Loss in range production capacity is evident in low forage density, a high percentage of inferior and worthless grazing species in the vegetation cover and soil erosion. It is estimated that mountain ranges in this region are producting only about 50 percent of former or potential capacity.

Improvement of these ranges is dependent on proper management of grazing and the application of cultural practices like artificial reseeding and obnoxious plant control. Grazing management is most important because maintenance of all forage on the range is dependent on proper grazing.

A system of grazing management that promises to restore the production capacity and promote maximum use of mountain summer ranges was developed on the basis of plot and small pasture studies at the Burgess Spring Experimental Range in northeastern California from 1935 to 1951. The purpose of the present study is to test the effectiveness of the Burgess Spring grazing plan on a practical scale. The study will be carried out in cooperation with the Lassen National Forest, the Regional Office, Lassen forest grazing permittees, Agricultural Research Service, and the Lassen County Farm Advisor.

## IMPORTANCE OF STUDY

From about 1860 to 1905 mountain ranges in northeastern California were grazed by large numbers of cattle and sheep without supervision. These ranges were part of the public domain and open to grazing without cost, so stockmen grazed large numbers of livestock on them for as long a season as possible year after year. This led to heavy range deterioration which is still evident today. Even after the national forests were established in 1905 many of these ranges continued to deteriorate under the grazing management practices used. In fact, as late as 1936 when the Burgess Spring studies were started fully satisfactory methods of managing grazing had not been developed.

The principles of grazing management developed from the Burgess Spring studies and to be tested on the Harvey Valley allotment promise to increase the carrying capacity of these ranges. These principles can be applied on mountain ranges throughout the State. Improvement of mountain ranges for livestock grazing can lead to benefits that have far reaching influence on the economy of the entire State. A full vegetation cover provides not only sustained livestock production but better watershed function and enhancement of wildlife and recreation values.

## THE EXPERIMENTAL ALLOTMENT

The study will be conducted on the Harvey Valley cattle allotment on the Lassen National Forest located some 40 miles northwest of Susanville. The Burgess Spring Experimental Range is located in the northeast corner of this allotment.

The Harvey Valley allotment covers 32,352 acres of which 20,645 are estimated to be usable by cattle. The allotment is quite diverse with respect to vegetation, soils, and topography as indicated in tables 1, 2, and 3.

Table 1.--Principal vegetation types

| Name | Acres | Percent |
|---|---|---|
| Grassland | 505 | 1.5 |
| Meadow | 1,322 | 4.1 |
| Sagebrush | 4,105 | 12.7 |
| Conifer | 14,713 | 45.5 |
| Waste | 11,707 | 36.2 |
| Total | 32,352 | 100.0 |
| Usable range | 20,645 | |

Table 2.--Principal soil types

| Series name | Acres | Percent |
|---|---|---|
| Pit | 360 | 1.1 |
| Antelope | 1,452 | 4.5 |
| Meadow | 257 | 0.8 |
| Medoc | 1,086 | 3.2 |
| Bieber | 464 | 1.4 |
| Hanks | 3,337 | 10.3 |
| Patterson | 24,406 | 75.5 |
| Scabland | 1,050 | 3.2 |
| Total | 32,352 | 100.00 |

Table 3.--Slope

| Slope class | Acres | Percent |
|---|---|---|
| 0 to 3% | 4,628 | 14.3 |
| 4 to 9% | 4,085 | 12.5 |
| 10 to 20% | 5,542 | 17.1 |
| 20% plus | 18,157 | 56.1 |
| Total | 32,352 | 100.0 |

Almost half of the usable area is covered by coniferous timber types, 13 percent by sagebrush types, and a little over 5 percent by grassland types. Over 97 percent of the herbaceous vegetation is made up of bunchgrass type species. Only about 3 percent consists of sod species which are located mainly in meadow areas. The soils on these ranges vary from light, well-drained loams on upland areas to heavy clays and adobes in drainage basins. Over half the allotment is mountainous with slopes exceeding 20 percent. Fourteen percent is nearly flat.

About 17 percent of the allotment is in excellent condition (table 4). A little over half is in good condition. Twenty seven percent mainly in the sagebrush types is in fair or poor condition. There is, therefore, considerable room for improving the condition and grazing capacity of the allotment.

Table 4.--Condition of usable range by vegetation types

| Vegetation type | Range condition | | | | |
|---|---|---|---|---|---|
| | Excellent | Good | Fair | Poor | Total |
| | Acres | Acres | Acres | Acres | |
| Dry Grassland | | | 266 | 239 | 505 |
| Meadow | 142 | 935 | 118 | 127 | 1372 |
| Sagebrush | | | 719 | 3,386 | 4105 |
| Conifer | 3,280 | 10,700 | 718 | 15 | 14,713 |
| Total | 3,422 | 11,635 | 1,821 | 3,767 | 20,645 |
| Percent | 17 | 56 | 9 | 18 | 100 |

## Stocking and Season of Grazing

The allotment has been grazed by a mixed herd of Hereford cattle--mainly by cows and calves--for many years. The permitted numbers have been 500 animal units. A cow and a calf under six months of age has been counted as an animal unit. The grazing season is from June 1 to September 30. The present study will be initiated with the same general kind of cattle, the same stocking rate, and essentially the same season of grazing used in the past.

## Grazing Plan

One of the main objectives of the grazing plan is to promote regular establishment of reproduction of desirable forage species for with reproduction establishment the range will ultimately build up to maximum grazing capacity. The grazing plan provides for reproduction establishment thru periodic resting of the range from grazing.

The timing of resting and grazing is based on the growth requirements of the key forage species on the range--Idaho fescue. This species is more susceptible to grazing injury than most of the other forage species growing with it on the range. Most forage species on the range, therefore, will be maintained by a grazing plan that maintains Idaho fescue.

The range will be subdivided into five units of equal grazing capacity. Three units will be grazed and two rested each year. The range will be stocked to get 33 percent use of the forage on the allotment.

During a 5-year period each range unit will be grazed as shown in table 5. Close grazing (60 to 70 percent) will be employed the first season to insure full use of the available forage. Rest will be provided the entire second season and half of the third to permit the grazed plants to recover vigor and produce seed. Close grazing will be used during the latter half of the third season to get as much seed as possible trampled into the soil. The unit will be rested the fourth season to give the young seedlings a chance to become established. Moderate grazing (30 to 35 percent) will be employed the first half of the fifth season to give the young plants further opportunity of becoming established.

The grazing schedule for all five units during a 5-year cycle is shown in table 6. This sequence of grazing will be repeated every five years indefinitely. The proposed stocking and grazing schedule for the Harvey Valley allotment up to 1960 is shown in table 7.

Table 5.--Schedule of grazing for any one unit during a 5-year cycle

| Year | Treatment | Character of treatment | Main purpose of treatment |
|---|---|---|---|
| 1st | A | Close use season-long | Maximum forage utilization |
| 2nd | B | Rest season-long | Recovery of plant vigor |
| 3rd | C | Rest until mid-season | Permit plants to ripen seed |
| | | Graze heavily second half of season | Trample seed into the soil and forage utilization |
| 4th | D | Rest season-long | Aid establishment of new reproduction |
| 5th | E | Graze moderately until mid-season and rest second half of season | Aid establishment of new reproduction |

Table 6.--Schedule of grazing of five units during a 5-year cycle

| Year | Range unit 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|---|
| | Treatment[1/] | | | | |
| 1st | A | B | C | D | E |
| 2nd | B | C | D | E | A |
| 3rd | C | D | E | A | B |
| 4th | D | E | A | B | C |
| 5th | E | A | B | C | D |

1/ See A to E in table 2

Table 7.--Planned grazing schedule for Harney Valley allotments 1/

| Year | Range unit 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|---|
| | Stocking - animal units | | | | |
| 1952 | B Rest | C Rest 400 | D Rest | E 200 Rest | A 300 100 |
| 1953 | C Rest 2/ 400 | D Rest | E 200 Rest | A 300 100 | B Rest |
| 1954 | D Rest | E 200 Rest | A 300 100 | B Rest | C Rest 400 |
| 1955 | E 200 Rest | A 300 100 | B Rest | C Rest 400 | D Rest |
| 1956 | A 300 100 | B Rest | C Rest 400 | D Rest | E 200 Rest |
| 1957 | B Rest | C Rest 400 | D Rest | E 200 Rest | A 300 100 |
| 1958 | C Rest 400 | D Rest | E 200 Rest | A 300 100 | B Rest |
| 1959 | D Rest | E 200 Rest | A 300 100 | B Rest | C Rest 400 |
| 1960 | E 200 Rest | A 300 100 | B Rest | C Rest 400 | D Rest |

1/ Treatments above the dotted line were not applied in the years indicated because management facilities, particularly fences, were not completed.

2/ Top figure or comment indicates stocking or treatment during first two months of the season, and bottom figure or comment indicates stocking or treatment during last two months of the season.

The grazing in each unit in a given season is obtained as follows (refer to first year in table 6). At the beginning of the grazing season 60 percent of the animals to be grazed on the entire range are placed in unit 1 and the remaining 40 percent are placed in unit 5. In mid-season two-thirds of the animals in unit 1 and all of those in unit 5 are moved to unit 3. In this way units 1 and 3 are grazed closely, unit 5 moderately, and units 2 and 4 are rested. Should the forage in the closely grazed units--those receiving treatments A and C in table 4--be inadequate for the livestock in any given season because of low forage production, the livestock can be moved to units receiving treatments B and E. Only in extreme cases will the unit receiving treatment D be opened to grazing.

This grazing plan provides positively step by step for (1) reestablishment of vigor of grazed plants, (2) protection of the developing seed crop from grazing, (3) trampling of seed into the soil, (4) protection of seedlings from grazing until established, and (5) increasing soil fertility on all areas on the range thru disposition of litter.

Cultural Treatments and Range Management Facilities

In addition to management of grazing, the allotment will be improved thru artificial reseeding, chemical weed control, drainage improvement and similar cultural practices. Forage produced by these means will be managed together with the rest of the vegetation on the allotment without special fence control. In any given year artificial reseeding and erosion control will be carried out in the unit grazed closely for an entire season just before it is rested for a season

and a half. Chemical weed control, and drainage improvement will be carried out in any unit in any year such work is feasible. The improvement program for the allotment is brought out in tables 8 and 9.

## Livestock Distribution

Desired distribution of livestock within allotment units will be obtained by judicious location of fences, stock water, and salt grounds. The location of salt grounds will be determined after the units are grazed and a realistic picture is obtained of where the animals actually graze.

Table 8.—Range improvement program[1] Harvey Valley Experimental Range

| Improvement | Total needed | Estimated cost per unit | Total cost | Completed to June 1954 Units | % of total | Completion schedule by fiscal years 1955 Units: | Cost | 1956 Units: | Cost | 1957 Units: | Cost |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Fences and cattle guards | 26 miles | $1,200 | $31,200 | 16 | 62 | 3 | $3,600 | 7 | $8,400 | | |
| Reseeding | 615 acres | 10 | 6,150 | 585 | 95 | 30 | 300 | | | | |
| Spraying | 5,350 acres | 3.50 | 18,725 | 1,850 | 35 | 500 | 1,750 | 2,000 | 7,000 | 1,000 | $3,500 |
| Spring developments | 3 | 400 | 1,200 | 0 | 0 | 1 | 400 | 1 | 400 | 1 | 400 |
| Reservoirs | 8 | 500 | 4,000 | 2 | 25 | 1 | 500 | 3 | 1,500 | 2 | 1,000 |
| Corrals | 1 set | 2,000 | 2,000 | 0 | 0 | | | 1 | 2,000 | | |
| | | | $63,275 | | | | $6,550 | | $19,300 | | $4,900 |

1/ In addition to existing as of January 1954.

| | |
|---|---|
| Estimated total expenditures to June 1954 | $32,525 |
| Remaining expenses | 30,750 |
| Total | $63,275 |

Table 9.--Cultural treatments

| Treatment | Acres | Percent |
|---|---|---|
| Cultivate and plant introduced species | 201 | 3.1 |
| Spray and plant introduced species | 343 | 5.3 |
| Spray and disc or harrow in native species | 490 | 7.6 |
| Spray only (release native species) | 4,531 | 70.0 |
| None at present | 911 | 14.0 |
| | 6,476 | 100.0 |
| None practical at any time | 25,876 | |
| Total | 32,352 | |

## ANTICIPATED RESULTS

The grazing capacity of the allotment is expected to be doubled in 20 years thru the application of the 5 unit grazing plan, cultural practices, and logging (table 10). About 43 percent of the total increase is expected on areas where only grazing is managed; another 42 percent on areas where cultural practices and grazing management are applied; and 15 percent on areas where logging and grazing management are applied. Stocking rate will be increased progressively as grazing capacity increases.

## MAIN COMPARISONS IN STUDY

Results on the Harvey Valley allotment will be judged in relation to results obtained under conventional season-long grazing on the adjoining Poison Lake cattle allotment. Basic comparisons will be made in vegetation and soil conditions and cattle weight gains and condition.

Vegetation and soil conditions on the grazed portions of the Harvey Valley allotment will also be compared with conditions inside livestock enclosures on the allotment. This will provide information on the influence of weather and protection from grazing on the range.

An increase in grazing capacity is anticipated in a different allotment unit each year from increased vigor of existing plants and establishment of new reproduction. Thus the effectiveness of the grazing management system can be checked each year. This will provide five checks on a five year cycle.

Table 10.--Estimated grazing capacity of the Harvey Valley cattle allotment by vegetation types 1951 and 1971

| Vegetation types | Area | Percentage | Grazing capacity 1951 | Grazing capacity increase by 1971 resulting from various range practices: Grazing management alone | Grazing management & cultural practices | Grazing management & logging | Total increase all practices | Estimated Total grazing capacity 1971 |
|---|---|---|---|---|---|---|---|---|
| | | | A.U.1/ | A.U. | A.U. | A.U. | A.U. | A.U. |
| Dry grassland | 505 | 1.5 | 29.7 | 16.3 | 12.6 | 0 | 28.9 | 58.6 |
| Wet grassland | 1,322 | 4.1 | 149.8 | 60.8 | 18.6 | 0 | 79.4 | 229.2 |
| Sagebrush | 4,105 | 12.7 | 139.2 | 90.1 | 192.2 | 0 | 282.3 | 441.5 |
| Pine-fir | 14,713 | 45.5 | 207.4 | 79.2 | 14.6 | 82.8 | 176.6 | 384.00 |
| Waste | 11,707 | 36.2 | 0 | ---- | ---- | ---- | ---- | ---- |
| Total | 32,352 | 100 | 546.1 | 246.4 | 238.0 | 82.8 | 567.2 | 1,113.3 |
| Percent | -- | -- | -- | 43 | 42 | 15 | 100 | -- |

1/ A. U. - Animal unit. One animal unit is equal to one mature cow.

for 4 months

546.1
4
2174.4 Total AUMs

The cattle on the Harvey Valley allotment will be grazed in two different ways. One group will be grazed season-long in one allotment unit whereas two other groups will be moved from one unit to another once during the season. Separate weight and condition records will be kept of the cattle handled in these two ways. These records will be compared with others obtained under continuous season-long grazing on the Poison Lake allotment.

## RECORDS AND MEASUREMENTS

The effects of grazing management, cultural treatments, and logging will be evaluated in terms of vegetation, soil, and livestock responses. The factors that will be measured or observed and the methods to be used are outlined below.

| Factors to be measured | General methods |
|---|---|
| **I. Range** | |
| A. Range condition and trend by range condition classes within soil and vegetation types. | Measurements and descriptions on line transects and quadrats. |
| B. Herbage production of forage species by vegetation types and species. | Density and clipped yield measurements on established transects and areas. |
| C. Herbage utilization of forage species by vegetation types and species. | Ocular estimates along established line transects. |
| D. Reproduction of important range plants. Production of viable seeds. Seedling establishment. | Collect and germinate seeds in laboratory. Counts on line transects and quadrats. |
| E. Phenology. Growth and development of about 30 important range species. | Measurements at 2 or 3 week intervals on staked plants of each species in livestock exclosures. |

| Factors to be measured | General methods |
|---|---|
| II. Livestock | |
| Weight by classes of animals, condition, and grade. | Scales. Ocular estimate. |

## METHODS

### Range Condition and Trend

Measurements of range condition and trend are needed to indicate the nature of changes and the rate of change in vegetation and surface soil conditions brought about by grazing. Measurements will be made on two permanently staked line transects located on sites in fair condition in each of the principal vegetation types (table 11). Similar measurements will also be made in livestock exclosures located in these types and on culturally treated areas. Details of procedures for establishing and measuring these transects are given in the appendix.

Additional quantitative information on vegetation changes along these transects will be obtained from vertical photographs of four 2-foot-square quadrats located on the line. Basal or crown area of all perennial plants on the quadrats will be outlined in the field on enlarged photos (8 inches square) of the quadrats.

Table 11.--Principal vegetation types to be measured on the experimental allotments

| | |
|---|---|
| A. Grassland | |
| 1. Terrace site - Carex filifolia cover | |
| 2. Meadow sites | |
| a. Grass-forb-sedge-rush cover | |
| b. Sedge-rush cover | |
| B. Sagebrush | |
| 1. Big sagebrush site | |
| 2. Black sagebrush site | |
| 3. Silver sagebrush site | |
| C. Timber (cutover) | |
| Ponderosa-Jeffrey pine site | |

The density of each mapped plant species will be measured in the office by dot-template counts. The photos will also provide visual evidence of changes in range condition and will be used to determine when remeasurement of the transects is necessary.

Herbage Yield and Utilization

Measurements of these factors will be made to check grazing capacity and changes in range condition. Yield on range areas will be calculated from density and yield figures for the most abundant forage species (table 12).

Table 12.--Species to be clipped for herbage yield

| Species | Native range types | |
|---|---|---|
| | Upland timber, sagebrush | Bottom land terrace, meadow |
| 1. Festuca idahoensis | x | x |
| 2. Sitanion hystrix | x | x |
| 3. Stipa occidentalis | x | x |
| 4. Poa sandbergii | | x |
| 5. Poa nevadensis | | x |
| 6. Bromus marginatus | x | |
| 7. Carex rossii | x | |
| 8. Wyethia mollis | x | |
| 9. Lupinus calearatus | x | |
| 10. Carex filifolia | | x |
| 11. Carex nebrascensis | | x |
| 12. Carex-juncus complex | | x |
| 13. Juncus balticus | | x |
| 14. Juncus-eleocharis complex | | x |
| 15. Danthonia californica | | x |
| 16. Purshia tridentata | x | |
| | Culturally treated areas | |
| 1. Festuca idahoensis | x | |
| 2. Stipa occidentalis | x | |
| 3. Agropyron cristatum | x | |
| 4. Bromus marginatus | x | |
| 5. Sitanion hystrix | | x |
| 6. Poa sandbergii | | x |
| 7. Bromus inermis | | x |
| 8. Agropyron intermedium | | x |
| 9. Poa nevadensis | | x |
| 10. Agropyron elongatum | | x |

The density of individual species will be measured on 100 50-inch-long lines spaced 6 to 12 feet apart on two permanent staked transects in each vegetation type, inside and outside livestock enclosures. A 50-inch-long rod marked off in inches will be placed on the ground at intervals along and at right angles to the transect line. Crown or basal area intercepts across all perennial plant species will be estimated ocularly.

The yield of a unit of plant density will be obtained by clipping appropriate units of each forage species. In the case of bunchgrasses and tufted species the entire plant will be the clipping unit. In the case of shrubs a square foot of crown area, and in the case of sod species a square foot of ground area will be the clipping unit. One hundred units will be clipped of each species. In the case of tufted and sod species the growth on the entire unit will be clipped off 1.5 inches above ground level. Basal area measurements will be made on these species. In shrubs all current twig growth will be clipped off.

Plants will be clipped on both grazed and protected areas. From the former estimates will be obtained of yields on grazed areas and from the latter on protected areas. In both cases the vegetation will be clipped when full grown on permanently staked areas. Each year clippings on the grazed range will be made prior to grazing in the allotment unit that is deferred from grazing till mid season.

Utilization will be measured on all transects established for measurement of plant density and also on the condition and trend transects and two-foot-square quadrats. Ocular estimates will be made of volume of herbage grazed on individual plants. On the density transects 100

plants of each of the important forage species on the transects will be estimated. Observations will be made at about 12 foot intervals along the transect line. The closest plant of each species and the point will be estimated.

On the condition and trend transects and 2-foot-square quadrats utilization will be measured on all perennial plants touching the lines or encompassed in the quadrats.

## Reproduction

One-and two-year-old seedlings of the more abundant plant species will be counted on the 2-inch-square areas and on the 2-foot-square quadrats on the condition and trend transects to provide information on how the range improves or deteriorates and to provide criteria for judging trend in range condition.

Twenty seedlings on each quadrat will be counted. Numbers above 20 will be estimated. No attempt will be made to count seedlings in dense meadow or sod types.

## Seed Production

Lack of seedlings in given year may be due to grazing, adverse weather during seedling growth, lack of seed or low seed viability. The effect of the first two factors will be observed or measured on the plots outlined above. A check on the latter two points will be obtained from samples of seeds collected from the more abundant plant species each year. Samples of seeds of the various species clipped for yield will be collected each year on designated areas inside and outside livestock enclosure. One hundred samples of seed will be collected at

random for each species. The sample will vary by species. For example, in bunchgrasses and plants of similar growth habit, a sample will consist of all the seeds from a plant and in bitterbrush all the seed producted on a square foot of crown area. The kind of sample used for each species will be decided on the ground when the first seed collection is made.

Basal, crown, or ground areas will be recorded for all sampling units so seed production per acre can be calculated. The seeds from the 100 samples of each species will be composited, and three 100-seed samples will be drawn from this mass for germination tests in the laboratory.

## Phenology

Growth and development records will be made at 2 week intervals from the start of the growing season through the end of the grazing season on about 30 of the abundant plant species. Included will be the 20 species used for yield determinations. All the plants will be staked and located inside the livestock exclosures.

## Livestock

Records will be kept of the number and classes of cattle grazed on the allotments. Each animal used to supply information on livestock reactions to the management systems, will be weighed to the nearest two pounds, both at the beginning and end of the grazing season. Each animal will be ear-tagged and described for grade and condition. The animals will be grazed on the allotment for 2 or 3 days before each weighing to overcome effects of driving, shipping, or handling. Livestock information will be obtained if possible on cows and calves breeding heifers and steers

## NUMBER OF PLOTS

The approximate number of transects, quadrats, and plots to be used on the Harvey Valley and Poison Lake allotments are shown in tables 13 and 14.

Table 13.--Number of transects, quadrats, and plots to be used on Harvey Valley allotment

| Type of measurement | Untreated range: Transects | Untreated range: Quadrats | Untreated range: Plots | Culturally treated range: Transects | Culturally treated range: Quadrats | Culturally treated range: Plots |
|---|---|---|---|---|---|---|
| | | | Numbers | | | |
| Vegetation density: | | | | | | |
| On allotment | 70 | | | 54 | | |
| In enclosures | 14 | | | 10 | | |
| | 84 | | | 64 | | |
| Yield of plant units: | | | | | | |
| On allotment | | | 20 | | | 10 |
| Inside enclosures | | | 6 | | | 2 |
| Condition and trend: | | | | | | |
| On allotment | 70 | 280 | | 10 | 40 | |
| Inside enclosures | 14 | 64 | | 6 | 24 | |
| Vegetation utilization | Use transects established for vegetation density. | | | | | |
| Seed production | Use plots established for yield of plant units. | | | | | |
| Seedling counts | Use condition and trend transects and quadrats. | | | | | |
| Total | 168 | 344 | 26 | 80 | 64 | 12 |
| Grand total | ----- 694 ----- | | | | | |

Table 14.--Number of transects, quadrats and plots to be used on Folson lake allotment

| Type of measurement | Native untreated range | | |
|---|---|---|---|
| | Transect | Quadrat | Plot |
| | Number | | |
| Vegetation density | 48 | | |
| Yield of density units | None | | |
| Condition and trend | 24 | 96 | |
| Vegetation utilization | Use density transects | | |
| Seed production | None | | |
| Seedling counts | Use condition and trend quadrats | | |
| | — | — | — |
| Total | 72 | 96 | - |
| Grand total | - - - 168 - - - | | |

Table 15.--Color scheme to be used on plot markers

| Type of plot | Color | |
|---|---|---|
| | Marker | No. on marker |
| Condition and trend transects: | | |
| Head post | Orange | Black |
| End post | Yellow | Black |
| Utilization transect: | | |
| Head post | Red | Aluminum |
| End post | Red | Aluminum |
| Photo station (other than along transects-plots): | | |
| Hub | Red | Aluminum |
| Post | Green | Aluminum |
| Quadrat and pot pegs (all except photo hub. See above) | Orange | Black |
| Forage production plots: | | |
| Posts (all) | Brown | Aluminum |

Note: Posts marking the head end of line transects, photo stations and starting corner of plots will be set spade up. All posts marking the end of line transects, line of direction or plot corners, other than starting corners, will be set spade down.

Table 16.--Schedule of yearly measurements and observations

| Measurement or observation | Time of season |
|---|---|
| **Harvey Valley allotment** | |
| Forage production: | |
| In allotment units: | |
| Vegetation density | July and August in the 3 units that are grazed. |
| Clipped yield, 15 to 20 species | July in the unit receiving treatment C. |
| In livestock exclosures: | |
| Vegetation density | July and August in all exclosures. |
| Clipped yield, 15 to 20 species | July in all exclosures. |
| Utilization | Late September or early October in the 3 units that are grazed each year. |
| Condition and trend | July and August in the unit receiving treatment C. |
| Seedling germination and establishment | August in the units receiving treatments D and E. |
| Seed production: | |
| a. On allotment | July and August in the units receiving treatments A (poorest vigor) and C (best vigor). |
| b. In livestock exclosures | July and August in all exclosures. |
| Livestock production: | |
| Individual livestock weights--beginning and end of grazing season | About May 25 and September 25. |
| **Poison Lake Allotment** | |
| Same as for Harvey Valley allotment except range condition and trend is measured only once every 5 years. | |

## PRESENTATION OF RESULTS

The information obtained in this study will be presented in simple graphs and tables, in photographs, and in text. In order to show that the 5 unit rest-rotation system increased grazing capacity it will be necessary to show that:

1. Livestock numbers were increased, see figure 1 for hypothetical trend.
2. Forage production was increased (fig. 2).
3. Seasonal weight gains, condition, and dollar income per animal unit grazed was maintained or increased (fig. 3).
4. Forage utilization at the end of the grazing season was maintained at a desirable level (fig. 4).

Figure 1.--Trend in cattle numbers

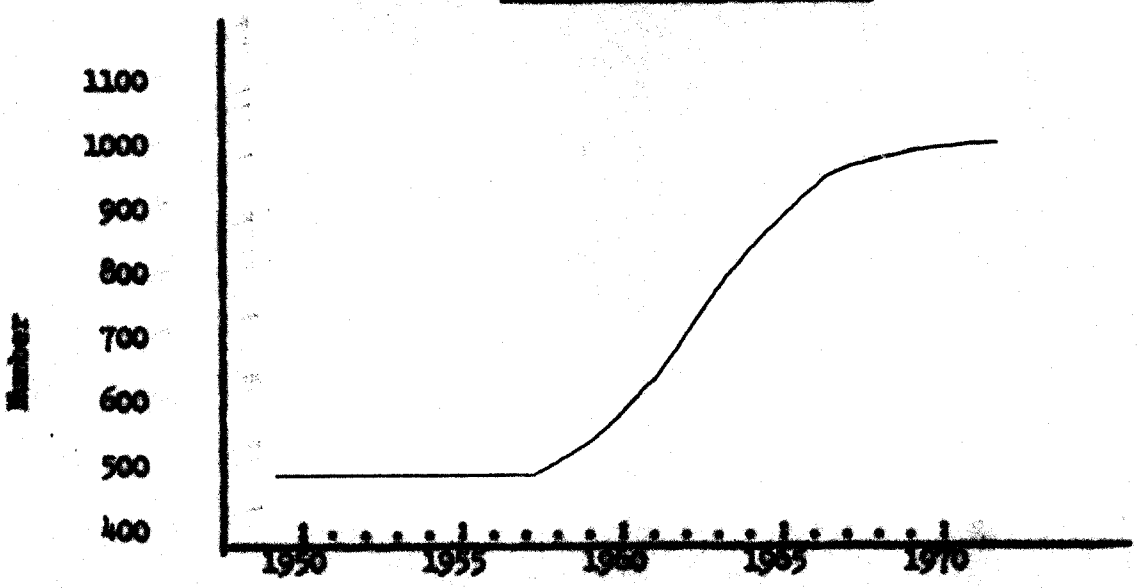


Figure 2.--Trend in forage yield per acre

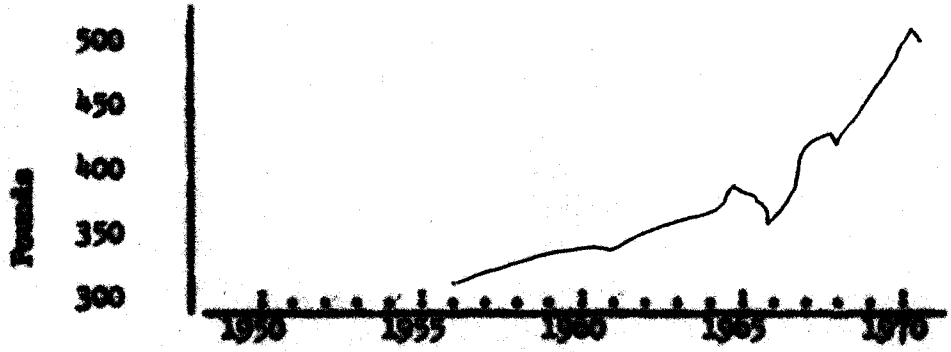



Figure 3.--Trend in seasonal weight gains of cattle (cows, calves, yearlings, etc. separately)

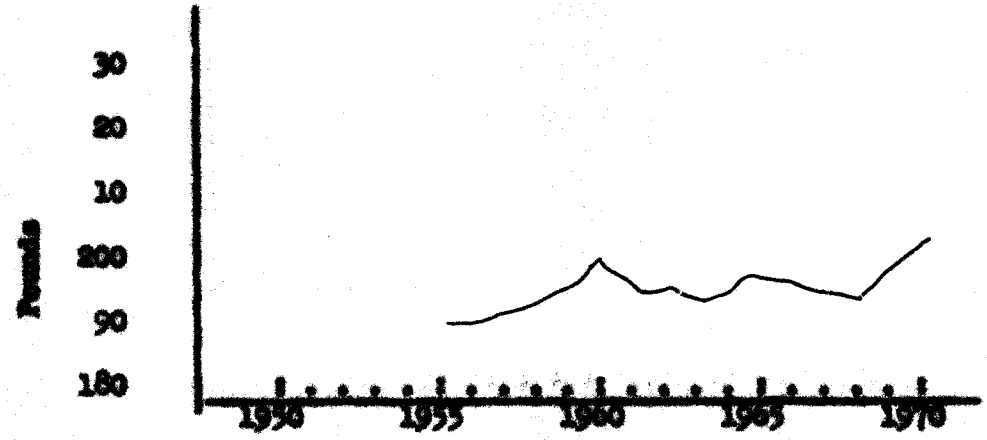


Figure 4.—Trend in degree of forage use at end of grazing season

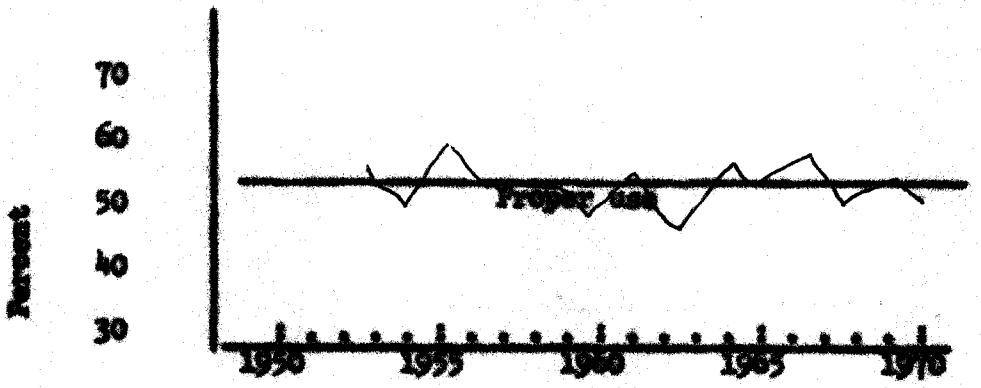
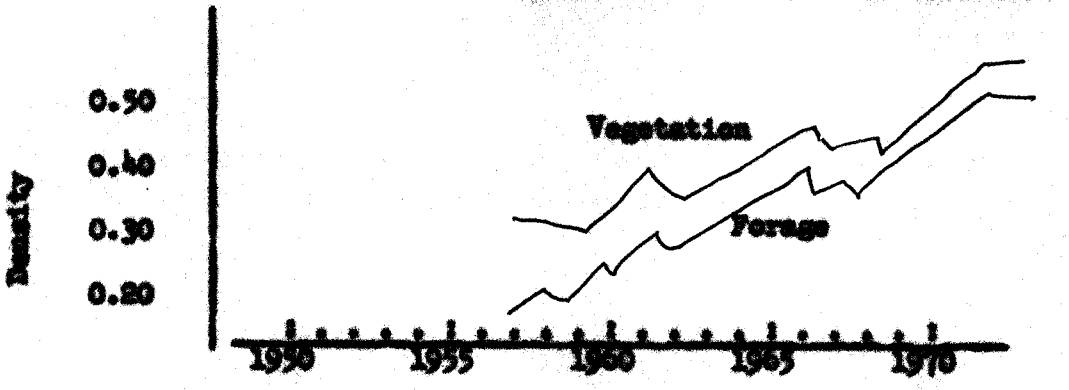



Figure 5.—Trend in vegetation and forage density



Weight records and descriptions of the individual animals will provide the necessary livestock information. Changes in vegetation production will be obtained from data on vegetation composition, density, and yield (fig. 5). A cross check on vegetation production and grazing capacity will be obtained from data on livestock numbers, forage production, and forage utilization.

Information on frequency of seed crops and seedling establishment by individual species will be used to explain trends in vegetation changes.

For the Harvey Valley allotment this information will be presented for the allotment as a whole and for allotment units. Information on the rate of range recovery (or deterioration) will be presented for specific soil and vegetation types in moderate to heavily deteriorated condition.

For the Poison Lake allotment comparable but more limited information will be presented.

Assignment: A. L. Harvey and R. J. Woolfolk

## APPENDIX

## METHOD OF MEASURING VEGETATION AND SOIL CONDITIONS ON LINE TRANSECTS BY THE 2-INCH-SQUARE FRAME AND PHOTOGRAPH METHODS

1. Laying out the line transect and photo quadrats

A. The transect

A 100-foot long line transect is laid out between two guide posts as follows:

(1) Drive a 5-foot steel fence post with spade up, 2 feet into the ground. This is the head post of the line.

(2) Orient the line. Vertical photographs of 2-foot-square quadrats will be taken [illegible] intervals along this line.

To avoid having the shadows of the camera tripod legs fall across the quadrat, orient the transect line at the time it is established so the sun's rays cross the line at right angles. Record the date and time of day of establishment of each transect to permit repeat photos to be taken under the same conditions.

(3) At 25 feet from head post drive a stake (5/8" x 1' reinforced rod) to within 1 inch of the soil surface. This marks the beginning of line transect.

(4) At 24.6 feet and 59.6 feet drive similar stakes marking control corners of two 24-inch-square quadrats.

(5) At 100.6 feet drive end stake of transect.

(6) At 125.0 drive 5-foot steel fence post 2 feet into the ground, spade down. This is the line transect tail end guide post.

B. Photo quadrats

Lay a 24-inch-square metal frame on the line at the 24.6, 42.6, 59.6, and 77.6 foot points so the quadrat lies to the right and toward the head end of the transect when viewed from the head end of the transect.

Set four steel pegs in each quadrat corner.

Lay out a fifth larger quadrat (4'6" x 6') astride the line at the head end of the transect as follows:

Set stakes at right angles and on both sides of the transect line 2'3" out from the line at the beginning line stake and out from a point 6 feet along the line from the beginning line stake.

2. Type of photographs

A. Two-square-foot quadrats; vertical from a height of 6 feet. These photos are taken facing the sun.

B. Large 4'6" x 6' quadrat; oblique from a height of 11 feet and 3 feet back toward head line post from the head stake on the line transect.

C. Thirty foot oblique (from position in "B") showing first quadrat on transect and area back to end of transect and beyond.

3. What will be measured

A. Vegetation

Density of the most abundant perennial species--live and dead portions separately.

(Annual plants, perennial seedlings and unimportant perennials will be lumped into one estimate under the heading "others").

B. Soil

Density of erosion pavement, rock, bare soil, and litter.

Supplementary notes are made of the depth and extent of erosion and the location of seedlings on and about the transect.

4. How the measurements will be made

See attached article, "Getting better records of vegetation changes with the line interception method" by A. L. Hormay for background information.

Vegetation and soil measurements will be made at foot intervals along the line transect starting at the 1-foot mark and ending on the 100-foot mark. All measurements will be made on the left side of the line viewed from the head end. One side of the measuring frame will be held parallel and touching a vertical plane through the transect.

At each point on the line an estimate will be made in percent of the area in the 2-inch-square frame covered by vegetation, litter, rock, and soil. The basis for judging the area covered by individual plants is outlined in the article cited above. The area influenced by the

average bud on a plant crown will be set up for each species by sites. This will permit determining the edges of plant crowns. The area influenced by an average bud on Festuca idahoensis may be 1/8-inch-square, Carex spp. 1/4-inch-square, and Hythia wallis 1-inch-square.

All first year seedlings of forage species in the frame will be counted by species.

The following definitions will be used:

A. A hole in the crown of a shrub; an area 4-square-inches or larger. The measuring frame will drop through this size hole.

B. Soil; rock particles less than 1/8-inch in diameter.

C. Erosion pavement; rock particles 1/8-inch to 2-inches in diameter.

D. Rock; rock fragments 2-inches and larger in diameter.

E. Litter; all dead plant tissue lying on the surface of the soil whether attached to the living plant or not and still recognizable as plant tissue; all animal products.

Table 17.--Area and percent equivalents

| Size of area | Percent of 2-inch-square frame |
|---|---|
| 1/8-inch-square | 0.39 |
| 1/4-inch-square | 1.56 |
| 1/2-inch-square | 6.25 |
| 3/4-inch-square | 14.06 |
| 1-inch-square | 25.00 |

See CFRRS form number 857 for further details on recording.

Reprinted from JOURNAL OF RANGE MANAGEMENT
Vol. 2, No. 2, April, 1949

# Getting Better Records of Vegetation Changes with the Line Interception Method

A. L. HORMAY

*California Forest and Range Experiment Station, U. S. Forest Service, University of California, Berkeley, California*

BASICALLY the line interception method is a means of determining areas by the measurement of line segments. It has been adapted and applied to range work by several men since about 1937 (*1*). In the opinion of the writer, it is a very useful range technique. It is highly adaptable and in combination with other methods can be used to measure vegetation factors like density, composition, yield, utilization, vigor and reproduction; and soil factors like erosion, bare soil, rock, and litter cover. The line plot is an efficient sampling unit; it is easily established and quickly measured.

The line interception method has been described in detail by Canfield (*1*). The purpose of this paper is to point out a few ways in which the method can be employed more effectively in measuring changes in range vegetation. Particular attention is given to ways of increasing the accuracy of the method and of using the method to determine vegetation yield. The remarks are based on experiences with the method in pine timber, sagebrush, and meadow types in northeastern California and apply principally to bunchgrass types.

## GREATER ACCURACY

Accuracy and consistency in the use of this method revolve around the determination of the end points of the line intercepts. The proper placement of these points depends on a knowledge of the growth habit of the plant. Two characteristics in particular must be clearly visualized: (1) the unit of plant measurement, and (2) the normal foliar density of the species.

The observer must hold to definite standards on what constitutes the plant unit to be measured. In many cases it is obvious. In bunchgrasses it is the tuft, and in shrubs the crown. However, in many species, for example mule-ears (*Wyethia mollis*), a tap-rooted perennial, and even in sod formers, like wire rush (*Juncus balticus*), there is a choice between using a portion of the plant, usually a fascicle, or the entire plant as the unit of measurement. The fascicle is simply the group of leaves and flower-stems that emerges from one of the buds on the root crown, rhizome, or branch of a plant. These fascicles are widely spaced on many species and stand out like distinct plant units. If the fascicle is chosen as the unit of measurement, the interspaces between fascicles would be recorded as soil or some form of ground cover. If the plant is chosen as a unit, the interspaces within the plant crown would be measured as vegetation. That is, in the case of mule-ears the distance across the entire root crown, and in the case of wire rush the distance across the sod area would be measured as vegetation. Uniformity in choosing the unit is essential for accuracy and consistency. That the plant is the most logical and soundest unit of plant measurement becomes clear with a consideration of foliar density.

Foliar density and the size of foliar interspaces vary with each species. For example, buds on the root crown of Idaho fescue (*Festuca idahoensis*), a perennial bunchgrass, are spaced about $\frac{1}{16}$ of an

inch apart, in mule-ears one inch or more apart. In measuring these two species on the line plot, an interspace of one square inch in a tuft of Idaho fescue would be considered abnormal and would probably be classified either as a dead spot or as a soil area. The same size interspace in the root crown of mule-ears would be considered normal even though it consists of bare soil. Thus a one-inch soil intercept in the crown of one species may be classified as soil and in another as vegetation. The size of an interspace is judged normal or abnormal in relation to the average size of interspaces in normal plants of a species on a given site. This is simply to say that there is a normal foliar density for each species on a given site. And it follows that there is a normal density of interspaces. This concept provides the basis for deciding when a given size interspace is part of the plant and when it is part of the non-plant ground cover. It permits marking the edges of plant crowns and conditions within crowns more definitely and classifying the character of cover more uniformly. It points to the plant rather than any part of it as the unit of vegetation to be measured.

By using the normal density concept the line interception method can be used to measure annuals like cheatgrass (*Bromus tectorum*), ground smoke (*Gayophytum* spp.), Collinsia (*Collinsia* spp.), and others found in the interspaces between perennials in the bunchgrass type. It can also be used to measure sods and meadow type vegetation. In these kinds of vegetation it is the crown cover that is important. Measurements of stems and fascicles at ground level have little significance. Because the plant crowns interweave and overlap it is not practical to measure the crowns on individuals, so consideration has to be given the crown masses. Satisfactory records of density and composition can be obtained in terms of linear measurements in three steps: (1) Estimating the total vegetation density on short segments (6 to 12 inches long) of a belt plot located parallel and astride or adjoining the line plot; (2) converting these estimates to inches; and (3) proportioning the length of line representing the entire vegetation among the important species. A plot 6.27 inches wide and 100 inches long covering an area of 1/10,000 of an acre is a convenient size. The total vegetation density can be estimated most easily by judging the percentage of ground space, including abnormal foliar interspaces, on a segment and subtracting the figure from 1.0.

In long-time studies of vegetation changes, the line plots should be established precisely and permanently so remeasurements can be made on the same line and sampling errors between examinations largely eliminated. A 100-inch long (8′-4″) plot has been found satisfactory in bunchgrass types. It permits summarizing the data in original units and percentages without additional calculations. It is suggested that the end points of the line be marked to within $\frac{1}{8}$ of an inch on metal hubs set in concrete footings. So as not to interfere with the growth and use of the vegetation, the footings should be located from 1 to 2 feet beyond the ends of the 100-inch line segment on which the vegetation is measured. Changes in individual plants and plant groups can be followed by making measurements progressively along the line and recording each plant or plant group on a separate line on the form. With permanent hubs, information can also be obtained on soil erosion in many situations by stretching a straight rod between the hubs and measuring the distance to the soil surface at several points.

## Yield

The yield of a given species can be obtained from an estimate of its basal

area provided by the line plot and an estimate of yield per unit of basal area obtained from clippings on plots 100 inches long and 6.27 inches wide located at random on the site being studied. The density estimates obtained on the line plot can be expressed in square inches per acre, and the clippings in grams per square inch of basal area. Production in pounds per acre for each species can be calculated from these figures.

The clipping unit may be the entire plant or only a portion of it. In bunchgrasses and species like mule-ears and lupine, the entire plant is a practical unit. All plants of a given species whose crown centers are located within the boundaries of the plot are measured for basal area, clipped, dried and weighed. The yield per unit of basal area is calculated from a number of plots. In the case of shrubs the entire crown area within the boundaries of the plot is clipped.

Stands of annuals and sods are clipped on the same basis as shrubs, and the breakdown into species can be handled in three ways. In the first place, one can estimate crown densities and determine line intercepts for each species before clipping as on the line plots. This procedure assumes that the plant yield per unit of line is the same for all species. If greater accuracy is needed, the weight of the most important species or species groups (usually 3 to 5 in number) can be calculated by the method of least squares from several sample plots. The information needed from these plots is the total weight of all species under consideration and the line intercept measurements of each species. A third alternative for handling this type of vegetation is to segregate and weigh each species.

Determining yield by applying an average weight per unit of basal area of individual species to the basal area measurements of those species on line plots has several advantages over clipping the entire vegetation on sample plots and segregating and weighing each species. It provides a means of getting at yields of plants on which density and other basic measurements are made over a period of time without clipping the plants. It permits dealing with one or as many species as desired. The yield of any species can be determined to any degree of accuracy by varying the number of samples. Each species can be clipped at its peak yield. The tedious and time-consuming job of segregating species after clipping is avoided.

To get a full expression of yield and other measures, the treated and check plots should be protected from grazing in years measurements are made and the vegetation examined as close to the peak of growth as possible. Furthermore, vegetation changes should be measured by soil types since the yield, reproduction, vigor, and management of the vegetation is closely tied to the soil.

It should be appreciated that the accuracy of any method of measuring vegetation rests as much upon the judgment of the observer as upon the mechanics employed. In order to reduce errors in personal judgment and thereby to obtain greater accuracy with the line interception method, it is essential to study the growth habit of the important species to determine units of plant measurement and normal foliar densities prior to the start of measurements.

## LITERATURE CITED

(1) CANFIELD, R. H. 1941. Application of the line interception method in sampling range vegetation. Jour. of Forestry 39: 388-394.