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By Jim Yoakum, Bureau of Land Management, Ely, Nevada.

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Comparative Forage Values of California Oatgrass and Soft Chess

HAROLD F. HEADY, D. W. COOPER, J. M. RIBLE, AND J. F. HOOPER

Professor, School of Forestry, Berkeley; Farm Advisor, Agricultural Extension Service, Eureka; Extension Technologist, Agricultural Extension Service, Riverside; and Research Assistant, Berkeley; all in the University of California.

Rangelands of Humboldt County in northwestern California are characterized by the presence of grasses of the California annual type growing in association with native perennial grasses. In preference and abundance, California oatgrass *(Danthonia californica)* is the most important perennial grass (Sampson and Parker, 1930; Hufaker and Kennett, 1959), whereas soft chess *(Bromus mollis)* is the most used annual grass. Their relative proportions vary with soil series and topographic situations, but management systems can favor either species (Cooper, 1960).

Although these rangelands have been grazed by domestic livestock for over 100 years, little information has been reported on the forage values of the species named or on the desirability of altering management systems to favor either or both of them. It was with this in mind that a study of species composition, relative growth patterns, grazing preferences, and chemical content of these two species was undertaken.

Methods

Data were collected in a 60-acre pasture on the Dwight May Ranch near Bridgeville. Forage sample collections were made on McMahon soil which is representative of large acreages of rangeland in Humboldt County. Species composition was determined on 1000 feet of permanent line intercept transect and 1000 feet of point step taken in June each year. Other data were determined at monthly intervals.

The growth stage was determined randomly throughout the pasture by ocular estimate and measurement of leaf height. Observations of grazing by 10 second-calf or older Hereford cows in excellent condition for 3 to 6 hours on the days of sampling were used as the basis of grazing preferences and for determining the proportion of old and new growth clipped for chemical analyses each month.

One pound green weight samples of each species were clipped in the part of the pasture that the cattle were using to approximate the manner of grazing and the proportions of old and new growth taken by the animals. California oatgrass was collected over a three-year period, 1959-1961, and soft chess for 24 months during 1960-1961. The chemical analysis was performed by the University of California Agricultural Extension Service Laboratories at Riverside, California. Standard American Organization Agricultural Chemist procedures were followed in making the chemical analyses for crude protein, phosphorus, crude fiber, ether extract, ash, calcium, and nitrogen free extract.

Results

Throughout the study, California oatgrass and soft chess made up approximately 88 percent of the available forage. California oatgrass contributed 18-21 percent and other perennials about ten percent. Soft chess contributed 67-70 percent and other annuals about three percent.

At no time during the three-year study was California oatgrass completely dormant (Table 1). New leaves appeared before November when the rainy season began, but did not elongate beyond three inches until April. Frost damage was present throughout this period, as indicated by dead tips on the leaves. The full length of the leaves, seven inches, was reached in June. The culms first appeared in April, spikelets were present in May, and the seed matured in July with fruiting stalks averaging about 18 inches in length. The flower stalks of this species detach at the base during July and August so more stems are included in the analyses during the growing season than later. Cleistogenes matured in Septem-

Table 1. Annual growth cycles and comparative grazing preference of California oatgrass and soft chess.

	California Oatgrass		Soft Chess	
Month	New Growth	Grazing Preference	New Growth	Grazing Preference
January	Leaves 3 inches	High	Leaves 2 inches	Very Low
February	Leaves 3½ inches	High	Leaves 3 inches	Very Low
March	Leaves 3½ inches	High	Leaves 3½ inches	Low
April	Leaves 5 inches Culms appearing	High	Leaves 6 inches Few spikelets	Moderate to High
May	Leaves 6 inches Spikelets emerging	Moderate to High	Leaves 7 inches 70% flowering at 14 inches	High
June	Leaves 7 inches 60% flowering at 14 inches	Moderate	Leaves 14 inches Seed forming at 18 inches	High
July	Seed maturing at 18 inches	Moderate to High	Beginning to dry	Moderate to High
August	Beginning to dry	High	Dry	Low to Moderate
September	Partly dry	High	Dry	Low
October	Green at base	High	Dry	Low
November	New leaves 2½ inches Old stems green at base	High	Leaves 1½ inches	Very Low
December	Leaves 3 inches	High	Leaves 2 inches	Very Low

ber. Green material was available for grazing even through the period of summer drought, from July to October.

Soft chess exhibited a different growth pattern from that of the perennial oatgrass. The seed germinated in November or earlier when rain was adequate, grew slowly during the winter, rapidly in April and May, and matured in June. During July the top growth became completely dry and the seeds were shattered by mid-August. Seed maturity of soft chess was about a month earlier than was the oatgrass. Only traces of old growth remained of either species as late as March.

Preference for California oatgrass was high from August to April and moderate in May, June, and July. In the latter period the oatgrass was grazed but utilization was not as heavy as in other times of the year. On the other hand, soft chess was selected to the greatest extent in May and June. There was little use of soft chess during the time it was dry. The terms "high", "moderate", and "low" as enumerated in Table 1, indicate the relative preference for the two species by cattle. Grazing pressure in the pasture was moderate to light at all times during the three years.

No significant difference between years for any chemical component, except possibly phosphorus in soft chess, was indicated by analyses of variance. Therefore, the data are presented as average monthly percentage chemical compositions (Figure 1).

Annual cyclic patterns, except during the winter part of the growing period, were similar to those found for other forage species (Hart, Guilbert and Goss, 1932; Sampson and McCarty, 1930). Crude protein and phosphorus for both species increased during the winter until the leaves were about three to four inches in length, reached the highest point at the time of culm initiation, and decreased as the plants matured. These components were lowest in the dry herbage. Crude fiber, however, reached a maximum in the dry forage of both species.

Of more importance were the large differences found between the two species. California oatgrass was always higher in crude protein and lower in crude fiber than soft chess. In oatgrass crude protein remained in the range of "suggested minimum requirements" for livestock (National Research Council, 1957, 1958) throughout the year. Soft chess, on the other hand, was below the "suggested minimum requirements" except during the March to June period of fast growth.

Phosphorus was higher in soft chess than in the oatgrass during the growing season and lower during the dry period. Phosphorus in both species was above the "suggested minimum" livestock requirement during the period of fast growth, and for oatgrass also when new growth was initiated in the fall. Ether extract was consistently higher in California oatgrass and uniform in both species throughout the year. Nitrogen free extract was lowest in soft chess during January and February, but was high in oatgrass throughout the study period. Nitrogen free extract is a high-energy source of food, and is an important component to consider in feeds, because of the long cool, wet winters. Otherwise there were no significant differences between species or time of year.

A relationship between chemical content and grazing preference is not clearcut. The grazing preference changed in late April or May from California oatgrass to soft chess. Later in July or early August, the animals again preferred the oatgrass. Crude protein and phosphorus content of both grasses were decreasing at the same rate during the spring change. However, the ob-

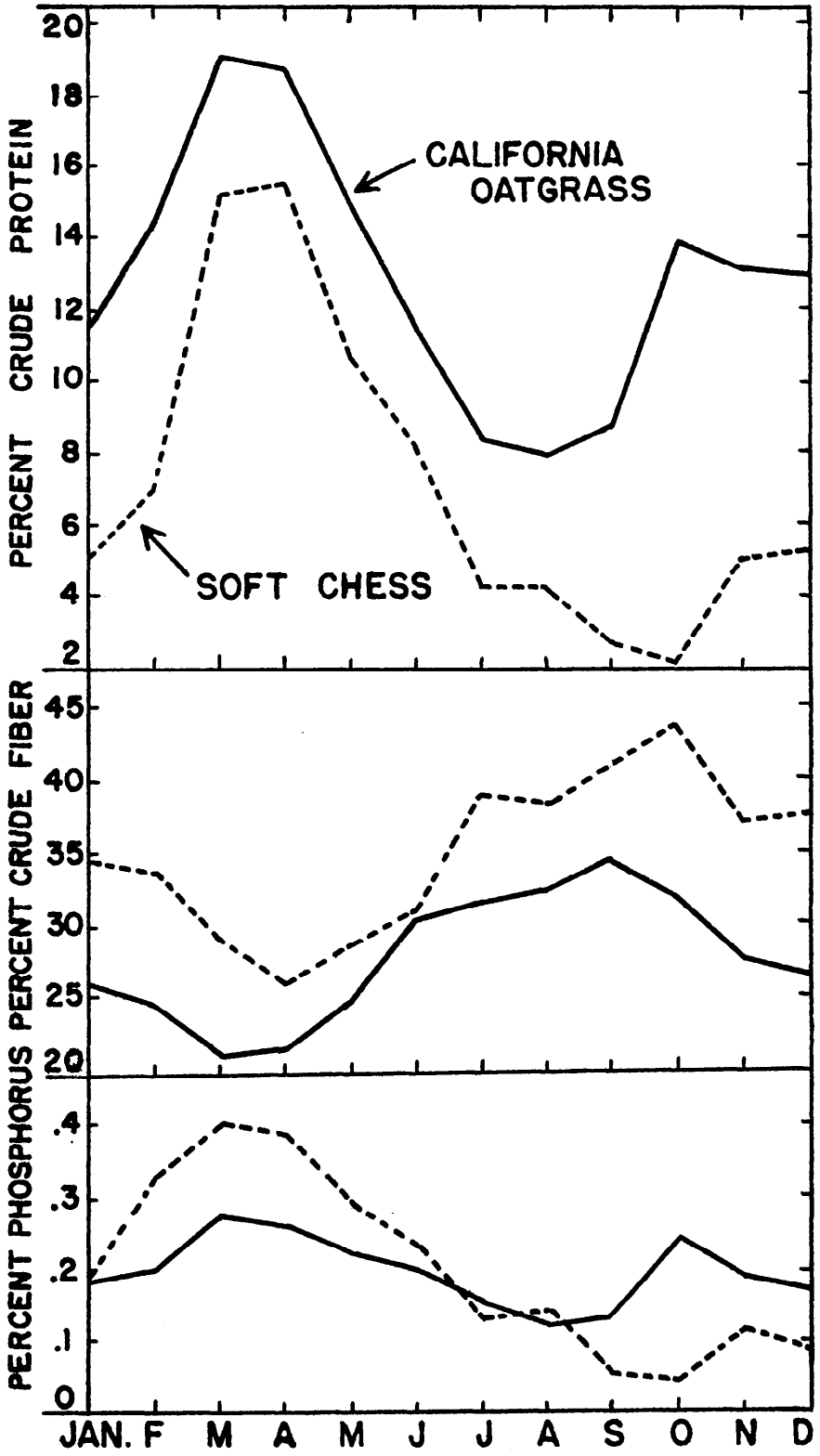

FIGURE 1. Annual cycles of percentage crude protein, crude fiber and phosphorus in California oatgrass and soft chess.

servations indicate that the change was due primarily to the selection of soft chess for the plump seed heads. The change in preference back to the oatgrass in July or August may be related to the shattering of soft chess seed heads and to an increasing differential in the crude protein and crude fiber contents of the two species. Soft chess was completely dry at this season and crude protein was at a low level. Oatgrass at this time still provided green forage which was more attractive to livestock than the dry soft chess.

Conclusions

1. California oatgrass, in all months, is higher in crude protein and lower in crude fiber than soft chess. Contents of phosphorus, calcium, ash, ether extract, and nitrogen free extract in oatgrass are less variable with seasons and usually higher than in soft chess.

2. Grazing preferences exhibited by second-calf or older Hereford cows indicate that California oatgrass, which provides green forage year-long, is preferred except for a brief period when the plump seeds of soft chess are maturing.

3. Chemical content and grazing preferences suggest that California oatgrass is a better forage species and that a management system should be designed to favor it over soft chess.

4. Observations by the authors indicate that under moderate grazing California oatgrass stools readily and forms a sod which produces large volumes of high quality forage. Less desirable perennials and annuals decrease in abundance as the sod forms. Observations also indicate that the change in preference in late spring, which lightens grazing pressure on oatgrass when it is flowering and setting seed, is a fortunate circumstance that has permitted maintenance of this desired species even under heavy grazing. Presumably a management system to favor this species should defer grazing until after its seed has set. The ecology and management considerations of California oatgrass are the subject of further study.

LITERATURE CITED

COOPER, D. W. 1960. Fort Baker

ranges returned to champagne grasses. Jour. Range Mangt. 13: 203-205.

HART, G. H., H. R. GILBERT, AND H. GOSS. 1932. Seasonal changes in the chemical composition of range forage and their relation to nutrition of animals. Calif. Agric. Expt. Sta. Bull. 543. 62 pp.

HUFFAKER, C. B. AND C. E. KENNETT. 1959. A ten year study of vegetation changes associated with biological control of klamath weed. Jour. Range Mangt. 12: 69-82.

NATIONAL RESEARCH COUNCIL. 1957. Nutrient requirements of domestic animals: Nutrient requirements of sheep. Revised.

NATIONAL RESEARCH COUNCIL. 1958. Nutrient requirements of domestic animals: Nutrient requirements of beef cattle. Revised.

SAMPSON, A. W. AND E. C. MCCARTY. 1930. The carbohydrate metabolism of *Stipa pulchra*. Hilgardia 5: 61-100.

SAMPSON, A. W. AND K. W. PARKER. 1930. St. Johnswort on range lands of California. Calif. Agric. Expt. Sta. Bull. 503. 48 pp.

Grazed-class Method of Estimating Forage Utilization[1]

ERVIN M. SCHMUTZ, GARY A. HOLT AND CHARLES C. MICHAELS

Research Associate in Range Management, Arizona Agricultural Experiment Station, Tucson, Arizona; Range Conservationist, SCS, Tucson, Arizona and Inter-Area Range Conservationist, SCS, Phoenix, Arizona.

Obtaining proper forage utilization, and its measurement, are essential parts of good range management. Proper stocking is the most important single practice influencing the proper use of the range. In fact, proper stocking is so essential to proper range use that the terms are frequently used interchangeably.

Determination of proper stocking and/or proper range use has been attempted by various methods. Long-time proper stocking rates have been estimated by averaging yearly stocking records, by using range survey methods, by classifying range conditions which are correlated with grazing capacities, and by forage weighing and estimating procedures. These estimates are useful mainly in determining starting stocking rates or as average guides since production on a particular range may vary from year to year. Amount and distribution of seasonal rainfall, temperature variations and wind movements, changes in plant vigor and range condition, application of fertilizers and nutrient availability, rainfall during the previous season of growth, and/or grazing intensity and frequency during previous seasons all affect production. Short-time annual or seasonal adjustments in range use have been based largely on measurements of forage grazed or herbage left. These short-time measurements are the most important and, in time, will furnish the most accurate data on long-time or average stocking rates.

Range utilization is closely correlated with and has a direct short-time effect on range trend, a long-time effect on range condition, and both a short- and long-time effect on forage density and range productivity. Other factors influenced by range use are soil erosion; water yield and runoff; vigor and reproduction of important forage, timber and weed species; litter accumulation; trampling of forage plants by livestock; and recreation and wildlife values.

The major problem in determining utilization is the actual measurement or estimation of the percentage or amount of the plant utilized. Direct measurement of forage consumed is difficult so most methods rely on determination or estimation of the forage left in relation to measured or reconstructed production, the assumption being that the missing forage has been eaten by livestock. In addition there is considerable variation in the accuracy and use of the various methods used to measure plant height, weight or numbers grazed. Regrowth of grazed plants also complicates estimation of degree of use.

Other problems influencing range utilization are differences in palatability and aggressiveness of associated species; variations in forage preference by different classes of stock; differences in the amount of grazing various plants can withstand; difficulties in selecting key plants and key areas upon which to make utilization estimates; differences in accessibility of areas to livestock grazing; variations in slope and susceptibility of the soil to erosion; differences in location and frequency of livestock water; and variabilities in size and shape of pastures.

In spite of all these difficulties, or maybe because of them, numerous methods have been devised to estimate or measure forage utilization. Reviews of various methods have been made by Pechanec and Pickford (1937); Campbell (1943); Dasmann (1948); Heady (1949); Humphrey (1949); Joint Committee-ASA, ADSA, ASAP, ASRM (1952); Parker (1952); Sampson

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[1] *Contribution from the Department of Watershed Management, Arizona Agricultural Experiment Station, University of Arizona and the Soil Conservation Service, U.S. Dept. of Agriculture.*

The authors express appreciation to administrative and technical personnel of the Soil Conservation Service and the Arizona Agricultural Experiment Station for their assistance in testing the method.

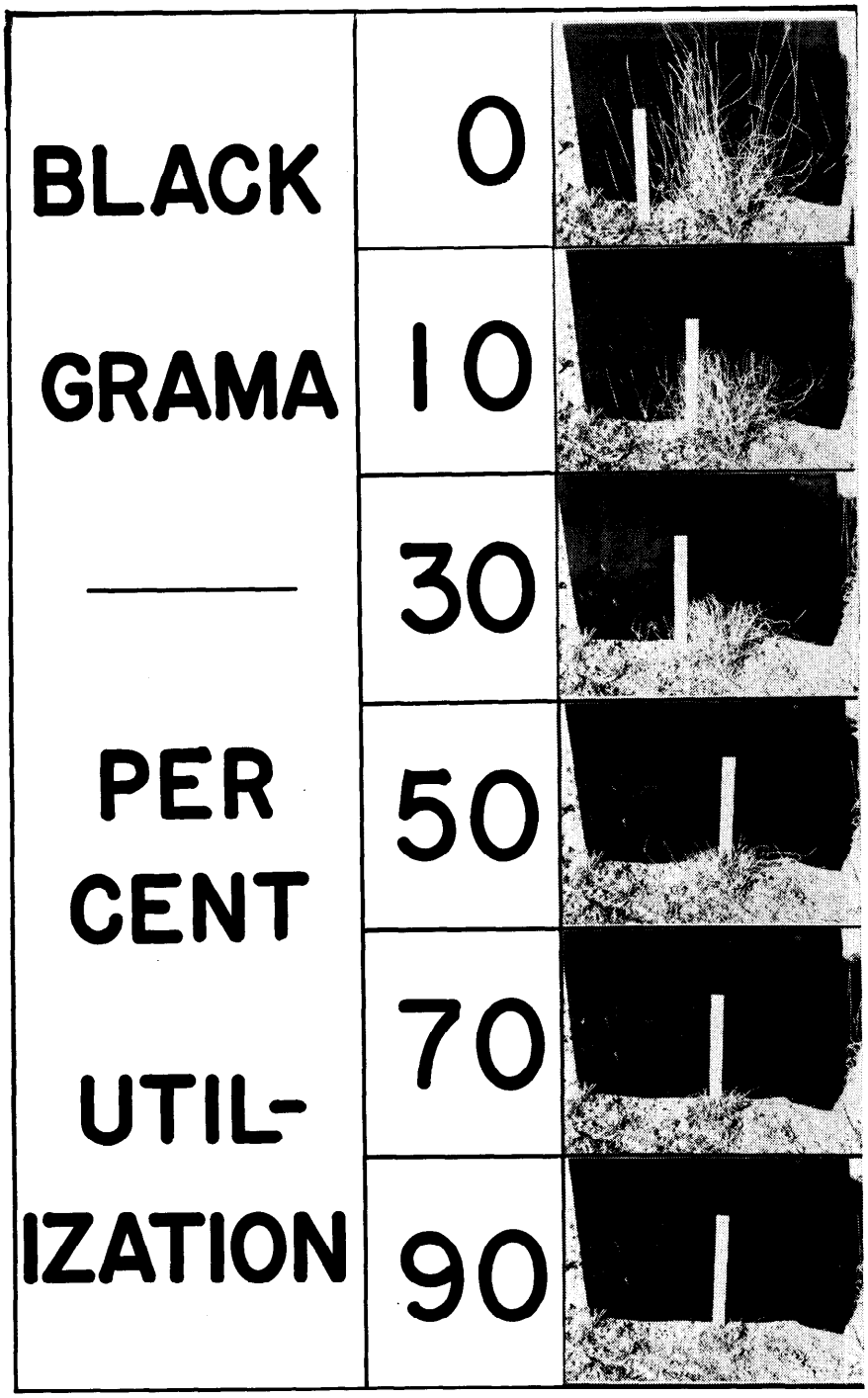


FIGURE 1. Photographic grazed-class guide for estimating forage utilization.

(1952); Brown (1954); Stoddart and Smith (1955); Hedrick (1958); U. S. Forest Service (1959); and Joint Committee-ASRM, Agricultural Board (1962). Some of these methods have been devised mainly for quantitative research measurements and others for qualitative management purposes. Some have broad application to a large variety of species and vegetative types; others are restricted to particular classes of plants with specific growth forms. Some methods are rapid and provide data from extensive areas while others are tedious and can be used only on representative or indicator areas. Whether a universal method can be developed is questionable.

In an attempt to develop a fast, accurate, statistically sound method of measuring forage utilization; useable by both ranchers and technicians; the grazed-class method was developed.

The Grazed-Class Method

The grazed-class method combines the advantages of several methods. Photographic guides, based on locally developed height-weight curves, are set up in card form for each key species (Figure 1). The guides are developed by clipping and photographing plants of average growth form to represent 0, 10, 30, 50, 70 and 90 percent use. Using these guides the examiner places up to 100 plants of each key species, located by toe-pace transects, into their appropriate grazed-classes (Table 1). Data for each key species are recorded separately although evaluations of two or more species may be made simultaneously. The percentage utilization for each species is determined by multiplying the average precentage use of each grazed-class by the percentage of grazed plants in each grazed-class and totaling the products.

Sampling Procedures

Proper sampling of a grazed pasture is essential if estimates of range use are to be reliable. Key areas may be sampled where they represent a true index to the overall use in the pasture (Sampson, 1952; and Stoddart and Smith, 1955). However, where marked variations in use occur due to site differences, topography or water distribution, the pasture may need to be subdivided for sampling purposes. This procedure was found by Costello and Klipple (1939) to increase the accuracy of sampling density. The simplicity and speed of the grazed-class method makes it adaptable to rapid sampling of several areas.

Estimates may be made at mechanically determined, uniform intervals along sampling lines or at random points in pre-selected locations representative of the area. One to several estimates may be made for each species at each location and totaled for the area. For simplicity in conversion to percentages, composite totals of 20, 25, 50 or 100 estimates may be made for each key species in each pasture or subdivision of the pasture.

Ordinarily from one to three key species are adequate to estimate utilization. Where more than one key species is used to estimate utilization, the percentage composition of each key species in the forage type must also be estimated or obtained from range survey records. This estimation of percentage composition introduces a possible source of error and calculations are increased slightly which may or may not be offset by the introduction of a larger vegetative sample on which to base use estimates.

Calculation of Grazing Use

Current percentage utilization is calculated for each key species as indicated in Table 1. If current use of a species is 43 percent and its proper use is 50 percent then the difference is the forage units remaining. If the cow-months (CM) of current use are known, e.g. 60 head for 10 months, the remaining use may be calculated according to procedures outlined by Stoddart and Smith (1943) or Sampson (1952):

Table 1. Grazed-classes and method of calculating current use by the grazed-class method of estimating utilization.

Descriptive names of grazed-classes	Range of utilization by grazed-classes	Average utilization by grazed-classes	Plants by grazed-classes	Current utilization
		(Percent)		
Ungrazed	0	0	4	0
Slight use	0- 20	10	12	1.2
Light use	20- 40	30	24	7.2
Moderate use	40- 60	50	40	20.0
Heavy use	60- 80	70	18	12.6
Severe use	80-100	90	2	1.8
			Totals 100	42.8

Using the above formula the cow months remaining $= \frac{14}{18} \times 600 = 467$ CM.

Total proper use for the pasture can be obtained by adding cow months used and cow months remaining for a total of 1067 CM.

For intensive management or research studies, where pastures are subdivided for utilization estimates and determination of grazing efficiency, the acreage in each subdivision must also be measured and correlated with grazing capacity in order to calculate needed adjustments in the stocking rate. However, with most utilization checks the use of key areas to indicate the degree of utilization for the whole area is adequate and avoids detailed calculations.

The method, without the photographic guide, has been used in the field by two of the authors for about three years with satisfactory results. The use of the photographic guide will result in more uniform estimates and facilitate its use by less experienced personnel.

For a single key species:

$$\text{Cow months remaining} = \frac{\text{Forage units remaining (7)}}{\text{(Proper use minus current use)}} \times \text{Cow mos. used (600)} = 98 \text{ CM.}$$

$$\frac{\text{Forage units used (43)}}{\text{(Current percentage utilization)}}$$

For several key species:

Species	Forage units available (Percentage composition × Percentage proper use)	Forage units used (Percentage composition × Percentage utilization)	Forage units remaining (Forage units available − Forage units used)
Sideoats grama	40 × 50 = 20	40 × 30 = 12	
Black grama	30 × 40 = 12	30 × 20 = 6	32 — 18 = 14
	Total 32	Total 18	

Test and Analysis of the Grazed-Class Method

To test the accuracy of the method and to study its use on differing types of forage and by personnel with varying experience in estimating utilization by other methods, two inexperienced observers (A and B) and two experienced observers (C and D) estimated utilization by the grazed-class method on two species with differing growth form. The two species were sideoats grama (*Bouteloua curtipendula* (Michx.) Torr.), representing a bunchgrass type growth under desert grassland conditions, and black grama (*B. eriopoda* (Torr.) Torr.), a stoloniferous sodgrass. None of the examiners had any previous experience using the grazed-class method. Estimates were made on a desert grassland site near Sonoita, Arizona.

Before making the estimates, ungrazed fully grown plants were located by toe-pace transect. The plants were clipped to simulate grazing and the clipped forage was placed in individually numbered paper sacks. Three one-hundred-plant transects were clipped for each species, making a total of 600 plants. The clipped plants were then placed into grazed-classes by the examiners using the photographic guides and working independently. After the esti-

mates were made, the remaining part of each plant was clipped to ground line, placed in individually numbered sacks, and stapled with the top sample. The samples were oven dried, individually weighed, and the percentage utilization was calculated by the weight method for each plant. A summary of grazed-class utilization estimates made by the various examiners, as compared to the degree of utilization determined from weight data, is shown in Table 2. The examiners are listed in order of experience in other methods of estimating forage utilization, Examiner A being the least experienced and D the most experienced.

The close correlation between the arithmetic average of 100 weighed values (column 2, Table 2) and the percentage utilization determined by placing the weighed values in grazed-classes (column 3) demonstrates the validity of using the grazed-class method of calculation where 100 estimates are used. An important factor here is that errors of classification are compensating.

To determine the relative accuracy of different sized samples the coefficient of variation of the mean was plotted against sample size, using the data from Replications I for both sideoats and black grama (Figure 2). These curves indicate that errors of less than 5 percent can be expected with 100 estimate samples and errors of less than 10 percent can be expected with samples above 20. Samples below 20 were highly variable and the degree of error increases rapidly with smaller samples. Since, as previously indicated, there was no difference in results between the arithmetic average of 100 weighed samples and the same data placed in grazed-classes, the expected variation is due to sampling and experimental errors rather than to the method procedure of placing estimates in classes.

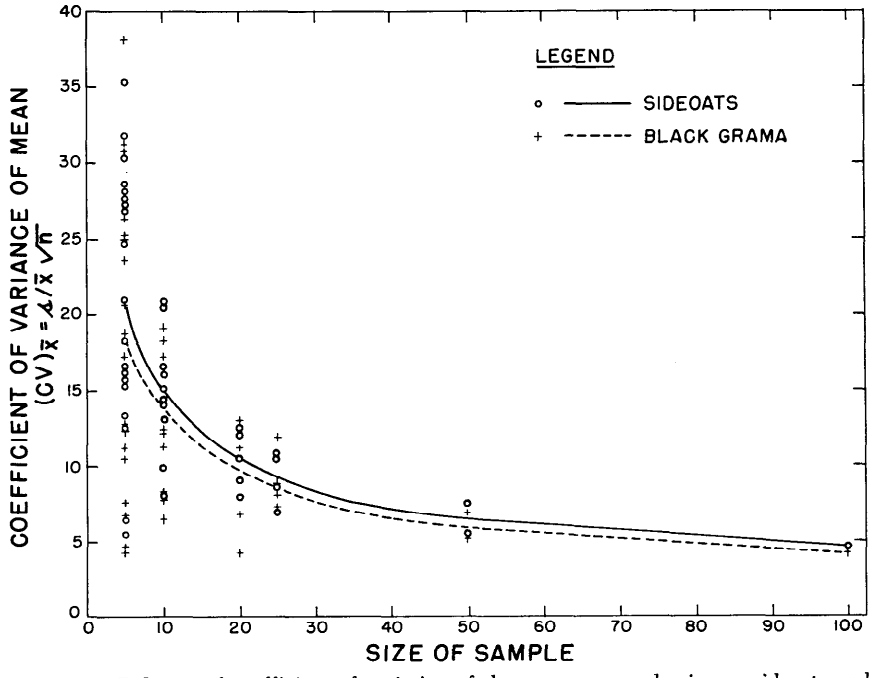


FIGURE 2. Relation of coefficient of variation of the mean to sample size on sideoats and black grama.

Choice of sample size will also depend on variations in pasture conditions; such as variability of grazing, heterogeneity within the type, and other factors. These problems in relation to density estimates are analyzed by Costello and Klipple (1939).

The effect of prior experience in making utilization estimates by other methods is shown in Table 2 by the consistently greater accuracy of the more experienced Examiners C and D.

Statistical analyses of the variation between examiners, weight-checks versus examiners, and between replications for both species are shown in Table 3. These analyses show the effect of experience in using the grazed-class method. Since readings were made on sideoats grama first, the highly significant difference between examiners on the sideoats grama readings followed by no significant difference between examiners on the black grama readings indi-

Table 2. Utilization estimates made by various examiners using the grazed-class method compared to utilization determined from weight data.

Species and replications	Weight method arithmetic average	Estimates of utilization by the grazed-class method				
		Weight check	Examiner A	Examiner B	Examiner C	Examiner D
	(Percent)					
Sideoats grama						
Rep. I	47.5	47.6	33.5	36.1	49.1	47.1
Rep. II	37.5	37.6	32.6	33.3	42.6	43.7
Rep. III	50.9	50.9	39.5	44.5	52.0	47.7
Means	45.3	45.4	35.2	38.0	47.9	46.2
Black grama						
Rep. I	56.1	56.1	40.6	39.3	41.8	48.7
Rep. II	58.7	58.6	43.1	42.3	50.3	52.2
Rep. III	58.5	58.5	47.9	47.1	43.5	48.8
Means	57.8	57.7	43.9	42.9	45.2	49.9

cates that acceptable uniformity can be obtained between examiners after only one or two hours use of the grazed-class method, regardless of prior experience. This uniformity should continue to improve with added experience.

The increased accuracy following experience in the use of the method is confirmed by the variation between replications, which is highly significant in the sideoats grama tests and not significant in the black grama tests. However, part of this difference may have resulted from differences between the growth form of the two plants and variations in degree of clipping.

The analyses of weight-checks versus examiners, emphasizes need for caution in the preparaiton of photographic guides. In developing the photographic guide for this study, sample plants for both species were preclipped at two-inch height intervals, oven-dried and the growth form plotted as height-weight curves. Similar height-weight curves were taken from references by Crafts (1938) and Caird (1945), adjusted to uniform height and averaged with the data from plants clipped in the field. These averages were used to estimate the heights to clip the photo plants used in making the photographic grazed-class guides for the respective species. As a check, the oven-dry weights of the photo plant were plotted with the other curves.

In the case of sideoats grama the curves for the photo guide and photo plant matched quite closely. The use of this guide by the examiners showed a close correlation with the weight-check. In the case of black grama, there was considerable difference between the photo guide and the photo plant curve. The use of this guide resulted in a highly significant difference between the weight-check and estimates by the examiners. (Table 3).

Table 3. Statistical analyses of utilization estimates made on sideoats and black grama by the weight and grazed-class methods.

Source of variation	df	Sideoats grama		Black grama	
		ss	F	ss	F
Examiners:					
Between examiners	3	343.60	19.47**	86.62	3.90
Weight-check vs. examiners	1	29.26	4.98	363.09	49.00**
Between reps	2	201.77	17.16**	51.81	3.50
Error	8	47.00		59.27	

* Significant difference at 5 percent level
** Highly significant difference at 1 percent level

This points up the need for close correlation between the photographic guide and the height-weight curve of the average plant clipped to make the photographs. Since this cannot be determined until after the photographs have been taken and the clipped plant oven dried and weighed, it may mean making several sets of photographs until a close match is obtained.

Another point closely related to this problem is the question of how much the growth form of the guide plant can vary from the plants being estimated in the field. This factor is compensating so considerable variation appears permissible, particularly where larger 50- and 100-estimate samples are taken. Several guides may need to be developed for each key species to match wide year-to-year or site-to-site variations in growth form. Development of guides based on averages of local plants within a given region will reduce the possibility of variation such as might result from using curves developed for broad geographic regions or between states.

The adaptability of a guide for a given situation may be checked by clipping representative plants according to the guide classes, weighing the clipped portions and calculating the various percentages removed. Green weights may be used for quick field checks and oven-dry weights for more accurate data.

The method also tends to reduce errors caused by variability in height growth, one of the major sources of error in height-weight methods. In making estimates of utilization by the grazed-class method, the growth form of the plant is used as the primary guide and visual adjustments for differences in height can easily be made by the examiner.

Another advantage in the use of the method is that, while the estimate of utilization is based on forage removed, each grazed-class shows both the degree of use and the amount of herbage remaining.

The method also facilitates estimation of irregular grazing of plants. Although the guide plants are clipped to a certain height and may not represent the normal pattern of grazing, they do provide a visual picture of the volume by grazed-classes and serve as a guide to the examiner in estimating irregular use of the plant, such as occurs in side-trimming of leaves or partial-grazing of seed stalks. This requires judgment on the part of the examiner but accuracy increases with experience and errors are compensating. Thus the method is largely free from personal bias yet allows for experienced judgment on grazing use of irregularly grazed plants.

The importance of a guide to standardize utilization estimates is indicated by Smith (1944) who analyzed density estimates made by uniformly and intensively

trained examiners. He found that personal bias and inconsistencies of estimates made without benefit of a guide resulted in highly significant variation among men from day to day and even on the same plots at different times of the day. Some individuals tended to remain high estimators and others low estimators but there occurred many exceptions with a given individual showing significant inter- and intra-daily variation. Therefore, the use of a guide facilitates making of uniform estimates by inexperienced ranchers and technicians after relatively little training. However, setting up and checking the adaptability of the guide remains a technical job.

The grazed-class method is adaptable for use in both administration and research. Use of the method on a single dominant key species with relatively few estimates provides the rancher or technician with a simple, fast, moderately accurate method of checking the grazing use of a pasture. On the other hand, larger samples, taken more frequently on more species, provide more accurate, statistically analyzable data for more intensive studies in both administration and research.

Many problems remain to be solved in range utilization. These include studies on the variability of proper use factors of various species under different range conditions and different degrees of use and vigor; the degree of water development and other improvements necessary to obtain uniform grazing; the effects of soil fertility, slope, exposure, shading and other site factors on grazing use; regrowth as a factor in utilization; variations in use at different seasons and by different classes of livestock and game; measurement of proper use on plants with differing growth forms; and rechecks on the validity of the key species and key area concepts. The availability of this fast, statistically sound, reasonably accurate method of measuring utilization provides a useful tool to help solve some of these problems.

Summary

A grazed-class method of estimating range utilization combines the advantages of several systems in use. It is proposed for use in both administrative and research phases of range management.

The method is based on a procedure which classifies grazed plants into six grazed-classes — 0, 10, 30, 50, 70 and 90 percent use. Photographic guides, developed from height-weight curves of average local plants, are used for each key species to guide the examiner in placing grazed plants into the grazed-classes. Representative samples of 20, 25, 50 or 100 plants, located by toe-pace transects, are estimated for each key species to determine the percentage of grazed plants in each grazed-class. Current utilization is calculated by multiplying the average use factor for each grazed-class by the corresponding percentage of grazed plants in each class and totaling the products. Based on this percentage of current use, plus data on the cow months grazed and proper use of the key species, the cow months remaining and the total proper use can be estimated by simple calculations.

The method was tested against the weight-method and was found to be fast, simple, statistically sound and reasonably accurate. Estimates were made on two species, sideoats grama and black grama, representing a bunchgrass and sodgrass type growth. After only a few hours use of the method, statistically satisfactory estimates were made by both experienced and inexperienced examiners.

The use of photographic guides makes possible the estimation of utilization based on forage removed (but also shows herbage remaining) and facilitates judgment of irregular grazing on the plant. Errors are compensating and guides can be easily checked against clipped weights.

The method requires reasonably close correlation between the photographic guide and (1) the height-weight curve of the average plant used to make the guide and (2) the growth form of the plants estimated in the field, but permits considerable variation in height of plants.

The grazed-class method is easily adapted to use by ranchers, technicians or research workers. Many problems in utilization remain to be solved and the grazed-class method offers a tool to help solve these problems.

LITERATURE CITED

BROWN, D. 1954. Methods of surveying and measuring vegetation. Commonwealth Bureau of Pastures and Field Crops Bulletin 42. Commonwealth Agric. Bur., Farnham Royal, Bucks, England. 223 pp.

CAIRD, R. W. 1945. Influence of site and grazing intensity on yields of grass forage in the Texas Panhandle. Jour. Forestry 43: 45-49.

CAMPBELL, R. S. 1943. Progress in utilization standards for western ranges. Wash. Acad. Sci. Jour. 33: 161-169.

COSTELLO, D. F. AND G. E. KLIPPLE. 1939. Sampling intensity in vegetation surveys made by the square foot density method. Agron. Jour. 31: 800-810.

CRAFTS, E. C. 1938. Height-volume distribution in range grasses. Jour. Forestry 36: 1182-1185.

DASMANN, W. P. 1948. A critical review of range survey methods and their application to deer range management. Calif. Fish and Game 34: 189-207.

HEADY, H. F. 1949. Methods of determining utilization of range forage. Jour. Range Mangt. 2: 53-63.

HEDRICK, D. W. 1958. Proper utilization—a problem in evaluating the physiological response of plants to grazing use: A review. Jour. Range Mangt. 11: 34-43. Also Oregon Agric. Expt. Sta. Misc. Paper 46.

HUMPHREY, R. R. 1949. An analysis of forage utilization methods and a proposal for utilization surveys by range condition classes. Jour. Forestry 47: 549-554.

JOINT COMMITTEE — ASA, ADSA, ASAP, ASRM. 1952. Pasture and range research techniques. Agron. Jour. 44:39-50.

JOINT COMMITTEE—ASRM, AGRICULTURAL BOARD. 1962. Basic problems and techniques in range research. National Academy of Sciences—National Research Council Publ. No. 890. 341 pp.

PARKER, K. W. 1952. New trends in standards for range use. Jour. Forestry 50:856-859.

PECHANEC, J. F. AND G. D. PICKFORD. 1937. A comparison of some methods used in determining percentage utilization of range grasses. Jour. Agr. Res. 54:753-765.

SAMPSON, A. W. 1952. Range management principles and practices. John Wiley & Sons, Inc., New York, N. Y. 570 pp.

SMITH, A. D. 1944. A study of the reliability of range vegetation estimates. Ecology 25:441-448.

STODDART, L. A. AND A. D. SMITH. 1943. Range Management. McGraw-Hill Book Co., Inc., New York, N. Y. 547 pp.

STODDART, L. A. AND A. D. SMITH. 1955. Range Management, 2nd ed. McGraw-Hill Book Co., Inc., New York, N. Y. 433 pp.

U. S. FOREST SERVICE. 1959. Techniques and methods of measuring under-story vegetation. U. S. Forest Service Southern Forest and Southeastern Forest Experiment Stations. Proceedings of a Symposium at Tifton, Georgia, October 1958. 174 pp.

Effects of Grazing and Protection on a Twenty-Year-Old Seeding

D. A. RIEGEL, F. W. ALBERTSON, G. W. TOMANEK AND FLOYD E. KINSINGER

Assistant Professor of Botany, Professor of Botany (Deceased), Professor of Biology and Associate Professor Botany, Respectively, Fort Hays Kansas State College, Hays, Kansas.

Millions of acres have been and are being seeded to grass in the western United States in attempts to restore depleted range and crop lands. Some areas are grazed soon after successful establishment while others are protected for periods of time varying with requirements of government programs. Some areas have been seeded to native grasses while on others, introduced species are used. Many questions arise about proper seeding mixtures and management in relation to establishment of permanent high-producing grasslands. Long term studies are necessary to find answers for these questions.

This paper reports a survey of an area seeded to three different grass mixtures in 1941. Part of each seeded area has been protected and a part grazed. Therefore, an opportunity was provided to measure the stability, over a long period of time, of seeded grassland under grazing and protection.

Methods of Study

Three different grass mixtures were seeded on an upland field previously cultivated for nearly 40 years. The soil is uniform and typical of the clay upland range site in western Kansas (Table 1). Under natural conditions the bulk of the climax native vegetation would be blue grama *(Bouteloua gracilis)*, western wheatgrass *(Agropyron smithii)* and buffalo grass *(Buchloe dactyloides)* (Albertson, 1937). Small amounts of sideoats grama *(Bouteloua curtipendula)* and big and little bluestem *(Andropogon gerardi* and *A. scoparius)* are found in the more favorable mesic locations on the site.

Part of the field was seeded to a bluestem mixture which consisted of four pounds of big and little bluestem, three pounds of sideoats grama, two pounds of blue grama and two pounds of switch grass *(Panicum virgatum)* per acre. Another portion of the field was seeded to blue grama at the rate of 10 pounds per acre. A third portion was seeded to a mixture of two pounds of sideoats grama, two pounds of blue grama and eight pounds of western wheatgrass. The three mixtures will be referred to as the bluestem mixture, blue grama, and wheatgrass-grama mixture in the order mentioned above. Different methods of seedbed preparation were used but for the purposes of the study reported here, the important fact is that a good stand was obtained at the end of two years by all methods.

Three years after seeding, the area was fenced in with a native pasture for use by livestock. The seeded field has been moderately grazed for the past 17 years. Two exclosures, 135 feet long and 40 feet wide, were constructed to protect small portions from grazing. One exclosure was constructed across the ecotone of the blue grama and bluestem mixture (Exclosure I) and the other on the border between blue grama and the wheatgrass-grama seeding (Exclosure II) (Figure 1).

Table 1. Soil profile description of clay uplands site used for seeding three grass mixtures.

Horizon	Depth	Texture	Structure	Reaction
A_1	0-13″	silty clay loam	weak, granular, massive	none
B_1	13-18″	silty clay	blocky, platy	none
B_2	18-25″	silty clay	blocky, massive	slight
B_3Ca	25-30″	silty clay	blocky, massive	strong
C_1	30″ +	silty clay	massive	none

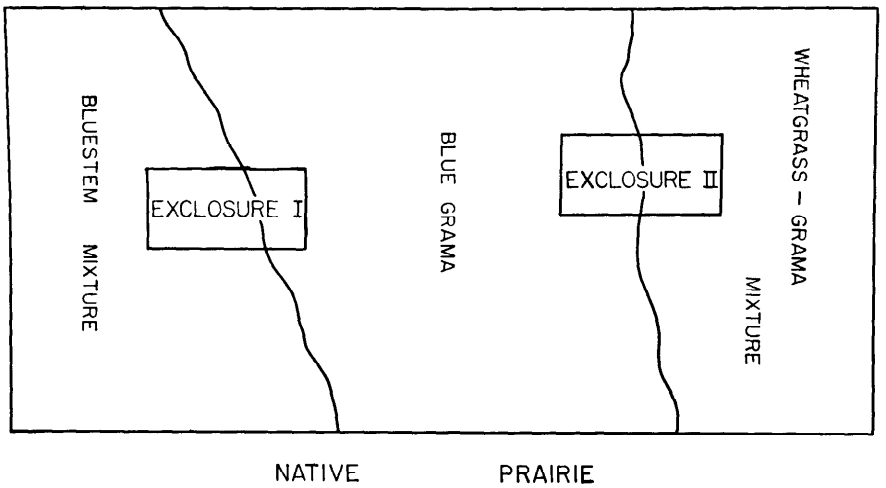


FIGURE 1. Reseeded area showing locations of plantings of different mixtures and exclosures that protected small areas from grazing.

Measurements were made in 1961, 20 years after planting, of the composition and yield of the vegetation inside and outside exclosures. With exclosures located on ecotones of the seeded areas, an excellent opportunity was provided for comparing vegetative composition, yield and the extent of the spread of various species under both protected and grazed conditions. Measurements were taken in all three seeded areas under both treatments.

Percentage composition and cover was measured by use of randomly placed point frames as described by Levy and Madden (1933). A total of 3,000 points were used in each treatment of each area. Yields were determined by clipping five meter quadrats at the end of the growing season in each treatment of each area. Portable cages were used to protect clip quadrats from grazing.

Results

The bluestem mixture was successfully established on the heavy upland soil even though the bluestems are not often abundant in native vegetation on such sites. Big and little bluestem accounted for 90 percent of the total vegetation in the area seeded to the bluestem mixture and protected from grazing for 20 years (Table 2). With exclusion of livestock the area was occupied and dominated by big and little bluestem. Switch grass and tall dropseed *(Sporobolus asper)* were the only other common grasses found on the portion seeded to the bluestem mixture.

Under protection at the other end of the exclosure, the area seeded to blue grama was successfully invaded by many other grasses (Table 2). Blue grama composed only 30 percent of the vegetation while the bluestems and switch grass furnished over 57 percent (Table 2). Small amounts of sideoats grama had also invaded from the other part of the exclosure located in the bluestem mix seeding. Western wheatgrass had invaded from a considerable distance outside the exclosure. In other words, long-time protection from grazing permitted the taller mesic grasses to invade a blue grama grass seeding even though the nature of the soil was presumably more suitable to blue grama. Apparently, even the drouth, 1952-1956, did not favor the short grass sufficiently to reassert dominance under protection.

Western wheatgrass formed over half the vegetation in the area seeded with wheatgrass-grama (Table 3). Blue grama and sideoats grama each formed about 20 percent of the vegetation. At the end of the exclosure situated in the area seeded to blue grama, the major portion of the vegetation was blue grama (Table 3). Western wheatgrass was the most successful invader forming 17.8 percent of the vegetation while sideoats grama accounted for only four percent.

Table 2. Composition of vegetation from two seeded areas after 20 years of protection inside an exclosure compared to composition on moderately grazed areas outside the exclosure (Exclosure I).

Species	Bluestem mix		Blue grama	
	Protected	Grazed	Protected	Grazed
	(Percent)			
Big bluestem	47.64	0.35	9.63	.....
Little bluestem	42.45	12.50	19.79	.....
Blue grama	.....	24.31	30.01	86.38
Sideoats grama	0.94	9.03	1.07	.....
Western wheatgrass	.....	1.39	4.81	0.51
Switch grass	6.13	5.90	27.80	.....
Tall dropseed	1.42	11.11	.....	.....
Buffalo grass	.....	6.25	.....	0.51
Subsere grasses	.....	15.97	.....	2.32
Other grasses	0.47	6.94	1.06	4.88
Forbs	0.94	6.26	4.80	5.40

Effects of Grazing

Areas outside the exclosures had been subjected to moderate grazing for 17 years. Observations indicated that animals concentrated more in the area seeded to bluestems and, therefore, grazing was heavier in that area.

A wide variety of grasses was found in the grazed area planted to the bluestem mixture (Table

Table 3. Composition of vegetation from two seeded areas after 20 years of protection inside an exclosure compared to composition on moderately grazed areas outside the exclosure (Exclosure II).

Species	Wheatgrass-Grama mix		Blue grama	
	Protected	Grazed	Protected	Grazed
	(Percent)			
Blue grama	20.31	43.66	70.11	92.60
Sideoats grama	20.31	35.92	4.02	0.26
Western wheatgrass	53.13	11.97	17.81	.....
Buffalo grass	.....	3.17	.....	0.77
Subsere grasses	.....	0.70	.....	2.05
Other grasses	4.91	2.82	3.06	1.79
Forbs	2.34	1.05	5.16	5.16

2). The five grasses used in the original planting constituted only 52 percent of the vegetation. Blue grama alone comprised over 24 percent of the vegetation cover under grazing but was not present in the protected area. Tall dropseed with over 11 percent could have been in the original mixture in small quantities or may have invaded from the nearby native prairie. Buffalo grass and western wheatgrass probably invaded from the nearby native prairie. Grasses typical of a late stage in secondary succession, referred to as subsere grasses, furnished nearly 16 per cent of the cover. These included such grasses as sand dropseed *(Sporobolus cryptandrus)*, red threeawn *(Aristida longiseta)*, windmill grass *(Chloris verticillata)* and similar species. Little bluestem was common but had been greatly reduced by grazing. Big bluestem did not survive the moderate grazing pressure on the site.

Blue grama formed more than 86 percent of the vegetation on the grazed area outside exclosure one in the blue grama seeding. Even though the bluestems and switch grass were successful invaders of the blue grama seeding under protection, none of these species were found in the grazed area. Apparently, the habitat was borderline for support of the taller grasses. With the added moderate grazing factor, the tall grasses disappeared. Only 2.3 percent were subsere grasses.

Vegetation on the wheatgrass-grama mix seeding was quite stable under moderate grazing (Table 3). After 17 years of use, over 91 percent of the total vegetation was still furnished by the three species originally planted. Western wheatgrass was considerably reduced but both blue grama and sideoats grama were more abundant than in the protected area. Small islands of buffalo grass were widely scattered throughout and subsere grasses were rare.

On the grazed area planted to blue grama near exclosure two, over 92 percent of the vegetation was furnished by this one species. No significant invasion was made by any other species.

Forage Production

Seasonal production of forage in the area seeded to the bluestem mixture was greatly different between grazed and protected locations. Protected areas produced more than twice as much forage as grazed areas (Table 4). Besides the reduction in the higher producing bluestems due to grazing, the general vigor of all the grazed plants appeared to be decreased. Since grazing management is based on forage production potential of an ungrazed site it might be assumed that moderate grazing of the bluestem mixture is not the proper degree of use. Lighter grazing may have maintained the abundance and vigor of the bluestems. However, it has been observed that even very light grazing on the clay upland site in native prairie causes the disappearance of the bluestems. The type of management necessary to maintain the bluestems on the clay upland site may not be economically feasible.

Production from the protected area of wheatgrass-grama mixture was 3,439 pounds per acre as compared to 2,988 pounds on the grazed area. Even less difference in production existed between the protected and grazed locations in the blue grama seeding (Table 4).

Forage yields under moderate grazing of three types of seeding were quite similar indicating that, under grazing, the production for the site was similar irrespective of the seeded species. However, there was a large difference in yields of three protected areas.

Records of forage production on the grazed seeded area and on an adjacent native pasture have been kept from 1945 to 1961 (Table 5). Clippings made on the seeded area were averaged from quadrats on all three types of seeding. Very little difference was found in the average production of the native and seeded

Table 4. Production in 1961 of grass in three seeded areas grazed moderately for 17 years and adjacent comparable areas protected for 20 years.

	Bluestem mix	Blue grama	Wheatgrass-Grama
	(Pounds)		
Protected	5,525	2,210	3,439
Grazed	2,171	2,120	2,998

Table 5. Average forage yields from 1945 to 1961 on seeded area compared to native grassland on the same site.

	Native	Seeded
Average	2,190	2,028
Highest Year	4,271	2,028
Lowest Year	897	679
1961	2,823	2,845

grasslands (2,190 and 2,028 pounds per acre respectively). The native prairie was dominated by buffalo grass and blue grama and had been grazed moderately for many years while the seeded area contained many species all subjected to the same grazing intensity. Production in 1961 was almost identical on both locations.

Discussion and Summary

Study of a seeded area after twenty years of protection and 17 years of moderate grazing revealed many characteristics of an upland area in west-central Kansas.

Three different grass mixtures were seeded on a clay upland site characterized by a heavy silty clay loam to silty clay soil. The grass mixtures used were bluestem mixture containing big and little bluestem, sideoats grama, and switchgrass; blue grama only; and western wheatgrass-grama mixture with western wheatgrass, blue grama, and sideoats grama.

Big bluestem and little bluestem can be maintained on the clay upland site under protection. After 20 years of protection, the two bluestems formed 90 percent of the total plant population where the bluestem mixture had been seeded. However, only small amounts of the bluestems occur in an adjacent similar native prairie. In fact, the two bluestems and switch grass successfully invaded a stand of blue grama (one of the dominants of the clay upland) when protected from grazing.

Moderate grazing greatly reduced the abundance of the bluestems. Blue grama was the most abundant grass in the grazed area seeded to bluestem mixture, but many of the taller grasses were still present in larger amounts than on native prairie. No significant invasion of blue grama by the taller grasses occurred under moderate grazing. Large numbers of subsere grasses were found in the grazed bluestem mixture area indicating a lack of stability.

All three grasses in the wheatgrass-grama mixture seeding were were still dominant after 20 years of protection. Moderate grazing reduced the relative amount of western wheatgrass and allowed blue grama and sideoats grama to increase but all three were sufficiently abundant to be considered dominants. Invasion of the blue grama seeding by the two taller grasses occurred to a limited extent and only when protected from grazing.

Areas seeded to pure blue grama were relatively stable after 20 years when subjected to moderate grazing. Only about two percent of the vegetation was furnished by subsere grasses and nearly 90 percent by blue grama.

Production from the bluestem mixture when protected was over two and one-half tons in 1961 but 17 years of moderate grazing had reduced it to slightly over one ton for the same year. Production on the blue grama seeding was nearly equal on grazed and ungrazed areas but moderate use did reduce the yield on the wheatgrass-grama mixture.

It is interesting to note that variation in production of the three mixtures was not as great under moderate use as it was when the areas were protected from grazing. Yields from moderately grazed bluestem mixture and blue grama were nearly equal while the wheatgrass-grama area produced nearly one-third more forage.

Average yields of native and seeded grasslands for the past 17 years were about equal indicating that the site potential under grazing is about the same regardless of species.

Although bluestems will grow on this site, they do not produce any more than blue grama with moderate use. Results of this study of a 20-year old seeding trial would indicate that use of dominant, native grasses in a seeding mixture is most satisfactory. Results of this study indicate that the clay upland site is capable of maintaining tall grasses with complete protection but not with moderate use.

Previous history of cultivation may influence the type of grasses the soil will support. Adjoining native grasslands on the same soil type protected for 30 years and close to a seed source of the bluestems did not support big and little bluestem.

LITERATURE CITED

ALBERTSON, F. W. 1937. Ecology of the mixed prairie. Ecol. Monog. 7: 481-547.

LEVY, E. B. AND E. A. MADDEN. 1933. The point method of pasture analysis. New Zealand Jour. Agric. 46: 267-279.

Responses of Annual-Type Range Vegetation to Sulfur Fertilization

CHARLES F. WALKER AND WILLIAM A. WILLIAMS[1]

Associate Specialist in Agronomy and Associate Professor of Agronomy, University of California, Davis, California.

The importance of remedying the prevalent soil deficiencies of nitrogen, phosphorus and sulfur on California range lands has been increasingly recognized over the past 25 years. Of these three nutritional elements sulfur has received the least attention in connection with its use to enhance growth of resident species of annual-type range vegetation. Recently, however, Martin (1958) indicated the extensiveness of sulfur-deficient areas.

Response of introduced annual legumes such as bur clover *(Medicago hispida)* and rose clover *(Trifolium hirtum)* to sulfur-containing materials has been reported by Conrad et al. (1948), Conrad (1950), Arkley et al. (1955) and McKell and Williams (1960). Response of native annual legumes, chiefly littlehead clover *(Trifolium microcephalum)* was reported by Bentley and Green (1954), Bently et al. (1958), and Woolfolk and Duncan (1962). In most instances growth of associated resident annual grasses has been stimulated, but it has been in the second or subsequent years after sulfur application.

Numerous sulfur-containing materials have been used on California range lands, both experimentally and on a commercial scale. The main materials are elemental sulfur, gypsum, single superphosphate and ammonium sulfate. The last two contain the elements phosphorus and nitrogen, respectively, which complicates the interpretation of results. Conrad (1950) found on bur clover that elemental sulfur gave yield increases about equal to those from gypsum-sulfur except when applied to the soil surface in areas where limited rainfall occurred only in the colder months. Under these conditions, response to gypsum exceeded the response to elemental sulfur. Elemental sulfur is oxidized to sulfuric acid by the action of certain soil bacteria, and rapid oxidation occurs only in warm, well-aerated, moist soil (Aldrich and Schoonover, 1951). Therefore, sulfur application in late fall or winter may have little or no effect until the following spring. McKell and Williams (1960) found from a lysimeter study that gypsum leached rapidly in a season of heavy rainfall.

A series of investigations was initiated in 1955 to study the effects of sulfur fertilization on annual-type range vegetation. The factors studied were (1) forage yield, (2) protein content and (3) sulfur content as influenced by several sources of sulfur and nitrogen applied in the autumn and winter. Nitrogen fertilization was included in all comparisons since it was known to be the primary nutrient deficiency of soils supporting annual-type vegetation (Martin and Berry, 1955).

Description Of The Area

The study sites are located near Badger (Tulare Co.), California at 3,500 feet elevation in natural grassland areas surrounded by chaparral or woodland (Figure 1). These areas are adjacent to pioneer homesteads, and in the early decades of this century provided arable land for the production of cereal hay. The plant community is dominated by winter annual grasses, chiefly *Bromus mollis, B. rigidus, Avena fatua,* and *Festuca megalura* with a lesser component of forbs such as the

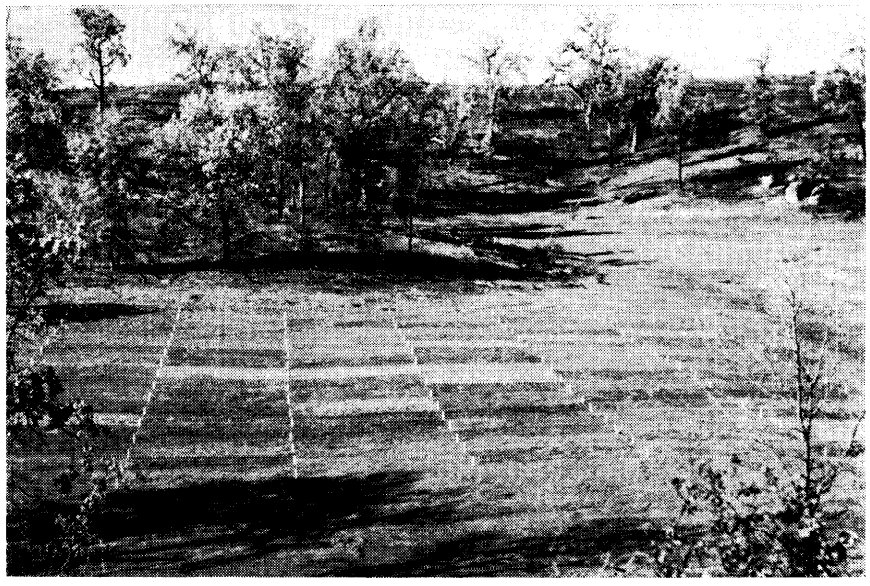


FIGURE 1. Site of experiment 3 showing evidence of response to September fertilizer applications. Photo taken February 1957.

[1]*The authors wish to extend grateful acknowledgement to J. E. Street, R. L. Worrell and R. A. Evans for technical aid and to Keith Manley and Burrel Hyde for providing facilities for these experiments.*

winter annual, *Erodium botrys*, and the summer annual tarweed, *Hemizonia virgata*.

The main soil of the experimental areas is represented by the Auberry series described as follows: grayish-brown, moderately deep, well-drained, slightly acid, moderately developed prairie soil, derived from crystalline, granular, acid, igneous rocks weathered in place.[2]

The climate is of the Mediterranean type or dry-summer subtropical (Koppen's Csa) and has the following characteristics: annual precipitation of 35 inches occurring mainly in the winter, summers essentially rainless; temperatures mild in winter and warm to hot in summer (Kesseli, 1942); mean annual temperature 56° F.

Procedure

Experiment 1

During February 1955 nitrogen, both as ammonium nitrate and ammonium sulfate, was applied at 33, 66 and 132 pounds of nitrogen per acre. The ammonium sulfate applications contained 37, 75 and 150 pounds of sulfur per acre, respectively. Plot size was 50 by 109 feet. In this and the following experiments, protein was determined by the macro-Kjeldahl method and sulfur by the method of Johnson and Nishita (1952).

Experiment 2

In December 1955, ammonium nitrate, gypsum, and ammonium nitrate plus gypsum were applied at rates equivalent to 100 pounds of nitrogen, 107 pounds of sulfur, or both, per acre in eight replications.

Experiment 3

Sulfur was applied in the materials gypsum, elemental sulfur and ammonium sulfate. Combinations of gypsum and elemental sulfur with ammonium nitrate and urea were also used as well as ammonium nitrate and urea alone. The rates of application were sulfur—120 pounds per acre and nitrogen—105 pounds per acre. The fertilizers were main plot treatments, and sub-plot treatments were times of application (September 1956 and February 1957) in a split-plot design. The size of sub-plots was 10 by 20 feet, and the treatments were replicated six times. A sample from each plot was hand separated by species after harvesting in May.

[2] *Huntington, G. L., personal communication.*

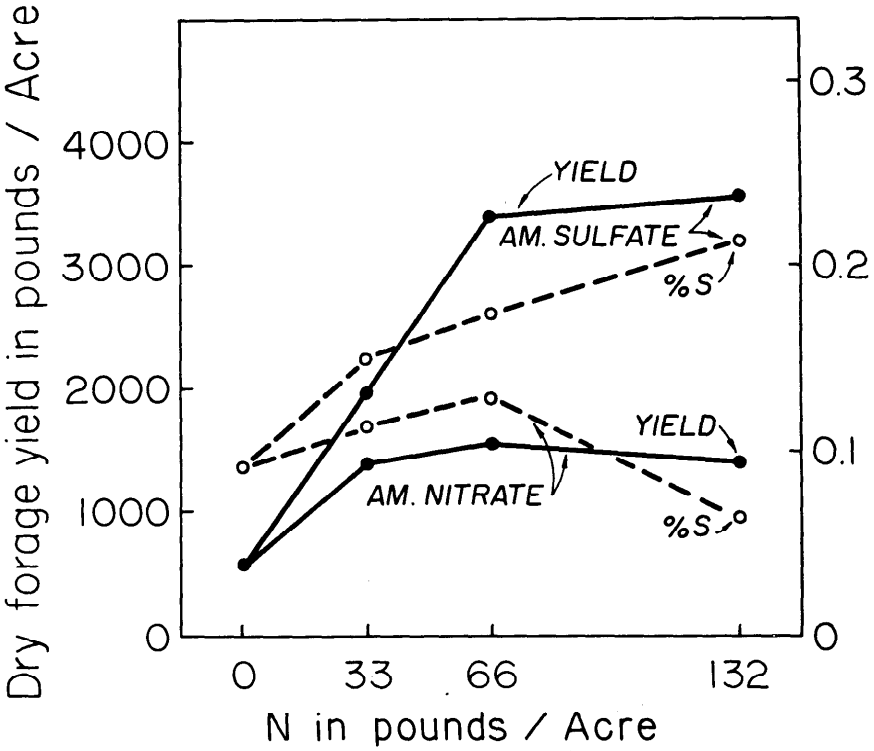


FIGURE 2. Yield of sulfur content of forage from annual-type range fertilized with ammonium sulfate and ammonium nitrate (equal nitrogen basis), Experiment 1.

Experiment 4

Procedure was the same as for experiment 3 except that the times of application were September 1957 and February 1958, and a uniform application of an additional 66 pounds of nitrogen per acre was applied over the whole plot area in September 1958.

Results

Experiment 1

The results of the first experiment indicated soil deficiencies of both nitrogen and sulfur. Nitrogen alone applied as ammonium nitrate increased forage yield by a maximum of 880 pounds per acre (Figure 2). Sulfur plus nitrogen applied as ammonium sulfate was superior to nitrogen alone at all levels with a maximum additional increase over the best ammonium nitrate treatment of 2,110 pounds per acre. Visual observation before sampling indicated greener color of foliage on the plots receiving sulfur. Plots that received nitrogen only were not noticeably different in color from unfertilized plots.

Analyses showed that forage on the control plots and on the plots fertilized with ammonium nitrate contained less than 0.13 percent sulfur (Figure 2). Ammonium sulfate, by supplying both sulfur and nitrogen, increased the sulfur content of the forage to 0.21 percent at the highest rate of application. The yield response leveled off at 0.18 percent sulfur in the harvested forage.

Application of ammonium nitrate raised the crude protein

Table 1. Crude protein content and N:S ratio of forage from annual-type range fertilized with ammonium sulfate and ammonium nitrate.

Fertilizer material	N	S	Crude Protein		N:S ratio
	Pounds/acre		Percent	Pounds/acre	
Control	0	0	7.9	45	13.7
Ammonium nitrate	33	0	10.2	143	14.4
Ammonium nitrate	66	0	12.3	179	15.2
Ammonium nitrate	132	0	13.1	184	31.7
Ammonium sulfate	33	37	6.5	127	7.0
Ammonium sulfate	66	75	8.7	295	7.9
Ammonium sulfate	132	150	10.8	384	7.8

(nitrogen x 6.25) level of the forage from 7.9 percent for the control to 13.1 percent for the highest rate (Table 1). Ammonium sulfate applied at equivalent nitrogen rates depressed crude protein percentage by an average of 3.2 percent. However, the enhancement of yield by the sulfur in ammonium sulfate overbalanced the reduced protein concentration; thus, the crude protein production on an acre basis was increased at the higher rates of application. At the highest rate of application ammonium sulfate produced 384 pounds per acre crude protein whereas ammonium nitrate produced 184 pounds per acre.

The species in greatest abundance at the test site were soft chess *(Bromus mollis)* and broadleaf filaree *(Erodium botrys)*. After maturity was achieved by the winter annuals tarweed *(Hemizonia virgata)*, a summer annual, assumed dominance. Visual observaton indicated a reduction in the prevalence of tarweed was associated with certain fertilizer treatments. The reduction resulting from the ammonium sulfate treatments ranged from 30 to 60 percent with the greatest reduction occurring with the highest rate of application. Ammonium nitrate had no effect on tarweed abundance except a 10 percent reduction at the highest rate.

Experiment 2

To detect possible responses to sulfur alone as well as to a nitrogen and sulfur combination a second trial was established the following year using gypsum, ammonium nitrate and the combination of the two. A moderate increase in forage production was obtained following the ammonium nitrate treatment, but no increment resulted from gypsum applied with ammonium nitrate, nor did the gypsum-alone treatment differ from the control. Rain began the day after the applications were made, and 14 inches fell within a month. Gypsum is readily leached as shown by the lysimeter work of McKell and Williams (1960). Thus leaching would seem to be a most reasonable explanation for the lack of sulfur response in this particular season. This hypothesis is supported by tissue analysis which showed that very little additional sulfur was taken up by plants on the gypsum treated plots. This was in contrast to the marked increase in sulfur content the previous year when the response to ammonium sulfate was large.

Experiment 3

In experiment 3, several carriers of both nitrogen and sulfur were applied in the autumn and in the winter. The averages of the two times of application show that nitrogen alone from both ammonium nitrate and urea produced a large response in forage yield (Table 2). The several forms of sulfur in combination with nitrogen resulted in further significant increases in production.

Hand separation of forage samples for botanical composition showed that the most prevalent grass was soft chess *(Bromus mollis)*. Other grasses were principally *B. rigidus, Avena fatua* and *Festuca megalura*. The most important forbs were the filarees *Erodium botrys* and *E. cicutarium*. Other forbs included *Hemizonia virgata, Plagiobotrys northocarpus* and *Amsinkia tessellate*. Legumes noted were, in very minor amounts, *Trifolium microcephalum, T. variegatum, Lupinus bicolor,* and *Lotus purshianus*. The botanical separation data were combined for both times of application of the two nitrogen carriers and the five nitrogen and sulfur combinations for presentation in Figure 3. Soft chess and filaree responded equally well to nitrogen; other grass produced a lesser response; and other forbs and legumes showed no response. Soft chess demonstrated a strong response to sulfur in combination with ni-

Table 2. Forage production by annual-type range fertilized with various sources of nitrogen (105 pounds/acre) and sulfur (120 pounds/acre in the autumn or winter, Experiment 3.

Fertilizer material	Autumn applied	Winter applied	Ave.
	(pounds/acre)		
Control	1060	1060	1060
Ammonium nitrate	2970	2950	2960
Ammonium nitrate and gypsum	3610	3560	3580
Ammonium nitrate and elemental sulfur	3780	4000	3890
Urea	2850	2190	2520
Urea and gypsum	3050	3880	3460
Urea and elemental sulfur	3380	4330	3860
Ammonium sulfate	3160	4180	3670
LSD 5% fertilizer	770	770	480
LSD 5% time	850	850	.....

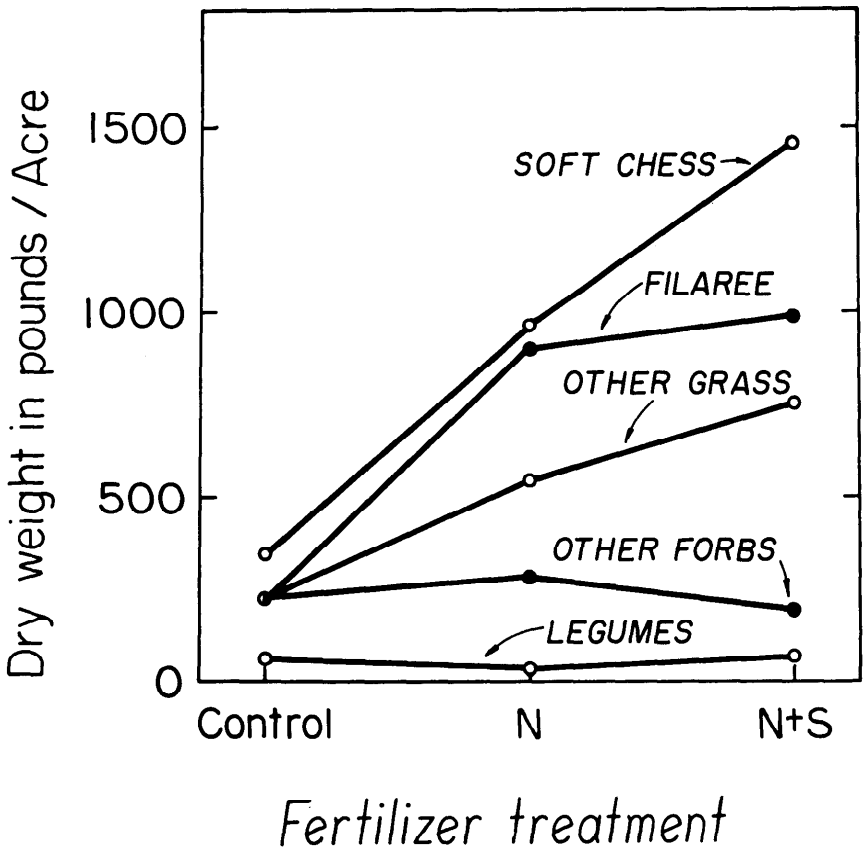


FIGURE 3. Botanical components of annual-type range fertilized with nitrogen (105 pounds/acre), and equivalent nitrogen plus sulfur (120 pounds/acre), Experiment 3.

trogen; other grass produced a lesser response and filaree, other forbs and legumes showed no response to sulfur.

The results of sulfur analyses revealed that the sulfur percentage of the whole forage was increased significantly from 0.12 for the control plots to 0.18 for the nitrogen-sulfur plots (Table 3). The increase in sulfur percentage of each of the forage components approached significance. The sulfur concentration in the plants fertilized with nitrogen only was not significantly different from the controls. The protein percentage of whole forage was not appreciably influenced by fertilization in this experiment, although filaree responded positively and the other forbs, negatively.

Experiment 4

In experiment 4 the treatments used in experiment 3 were repeated at a nearby location with substantially the same yield response at a slightly lower level of production over all in 1958 (Table 4). The annual grasses again responded strongly to nitrogen, with a further large increase in production occurring where sulfur was added to nitrogen (Figure 4). In this location and season the forbs responded to neither nitrogen nor sulfur.

A blanket application of urea was applied over experiment 4 in the autumn of 1958, and carryover sulfur responses were measured in the subsequent year. The yields in 1959 showed a response from residual sulfur applied in the autumn of 1957, but there was no residual effect of sulfur applied in the winter of 1958. Apparently, residual response to the autumn application was the result of sulfur uptake by the plants and subsequent return during decomposition of plant residues between growing seasons, and then uptake by plants again in the 1958-59 growing season.

Discussion

Previous reports have attributed increases in production of winter annual range grasses resulting from sulfur fertilization to an initial stimulation of native or introduced legumes, followed in the subsequent year or years by increased grass production as a result of a nitrogen accumulation in the soil from the legumes (Conrad et al., 1948 and Bentley et al., 1958). However, in these

Table 3. Sulfur and crude protein content of various botanical components and the N:S ratio of whole forage from annual-type range fertilized with nitrogen (105 pounds/acre) and equivalent nitrogen plus sulfur (120 pounds/acre), sources combined, Experiment 3.

Forage component*	Fertilizer treatment			
	Control	Nitrogen	Nitrogen-Sulfur	LSD 5%
		Sulfur (Percent)		
Soft chess	0.11	0.08	0.14	0.05
Other grass	.11	.10	.18	.05
Filaree	.13	.09	.20	.09
Other forbs	.16	.14	.28	.14
Average (weighted)	.12	.09	.18	.06
		Protein (Percent)		
Soft chess	9.8	12.1	8.6	NS
Other grass	7.4	8.2	7.8	NS
Filaree	7.4	10.8	9.4	1.5
Other forbs	16.3	14.9	12.6	3.1
Average (weighted)	10.2	11.1	8.9	1.8
		N:S ratio		
Whole Forage	12.8	19.0	8.1	.....

*Legume component inadequate for chemical analysis.

Table 4. Forage production by annual-type range fertilized with various sources of nitrogen (105 pounds/acre) and sulfur (120 pounds/acre) in the autumn or winter and with the residual the succeeding year, Experiment 4.

Fertilizer material	1958			1959		
	Autumn applied	Winter applied	Ave.	Autumn applied residual	Winter applied residual	Ave.
	(Pounds/Acre)					
Control	960	960	960	1420	1420	1420
Ammonium nitrate	2260	2160	2210	1500	1560	1530
Ammonium nitrate and gypsum	3490	2820	3160	2030	1640	1840
Ammonium nitrate and elemental sulfur	2920	3000	2960	2040	1720	1880
Urea	2370	2150	2260	1500	1730	1620
Urea and gypsum	2840	2860	2850	1660	1610	1640
Urea and elemental sulfur	3100	2650	2880	2100	1640	1870
Ammonium sulfate	3230	2670	2950	2280	1430	1860
LSD 5% fertilizer	680	680	530	560	560	470
LSD 5% time	600	600	.....	460	460	.....

experiments there was a direct effect of the sulfur on the grass production with legumes participating in no obvious manner. A direct response to sulfur fertilization in cereal grain production has been reported by Harder and Baker (1961).

Walker and Adams (1958) have reported that perennial grasses have the ability to compete successfully with Trifolium species for the available sulfur in the soil. In our experiment, increase in percent sulfur in the filaree and forbs in the presence of applied sulfur was at least as great as that in the soft chess and other grass (Table 3). Hence, competition for sulfur does not seem to explain the increased growth of grasses. Rather it appears that the grasses may require a higher level of sulfur than the other components of the plant community. Alternately, it may be that the competitive interaction was indirect, i.e. that the taller growing grasses were able to shade the forbs by the advantage in growth obtained from more adequate sulfur nutrition.

Loosli (952) has proposed a critical ratio of nitrogen to sulfur of 15 in feedstuffs for ruminants. Forages having ratios greater than this are considered to contain inadequate sulfur. Ratios for the whole forage were calculated from the nitrogen and sulfur analyses conducted in experiments 1 and 3. Ratios for nitrogen-only treatments varied from 14.4 to 31.7 indicating marginal to very inadequate sulfur levels from the standpoint of ruminant nutrition. The range of ratios of 7.0 to 8.1 for the various nitrogen-sulfur treatments is evidence of adequate sulfur levels in the forage produced (Tables 1 and 3).

There were no significant differences among the sources of nitrogen or sulfur in experiments 3 or 4 (Tables 2 and 4). Time of application had a statistically significant effect, on the average,

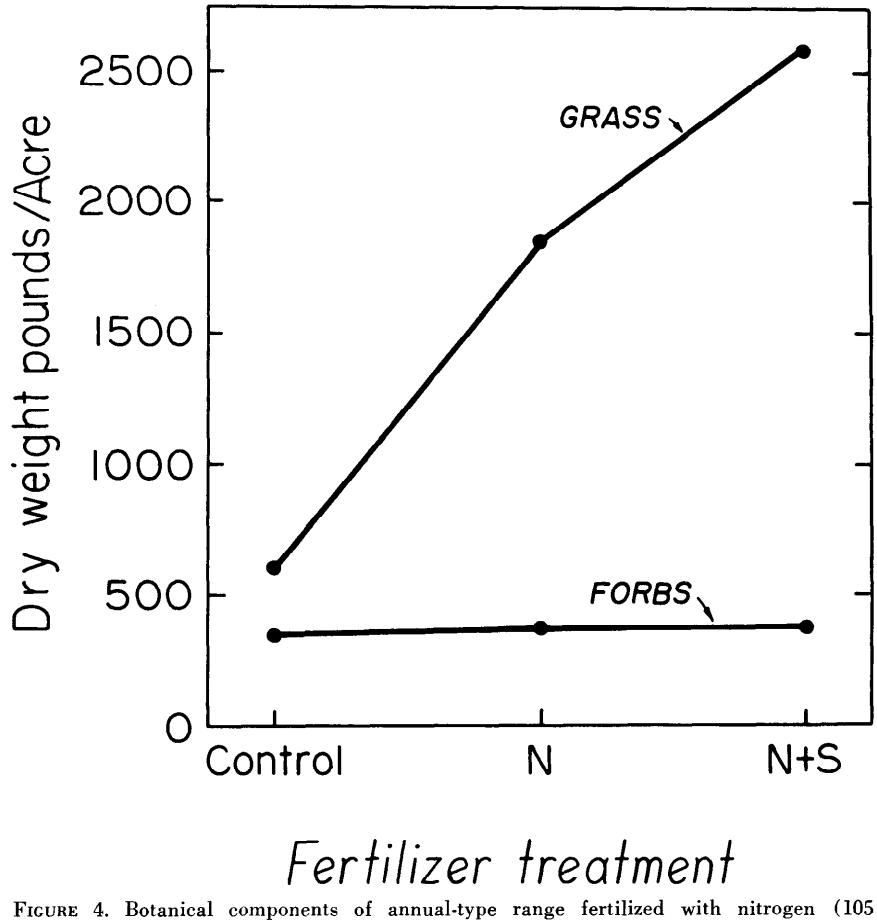


FIGURE 4. Botanical components of annual-type range fertilized with nitrogen (105 pounds/acre) and equivalent nitrogen plus sulfur (120 pounds/acre), Experiment 4.

Table 5. Monthly precipitation during growing season, Badger (Tulare Co.) California.

	1954-55	1955-56	1956-57	1957-58	1958-59	Ave.
			(Inches)			
September	0	0	0	1.50	2.15	
October	0	0	2.16	.87	.30	
November	3.85	3.10	0	2.96	0	
December	3.65	16.05	2.35	6.13	.85	
January	4.50	6.70	2.91	6.30	5.10	
February	7.90	2.20	6.91	10.25	7.20	
March	.30	0	5.12	16.27	0	
April	3.95	3.65	6.29	5.20	1.55	
May	1.25	2.97	1.47	1.90	0	
Seasonal Total to Feb. 1	12.00	25.85	7.42	17.76	8.40	
Total	25.40	34.67	27.21	51.38	17.15	31.16

but it was not consistent among materials applied in the two successive years and is somewhat difficult to interpret. Where differences were apparent, winter application was superior to autumn application in experiment 3 and autumn application was superior to winter application in experiment 4. Precipitation was sparse in the fall of 1956, since only 7.4 inches of rain was recorded to February 1957, and it is assumed that soil moisture was inadequate for optimum utilization of autumn application in experiment 3 (Table 5). A more adequate rainfall of 17.8 inches was recorded by February during the 1957-58 season, but excessive rain of 16.3 inches fell during the four weeks immediately after the winter application in experiment 4. In this instance undue leaching probably was an unfavorable factor.

Cattle were allowed to graze all plots after sampling. In all cases the cattle grazed the fertilized plots more heavily than they grazed the controls.

Summary

Previously reported increases in annual grass production following sulfur fertilization have been attributed to an initial stimulation of native or introduced legumes, followed in subsequent years by increased grass production as a result of nitrogen build-up in the soil by the legumes. In the experiments reported here various sources of nitrogen and sulfur were applied in the autumn and winter seasons to resident annual-range type vegetation. Combinations of sulfur and nitrogen materials resulted in increased forage production over nitrogen applications alone. The increased yield due to sulfur fertilization occurred consistently in the annual grass component, with no perceptible response by the forbs. Possibly superior competitive ability of the grass for sulfur *per se* does not explain their response, as the sulfur content of the forbs was equal to or greater than the grasses in all treatments. The nitrogen-sulfur ratio was affected by fertilization, being widened by nitrogen applications and narrowed by sulfur and nitrogen combinations. It is concluded that sulfur can be an important fertilizer element on annual-type range, and can enhance directly, the growth of common annual-range grass species when their need for nitrogen is satisfied.

LITERATURE CITED

ALDRICH, D. G., AND W. R. SCHOONOVER. 1951. Gypsum and other sulfur materials. Calif. Agr. Exp. Sta. Circ. 403.

ARKLEY, R. J., W. N. HELPHENSTINE, AND W. A. WILLIAMS. 1955. Rangeland forage almost trebled by seeding rose clover and use of sulfur-bearing fertilizers. Calif. Agr. 9(8):15-16.

BENTLEY, J. R. AND L. R. GREEN. 1954. Stimulation of native annual clovers through application of sulfur on California foothill range. Jour. Range Mangt. 7:25-30.

———, L. R. GREEN, AND K. A. WAGNON. 1958. Herbage production and grazing capacity on annual-plant range pastures fertilized with sulfur. Jour. Range Mangt. 11:133-140.

CONRAD, J. P. 1950. Sulfur fertilization in California and some related factors. Soil Sci. 70:43-54.

———, H. L. HALL, AND B. A. CHAUGULE. 1948. Sulfur fertilization of legumes in the upper Ojai Valley, California and the resulting effects on the following nonlegumes. Soil Sci. Soc. Amer. Proc. 12:275-277.

HARDER, R. W. AND G. O. BAKER. 1961. Sulfur fertilization necessary for grain production in northern Idaho. Ida. Agr. Exp. Sta. Progress Rep. 54.

JOHNSON, C. M., AND H. NISHITA. 1952. Microestimation of sulfur in plant materials, soils, and irrigation water. Anal. Chem. 24:736-742.

KESSELI, J. E. 1942. The climates of California according to the Koppen classification. Geogr. Rev. 32: 476-480.

LOOSLI, J. K. 1952. Meeting the sulfur requirements of ruminants. Feed Age 2(6):44-45, 58.

MARTIN, W. E. 1958. Sulfur deficiency widespread. Calif. Agr. 12(11):10-12.

———, AND L. J. BERRY. 1955. Fertilized range can pay dividends. Univ. of Calif. Agr. Ext. Ser. Mimeo 32 pp.

MCKELL, C. M. AND W. A. WILLIAMS. 1960. A lysimeter study of sulfur fertilization of an annual-range soil. Jour. Range Mangt. 13:113-117.

WALKER, T. W. AND A. F. R. ADAMS. 1958. Competition for sulfur in a grass-clover association. Plant and Soil 9:353-366.

WOOLFOLK, E. J. AND D. A. DUNCAN. 1962. Fertilizers increase range production. Jour. Range Mangt. 15:42-45.

Contrasting Effects of Big Sagebrush and Rubber Rabbitbrush on Production of Crested Wheatgrass

NEIL C. FRISCHKNECHT

Range Conservationist, Intermountain Forest and Range Experiment Station, U.S. Dept. of Agriculture, Forest Service, Ogden, Utah.

Big sagebrush *(Artemisia tridentata)* and rubber rabbitbrush *(Chrysothamnus nauseosus)* have increased greatly under all grazing treatments on the Benmore Experimental Range in west central Utah (Frischknecht *et al.* 1953). Whereas it is generally considered that both species reduce grass yields, this paper reports results of three correlated studies of grass clipping showing that they differ markedly in their effects upon production of crested wheatgrass. In a general way, results are related to differences in brush root systems and growth habits.

The competitive relationship between big sagebrush and grass is well documented. Nearly 20 years ago Pechanec *et al.* (1944) and Robertson and Pearse (1945) recognized that successful establishment of artificial seedings depended upon successful eradication of sagebrush. Blaisdell (1949) observed that when grass and sagebrush became established at the same time, grass had the initial advantage but sagebrush eventually gained a prominent place in the stand. Sagebrush had the advantage from the start when it became established before grass.

Less information is available about competition between rubber rabbitbrush and grass. McKell and Chilcote (1957) observed that growth and seed production of rubber rabbitbrush increased when competing vegetation was removed. Plummer *et al.* (1955) listed both rabbitbrush and sagebrush among the undesirable competition to be eliminated to assure success of introduced grass in range seedings. They reported that successful plantings had been made into thin stands of rabbitbrush. These authors and others have emphasized that rubber rabbitbrush is more difficult to control than big sagebrush because it habitually resprouts.

Effects of big sagebrush and rubber rabbitbrush upon productivity of crested wheatgrass were studied on caged plots during two years of spring cattle grazing and from open plots a third year when there was no spring grazing. Ring counts showed that these brush plants had invaded over the years after grass was seeded.

Study No. 1

On April 16, 1957, before the first spring grazing, pairs of sagebrush and rabbitbrush plants of comparable size in each of 24 experimental pastures were selected for study of understory grass yields. One brush plant of each pair was selected at random, cut and removed. A cage of the type described by Robertson (1954) was placed over each brush stump and over each remaining brush plant. The cages protected grass from being grazed on circular plots 9.6 square feet in area, centered at the brush stems; plot size was selected largely for convenience in expressing yields in pounds per acre (Frischknecht and Plummer, 1949). In addition, two nearby randomly located grass plots without brush were similarly protected from grazing in each pasture. Three months later, after spring growth was completed, grass on each plot was hand-clipped, air-dried, and weighed. Simple "t" tests were applied to yield data.

Grass yields and numbers of seed heads were less under sagebrush but greater under rabbitbrush than on brush-free plots (Table 1). The responses to removal of shrubs early in the growing season (April 16) probably provide the most critical measures of competitive (and shading) effects in this preliminary study. Removal of sagebrush increased grass yield nearly 20 percent, whereas removal of rabbitbrush had little effect. Numbers of grass seed heads increased about 20 percent following early removal of both brush species. Height growth was less after removal of brush shade, and least where there had been no brush at the outset.

Study No. 2

In 1958, grass yields were weighed around brush plants of

Table 1. Herbage yield, seed heads, and height of crested wheatgrass in mid-July, 1957, on 9.6 sq. ft. plots without brush initially, with brush removed early in the growing season, and with brush remaining.

Plot variable	Herbage yield[1] (air dry) (Pounds/A.)	Seed heads (Number)	Ave. Culm height (Inches)
No brush	958[a]	213	15.3
With sagebrush:			
Removed April 16	842[a]	130	17.4
Not removed	705[b]	107	19.7
With rabbitbrush:			
Removed April 16	1,624[c]	308	18.3
Not removed	1,548[c]	261	20.1

[1] Means with same superscript are not significantly different at the 5-percent level (based on "t" tests).

Table 2. Grass and associated brush measurements on two grazing units in 1958.[1]

Sampling unit	Grass		Brush		
	Yield[2]	Height	Height	Crown diameter	Age
	(Pounds/A.)	— — —	(Inches)	— — — —	(Years)
Lightly grazed pastures:					
Big sagebrush plots	557[a]	16.8	23.1	20.7	11
Rubber rabbitbrush plots	969[b]	16.8	19.5	17.6	8
Brush-free plots	858[b]	15.4	....	....	....
Heavily grazed pasture:					
Big sagebrush plots	294[c]	13.1	20.9	21.7	12
Rubber rabbitbrush plots	586[d]	13.6	19.4	19.2	9
Brush-free plots	669[d]	12.5	....	....	....

[1] Data are means of 30 plots.

[2] Means with same superscript are not significantly different at the 5-percent level.

a greater size range than those of the previous year. Effort was confined to only two experimental range pastures where grass had been utilized relatively lightly (about 50 percent by weight) and heavily (80 percent) by cattle for 10 consecutive spring seasons. In each pasture 30 plants of big sagebrush were paired for size with 30 nearby plants of rubber rabbitbrush, and all were caged during early growth and before grazing started the last week in April. A brush-free plot, chosen at random, was caged in the vicinity of each pair of brush plants. Data on grass yields and brush measurements were obtained during the first week of July, when grass had completed spring growth. Analysis of variance was used in testing effects of experimental variables on grass yields.

Again, grass yield was much less on the sagebrush plots than on the rabbitbrush plots and brush-free plots in both pastures (Table 2). Differences in yield between rabbitbrush plots and brush-free plots, however, were much smaller than in 1957, perhaps because brush plants were smaller (they averaged approximately eight inches, or about 30 percent, less in crown diameter). The effects of brush size on grass yield were highly variable and inconclusive. Presumably, the plots were not large enough to measure adequately the effect of large brush plants.

The heavily grazed pasture was located 200 feet lower and about 2½ miles north of the other pasture. This heavily grazed pasture receives an average of 11 percent less precipitation annually. This in addition to differences in past use may have contributed to the lower grass yields.

Study No. 3

The study in 1959 was more comprehensive than the first two. Cages, which had restricted plot size in previous studies, were unnecessary since the experimental ranges were not grazed in the spring. A minimum of 10 brush plants per species was sampled in each of eight crown-diameter classes and extra sampling in the most common classes brought the total to 120 plants per brush species. Grass yields were measured throughout the zone of brush influence by clipping concentric areas in increments of one-foot radii from the brush stem. Small brush plants sampled were at least six feet apart, and large brush eight to ten feet apart, to climinate effects of adjacent plants.

The 120 plants of each species were equally divided between two sites similar in types of soils and amount of precipitation received but differing in grazing history. One was in the lightly grazed pasture sampled in Study No. 2; the other was in a nearby pasture where spring grazing had been heavy (approximately 80-percent utilization) but had started ten days later in the spring. The main differences in grass yields around shrubs in the two pastures were not statistically significant (Table 3); so the data were combined for other interpretations.

Grass yields per unit area increased as crown diameter of associated rubber rabbitbrush

Table 3. Analysis of variance of grass yield means for (1) plot radius from brush stem, (2) brush species, (3) brush crown diameter, and (4) intensity of previous grazing of pasture.

Source of variation	Degrees of freedom	Mean square	F value
Species of brush (S)	1	22,814	100.946**
Past grazing intensity (I)	1	250	1.106
Brush diameter class (C)	7	516	2.293*
Radius zone from stem (R)	2	5,975	26.438**
S X I	1	704	3.115
S X C	7	1,840	8.141**
S X R	2	2,054	9.088**
I X C	7	89	0.394
I X R	2	842	3.725*
C X R	14	800	3.540**
Error	51	226	
Total	95		

*Significant at the 5-percent level.
**Significant at the 1-percent level.

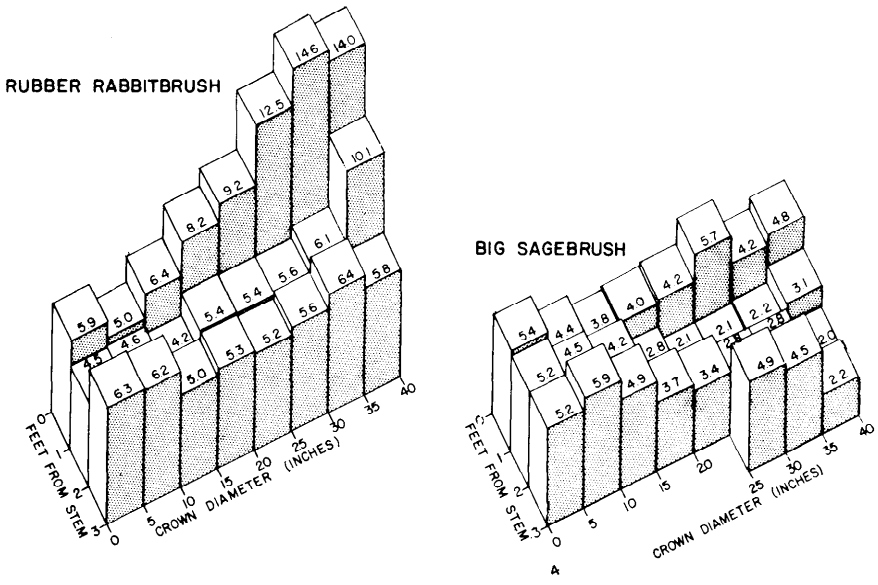


FIGURE 1. Herbage yield (grams per square foot, air dry) of crested wheatgrass in concentric one-foot plots around individual sagebrush and rabbitbrush plants of eight crown-diameter classes (1959). The three- to four-foot zone was sampled only for sagebrush having crown diameters greater than 25 inches. The total sample included 120 plants of each species—10 to 20 for each diameter class.

plants exceeded 15 inches (Figure 1). This was most marked in the area within a one-foot radius around the brush stem. Beyond this distance rabbitbrush usually influenced grass yields very little; however, the largest plants (35 to 40 inches in diameter) showed increased yields in the one- to two-foot zone.

Conversely, grass yields per unit area around sagebrush decreased as shrub size increased. Yields of grass in the one-foot zone around sagebrush stems were essentially unaffected by sagebrush size, but yields in the one- to 2- and 2- to three-foot zones decreased greatly as sagebrush increased in size, especially when sagebrush crowns exceeded 15 inches' diameter. Unlike rabbitbrush, the largest sagebrush plants affected grass yields markedly beyond the three-foot zone. None of the plants sampled appeared to influence grass yields beyond the four-foot zone; hence plots were not extended further.

Discussion of Related Factors

Snow Accumulation

Under conditions at Benmore, both brush species increase deposition of drifting snow; this results in increased moisture around brush plants in early spring. Rabbitbrush appears to be the more effective of the two because it has a less dense crown and loses proportionately more of its leaves in winter; this permits more snow to reach the ground. Although leaves of both species contribute to surface litter, soil organic matter, and improved soil-water relations, the situation appears accentuated under the more open crowns of rabbitbrush.

Root Systems and Growth Periods

Comparison of root systems of big sagebrush and rubber rabbitbrush further accounts for their contrasting effects upon grass production. Lateral roots of big sagebrush become more highly developed than laterals of rubber rabbitbrush in the surface soils—the zone where grass roots are most numerous. This is especially true on soils having a calcareous hardpan—characteristic of the areas sampled—or a heavy clay subsoil or a layer of high salt accumulation. Such subsoils restrict sagebrush taproots more than taproots of rubber rabbitbrush (Figure 2).

The abundant, shallow roots of big sagebrush compete intensely with the roots of crested wheatgrass for soil moisture because these two species grow actively at the same time. On the other hand, crested wheatgrass is usually headed out by the time rabbitbrush is most active, and the secondary rabbitbrush laterals seemingly offer little competition to the grass. Taproots of both brush species draw moisture from deeper sources than the main root system of wheatgrass; but where the sagebrush has poorly developed taproots it must derive moisture from the same level as the grass does.

Crested wheatgrass appeared to have a competitive advantage over rubber rabbitbrush in both time of growth and type of root system, and to inhibit rabbitbrush more than rabbitbrush inhibited grass. This premise is supported in part at least by McKell and Chilcote (1957), who found that removal of competing native vegetation greatly increased growth of rubber rabbitbrush.

Grass Utilization

At Benmore, in early spring, grass grows more rapidly underneath brush than in the open. Usually it is four to six inches taller than grass in the open at the beginning of spring grazing in April. The taller understory growth appears less preferred by cattle; at least it tends to be grazed later in the season than grass growing in the open, even where brush provides little obstruction to animals. Of course, as mechanical obstruction becomes more pronounced, understory grass is more lightly used—even under heavy stocking where cattle graze closer to brush than under light stocking. In effect, the delayed and/or lighter spring use should contribute to improved vigor of

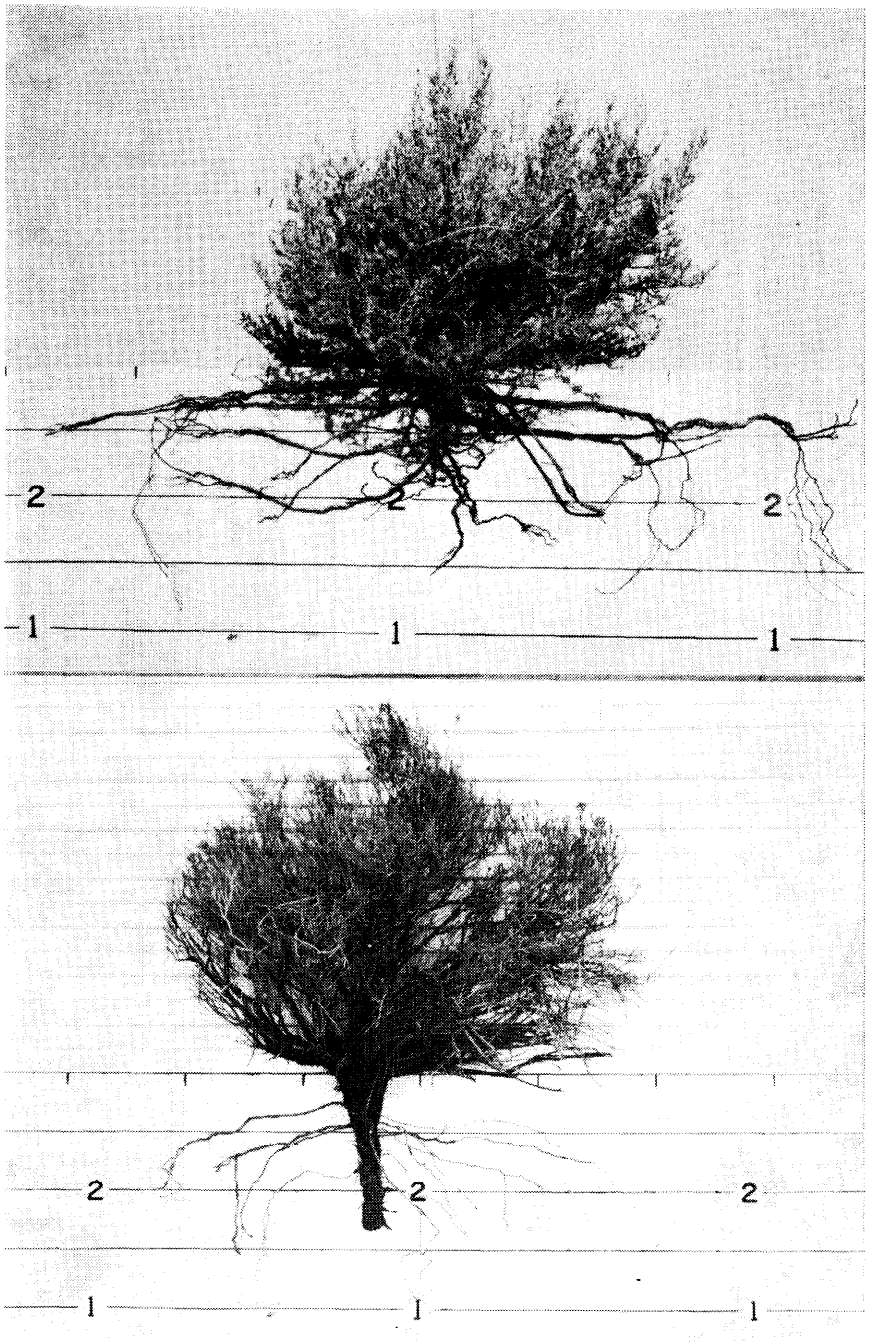


FIGURE 2. Upper: Main root system of this sagebrush plant is chiefly lateral roots in the upper 14 inches of soil. One lateral root was followed for six feet from the brush stem. The poorly developed taproot extended only 16 inches deep, where apparently it was restricted by a calcareous layer. Lower: Most lateral roots of this rubber rabbitbrush plant, which grew within 20 feet of the sagebrush plant above, turned downward within two feet of the brush stem. Judging from other excavations, it is likely that this thick taproot, which was cut at 16 inches, extended to great depth.

grass under brush.

These and other possible beneficial influences may account for increased grass yields associated with rabbitbrush. With sagebrush, however, adverse competition evidently outweighs the beneficial influences. Spring grazing, by further reducing grass vigor and yield, gives the sagebrush still greater advantage (Figure 3).

Fall Grazing Improved by Rabbitbrush

In four years of fall grazing, cattle have been observed to forage more around and under rabbitbrush plants than elsewhere, except in swales where moisture accumulates. Mechanical obstruction of brush to animals was much less of a problem than it had appeared to be in the spring. This is explained by the additional observation that crested wheatgrass remained more succulent under rabbitbrush throughout the summer. Also, late summer and fall regrowth of grass was more lush under rabbitbrush than under sagebrush or in the open. Thus, under conditions at Benmore, the presence of rabbitbrush increased the value of crested wheatgrass range for fall grazing.

Present information suggests that little effort is justified for controlling rubber rabbitbrush on crested wheatgrass range, particularly where fall grazing is practiced. On the other hand, control of big sagebrush on such range for cattle appears to be a worthwhile objective.

Summary and Conclusions

Removal of big sagebrush plants in mid-April 1957 increased grass yields by July 16 about 20 percent. Early removal of rubber rabbitbrush had little effect on grass yields. Numbers of grass seed heads increased about 20 percent following early removal of both brush species, but culm height was about two inches shorter.

In each of three years, grass yields were greater under rabbitbrush plants than under sagebrush plants. The effect of size of brush on grass yields was inconclusive in two of the years when cages restricted plot size. More intensive study in the third year showed that grass yields per unit area increased as rubber rabbitbrush crown diameters ex-

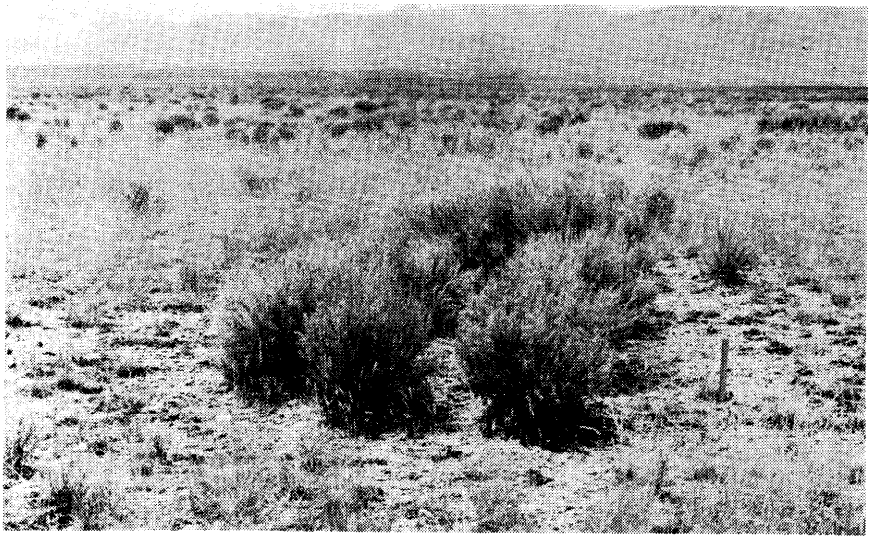


FIGURE 3. Bare "halo" areas develop around big sagebrush plants as grass plants weaken and die.

ceeded 15 inches. The increase was greatest within a one-foot radius from brush stems, but it extended to the two-foot radius when brush crown diameter approached 35 inches. In contrast, grass yields usually decreased as crown diameter of sagebrush plants reached about 15 inches. Sagebrush influenced grass yields markedly to the three-foot radius in large plants.

Depressed yields of grass around big sagebrush plants are associated with highly developed lateral brush roots in the grassroot zone. In contrast, relatively few lateral roots of rubber rabbitbrush occur in this zone. Also, the most active growth periods of crested wheatgrass and big sagebrush coincide, whereas crested wheatgrass makes most of its growth prior to the most active growth of rubber rabbitbrush.

The presence of rabbitbrush improved fall grazing because the understory grass remained more succulent and fall regrowth was more abundant under rabbitbrush than in the open or near sagebrush. Control of big sagebrush on crested wheatgrass range for cattle is a worthwhile objective. Just how much effort is justified in controlling rubber rabbitbrush is questionable, particularly where fall grazing is practiced.

LITERATURE CITED

BLAISDELL, JAMES P. 1949. Competition between sagebrush seedlings and reseeded grasses. Ecology 30: 512-519.

FRISCHKNECHT, NEIL C. AND A. PERRY PLUMMER. 1949. A simplified technique for determining herbage production on range and pasture land. Agron. Jour. 41: 63-65.

———, LORIN E. HARRIS, AND HARRY K. WOODWARD. 1953. Cattle gains and vegetal changes as influenced by grazing treatments on crested wheatgrass. Jour. Range Mangt. 6: 151-158.

MCKELL, CYRUS M. AND WILLIAM W. CHILCOTE. 1957. Response of rabbitbrush following removal of competing vegetation. Jour. Range Mangt. 10: 228-230.

PECHANEC, JOSEPH F., A. PERRY PLUMMER, JOSEPH H. ROBERTSON, AND A. C. HULL, JR. 1944. Eradication of big sagebrush *(Artemisia tridentata)*. U. S. Dept. Agr., Forest Service, Intermountain Forest and Range Expt. Sta. Res. Paper 10, 23 pp.

PLUMMER, A. PERRY, A. C. HULL, JR., GEORGE STEWART, AND JOSEPH H. ROBERTSON. 1955. Seeding rangelands in Utah, Nevada, southern Idaho, and western Wyoming. U.S. Dept. Agr., Agr. Handbook 71, 73 pp.

ROBERTSON, JOSEPH H. 1954. A low-cost portable cage for range and pasture plots. Jour. Range Mangt. 7:42.

———, AND C. KENNETH PEARSE. 1945. Artificial reseeding and the closed community. Northwest Sci. 19: 56-66.

Some Effects of Chemical Sagebrush Control on Elk Distribution

DON E. WILBERT

Late Range Conservationist (deceased May 15, 1962) U.S. Soil Conservation Service. With Wyoming Game and Fish Commission 1958-59.

During the past several years, there has been a great deal of work accomplished in the relatively new field of chemical control of the various species of sagebrush *(Artemisia)*. Most of this work has been on cattle and sheep ranges. The resulting increase in herbaceous vegetation, generally, has been rather remarkable (Alley & Bohmont, 1958) (Bohmont, 1954) (Hyder & Sneva, 1956) (Kissinger et al, 1952). Several workers have reported the apparent attraction of grazing animals to newly sprayed areas (Alley & Bohmont, 1958).

Among persons with major interest in our wildlife, some have viewed sagebrush control with misgivings, particularly for areas having big game populations. In many areas, sagebrush furnishes the principal winter forage for deer (Hill, R. R., 1956) and it is known to provide a large part of the annual diet of antelope in sagebrush areas. This paper reports a study of the problem on the Gros Ventre elk winter range in Teton County, Wyoming.

This area, of some 135,000 acres, is characterized by raw immature soils in complex patterns, and rugged topographic features. The area receives an average of about seventeen inches of precipitation annually; much of it in the form of snow. The vegetative types are many and varied, reflecting the immaturity of the soils and varied parent materials.

Most of the Jackson Hole elk herd is forced to winter on the Federal Elk Refuge just north of the town of Jackson, on the Gros Ventre River drainage east of Jackson. The Gros Ventre winter game range is within the boundaries of the Teton National Forest. It was set aside in 1919 as game range but some 4500 cattle are trailed through the drainage twice each year in going to and from their summer allotments. No appreciable competition was found between domestic animals and elk on the game range area (Smith, 1961) (Wilbert, 1959).

Anderson (1958) found, from studies of elk distribution and migration, that large numbers of elk come into the Gros Ventre drainge in the late fall as snow conditions in the higher country force them down. They characteristically arrive after deep snow that prevents grazing of the sagebrush covered draws and upland flats. Hence, they are forced to winter on the wind swept ridges and south facing slopes where vegetation is naturally more sparse because of site limitations.

This study was undertaken to determine if the spring distribution of elk *(Cervus canadensis)* could be influenced by chemical control of big sagebrush *(Artemisia tridentata)*. The study areas chosen were in the Gros Ventre game range area. Two plots — each of 25 acres — were treated in a similar manner. The two locations — Dry Dallas and Breakneck Flat—were two miles apart at about the same elevation. Both contained dense stands of big sagebrush but the Dry Dallas area was much more productive because of a deeper, less droughty soil. The herbaceous understory on the Dry Dallas drainage was principally Idaho fescue *(Festuca idahoensis)*, Montana wheatgrass *(Agropyron albicans)*, spikefescue *(Hesperocholoa kingii)*, canby bluegrass *(Poa canbyi)*, Sandberg bluegrass *(Poa secunda)*, sedge *(Carex* sp.*)*, silvery lupine *(Lupinus serecius)*, and rose pussytoes *(Antennaria rosea)*. The herbaceous understory on Breakneck flat consisted primarily of Sandberg bluegrass, Montana wheatgrass, thickspike wheatgrass *(Agropyron dasystachyum)*, needleleaf sedge *(Carex eleocharis)*, western needlegrass *(Stipa occidentalis)*, silvery lupine, and rose pussytoes.

Methods and Procedure

The treatment consisted of 2,4-D ester at the rate of two pounds acid equivalent per acre. Diesel oil, at the rate of two gallons per acre was used as a carrier. The material was applied from the air in early June, 1957. Soil moisture conditions were good. In fact, it rained the day the material was applied.

During the late summer of 1958, clipping studies were initiated. The 9.6 square foot plot method of clipping was used. A total of ten such sample units were clipped in each of the treatment areas as well as in the surrounding, untreated areas. Clipped material was separated into three categories, namely browse, forbs, and grass and grasslike plants. This material was air dried and weighed to measure responses of vegetation to the chemical treatment.

Animal distribution also was studied by actual animal sightings, and by intensive pellet group counts inside and outside the two treated plots. Over 600 acres of the Dry Dallas drainage is visible from a point on the main Gros Ventre road just below Upper Slide Lake. This vantage point was used as the observation location for animal sightings on the Dry Dallas treatment. Unfortunately, no such ideal observation point was readily available on the Breakneck plots. The road that overlooks Breakneck Flat traverses the edge of the Flat before breaking out on a good vantage point. Consequently, the animals were usually disturbed. However, this point above the Flat was used for animal sightings on the Breakneck plots. Again, over 600 acres is visible from this point with the treated 25 acres toward the lower end of the Flat. Sightings were made and recorded when the author was working in the area. No particular schedule for observation was followed except that observations were made from the two specific locations during May and June of 1958 and 1959. All snow in the brushy areas had melted by May 10, both years.

Pellet group counts were made in belt transects. These transects were 545 feet long and 8 feet wide or the equivalent of about one-tenth of an acre in size. Twenty such transects were run in each of the four areas during mid-summer of 1958 and 1959.

Results

Herbage data from clipped plots converted to pounds, air-dry, per acre, are shown in Table 1.

From Table 1, it may be noted that the Dry Dallas untreated area had an average production of 514 pounds of grass, 562 pounds of forbs, and 654 pounds of brush or a total vegetative growth of 1728 pounds per acre. The adjacent sprayed area produced 1300 pounds of grass in 1958, 584 pounds of forb growth, and only 136 pounds of brush for a total production of 2020 pounds

Table 1. Yield of air-dry herbage, in pounds per acre, from plots sprayed for brush control and from check plots.*

	Dry Dallas				Breakneck Flat			
1958	Sprayed	Check	Change	Percent change	Sprayed	Check	Change	Percent change
Grass	1300	514	+786	+253	346	124	+222	+279
Forbs	584	562	+ 22	+ 4	182	202	− 20	− 11
Brush	136	654	−418	− 79	108	356	−248	− 70
Totals	2020	1728	+292	+ 17	636	682	− 46	− 7
1959**								
Totals	1570	890	+680	+ 76	570	450	+120	+ 27

* Average of 10 plots for each category.

** Same sample size except clipped two months earlier well before plant maturity.

per acre. This represents an increase of 786 pounds of grass or 2.53 times more. The forbs remained fairly stable. The brush was, of course, mostly big sagebrush and decreased 418 pounds, or to only 21 percent of the original amount. The gain in total forage was only 292 pounds, or 17 percent more, but nearly all of the forage remaining after spraying was desirable and usable.

The Breakneck area, because of shallower soils, is not nearly as productive. Yet, the percentage changes in the vegetative categories examined were much the same as those just reported for the Dry Dallas location. On the untreated area at Breakneck, grass production was only 124 pounds, forbs produced 202 pounds of growth, and the brush clipped 356 pounds for a total vegetative production of 682 pounds per acre. On the adjacent sprayed plots, the grass increased 222 pounds to a total of 346 pounds, or 2.79 times. The forbs again remained fairly constant. The brush was decreased by 248 pounds to a total of only 108 pounds on the sprayed area or about 30 percent of the original amount.

Additional clippings were made in late June and early July of 1959. Again, ten plots were clipped in each of the sprayed areas and a like number in each untreated area, but grass, forbs, and browse were not segregated. The data from 1959 show that the sprayed areas made earlier vegetative growth than the unsprayed areas. None of it was nearing maturity but, these data indicated that total production, at least on the treated areas, would exceed the production of the previous year. This quick surge of early spring growth on the treated plots perhaps accounted for the change in elk distribution that was apparent by actual observation of the elk, and from intensive pellet group counts inside and outside the treated plots.

The spraying was accomplished in the spring of 1957. Early morning and late evening observations during May and June of 1958 failed to reveal any special attraction to the treated plots by game animals. A check of actual forage use differences between the treatments and untreated surrounding areas showed slightly more use inside the treated plots during this first spring following the spraying. Results of pellet group counts made during the early fall of 1958, based on twenty one-tenth acre transects run in each of four areas, are shown in Table 2. The average number of pellet groups per acre in the Dry Dallas sprayed plots was 268, compared to 192 in the surrounding untreated areas. This indicates nearly forty percent more use by elk on the treated plots. Assuming the average defecation rate to be about 13 groups per day, these 1958 counts indicate a use rate of about 20.6 elk days per acre on the Dry Dallas treated acreage and 14.8 elk days per acre on the surrounding acreage. On the Breakneck study area, the average number of pellet groups counted was 190 per acre of treated vegetation and only 137 on the untreated portions. This, again, is an increase of nearly 40 percent. Converted to elk days use per acre, the figures are 14.6 for the treated and 10.5 on the untreated. Based on these pellet group counts and observed increased forage use in both the Dry Dallas and Breakneck plots, there appeared to be a definite concentration of elk in the treated plots the first spring following treatment.

Based on observations during the fall of 1958, there appeared to be few elk attracted to the plots during this fall season. Most previous census work in the area indicated a very low elk population in the Gros Ventre during this fall season. Very late fall and winter populations build up as elk come into the drainage from the north during migrations (Anderson, 1958).

Table 2. Results of elk pellet-group-counts in plots sprayed for brush control and in check plots.

	Ave. Pellet Groups/Acre		Elk Days Use/Acre @ 13 pg's/Day		
	Treated	Untreated	Treated	Untreated	Increase
1958					
Dry Dallas	268	192	20.6	14.8	40%
Breakneck Flat	190	137	14.6	10.5	40%
1959					
Dry Dallas	343	222	26.4	17.1	55%
Breakneck Flat	230	122	17.7	9.4	89%

During the spring of 1959, actual animal sightings were rather remarkable. On one occasion in June, from the Dry Dallas vantage point, a total of 167 elk were visible. Of this number, 77 or nearly half the elk were concentrated in the 25-acre sprayed plot. On another occasion, ten of thirteen elk seen were in the sprayed area. On still another evening, all 17 elk that were visible were in the sprayed plot. Usually when any elk were present, a high proportion of them appeared in the sprayed plot at Dry Dallas. As explained previously, no such ideal vantage point was available overlooking the Breakneck plots. It was evident, however, that numerous elk were using this sprayed plot, also. On one occasion some fifty elk remained on the Flat after the vantage point was reached with 38 of these animals in the sprayed plot. On several other occasions when elk were on the Flat, they were frightened at the approach of the vehicle; but many remained milling in or near the sprayed plots when the vantage point was reached.

Pellet group counts were made in both study locations in early July of 1959. They show even more conclusive results than during the previous year. A total of 20 one-tenth acre belt transects were again counted at each of the four locations. The average number of pellet groups per acre in the Dry Dallas treatment was 343 or 26.4 elk days use per acre. On the surrounding untreated range the figures were 222 groups per acre or 17.1 days use per acre. This indicates a use rate some 55 percent heavier on the sprayed acreage than that which occurred on the untreated. The Breakneck plots produced figures of 230 pellet groups per acre or 17.7 elk days use on the treated acres and only 122 groups or 9.4 days use on the unsprayed. This suggests a use rate 89 percent heavier on the treated acres. Observation of actual forage use in both areas further corroborate these figures. The data show that elk were attracted to areas where sagebrush was reduced; and that this attraction was greater the second spring following treatment.

Discussion and Summary

The portion of the Gros Ventre drainage included in this work has long been a controversial area. The Jackson Hole elk herd and its habitat has been observed and studied for many years. Almost without exception, every published report on the subject considers the Gros Ventre area an important game winter range. With this in mind, the U. S. Forest Service set aside some 135,000 acres of this watershed in 1919 as game range.

This is an area of relatively severe winters. Snow accumulations frequently measure three feet and more on the level. Therefore, much of the low growing vegetation is largely unavailable through a portion of the winter season.

The chemical control of big sagebrush definitely increased the production of grass and decreased the quantity of sagebrush during each of the two years following the chemical application. The year following the spraying, grass production increased nearly three times and brush was decreased to about 25 percent of the original amount. There was little change in the total production of forbs. Production studies the second year following the treatment showed that vegetative growth in the brush control areas began earlier than in surrounding untreated areas. It was also evident that total forage production after the first year of treatment would at least equal and probably exceed that of the first year.

The chemical control of sagebrush on selected areas had striking effects on distribution of game animals. All data gathered indicate that the treated areas provided a definite attraction for the elk, especially in the late spring. Pellet-group-count procedure indicated there was about a 40 percent increase in game animal activity inside the treated areas in the spring of 1958. The same procedures in the spring of 1959 revealed some 55 percent more pellet groups inside the Dry Dallas treatment than occurred on the surrounding untreated sagebrush range. On Breakneck Flat, the increase in pellet groups inside the sprayed area was even more marked. Nearly 90 percent more groups were counted inside than outside.

These data would indicate that manipulation of sagebrush range offers possibilities as a practical tool to aid in the distribution of elk in the spring of the year. In the case of the sagebrush spraying in this particular locality, increased use of the relatively lush grass growth in the brushy areas relieves some of the pressure on the already overused and abused ridge tops and steep slopes.

Production figures indicate that these areas, following spraying, can support the use they are receiving. According to the pellet group data, the Dry Dallas treated plot was receiving a little over 26 elk days use per acre. Most authorities agree that a mature elk will consume about seven pounds of forage (air-dry basis) per day (Anderson, 1958; Murie, 1941; Craighead, 1952) so only about 300 pounds per acre of the forage was being removed. This was well under a third of the usable forage available at that time of year. The Breakneck plot was receiving nearly 18 elk days use so only about 200 pounds of the approximately 500 lbs. available was being used. Summer or spring use of herbaceous forage at a rate not exceeding 50 percent of the total available is considered safe and proper in most instances.

LITERATURE CITED

ALLEY, H. P. AND BOHMONT, D. W. 1958. Big Sagebrush Control. Wyo. Agric. Experiment Station Bulletin 354. 5 pp.

ANDERSON, CHESTER C. 1958. The Elk of Jackson Hole. Wyoming Game & Fish Commission Bulletin #10. 184 pp.

BOHMONT, DALE W. 1954. Chemical Sagebrush Control—Good and Bad! Wyo. Agric. Exp. Sta., Circular #54. 7 pp.

CRAIGHEAD, JOHN J. 1952. A Biological and Economic Appraisal of the Jackson Hole Elk Herd. N. Y. Zool. Soc. and Conservation Foundation, N. Y., 16, N. Y., 32 pp.

HILL, RALPH R. 1956. The Deer of North America. Forage, Food Habits, and Range Management of the Mule Deer. P 393-429.

HYDER, D. N. AND F. A. SNEVA. 1956. Herbage response to Sagebrush Spraying. Jour. Range Mangt. 9: 34-38.

KISSINGER, N. A. JR., A. C. HULL, JR., AND W. T. VAUGHN. 1952. Chemical Control of Big Sagebrush in Central Wyoming. Rocky Mountain Forest and Range Experiment Sta., Station Paper No. 9. 15 pp.

MURIE, OLAUS J. 1951. The Elk of North America. Stackpole Co., Harrisburgh, Pa. 376 pp., illus.

SMITH, DIXIE R. 1961. Competition between Cattle and Game on Elk Winter Range. Univ. of Wyoming Ag. Experiment Station, Bulletin #377. 16 pp.

WILBERT, D. E. 1959. Forage Use, Competition, and Trend Studies on Big Game Range Areas. Wyoming Game and Fish Commission. Processed Report W-67-R-1. 22 pp.

Grass-Alfalfa Versus Grass-Alone Pastures Grazed in a Repeated-Seasonal Pattern

J. B. CAMPBELL

Experimental Farm, Research Branch, Canada Department of Agriculture, Swift Current, Saskatchewan, Canada.

Legumes in swards increase dry matter yields, crude protein content of the herbage, and livestock gains (Whyte *et al.*, 1951). The same authors agree that alfalfa is one of the most useful legumes because it grows under a wide range of environments and is a multi-purpose crop.

This paper presents the yields of herbage, and live-weight gains of yearling Rambouillet ewes from dryland grass-alfalfa and grass-alone pastures at Swift Current, Saskatchewan. It is postulated that the results apply to a considerable portion of the Northern Great Plains region of North America.

Materials and Methods

Crops

The grasses used were crested wheatgrass, *Agropyron cristatum* (L.) Gaertn.; intermediate wheatgrass, *A. intermedium* (Host.) Beauv.; and Russian wild ryegrass, *Elymus junceus* Fisch. The alfalfa, *Medicago* spp., was a locally selected strain somewhat similar to the variety Rambler (Heinrichs and Bolton, 1958). The crops were sown in 12-inch rows, with 30 pounds of wheat per acre. Excellent stands were obtained.

Treatments

Three treatments were established in duplicate according to the schedule shown in Table 1. The site was summerfallowed in 1953, seeded in May 1954, cut for hay in 1955, and grazed from 1956 through 1961. Each treatment replicate was fenced into three 1.2-acre paddocks, and grazed in a repeated-seasonal pattern as indicated in Table 1 and described by Campbell (1961).

Livestock and Grazing Management

Yearling Rambouillet ewes were placed on paddock A of all treatments during early May each year when the grass was about 4 inches tall. After the A paddocks were grazed to a 3-inch stubble (35 to 55 days), the ewes were moved to the B paddocks, and thence to the C paddocks when necessary. All treatments were stocked at a rate of 2.7 ewes per acre in 1956. This rate was maintained on Treatments 1 and 2 through 1961, but was reduced on Treatment 3 to two ewes per acre in 1957 and 1958, and to 1.7 ewes per acre from 1959 through 1961. The stocking rates were sufficiently high to use about 65 percent of the total growth during an average growth year.

Ewes were weighed weekly. The herbage was harvested with grass shears every third week from six caged and six grazed 1- x 2-yard plots per paddock. An additional harvest was taken whenever sheep were moved to a succeeding paddock. The grazing season ended when the ewes made no gain or lost weight during two successive weekly weighings in late September or early October.

Results and Discussion

Influence of Precipitation on Production

Precipitation was below average during each of the six years. In 1958 and 1961 the seasonal rainfall was approximately half of average. Soil moisture reserves were low each spring, barely more than sufficient to start growth. These and other indications of drought are shown by data presented in Table 2.

Dry matter yields decreased steadily with reduced moisture supplies, although Johnston and Wilson (1962) report that annual yields of these species decrease as the stands age. Notwithstanding decreasing yields and apparent consumption of dry matter, the average live-weight gain per ewe during the last three years (1959 to 1961) was nearly equal

Table 1. Treatments established.

Treatment	& Paddock	Grazing period	Crop and rate of seeding	lb./ac.
1	A	Spring	Crested wheatgrass	6
			Alfalfa	1
	B	Summer	Intermediate wheatgrass	10
			Alfalfa	1
	C	Autumn	Russian wild ryegrass	8
			Alfalfa	1
2	A	Spring	A mixture of:	
	B	Summer	Crested wheatgrass	2
	C	Autumn	Intermediate wheatgrass	4
			Russian wild ryegrass	3
			Alfalfa	1
3	A	Spring	As for Treatment 2	
	B	Summer	but without alfalfa	
	C	Autumn		

to that during the first three years (1956 to 1958). This is credited to the nature of growth, because the grass portion of the swards was comprised largely of leafage from 1959 to 1961, and thus would have a higher nutritive rating than in 1956 and 1957 when stems comprised a considerable portion of the yield. The yearly decrease in the ratio of pounds of forage disappearance per pound of live-weight gain is attributed to the same reason.

Apparent consumption per ewe-day was equal in 1956 and 1959, although there was a considerable difference in apparent consumption per acre. This is explained by the pattern of May-July rainfall in 1959 when 4.4 of the 6.8 inches fell within ten days in late June and early July. Considerable leafy growth developed in July, which produced an acceptable and nutritious sward that promoted rapid livestock gains during a short period.

A close relationship was established between annual yields of dry matter per acre and apparent daily consumption per ewe, although the 1959 results distort the pattern somewhat. The correlation coefficient between these variables was calculated to be r = 0.84 ($P > 0.01$). The regression coefficient and regression equation is as follows:

$$b = 1.036(10^{-3}) \pm 0.093(10^{-3}) \qquad P < 0.05 \qquad -1-$$

$$Y = 1.257 + (1.036 \times 10^{-3})X. \qquad (500 < X < 2000) \qquad -2-$$

when Y = apparent daily consumption per ewe in pounds, and
X = D.M. yield in pounds per acre.

These results indicate that sheep will eat according to the pasture supply, consuming less each day as the supply diminishes. They suggest also a reason why short pastures can carry a livestock load greater than anticipated for short periods. Similar observations have been made for cattle and sheep by Semple (1951) and Cox *et al.*, (1956).

Forage and Livestock Yields by Treatments

There are several advantages for the inclusion of one pound of alfalfa in a pasture mixture (Table 3). This addition apparently increased dry matter production, produced greater liveweight gains per ewe and per acre, and greatly reduced forage consumption per pound of liveweight gain. In percentage units the average increases of Treatments 1 and 2 over that of Treatment 3 are as follows: rate of grazing, 40 percent; yield of D.M., 55 percent; live-weight gain per

Table 2. Influence of years on herbage production and livestock gains for all crops.

Year	Soil[1] moisture reserve on May 1st	Precipitation in inches: May to July	Precipitation in inches: Annual	Average dry matter production lb./ac.	Apparent consumption: lb./ac.	Apparent consumption: lb./ewe/day	Lightweight gain in lb.: per ewe	Lightweight gain in lb.: per acre	Pounds forage disappearance lb. ewe gain	Ewe days/ acre
1955	1.8	9.31	17.30	3180[2]	.....	....	....	....	....	....
1956	1.3	6.34	13.15	1630	1320	3.1	13	35	38	426
1957	1.1	4.69	11.83	1260	965	2.65	14	36	30	363
1958	0.8	3.45	11.50	760	605	2.15	7	19	32	295
1959	0.8	6.81	13.99	1020	885	3.1	14	35	25	297
1960	1.2	4.86	12.44	870	735	2.3	11.5	29	25	320
1961	0.8	3.25	8.90	580	480	2.05	8.5	20	24	235
Mean 1956-61		4.90	11.93	1020	830	2.65	11.3	29	29	323
Mean 1886-61		6.86	14.70							

[1]Soil moisture reserve equivalent to inches of water.
[2]Harvested for hay in 1955.

Table 3. Response of crops and livestock by treatments (1956 to 1961).

Treatment	Production lb./ac.	Consumption lb./ac.			Pounds gain per ewe	Pounds gain per acre			Ewe days/ acre	Apparent consumption pounds of herbage	
	Mean	High	Low	Mean		High	Low	Mean		Per ewe per day	Per lb. of ewe gain
1	1290	1600	610	1015	14.5	52	27	41.3	378	2.5	24.5
2	1020	1320	420	800	13.4	46	26	35.3	333	2.4	22.7
3	750	1040	415	675	6.0	15	7	11.0	257	2.6	61.3
Mean	1020	.....	.....	830	11.3			29.0	323	2.5	36.2
$SE\bar{x}\%$	11.6	.....	.....	13.0	9.3			9.8	5.6	8.3	8.7

ewe, 135 percent; and live-weight gain per acre, 215 percent.

The swards did not possess a high crude protein content at any time (Table 4). The results indicate moderately high contents with small difference between treatments during the spring, but marked reductions on the grass-alone sward during the summer and autumn. Peters (1955) reports percentage crude protein of local native range similar to those for the grass-alone paddocks.

Table 4. Mean percentage crude protein contents by treatments and season. Each season estimate is the mean of three harvests from 1956 through 1961.

Treatment	Season		
	Spring	Summer	Autumn
	— — — (Percent) — — —		
1	13.0	11.5	9.0
2	12.8	11.6	8.2
3	11.1	8.3	5.5

Mean liveweights of ewes at twice-monthly intervals by crop treatments from 1956 through 1961 are plotted on Figure 1. Liveweight increases are nearly equal for all treatments until the end of July, although no apparent gain was recorded on any treatment during July; the same observation was reported by Campbell (1961). However, from August until the end of the grazing season liveweight increased satisfactorily on the grass-alfalfa treatments, but no measurable gain was recorded for Treatment 3. As apparent consumption per ewe day was similar on all treatments (Table 3), the liveweight increase on the grass-alfalfa swards must be credited to the properties of the alfalfa.

Although details of cover analyses are not being presented in this paper, it is worthwhile reporting a few observations. The intermediate wheatgrass was killed out completely by 1960 in all treatments, and was replaced in Treatment 1 by crested wheatgrass which invaded from adjacent roadways. In Treatments 2 and 3 both crested wheat and Russian wild rye replaced intermediate wheatgrass. The dead crowns of the intermediate acted as seedbeds in all cases.

The death of the intermediate wheatgrass demonstrated one weakness in a sward comprised of a single grass. Its loss might have reduced grazing capacity until a new crop could be established, although in this test it

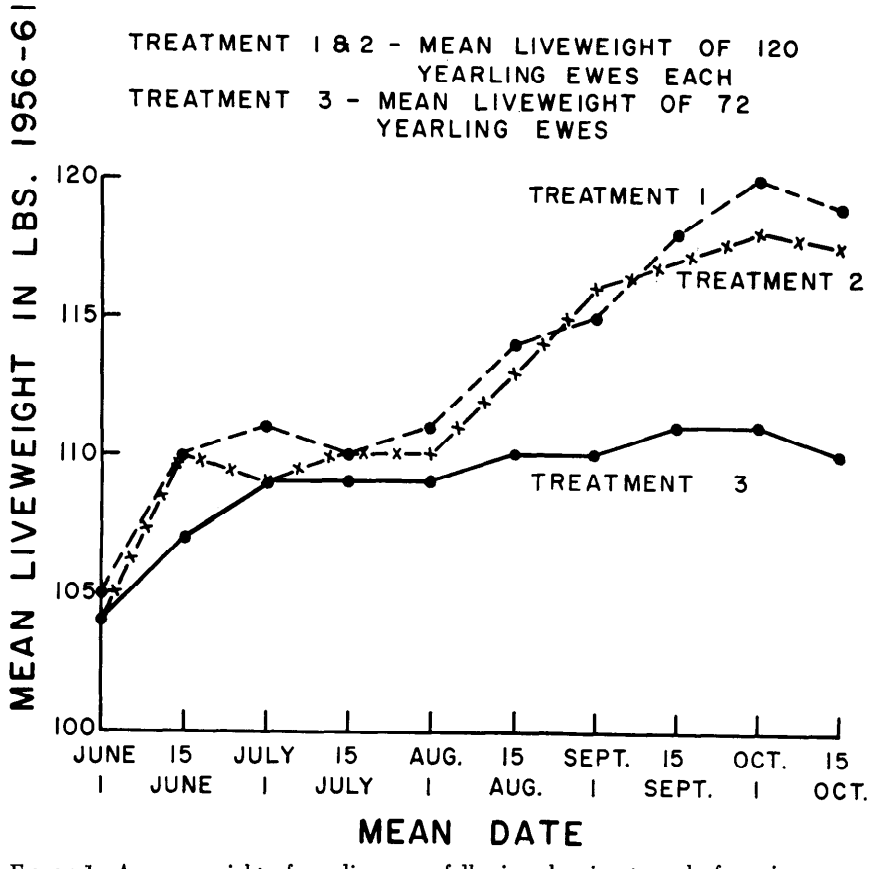


FIGURE 1. Average weight of yearling ewes following shearing to end of grazing season (1956-1961). The weight recorded is the mean weight of 120 ewes on treatments 1 and 2 and 72 ewes on treatment 3.

did not matter as there was a good supply of crested wheatgrass seed available and establishment was rapid on the small fields; such would not likely occur over a large area. The loss of the intermediate wheatgrass in Treatments 2 and 3 was not serious because there was seed of both crested wheatgrass and Russian wild rye available throughout each paddock and recovery of a stand was rapid. The same advantageous seed situation would likely occur wherever moderate-continuous or repeated-seasonal grazing was practised on mixed grass swards.

Treatment 1 outyielded Treatment 2 in both dry matter yields and lightweight gains. However, Treatment 2 was a more consistent producer from year to year. This is accounted for by the rapid loss of the intermediate wheatgrass which upset the grazing balance in Treatment 1 during 1958 and 1959. Notwithstanding the slightly lower yield of Treatment 2, the results of this test suggest that mixtures are preferable to single grass swards when large acreages are being seeded for pasture, particularly when one species is less hardy than the others.

The alfalfa stands were rereduced gradually as the experiment progressed. This is attributed to heavy use and drought. Few plants remain on the level portions of the paddocks, but strong plants persist in low spots and on north-facing slopes. There is every reason to believe that these better sites will maintain strong alfalfa plants for many years. Because the live-weight gains of the ewes have maintained the differential in favor of the grass-alfalfa mixture with decreasing alfalfa stands, it is suggested that even small quantities of alfalfa in a pasture will materially increase live-weight gain on yearling ewes, particularly during late summer and autumn. The following data indicate the consistent differential favoring the grass-alfalfa treatments by years:

Year	Average Lightweight Gain in Pounds Per Ewe by Treatments		
	1	2	3
1956	17	17	5
1957	19	16	9
1958	8	8	4
1959	17	17	7
1960	16	10	6
1961	10	12	5

Observations of crested wheatgrass and Russian wild ryegrass in Treatments 2 and 3, suggest that Russian wild ryegrass is more competitive and equally, if not more, drought tolerant than creasted wheatgrass. These characteristics were not noticeable during the early years of the test, but since 1959 Russian wild ryegrass has been increasing its stands while crested wheatgrass plants have been dying out slowly.

Summary and Conclusions

This paper summarizes observations based on a repeated-seasonal grazing test undertaken to compare grass-alfalfa and grass-alone swards. The study was conducted during a period of years (1956-1961) when rainfall was below average.

The yield of dry matter and number of grazing days per acre decreased as the experiment progressed. This was associated largely with progressive drought, but also with physiological age of the plants. Of the three grasses employed, Russian wild rye produced the most consistent yearly yield and has maintained the best stand.

Intermediate wheatgrass killed out completely in four years. It was replaced by invading crested wheatgrass on Treatment 1 where a nearly complete stand was established. On Treatments 2 and 3 the intermediate wheatgrass was replaced by crested wheatgrass and Russian wild ryegrass, both being components of the seeded mixture.

One pound of alfalfa in the seed mixture provided several benefits over the grass-alone sward. Greater yields of dry matter and higher precentage contents of crude protein were recorded. These increased yields were reflected in higher carrying capacity, increased liveweight gains per ewe and per acre, and greatly reduced consumption per pound of liveweight gain.

LITERATURE CITED

CAMPBELL, J. B. 1961. Continued versus repeated-seasonal grazing of grass-alfalfa mixtures at Swift Current, Saskatchewan. Jour, Range Mgnt., 14: 72-77.

COX, C. P., A. S. FORD, Z. D. HOSKING, C. LINE AND S. J. ROWLAND. 1956. The direct evaluation of pasture in terms of milk production of individually grazed cows. Jour. Brit. Grassland Soc. 11: 107-118.

HEINRICHS, D. H. AND J. L. BOLTON. 1958. Rambler Alfalfa. Can. Dept. of Agr. Pub. #1030.

JOHNSTON, A. AND D. B. WILSON. 1962. The range story of the prairies. Agr. Inst. Review, 17: 9-11.

PETERS, H. 1955. Progress Report, Range Expt. Station, Manyberries, Alta. Queen's Printer, Ottawa, Canada.

SEMPLE, A. T. 1951. Improving the world's grasslands. FAO Agricultural Studies #16, Rome, Italy.

WHYTE, R. O., G. NILSSON-LEISSNER AND H. C. TRUMBLE. 1953. Legumes in agriculture. FAO Agricultural Studies 21, Rome, Italy.

A Larger Bitterbrush

RICHARD S. DRISCOLL

Range Conservationist (Research), Pacific Northwest Forest and Range Experiment Station, Forest Service, U.S. Department of Agriculture, Portland, Oregon.

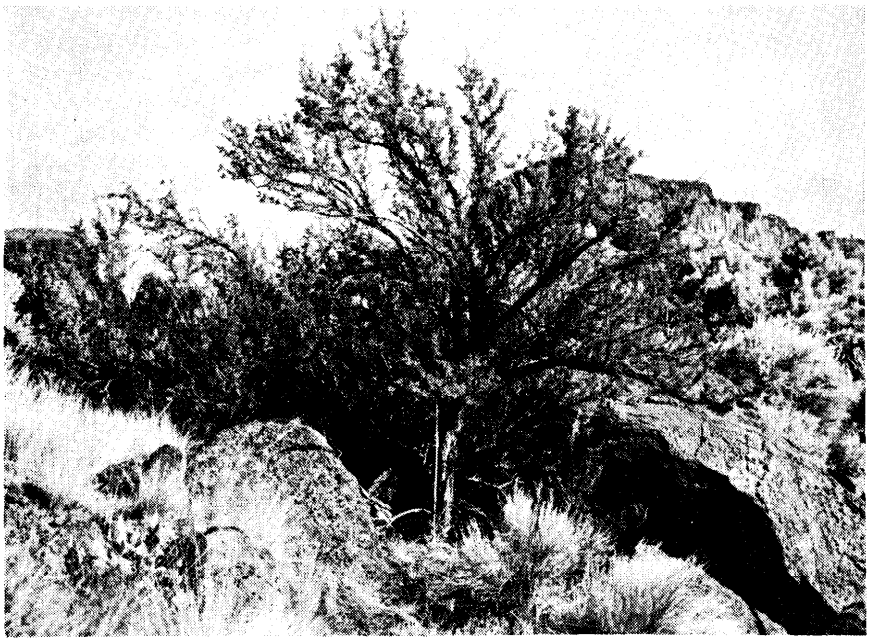


FIGURE. 1. The largest bitterbrush? The tape measure near the stem indicates 4 feet.

A large plant of antelope bitterbrush *(Purshia tridentata* (Pursh) DC.) has been found in central Oregon which may be the monarch of the species (Figure 1). This specimen is located in the Cove Palisades State Park, Jefferson County, Ore. It had the following characteristics when measured April 15, 1961:

Main stem circumference, 1 foot above ground and below lowest branches	38 inches
Height, excluding current year's growth	14.2 feet
Widest crown diameter in straight line measured through the center of the largest stem	21.7 feet
Narrowest crown diameter, in straight line measured through the center of the largest stem	18.5 feet

The size index of this plant, computed by the method suggested by Nord (1962), is 57.2. This exceeds the index of the large specimen found by Nord *op. cit.* in Lassen County, Calif., by 4.3 points.

Two small stems protrude from the ground line at the same place from which the large stem arises. The circumferences of these stems, measured 1 foot above the ground line and below the lowest branches, are 18 and 16 inches, respectively. No attempt was made to ascertain whether the three stems were branches from a common root crown or actually represented individual plants. Crown diameter and plant height measurements do not differentiate between stems.

Site conditions where this plant is located include a 30 percent, west-northwest-facing slope. The soil is a very stony loam with large basaltic stones lying on and protruding from the surface. Associated species include arrowleaf balsamroot *(Bal-*

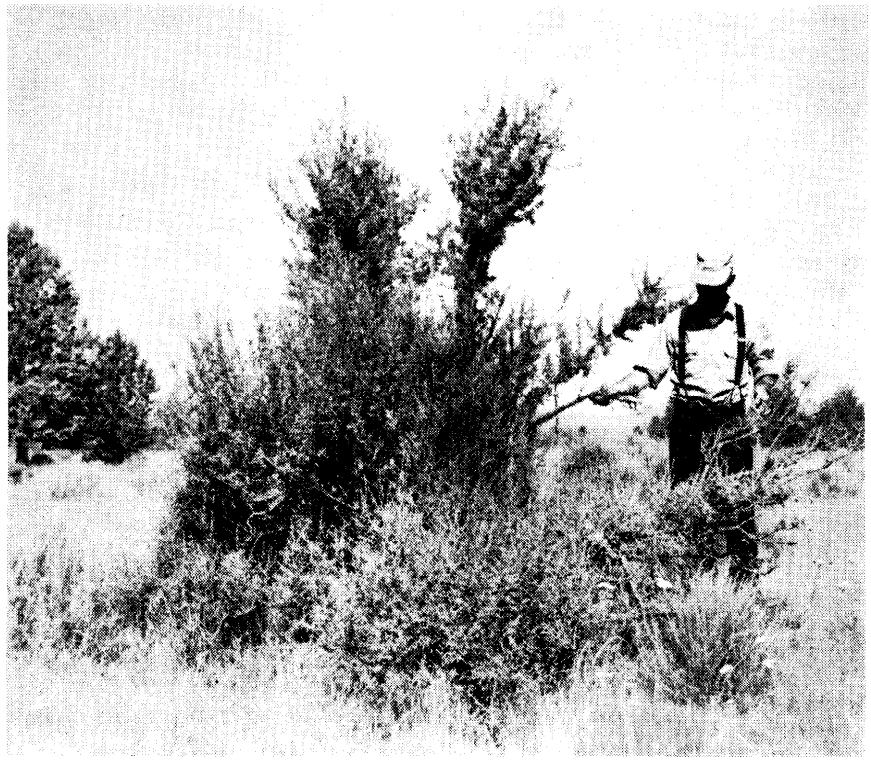


FIGURE. 2. A 9-foot plant in a stand of tall bitterbrush near the location of the specimen in Figure 1.

samorhiza sagittata (Pursh) Nutt.), bearded bluebunch wheatgrass (*Agropyron spicatum* (Pursh) Scribn. & Sm.), big sagebrush (*Artemisia tridentata* Nutt.), rubber rabbitbrush (*Chrysothamnus nauseous* (Pall.) Britt.), and western juniper (*Juniperus occidentalis* Hook.).

This specimen is not a single individual in its class of the species. Stands of antelope bitterbrush with plants 8 to 12 feet tall (Figure 2) can be found within a 5-mile radius of where this large plant is growing. Individuals have been grazed by deer, sheep, and cattle. Consequently, they do not depict an undisturbed growth form.

Bitterbush is one of the most important game forages in the western United States (Hormay, 1943). On many livestock ranges, it is also a very desirable forage plant. This is particularly true in areas like eastern Oregon and Washington where annual summer droughts cause herbaceous species to dry and become nonpalatable and lose nutritional qualities early in the summer grazing season. Game and livestock grazing, together with fire, rodents, insects, and disease, seriously depletes many bitterbrush stands. Other shrub species important for game and livestock forage, including species of serviceberry (*Amelanchier* Medic.), sagebrush (*Artemisia* L.), ceanothus (*Ceanothus* L.), cercocarpus (*Cercocarpus* H.B.K.), and cliffrose (*Cowania* D. Don), are also being depleted.

In an effort to restore suitable habitats with these species, much attention is being given to seeding and planting. It seems logical, then, to select seed from parent plants showing genetic characteristics of high volume production, recognizing that the degree of ecotypic and ecophenic variation within species needs to be ascertained. Therefore, it would be desirable to establish a readily available central register of facts concerning the location of the largest plant of the species as well as of stands composed of large, high-producing individuals. Such a register would also stimulate greater appreciation of shrubby plants and serve to protect the monarchs of the species as interesting landmarks.

The American Forestry Association (Dixon, 1961) has such a record for trees, but their measurement procedures are not realistic for shrubs. For one thing, stem circumferences are measured at 4½ feet above the center of the base of the tree. This rule is impractical for shrubs because of multiple branching at or near the ground line in many species. Therefore, the following rules are proposed as a guide toward the possibility of establishing a register for big shrubs:

1. Stem circumference: For single-stemmed plants, the circumference, in inches, is measured 1 foot above the ground line. If this point occurs above a branch, circumference is measured below the stem swell at the junction of the branch and stem but above butt swell. For plants with multiple stems originating at or below the ground line, the the area of each stem will be computed from circumference measurements following the described procedure. The areas of these stems are then totaled and converted to an aggregate circumference.
2. Plant height: Measured in a straight line from where the stem or stems protrude from the ground to the highest point in the crown but excluding current year's growth.
3. Crown spread: Crown spread is expressed as an average of the widest and narrowest diameters of live crown measured on a straight line passing through the center of the largest stem where circumference is measured, or as area of an ellipse computed from these measurements.

LITERATURE CITED

DIXON, DOROTHY. 1961. These are the champs. Amer. Forests 67(1): 40-46, 48-50, illus.; 67(2): 41-47, illus.

HORMAY, AUGUST L. 1943. Bitterbrush in California. U. S. Forest Serv. Calif. Forest & Range Expt. Sta. Res. Note 34, 13 pp., illus.

NORD, EAMOR C. 1962. Was this a prize bitterbrush? Jour. Range Mangt. 15: 82-83, illus.

BOOK REVIEWS

Edited by D. G. Wilson, Dept. of Watershed Management, Uni. of Arizona, Tucson.

Introduction to Mammalogy. By E. Lendell Cockrum. *The Ronald Press, New York, N. Y. 455 pages. 1962. $9.00.*

This book was designed for an introductory course in mammalogy and wildlife management. The text is divided into two parts; one discusses the basic biological principles of mammalogy; the second part describes in systematic order the families of living mammals found in both the Old and New Worlds.

The author is, at present, Professor of Zoology and Curator of Mammals for the University of Arizona. In addition, he is a Research Associate, Division of Mammals, American Museum of Natural History. Some of his other major publications have been "Mammals of Kansas", "The

Mammals of Arizona, their Taxonomy and Distribution", and "A Manual for Introduction to Mammalogy".

Biological principles are discussed in the first part of the book in the following chapters: (1) Characteristics of Mammals, (2) Distribution and Classification, (3) Reproduction and Development, (4) Behavior, (5) Populations, and (6) Economic Relationships. The second part of the book devotes one chapter to each of the 19 orders of living mammals. The families within each order are discussed as to (1) structure, (2) natural history, and (3) a listing of recent genera and their distribution.

The book is well illustrated by line charts, graphs, and photographs. Distribution maps, outlining worldwide distribution of families, are particularly good. Also, there are comprehensive tabulations of data on such subjects as reproduction, home range and population densities, and metabolic rates of hibernating mammals.

In this condensed version of mammalogy, examples of various attributes of mammals are highly selective. Opinion as to appropriate examples for an introductory textbook will probably vary among mammalogists. As an example of divergent opinion, this reviewer wonders why, under Economic Relationships, so much space was devoted to the ecology of rodents without citation of some of the important animal-environment interactions of ungulates, carnivores, or lagomorphs.

Some space is devoted to criticism of controversial hypotheses, techniques, or findings. Such discussion could have been left to the lecturer, and more emphasis placed upon accepted biological principles. Also, if the book is to be used by naturalists, wildlife technicians, and others interested in mammals, a glossary would have been helpful to assist with the rather specialized and technical terminology, particularly with regard to strucural descriptions.

The book should serve as an adequate text for an introductory course in mammalogy if it is supplemented with more detailed information in lectures. Also, anyone familiar with the technical terminology can obtain a cursory review of the living mammals of the world. The book does not, however, provide sufficient detail for a reference text for specialists in mammalogy, wildlife, or allied fields.—*H. G. Reynolds,* Rocky Mountain Forest and Range Experiment Station, Forest Service, U. S. Department of Agriculture, Tempe, Arizona.

Management of Artificial Lakes and Ponds by George W. Bennet. *Reinhold Publishing Co., New York, 283 pages. 1962. $8.00.*

The majority of the readers of this Journal are probably interested in the production of fish in small impoundments and tanks which are constructed as livestock watering reservoirs. My critique will consider the book from this viewpoint.

Dr. Bennet's book is principally a review of fishery management practices developed and used in the United States east of the Missouri River. There are also interesting general sections on commercial sport fishing, fish behavior, and population dynamics. Warm water game and pan fish management in impoundments is the principle theme. The book reflects Dr. Bennet's considerable fishery experience in Illinois. The author's own opinions based on personal experiences are more valuable than anything to be deduced from his less interpreted considerations of the literature. A greater service would have been rendered to amateur (and professional) fishery managers had the book been considerably more critical of the prevailing concepts of "standing crop" and "population balance".

The lack of discussion concerning trout management in ponds decreases the value of the book with regard to application in the Rocky Mountain and Intermountain regions. Most warm water game and pan fishes have given poor fishing results at elevations above 4,000 feet. In contrast trout have often given excellent management results particularly in renovated waters where fishing is maintained by periodic plants of fingerlings. Furthermore, the success in producing excellent trout fishing from fingerling plants in western ponds undoubtedly carries implications for the future of warm water fishery management. One of the implications being that true management of lakes and ponds for maximum yield of desirable species and sizes of fish will depend on complete human control of population size and composition and not on precarious "natural balances".

A person who did not have considerable experience in fishery management would have a difficult time deciding a course of action based on this book. This is no fault of the author's but is a reflection of the present state of the art of fishery management. This reflection underscores the desirability of seeking professional guidance when attempting to develop private fisheries.—*William J. McConnell,* Cooperative Wildlife Research Unit, University of Arizona, Tucson.

Weed Control. By Alden S. Crafts and Wilfred W. Robbins. *McGraw-Hill Book Co., Inc. New York, San Francisco, Toronto, London. 660 pages. 1962. $14.75.*

This book is the third edition of the popular "Weed Control" by W. W. Robbins, A.S. Crafts and R. N. Raynor. The present edition has been expanded by about 150 pages to accommodate information on the herbicides that have been developed and have come into general use since publication of the second edition in 1952. As an indication of the rate of herbicide development, about 30 herbicides were listed in the second edition while about 60 are listed in the third edition.

Those familiar with the second edition will feel at home with the present third edition. Figures and tables are identical for the most part and the same is true of the textual material. This has led to a few unfortunate results. For example, in discussing the extent of research on weed control the statement that "The Bureau of Plant Industry, Soils, and Agricultural Engineering has established a Division of Weed Investigations . . ." was true in 1952, but a reorganization of the Department of Agriculture in 1954 abolished the Bureau and reorganized the research into what is now a number of Divisions in the Agricultural Research Service. Dr. Crafts is of course aware of the reorganization and mentions the new alignment in other sections of the book.

In earlier editions only a few pages were devoted to the cost of weeds.

This important topic is given the status of a complete chapter in the third edition. The increased emphasis is welcome because too few people realize the tremendous losses in crop production due to weed competition. Although losses in crop production due to various causes are not precisely known, it is believed that losses caused by weeds in the United States equal the combined losses from insects and disease, and rank second only to those caused by soil erosion. When these facts are more widely known the need for weed research and education can be more easily justified. An interesting aspect of the weed problem is that a high percentage of our weed flora represents introductions from foreign countries, mostly Europe and western Asia.

Two chapters are devoted to herbicidal control recommendations. Actual recommendations are presented in tables. The first chapter includes a table arranged by crop plants showing the use of selective herbicides in cropped areas. The second chapter is devoted to the use of nonselective herbicides on non-cropped areas and includes a table organized by specific weeds or weed complexes. Both tables are informative and useful, but the user will want to supplement the information with local recommendations in many cases.

A new table in the appendix lists common and chemical names of herbicides as well as the structural formula. This table will be appreciated by students in weed control classes who use the book as a text and by persons who have difficulty in remembering the many chemical compounds used as herbicides.

The forester or range manager interested in specific recomemndations for woody plant control will be disappointed. Only a general discussion of woody plant control is given instead of the table of recommendations as is given for weeds in cultivated crops. This deficiency could have been alleviated by a more comprehensive bibliography of woody plant control.

The book is intended principally as a text for teaching classes in weed control. It is admirably suited for that purpose. It presents a broad foundation for the understanding of the biological principles of weed control.—*Fred H. Tschirley.* Crops Research Division, Agricultural Research Service, U. S. Department of Agriculture, Tucson, Arizona.

Land Economics Research. Edited by Joseph Ackerman, Marion Clauson and Marshall Harris. *John Hopkins Press, Baltimore, Maryland. 270 pages. 1962. $4.00.*

Land Economics Research is a collection of 15 papers assembled in four parts. These papers were presented at a symposium on Land Economics Research held at Lincoln, Nebraska, June 16-23, 1961 under the joint sponsorship of the Farm Foundation and the Resources for the Future, Inc.

Part I, Scope, Problem, and Objectives, contains six chapters (papers) dealing with the definition of land economics, problems that land economists are researching and are going to need to research in the near future, and the objectives of land economics research. The major research problems considered are the tenure structure, urban and regional planning, and land economics research for world agriculture. In addition chapter 3 surveys the objectives of land economics research while chapter 4 deals with the problem of obtaining better utilization of the results of land economics research.

Part II, Theoretical Considerations, uses four chapters to discuss theoretical approaches to research in land economics. Chapter 7 is concerned with the relevance of production theory to land economics research. The author of this paper points out the problems involved in using production theory to determine the solution to problems in land economics. Chapter 8 deals with land and rent in welfare economics. The objective of the chapter is to examine the possiblity of land with the most favorable location as to source of water, power, etc., deriving the full benefit of this location. Chapter 9 discusses the contribution of institutional economic analysis to land problems, while chapter 10 considers the synthesis and differentiation of economic theories.

Part III, Procedural Framework, deals with interdisciplinary approaches and procedures to land economic research and the steps in carrying out formal research projects. This section discusses the different research tools and the scientific approach to land economic research problems.

Part IV, Program and Organization, is concerned with the probable research areas in land economics during the next ten years, the organization of research staffs, and administration of these staffs to produce effective research in land economics.

A book consisting of a collection of papers is not as easy to read as one written by one or two individuals. However, due to the planning that went into the selection of the topics for the papers, Land Economic Research has more continuity than most books of this type: It contains a great amount of material that will be of interest to land economists; in fact, it is a book with which most everyone trained in economics should be acquainted.

The fact that Land Economic Research is written for economists limits its readers. In order to understand this book the reader must be acquainted with the formal language of the economist—*Thomas M. Stubblefield,* Department of Agricultural Economics, University of Arizona, Tucson, Arizona.

1961 Forest Tree Seed Directory. Food and Agriculture Organization of the United Nations. *International Documents Service, Columbia University Press (Sales Agent in the United States), 2960 Broadway, New York 27. 463 pages & 49 page appendix. 1961. $2.00.*

The Food and Agriculture Organization of the United Nations (FAO) has made notable contributions to agriculture throughout the world by disseminating information on many subjects. Among these contributions is a Forest Tree Seed Directory printed in English, French and Spanish which lists seed sources of tree species used for forest production, erosion control, range and wildlife management, shelterbelts, windbreaks and other purposes. The 1961 directory goes much farther than its predecessors by providing more information than is implied by the title. Besides the names and addresses of commercial and other

suppliers of seed of tree and some shrub species in 95 different member nations of the FAO, it has an appendix section on methods for collecting, and handling Eucalypt seed, and the latest rules and procedures adopted by the International Seed Testing Association.

The directory lists seed sources for more than 1900 species or varieties of trees and shrubs ranging from *Aberia caffra* in Kenya to *Zixyphys talanai* in Indonesia. Scotch Pine *(Pinus sylvestris)* has the largest and most widespread array of seed sources, 54 sources in 19 different countries. Also information is provided on the locality of seed origin including the elevation, latitude and longitude and whether or not certificates are required for seed shipment into other countries. The appendix includes general and special directions for germination tests. Certain points relating to seed collection and handling of 118 Eucalypt species, classified according to their suitability to grow in certain broad climatic zones, are emphasized.

The directory has some shortcomings. It does not include any seed sources within the vast area of the U.S.S.R. or Communist China; however, some sources in a few other communist dominated nations are included. The title of the work suggests a limited content. However, it includes the most recent procedures adopted for testing tree seed and considerable additional information supplied by the Commonwealth Forestry And Timber Bureau at Canberra on Eucalypt seed. These features greatly enhance the usefulness of the publication.

The book is adequate for its intended purpose, notwithstanding it is a paper bound, near-print publication. The print is of adequate size for interlined comment or additions, especially for other languages.

The appearance of this exhaustive directory is especially appropriate at this time in view of the expanding interchange of information and materials reaching beyond most barriers which have heretofore constrained the advance of knowledge and progress of land management. The editors and contributors to this directory are to be congratulated on having produced a very comprehensive and valuable addition to other seed lists. It should prove a useful handbook for many individuals, agencies and institutions engaged in research, development or management of wildlands because it is practically world-wide in scope and contains one of the most comprehensive guides to sources of tree seeds throughout the world.—*E. C. Nord,* P.S.W. Forest and Range Expt. Sta., Berkeley 1, California.

CURRENT LITERATURE

Edited by D. F. Hervey, Meredith Morris and Graduate Student-Faculty Seminar members, Range Management Department, Colorado State University.

RANGE AND PASTURE MANAGEMENT

Alexander, C. W., and D. E. McCloud. Influence of time and rate of nitrogen application on production and botanical composition of forage. *Agron. Jour. 54(6):521-522. Dec., 1962.* (Crops Res. Div., ARS, USDA, Beltsville, Md.)

Allred, B. W. There can never be a surplus of grass. *West. Livestock Jour. 41(9):99-107. Jan., 1963.* (SCS, USDA, Washington, D. C.)

Atkins, M. D. Conservation plant materials for the Great Plains. *Jour. Soil and Water Conserv. 17(5):199-203. Sept.-Oct., 1962.* (SCS, USDA, Denver, Colo.)

Bisset, W. J. The black speargrass *(Heteropogon contortus)* problem of the sheep country in central-western Queensland. *Queensland Jour.* Agr. and Stock, Brisbane, Queensland, Austral.)

Brockington, N. R. Fertilizer trials on some cultivated grasses in Northern Rhodesia. *Empire Jour. Expr. Agr. 30:345-354. Dec., 1962.* Ministry of African Agr., Northern Rhodesia)

Chiarella, Joseph V. Catchments catch on. *West. Livestock Jour. 41(9):163-166. Jan., 1963.* Bureau of Indian Affairs, USDI, Phoenix, Ariz.)

Chohlis, John. "Built for stout" range seeding rigs. *West. Livestock Jour. 41(9):131-137. Jan., 1963.* (West. Livestock Jour., Denver, Colo.)

Gomm, F. B. Reseeding studies at a small high-altitude park in southwestern Montana. *Mont. Agr. Expt. Sta. Bul. 568, 16 p. June, 1962.* (Bozeman)

Hyder, D. N., Forest A. Sneva, and Virgil H. Freed. Susceptibility of big sagebrush and green rabbitbrush to 2,4-D as related to certain environmental, phenological, and physical conditions. *Weeds 10(4):-288-295. Oct. 1962.* (Crops Res. Div., ARS, USDA, Colo. State Univ., Ft. Collins)

Johnsen, Thomas N., Jr. Chemical control of Colorado rubberweed in Arizona. *Weeds 10(4):328-329. Oct., 1962.* (Crops Res. Div., ARS, USDA, Flagstaff, Ariz.)

McGuire, E. N. Chain gang brush killers. *West. Livestock Jour. 41-(9):113-117. Jan., 1963.* (SCS, USDA, Durango, Colo.)

Morgan, L. W., H. H. Tippins and C. M. Beckham. Experiments for the control of Debrobrachus brevicollis (Serv.), a pest of Bahia grass. *Ga. Agr. Expt. Sta. Mimeo. Series 154, 10 p. Nov., 1962.* (Experiment, Georgia)

Newell, L. C., R. J. Staten, E. B. Jackson and E. C. Conard. Sideoats grama *(Bouteloua curtipendula)* in the central Great Plains. *Nebr. Agr. Expt. Sta. Res. Bul. 207, 38 p. Apr., 1962.* (Lincoln)

Pringle, William L. and Alastair McLean. Seeding forest ranges in the dry belt of British Columbia. *Canada Dept. Agr. Publication 1147, 11 p. Sept., 1962.* (Kamloops, B.C.)

Ratliff, Raymond D. Preferential grazing continues under rest-rotation management. *U. S. Forest Serv. Pac. SW For. & Range Expt. Sta. Res. Note 206, 6 p. 1962.* (Berkeley, Calif.)

Reid, D. Studies on the cutting management of grass-clover swards. III. The effects of prolonged close and lax cutting on herbage yields and quality. *Jour. Agr. Sci. 59-(3):359-368. Fall, 1962.* (Lab. Animal Physiol., Agr. Univ., Wageningen, The Netherlands)

Southcott, W. H., R. Roe and Helen Newton Turner. Grazing management of native pastures in the New England region of New South Wales. *Austral. Jour. Agr. Res. 13(5):880-893. Sept., 1962.* (Div. of Animal Physiology, CSIRO, Pastoral Res. Lab., Armidale, N.S.W.)

Taylor, H. M. Seedling emergence of wheat, grain sorghum, and guar as affected by rigidity and thickness of surface crusts. *Soil Sci. Soc. Amer. Proc. 26(5):431-433. Sept.-Oct., 1962.* (ARS, USDA, SW Great Plains Field Sta. Bushland, Tex.)

Woodcock, J. W. Insecticides on pastures must be used carefully. *New Zeal. Jour. Agr. 105:294-300. Oct., 1962.* (Dept. Agr., Wellington, N. Z.)

RANGE AND LIVESTOCK ECONOMICS

Edminster, Frank C. Profit from recreation on farms and ranches. *Jour. Soil and Water Conserv. 17(5):195-198. Sept.-Oct., 1962.* (Plant Technol. Div., SCS, USDA, Washington, D. C.)

Gray, J. R. and N. W. Springfield. Crested wheatgrass for lambing pays high returns. *Natl. Wool Grower 53:12-14. Jan., 1963.* (Agr. Econ. Dept., New Mex. State Univ., State College, New Mex.)

Rickenbacker, J. E. Losses from handling sheep and lambs. *U. S. Dept. Agr. Mktg. Res. Rpt. 544, 21 p. July, 1962.*

Skovlin, Jon M. Cow and calf weight trends on mountain summer range. *U. S. Forest Serv. Pac. NW For. & Range Expt. Sta. Res. Note 220, 7 p. Sept., 1962.* (Portland, Ore.)

Swiger, L. A., R. M. Kock, K. E. Gregory and V. H. Arthaud. Selecting beef cattle for economical gain. *Jour. Animal Sci. 21(3):588-593. Aug., 1962.* (Beef Cattle Res. Branch, Animal Husb. Res. Div., ARS, USDA, Lincoln, Nebr.)

Williams, W. F. The role of grade standards and grading in livestock and meat marketing. *Okla. Agr. Expt. Sta. Processed Ser. P-419, 90 p. June, 1962.* (Stillwater)

RANGE ECOLOGY AND PLANT CLASSIFICATION

Beetle, A. A. Range survey in Teton County, Wyoming. Part I. Ecology of range resources. *Wyo. Agr. Expt. Sta. Bul. 376, 42 p. Mar., 1961.* (Laramie)

Beetle, A. A. Range survey in Teton County, Wyoming. Part II. Utilization and condition classes. *Wyo. Agr. Expt. Sta. Bul. 400, 38 p. Dec., 1962.* (Laramie)

Daubenmire, R. Vegetation of the state of Idaho: A Bibliography. *Northwest Sci. 36(4):120-122. Nov., 1962.* (Washington State Univ., Pullman, Wash.)

Johnsen, Thomas N., Jr. One-seed juniper invasion of northern Arizona grasslands. *Ecol. Monog. 32-(3):187-207. Summer, 1962.* (Crops Res. Div., ARS, USDA, Flagstaff, Ariz.)

Johnson, W. M. Vegetation of high-altitude ranges in Wyoming as related to use by game and domestic sheep. *Wyo. Agr. Expt. Sta. Bul. 387, 31 p. June, 1962.* (Laramie)

King, J. The Festuca-Agrostis grassland complex in south-east Scotland. *Jour. Ecol. 50(2):321-355. July, 1962.* (Hill Farming Research Organization, Edinburgh, Scotland)

Langenheim, Jean H. Vegetation and environmental patterns in the Crested Butte area, Gunnison County, Colorado. *Ecol. Monog. 32(3):249-285. Su., 1962.* (Dept. of Botany, Univ. of Ill., Urbana)

Martin, Helene A. and R. L. Specht. Are mesic communities less drought-resistant? A study on moisture relationships in dry sclerophyll forest at Inglewood, South Australia. *Austral. Jour. Bot. 10:106-118. Nov., 1962.* (Botany Dept., Univ. of Adelaide, Adelaide, S.A.)

Paul, F. W. and D. R. Cable. Recovery of vegetation following wildfire on a chaparral area in Arizona. *U. S. Forest Serv. Rocky Mtn. Forest & Range Expt. Sta. Res. Notes 72, 4 p. June, 1962.* (Ft. Collins, Colo.)

Snaydon, R. W. The growth and competitive ability of contrasting natural populations of Trifolium repens L. on calcareous and acid soils. *Jour. Ecol. 50(2):439-447. July, 1962.* (Dept. Agr. Botany Univ. College of North Wales, Bangor, Wales)

PLANT PHYSIOLOGY AND GENETICS

Ackley, Rodney J. and Rudolph Ulrich. The use of calculated actual and potential evapotranspiration for estimating potential plant growth. *Hilgardia 32(10):-443-462. May, 1962.* (Soils Dept. Univ. of Calif., Berkeley)

Avers, Charlotte J. Fine structure studies of Phleum root meristem cells. I. Mitochondria. *Amer. Jour. Bot. 49(9):996-1003. Oct., 1962.* (Dept. of Biol. Sci., Douglass College, Rutgers—The State Univ., New Brunswick, N. J.)

Beinhart, George. Effects of temperature and light intensity on CO_2 uptake respiration and growth of white clover. *Plant Physiol. 37-(6):709-715. Nov., 1962.* (Crops Res. Div., ARS, USDA, Clemson, S. C.)

Ben-Zeev, Nechama and Stephen Zamenof. Effects of high temperatures on dry seeds. *Plant Physiol. 37(5):696-704. Sept., 1962.* (Dept. Biochem., Columbia University, New York, N. Y.)

Craigmiles, J. P. and J. P. Newton. The effect of Gibberellin on forage crops. *Crop. Sci. 2:467-468. Nov.-Dec., 1962.* (Ga. Agr. Expt. Sta., Experiment, Georgia)

Evans, G. C. and A. P. Hughes. Plant growth and the aerial environment. III. On the computation of unit leaf rate. *New Phytol. 61:322-327. Oct., 1962.* (Botany School, Universtiy of Cambridge)

Harlan, J. R., J. M. J. deWet, W. L. Richardson and H. R. Chedda. Improving Old World bluestems for the South. *Okla. Agr. Expt. Sta. Processed Ser. P-412, 21 p. May, 1962.* (Stillwater)

Hay, J. R. Experiments on the relative susceptibility of weeds to auxin herbicides. *Canad. Jour. Bot. 40:1401-1409. Nov., 1962.* (Experimental Farm, Regina, Saskatchewan)

Jung, G. A. Effect of uracil, thiouracil and guanine on cold resistance and nitrogen metabolism of alfalfa. *Plant Physiol. 37(6):768-774. Nov., 1962.* (Dept. Agron. and Genetics, West Virginia University, Morgantown)

Linscott, D. L. and M. K. McCarty. Effect of mowing and 2,4-D on carbohydrate content and amount of ironweed roots. *Weeds 10(4):-298-303. Oct., 1962.* (Crops Res. Div., ARS, USDA, Cornell Univ., Ithaca, N. Y.)

Lowe, R. H. and H. J. Evans. Carbon dioxide requirement for growth of legume nodule bacteria. *Soil Sci. 94(6):351-356. Dec., 1962.* (Oregon State Univ., Corvallis, Ore.)

Nielsen, E. L., P. N. Drolsom and S. M. Jalal. Analyses of F_2 progeny from Bromus species hybrids. *Crop. Sci. 2:459-462. Nov.-Dec., 1962.* (Crops Res. Div., ARS, USDA, Madison, Wisc.)

Nielsen, E. L., M. R. Hanna and P. N. Drolsom. Fertility relations and analysis of F_1 progenies of Bromus species. *Crop. Sci. 2:456-458. Nov.-Dec., 1962.* (Crops Res. Div., ARS, USDA, Madison, Wisc.)

Schulz-Schaeffer, Jurgen and Peter Jurasits. Biosystematic investigations in the genus Agropyron. I. Cytological studies of species karyotypes. *Amer. Jour. Bot. 49(9):-940-953. Oct., 1962.* (Montana Agr. Expt. Sta., Bozeman)

Stafford, Helen A. Histochemical and biochemical differences between lignin-like materials in Phleum pratense L. *Plant Physiol. 37(5):643-649. Sept., 1962.* (Biol. Dept., Reed College, Portland, Ore.)

Whitehead, F. H. and P. J. Myerscough. Growth analysis of plants. The ratio of mean relative growth rate to mean relative rate of leaf area increase. *New Phytol. 61:-314-321. Oct., 1962.* (Botany Dept., Imperial College, London)

CHEMICAL COMPOSITION OF PLANTS AND ANIMAL NUTRITION

Dietz, Donald R., Robert H. Udall and Lee E. Yeager. Chemical composition and digestibility by mule deer of selected forage species, Cache la Poudre range, Colorado. *Colo. Game and Fish Dept. Tech. Publn. 14, 89 p. Dec., 1962.* (Colo. Coop. Wildlife Res. Unit, Colo. State Univ., Ft. Collins)

Ferguson, K. A. The relation between the response of wool growth and body weight to changes in feed intake. *Austral. Jour. Biol. Sci. 15(4):720-731. Nov., 1962.* (Div. of Animal Physiol., CSIRO. The Ian Clunies Ross Animal Res. Lab., Prospect, N.S.W.)

Johnson, R. R., Burk A. Dehority, J. L. Parsons, and H. W. Scott. Discrepancies between grasses and alfalfa when estimating nutritive value from In Vitro cellulose digestibility by rumen microorganisms. *Jour. Animal Sci. 21(4):892-896. Nov., 1962.* (Dept. Animal Sci. Ohio Agr. Expt. Sta., Wooster, Ohio)

Reid, C. S. W., J. W. Lyttleton and J. L. Mangan. Bloat in cattle. XXIV. A method of measuring the effectiveness of chewing in the release of plant cell contents from ingested feed. *N. Z. Jour. Agr. Res. 5(3 and 4). Su., 1962.* (Plant Chem. Div., Dept. Sci. and Indus. Res., Palmerston North)

Richards, C. R., G. F. W. Haenlein, M. C. Calhoun, J. D. Connolly and H. G. Weaver. Date of cut vs. the combination of crude fiber and crude protein as estimators of forage quality. *Jour. Animal Sci. 21-(4):844-847. Nov., 1962.* (CSESS, USDA, Washington 25, D. C.)

Shelton, M. Relation of one dry season to subsequent reproductive performance of fine wool ewes. *Tex. Agr. Expt. Sta. Prog. Rpt. 2238, 7 p. May, 1962.* (College Station)

Speth, C. F., V. R. Bohamn, H. Melendy and M. A. Wade. Effect of dietary supplements on cows on a semi-desert range. *Jour. Animal Sci. 21(3):444-448. Aug., 1962.* (Univ. of Nev., Reno, Nevada)

Stevenson, Audrey E. Measurement of feed intake by grazing cattle and sheep. VIII. Some observations on the accuracy of the chromic oxide technique for the estimation of faeces output of dairy cattle. *New Zeal. Jour. Agr. Res. 5(3 and 4):339-345. Su., 1962.* (Ruakura Animal Res. Sta., Dept. Agr., Hamilton, N. Z.)

Williams, C. H., D. J. David and O. Iisman. The determination of chromic oxide in faeces samples by atomic absorption spectrophotometry. *Jour. Agr. Sci. 59(3):381-385.* Div. Plant Indus. CSIRO, Canberra)

METHODS AND TECHNIQUES

Joblin, A. D. H. The use of grazing-animal observations in the early stages of pasture evaluation in the Tropics. I. The measurement of relative palatability. *Brit. Grassland Soc. Jour. 17(3):171-177. Sept., 1962.* (Dept. of Agr., Serere Expt. Sta., Uganda)

Shiue, Cherng-Jioun and H. H. John. A proposed sampling design for extensive forestry inventory: Double systematic sampling for regression and multiple random starts. *Jour. Forestry. 60(9):607-611. Sept., 1962.* (School of Forestry, University of Minnesota, St. Paul)

Smith, Arthur D. and Philip J. Urness. Analyses of the twig length method of determining utilization of browse. *Utah State Dept. Fish and Game Publication 62-9, 35 p. 1962.* (Range Management Dept., Utah State Univ., Logan)

Society of American Foresters, Committee on forestry research. An analysis of forestry research in the United States. *Jour. Forestry. 60-(12):863-871. Dec. 1962.*

Woolfolk, E. J. Identification marking of experimental animals. *U. S. Forest Serv. Pac. SW For. & Range Expt. Sta. Res. Note 205, 4 p. 1962.* (Berkeley, Calif.)

Yamaguchi, M., F. D. Howard, D. L. Hughes and W. J. Flocker. An improved technique for sampling and analysis of soil atmospheres. *Soil Sci. Soc. Amer. Proc. 26(5):512-513. Sept.-Oct., 1962.* (California Agr. Exp. Sta., Univ. of Calif., Davis, Calif.)

RANGE SOILS

Allmaras, R. R. and C. A. Black. Relative value of calcium metaphosphate and superphosphate as sources of phosphorus for plants on different soils. *Soil Sci. Soc. Amer. Proc. 26(5):470-475. Sept.-Oct., 1962.* (ARS, USDA, Morris, Minnesota)

Nimlos, T. V. and R. C. McConnell. The morphology of Alpine soils in Montana. *Northwest Sci. 36(4):99-112. Nov., 1962.* (School of Forestry, Montana State Univ., Missoula, Mont.)

Simpson, J. R. Mineral nitrogen fluctuations in soils under improved pasture in Southern New South Wales. *Austral. Jour. Agr. Res. 13(6):1059-1072. Nov., 1962.* (Div. of Plant Industry, CSIRO, Canberra)

Van Der Paauw, F. Effect of winter rainfall on the amount of nitrogen available to crops. *Plant and Soil XVI (3):361-380. Su., 1962.* (Inst. for Soil Fertility, Groningen, Netherlands)

NEWS AND NOTES

New Plant

Stock feeders and dairymen alike will have a chance to test a new annual grazing and green chop plant next spring. Called Trudan I, it is the first *true* sudangrass hybrid commercially available to farmers—and it promises some exciting results.

Producing the same economical, nourishing green feed for all classes of livestock that common sudangrass does, Trudan I has shown its hybrid vigor in out-yielding common sudangrass by 30 to 40 percent. The new hybrid has considerably faster regrowth after grazing or clipping, greater seedling vigor and lower hydrocyanic (prussic) acid content than sweet or green leaf sudangrasses.

Developed by Northrup, King & Co. after intensive research, the hybrid proved its performance in 1962 yield trials in this country. It can be grown wherever common sudangrass is grown. And it has consistently out-performed common sudangrass because of its tremendous vigor.

Notice

For several decades, the U.S. Forest Service has been publishing its research findings in a variety of ways. In order to simplify shelving and cataloging, all of the old series have been discontinued except for certain miscellaneous material such as annual reports and experimental forest guides.

Effective January 1, 1963, all research documents printed or processed by the Forest Service will be classifiable under one of these three categories:

1. A numbered series entitled *U.S. Forest Service Research Papers.*
2. A numbered series entitled *U.S. Forest Service Research Notes.*
3. A numbered series entitled *U.S. Forest Service Resource Reports.*

Each publishing research unit will be identified by a prefix before the number, and the numbers will follow in order of date of publication.

Prefixes for the various units are as follows:

NOR=Northern
PNW=Pacific Northwest
PSW=Pacific Southwest
INT=Intermountain
RM=Rocky Mountain
LS=Lake States
CS=Central States
NE=Northeastern
SO=Southern
SE=Southeastern
ITF=Institute of Tropical Forestry
FPL=Forest Products Laboratory
WO=Washington Office

Poly Royal

Poly Royal, the traditional open house event that attracts more than 15,000 visitors annually to the 3,000-acre campus of California State Polytechnic College in San Luis Obispo, is slated for April 26-27.

Carl "Gus" Beck is father of Poly Royal and chief advisor to the student executive board that annually sponsors the affair.

Student representatives from Cal Poly's Agriculture, Engineering, Applied Arts and Applied Sciences divisions are laying early plans for the gala 31st Annual Poly Royal.

On tap this year for visiting parents and the general public are numerous activities including a two-day National Intercollegiate Rodeo Association rodeo with some of the top college talent in the country; a three-game baseball series with San Diego State College; livestock judging contests; coronation ball, western dance, band concert, carnival and a whole host of other entertaining events.

The campus-wide open house will reveal Cal Poly's renowned "learn by doing" approach to education as more than 35 departmental displays and exhibits from the four academic divisions round out the Poly Royal agenda.

Medusahead Meeting

The annual weedy grass, medusahead (*Elymus caput-medusae* L. of our floras, *Taeniatherum asperum* (Simk.) Nevski more precisely), has become a very serious range pest in the Pacific Northwest in recent years. It has taken over on many ranges in the seasonally arid areas of the lower Columbia River, lower Snake River, and coastal mediterranean climates. Medusahead thrives on lands which have been occupied by annual grasses such as cheatgrass (*Bromus tectorum*) and soft chess (*Bromus mollis*) following destruction of the original plant cover by overgrazing and fire.

The first regional conference on medusahead was organized by *Min Hironaka* and met in Boise, Idaho on July 21 and 22, 1960. Some two dozen persons interested in control of the weed attended from Idaho, Washington, Oregon, California, and Nevada. Agencies represented included the respective state universities, agricultural experiment stations and extension services, the Forest Service, Bureau of Land Management, and Agricultural Research Service.

A second regional meeting was held at Davis, California on March 26 and 27, 1962. The same states and agencies in general were represented, but of the 23 men in attendance, 19 were new so many new personal contacts were made and old ones renewed.

Again, the first day was spent exchanging information. Use of fire, various herbicides, fertilization, reseeding, grazing management, and directed plant succession were presented and discussed as measures either of control or means by which the livestock industry can live with the plant. Everyone agreed the marriage would not be a perfect one. Perhaps the most provocative idea at this meeting was *Jim Street's* that the invasion of medusahead has given research and extension a gimmick with which to draw the range manager into a long-needed

program of range improvement. The idea was seconded by many of those present, but it was also pointed out that the invasion of medusahead is itself an unmitigated loss to the livestock industry comparable only to the previous invasion of cheat grass.

The second day *Bud Kay* showed most interesting field trials of medusahead range improvement using seeding of rose and sub clovers and Harding grass, fertilization, fire, and a very wide spectrum of herbicide applications.

Many of the data and ideas presented and discussed are appearing or will appear in this Journal, Weeds, Ecology, California Agriculture, etc. A list of the people attending is available to workers inadvertently missed or to new ones.

The meeting resulted in the direct demise of little medusahead, but all working on the problem now know what the overall problem is, what research is going on to solve it, to whom to turn for help on a particular phase, and that progress is being made both in understanding the problem and reducing it to manageable size.

The next medusahead meeting will be in conjunction with the Western Weed Control Conference in Portland.

Wilderness Areas Designated

Announcement of the reclassification of the former Anaconda-Pintlar Primitive area to full-fledged wilderness status was made in mid-December by *Orville L. Freeman,* Secretary of Agriculture. The new designation is in line with multiple use management of the national forests and the preservation in their natural state for present and future Americans those areas most suitable for recreation and scenic enjoyment.

Situated in the Deerlodge, Bitterroot and Beaverhead National Forests, about 25 miles south of Butte, the 159,000-acre area should have special appeal to persons wishing to enjoy short wilderness trips as well as those of longer duration. Ranging from 6,100 feet to 10,475 feet in elevation, the Anaconda-Pintlar Wilderness Areas has striking scenery, timbered slopes, meadows, streams and lakes. Its animal life includes mountain goats, elk, moose, mule deer, wolverine, black bear, and many other species of mammals and birds.

More recently, *Secretary Freeman* proclaimed establishment of the Selway-Bitterroot Wilderness Area, comprising nearly 1¼ million acres in four National Forests of Idaho and Montana and the largest wilderness area yet established in the Nation. Left in primitive classification, pending further study, are 216,000 acres south of the Magruder Road. This new wilderness area lies within the Lolo, Bitterroot, Clearwater and Nezperce forests. It encompasses the crest of the Bitterroot Mountains for about 30 miles, a 45-mile section of the Selway River, the Selway River Canyon, many beautiful mountain lakes, and much wild forested country. Summer range for one of the largest elk herds in the country, it is extensively used for big game hunting.

Proposed Legislation

Senator Clair Engle (D-Calif.) is preparing legislation to authorize a Channel Islands National Seashore off the coast of Southern California. The bill would promote wildlife conservation on all the islands, which are the home of elephant seals and many sea bird rookeries and would make possible their development for public recreation. Recreational uses include camping, swimming, fishing, hiking, yachting, nature study and possibly summer cabin leases.

The proposed park would include all or parts of Santa Rosa and Santa Cruz Islands and possibly San Miguel and San Nicholas Islands. It would also include two small islands that are presently national monuments — Anacapa and Santa Barbara Islands.

Senator Engle is formulating his proposal with the assistance of the National Park Service. He also has been in touch with the Navy with respect to San Miguel which is held as a Naval Petroleum Reserve and a possible missile site. He said that the Navy and the Park Service have been working on a proposed plan to provide some recreational use on San Miguel — irrespective of the Senator's plan.

Motorized Range Seeder

Here is a "Jeep" seeder combination that does the job and is easy to operate. It is a "Cyclone" type mounted in a box and is powered with a small electric motor wired to the car battery. The control switch is on the dash where the driver can easily control the seeder.

Although it is used currently in seeding strip mines in eastern Kentucky, it could be used by ranchers and farmers for broadcasting grass and legume seed or pelleted fertilizer.

It is mounted on the rear of the Jeep so it will swing 90° in order to throw the seed down the slope or in places difficult to reach by the driver.

The seeder can also be adjusted for sowing tree seeds such as pine.

For more information, contact C. K. Spurlock, Field Director for the Kentucky Reclamation Association at Cawood, Kentucky.

Field Day Planned

On April 4, a field day open to the public will be held at the San Joaquin Experimental Range, 28 miles north of Fresno, California on highway 41. Current research on grazing management of fertilized and unfertilized range, cooperative research with the University of California on radioactive sulfur fertilizers, and new techniques in range sampling and data processing will be covered.

This will be the second public showing of the new research program started in 1959. The field day is being co-sponsored by the San Joaquin Advisory Board and the Pacific Southwest Forest and Range Experiment Station, U.S. Forest Service.

Wilderness Trips Announced

The Wilderness Society of Washington, D.C., has announced its new schedule of summer and fall trips into Western wilderness areas. Seven trips, 10 to 12 days in length, are offered for the public during the summer months of June through September.

The wilderness trip program, described by the Society as "A Way to the Wilderness," is "designed to provide an opportunity for those who seek to visit some of the Nation's outstanding areas of wilderness." The Society points out that dozens of people of all ages—individuals, groups, and families with children—have enjoyed these trips in the past. They offer wilderness

living, unsurpassed scenery, wildlife and nature study opportunities on a horseback tour with stops and layovers at beautifully situated "high country" camps. The Society is sponsoring the trips for the fourth year as a not-for-profit venture under the direction of Don Clauser, noted wilderness trail rider of Santa Fe, New Mexico, who has served wilderness vacationers in the West for the past ten years.

The 1963 trips will take vacationers to the following wilderness areas: Pecos in the Sangre de Cristo Mountains, New Mexico, June 10 to 19 and September 17 to 26; Selway-Bitterroot, Idaho and Montana, July 15 through 26; Teton and Yellowstone, Wyoming, July 15 to 26; Bob Marshall of Montana, August 5 to 16; Flat Tops of Colorado, August 15 to 25; Rio Grande and San Juan of Colorado, August 12 through 25. Costs for the trips range from $237 to $310.

Reservations may be made with Don Clauser, Director, A Way to the Wilderness, P.O. Box 1229, Santa Fe, New Mexico. Information and copies of the free illustrated brochure also are available from Mr. Clauser or The Wilderness Society, 2144 P Street, N.W., Washington 7, D.C.

Closing Dates for NSF Research

The National Science Foundation announces the next series of closing dates for receipt of proposals for:

1. Basic Research
   Life Sciences—May 15, 1963
   Social Sciences—May 1, 1963
2. Renovation and Construction of Graduate-level Research Facilities—April 1, 1963. (Departments of institutions are eligible to apply for assistance if they offer at least the master's degree in the life, social, or physical sciences, including mathematics and engineering.)

Proposals received prior to these dates will be reviewed and notification of the Foundation's action will be made within four months. Proposals recevied after these dates will be reviewed following the fall closing dates (Life Sciences, September 15; Social Sciences, October 1; Graduate-level Research Facilities, August 1).

Inquiries or proposals requesting support should be addressed to the National Science Foundation, Washington 25, D.C.

Latin American Conference

The "Latin American Conference for the Study of Arid Regions" will be held under the auspices of UNESCO in Buenos Aires, Argentina, from September 16 to 21, 1963.

The tasks of this conference covering the study of arid regions will be devoloped via six principal and major areas or systems as follows:

1. Reports from individual nations.
2. Plenary sessions.
3. Symposia (work sessions).
4. Round tables (study sessions).
5. Conferences
6. Scientific and technical communications.

Each Latin American country which is faced with problems of aridity will prepare and present a report at the Buenos Aires Conference.

Subjects to be considered in Plenary Sessions include:

1. Importance of the agrarian structure in the development of arid zones.
2. Economic development of arid zones.
3. Influence of internal and international commerce on the production of raw materials and the industrialization of arid zones.
4. Methods recommended to undertake the study of Latin American arid zones.

Subjects to be considered in the Work Sessions are:

1. Agriculture in arid regions.
2. The water economy as related to the vegetation of arid regions. Resistance to drought and salinity.
3. Management of plant communities in arid zones.
4. Management of watersheds in arid regions.
5. Human problems in arid zones.
6. Possibilities, methodology and coordination of interdisciplinary studies in arid regions.
7. Criteria for the defining of aridity.

Subjects to be considered in the Study Sessions are:

1. Grazing land and range management of grazing lands in arid zones.
2. Plagues as aggravating factors in desertization.
3. Erosion in arid zones.
4. Land use in arid zones.
5. Exploitation of subterranean waters in arid zones.
6. Soil and water conservation in arid zones.
7. Saline and alkaline lands. Genesis, evolution and management.
8. Evapo-transpiration in arid regions.

Each day during the Conference there will be a basic conference on one of the following titles:

1. De-salinization of water.
2. Planning and management of water use in arid zones.
3. Vegetation as an indicator of hydrological equilibrium.
4. Hydroponic and geoponic cultivation.
5. Meteorological problems.

It will be of great value to all to know schematically the work in progress as this will assure the availability of an inventory and catalogue of the works and tasks which are being realized of a scientific technological nature which are related to arid and semi-arid lands and zones. Useful too will be a list of individuals and work areas covered by these specialities. To accomplish this it is requested that resumes (limited to 500 words) be sent relative to all investigations, research, and work being realized at present in Latin America. All contributions received will be catalogued and printed, and listed alphabetically and geographically by subject and author. This task should be finished prior to the Conference in Buenos Aires so that it will not interfere with nor require time devoted to the Conference—this being the case the 30th of June has been established as the last date for the receipt of these communications in Buenos Aires. There will be no extension of this date.

Change of Address

Dr. Robert A. Darrow, a director of the American Society of Range Management, and professor in the Department of Range and Forestry at Texas A & M College, recently became Branch Chief, Crops Division, Army Biological Laboratories, Fort Detrick, Maryland. Bob's new home address is Route 7, Box 323, Frederick, Maryland.

Bernhard Promoted

Lloyd L. Bernhard has been appointed Assistant Regional Forester in charge of Watershed Management and Multiple Use Planning for the California Region of the U.S. Forest Service. He will fill the vacancy created by the November death of *Lloyd R. Rickel.* Regional Forester *Charles A. Connaughton,* in making the announcement, said that *Mr. Bernhard,* who is presently in the Range and Wildlife Division in the California Regional Office, assumed his new duties February 3.

Mr. Bernhard brings 29 years of Forest Service experience to his new job. He started in 1934 as a range technician in Montana where he held various jobs in the field of range management until he was promoted and transferred to the District Ranger position on the Okanogan Ranger District on the Okanogan National Forest in Washington. Later he served as District Ranger on the Chelan National Forest in Washington and as Range Staff Officer on the Malheur National Forest in Oregon.

As Assistant Regional Forester, *Bernhard* will be in charge of the watershed management work in the National Forests of California. In addition, he will coordinate multiple use planning on the National Forests. Multiple use is the basis of National Forest management.

In his previous position, which he occupied since 1956, *Mr. Bernhard* was in charge of the range management section of the Division of Range and Wildlife Management. In that job, he coordinated the grazing activities on California's National Forests. His successor has not been named. He is a charter member of the American Society of Range Management.

Ensminger Moves

Dr. M. E. Ensminger, Chairman, Department of Animal Science, Washington State University for 21 years, resigned September 1 and is now conducting a consulting service called "Agriservices" from headquarters in Clovis, California. Agriservices offers to (1) translate research into practical application, (2) sift out and correlate the latest in current developments, (3) tailor programs to specific enterprises, (4) complement existing university, state and federal programs, (5) provide counsel for the conduct of independent research and (6) create a better image for its clients through improved public relations. *Ensminger* is a member of the American Society of Range Management and has recently transferred to the California Section.

ASRM Member Becomes Governor

Cliff Hansen, regular member of the Wyoming Section, ASRM, since 1957, conducted a successful campaign for Governor of Wyoming prior to last fall's election. *Hansen* is a native of Wyoming, born in Jackson Hole in 1912. His parents, Peter and Sylvia Hansen came to Jackson Hole in 1897, and homesteaded. Cliff's father, appointed by Governor Carey, helped organize Teton County and later served in the State Senate. *Cliff Hansen* attended grade and high schools in Jackson and graduated from the University of Wyoming in 1934. The Wyoming Section is proud to list *Governor Hansen* as a member.

Johnston Returns

Alex Johnston, Research Station, Lethbridge, Alberta, returned from an FAO assignment to West Pakistan in November. While in Pakistan, he and his counterpart, *Ijaz Hussain,* prepared a "West Pakistan Range Management Guide" which was patterned after the range manual developed by the Committee for Co-operation With Youth Groups, ASRM. The authors hope that it will be used in training programs and as a field tool by technicians. They also prepared a "Handbook of Range Research for West Pakistan" which was designed to help the technical workers of the country in their range program. Alex worked for about a month with *Norman H. French,* ASRM member, who is presently in West Pakistan on an AID mission.

Goebel Receives Fellowship

Dr. Carl J. Goebel, assistant professor of forestry at Iowa State University, was awarded a Bullard Fellowship in Natural Resources for postdoctorate study at Harvard University Graduate School of Ppblic Administration. The fellowship is a memorial to Charles Bullard and carries a stipend up to $15,000 for a year of study and research.

A native of Wisconsin, *Goebel* studied at the University of Wisconsin, University of Idaho and at Utah State University. He was employed by the U.S. Forest Service and the Bureau of Land Management before assuming teaching duties at Iowa. *Dr. Goebel* is a member of the American Society of Range Management, the Society of American Foresters, Xi Sigma Pi and Sigma Xi honorary fraternities.

Murphy Receives Grant

James L. Murphy, Research Forester, Pacific Southwest Forest and Range Experiment Station, Forest Service, received a Sigma Xi grant-in-aid award of $400 to assist his study of conflagration control on forest lands in the Sierra Nevada. *Murphy* received both the B.S. and M.S. degrees at Utah State University and is scheduled to complete requirements for a PhD. at the University of Michigan in June.

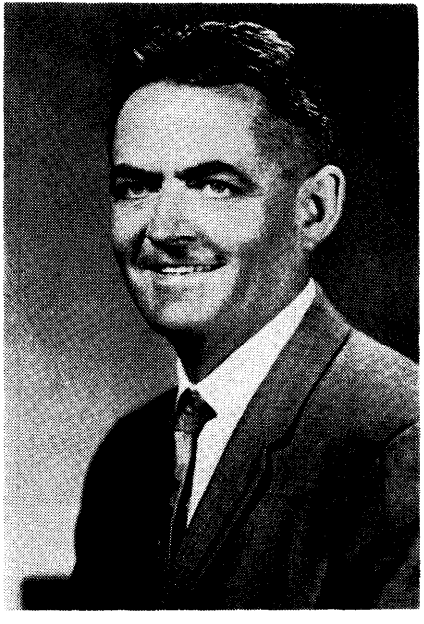
Personnel Changes

Regional Forester *Floyd Iverson,* U.S. Forest Service, has announced important personnel changes in the Intermountain Regional Office Staff.

Mr. Leon R. Thomas, Chief of the Division of Watershed and Multiple Use, will transfer to Washington, D.C., as Special Assistant to Deputy Chief *Arthur W. Greeley,* in charge of Multiple-Use Planning and Coordination.

Mr. Gordon L. Watts, presently Assistant to the Deputy Chief of the Forest Service in charge of Program Planning and Legislation, Washington, D.C., will head up the Watershed and Multiple-Use Division for the Intermountain Region.

Mr. Thomas, who transferred from the Southern Region, Atlanta, Georgia, was the Intermountain Region's first chief of the Watershed and Multiple-Use Division which was established on September 19, 1960.



His background includes a degree in Forestry from the University of California in 1936 and progressive employment since with the Forest Service, excluding World War II, when he was a signal corps captain in England, France, and Germany.

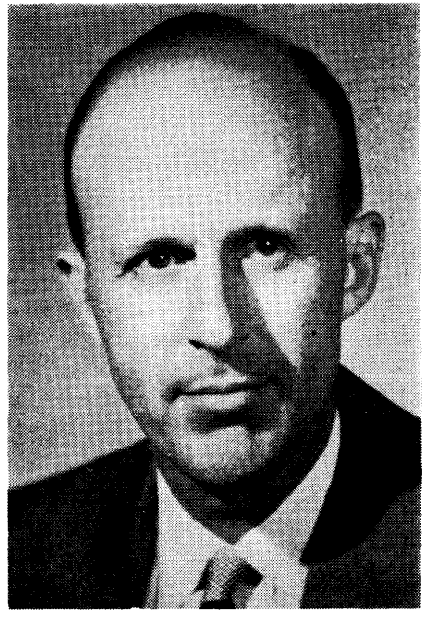
During the early years of his Forest Service career, *Mr. Thomas* worked in the California Region first as a field assistant, then progressed upward through the Ranger position to staff assistant in Fire Control, and later Forest Supervisor on the Mendocino and the Sierra National Forests. In 1957 he was named Chief of the Division of Fire Control for the Southern Region in Atlanta, Georgia. In 1958 he organized and headed up a new Division of Watershed, Multiple Use, Range and Wildlife in that Region. He transferred to the Intermountain Region, Ogden, Utah, as Chief of the Division of Watershed and Multiple Use at its origin in 1960.

Gordon L. Watts began his career with the U.S. Forest Service as a Field Assistant at the Northern Rocky Mountain Forest and Range Experiment Station, Missoula, Montana, the summer of 1937. The following summer, he worked for the Appalachian Forest Experiment Station, Asheville, North Carolina.

Mr. Watts graduated in Forestry from the University of Michigan in 1941. He was appointed Agriculture Aid in the U.S. Soil Conservation Service at Griffin, Georgia, in October 1941.

From February 1942 to March 1946, he served in the United States Army.

Mr. Watts first worked in the Intermountain Region as a forester on the Boise National Forest in Idaho



in February 1946. In January 1949, he was promoted to Ranger on the Idaho City District of the Boise National Forest. He was Assistant Supervisor of the Challis National Forest in Idaho in March 1951, and was promoted to Supervisor of the Targhee National Forest in August 1955.

In September 1959, he became Assistant to the Deputy Chief of the U. S. Forest Service in charge of Program Planning and Legislation, Washington, D.C. *Mr. Watts* is a son of the late *Lyle F. Watts*, a former Chief of the U.S. Forest Service.

WITH THE SECTIONS

ARIZONA

The annual winter meeting of the Arizona Section was held at Nogales, Arizona and Sonora, Mexico January 17 and 18, 1963. Registration totalled 158. The theme of the meeting was: "Game Management as a Phase of Range Management." Formal papers including the effects of fire on wildlife and wildlife habitats, need for a wildnerness program, legal aspects of hunting on public lands, and the effects of various game practices on rangelands were presented on January 17.

The Friday program was arranged by our good friends and neighbors in Sonora, Mexico. Five buses provided transportation for a tour of the Agua Zarca Ranch south of Nogales, Sonora. Later the group inspected the facilities at the quarantine station and witnessed the procedure used for dipping animals in toxaphene before they enter the United States. Our Mexican hosts also provided a fine barbecue for the 150 people on the tour.

At the banquet on Thursday evening awards were presented to three

individuals for outstanding achievements in range management. *Billie*

Riggs was honored as Arizona's 1962 "Range Management Man of the Year." He was particularly commended for having an excellent reserve feed supply in a dry year. *H. E. Wall, Jr.,* an SCS employee, received a plaque for his work in establishing soil and water conservation plans on ranches in central and northern Arizona. Also, *Henry Boice* was awarded a plaque honoring him as a pioneer rancher whose devoted interest and outstanding leadership have furthered the cause of sound range management practices.

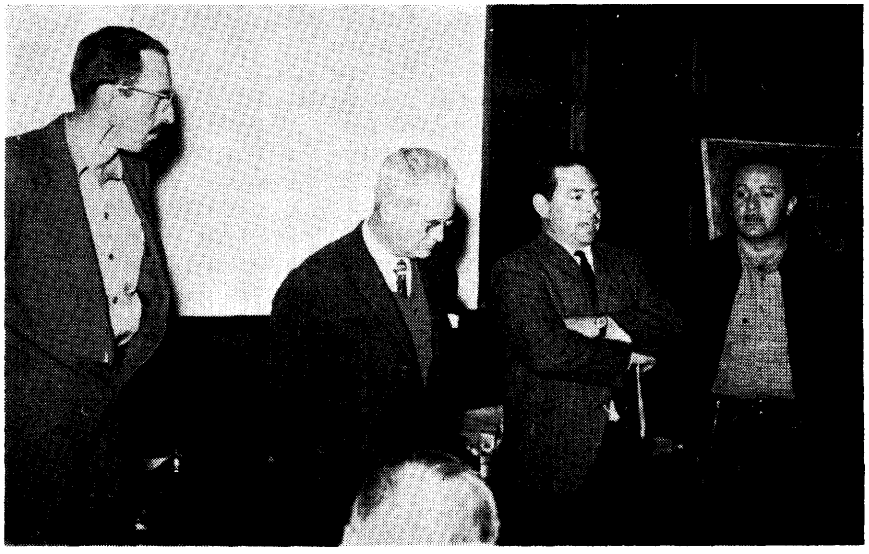
New officers installed for 1963 included: *J. T. Rigden,* President; *Fred H. Tschirley,* Vice President; *Truman C. Anderson.* Sec.-Treas.; *H. E. Wall, Jr.,* Councilman South and *Paul Riggs,* Councilman North. *Darwin Anderson* and *Ted Lee* are the holdover councilmen.

MEXICO

With a very interesting program, the Mexico Section celebrated its Fifth Annual Reunion the 4th of January, at the conference room of the beautiful Livestock Union building in Chihuahua, Mexico.

During this reunion, new officers were elected for the 1963 preiod. They are *Martin H. González,* President; *Guillermo H. Dominguez,* Secretary-Treasurer; and *Guillermo Falomir* and *Miguel Márquez* for two year directors. One year directors are *Joseph L. Hearn* and *Jesus Almeida N.*

Armando Raynal, past-President, informed about the activities of the Mexico Section during the last year. The program also included talks by *Gilberto Valdez,* on the reseeding program on his ranch; *Dr. John A. Pino,* director of the Centro Nacional de Investigaciones Pecuarias and the Rockefeller Foundation, talked about



the organization of this new organism which will be in charge of all the range improvement programs for Northern Mexico.

Martin H. González informed about the creation of the scholarship fund of the Mexico Section, which received an initial contribution from *Dr. Morton May,* Wyoming Section, during his recent visit to Chihuahua.

Dr. Ned S. Raun, animal nutrition specialist also of C.N.I.P. and *Dr. Hank Tunnesson,* FAO forage specialist commissioned in Mexico, participated in the program with interesting papers.

Plans were made to attend the Society meetings in Rapid City and seven new members were recruited for the Mexico Section during this reunion. The future of the Section looks bright for the coming year.

NEVADA

The twelfth annual business and technical meeting of the Nevada Section ASRM was held January 9-10, 1963, at Elko, Nevada. Some 85 range managers, technicians, students, professors, and ranchers attended, making this one of the largest meetings held to date, Section Chairman *Charles Saulisberry* stated.

January 9th was devoted to a business meeting. *Royal Holl* of Las Vegas was elected Vice-Chairman, and *Fred Harris* of Elko will carry on the Section Chairmanship for 1963. Of primary importance at this business meeting was the discussion and planning for the 1965 parent society's annual convention which will be requested to be held in Nevada. The section's June field trip will be conducted in White Pine County, and the 1963 annual meeting will be at Fallon. Later during the evening a friendly social "get-together" was enjoyed at the Star Hotel where refreshments and a Basque style dinner were enjoyed by all members present.

January 10th witnessed an active program of philosophical, educational, and technical papers on range management under the program chairmanship of *Fred Harris. George A. Judah,* Vice President and Chief Appraiser of the Utah Mortgage Loan Corporation, Logan, Utah, led the agenda with the first paper entitled "Ranch Values and the Economic Relationship of Western Livestock Ranchers." Next was *William F. Schroader,* Attorney at Law from Vale, Oregon, who spoke on "The Price of the Manifest Destiny." *Roger Smith,* Vice President, Nevada Cattle Association, Ruby Valley, Nevada, followed with a brief resume of the Association's past accomplishments and future objectives. *Stanley Ellison,* President, Nevada Woolgrowers Association, Elko, Nevada, spoke on the present status of the Association. *Dr. D. I. Rasmussen,* Forest Service Wildlife Expert, Ogden, Utah, presented a paper dealing with past big game-range management problems in the Jackson Hole, Wyoming, and Kaibab, Arizona areas.

After lunch the program continued with *Dr. Joseph H. Robertson,* Range Management Professor, University of Nevada, reporting on his trip to South America where he studied range management practices.

Robertson's talk was accompanied with many colorful and interesting slides.

Next *Jim Yoakum,* Wildlife Specialist for the Bureau of Land Management, Reno, presented an illustrated slide lecture on "Game-Range Improvements on the National Land Reserve." *Mike Kilpatrick,* Range Specialist for the University of Nevada, followed with a stimulating report on the objectives, accomplishments, and future plans of the Section's Summer Range Youth Camp program.

During the evening a banquet was held with the very apt and skilled *Dr. Joe Robertson* as Master of Ceremonies. Highlights of the banquet were (1) the collecting of some $80 for the Section's scholarship fund, (2) a report by two attendees from the 1962 Section's Summer Youth Camp, and (3) announcement of the Section's Range Man of the Year Award. *Walter (Butch) Gouoechea* from Elko and *Joe Sastachia* of Lamoille were the youths present who discussed their range management knowledge obtained, conservation values received, and personal experiences gained at the last Summer Range Youth Camp.

Then came the announcement of the Section's honored NEVADA RANGE MAN OF THE YEAR AWARD to *EMERY CONWAY,* local rancher from Caliente, Nevada. A

testimonial of Emery's range management practices, accomplishments, and interests states:

"For two years you have been president of the Nevada Association of Soil Conservation Districts. Your sincere assistance has helped the nearly 40 Nevada Districts advance their district programs in the adoption of many range management practices. In this work you spent many days away from the ranch amounting to approximately three days per month. Your travels took you to most of Nevada's communities and to many adjacent states. Your work in behalf of the National Associations of SCD's Public Lands Committee has been very valuable.

"You have served with the Bureau of Land Management as a member of the Las Vegas District Advisory Board for ten years and as an alternate to the BLM's State Advisory Board for several years. The BLM reports your assistance and counsel has been most helpful.

"You practice what you preach—as the work you accomplish on your own land in 1962 testifies the following: 100 acres leveled, one irrigation well developed, two miles of irrigation ditches completed, three miles of stockwater pipeline constructed, and the enlargement of one stockwater reservoir.

"You believe in developing and improving your individual grazing allotment on the national land reserve. You have worked with the BLM over the years so that the allotment your livestock graze in is now practically enclosed by 50 to 75 miles of fences. Within this grazing allotment, pasture fences totaling another 15 miles are now underway. You have cooperated with the BLM in a 1500-acre range seeding by contributing part of the seeding cost and aiding in the construction of protection fences. A new seeding of some 5,000 acres was just started this year in which you again cooperated with the Bureau. You practice rotational livestock grazing on these rangelands by controlling use of the waters.

"In view of this and many other advancements in the science and art of range management, the Nevada Section of the American Society of Range Management honors you, *Emery Conway,* as Nevada's Range Man of the Year for 1962."

In the photo *Tom Turner,* on behalf of the Nevada Section of the ASRM, presents the "Nevada Range Man of the Year Award" to *Emery Conway,* local rancher of Caliente, Nevada.

NORTHERN GREAT PLAINS

Twenty-two Montana members along with 24 guests met October 5, 1962 at Bridger, Montana for a fall tour.

First stop on the tour was the Soil Conservation Service Plant Materials Center located 3½ miles southeast of Bridger. This center was started in 1959 as a result of recognized need for evaluating and initially increasing native forage plants and trees for re-establishment on lands in Montana, Wyoming and the western Dakotas. *Mr. Ashley Thornburg,* Plant Materials Center manager, conducted the group on a 2-hour tour of the Center. The group looked at and discussed grass plantings and tillage, harvesting, seed cleaning and processing equipment.

After a coffee break, the group traveled to the Forest Service ranger station on Sage Creek for lunch.

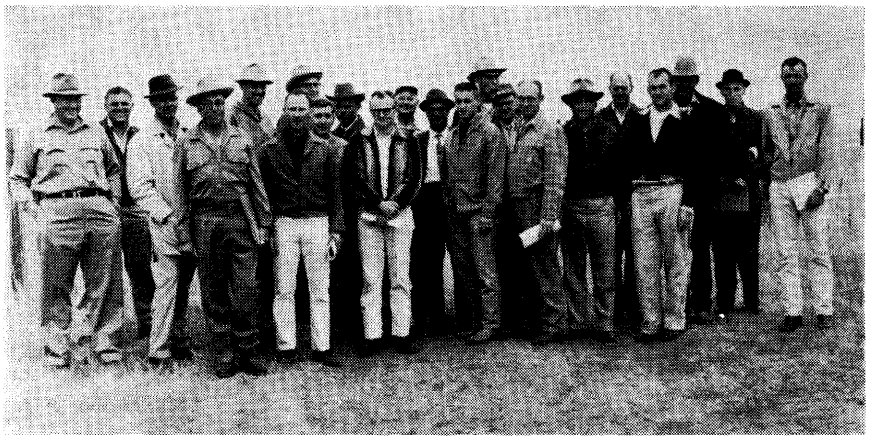
The next stop was on Crooked Creek where Forest Service sagebrush spraying and range resting results were considered. The work was discussed by *Mr. Jack Royle* and other Forest Service personnel. From there, the group traveled across National Forest lands to adjacent Bureau of Land Management lands to view a large livestock exclosure. An unusual sight nowadays, a small herd of wild horses, was seen enroute. *Wayne Wilde,* BLM manager discussed the vegetation of the exclosure and answered questions.

BLM water developments and halogeton weed problems were considered at stops made on the way back to the highway at Warren, Montana. Another stop was made on a cooperative Montana Highway Department and BLM roadside and borrow pit grass seeding. This seeding was put in to control halogeton invasion.

The last stop was to see Carbon Soil and Water Conservation District —BLM grass identification plot.

The North Dakota membership conducted its first fall field trip on October 6, 1962. The general enthusiasm of those participating will no doubt nurture this small beginning to an annual affair.

Eighteen members (50 percent of the total North Dakota membership) and six guests toured the grazing studies at the Northern Great Plains Field Station, Mandan, North Dakota. *George A. Rogler* and *Russell J. Lorenz,* ARS Research Agronomists, spoke at various stops and answered numerous questions. Of



particular interest was a new experiment involving various methods of grazing management on Russian wildrye. Cattle were still grazing a pair of pastures deferred for late fall use.

The remainder of the morning was spent in looking over the fertilized crested wheatgrass and fertilized native pastures. Discussion of relative merits of various grazing practices followed and continued during the noon luncheon in Mandan.

A short business meeting was called after lunch. *Hugh E. Cosby,* SCS, NGP Section Vice-president, presided. During the discussion which followed, the members present expressed a desire to continue gathering for an annual fall field trip by states or provinces. *Kenneth Dohrmann* and *Emil Zimmerman,* two rancher members present, expressed the belief that if ranchers once attended a field trip similar to this one, they would make every effort to attend thereafter, because this is what the ranchers are interested in.

Dr. Warren Whitman, Botany Department, NDSU, spoke briefly following the business meeting. "Doc" was formerly editor of the Journal.

The tour resumed following lunch. The effects of fertilizer on native range were looked at and discussed in much detail. Rain kept the group under a shelter during a discussion of the long-time intensity of grazing studies, but a short excursion was made into the heavily grazed pasture between showers. An interesting discussion of the aims and goals of the grass breeding program at Mandan was presented by *Dr. Herbert Schaaf,* ARS, at the last stop on the tour.

The Canadian members held their first annual meeting in Regina, Saskatchewan on November 23.

Eighteen members (75 percent of the members) and sixteen guests attended the one-day session. The program theme was "Range Administration in Saskatchewan" and was designed to acquaint the members with the place and policy of the Federal and Provincial Governments in range and pasture administration.

Speakers included *H. Hargrave,* Chief, Agricultural Division, Prairie Farm Rehabilitation Administration; *A. M. Thompson,* Head, Land Branch, Saskatchewan Department of Agriculture; *P. O. Moen,* Assistant Director, Conservation and Development Branch, Saskatchewan Department of Agriculture; and *W. H. Horner,* Deputy Minister of Agriculture, Saskatchewan.

M. J. Fitzgerald, Director, Prairie Farm Rehabilitation Administration, also was in attendance.

Some interesting facts about grazing lands in Saskatchewan indicate the importance of range management in that Province.

PFRA Community Pastures administer about 1,500,000 acres which provide summer grazing for 133,000 cattle owned by over 7,000 patrons. These figures include pasture units in Manitoba and one unit in Alberta.

The Saskatchewan Lands Branch estimates that there are 7,870,000 acres of provincial grazing lands (including the 1,500,000 acres of PFRA land) plus some 16,627,000 acres of private land available for grazing. The provincial grazing lands other than PFRA are chiefly in grazing leases (5,392,000 acres) but there are also cooperative and municipal pastures (550,000 acres) and provincial community pastures (375,000 acres).

Saskatchewan Provincial Government grazing lease rentals presently are:

	Land Class	Carrying Capacity	Rental per acre
85-90% of total	(1	less 5 animals/quarter	5.5¢
	(2	6-8 animals/ quarter	6.5¢

The present PFRA grazing charge is estimated at $6.07 per animal per season. It is expected that this might be raised in the near future.

The committee in charge consisted of *T. L. Jermyn, T. Townley-Smith, S. Smoliak* and *Robert W. Lodge.* The attendance at this first meeting, and the expressed interest in local meetings seemed to justify this effort. A committee headed by *Dr. Lodge* plans to evaluate this meeting and make recommendations for future area meetings.

U.S.U. Student Chapter

The Utah State University Student Section has enjoyed an active and interesting fall quarter. To start the ball rolling, *John W. Deinema,* Placement and Employee-Management Relations Specialist for the U.S.F.S. at Ogden, Utah, was the guest speaker. He elaborated on the opportunities of employment for permanent and temporary personnel with the Forest Service, also advancements and benefits connected with employment. At the November meeting *R. D. Nielsen,* State Director of the B.L.M., also spoke on employment, enlarging upon seasonal and career opportunities with the B.L.M. A large turnout, including many guests, was enjoyed by both speakers.

The December meeting was held at the home of *Dr. D. L. Goodwin,* and after a short business meeting, slides of the senior range field trip were shown. Following the meeting donuts and Providence apple cider was enjoyed by members and their wives.

The annual Utah Rancher of the Year award was presented to *Charley Redd* of La Salle, Utah, at the annual Society meeting in Salt Lake City, on January 15. In the absence of student chairman, *Dan Bromley,* the award was presented by Sec.-Treas. *Don Schmidtlein* at the luncheon in the Newhouse Hotel.

The guest speaker for January was

Oliver Johnson, president of the local Cattlemen's Association. He discussed the goodwill trip taken by a group of ranchers, representing the U.S. government, to Russia during the summer of 1962. Russian agricultural methods were discussed in detail and with interest.—*Donald W. Schmidtlein.*

WYOMING

During 1962 we picked up several new members but also had several transfers into and out of the section. On the whole, membership increased and the total now stands at 169 compared to 161 during 1961. Of this 1962 total, 131 are regular members, 13 faculty and staff and 25 are students.

The scholarship fund is continuing to grow, with new goals set for each year. The goal of $3,000 for 1962 was met and up to January 15, 1963 had reached $3,115.65. The 1963 goal is $4,000 and under the dedicated guidance of *Dr. A. A. Beetle* will be accomplished. The 1962 recipient will be announced at the annual meeting.

During 1962 the section issued seven Newsletters and eleven Range Management Notes. A section meeting was held in July 1962 at the Pilot ranch near Douglas. Highlights of this meeting were the lamb breakfast, a report of research on animal movements and habits as related to vegetation types, topography and climatic factors, trials by U.S. Steel representatives on types and methods of fencing, a panel discussion by ranchers and members of State and Federal agencies and the banquet with guest speakers and movies on range management.

In June five members gave instructions in range management to 40 students at the 4-H Camp. Instructions given included soil-range relationships, range-wildlife relationships, use of exclosures, range plant identification, range survey methods, water spreading, sagebrush spraying, and many other range management and improvement practices. The student section was active with two spring meetings, one in April for the election of officers and one in May at which slides and movies of the spring range trip were shown and narrated. Fall meetings were held in September and November. A turkey shoot was sponsored by the student section in November. Even though a snowstorm struck on the day of the shoot, $42 profit was realized. This money goes to the range judging team participating at the national meeting.

LETTERS TO THE EDITOR

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Dear Sir:

I wish to become a member of your Society. Would you please send me your formal application for membership and statement of dues?

I am employed as Management Officer with the New Zealand Tussock Grasslands and Mountain Lands Institute, which is based at Lincoln College—the agricultural department of the University of Canterbury. My duties are the assumption of responsibility for investigating and advising on problems of range management, and co-ordinating the work of the field officers of Government and local agencies associated with these lands. Their extent is some 12 million acres of occupied and 28 million acres of unoccupied (mountains) land in the South Island of New Zealand. There are also a few hundred thousand acres of this land in the North Island.

For your information, the Institute was set up in 1960 by the New Zealand Government, in conjunction with the Meat & Wool Boards, to investigate the management of tussock grasslands and mountain lands; develop techniques for their protection; and co-ordinate or promote research for their improvement.

From time to time the Institute publishes a "Review" containing articles dealing with rangeland, for distribution mainly to graziers, and has recently produced the first of a series of special publications which will deal with particular facets of grazing land research and management.

I am sure, therefore, that the interests of your society are closely interwoven with our own.

I trust you will give my application your favourable consideration.

Yours faithfully,
J. G. Hughes
Management Officer.

COMMON NAMES FOR GRASS GENERA[1]

ALAN A. BEETLE

Twenty years have passed since publication of the second edition of "Standardized Plant Names," prepared for the American Joint Committee on Horticultural Nomenclature by Harlan P. Kelsey and William A. Dayton (J. Horace McFarland Co., 1942). Most of the common names for grass genera published here are commonly accepted in range literature. The following list includes either additions to or suggested changes in the basic list to be found on pages 278-288 of "Standardized Plant Names."

Aciachne	- Andesgrass
Acroceras	- Nilegrass
Aegilops[2]	- Goatfacegrass (Goatgrass, as recommended by S.P.-N., is an unfortunate shortening of the real Old World common name.)
Aegopogon	- Relaxgrass
Aeluropus	- Elurope
Alloteropsis	- Bugseedgrass
Ampelodesmos	- Vinereed

Ancistragrostis - Hookawngrass
Anthephora - Borseltjiesgrass
Apera - Windgrass
Arctagrostis - Articgrass
Arrhenatherum[2] - Falseoat (Helictotrichon is the preferred name for oatgrass.)
Arthraxon - Arthraxon
Arthrostylidium - Blowgrass
Arundinella - Canuela
Bewsia - Bewsgrass
Bothriochloa - Sourgrass
Brachelytrum - Shorthusk
Catapodium - Ferngrass
Chloridion - Gilstongrass
Dichelachne - Plumegrass
Dielsiochloa - Dielsgrass
Digraphis - Hardinggrass
Diplachne - Swampgrass
Ehrharta - Veldtgrass
Ekmanochloa - Ekmangrass
Epicampes - Deergrass
Eremopyrum - Falsewheatgrass
Erioneuron - Falsetridens
Fingerhuthia - Kalkgrass
Garnotia - Patiluk
Gigantochloa - Giantgrass
Gilgiochloa - Gilgigrass
Gouinia - Gouingrass
Guadua - Otate
Hakonechloa - Hakongrass
Harpochloa - Harpgrass
Helictotrichon - Oatgrass
Homolepis - Comino
Humbertochloa - Humbertgrass
Hymenachne - Dal
Hyparrhenia - Thatchinggrass
Isachne - Isachne
Ischaemum - Krulgrass
Ixophorus - Mexicangrass
Jouvea - Dunegrass
Lasiacis - Tibisee
**Lolium* - Darnel (Ryegrass tends to suggest Hordeae; use of the Old World common name would speed recognition of the correct alignment of this genus.)
Massia - Massia
Metcalfia - Metcalfgrass
Microlaena - Weepinggrass
Mniochloa - Mossgrass
Monerma - Thintail
Neurachne - Mulgagrass
Neyraudia - Burmareed
Ochlandra - Batagrass
Parapholis - Hardgrass
Paspalidium - Hatana
Pentachistis - Mafole
**Phyllostachys* - Timberbamboo (To distinguish from *Bambusa*-Bamboo)
Pleioblastus - Bamboograss
Polytrias - Javagrass
Pringleochloa - Pringlegrass
Pseudobromus - Falsechess
Pseudochaetochloa - Falsebristlegrass
Rhynchelytrum - Natalgrass
Schizachyrium - Autumngrass
Schmidtia - Sandquick
Sehima - Rattailgrass
Sesleria - Moorgrass
Sieglingia - Heathgrass
Spinifex - Spinifex
Taeniatherum - Medusahead
Tetrachaete - Fourawngrass
Themeda - Kangaroograss
Torreyochloa - Falsemanna
Trichoneura - Silveusgrass
Tridens - Tridens
Vulpia - Sixweeksgrass
Zoysia - Zoysiagrass

[1] Published with approval of the Director, Wyoming Agricultural Experiment Station, as Journal Paper No. 194.

[2] Changes suggested in the 1942 list of Standardized Plant Names.

The Grasses in Literature

Some of the earliest written records of grass are found in the Old Testament of the Bible. Acording to Hitchcock and Chase (1931), "The theme of grazing runs all through Genesis and Exodus. But long before cattle were domesticated, primitive man, living largely on animals he could kill, was vitally concerned with grazing lands. He must have followed the herds of wild cattle and bison, the flocks of wild sheep and goats, as the North American Indian followed the herds of American bison, or buffalo."

Ralph Waldo Emerson, in a statement quoted by Gay (1928), suggested that the importance of grass was doubtless recognized long before the time of written records. Emerson wrote: "—clouds and grass are older antiquities than pyramids or Athens—."

Whittier (1894) refers to hay, from grass, in well-known poem, Snowbound:

"Meanwhile we did our nightly chores,
Brought in the wood from out of doors,
Littered the stalls, and from the mows,
Raked down the herds grass for the cows."

Piper and Bort (1915) described some confusion which once occurred as a result of using two names for timothy. They state that in a letter to Jared Eliot, dated July 16, 1747, Benjamin Franklin wrote: "You made some mistake when you intended to favor me with some of the new valuable grass seed (I think you called it herd-seed), for what you gave me is grown up and proves mere timothy; so I suppose you took it out of a wrong paper or parcel."

In the upper Mississippi valley in the United States, grass lands known as prairie originally extended over vast areas. They were composed chiefly of tall grasses. After this region was settled by white people, most of the prairie—referred to as virgin sod in the following poem by Rudolph Ruste—became transformed into fertile agricultural land. Ruste's poem is quoted here from Hughes (1946).

"We broke today on the homestead
The last of the virgin sod,
And a haunting feeling oppressed me
That we'd marred a work of God.

A fragrance rose from the furrow,
A fragrance both fresh and old;
It was fresh with the dew of morning
Yet aged with time untold.

The creak of leather and clevis,
The rip of the coulter blade,
And we wreck what God with the labor
Of a million years had made.

I thought, while laying the last land,
Of the tropical sun and rains,
Of the jungles, glaciers, and oceans,
Which had helped to make these plains.

Of monsters, horrid and fearful,
Which reigned in the land we plow,
And it seemed to me so presumptious
Of man to claim it now.

So when, today on the homestead,
We finished the virgin sod
Is it strange I almost regretted
To have marred that work of God."

In 1872 Ingalls' essay on "Blue grass" appeared in the Kansas Magazine. Quotations from it follow:

"Lying in the sunshine among the buttercups and dandelions of May,—our earliest recollections are of grass; and when the fitful fever is ended, and the foolish wrangle of the market and forum is closed, grass heals over the scar which our descent into the bosom of the earth has made, and the carpet of the infant becomes the blanket of the dead.

"—Grass is the forgiveness of nature,—her constant benediction. Fields trampled with battle, saturated with blood, torn with the ruts of cannon, grow green again with grass, and the carnage is forgotten. Streets abandoned by traffic become grass-grown like rural lanes, and are obliterated. Forests decay, harvests perish, flowers vanish, but grass is immortal.—"

LITERATURE CITED

GAY, R. M. 1928. Ralph Waldo Emerson. Pages 104-106.

HITCHCOCK, A. S. AND A. CHASE. 1931. Old and new plant lore—grass. Smithsonian Scientific Series; 2: 201.

HUGHES, H. D. 1946. The role of sod crops in production and conservation programs. Jour. Amer. Soc. Agron. 38:1035-1048.

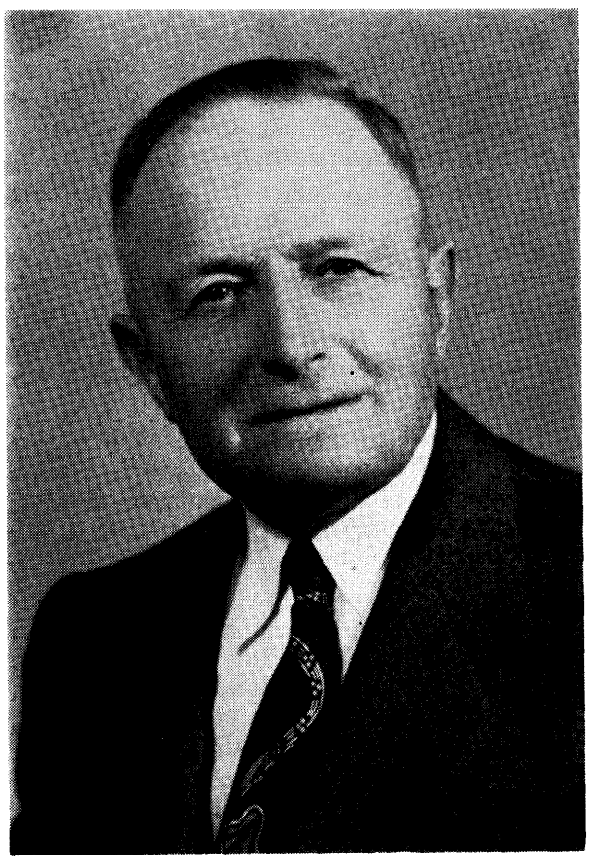
INGALLS, JOHN JAMES. 1872. Blue grass. Kansas Magazine. 2(3):270-277. ("Blue grass" was afterwards republished, in 1902, in a book with the title "John J. Ingalls, a collection of his writings," by Hudson-Kimberly Publishing Company, Kansas City, Mo.)

PIPER, CHARLES V. AND KATHERINE S. BORT. 1915. The early agricultural history of timothy. Jour. Amer. Soc. Agron. #7:1-14.

WHITTIER, JOHN G. 1894. Snowbound. The complete poetical works of John Greenleaf Whittier. Cambridge edition. Pages 398-406.

MORGAN W. EVANS
Wooster, Ohio

Louis E. Coughlin—Wyoming's Contribution to the Cause of Conservation[1]



Louis E. Coughlin was born on a cattle ranch in the Little Laramie River Valley of Albany County, Wyoming, July 26, 1883, son of Michael J. and Mary (Strobel) Coughlin. Only 14 years before, in 1869, Wyoming's first legislative assembly had met; the population of the Territory was still less than 10,000 and located largely in railroad settlements and mining camps. Several years were to pass before the founding of the University of Wyoming, or for Wyoming to change from territorial status to that of a state.

Only five years after the Forest Service was established in Washington in the U. S. Dept. of Interior and only three years after its transfer to the U. S. Dept. of Agriculture, *Mr. Coughlin* passed his Civil Service examination at Saratoga, Wyoming, for the post of Assistant Ranger. Seventeen others took the examination, which extended over three days, two for the written section and one for field tests. The written test consisted mostly of lengthy write-ups to bring out the experience of competitors in handling livestock, in range management, and in lumbering. The field tests were designed to test the competitor's efficiency in handling horses, riding, packing, and reading and handling the compass.

Coughlin entered the service as a forest guard in charge of the Battle Mountain District on May 1, 1908. According to his own account at this point in his career, "My forestry experience was indeed very weak, having been confined to corral poles and buck sticks. On the other hand my livestock and ranching experience was extensive and in some respects intensive. In those days, in connection with applications where references were required, it was quite the thing to secure the signature of a political big shot. Of course, I was well supplied with two of

them." Here, in less than a year, he became the district forest ranger under Supervisor *Jesse W. Nelson* of what was then the Cheyenne National Forest, Headquarters were on Battle Creek, about twelve miles from Slater, Colorado. The improvements consisted of an abandoned cabin with a dirt roof and no floor; the furnishings, an old board table and a tin camp stove.

According to *Coughlin's* own account, "I found I had a dual-use range, where, after lambing or toward the end of June, the sheep were trailed to the higher country for the summer and the cattle were permitted on the range. As to the people, there were cattlemen along the Little Snake River where the state line between Colorado and Wyoming has been the dead line for sheep; sheepmen north of the line on a woefully overstocked range; prospectors and miners working out from Battle, Dillon, and Copperton. Each of the three classes were, of course, wrangling with each other and among themselves. The Hayden Division was placed under administration only the year before, 1907. Since this was some five years after the Medicine Bow was created, and the sheep using the area embraced in the Medicine Bow were sharply curtailed, a large shift to the Hayden Division was made.

The concentration was further intensified by the efficacy with which the Colorado cattlemen maintained the dead line. The crowding of the sheep was so intense that numerous difficulties plagued everyone connected with the handling of the sheep. Herders and camp movers, generally loyal, had a code which impelled them to secure the best feed possible for the flocks they handled. Sometimes this gave rise to encounters that ended in killings, but, on the whole, the men got along very well. The worst damage to the flocks was caused by constant mix-ups resulting from one band trying to crowd another off its range. A few of the situations were tragic, but most of them were amusing."

Coughlin saw the Sierra Madre division included in the area of the Hayden National forest, now a division of the Medicine Bow, and the entire area west of the Continental Divide, as well as the Whiskey Peak area in Colorado, was placed in his charge. He transferred to the Medicine Bow on April 1, 1909, as District Forest Ranger, and was assigned to the Foxpark district. On October 1, 1910, he was transferred to what is now the Centennial district. Here the old North Park Stage was still running, and the railroad pushed through from Albany to South Park. The automobile had not yet progressed to a point where it was practical, particularly in the mountain country. For a more detailed account readers are referred to a M.S. thesis by Robert Keady Bruce, 1959, History of the Medicine Bow National Forest, 1902-1910, University of Wyoming Library call number 634.925787 B83.

In April 1913, *Mr. Coughlin* was assigned to the forest supervisor's office in Laramie, where he became office manager and later served under the titles of deputy forest supervisor, "acting" forest supervisor, senior clerk, and executive assistant. Here he revised a type of financial statement that is still in use by the Forest Service.

Coughlin transferred to the San Juan as wildlife specialist in September, 1936, and returned to the Medicine Bow in the same capacity in April, 1938. From July 1, 1943, until his retirement in 1952 he was district forest ranger of the Pole Mountain district, Medicine Bow National Forest. Here he pioneered in the establishment of crested wheatgrass at elevations above 8,000 feet. Here also he organized the Pole Mountain Cattle association, made up of permittees using range land in the forest areas. Of these cattlemen the first membership list of the American Society of Range Management carries the names of *Alwyn Bath, Walter Ferguson, Art King, J. H. King, Harry Olson, John Stevenson, Gudmund Sundly, Francis Warren,* and *Chester Williams.*

Since Wyoming was the first section of the Society, *Mr. Coughlin* was also the first Section Chairman of the whole American Society of Range Management, of which he was, himself, a charter member.

In the record-breaking 45 years of service, *Coughlin* waged a tireless battle for the Forest Service. While working in the Foxpark district with *John Mullison,* oldtime Indian agent, he established the Somber Hill fire-lookout tower and helped pioneer the Medicine Bow peak tower (a former prominent landmark no longer in existence) erected by the late *Fred Miller.* On the same Medicine Bow National Forest he helped promote the Wood Creek road, which is now part of the Rocky Mountain highway from Woods Landing to Chimney Park. He also took a lead in building most of the forest trails which connect parks in the foothills near Foxpark.

After his retirement he was honored in

1953 by the Nash Motor Company in recognition of exceptional service to the cause of conservation. *Mr. Coughlin* was married; his wife *Nellie V. Coughlin* died in October 1954. His son, Charles, lives in Berkeley, California.

For Wyoming range management, *Coughlin* blazed many trails. On November 4, 1962, in the town of Laramie, very near the spot where he was born, but 79 fruitful years later, *L. E. Coughlin*, pioneer, died.

Alan A. Beetle
Professor, Range Management
University of Wyoming

[1]*Published with approval of the Director, Wyoming Agricultural Experiment Station, as Journal Paper No. 196.*

Editor Changes Address

HEREAFTER UNTIL FURTHER NOTICE PLEASE SEND ALL MANUSCRIPTS, CORRESPONDENCE AND OTHER MATERIAL INTENDED FOR THE EDITOR, JOURNAL OF RANGE MANAGEMENT

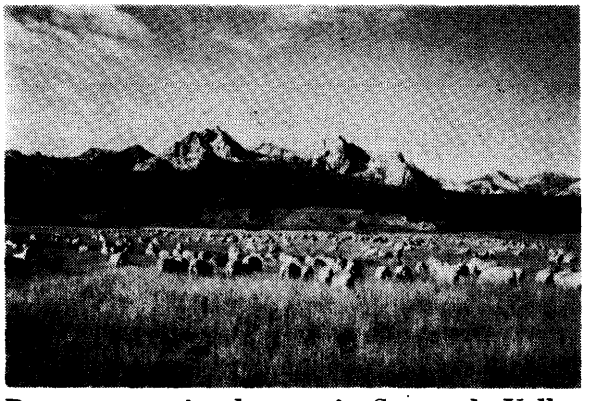
to: 392 Colorados Court, Lafayette, Calif.

IDAHO SECTION

Lyman Richwine Chapter **Student Chapter**
Southern Idaho Chapter **Western Idaho Chapter (proposed)**

PRINCIPAL ACTIVITIES

Annual convention and summer tour rotated among chapters — Quarterly newsletter edited by Dave Mead — Range management scholarship at University of Idaho — Awards to outstanding high school boys, UI Conservation camp



Range scene in the scenic Sawtooth Valley

CHAPTER OBJECTIVES

To foster better relations between ranchers, agencies and agribusiness by providing opportunities to associate and exchange ideas for the betterment of range lands and the livestock industry. Chapter participation by technical people and ranchers has strengthened the section.

Grass seed production on irrigated farm land

UNDERSTANDING AS YOUTH

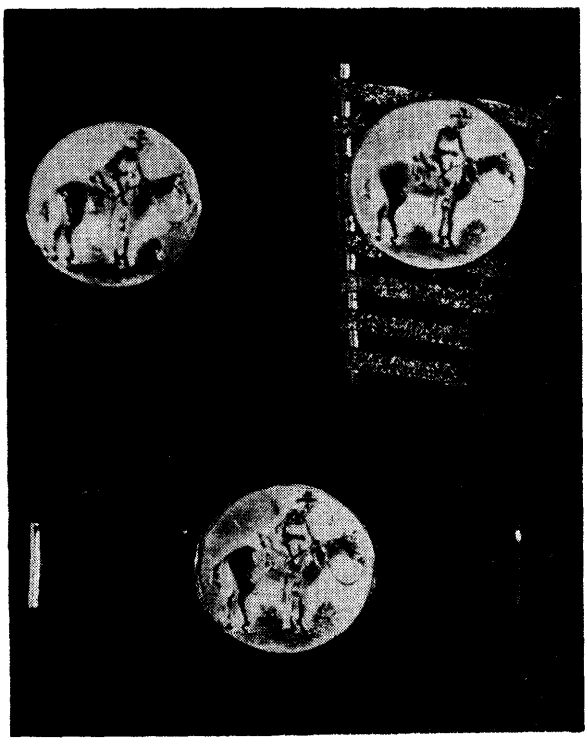
The Nebraska Section American Society of Range Management

Completeing a decade of progress, the Nebraska Section is dedicated to increasing and extending the knowledge and the art of grazing land management throughout all segments of the Livestock Industry. In the "Beef State," High Quality Cattle require High Quality rangeland for outstanding performance.

Accomplishment over the years is reflected in our active youth program, summer field meetings, an outstanding annual meeting and a top-notch Newsletter. Challenges ahead center about a range camp for youth, scholarship funds, recognition of outstanding workers in the field and an expanded membership.

"Hats Off" to our University of Nebraska for "beefing up" its range management program. Now offered are a 4-year curriculum for range students and opportunities for graduate study. Nebraska now boasts, for the first time in history, a full-time Extension specialist in range management.

PROGRESS IN PRACTICE



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E. J. Woolfolk, 392 Colorado Court, Lafayette, California.

High quality papers concerning technical and practical problems or practices of range management are suitable for publication. Review papers on selected subjects may be suitable but are usually invited. All papers must be accepted by the Editorial Board. Short articles concerned with research results, experimental equipment or techniques are suitable for the Technical Notes Section. Articles reporting individual or groups of plants useful for range seedings may be suitable for publication as: (a) technical papers if based on research data and comparisons with other species, or (b) as technical notes based on observational results without specific research data.

Papers should be based on new and adequate information. The introduction should state clearly and concisely the purpose of the report and its relation to other work in the same field. Unsupported hypotheses and rambling discussion should be avoided. Organization of the manuscript may vary to fit the content but the text should point out the application of the results to the range management problem considered. The paper should end with a brief summary of the outstanding points and their practical application.

All papers will be critically reviewed by the Editorial Board, or other subject-matter specialists designated by the Editor. Papers returned to the authors for revision should be handled promptly. Unsuitable papers will be returned to the authors with an explanatory statement. Prior publication of a manuscript or concurrent submission to another outlet automatically precludes publication in the JOURNAL OF RANGE MANAGEMENT.

Preparation of Manuscripts

(Illustration on back of sheet)

1. Manuscripts must be typewritten, double-spaced with ample margins, on good-quality white paper, size 8½ x 11 inches. Use one side only of the paper and number all pages. Submit the original or ribbon copy.

2. The title of the manuscript and name, position, and complete address of the author should be typed as distinct, well spaced entries on a separate page. Such a "title page," number one, must accompany each manuscript, see Figure 1.

3. Names of plants and wild animals must be shown in both common and scientific form the first time mentioned in the text. Further references should be to common names only.

4. Tables should be few and as simple as feasible. They must be typed, double-spaced, each on a separate sheet of regular-sized paper. Each table should carry its own separately numbered footnotes. They should be minimized, Figure 4.

5. Illustrations are desirable but should be held to a minimum. Glossy unmounted prints of photographs are desired. Protect these against damage in transit. Graphs should be prepared on white or blue-lined cross-section paper with neat lettering of a size suitable for reduction in printing. All figure titles should be typed, double-spaced, on a separate sheet, Figure 3. Photographs and graphs should carry an identification number. Never write on the back of photographs or attach paper clips to them.

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7. Literature citations should be listed in alphabetical order and referred to in the text by author and date, i.e., Jones (1949), or (Jones, 1949). Literature citations should be typed, double-spaced, in the style of the following examples:

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Figure 1. Title page.

2.

Footnotes

[1]Central headquarters maintained in cooperation with Colorado State University at Fort Collins.

2

3

4

Figure 2. Footnote page.

3.

Figure titles

Figure 1. Large Brush-free openings characteristic of much of the cattle range.

Figure 2. Forbs were common on the cattle range.

Figure 3.

Figure 4.

Figure 3. Figure caption page.

4.

Table 1. Average preference rating of major grasses and sedges at the end of grazing season, 1951-54.[1]

	Grass-Forb cover		Sagebrush cover
Species	Sedimentary soils	Granitic soils	Sedimentary soils
Big bluegrass			[2]

[1]1953-54 only for sagebrush
[2]Intermediate

Figure 4. Table page.