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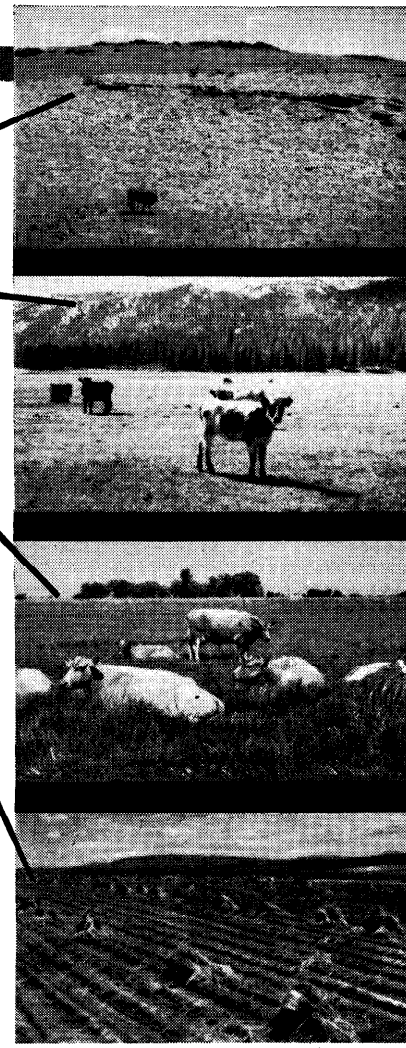

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OBJECTIVES

To foster advancement in the science and art of grazing land management, to promote progress in the conservation and greatest sustained use of forage and soil resources, to stimulate discussion and understanding of scientific and practical range and pasture problems, to provide a medium for the exchange of ideas and facts among society members and with allied technologists, and to encourage professional improvement of its members.

MEMBERSHIP

Persons shall be eligible for membership who are interested in or engaged in practicing range or pasture management or animal husbandry; administering grazing lands; or teaching, or conducting research, or engaged in extension activities in range or pasture management or related subjects.

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Journal of RANGE MANAGEMENT

Editorial

The Place of Range Research in Our Expanding Economy

IT IS A matter of common observation that we live in a period of rapidly growing demand for livestock products and hence for range and pasture forage. The big problem ahead appears to be that of producing enough meat and allied products to keep up with this demand, and of producing it on about the same amount of land that is now available!

Under the circumstances, it seems pertinent to consider the place of range research in meeting this situation. What sort of guidance has research provided for the range industry in the past and what are the prospects for the future?

Anyone who considers the history of range research can hardly fail to be impressed with the length of time by which the "art" preceded the "science." The use (and misuse) of grazing lands dates back into the early history of mankind, while the scientific approach is so recent that the earliest investigators have in their own lifetime spanned the interval from the pioneering stage to the present. Research on pasture lands in Europe and Great Britain can be traced back a little farther, but even here the field is new. Small wonder that we do not yet have all the answers!

Viewed from the standpoint of its comparative infancy, the past performance of range research is a creditable one. Starting almost from scratch with such essential tools as plant ecology, soil science, and animal nutrition themselves still in an early stage of development, a considerable knowledge of the range resource and its efficient use has been built up. The pioneers in range research developed sound principles of management, including such things as the effects of grazing on plant succession, allowable levels of forage utilization, and proper seasons of use.

Until the middle 1930's, the size of the total group engaged in range research was extremely small in relation to the importance of the resource involved. At

E. W. TISDALE

this time the pace was quickened as more personnel and funds became available. The successful development of large-scale range reseeding introduced a whole new approach to range renovation and increased production. More recently, the development of range condition and trend techniques has brought new vitality and usefulness to range survey and management planning. Other recent advances worthy of note include studies of the economics of range management, of the nutrition of livestock on the range and of the ecology and control of undesirable range plants.

In spite of these accomplishments, range research will not lack for tasks in the years ahead. Emphasis on more intensive use of grazing lands will require a better understanding than we now possess. We still know relatively little about the long-term response of many range types to different kinds of grazing use, or about the life history and requirements of many important range plants. Economically feasible means have still to be worked out for reasonably fast renovation of many range types, such as shadscale and desert shrub. The encroachment of undesirable plants still presents a serious threat to forage production in large range areas. These are only a few of the more obvious problems that must be attacked in the near future.

As members of the Range Society, we have a vital interest in the ability of range research to meet the challenge created by the need for higher, sustained production. How then can each of us help to ensure the success of research? To answer this, we must consider what factors are involved. Two of the most important are the quality of research and the effectiveness with which research findings are put to use.

Quality of research is of the utmost importance and depends mainly on quality of personnel. The research worker, in range as elsewhere, needs to be an individual of keen mentality, with the best training obtainable, and an absorbing interest in his work. To attract and to hold the kind of men needed are problems for research institutions these days, in view of the greater financial rewards available in many other occupations. The need for advanced training has increased as the science of range management has advanced. Encouragement of graduate study and some concrete recognition for staff members who undertake such studies can constitute a valuable contribution by research agencies. At the same time the colleges need to strive continually to improve the quality and usefulness of their instruction. An effective type of graduate work, especially for relatively inexperienced men, is that involving research fellowships. Here the student gets valuable training in actual research by taking part in well supervised college research programs, using some of the data so obtained for his thesis.

Even the best of research is of little value unless its findings can be put to use within a reasonable time. That a gap exists between available knowledge and common practice in range management is evident, and has been the subject of several articles in this Journal. We are all concerned with ways in which this gap can be narrowed. Obviously three main groups are involved, namely research workers, the extension services, and the range users or administrators. Each of these groups can help in this vitally important business of getting research results disseminated and put into practice.

The researcher can help by planning and conducting his studies in such a way as to obtain clear-cut results, and then presenting this information in clear, readable and logical form. Study of any representative group of publications will reveal many which fail to

deliver an effective message because (a) the experiment did not produce conclusive results or (b) the author failed to give a clear and complete picture of the information obtained. These faults, rather than excessive use of technical terms seem to be the major factors reducing the effectiveness of the written word, which should be the mainstay of the research worker.

The second group needed is that of the extension men. Actually, they are the key group, for it is their particular job to create a connecting link between research and the land user, and this function has long been recognized and promoted in the fields of cultivated agriculture. In the past, range management has been weak on the extension side; this has been a principal reason for the frequent failure of research to carry through to the range user. The suggestion sometimes made that range research men should do their own extension work reveals a lack of understanding of the function and responsibilities of research as well as an under estimation of the particular training and personality needed for successful extension effort.

The recent appointment in several states of range extension specialists is helping this situation, but there are still states without such workers, and in some states one man constitutes a rather small force. Appointment of county agents with good range training for work in predominantly range counties is still not as common as one might expect. Further development of range extension both state and federal, is a real need.

The third group involved in this matter is that of the range users and administrators themselves. They can help greatly by maintaining a receptive attitude and a willingness to discard old practices and adopt new ones when the evidence indicates that this is desirable. By showing an interest in using proven results and sympathy for the difficulties and limitations of research, range users can do a great deal to encourage and stimulate the range research worker.

What we have said here might be boiled down to a statement that the range industry consists of mutually dependent groups, all of whom are seeking the common goal of the best possible management. With a reasonable amount of mutual understanding and cooperation, all can help to ensure the ability of range research to meet any task which lies ahead.—*E. W. Tisdale,* Head, Range Management, School of Forestry, University of Idaho, Moscow, Idaho.

The Contribution of Elias Emanuel Nelson to Range Management[1]

ALAN A. BEETLE

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ELIAS EMANUEL NELSON was a native of Sweden, born on September 7, 1876. His American education included two degrees in botany at the University of Wyoming, the A.B. in 1898 and the M.A. in 1899. He was then Assistant in Horticulture and Agrostology at the Wyoming Agricultural Experiment Station, resigning in 1905 to go to the Washington Experiment Station. It was during this six-year period that he made his main contributions to the science of range management.

Although not a relative, he studied under and made collections with Aven Nelson, long-time member of the University faculty and who passed away in 1952. E. E. Nelson married Emma Nelson (also no relation) who was graduated from the University of Wyoming about 1907. His first scientific contribution was a "Revision of the Western North American Phloxes" which was his Master's degree thesis published as part of the ninth report of the Wyoming Agricultural College in 1899 (1). This added a number of new names to the plants of the West, including *Phlox glabrata* (then described as *P. hoodii glabrata* n. var.) the common increaser on shortgrass ranges.

At about the same time Nelson was interested in the genus *Antennaria* and published four short papers on that genus, two in 1899 and one each in the two following years, again including a number of new species (3, 4, 5, 6). During this period he found time to work for the United States Department of Agriculture, Division of Agrostology, during the summer of 1900, as Scientific Aid, doing field work (descriptive range survey and plant collection) in southern Wyoming (17).

Nelson's "Shrubs of Wyoming" contains a list of those shrubs he knew to be present in the state, a brief description of them, their habitat, and their uses and grazing value (8). His part of the bulletin "Wheatgrasses of Wyoming" (the other part was written by Aven Nelson) gives

ELIAS EMANUEL NELSON

[1] Published with approval of the Director, Wyoming Agricultural Experiment Station, as Journal Paper No. 12.

recommendations for the culture of 11 species which he says "are the most nutritious hay and pasture grasses that we have. Only the seed of slender wheatgrass can be obtained from seedmen" (9). His *Agropyron bakeri*, Baker wheatgrass, is still accepted as a valid species (10).

Nelson's "Native and introduced saltbushes, Three season's trials" includes a list and description of both native and introduced saltbushes present in Wyoming describing their natural habitat, forage value, use for cultivation and reseeding range land, and methods of seeding (11). He states "Nuttall and Nelson saltbush may be grown for pasturage. They make good stands under favorable conditions, but grow slowly and require several seasons to attain full size."

In the Wyoming Station Report for 1902 on pages 34 and 37 Nelson has an article on "The management and improvement of the range." Methods of range management and improvement are briefly discussed. Among the means described are resting, rotative pasturing, reseeding, harrowing, and disking.

Nelson was later with the U.S.D.A. Experiment Farm at Bent, Oregon, devoting his chief attention to forbs; with the Idaho Experiment Station working primarily with farming problems, both dryland and irrigated; and with the U. S. Irrigation Department at Twin Falls, Idaho. After his retirement from active status at the Washington Experiment Station he lived in Yakima, Washington, where he carried on his research. He wrote regularly for a horticultural column in the *Yakima Morning Herald*, a daily newspaper. He was working on hybrid iris (16) at the time of death on August 9, 1949.

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Utilization of Grasslands in the Flint Hills of Kansas[1]

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THE Flint Hills of Kansas constitute one of the last large segments of true prairie in the United States. They cross Kansas between the 96th and 97th meridians, narrowing abruptly to the north and ending before the Nebraska boundary is reached. To the westward there occurs a gradual transition to mixed prairie and to the east lies a diversified farming area once covered by true prairie but now largely broken, except for the rougher portions. Toward the south, however, the eastern side of the Flint Hills is bounded by sandstone hills with similar terrain and with a vegetative cover of true prairie and in sandy places savanna. On their southern end the Flint Hills join the Osage range lands of Oklahoma, a region of similar grasslands.

As the name Flint Hills suggests, this is a hilly region with the cherty, limestone beds strongly dissected by erosion that is still somewhat active in spite of the rather good grass cover. The ridges tend to be narrow and the side slopes steep. The soils are shallow in terms of cultivation but the limestone of the slopes is broken, thus allowing good penetration of moisture and of plant roots. The ridgetops often have shallow soils over dense clay and with less favorable moisture relations. The soils generally are rocky, often with cherty materials at the surface, and thus only limited areas can be brought under cultivation. Cultivation is limited to the small valleys and to certain gently sloping uplands. The terrain and soil conditions have been described by Fly (1946).

Native vegetation is the only agricultural crop that these rough lands are capable of supporting. Should it be destroyed, the productive capacity of the land would be lost until such time as the vegetation could be restored. On rough, rocky lands such as most of these, revegetation by any means other than natural succession may be so costly as to be impractical, and may even be impossible. It is therefore imperative that utilization practices be compatible with the ecological and physiological needs of the vegetation. Aldous (1935) and Anderson (1940) have discussed pasture practices for this area.

Historical

The Flint Hills have been used intensively for grazing since the early 1880's when southwestern cattlemen discovered that animals could be fattened to market conditions on them in a single summer season. There developed a grazing system in which the grasslands are leased by cattlemen of the Southwest and cattle are shipped to the area at or near the beginning of spring growth of the vegetation. This leasing for summer grazing has set the pattern for grazing management throughout the Flint Hills.

[1] Contribution No. 455, Department of Agronomy, Kansas Agricultural Experiment Station.

The Flint Hills rapidly came under fence after their use by southwestern cattle began and, therefore, have practically no history of intensive use as open range. For this reason they were not subjected to the abuses inherent in the uncontrolled use which began on the mixed prairie of Kansas with the coming of the railroads in the mid 1860's.

The cattle shipped to the Flint Hills in the early days were all mature animals, many of them 4- or 5-year-olds, or even older. As the demand for smaller animals has developed, there has been a shift to younger cattle. Some aged cattle are still pastured there, but the most common age is 2 years and a few groups of yearlings are to be found among the transient animals.

Importance of the Area

The agricultural and economic importance of the Flint Hills bluestem grazing lands has been emphasized by the reports of the Kansas State Board of Agriculture (1950 and 1951b) which show that, in addition to approximately one-half million head of local beef cattle, an average of nearly 300,000 head are shipped each spring from the ranges of the Southwest to fatten on the summer-growing bluestems. Pastures for these so-called transient animals are leased by the cattlemen on a "per head" basis, the leases stipulating acreage allowances, grazing dates, and other conditions of management agreed upon at the time the leases are drawn in late winter or early spring.

The southwestern cattle reach the Flint Hills in the late spring, usually late April, but sometimes earlier or later than this. They are considered to be in transit to market, stopping enroute to fatten. They are then moved to market when the owner deems them to be ready for sale, the better ones attaining this condition by late July or August. Shipment continues well into the fall.

Livestock gains are high on good or excellent Flint Hills pasture. Weight gains of 200 to 300 pounds per head are not uncommon for 2-year-old steers, while thin, mature animals may gain up to 350 pounds or more in a grazing season.

The Flint Hills are traditionally a cattle country, very few livestock of other classes occurring there. Cattle lend themselves to undisturbed grazing in large pastures. Here they are visited at regular intervals by riders who check on the condition of the cattle and the grass, and who tend the fences and the watering and salting facilities. The land owner, or his agent who arranges for the lease and distributes the cattle, is responsible for the care of the animals and is required to deliver them at the close of the grazing period or to furnish evidence of their death in the event of loss. Practically all leases stipulate the grazing fee and the acreage allowance per head of stock. Recently a few contracts have been written in which the grazing fee is determined by the amount of gain made by the animals.

Local cattle are managed on the bluestem pastures in much the same manner as the transient animals. Some land owners purchase animals for summer grazing in preference to leasing their pastures. Cattle often are purchased in the fall and wintered in lots or in farm fields. Where sufficient tillable land is available for the production of winter feeds, breeding herds are found. They, too, are generally turned onto native grass at about the same time as transient cattle, but the practice of wintering them on bluestem is now being tried in some sections. The dried grass is extremely low in protein and may be so leached as to contain little in the way of minerals, but when fed a supplement

of oilseed cake the animals wintered on it may be expected to maintain their body weights or, in favorable seasons, gain 50 or 75 pounds during the winter.

Utilization by Grazing Animals

The management of grazing on range pastures generally is concerned with obtaining the maximum degree of utilization that is compatible with efficient livestock production and with maintenance of the forage resource. In the Flint Hills, on the contrary, the major objective has been to obtain rapid steer gains during the early part of the growing season. To this end annual spring burning and carly stocking have been practiced since the 1880's, when these grasslands first came into extensive use.

That so much of the Flint Hills range land has been maintained in a relatively good condition is due in part to the leasing arrangements. To bring about rapid livestock gains at a time of year when the major forage species are just beginning to grow rapidly, the cattlemen have demanded adequate acreage allowances. This, together with the fact that many animals attain market condition during midsummer and are then removed for sale, has left these pastures understocked in the last half of the growing period, thus, a large volume of growth and relatively adequate carbohydrate food reserves have been allowed to accumulate each season. This has tended to compensate for the depleting effects of early stocking and annual spring burning, but some degree of deterioration has occurred even under this system. Pastures grazed the full season without reduction in stocking load, and especially the smaller ones that nearly always are stocked heavily, have suffered moderate to severe depletion.

Ecological Structure

The Vegetation

The vegetation of the Flint Hills is that of true prairie, the two bluestems being the most abundant species. Anderson (1951) reported that little bluestem (*Andropogon scoparius*) made up 24 percent and big bluestem (*A. gerardi*) 18 percent of the vegetation of experimental pastures in typical Flint Hills range near Manhattan, Kansas. Other species of major importance in this study were indiangrass (*Sorghastrum nutans*) and sideoats grama (*Bouteloua curtipendula*) each 8 percent, blue grama (*Bouteloua gracilis*) and hairy grama (*B. hirsuta*) taken together 6 percent, buffalograss (*Buchloe dactyloides*) nearly 5 percent, and the introduced Kentucky bluegrass (*Poa pratensis*) 8 percent of the population. Perennial grasses made up 84 percent of the vegetation of these pastures, sedges and rushes (*Carex* and *Juncus* species) 6 percent, annual grasses less than 2 percent, perennial forbs a little more than 5 percent, annual forbs 2 percent, and shrubs only 0.3 percent.

Cover

Bluestem vegetation of the Flint Hills provides a full vegetative cover. The undisturbed or only moderately grazed canopy of living tops, or of frosted top growth in winter, gives complete coverage of the soil and full protection against accelerated erosion. Runoff losses are minimized by this protective mantle of grass tops, as are moisture losses by evaporation from the soil surface. Basal cover, on the other hand, is quite sparse in good bluestem vegetation. Anderson (1951) found the area occupied by basal portions of plants to be only 21 percent of the soil surface. This sparse basal cover is typical of bluestem grasslands in

excellent range condition, and any decline in range condition due to excessive grazing will result in at least a temporary increase in percentage basal cover as certain species increase and others invade. Increasing perennial grasses include Kentucky bluegrass, buffalograss, the gramas, certain dropseeds (*Sporobolus* species), the rosette forming panicums (*Panicum* species) and others.

Herbage Production

Climax prairie vegetation in the Flint Hills contains very little nonpalatable plant growth. The yield generally is high and all of the tops are accessible and more or less readily available to grazing. Yields of 2000 to 3000 pounds of dry matter per acre per season are not uncommon under excellent range condition, and yields upward of 1000 pounds are the rule rather than the exception. Assuming that at least half of the forage can safely be removed by grazing and that an average of 20 pounds of dry matter per day would be sufficient for the average grazing animal, it will be seen that production will vary from nearly 1 to about 2½ animal-unit-months of grazing per acre. This is in agreement with the acreage allowances in Flint Hills commercial pastures, although they are seldom stocked at the heavier of these rates. The Kansas State Board of Agriculture (1951a) reported that 1951 acreage guarantees for a 6-month grazing season ranged from 3.5 to 6.5 for steers and cows and 2.5 to 4.5 for young cattle, although fattening animals often are marketed before the end of the 6 months.

Climatic Reactions

The Flint Hills lie in the 30–36 inch rainfall belt in an area of relatively mild temperatures. Forest generally has been excluded except in postclimax sites, although during favorable periods there does occur some extension of forest onto the uplands.

Deep penetration of rainfall allows deep-rooted prairie species to dominate on all but the driest upland sites. There reduced infiltration and water loss by runoff and evaporation bring about preclimax conditions favoring the shorter grasses. These often become the major species on such sites even under moderate grazing.

It has been said that the true prairie would have been forest except for such factors as frequent fires and occasional periods of extreme drought. These have been natural factors of the environment however, and the Flint Hills can therefore be considered to exhibit a true grassland climate. As Borchert (1950) has pointed out, "The prairie has had a climate more like that of the steppe than the eastern forests during most winters and the summers of major drought years. But during most summers the climate is more like that of the eastern forest."

Prior to 1934 there had, in fact, occurred some extension of forest vegetation from its postclimax position along streams and draws out onto the true prairie uplands of the Flint Hills. Its destruction during the drought of the mid 1930's was striking evidence of the influence of climate on the character of the vegetation.

Major Influents

The major influents superimposed upon the bluestem vegetation by man are grazing and frequent burning. Both have long been major factors influencing vegetative population and trends. Prior to settlement, the grazing was by wild herds and the burning by the uncon-

trolled fires set by Indians or by natural causes. At present the grazing is principally by cattle and the burning by the more or less controlled fires employed in the management of the pastures.

Ecological Succession

Ecological succession is profoundly affected by grazing. Close forage removal results in retrogression as evidenced by rapid decrease of certain major grass species typified by the bluestems and by such forbs as perennial sunflowers and legumes. At the same time other grasses such as the gramas and certain dropseeds, and numerous forbs and shrubs such as ironweed (*Veronia*), verbena (*Verbena*), ragweed (*Ambrosia*), coralberry (*Symphoricarpos*), and sumac (*Rhus*) become more abundant. Invasion, principally by annual grasses and forbs at first and later by perennials, also occurs.

Succession Induced by Grazing

Succession following depletion, if encouraged by carefully controlled grazing, may advance rapidly toward climax in pastures where the retrogression has not been too great. The prairie dominants recover rapidly under protection and spread by vegetative means as well as by natural reseeding to reoccupy the ground lost by depletion. Seedlings of the major species compete successfully, establishing themselves in stands either of increasers or of invaders.

Succession following severe depletion is slowed to the extent that the dominant forage species have been eliminated. If a pasture has been so depleted that little or no seed is available for natural revegetation, the restoration of the bluestems must depend on outside sources of seed. Fortunately, relatively little of the region has been plowed but remains in natural vegetation, so the source of seed is as near as the nearest pasture or fence row. However, pastures so severely depleted as this are likely to be so weedy and brushy that reestablishment of the bluestem vegetation would be seriously delayed even if seed were available. In this event, weed eradication measures are needed.

This extreme situation exists in very few Flint Hills pastures, so restoration is mostly a matter of encouraging natural succession. Only a few small farm pastures or parts of pastures near farmsteads or near watering facilities have become so depleted as to require reseeding. This is indeed fortunate because the steep terrain and rocky soils may preclude seedbed preparation and seeding.

Succession Induced by Cultivation

The problem of ecological succession induced by cultivation is of limited importance in the Flint Hills. The areas now in cultivation have mostly been rather carefully selected and, for the most part, are kept in the crop rotation. If such lands are sown to pasture, smooth brome (*Bromus inermis*) or other rotation pasture crops generally are used. Thus, relatively little "go back" land exists except in a few places where tillage during the early days of settlement was sometimes unwisely attempted on shallow uplands. These old fields soon were abandoned and were returned to the pastures, but their outlines still remain, emphasized by the plants that occupy them. Such old fields are now characterized by thin stands of native grass and an abundance of summer annuals such as prairie threeawn (*Aristida oligantha*), or often by seeded stands of Korean lespedeza (*Lespedeza stipulacea*). Soil depletion and erosion losses both have played a part in creating an environment unfavorable to the rapid reestablishment of the dominant prairie forage species. Furthermore, succession has been hindered by the fact that the

"go back" areas have not received protection, but have simply been thrown into the large pastures.

Succession Induced by Fire

Fire plays an important role in the management of Flint Hills pastures. Most leased pastures are lightly stocked in the latter months of the growing season, leaving a large accumulation of tops which remain on the land over winter. Pasture leases commonly contain clauses requiring its removal by burning prior to the beginning of the new grazing season. Since it is difficult to control the spread of fire and also because the commercial grazing management tends to set the pattern for the entire region, annual spring burning is widely practiced throughout the Flint Hills. Cattlemen maintain that the purpose of the burning is to prevent patchy grazing, but another factor is the increased rate of spring growth that occurs for a time on pastures burned early in the spring. Aldous (1934) showed that burned pasture plots outyielded unburned ones for a few weeks in the spring, but that the unburned ones rapidly overtook them during the summer months and greatly exceeded them in total growth for the season. It is important for transient cattle to fatten as rapidly and as early as possible, however, and the additional early-season growth afforded by early burning helps hasten these southwestern cattle to market.

The overall effect of pasture burning is to reduce total forage yields. The chief factor responsible for this is the reduction in soil moisture resulting from long spring exposure to runoff and from surface evaporation during the period between the date of burning and the beginning of growth of the summer growing prairie dominants. Needless to say, this effect is more pronounced in dry summers than in favorable ones.

Burning influences ecological succession. First, it removes all old growth, exposing the new growth to earlier use by animals. Thus, close grazing is encouraged, and should it be continued, depletion is hastened, not so much by the burning as by the abusive grazing. Secondly, burning may cause population changes even where grazing is not involved. Aldous (1934) showed that early spring burning caused an increase in density and favored the finer stemmed species such as little bluestem and prairie dropseed, while burning as late as possible before spring growth started caused a decrease in density and induced a trend toward the taller, coarser species such as big bluestem, indiangrass, and switchgrass (*Panicum virgatum*).

A study of the experiments by Aldous will reveal the reason for the population shift brought about by early burning. Species like little bluestem and prairie dropseed (*Sporobolus heterolepis*) are the natural dominants of relatively dry sites in the prairie. Early burning brought about reductions in soil moisture, thus making the environment less favorable for the larger species that are naturally more abundant in sites of favorable moisture conditions. The reason for the shift to taller, coarser species following annual late burnings is not clear.

The Future

The future of the Flint Hills as an agricultural region depends upon maintenance of the forage resource, the native vegetation, in a vigorous and productive state and upon wise and efficient utilization of this forage by grazing animals. Abusive grazing can destroy the vegetation and leave the land exposed to the ravages of erosion. Fortunately, the land owners realize this. They are interested in

maintenance of the pastures and those who understand the needs of the forage species practice moderate grazing.

There is little opportunity to increase the cultivated acreage for the production of the supplemental forage crops because of the rough, rocky nature of the soils, so the bulk of the forage must continue to come from native vegetation. Tillage is not reducing the natural grassland acreage of the Flint Hills materially, so this is not to be considered a vanishing grassland. The grazing may not always be too carefully regulated, but acreage allowances generally are sufficient, after the pattern set by the commercial grazing, so abusive grazing is not reducing the grassland acreage.

There is little likelihood, on the other hand, that the acreage of native grasses can be increased to any great degree. Most of the land now tilled will remain in cultivation for the production of feeds and forages to supplement the native pastures. Actually, there is too little tillable land to support completely balanced livestock husbandry. Only fields depleted by abusive farming practices will be returned to permanent pasture and only part of this will be sown to native grasses because cool-season crops such as smooth brome can be grown to extend the grazing season. Returning land to native pasture usually consists merely of extending the pasture fence to include the abandoned field in the hope that natural reseeding will take place. Some few depleted fields probably will be reseeded to bluestem mixtures, however.

Since continued productivity of these range pastures is dependent chiefly upon management of the grazing, it is imperative that correct practices be understood and applied to these grasslands. To this end an adequate grazing research program is a major requirement, and it must be accompanied by an active and enlightened extension program to carry the results of research to those who manage the grazing.

Because range condition is judged in terms of the vegetation that might be expected to occur naturally, the need for the preservation of undisturbed or primitive areas is emphasized for the maintenance of bluestem grasslands in their climax condition or as near to it as possible. These would be important supplements to grassland research and would serve as living museums for generations to come.

Summary

The Flint Hills bluestem prairie is not in great danger of destruction. The fact that it generally has not shown severe decline in condition is evidence that grazing has not been extremely abusive. This cannot be attributed entirely to good management based on full understanding of the growth requirements of the vegetation, but rather to the fortuitous circumstance that pasture leasing has been dominated by cattlemen of the Southwest. They have demanded an ample acreage allowance to permit quick fattening of the transient cattle and have begun removing finished animals in midseason, thus leaving the pastures lightly stocked during the latter part of the growing season. This has permitted the storage of sufficient organic reserves to maintain these pastures in relatively good condition in spite of annual burning and early stocking.

So long as the present grazing system is continued, the Flint Hills can be expected to remain in good condition. It seems imperative that maintenance should be based on a sounder foundation than this, however, and a knowledge of the ecological and physiological require-

ments of the forage grasses is therefore essential for every grassland manager.

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CALL FOR PAPERS FOR 1954 ANNUAL MEETING

Members who wish to present papers at the annual meeting in Omaha, Nebraska in January, 1954 are invited to offer them now. This is in accordance with Article V, Section 6 of the Bylaws (See March 1951 Journal, Vol. 4: 134).

Titles and approximately 200 word abstracts should reach the Program Chairman as early as possible to permit consideration by the Program Committee in completing a well-balanced program.—*Floyd D. Larson* Chairman, Program Committee, U. S. Bureau of Land Management, 326 Stapleton Bldg., Billings, Montana.

The Influence of Intensity and Frequency of Clipping on the Root System of Brownseed Paspalum

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IT IS common knowledge that the frequent removal of a large percentage of the leaf and stem growth of grasses over long periods of time will not only reduce their vitality and production, but may cause the death of such plants. To what extent the root system of the grass plant suffers from various intensities and frequencies of utilization in different environments is only generally understood. Such investigators as Fitts (1925), Weaver (1926), Harrison (1931), and Parker and Sampson (1931), working outside the boundaries of Texas, report that intensive clipping on certain grasses was detrimental to root production. In addition, McCarty and Price (1942) state that root reserves were influenced less by the number of clippings than by the time and degree of clipping on annual range, while Harrison (1931) found that mineral fertilizers did not compensate for a lack of top growth due to clipping in the production of roots.

With these points in mind, a study was introduced on the Encino Experimental Range of the King Ranch, South Texas, in 1948. The objectives were to determine what effect different intensities (heights) and frequencies of clipping might have on the root systems of the "key" range grasses of the area. The grasses included are of the bunch grass type common to the better sites on the sandy soils of the large area within the general region (Fig. 1A). Since these are of the better grasses of the region, they have suffered severely in the past from heavy utilization and especially during years of low rainfall (Fig. 1B). Thus it is apparent that any information on the volume and depth of the root systems in relation to clipping heights and intensities would be of great value in the formulation of proper management practices for such grasses to obtain a sustained forage yield. Since the preliminary trials to obtain such information revealed that time and funds were the limiting factors in testing all the important grass species, brownseed paspalum (*Paspalum plicatulum*) was selected because it was the most abundant among the grasses and equally as palatable.

The study area provides a means whereby data could be obtained under different utilization practices as associated with clipping and grazing on both non-fertilized and fertilized (phosphate) treatments for given periods of time. This particular paper gives the results of the first 18 months of the over-all study.

Experimental Area

The Encino Experimental Range consists of seven, 640-acre, native pastures. The Nueces soil found on this Range is a gray, loose, fine soil to a depth of about three feet overlying a gray or yellowish noncalcareous friable subsoil. The parent material is a windblown sand beach deposit over Pleistocene clays. The three pastures among the seven selected to obtain root samples from were: Number 1, unfertilized, Number 3, fertilized with

300 pounds 20 per cent superphosphate per acre, and Number 4, fertilized with 300 pounds raw rock phosphate per acre.

The region has a marine climate with comparatively pleasant summers, mild winters and cool springs, with an average growing season of about 290 days. The average annual precipitation reported for a 32-year period is 23.92 inches; however, the area is subjected to long periods of drought and occasional severe tropical storms.

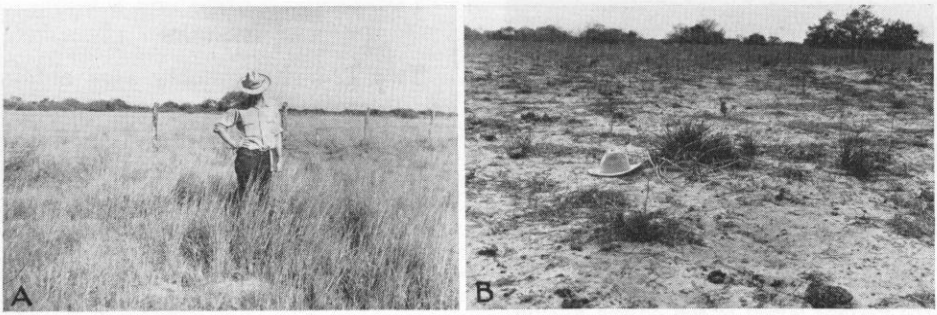

FIGURE 1. Bunch-grass range. *A*. Good condition bunch-grass range on Encino Division of the King Ranch in the Rio Grande Plain of Texas where root studies of brownseed paspalum were carried on. *B*. The effect of severe utilization on the bunch grasses in the same vicinity. Note sandy top soil which is exposed to wind action. Sand drifting is common in the general region where over-utilization has occurred.

Vegetation common to this area is a bunch grass type composed principally of such desirable grasses as brownseed paspalum, seacoast bluestem *Andropogon littoralis*, thin paspalum *Paspalum setaceum*, purple dropseed *Sporobolus purpurascens*, hairy grama *Bouteloua hirsuta*, as well as a number of less desirable grass species.

EXPERIMENTAL PROCEDURE

Eighteen plants of brownseed paspalum were randomly selected in each of two one-acre enclosures in pastures 1, 3, and 4, as well as four plants outside but adjacent to each enclosure which were subjected to grazing. The enclosures consisted of a replicated experiment on the effects of intensity and frequency of clipping. One plant was taken from each of eighteen strips. Six of these were from check strips. Two strips were cut at a height of 6 inches and at a low frequency of clipping. This low frequency was one-half that of the two strips clipped at high frequency. Likewise, there were two strips at each frequency for the 4 and 2 inch heights of clipping. The brownseed paspalum plants had been clipped according to the above specification over a period of 18 months while the grazed plots outside the enclosures were grazed for a similar period under the grazing rates of 42 cattle per section in pastures 1 and 4 and 63 in pasture 3.

A soil coring machine manufactured by the Utah Research Foundation was used to obtain the root samples (Fig. 2). The boring tube was 4 inches in diameter and 10 feet long. The crown growth of brownseed paspalum was especially well shaped for centering the boring tube. The soil removed by the soil coring machine was sectioned at 12-inch intervals from the surface to the claypan and constituted the sand portion. As much of the claypan as could be obtained was used as the claypan unit, which in

many cases did not exceed 8 inches. When details concerning the entire root system were necessary for any particular grass, the soil block method was employed

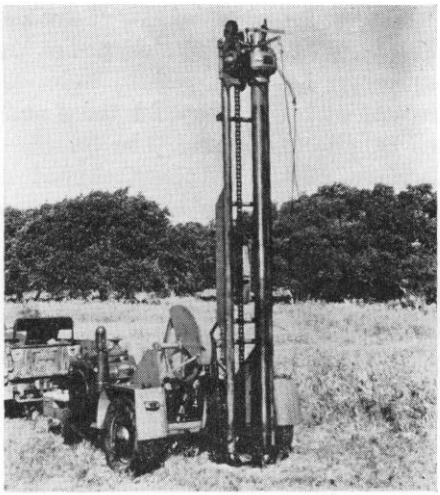

FIGURE 2. Soil coring machine used to study the roots of brownseed paspalum in the various layers of soil on the Encino Experimental Range.

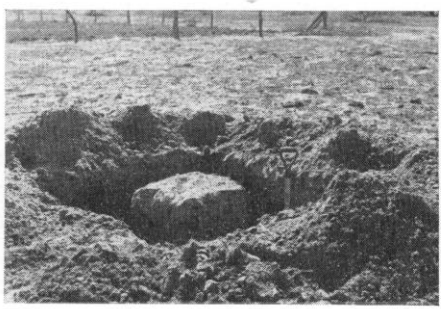

FIGURE 3. Method used to obtain the entire root system for any particular grass plant in the over-all range management study on the Encino Experimental Range of the King Ranch.

(Fig. 3). This was a very expensive and laborious method.

The sandy top soil and roots were separated after drying by the use of a one millimeter soil screen. The roots were also separated from the claypan portion of the soil with the aid of running water and the soil screen. The roots obtained were dried at 45°C. for 24 hours and weighed to the nearest tenth of a gram. Previous data indicated that small samples reached a constant weight at the above temperature and time. Data were obtained on root weights, per unit volume of soil, from each of the 12-inch segments.

All roots present in the soil core were used in this analysis. No separation of live and dead roots was possible. Thus there was a militating effect on the results obtained.

RESULTS

Two 12-inch segments were obtained of the root systems of 132 brownseed paspalum plants. The mean weights per unit volume soil are listed in Table 1 for each segment.

Effect on roots in surface foot of soil

The mean root weights of the 0–12 inch segment in pastures 1, 3, and 4 reveal a difference between pasture 4 and pastures 1 and 3. This difference may be due to the rock phosphate fertilizer applied to pasture 4, whereas pasture 1 was not fertilized and pasture 3 was fertilized with superphosphate, or it may be due to the location of the enclosures. There is also a possibility that the depth to the claypan may be a factor. However, the difference in depth of claypan between the enclosures in pasture 4 was not as great as between the pastures, even though the depth to the claypan in one enclosure was 24.8 inches while the other was approximately 34 inches. This difference in depth to the claypan was greater than the difference between pastures.

On the basis of statistical analysis, intensity and frequency of clipping did not significantly influence the weight of roots in the surface 12 inches of soil. Neither was the interaction of intensity and frequency significant. However, the sum

of squares associated with one degree of freedom of this interaction for the comparison of the 2-inch plus the 4-inch versus the 6-inch clipping height was significant (P .05). The remaining sum of squares associated with the other degree of freedom was not significant.

on the roots of brownseed paspalum in the surface foot of soil. A comparison of the root weights of the grazed and check plants shows no significant difference in the 0–12 inch segment of the roots. This similarity in root weights would be expected because the two

TABLE 1

Weight of roots of brownseed paspalum in grams, oven-dry weight, per unit volume of soil in relation to soil depth, grazing, and clipping treatments

PASTURE NUMBER	UNCLIPPED	GRAZED	CLIPPING INTENSITY AND FREQUENCY						*Average**
			2-inch stubble		4-inch stubble		6-inch stubble		
			Low	*High*	*Low*	*High*	*Low*	*High*	
			0 to 12 inch soil layer						
1	20.2	20.7	15.3	15.0	23.3	16.7	13.2	18.3	18.5
3	19.9	15.7	27.3	19.2	28.6	25.0	16.7	19.0	20.7
4	13.5	17.7	13.4	14.5	16.3	12.3	13.3	17.4	14.8
Average	17.9	18.0	18.7	16.2	22.7	18.1	14.4	18.6	
			12 to 24 inch soil layer						
1	.95	.89	.95	.84	.97	.78	1.13	.82	.82
3	1.05	1.12	.97	.93	.98	.76	.95	.98	.98
4	.78	.95	1.11	.64	1.10	.76	.75	.85	.85
Average	.92	.98	1.01	.82	1.01	.77	.94	.79	
			Claypan fraction						
1, 3 & 4	.15	.08	.11	.09	.10	.09	.12	.11	.10
			Adjacent sand						
1, 3 & 4	.05	.05	.05	.05	.05	.04	.06	.05	.05

* The average is a pasture average and includes all plants in each pasture, however the intermediate values are not shown in the table.

The significant value obtained above was due to a differential response of the roots of brownseed paspalum to frequency of clipping at the 6-inch clipping height as compared with the influence of clipping on the root weights of plants clipped at the 2 and 4-inch heights. Decreased intensity of clipping thus compensates for high frequency of clipping

previous growing seasons were favorable for forage production and the areas surrounding the enclosures were only lightly grazed.

Effects on roots in soil segment 12–24 inches

The root weights of the 12–24 inch section of the roots obtained from the plants mowed at different intensities and

frequencies are reported in Table 1. The weight of roots in this section were significantly (P. 05) reduced by the high frequency of clipping as compared with the low frequency of clipping. Effect of intensity of clipping was not significant in the second foot of soil.

The lack of significance for intensity of clipping was due probably to the growth habit of brownseed paspalum. This grass produces a leafy basal growth that enables it to continue photosynthetic activity even after being clipped to a height of 2 inches, thus reducing the demand on the root reserves for the production of new growth.

Frequency of clipping did not influence the weight of roots in the surface 12 inches of soil. The initial response of brownseed paspalum to clipping is thus a decrease in depth of the root systems. This reduction occurred above the claypan which may serve as a water reservoir and as a source of nutrients during periods of drought.

The difference in the root weights between the check plants and the grazed plants was not significant (P .05), which indicates that the intensity of grazing practiced on the areas surrounding the enclosures had little effect on the root system of brownseed paspalum. The claypan formation beneath the sand has a decided influence on the character of the root system. The weight of roots per unit volume of soil in the claypan samples was twice the weight of roots found in the sand immediately above the claypan (Table 1).

The roots in the claypan fraction of the soil show the same response to frequency of clipping as did the roots in the 12 to 24 inch segment of the roots which were in the sandy soil. Under the assumption that the claypan serves as the principal source of nutrients and water during drought periods, it becomes obvious that the shortening of the root systems will result in decreased forage production. The greater weight of roots in the claypan in comparison with the sand fraction above the claypan is a plant response to increased moisture and nutrients.

The claypan intra-faces were characterized by a fine network of roots and by a darker color which was probably due to an accumulation of organic matter. Roots passing through the sand or claypan areas free of fissures did not show such extreme branching. The penetration of the roots may have permitted more water to enter the claypan and the additional organic matter increased the water holding capacity of the soil.

Summary and Conclusions

Data obtained on the amount of roots of brownseed paspalum in the surface 12 inches of soil did not indicate that intensity or frequency of clipping during an 18-month period influenced the amount of roots in the surface soil. Decreasing the intensity of clipping was shown to compensate for increasing frequency of clipping in the surface soil.

Frequency of clipping had a detrimental influence on the amount of roots in the second foot of soil. Grazing was not detrimental to the root systems of the plants under the conditions of the experiment where over-utilization was not apparent for this period.

The amount of roots in the claypan was twice as great as the amount of roots in the sandy soil just above the claypan in all three pastures. Roots of brownseed paspalum were found to be concentrated on the claypan intra-faces wherever examined. Frequency of clipping appeared to be detrimental to the amount of roots in the claypan soil fraction.

These data which apply to brownseed paspalum may also apply to the other

perennial bunch grasses of the general region. Thus it may be assumed that heavy utilization of the foliage over a comparatively long period of time influences the root development by both quantity and length, and the plants are unable to contact the claypan which is the principal source of needed water supply during the long hot summers and death ultimately results. This may be one of the principal reasons why the perennial grasses of the bunch grass type in the general region have been replaced by the less desirable perennial and annual grasses and forbs with shorter roots.

ACKNOWLEDGMENT

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Seasonal Trends of Minerals and Proteins in Prairie Grasses

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EFFECTS of nitrogen and phosphorus fertilization on seasonal trends of minerals and protein in prairie grasses from virgin sod are valuable to agronomists in depicting certain soil-plant-animal relationships. Mineral and protein content of dominant grazing forages often reliably reflect soil characteristics. Analyses of calcium, phosphorus, and nitrogen, with certain restrictions, are widely used as a convenient alternative approach to more exacting but more expensive actual livestock assays. These constituents are often used for estimating the adequacy of mineral and protein for animal production.

Among the more comprehensive of the many reviews relating to minerals and protein in grazing forage are those of Theiler (1932 and 1941), Orr (1929), Watkins (1943), Stanley (1938), Vandecaveye (1940), Maynard (1941), and Beeson (1946). Beeson evaluates the present consensus of the various investigators in this field. Apparently, the important factors which tend to affect the nutritive content of grasses can be summarized as the inherent characteristics of the species, its stage of growth, the fertility of the soil, fertilizer applications, and the climate as it affects primarily the stage of growth, uptake of nutrients, weathering, and leaching of the tissues. Theiler's review is particularly devoted to the effect on animal performance of phosphorus deficiencies uncomplicated with various other nutritional deficiencies in natural grasslands of the world. His successors, Du Toit *et al* (1940), after extensive studies of the literature, nutrition balance studies, and the analysis of herbage samples from native grasslands, proposed levels of calcium, phosphorus, and protein required by cattle. United States authorities also have proposed well-accepted and widely used standards, however, for evaluating the nutritional qualities of the grasses in the present study, those of Du Toit in South Africa are used because of environmental similarities of natural grasslands.

The present study, concerned principally with the plant-animal relationship, reports the effects of nitrogen and phosphorus topdressings on the seasonal variation and differential concentration of calcium, phosphorus, and nitrogen in eight dominant grasses from a native prairie habitat near Lincoln, Nebraska. The general object was to relate quantitative variation of these plant constituents to differences in stage of maturity of the grasses and to a recommended nutritional standard for cattle on native grassland.

Experimental Methods

An experimental plot 58 x 72.6 feet was established on a true prairie near Lincoln, Nebraska. The soil type at this location was Carrington silt loam on undulating to gently rolling upland prairie soil developed under approximately 28 inches average annual rainfall. The site was undisturbed by man except for any effects attributable to an annual autum-

nal mowing for hay (Clements, 1934). Three fertilizer treatments were applied to 1/200 acre plots (3 x 72.6 feet) in a randomized block design with four replications. These treatments consisted of topdressings of ammonium nitrate fertilizer, superphosphate, and an untreated check. The superphosphate, containing 43 per cent available phosphoric acid, was applied on February 15, 1947, at the rate of 80 pounds P_2O_5 per acre. The ammonium nitrate was applied on April 14, 1947, at the rate of 60 pounds of N per acre. Two-foot guard strips separated the individual treatments.

The common and scientific names of the species investigated are arranged below into two groups according to the season in which growth is most active (Hitchcock, 1951).

Common Name	*Scientific Name*
Cool-season Species	
Junegrass	*Koeleria cristata* (L.) Pers.
Western wheatgrass	*Agropyron smithii* Rydb.
Needlegrass	*Stipa spartea* Trin.
Warm-season Species	
Prairie dropseed	*Sporobolus heterolepis* A. Gray
Little bluestem	*Andropogon scoparius* Michx.
Big bluestem	*Andropogon furcatus* Muhl.
Blue grama	*Bouteloua gracilis* (H. B.K.) Lag.
Side-oats grama	*Bouteloua curtipendula* (Michx.) Torr.

In sampling, all plants were clipped about 1.5 inches above ground. With the exception of blue grama, samples for the first growth stage consisted of new vegetative material produced since dormancy. Samples for successive growth stages prior to and including jointing were made up of vegetation produced after the first clipping. Clippings at the early jointing growth stage removed the flowering culms from original sub-samples. Later growth from tillers in these subsamples, although available for animal consumption, was not sampled, consequently, all clippings at growth stages subsequent to the removal of the first flowering culms were taken from previously unclipped subsamples. This method of harvesting follows the nutritive levels of young growth from dormancy, vegetative regrowth through the time of early jointing, and mature growth subsequent to the removal of flowering culms. Hence it was possible to follow the maturation and weathering trend of original growth during the later season.

For estimating comparative yields resulting from fertilizer treatments, the total mixed vegetation in quadrats 2 x 6 feet was clipped at three dates during the growing season. Clippings in this incidence were taken from previously unclipped areas and hence consisted of the total year's growth up to the time of harvest.

A sample for analysis usually consisted of 200 to 300 grams of freshly clipped material. This was placed loosely in a large paper bag and dried in a ventilated oven at 100 degrees C. for about 24 hours. The oven-dry material was broken into small fragments and mixed. A representative portion of about 40 grams was obtained by quartering. This was ground in a Wiley mill to pass a one-millimeter sieve. For calcium and phosphorus determination, one-gram samples of the ground material were digested with a 1 to 1 mixture of concentrated nitric acid and 60 percent perchloric acid on a hot plate until colorless, then filtered to remove silica. Phosphorus content of an aliquot of the clear solution was determined by the method of Shelton and Harper (1940–41). Calcium was determined on a separate aliquot by the AOAC method (1945). Nitrogen was determined in separate one-gram samples by the

Kjeldahl-Gunning method, modified to include nitrate. All data reported are the average of four replications, calculated to a moisture-free basis. Percentage protein is expressed as percent total nitrogen times 6.25, and percentage phosphorus as the elemental form.

Results

For convenient evaluation of the grasses in the present study, Du Toit's (1940) proposed requirements for an 800-pound beef steer consuming 16 pounds of dry matter per day are tabulated in Table 1. It is believed that greater meaning can be had from the analytical figures if the animal requirement is kept in mind.

TABLE 1

Phosphorus and protein requirements for an 800-pound beef steer consuming 16 pounds dry matter per day

PHOSPHORUS IN PASTURAGE (PERCENT)	PROTEIN (6.25 N) IN PASTURAGE (PERCENT)	REMARKS
Under 0.11	Under 5.0	Below growth requirements
0.11 to 0.14	5.0 to 7.0	Limited growth
Over 0.14	Over 7.0	Sufficient for normal growth

Limiting levels of calcium above the minimum requirement for growth are not given, but Du Toit concluded that pasturage containing a minimum of 0.14 percent calcium in the dry matter furnished the minimum requirement for an 800 pound beef steer consuming 16 pounds of dry matter per day. Younger animals may be expected to consume less than 16 pounds dry matter, and hence the nutritive constituents in the herbage should be higher for younger than for older animals. Similarly, in pregnant or lactating animals, amounts of phosphorus calcium, and protein should be superimposed on the requirements listed above or given in Table 1.

Crude Protein

The data for the nutrient constituents of the grasses at varying growth stages at successive harvest dates are shown in Table 2. It may be observed that the crude protein of the native grasses ranged from 30.3 percent, in nitrogen-treated junegrass at the medium vegetative growth stage, to 1.8 percent in phosphorus-treated big bluestem harvested October 27. It may be further observed that nitrogen-treated cool-season grasses were higher in crude protein at growth stages up to jointing time than were nitrogen-treated warm-season grasses at corresponding growth stages. Cool-season grasses at earlier growth stages also showed greater differences in crude protein between treatments than warm-season grasses at corresponding growth stages. Moreover, cool-season species usually retained the increased crude protein at a more advanced growth stage, but such advantage was seldom apparent after the jointing growth stage, and not discernible in mature, cured, or seed-shattering material. Superphosphate generally produced no significant effect on protein content of any grass at any time, with the single exception of needlegrass sampled May 21.

Phosphorus Content

Effects of fertilization and stage of growth on phosphorus content are given in Table 2. It may be observed that phosphorus in the grasses ranged from 0.51 percent in nitrogen-treated Junegrass at the medium vegetative growth stage to 0.09 percent in untreated little bluestem and prairie dropseed at the mature stage. As with protein content, the cool-season grasses were higher in phosphorus at growth stages up to jointing time than were warm-season grasses at corresponding growth stages. In many instances, fertilizer treatments increased the phosphorus content of the grasses. The differ-

ences in phosphorus content of fertilized and untreated grasses were greater in the earlier growth stages than in the later growth stages. In the majority of the cases, fertilization with ammonium nitrate produced greater increases in the phosphorus content of the grasses than did the application of superphosphate. The cool-season grasses at earlier growth showed greater increases in phosphorus content resulting from the fertilizer treatments than warm-season species at corresponding growth stages. Again, as with protein content, cool-season species retained this advantage in phosphorus content to a more advanced stage of growth; but differences were much less at the jointing stage, only slightly apparent at flowering, and were usually not discernible in mature or partly weathered material. As a rule, the phosphorus content of a grass was greatest in the earliest stage of growth and steadily became less as the plant developed and matured; but autumnal regrowth of western wheatgrass and needlegrass after a cutting for hay, and the regrowth of prairie dropseed after a previous cutting, showed an increase in phosphorus content in comparison to that of a preceding growth stage.

The nitrogen-treated vegetation was much darker in color and much more robust than the unfertilized or phosphated plots. This was especially true in the early part of the season, when the cool-season grasses were the principal components. Warm-season grasses responded less in color and growth to the application of nitrogenous fertilizer, but all species except big bluestem responded with increased phosphorus content at early vegetative growth stages.

Phosphorus fertilization produced a higher phosphorus content in both cool and warm-season grasses. This effect extended throughout all growth stages of the cool-season species, but was not always apparent in the late stages of warm-season grasses. Nevertheless, the warm-season grasses did show a delayed decrease as they matured. Irrespective of the treatment, they maintained higher phosphorus levels for a longer period of the year than the cool-season grasses. Thus the general downward trend of phosphorus content, as the plant developed, was similar to that of protein. This has been the observation of most investigators and in the present study was more clearly defined in cool-season than in warm-season species.

Calcium Content

Calcium in the tissues of range grasses is generally not deficient. Such was the case in the present study. For convenience of presentation of data, tabulation of calcium content at varying growth stages as influenced by fertilization has been omitted. However, the calcium in the grasses ranged from 0.12 percent in untreated western wheatgrass at the late jointing stage to 0.48 percent in phosphorus-treated big bluestem at the early vegetative stage. In general, the calcium content was more erratic than phosphorus or protein content. Junegrass was the only species which seemed to show a consistent downward trend in calcium content at successive stages of development, but more than half of the species were lower in calcium content in the post-flowering stages than in earlier stages. Blue grama and prairie dropseed, which tended to maintain rather high phosphorus and protein contents for a longer period of the year, showed increases in calcium content in post-flowering growth.

At the two early harvests the calcium content of cool-season grasses from superphosphate plots was higher than that from the nonfertilized plots, but lower than the ammonium nitrate plots. The three

TABLE 2

Effects of nitrogen and phosphorus fertilization on the protein and phosphorus content of native grasses at varying growth stages

SPECIES AND STAGE OF PLANT GROWTH	HARVEST DATES 1947	EFFECT ON PROTEIN			EFFECT ON PHOSPHORUS		
		60 lbs. nitrogen per acre	80 lbs. P_2O_5 per acre	Untreated	60 lbs. nitrogen per acre	80 lbs. P_2O_5 per acre	Untreated
		Percent	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*
Cool-season species							
Junegrass							
Early vegetative	4/21	27.1‡	21.1	20.1	0.40‡	0.41‡	0.31
Medium vegetative	5/3	30.3‡	17.7	18.2	0.51‡	0.37‡	0.29
Late jointing	5/23	17.8‡	11.3	10.7	0.31†	0.33‡	0.27
Anthesis	6/17	8.6†	6.8	7.4	0.26	0.29†	0.26
Seed shattering	8/12	4.1	4.3	3.5	0.12	0.14	0.11
Western wheatgrass							
Early vegetative	4/26	28.7‡	19.7	19.5	0.41‡	0.36	0.34
Medium vegetative	5/3	28.8‡	18.5	18.5	0.38‡	0.33‡	0.28
Late jointing	6/7	13.0‡	11.6	10.6	0.31	0.31	0.29
Anthesis	6/24	8.3†	7.5	7.2	0.28†	0.28†	0.26
Culms curing	8/13	5.2	5.5	5.0	0.15	0.16	0.15
Autumnal regrowth	10/27	—*	—	18.0	—	—	0.21
Needlegrass							
Early vegetative	5/3	23.7‡	17.4	16.2	0.37‡	0.27†	0.22
Late vegetative	5/21	18.0‡	13.2†	11.5	0.27‡	0.22†	0.20
Late jointing	6/7	12.9‡	9.8	8.4	0.23†	0.20	0.19
Early anthesis	6/24	6.6	6.1	5.8	0.16	0.15	0.14
Needles shattering	8/15	5.6	6.2	6.3	0.11	0.15	0.10
Autumnal regrowth	10/27	—	—	10.5	—	—	0.18
Warm-season species							
Prairie dropseed							
Early vegetative	5/10	18.4‡	13.6	13.4	0.34†	0.33	0.30
Medium vegetative	6/11	11.2†	9.7	10.0	0.18	0.20	0.16
Early jointing	8/14	6.6	6.0	6.2	0.18	0.22	0.19
Seed shattering	9/13	6.5	5.0	6.1	0.25	0.22	0.26
Increased maturity	10/27	5.9	4.9	5.8	0.16	0.17	0.16
Autumnal regrowth	10/27	—	—	9.8	—	—	0.20
Little bluestem							
Early vegetative	5/23	15.7†	13.5	13.7	0.28†	0.27	0.24
Late vegetative	6/14	12.4†	10.5	10.2	0.26†	0.25	0.22
Late jointing	8/5	6.8	6.1	6.0	0.19†	0.19†	0.15
Seed shattering	9/13	5.2	3.9	4.0	0.17	0.16	0.14
Mostly weathered	10/27	2.3	2.1	2.5	0.09	0.10	0.09
Autumnal regrowth	10/27	—	—	3.4	—	—	0.14
Big bluestem							
Early vegetative	5/26	14.4	14.7	14.3	0.30	0.34†	0.31
Late vegetative	6/15	11.1†	9.3	9.8	0.25	0.22	0.20
Late jointing	7/28	7.3	6.8	5.8	0.18	0.23†	0.18
Early anthesis	8/10	5.0	5.0	4.5	0.15	0.14	0.14
Panicles shattering	9/13	4.4	3.9	4.1	0.19	0.18	0.18
Increased maturity	10/27	2.0	1.8	2.0	0.12	0.12	0.14
Autumnal regrowth	10/27	—	—	9.0	—	—	0.25

TABLE 2—*Concluded*

SPECIES AND STAGE OF PLANT GROWTH	HARVEST DATES 1947	EFFECT ON PROTEIN			EFFECT ON PHOSPHORUS		
		60 lbs. nitrogen per acre	80 lbs. P_2O_5 per acre	Untreated	60 lbs. nitrogen per acre	80 lbs. P_2O_5 per acre	Untreated
		Percent	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*
Warm-season species—Continued							
Blue grama							
Early vegetative	5/26	16.7†	12.3	12.3	0.30†	0.30†	0.25
Medium vegetative	6/25	9.5†	8.3	8.6	0.24	0.26	0.25
First racemes exerted	7/30	8.8	9.0	9.9	0.23	0.24	0.22
Variable	9/23	11.5	10.7	11.5	0.22	0.22	0.21
Side-oats grama							
Late vegetative	6/20	13.4‡	10.8	10.6	0.33‡	0.29‡	0.24
Medium jointing	7/17	7.2	7.8	7.4	0.25	0.29‡	0.24
Anthesis	7/28	5.7	5.5	5.9	0.20	0.22	0.18
Variable, more mature	8/14	4.5	4.4	4.6	0.19	0.22	0.18
Variable, more mature	9/23	3.8	3.6	3.6	0.19	0.17	0.18
Mostly weathered	10/27	2.8	2.8	2.9	0.11	0.12	0.09

* Vegetation not analyzed.
† Significant at .05 level.
‡ Significant over untreated at .01 level.

nitrogen-treated cool-season species were significantly higher in calcium content at the early vegetative stage than were the same species treated with superphosphate or left untreated. As a rule, the response of individual species to fertilizer treatment was less consistent as to calcium content than it was in regard to phosphorus and protein contents.

Nutrients in Mixed Herbage

Yields and phosphorus, calcium and protein contents of mixed herbage are shown in Table 3. Probably the most striking observation is the great increase in yield resulting from the use of nitrogen fertilizer on the native vegetation. Ammonium nitrate treated plots yielded 4.5 times as much dry matter at the May harvest, three times as much when cut in June, and twice as much at the August cut, as the nonfertilized plots. The nitrogen treatment also produced significantly higher phosphorus and protein per-

TABLE 3

Yield and composition of mixed herbage from fertilized plots on native grass prairie

SOIL TREATMENT	YIELD	PHOSPHORUS CONTENT	CALCIUM CONTENT	PROTEIN (6.25 N) CONTENT
Lbs. per acre	*Tons per acre*	*Percent*	*Percent*	*Percent*
Sampled May 20, 1947				
None	0.50	0.23	0.34	9.8
60 nitrogen	2.28*	0.29*	0.30	15.4*
80 P_2O_5	0.55	0.25	0.35	11.1
Sampled June 27, 1947				
None	0.76	0.19	0.33	7.0
60 nitrogen	2.38*	0.26*	0.27	8.1†
80 P_2O_5	0.96	0.21	0.36	7.0
Sampled August 5, 1947				
None	1.20	0.19	0.41	5.0
60 nitrogen	2.64*	0.24	0.43	5.1
80 P_2O_5	1.50	0.19	0.41	4.9

* Significant at .01 level, compared to untreated.
† Significant at .05 level.

centages in the May and June cuttings of hay.

Application of superphosphate produced approximately 25 percent apparent increases in yield of later cuttings, and a significant increase in phosphorus content of the first cutting of mixed herbage.

Discussion

Clippings of the early vegetative stage of Junegrass were slightly lower in phosphorus and protein than those of the medium vegetative stage. Early growth of Junegrass produced after dormancy may have contained sufficient amounts of dormant material low in nutrients to influence the protein and phosphorus content. With the exception of this species, any grass sample composed of vegetation in a clearly defined growth stage was always higher in phosphorus and protein than a similar sample of the same species at a more mature stage. Accordingly, species such as blue grama seldom show clearly defined growth stages after early season growth. Blue grama may have young, flowering, and mature vegetation on the same plant at the same time. As a result, phosphorus and protein in such species and the general downward trend with advancing season are influenced in part by the proportions of material composing the sample. This observation is in general agreement with those of other workers and may indicate that a grass which remains in the vegetative stage of growth for a long period usually has a more desirable phosphorus and protein concentration than one with early culm formation. The last three growth stages of prairie dropseed illustrate such an effect.

For comparing the behavior of the species as a whole, particularly for satisfying the requirement of an 800 pound beef steer, it is difficult to designate an exact growth stage where phosphorus or crude protein had decided decreases. Late growth stages composed of mature and partly-weathered material with seeds shattered would be most striking from the viewpoint of physiological importance to the animal. It is near this growth stage that phosphorus concentration becomes insufficient for normal growth of an 800 pound beef steer considered to consume 16 pounds of dry matter per day. However, crude protein at the late growth stages would be of much greater importance since undernourishment in this constituent may immediately limit production or prevent it entirely. In contrast, low phosphorus levels in range grasses in late season apparently are not of immediate importance because reserves in the animal's body may sustain it over a rather lengthy period of inadequate intake without seriously affecting productive performance (Fraps and Fudge, 1940). Those stages of plant maturity when seeds or inflorescences or both began to shatter, and foliage began to cure or turn brownish-colored, were usually suboptimal in crude protein. Little bluestem, big bluestem, and sideoats grama were strikingly deficient in this constituent at the last growth stages after seeds began to shatter.

Many studies from various regions of the world have shown that certain areas produce native vegetation below the optimal nutritional requirements for cattle, but in other areas an adequate supply of constituents has been found. Calcium deficiencies in feeds under drylot condition have been found to cause disturbances in the health of animals (Eckles *et al.* 1932), but few range grasses have been found deficient in this element (Fudge and Fraps, 1944). Protein deficiencies often were found to be coexistent with phosphorus deficiencies.

Compared with analyses from in-

vestigations in other grasslands, the constituents in the present study were relatively high. However, blue grama was the only species investigated that contained both phosphorus and crude protein at levels sufficient for normal growth throughout the period of the study. Although not especially high above requirements adequate for normal growth in any of the constituents, blue grama retained the levels of its intermediary stages of growth for a relatively long period. In fact, there was a slight increase in protein at the time other prairie grasses were very low in concentration. Differences in the response of blue grama may have resulted from closer clipping, a practice that would include larger amounts of meristem tissue in the sample providing richer protein and phosphorus.

Summary and Conclusions

1. Experimental plots were established on an area of upland true prairie near Lincoln, Nebraska, to study the effect of nitrogen and phosphorus fertilization on the phosphorus, calcium, and protein concentration in eight climax grasses at several successive stages of growth during 1947.

2. Samples of Junegrass, western wheatgrass, needlegrass, prairie dropseed, little bluestem, big bluestem, blue grama, and side-oats grama were harvested at dates ranging from April 21 to October 27. Samples represented as clearly as possible varying growth stages of advancing maturity between these dates.

3. Phosphorus content of grasses varied from 0.51 percent in nitrogen-treated Junegrass at the medium vegetative growth stage to 0.09 percent in unfertilized little bluestem and prairie dropseed at the mature and partly weathered stage.

4. Calcium content of grasses ranged from 0.48 percent in phosphorus-treated big bluestem at the early vegetative growth stage to 0.12 percent in unfertilized western wheatgrass at the late jointing stage.

5. Crude protein in the grasses varied from 30.3 percent in nitrogen-treated Junegrass at the medium vegetative growth stage to 1.8 percent in phosphorus-treated little bluestem harvested October 27.

6. Nitrogen-treated cool-season grasses were higher in phosphorus and protein at growth stages up to jointing time than warm-season grasses, irrespective of fertilization, at corresponding growth stages.

7. Calcium content of all species except Junegrass was inconsistent and erratic compared with the general downward trends observed with phosphorus and crude protein.

8. Nitrogen fertilization resulted in greatly increased growth of the cool-season grasses. Yield of mixed vegetation where these species were the principal components was increased fourfold.

9. It may be concluded from a consideration of the data obtained that an 800-pound beef steer whose sole ration consisted of 16 pounds daily of dry matter having the composition of that in this study would consume adequate phosphorus and calcium for normal growth. Protein might be a limiting factor for normal growth from early August until new growth was produced by favorable environmental conditions.

Acknowledgment

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JOURNAL DEADLINES—1953

The following are the dates copy must be in Baltimore, Maryland for the next several issues:

Issue	*Copy in Baltimore*
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Controlling Big Sagebrush with Growth Regulators

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THE possibility of using chemical sprays to kill big sagebrush (*Artemisia tridentata*) in a range improvement program is both interesting and promising. This paper presents the information gained from spraying big sagebrush with 4 formulations at 1, 2, and 3 pounds of acid equivalent per acre on 9 dates during the months of April, May, June, and July, 1950.

This one-year study was planned to evaluate the possibility of practical control of big sagebrush by spraying, and to evaluate the scope of research needed as a basis for recommendations. The results and interactions reported may be of importance to an understanding of past results and to the planning of future trials.

Review of Literature

A limited study was conducted at Squaw Butte, Burns, Oregon, by W. A. Sawyer and J. A. Singley during 1946. Sodium salt of 2,4-D was applied in 200 gallons of water per acre at acid equivalent rates of 1 to 8 pounds per acre inclusive on May 1, May 15, June 1, and June 15. The most favorable dates of application were June 1 and May 15. Significance was not found among rates of application (unpublished data). It was observed that mature sagebrush was affected more seriously than immature brush.

In Wyoming spraying on May 25 was more favorable than June 15, 1949 (Hull and Vaughn, 1951). In general 2,4-D butyl ester gave better results than did mixtures of 2,4-D and 2,4,5-T. Application of 1.5 pounds of acid gave 70 percent kill and 3 pounds gave 81 percent. The age and size of the sagebrush plants did not appear to influence the mortality rate.

Cornelius and Graham (1951) reported active growth of big sagebrush from May 1 to August 1, and concluded that the average period of most active growth, and the period during which spraying would be most effective, may be expected between May 1 and June 10. Butyl ester of 2,4-D applied on June 30, 1948, resulted in a high mortality.

Results from 1949 applications in Colorado (Colorado A. & M. College, et al, 1950) indicated that 2,4-D butyl ester was more effective than a 2:1 mix of 2,4-D and 2,4,5-T, and sodium salt of 2,4-D was least effective. The mix was superior to 2,4-D in 1950, and 2,4,5-T was superior to the mix (Colorado A. & M. College, et al, 1951). Spraying during 1950 with 2,4,5-T on May 27 was more effective than May 11 or June 15; however, 2,4-D was most effective when applied on June 15. A kill of 72 percent was attained with an application of 2 pounds of 2,4,5-T on May 27. On that date 57 percent of the sagebrush was killed with

[1] Squaw Butte-Harney Range and Livestock Experiment Station is jointly operated by the Bureau of Land Management, U. S Department of the Interior, and Oregon Agricultural Experiment Station, Oregon State College, Corvallis, Oregon. This report is published as technical paper No. 730 with approval of the Director, Oregon Agricultural Experiment Station.

a 2-pound application of 2,4-D. Spraying on a "swale" site was more effective than on either a side-hill or ridge-top.

Unpublished studies (Timmons, 1951) in Montana and Utah indicate rather similar results, but with a few noticeable variations. An interesting possibility is that of effective applications during the late-seed stage of big sagebrush.

Materials and Methods

Description of the Area

Squaw Butte range land is located about forty miles west of Burns in Harney County, southeastern Oregon. Elevation of the station range land varies from 4,600 to 5,200 feet above sea level.

This big sagebrush semi-desert range is predominately a sagebrush-bunchgrass type intermixed with juniper types. The forage is provided by bunchgrasses with very few palatable shrubs or forbs. Foremost among the grasses are bluebunch wheatgrass (*Agropyron spicatum*), Idaho fescue (*Festuca Idahoenisis*), Sandberg bluegrass (*Poa secunda*), Thurber needlegrass (*Stipa thurberiana*), squirreltail (*Sitanion hystrix*), and June grass (*Koeleria cristata*).

The average annual precipitation during the 14 years, 1937–1950 inclusive, was 11.58 inches with variation from 5.41 inches during 1949 to 15.93 inches during 1941. Although there was extreme variation between months and years, the precipitation was somewhat more concentrated during the winter months. Average monthly precipitation was highest during June, but June was the month of heaviest precipitation only twice during the 14 years. July and August were the months of lightest precipitation by average.

Design of Experiment

The experiment was conducted as a factorial in three randomized blocks located to attain a near maximum difference between the blocks.

Block number one was located on a bottom site in a dense stand of old mature sagebrush with an understory dominated by sagebrush seedlings. The soil is fine loamy sand and supports an average of 109 sagebrush per 500 square feet. Mature sagebrush was about four feet high with a few plants as high as seven feet.

Block number two was established about fifty yards from number one on the same bottom site. The original stand of sagebrush on this area was grubbed during 1935, and now supports an average of 130 young mature sagebrush per 500 square feet and a thin understory of grass.

Block number three was established on a south exposed site with a shallow, rocky soil. The site supports an average of 31 old mature sagebrush per 500 square feet and a good understory of bluebunch wheatgrass and Thurbers needlegrass. The sagebrush on this site stands about two and one-half feet high.

Plots were 10 by 50 feet in size and placed adjacent to each other within each block.

Treatments

One hundred and thirty-five treatments were assigned to plots at random within each block.

Four chemical formulations and a check were included as follows:

1. A 1:1 mix of isopropyl esters of 2,4-D and 2,4,5-T was prepared with 2 gallons of stove oil emulsified in water and made up to a total spray volume of 10.9 gallons per acre. The stove oil was emulsified in water with a neutral detergent.

2. Sodium salt of 2,4-D was prepared with 2 gallons of stove oil emulsified in water and made up to a total spray volume of 10.9 gallons per acre.

3. Butyl ester of 2,4-D was mixed with

water to a total spray volume of 10.9 gallons per acre.

4. Butyl ester of 2,4-D was prepared with 2 gallons of stove oil emulsified in water and made up to a total spray volume of 10.9 gallons per acre.

5. Check. Not sprayed.

Rates of application were 1, 2, and 3 pounds of acid equivalent per acre.

Spray applications were made on the following 9 dates: April 18, May 2, May 16, May 24, May 30, June 8, June 15, June 20, and July 6, 1950.

Application of the Spray

Applications were made with a hand sprayer at a pressure of about 25 pounds per square inch. The fan-type spray from a single Teejet 8001 nozzle was well suited to spraying the plots.

Distribution was accomplished by observing the time required to disseminate the amount of spray required for a single plot. Each plot was covered lengthwise in both directions spraying downward upon the vegetation and soil with no special attempt to cover individual sagebrush thoroughly. The sprayer was washed with water after each material.

Some difficulty was encountered in dissolving the sodium salt of 2,4-D. The small amount of precipitate which remained after thorough mixing was permitted to settle, and the clear solution was poured off to prevent frequent spray stoppage.

Dates of application were not at consistent intervals because calm days were selected for spraying. Spray drift did not appear to be a serious source of error.

Collection of Data

All living sagebrush were counted on each plot prior to spraying in 1950 and again during the spring growth period of 1951. Since a plant was considered alive if a single live branch remained, the percentage-kill data does not fully evaluate the effectiveness of the chemicals in reducing the demand of sagebrush for soil moisture and nutrients.

Complementary data was taken on precipitation, atmospheric temperature, humidity, and plant development. Soil temperature and soil moisture readings were taken on a number of plots in block number one. Soil moisture readings were taken with a Bouyoucos Soil Moisture Meter (Bouyoucos, 1950).

Results

The poor and inconsistent effectiveness of 2,4-D sodium salt (Table 1) is given initial consideration. The manner in which the sodium salt solution was prepared may have lowered its effectiveness.

To permit unrestricted consideration of the effectiveness of the 3 ester formulations, the results from their respective plots were segregated and analyzed. The subsequent reduction in coefficient of variation was from 30.2 percent with all plots, to 9.6 percent with ester-treated plots.

All main effects and interactions, except the interaction of formulation by rate, were significant in analysis of variance. Those significant sources of variation gave F values larger than the corresponding tabular values at a probability level of 0.01.

Difference among Blocks

Average sagebrush mortality was 77, 71, and 69 percent respectively for blocks 1, 3, and 2. The least significant difference at 0.05 probability is 3 percent.

Two factors are of major importance in considering the "very significant" difference among blocks. Those two factors are age of the sagebrush and site exposure. The observed difference between blocks one (old mature sagebrush, bottom site) and two (young mature sage-

brush, bottom site) was the age of the sagebrush, and the difference between blocks one and three (old mature sagebrush, south exposed site) was site quality and exposure.

The effectiveness of the chemicals was higher on the south exposed site when applied on May 2 and 16 but dropped off more quickly and consistently than on the bottom site. This difference in mortality between blocks one and three is supported by plant development data which indicates that plant growth was earlier but of somewhat shorter duration on the south exposed site than on the bottom site.

TABLE 1

Percent mortality of sagebrush resulting from the application of four separate "growth regulator" formulations at different dates

FORMULATION*	DATE OF APPLICATION									AVERAGE MORTALITY
	April	May				June			July	
	18	2	16	24	30	8	15	20	6	
No. 1	85	89	92	88	87	74	74	51	32	75
No. 2	21	39	31	35	28	32	48	24	12	30
No. 3	66	84	82	85	77	83	78	51	29	70
No. 4	69	85	86	87	75	82	72	66	30	72

* The formulations were as follows:
1. A 1:1 mix of isopropyl ester of 2,4-D and 2,4,5-T.
2. Sodium salt of 2,4-D.
3. Butyl ester of 2,4-D in water.
4. Butyl ester of 2,4-D in an oil emulsion.

Apparently, young mature sagebrush was more resistant to the growth regulators than old mature sagebrush, but not consistently so. The mortality of young sagebrush resulting from spraying on May 30 and June 8 was higher than that of old sagebrush (Fig. 1).

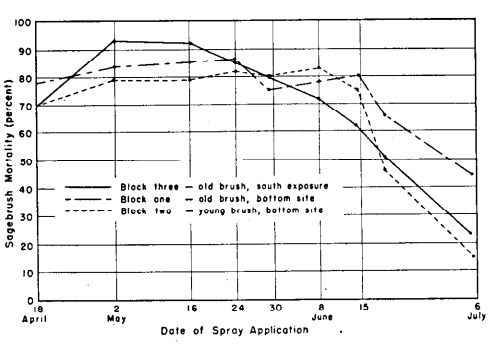

FIGURE 1. Average percent mortality of big sagebrush on the separate blocks resulting from 1, 2, and 3 pound applications of 1:1 mix of isopropyl esters of 2,4-D and 2,4,5-T in oil emulsion, 2,4-D butyl ester in water, and 2,4-D butyl ester in an oil emulsion.

Difference among Formulations

Average sagebrush mortality was 75, 72, and 70 percent respectively for the 1:1 mix of isopropyl esters of 2,4-D and 2,4,5-T in oil emulsion, butyl ester of 2,4-D in oil emulsion, and butyl ester of 2,4-D in water (Table 1). The least significant difference at 0.05 probability is 3 percent.

The 1:1 mix was significantly better than the butyl ester of 2,4-D; although the higher cost of 2,4,5-T at the present time may offset that advantage. Table 1 shows that the advantage was not consistent through all dates of application, but was of a seasonal nature which contributed to the "very significant" inter-

action of formulation by date. The 1:1 mix was consistently better than the butyl ester formulations during April and May applications, but was generally lower in effectiveness during June and July applications.

No significant advantage was gained by including stove oil as a part of the carrier of butyl ester of 2,4-D. The periodic reversion in mortality between the water and oil emulsion carriers is interesting. Of special interest is the large difference on June 20 when the oil emulsion attained a mortality of 66 percent as compared with 51 percent for the water carrier. The data is too limited to justify any conclusion; although, the outstanding difference on June 20 was uniform among the blocks.

Rate of Spray Application

Average sagebrush mortality was 63, 74, and 81 percent respectively for 1, 2, and 3 pounds of acid equivalent per acre. The least significant difference at 0.05 probability is 3 percent.

Of more importance is the average mortality for the separate rates during the first 3 applications in May; namely 77, 89, and 93 percent respectively for the 1, 2, and 3 pound rates.

Date of Spray Applications

The most favorable dates of application were May 2, May 16, and May 24 (Fig. 2).

The percent of sagebrush killed on June 8 and June 15 is interesting when considered with the percent of available soil moisture. Available soil moisture at the 6-inch level increased from 37 percent on June 5 to 66 percent on June 19. The precipitation received during early June increased the soil moisture level as deep as 12 inches below the surface, and apparently sustained growth activity of the sagebrush. This indicates the possibility of extending the period of application during favorable years.

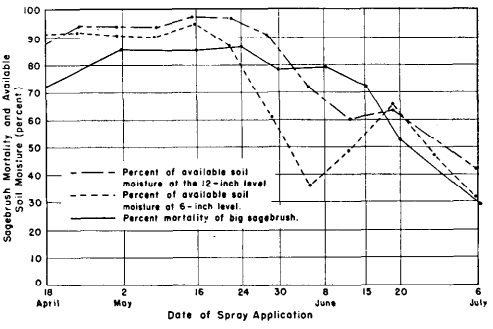

FIGURE 2. Percent mortality of big sagebrush by dates of application with available soil moisture in percent. (Average mortality resulting from 1, 2, and 3 pound applications of 1:1 mix of 2,4-D and 2,4,5-T in oil emulsion, 2,4-D butyl ester in oil emulsion, and 2,4-D butyl ester in water.)

DISCUSSION AND CONCLUSIONS

Since variation among blocks may be due to factors other than age and site, no facts can be drawn concerning age and site from the data presented. However, the writer believes that age and site are factors which caused a difference in the effectiveness of the spray applications, and that the differences among blocks are not misleading with respect to those two sources of variation.

The indication that site and exposure may influence the effectiveness of the growth regulators was also reported from Colorado (Colorado A. & M. College, et al, 1951). In the present study spring growth activity resumed at an earlier date on a south exposed site than on a bottom site and was of shorter duration. The exposure, shallower soil, degree of slope, and denser understory of grass on the south exposed site would tend to decrease the amount of moisture retained in the soil and to increase its rate of depletion. Since the effectiveness of the

chemicals was higher on the south exposed site when applied on May 2 and May 16, then dropped off more quickly than on the bottom site, the difference in sagebrush mortality between blocks one and three (Fig. 1) seems reasonable. The importance of spraying early in the growing season on large areas with changing slope and exposure is emphasized. It is probably better to spray too early than too late—the first three weeks of May is indicated.

That young plants may be more difficult to kill than old plants during the early season growth period (Fig. 1) supports the earlier observation at Squaw Butte in 1946. A similar observation was made in Colorado (Colorado A. & M. College, et al, 1950). However, Hull and Vaughn (1951) do not report differences in effectiveness due to age. Age is a probable source of variation in the effectiveness of growth regulators that may fluctuate with season, rate of application, and other factors. Such a possibility may be of benefit in selecting a rate of application, date of spraying, and the sites which will make the most economical improvement following spraying.

The poor and inconsistent effectiveness of 2,4-D sodium salt is not an isolated case (Colorado A. & M. College, et al, 1950). A preliminary trial in 1946 at Squaw Butte with 2,4-D sodium salt showed very inconsistent results. Although the difficulty encountered by the writer in dissolving sodium salt may have been a cause of poor and inconsistent results in the present study, another possible cause is apparent. Freed (1951) reported that for the control of annual weeds the ester formulations of 2,4-D are probably more effective than salt (amine or sodium) formulations because they are more able to wet plants and be absorbed by them. This difference in ability to wet plants and be absorbed by them seems equally true with respect to big sagebrush.

A 1:1 mix of isopropyl esters of 2,4-D and 2,4,5-T was more effective in killing big sagebrush than butyl ester of 2,4-D. Since 2,4,5-T is more costly than 2,4-D, its effectiveness on big sagebrush does not appear sufficient to justify its use at the present.

A highly significant interaction between formulations and dates of application emphasizes the importance of comparing formulations throughout the period or periods when favorable mortality might result rather than rely upon results attained from a single date of application. The most effective formulation on a given date may not be the best even 2 weeks later or earlier.

An oil emulsion with 2,4-D butyl ester was not better than water, each at 10.9 gallons of solution per acre. However, there is an indication that the oil emulsion spray remained effective at a later date than did water.

A rate of application of 1 to 2 pounds of acid equivalent per acre seems necessary for a suitable sagebrush kill. However, the degree of mortality which is most desirable and economical is speculative. It may be better to rely upon a one-pound rate of application repeated at intervals of 10 to 15 years rather than heavier applications.

The most favorable period of spray application included the applications on May 2, 16, and 24. A significant reduction of 7 percent in mortality occurred between May 24 and May 30 (Fig. 2). One and fifty-four hundredths inches of precipitation during the first 17 days of June apparently extended the period during which the growth regulators effectively killed big sagebrush. It appears that the period during which physiological changes rapidly increase plant resistance would have occurred between June 8 and

June 20 under continuously favorable moisture conditions.

Soil moisture was an important factor in determining the conclusion of the period during which growth regulators effectively killed big sagebrush. The possibility of using a plant development index of the soil moisture level was considered. Sandberg bluegrass appears to be a promising indicator. On May 23 Sandberg bluegrass growing on the bottom site was in early flower and was beginning to lose green color. Its development on the south exposed site was about a week earlier. It is tentatively concluded that a noticeable loss of green color in the leaves of Sandberg bluegrass can be used as an indication of the conclusion of the period during which spray applications will result in maximum effectiveness. However, during those years when late May and early June precipitation is well above average, spraying can probably be continued until about the middle of June.

Practical application of growth regulators for the control of big sagebrush is assured, if total spray volume can be sufficiently reduced to bring costs in balance with benefits.

Summary

1. This study of big sagebrush control was conducted at the Squaw Butte-Harney Range and Livestock Experiment Station about forty miles west of Burns, Oregon, on sagebrush-bunchgrass range having an elevation of 4,600–5,200 feet and a mean annual precipitation of 11.58 inches.

2. Four separate formulations of 2,4-D and 2,4,5-T were applied at 1, 2, and 3 pounds of acid equivalent per acre on 9 dates during April, May, June, and July 1950.

3. The treatments were applied as a factorial in 3 randomized blocks. Two of the blocks were located on a bottom site but segregated by a sharp demarcation in age of the sagebrush, and the third block was located on a south exposed site supporting old mature sagebrush.

4. Living sagebrush plants were counted on all plots during the spring of 1950 prior to spraying and again during the spring of 1951. The reduction in number of living plants was expressed in percent of the initial count for an evaluation of mortality.

5. The average mortality of old mature sagebrush was 77 percent, and the mortality of young mature sagebrush on a similar site was 69 percent.

6. Sagebrush mortality was greater on the south exposed site following May 2 and May 16 treatments, but dropped off more quickly and consistently than on the bottom site.

7. A 1:1 mix of isopropyl esters of 2,4-D and 2,4,5-T in an oil emulsion caused an average mortality of 90 percent when applied on May 2, 16, and 24; whereas, 2,4-D butyl ester in an oil emulsion killed 86 percent, 2,4-D butyl ester in water killed 84 percent, and 2,4-D sodium salt in an oil emulsion killed 35 percent.

8. The most favorable period of spray application included the applications on May 2, 16, and 24, 1950.

9. Early June precipitation apparently extended the period during which the growth regulators effectively killed big sagebrush.

10. An average mortality of 77, 89, and 93 percent was caused by applications of 1, 2, and 3 pounds of acid equivalent per acre respectively when applied during May. Those average results include all the formulations used except 2,4-D sodium salt.

11. A noticeable loss of green color in the leaves of Sandberg bluegrass may be a valuable indicator of the conclusion of

the period during which spray applications will result in maximum effectiveness.

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Annual Fluctuation in Production of Some Eastern Oregon and Washington Shrubs

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SHRUBS are an extremely important source of forage for livestock and big game in the forested ranges of Oregon and Washington east of the crest of the Cascade Mountains. On about 19 percent of the forested summer range the understory is made up mainly of shrubs; on the remainder, appreciable amounts of shrubs are associated with the more abundant grasses and forbs (herbaceous plants other than grasses or grasslike plants). The browse (or forage) furnished by many of these shrubs is important because it retains a fairly high nutritive content during the late summer, fall, and winter. At this time grass and forb herbage, even if not under a snow crust, is low in nutritive value, and the shrubs are heavily used by livestock and big game.

Management of ranges where there is considerable dependence upon shrubs has generally been based on the concept that browse production is fairly constant from year to year. This concept may stem from the year-around presence of woody plant parts, the long life, or the evergreen habit of some species. In other words, fluctuations in browse yields are commonly thought to be minor in comparison to differences among years in grass yields.

Yet biotic and climatic factors have been reported to cause severe reductions in shrub production. Girdling by rodents, defoliation by Great Basin tent caterpillars (*Malacosoma fragilis*), winter-kill, gall, rust, and excessive browsing can seriously injure or destroy antelope bitterbrush (*Purshia tridentata*) (Hormay, 1943). Damage to snowbrush ceanothus (*Ceanothus velutinus*) by both winter-kill and a defoliating caterpillar (*Nymphalis californica*) has been reported (Dahms, 1950). In Idaho 15 to 75 percent of new growth on redstem ceanothus (*Ceanothus sanguineus*) was killed in 1942 by a late spring frost, the severest damage occurring on southerly exposures (Young and Payne, 1948).

The effect of moisture conditions on average twig length of true mountain mahogany (*Cercocarpus montanus*) has been observed (Forsling and Storm, 1929). Computations made from southwestern Utah observations show the 1925 twig increment was 3.4 times the 1924 twig growth, moisture conditions in 1924 being less favorable for plant growth.

Grass, forb, and shrub cover measurements made in the Snake River plains of Idaho show the effect of the 1934 drought (Pechanec, Pickford, and Stewart, 1937). Computations made from a four year summary of 140 density-estimate plots show the density (coverage) for all grasses in 1933 was 3 times their density in 1934 and density for all forbs in 1935 was 5.1 times their density in 1934. The density-estimate method showed smaller changes, however, for shrubs. As a class, their greatest density occurred in 1933 and was 2.3 times their density for the dry year of 1934. Density of one shrub, downy rabbitbrush (*Chrysothamus puberulus*), in 1935 was 3.8 times its 1934 density.

The density of only one grass species fluctuated more widely, but variations in density of all principal forbs were decidedly greater.

Green-weight yields of grasses, forbs, and shrubs from 150 plots in eastern Oregon pine forest were measured by the weight-estimate method on both a wet and dry year (Harris, 1951). It was found the change in yield of pinegrass (*Calamagrostis rubescens*), elk sedge (*Carex geyeri*), or any other grass of importance between 1948 and 1949 was not significant, even though 1948 was a very wet year and 1949 was one of the driest on record. Of the important forbs only heartleaf arnica (*Arnica cordifolia*) showed a significant change; its 1948 production was 26 times its 1949 production. Among the shrubs no significant change in yield was found for two species, creeping mahonia (*Mahonia repens*) and *Rosa* spp., but shinyleaf spirea (*Spiraea lucida*) yielded 2.2 times more, and common snowberry (*Symphoricarpos albus*) yielded 1.8 times more herbage in 1948 than in 1949.

Twig length observations made in shrub studies by Julander (1937) and Young and Payne (1948) could also be used to demonstrate variation among years in shrub production.

In the foregoing review, evidence is presented which shows annual yield of some shrubs can fluctuate as much or more than grass yields. However, it appears shrub production does not vary as much from year to year as forb production. Further evidence of shrub fluctuation is presented here, from a study of proper use conducted by two U. S. Forest Service offices, the Pacific Northwest Forest and Range Experiment Station and the Pacific Northwest Regional office.

Field Layout and Procedures

The field layout of the proper use study consisted of a series of ¼-acre game-proof exclosures situated on National Forests in eastern Oregon and Washington. Within each exclosure or plot 15 plants of one of the following species were selected for study: antelope bitterbrush, snowbrush ceanothus, rubber rabbitbrush (*Chrysothamnus nauseosus*), creambush rockspirea (*Holodiscus discolor*), and big whortleberry (*Vaccinium membranaceum*). Three plants were assigned to each of five treatments and a prescribed amount of current growth was clipped from the treated plants each year. Clipping was done in the fall, mid- or late-winter; no clipping was done during periods of active growth. Time of harvest assigned each exclosure was used throughout the study. (Data on the effects of different intensities of clipping are to be presented in a later article).

Annual production (air-dry weight) records from this study have furnished the basis for most of the information to be presented here. During the four years of study it was found that for any one shrub species, fluctuations in production were similar regardless of clipping intensity. Therefore, for simplicity and to show variation in yield at a common utilization intensity, only data from the three plants that received the 50 percent clip in each plot will be presented for each of the five species studied. Records of production were multiplied by two to give total yield. Comparison between current production and precipitation were made for two plots where adequate precipitation records were available in the vicinity.

Antelope Bitterbrush

Variations in production of bitterbrush exemplified the effects of rodent attacks and annual variations in precipitation. In one instance (Plot No. 4), the yield for the year of greatest production, 1946, was about 3.2 times the yield in the poorest year, 1945 (Table 1). During

these same years the winter-summer precipitation, October through September, totaled 34.1 and 23.4 inches respectively as recorded by the nearest weather station having an altitude about the same as the study area (Fig. 1).

production in 1945 was 2.7 times its yield in 1948, a year considered to have above normal precipitation for the region in which this plot was located. Loss in productivity for that season probably can be attributed to extensive girdling of basal stems and some branches by rodents. Portions of the crowns died on girdled plants. Fluctuations in yield of the other two plots (No. 1 and No. 2) were rather small.

TABLE 1

Browse (or forage) production record of five shrub species

SPECIES	PLOT NO.	TOTAL TWIG YIELDS, THREE PLANTS PER PLOT*					ANNUAL YIELD ÷ LOWEST YIELD				
		1945	1946	1947	1948	1949	1945	1946	1947	1948	1949
		Grams									
Antelope bitterbrush	1	168	140	148	136	—	1.24	1.03	1.09	1.00	
	2	212	242	190	190	—	1.12	1.27	1.00	1.00	
	3	158	144	78	64	—	2.47	2.25	1.22	1.00	
	4	40	126	48	56	—	1.00	3.15	1.20	1.40	
Snowbrush ceanothus	5	—	1400	1180	2856	1420		1.19	1.00	2.42	1.20
	6	—	1420	1120	2056	1149		1.27	1.00	1.84	1.03
	7	—	950	660	1384	1204		1.44	1.00	2.10	1.82
Rubber rabbitbrush	8	154	126	232	216	—	1.22	1.00	1.84	1.71	
	9	538	752	648	334	—	1.61	2.25	1.94	1.00	
	10	878	642	1230	652	—	1.37	1.00	1.92	1.02	
Creambush rockspirea	11	196	780	420	330	—	1.00	3.98	2.14	1.68	
	12	386	556	600	480	—	1.00	1.44	1.55	1.24	
	13	38	40	20	20	—	1.90	2.00	1.00	1.00	
Big whortleberry	14	—	40	12	8	30		5.00	1.50	1.00	3.75
	15	—	28	10	12	12		2.80	1.00	1.20	1.20

* Yields shown for plot 4 are from only two plants; those for plot 13 from one plant.

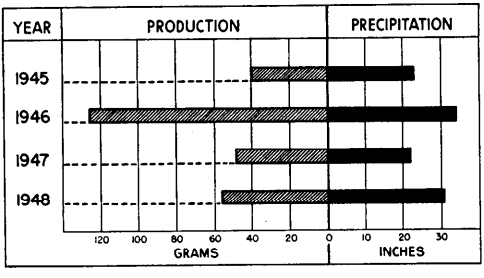

FIGURE 1. Comparison of antelope bitterbrush yields (Plot No. 4) and the annual precipitation recorded at Chemult, Oregon, for the winter-summer periods (October through September).

Fluctuation in yield of one of the other bitterbrush plots (No. 3) appeared to be mainly related to rodent damage. Its

SNOWBRUSH CEANOTHUS

Fluctuation in production of this species at all study locations appeared to reflect the annual variations for the October through September precipitation. Lowest yields for all snowbrush ceanothus plots occurred in 1947, a relatively dry year, and the greatest yield in 1948, when precipitation was much greater. However, only one plot (No. 5) was near enough to a weather station to permit

comparison of production and precipitation records (Fig. 2). This plot showed the greatest fluctuation in yield for this species; third annual harvest was 2.4 times the second harvest (Table 1). Maximum fluctuations for the other plots were not much less.

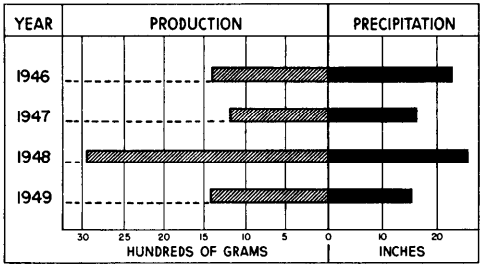

FIGURE 2. Comparison of snowbrush ceanothus yields (Plot No. 5) and the annual precipitation recorded at Austin, Oregon, for the winter-summer periods (October through September).

Insects demonstrated on this shrub that they are also a factor which can influence the amount of production. One of the three snowbrush ceanothus plots was attacked by cottonwood scale (*Chionaspis ortholobis*) about the time the study ended. The following year part of each clipped shrub died. Production of unclipped plants appeared unimpaired.

RUBBER RABBITBRUSH

Maximum fluctuation in yield of rubber rabbitbrush was less than that recorded for the other species studied. The yield for the year of greatest production in this case (Plot No. 9) was only 2.2 times as large as the low yield (Table 1). Variations in production were about the same magnitude for the other rubber rabbitbrush plots. Girdling by rodents in two plots was responsible for the low yields. In another instance (Plot No. 10) an infestation of various gall-forming insects of the families Itonidadae and Tephritidae restricted production by killing portions of the plants. These instances of low production occurred during years that were considered to have the most favorable moisture conditions for plant growth of the study period.

CREAMBUSH ROCKSPIREA

The largest fluctuation in production of creambush rockspirea was only exceeded by big whortleberry. At one location (Plot No. 11) the second annual yield of creambush rockspirea was practically 4 times the first harvest (Table 1). Maximum fluctuations at the other locations were only half as large or less. Weather records of the nearest Weather Bureau cooperators were too incomplete to permit a comparison of annual shrub production and precipitation records.

BIG WHORTLEBERRY

Big whortleberry production showed the largest yield variations of any shrub studied. Production of the most variable plot (No. 14), for the first year of the study, was 5 times the third harvest (Table 1). The greatest yield at the other location was 2.8 times the smallest harvest. Records of the nearest precipitation station were of no value in trying to explain these variations in yield. No rodent or insect damage to the shrubs was noted.

CONCLUSION

Biotic and climatic factors can cause wide variations in the annual production of shrubs. In a 4-year study in eastern Oregon and Washington on antelope bitterbrush, snowbrush ceanothus, rubber rabbitbrush, creambush rockspirea, and big whortleberry, variations in precipitation or damage by rodents and insects reduced the browse in some years to as little as one-third or one-fifth of

the production in other years. These fluctuations should be considered in grazing management for eastern Oregon and Washington shrub ranges.

ACKNOWLEDGMENT

The author is indebted to personnel of the Fremont, Malheur, Snoqualmie, and Whitman National Forests for their assistance in the establishment of plots and in some of the measurement work. Indebtedness to Robert S. Rummell for many of the field observations on cream-bush rockspirea is also gratefully acknowledged. Insect identifications were made by H. Morrison and R. H. Foote of the Bureau of Entomology and Plant Quarantine, U. S. Department of Agriculture.

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BOOK REVIEWS

JAMES BRIDGER, TRAPPER, FRONTIERSMAN, SCOUT, AND GUIDE. A HISTORICAL NARRATIVE. By J. Cecil Alter. 601 pp., illus. College Book Co., Columbus, Ohio, 1951. Special definitive edition, limited to 1,000 copies. $10.00.

JIM BRIDGER, GREATEST OF THE MOUNTAIN MEN. By Doris Shannon Garst. 242 pp., illus. Houghton Mifflin Co., Boston, 1952. $2.75.

JAMES BRIDGER, THE PATHFINDER OF THE WEST. By Louis O. Honig. 152 pp., illus. Brown-White-Lowell Press, Kansas City, Mo., 1951. Subscribers edition, limited to 500 autographed copies.

The variety of meshing interests in the scientific field of range management is well reflected not only in the diversified membership of the American Society of Range Management but also in the comprehensive nature of the articles contained in the Journal it sponsors. For this reason it does not seem out of place to call attention to the Bridger revival occurring in the field of Arts and Letters.

Jim Bridger (1804–1881) "resident of the West at large," could qualify as the ghost of range management (he certainly was not the father and that title is perhaps preëmpted). Simultaneously with the buffalo and the "virgin range" he was laid in an unmarked grave. After more than twenty years he was reburied in a marked grave. This was at the time the United States Forest Service started functioning in the field of range management. Now in the 1950s comes the Bridger revival coincident with the renewed interest in range management which is evidenced by the formation of the American Society of Range Management.

The essential greatness of Bridger is outlined on his 1904 tombstone as follows: "Celebrated as a hunter, trapper, fur trader, and guide. Discovered Great Salt Lake, 1824. The South Pass 1827. Visited Yellowstone Lake and Geysers 1830. Founded Ft. Bridger 1843. Opened Overland Route by Bridger's Pass to Great Salt Lake. Was guide for U. S. Exploring Expeditions, Albert Sidney Johnston's Army in 1857, and G. M. Dodge in U. P. Surveys and Indian Campaigns 1856–66." It is probable that trappers of the Astor party returning overland from the Pacific crossed South Pass before Bridger was there but it was Bridger who pointed the Oregon trail across it. Later to the south he showed the way for the Union Pacific railroad through Bridger Pass and Bridger was the first to see Two Ocean Lake and recognize that its waters flowed to separate oceans.

The books of Garst and Honig will satisfy quickly an interest in learning the recorded facts of Bridger's life and the principal legends of his feats. The work of Alter, however, goes much further in evaluating the record, in sympathetic treatment of hearsay, and in scholarly quotation of original sources, e.g. one reads in Alter's book (p. 587) "He says that twenty-five years ago the winter was very cold and the snow fell in the Salt Lake Valley, where he was encamped, for seventy days, at the rate of a foot a day. That the buffalo which then frequented the country west of South Pass, and all other animals, per-

ished, and since that time no buffalo have been seen west of the mountains."

One hopes that the Bridger revival is not ended—that a range manager will someday piece together the real virgin range as seen and lived in by Jim Bridger. Improbable as this may appear in the face of the handicaps (Bridger left no written record and had no schooling) there still remains the interesting possibility of reconstructing the facts as they must have been. Bridger knew about the numbers and kinds of game. He knew about the presence of feed for horses and the purity of water in the streams. Furthermore it is said by Maj. Gen. Dodge in his biographical sketch that "while Bridger was not an educated man, still any country that he had ever seen he could fully and intelligently describe, and could make a very correct estimate of the country surrounding it. . . . He never claimed knowledge he did not have of the country, or its history, and surroundings." Herein lies his importance to range management, for the field of synthetic bioecology is reaching a state of perfection whereby the accurate reports of animal numbers, of water supply and of feed or shelter must lead also to correlations in regard to the state of the virgin range.

Westerners may agree with Honig that Jim Bridger was "one of the greatest explorers in the History of the U. S." and that "in the short span of twenty years, he came to be recognized as having a greater knowledge of our western wilderness than any other human being" but range managers will feel unsympathetic toward Honig's interpretations of the few facts available when they read of Bridger Pass that "Sagebrush is almost the only vegetation, and it grows rough and ragged from one to three feet high. About the only real use ever found for this sagebrush was to make a quick fire for the emigrants' kettles." Of this country so close to the University of Wyoming campus he says "There is very little to redeem this area from utter worthlessness." Perhaps the illiterate Bridger knew and understood the West better one hundred years ago.—*Alan A. Beetle.* College of Agriculture, University of Wyoming, Laramie, Wyoming.

INDICATORS OF CONDITION AND TREND ON HIGH RANGE-WATERSHEDS OF THE INTERMOUNTAIN REGION. By Lincoln Ellison, A. R. Croft and Reed W. Bailey, Intermountain Forest and Range Experiment Station, Ogden, Utah. U. S. Dept. of Agr. Handbook No. 19, pp. 1–66. 1951.

Probably no phase of range management has received more attention during the past fifteen years than that of "condition" and "trend." This is a natural emphasis, for what could be more important than sound evaluation of "range health" and its tendency to improve or retrogress? The present publication constitutes an important contribution in this field, summarizing as it does the results of more than a decade of study on high mountain lands of the Intermountain Region. Written in highly readable fashion and well illustrated with photographs and other figures, it presents a large amount of basic information in easily assimilated form.

There seems to be general agreement that the fundamental basis of the range condition and trend approach is that of plant communities and successional behavior as affected by habitat factors and degree of grazing use. Recognition of this fact dates back a long way in range research, at least as far as Sampson's studies in the Wasatch Mountains (1919) in which he recognized and described

distinct stages in succession resulting from different intensities of grazing. In particular, the concept of secondary plant succession on grazing lands, whether towards or away from some optimum goal of desirable plant cover has been basic to studies of condition and trend.

Despite the existence of this common ecological foundation, there has been great diversity in the kinds of systems or classifications developed by different workers. In part this has been due to a necessary recognition of major differences in certain range types, as for instance those existing between perennial grasslands and the annual grasslands of California. Even with comparable vegetation, there have been many variations due to differences in approach, with each worker or group trying to apply the condition and trend concept in the most useful manner. As might be expected, in such a new and promising field and in face of the usual strong demand for usable results in a hurry, classification sometimes ran ahead of basic knowledge. Some of the earlier systems were built on too slender a foundation and applied too widely on a variety of range types. As knowledge of the subject has grown, some of these earlier efforts have been discarded while others have been modified.

The present publication, with its emphasis on ecological facts derived as a result of long and intensive study, is a good example of the kind of information needed as a basis for adequate condition and trend classification in any major range type. Certainly there is no reason to expect any short cut or easy road to understanding of the complexities of condition and trend in the many types of plant cover and site quality which occur on our ranges.

The objective of the bulletin is stated to be threefold: to provide first, a foundation of ecological principles; secondly, an understanding of condition and trend in relation to management objectives; and thirdly, an understanding of the indicators of condition and trend. The three main sections are designed to cover these major topics.

The opening section, dealing with the "range-watershed complex" and the principle of the interrelation of animals, plants, soil, climate and topography is of basic interest and importance. The maintenance of a stable soil cover is described as a primary objective in the management of high mountain range, with forage and water considered as secondary objectives. This emphasis on the importance of the soil is maintained throughout the publication. The discussion of the soil mantle and the state of balance brought about by vegetation and soils on steep slopes represents a significant contribution in a field which has received relatively little study to date.

In treating the climatic factors, overall, local and micro-climates are distinguished. This represents a deeper probing into climatic effects than has been customary in such studies, and an approach that might be extended with advantage to other types of range research. The importance of micro-climate in particular is stressed by the authors and the point made that it is the only form of climate which can be influenced by grazing management.

On the successional side, the concept of "destructive change" is introduced and used to differentiate changes in plant cover occurring on areas where accelerated erosion has been or is taking place. This concept fills a need by definitely characterizing a type of succession different from that ordinarily considered as secondary, where the soil mantle is relatively intact. The relationships of

primary and secondary succession and "destructive change" on high mountain ranges are fully analyzed. While applied by the authors to high mountain range only, this concept of destructive change would seem to apply equally well to large areas of Intermountain and Southern Desert Shrub range where severe soil erosion has often accompanied range depletion.

Only three condition classes are recognized in this study, these being "satisfactory", "unsatisfactory" and "very unsatisfactory". The "unsatisfactory" class is further divided into areas with stable soil and those where the soil is unstable. The "very unsatisfactory" category is considered as common, especially on well-drained herbaceous types in the subalpine and alpine zones. No finer condition classes are recognized, as the development of these is considered to require more detailed studies of specific areas.

Ungrazed, pristine areas are considered the normal, by which to judge the potentialities of each type, not as an objective in management. On subalpine ranges, this basis may well be correct, but on many other range types which previously supported large populations of native grazing animals, it might be argued that an ungrazed site does not represent the "normal" condition.

The importance of extremes of weather as a normal feature of the climate of any area is stressed. The point is made that the soil and plant cover of high mountain range lands has developed under extremes of climate as great or greater than those encountered in recent years. On this basis, there is no reason to believe that variations in weather alone can account for accelerated erosion. While this thesis seems basically sound, one might object to a rigid interpretation of it. Observation on areas of steep topography in particular, indicates that severe erosion may be caused by occasional torrential storms on areas which appear to possess stable soils and vegetation. It seems quite possible that similar local damage has occurred in past times also but that the affected spots have gradually been healed.

In discussing range trend, the authors point out that a feature on high mountain ranges is the fact that vegetation may remain relatively unchanged or even improve somewhat while accelerated soil erosion is still taking place. Under such circumstances it seems logical that trend cannot be considered to be upward where the soil is still deteriorating. This paradoxical condition may not be common, but the fact that it can exist points up the necessity for close study of soil conditions in connection with range trend. Certainly there is some evidence of a similar condition on other areas, for example the sagebrush-grass type of the Intermountain region.

In the treatment of range condition, the authors stress the importance of total vegetational cover, both living crowns and litter. The prime importance of good dispersion of litter as well as its quantity and the resulting inadequacy of patchy cover for soil protection is indicated. The point is made that there is a close relationship between the quantity and dispersion of litter on a site and the quantity and quality of forage which it is able to produce.

The discussion of indicators of condition and trend contains a wealth of information which cannot be treated adequately within the scope of this review. A mere listing of some of the indicators treated, such as soil movement, soil remnants, lichen lines, gullies, soil deposits, composition of the plant cover, age classes, invasion of bared areas, rill-channel ridges, plant relics and

utilization of forage species gives some idea of the scope of treatment. A large number of photographic and other illustrations, most of them of excellent quality, add to the value of this section.

One of the many interesting points brought out is the special importance of rhizomatous species in revegetating bared areas where conditions have become highly unfavorable for seedling establishment. Another feature is the indicator value shown for age classes of herbaceous as well as woody species in determining range condition and trend.

Implicit throughout the discussion is the importance of intensive, yearlong observation and study, especially of such features as the adequacy of cover during heavy storms, and signs of early spring erosion which are likely to become obscured later in the season.

There are no literature citations. Readers interested in the rather voluminous literature on the subject of condition and trend will find pertinent references in papers by Ellison which were published in 1949 in the Journal of Forestry and Ecological Monographs, Dyksterhuis's article in the July, 1949 issue of this Journal, and Sampson's new textbook "Range Management."

This bulletin can be highly recommended to all those interested in the management of our ranges and watersheds. It is a fine example also of the value of a basic approach in land management research.—*E. W. Tisdale*, School of Forestry, University of Idaho, Moscow, Idaho.

BEEF CATTLE. By Roscoe R. Snapp. Fourth Edition, xiv, 641 pp., illus. John Wiley & Sons, Inc., New York, 1952. $6.50.

Roscoe R. Snapp, professor of animal science at the University of Illinois, has revised and rewritten *Beef Cattle* for its fourth edition. Previous editions were published in 1925, 1930 and 1939.

Dr. Snapp divides his book into four parts: general aspects of beef cattle, the breeding herd, fattening cattle for market, and general problems in beef production.

This is an excellent textbook, and a valuable handbook for everyone in the beef cattle industry. An immense amount of current information on the breeding, feeding and management of beef cattle has been condensed and written in a concise and readable manner.

Although much of the information is based on corn-belt conditions, it is also basic and applies to every phase of the beef cattle industry. The information is supplemented by excellent tables and illustrations that are readily understood.

The changes that are taking place throughout the range area in range management practices and the increased interest in purebred cattle makes many of the paragraphs and chapters in this book pertinent and valuable to the range beef producer.

Chapters on the Selection of Breeding Stock, Feeding and Care of Young Cattle, Protein Requirements and How to Supply Them, Comparison of Silages, Grass as a Fattening Feed, Methods of Feeding, Diseases and Parasites, and Sterility, and paragraphs or sections on urea, minerals, vitamins and poisonous plants, are particularly applicable to present day problems throughout the range area.

Recommended reading and reference for every beef producer, this book deserves a place in the library of everyone connected with the beef cattle industry. —*Henry P. Holzman*, South Dakota Extension Service, Rapid City.

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NEWS AND NOTES

Eliminating Excess Horses in British Columbia

(Paper presented at annual meeting of Northwest Section, American Society of Range Management, at Ellensburg, Washington on November 22, 1952)

After horses first escaped from the early Spanish explorers in Mexico, they soon spread northward throughout the western ranges of this Continent. These new grasslands were not unlike the steppes of Asia where horses were first domesticated, and the mustangs prospered and multiplied in their new home. Three hundred years later, in 1811, when David Thompson descended the Columbia River, horses were already an established part of the landscape in British Columbia. A few bands in remote areas have been untamed for several generations, but all so-called "wild horses" on this Continent are escaped domestic horses.

They have served man well in the development of this western frontier, but our range plants have not evolved along with domestic animals and many of the open ranges in British Columbia have suffered as a result of yearlong grazing from an unnecessarily large "wild" horse population. For the protection of the Crown ranges, it therefore became imperative to eliminate the excess and unwanted ones. Naturally enough, any such program would be violently opposed by the parties wishing to leave their useful horses at large on Crown range.

Ranchers need saddle horses, guides and packers require strings of them, Indians must have them for their way of life, and loggers, rodeo people, and many others use horses regularly. In some cases, livestock men have made it a business to produce horses on Crown range for whatever market they can find. Many of these hardy animals are left at large all winter to rustle in the natural meadows, or paw away the days on the snow covered grasslands. It is a rough life for them, often so inhumane that many of them die in a severe winter. However, even if uncared for, they eventually multiply to bands that become a public nuisance. Their habit of denuding the feed from south-facing, open grassland areas as soon as the spring snows recede is extremely damaging to the ranges. The facts that they consume large quantities of hard grasses, that they are grazing the year around, and that for the most part they are at large in trespass, are further reasons for carrying out horse disposal work.

It has been found that the most practical method of dealing with this problem is to close the Crown range to all horses during the winter period of December 15th to April 15th. This is done by Districts by the Minister of Lands and Forests in cooperation with local Livestock Associations. Prior to the closed season it is necessary to advertise the closure for four consecutive weeks in local newspapers. Posting the notice in at least three conspicuous places about the District is also required. Local livestock men recommend responsible parties to carry out the horse roundup or horse shooting work. Near transportation facilities, where the horses can be shipped off for fox feed, roundup permits are issued. On the other hand, in remote areas where it is not practical to use the

horse meat, horse shooting licenses are issued.

A sketch map accompanying the roundup permit shows the area over which the permit operates. The permit period is shown, as well as conditions covering such items as notifying horse owners of horses rounded up, fees to charge for horses claimed, inspection and 50¢ clearance fee to the Forest Officer for horses to be shipped away, and one to the effect that an Indian without funds can substitute a horse of equal weight if he wishes to claim a horse. A horse shooting license gives details of the licensee's name, period dates, area under license, and the following conditions: licensee shall bear all costs and responsibilities, obviously good horses are not to be shot, and scalps with ears attached shall be submitted to the Forest Officer for bounty.

The Range Improvement Fund of the B. C. Forest Service's Grazing Division pays the bounty for horses and stallions shot under the above "Grazing Act" closures. It also pays bounties on stallions that are shot as a result of licenses issued in areas where stallions at large at any time of the year are declared a public nuisance. These bounties are currently $5.00 for horses and $7.50 for stallions.

The troubles encountered in the horse disposal programmes through the years are legion, and although there are only about four to five hundred horses a year taken off the ranges now, it is still well worth the effort as far as better range management is concerned. To a great extent the ranges have been saved from abuse and the extra forage available has been grazed by more useful kinds of livestock.—*H. K. DeBeck*, Grazing Division, British Columbia Forest Service, Kamloops, British Columbia.

California Establishes Curriculum in Range Management

Final approval has been given to a curriculum in range management at the University of California. The curriculum is designed to give students broad training and to qualify them as managers of ranch properties, as farm advisors, as range technicians in state and federal agencies, and for graduate studies leading to positions in teaching and research. Heretofore, range management courses have been offered in the School of Forestry and the Department of Agronomy curricula.

The new curriculum, which offers a degree in range management, will require that the student spend one of his upper division years on the Davis campus of the University where he will take principally animal husbandry and agronomy courses and the other on the Berkeley campus where he will take courses in range management and forestry. The first two years of the curriculum offer a broad basic training made up of courses which can be obtained in most colleges while the second two years are devoted chiefly to professional courses.

The courses required in the range management curriculum with semester units are listed as follows:

Chemistry (General Inorganic; Organic)	8
Zoology (General)	8
Botany (General; Plant Physiology)	9
English and/or Speech (Composition and/or Elements of Speech)	6
Geology or Soils (Structural Geology or Elements of Soil Science)	3 or 4
Engineering (Plane Surveying)	3
Physics (Mechanics; Heat; Light; Electricity)	6
Economics (Principles) or Economics (Principles) and Agricultural Economics	6
Animal Husbandry (Judging; Feeds and	

Feeding; Management; Meat Production)	10
Agronomy (Crop Production; Forage Crops; Range Plants)	9
Forestry (Range Management; Forest Ecology; Range Techniques; Range Utilization; Grassland Ecology)	12
Soils (Medium for Plant Growth)	4

In addition, the student must select fifteen units from a list of restricted electives which includes courses in agricultural economics, animal husbandry, botany, forestry, genetics, irrigation, soils, and zoology. The large number of restricted electives will make it possible for the student to select courses along lines of particular interest such as animal husbandry, agronomy, botany, or soils.

A six-weeks summer course in applied range management is required without units of credit. This should be taken at the end of the sophomore year.

The curriculum is administered by a committee composed of representatives of the Departments of Agronomy and Animal Husbandry on the Davis campus, and the School of Forestry on the Berkeley campus.

Chapline Retires and Goes to FAO

W. Ridgely Chapline, Chief of the Division of Range Research, Washington Office, U. S. Forest Service, retired October 24, 1952, after 40 years of service. Mr. Chapline has accepted a position with the Food and Agriculture Organization of the United Nations as a range consultant in the forestry division at Rome. He and Mrs. Chapline left the country Novenber 1, 1952. In his new position Mr. Chapline will deal with world-wide activities in the conservation, improvement and management of range lands.

Mr. Chapline has a broad understanding of range conditions in this country and abroad and is recognized as an international authority on range land problems. Upon entering the Forest Service at Ephraim, Utah, he worked on the first intensive study of erosion control and watershed management on range lands in this country. Since 1913 his quarters have been Washington, D. C., but he has spent much time in the field. He has been in charge of range research since 1920. During that time he has had first-hand contact with range activities in all parts of this country. He has written about 70 departmental publications and technical and practical articles on these activities.

Mr. Chapline has been a leader in expanding the range research of the U. S. Government in cooperation with State Agriculture Experiment Stations and stockmen. Range research now relates to some 950 million acres—half the land area of the Nation—and is conducted in all States of the West and in several Southern States. As a result of such research, millions of acres of seriously depleted range lands have been made highly productive through reseeding and more efficient grazing use. This in turn has produced more livestock and afforded greater financial returns to stockmen of the West and South.

Since 1937 when he attended the Fourth International Grassland Congress in Great Britain, Mr. Chapline has been active internationally in range work. He has attended and considered range problems at a number of other international conferences in this country and in Europe. This year he was Executive Secretary of the Organizing Committee of the Sixth International Grassland Congress held at Pennsylvania State College, August 17–23.

Mr. Chapline received his B.S. degree in forestry from the University of Nebraska in 1913.

Promotions and Transfers

H. R. Hochmuth, member of the Editorial Board, transferred from the Bureau of Agricultural Economics to the Bureau of Land Management in Washington, D. C. In his new position he is Chief of the Branch of Land Classification. The transfer was effective November 17, 1952.

Joseph F. Pechanec, Chief of the Division of Range Research at the Pacific Northwest Forest and Range Experiment Station, Portland, Oregon has transferred to Washington, D. C. In his new position he is Chief of the Division of Range Research, U. S. Forest Service. The transfer was effective January 4, 1953.

David F. Costello, Chief of the Division of Range Research at the Rocky Mountain Forest and Range Experiment Station, Fort Collins, Colorado was transferred to Portland, Oregon to replace Mr. Pechanec. The transfer was effective January 4, 1953.

Arnold Heerwagen, range conservationist, has been transferred from Raton, New Mexico, to the Regional Office in Albuquerque, New Mexico. In his new assignment as zone conservationist, he will work chiefly with range problems and techniques in Region 6 of Soil Conservation Service. He will be giving special attention to aiding field personnel and ranchers in applying range conservation.

Range Men Abroad

D. A. Savage, Superintendent of the U. S. Southern Great Plains Field Station, Woodward, Oklahoma is serving with the Food and Agriculture Organization of the United Nations as a range management specialist on a mission to Mexico. This important assignment is being conducted at the request of the stockmen and the government of Mexico.

Taking a 12-month leave of absence from his duties at the Woodward Station, Savage's work in Mexico will consist of advising and assisting the Government and stockmen of that country in planning, developing, and executing a program for greatly increasing the productivity of the natural grazing lands of the entire country. To be emphasized in this connection will be proper intensities and seasons of grazing with the best kinds of livestock for different areas; the introduction of new and improved species and strains of plants; the control of noxious plants and animals; reseeding; application of fertilizers, mineral supplements for livestock, and supplemental feeding by use of cultivated pastures, hay, and silage.

Savage reported for the assignment on November 10, 1952. He and Mrs. Savage will reside in Mexico City.

Mr. E. H. McIlvain will be Acting Superintendent in charge of the Woodward Station until Savage returns in 1953.

A. C. Hull, Jr., of the Washington Office Division of Range Research, left on October 30 for a 3-months' assignment to Egypt under the Technical Cooperation Administration (Point IV) program. The assignment is being made at the request of the Egyptian Government to assist in setting up experimental and large-scale range reseeding studies on the west coastal desert of Egypt. Rainfall there is approximately 7 inches

with a mild winter growing season, similar to parts of southern California. The summers are hot and dry with no rain. Through improved range and livestock management, noxious plant control, and range reseeding, the Egyptian Government hopes to increase the production of livestock and thus raise the present low standards of living of the nomadic Arabs. Mr. Hull has worked for a number of years on range reseeding problems, with special emphasis on reseeding the arid range lands of the West.

H. W. Springfield, of the Southwestern Forest and Range Experiment Station, left November 2 for Baghdad, Iraq, to take a two-year technical assistance assignment with the Technical Cooperation Administration. Springfield will assist and advise Iraqi technicians in range and pasture research. Range livestock production plays a very important role in the economy of Iraq. It is expected that this research will serve to bring about much needed improvements in management of the range lands and increased production of meat and fiber.

In Memoriam

The range management field and the ranching industry lost a friend and leader when Milton W. Reid passed away in the Washington Sanitarium, Takoma Park, Maryland, on October 21, 1952.

Milt was born in Romney, West Virginia on August 10, 1899. He was a veteran of World War I. In 1922 he moved to Salome, Arizona, where he engaged in the livestock business, running about 1200 cattle until 1938. On June 10, 1938 he entered duty with the Grazing Service at Phoenix, Arizona, as Range Rider. Following this he advanced through the following positions: Grazier Aide at Kingman, Arizona; District Grazier at Safford, Arizona; Grazier at Phoenix, Arizona; Regional Grazier at Rawlins, Wyoming; and Chief of the Division of Range Management at Salt Lake City, Utah. With the formation of the Bureau of Land Management in 1946, Milt was made Assistant Chief, Division of Range Management, Washington, D. C.

He has been a member of the American Society of Range Management nearly from the time of its organization.

WITH THE SECTIONS

SIXTEENTH SECTION BEING FORMED.

Twenty members of the Society residing in Nebraska met at Crawford, Nebraska on November 9, 1952 to form the Nebraska Section. There are some 50 members of the Society residing in Nebraska, of whom 18 are ranchers. Twenty-nine members have signed a petition addressed to the Society, requesting approval of the Section. This petition will be acted upon by the Board of Directors at its meeting in Albuquerque on January 19, 1953.

The officers elected for the new Nebraska Section are:

Chairman—L. F. BREDEMEIER, Soil Conservation Service, North Platte, Nebraska.

Vice-Chairman—SID E. SALZMAN, Rancher, Ainsworth, Nebraska.

Secretary-Treasurer—ELVERNE C. CONARD, College of Agriculture, Lincoln, Nebraska.

NORTHERN INTERNATIONAL MOUNTAIN

This section completed election of 1953 officers. The results announced on November 6 giving men who will take office on January 1 are as follows:

Chairman—R. W. PEAKE, Dominion Experiment Station, Lethbridge, Alberta.

1st Vice-Chairman—ED O'HARE, Stevensville, Montana.

2nd Vice-Chairman—M. J. REED, U. S. Forest Service, Missoula, Montana.

Secretary-Treasurer—ALEX JOHNSTON, Dominion Experiment Station, Lethbridge, Alberta.

Council Member—HOMER E. TURNER, Soil Conservation Service, Dillon, Montana.

IDAHO

The Idaho Section had a field trip on Bennett Mountain and Little Camas, about 30 miles northeast of Mountain Home on June 27, 1952. A large crowd of about 120 people turned out to see Mr. Jack Henley's range, alfalfa and grass plantings. Jack had done a wonderful job and had an excellent stand on 200 acres seeded in 1952. At noon everyone enjoyed a fine turkey dinner for which arrangements were made by the Forest Service members of the Society.

Many of the ranchers were interested in the Roto-Beater demonstration and commented on what a good job it did on reclaiming land from sagebrush. To top the day off, we concluded the field trip by seeing Mr. Pierce's seed production of intermediate wheatgrass and Ranger alfalfa.

We had more ranchers in attendance than other Society members. The comments from those in attendance have been very favorable and we hope next year's field trip, wherever it may be, will be just as successful.—*Liter E. Spence.*

On July 9th a group of members of the East Idaho Chapter of the Idaho Section and others met at the Court House in Dubois, Idaho. From that point they traveled to Spencer, Idaho and thence to the Dave Hagenbarth seedings in Camas Meadows. A recent seeding was made here with a Brillion Seeder and it was generally understood that this type of seeder was adaptable to areas where rainfall is not great during the spring months.

From the Hagenbarth seeding, the tour went to the West Camas area in

the Targhee National Forest, northwest of Kilgore, to look over areas that have been sprayed for the eradication of Wyethia and sagebrush. This portion of the tour went over areas where controlled operations have been conducted, and areas where the Intermountain Forest and Range Experiment Station has set up experimental plots near Pete Creek for the trial of different chemicals and formulations. Lunch was served at the Stoddard Forest Camp with food furnished through the courtesy of the Clark County Chamber of Commerce. The afternoon was spent in observing a demonstration by the Parkinson Tractor Company of Idaho Falls and a Case beater was demonstrated by the Laird Sales and Service Company of Dubois. This was the first annual field tour to be conducted by the newly organized East Idaho Chapter, and was attended by some 28 people in that area.—*Virgil E. Starr.*

Utah

Range tours were in order for the Utah Section during the 1952 summer season.

A tour to the 3,500 acre reseeded experimental area at Benmore started the season, June 11, with over 100 members and friends attending. The East Hoytsville Range Company tour held July 15 was equally well attended with ranchers, range technicians and other interested people from all parts of the State, the Nation, and Greece. The Pines Reseeding Project field day was well attended by ranchers and water users from most of the counties of the state, even though heavy storms discouraged some and muddy roads slowed the tour's progress. A fourth field day held at the Desert Range Experiment Station, September 1, closed the season to give Society members and guests a good coverage of the major classes of range lands in the State showing the problems and possible solution. Tours included high mountain range and watershed, intermediate mountain and foothill range, spring-fall range of the sagebrush zone and winter range of the West Desert types.

On the first tour at Benmore, Society members and friends saw the results of research that have been under way since 1935. Dee A. Broadbent, Acting Director, Utah Agricultural Experiment Station, gave a word of greeting and brief history of the Benmore program. A. Golden Kilburn, Extension Soil Conservationist, gave a brief coverage of the project. Ray Pehrson, a rancher from Vernon, Utah, gave the group his views on the value of pasture experiments to the local livestock growers.

Neil Frischknecht, Intermountain Forest and Range Experiment Station, and Dr. Lorin E. Harris, Animal Husbandry Department, U. S. A. C., discussed the management of crested wheatgrass for the production of beef cattle. Carrying capacities of seeded range were from 5 to 10 times as great as adjacent unseeded sagebrush—grass ranges. It was pointed out that moderate grazing not only favored the perpetuation of the grass stand but produced near the same total gain per acre as the heavily grazed pastures and close to the same average daily gain as the lightly grazed pastures.

During the noon hour, the Society members and friends received a brief message from Section Chairman, Albert Albertson, reminding us of the objectives of the Society. Greetings were received from Range Society President, L. A. Stoddart, and several other prominent people were introduced to the group.

Included on the program was a talk given by President J. Reuben Clark, Jr.,

of the L. D. S. Church. President Clark discussed "The Economy of Grass Seeding in a Ranch Program" and encouraged ranchers to plant grass on their own lands to ensure security of their operations.

The afternoon was devoted to observations and discussion of methods of reseeding range lands. Dr. C. Wayne Cook pointed out such interesting points as the effect of drill spacing on seedling establishment. Harry K. Woodward, District Conservationist, S. C. S., Tooele, Utah, told of the seeding program at Benmore. A demonstration was made of the newest equipment used in clearing brush and seeding range lands.

On the second tour, guests of the East Hoytsville Range Company and the Summit County Soil Conservation District saw an outstanding example of what could be done through cooperation on privately owned range to bring about rehabilitation.

The Company, consisting of eight members, has reason to be proud of its accomplishments. The 7,200 acres of range land has been turned from a liability to one where the Company's needs for livestock feed are well taken care of. The reseeded spring-fall range, the intermediate bench lands where water spreading, reseeding and "liberation" burning has done wonders toward its rebuilding, and the waist-high grass of the high summer range attest to economy of the practices of good range management on private lands.

Heber Sargent, President, and David W. Brown, Secretary, along with other company members told of the response of the range to their efforts and spoke of the fine cooperation they had received from all, including the water users on the farms in the valley.

Many of the visitors responded with words of praise for the work of the Range Company. Fred G. Renner, Chief, Range Division, U. S. Soil Conservation Service, and J. S. McCorkle, U. S. Soil Conservation Service, were among Range Society members who commented favorably regarding the work of the Company. Many ranchers from over the State remarked that had they not seen the accomplishment of the Range Company they could not have believed such results possible.

Water users told how the water spreading practices, the brush burning and the reseeding practices had greatly increased the available water during the summer irrigation season.

On the third tour to the Upper Seveir River watershed and the Pines Reseeding project, Society members and friends saw the outstanding accomplishments possible when a public agency (the Forest Service), the water users and livestock operators cooperate to do something for their range and watershed. Examples were seen of the use of erosion control structures such as earth de-silting dams along with vegetation to stabilize a watershed, raise the water table and to produce clear water to be stored in an irrigation company reservoir. Society members and guests saw how reseeded benchlands could be used to carry live stock while upper watersheds were being rebuilt.

Many livestock growers, water users, and range technicians pointed out the success of this 33,000 reeseding project, now considered the world's largest reseeding project, and of correlated improvement work that had been done on the watershed of the East Fork of the Seveir River.

For an outstanding summer's program, the Utah Section owes thanks to many, including the Program Committee, with A. Perry Plummer as chairman; county agents Ernest O. Biggs, Tooele, Lee

Guyman, Summit, and Ward Cluff, Garfield; rangers Max Reese and Grant Williams; Clyde Lowe and Howard Passey, Soil Conservation Service; and to the many livestock operators and water users of the State who contributed freely of their time and knowledge in the cause of range conservation.

Appreciation should be expressed to Section Chairman, Albert Albertson, who has been diligent in promoting and attending all field tours and who has taken advantage of each meeting to explain the cause of the Range Society.—*Max E. Robinson.*

Nevada

The Nevada Section met jointly with the Aggie Club of the University of Nevada at the Agricultural Building, University of Nevada, Reno, on September 26th to hear Selar Hutchings of the Intermountain Forest and Range Experiment Station, and member of the Utah Section, give an illustrated talk on the results of studies on winter range made at the Desert Range Branch Station near Milford, Utah. Forty-seven people attended this very interesting meeting.

Mr. Hutchings spoke from nearly twenty years experience at the Desert Station and illustrated his message with exceptionally good colored slides. He pointed out that the results obtained at the station are applicable to some 65,000,000 acres of desert land in the West. The experimental studies have centered on the utilization of forage species by sheep, influences of precipitation on herbage production, and effects of grazing treatment on forage yields, sheep weights, and wool production. It was clearly shown that these winter ranges can produce a great deal more nutritious forage than they now support and that income to livestock operators can be greatly increased under well managed use. Under moderate grazing the better forage species—winterfat, black sagebrush, and Indian ricegrass increased, while the poorer species such as rabbitbrush decreased. Under heavy grazing this process was reversed.

Comparisons of sheep production were made over an 8-year period on moderately and heavily grazed range. On the moderately grazed range, ewes wintered 8 pounds better per head, produced about 1 pound more wool, 11 per cent more lambs, and suffered 5 per cent less death loss than those on heavily grazed range. Increased production per head was $3.46 as compared with $1.69 for those on heavily grazed ranges. The greater net returns were directly attributable to the better condition of the sheep on moderately grazed ranges.

Our thanks to Mr. Hutchings for a very profitable and entertaining meeting. —*William N. White.*

Pacific Northwest

The fourth annual meeting of the Pacific Northwest Section convened in Ellensburg, Washington, November 21 and 22. Ninety-five members and guests attended. A lively, varied and interesting program resulted in comments about "the best meeting we have had yet."

Chairman Nadeau opened the meeting by introducing Alan Rogers who described the Ellensburg area and its importance to the State and to the Northwest Region from the standpoint of range production. With this orientation he introduced Mr. W. R. Cole, President of the Ellensburg Chamber of Commerce, who welcomed the Section to the City. Response was made by Tom Willis. Chairman Nadeau then reviewed the objectives of the Society and the part local sections play in terms of bene-

fits resulting from active programs on a local basis. He pointed out that the membership of the Pacific Northwest Section is about 230 of the 300 Society members situated within our geographical boundaries. He invited each Society member to affiliate and become active in the affairs of the local section. He expressed appreciation for Floyd Iverson's work as Chairman before transferring to Montana earlier this year.

Committee reports reveal an active year for the section. Hugh Nicholson of the Election Committee announced 1953 officers as follows: Leon R. Nadeau, Portland, Oregon, Chairman and John L. Schwendiman, Pullman, Washington, Vice-Chairman. New Council men are E. W. Anderson of Pendleton, Oregon; William R. Meiners of Yakima, Washington and Tom P. Wilson of Vinsulla, British Columbia.

Clark Holscher reported for the Committee on Range Research and the wide variety of problems that the Committee has been studying.

E. Wm. Anderson reported the activities of the Displays Committee including State livestock association meetings. His committee recommends expansion of the scope of our displays and showings at more meetings of local nature.

Bill Meiners reported for the Committee on Plant Identification contests and introduced Allen Barry of Dayville, Oregon, winner of the Oregon contest and Don Calahan of Thorp, Washington, winner of the Washington State contest. These young men were guests of the Section during the annual meeting and each reported to the group on his summer camp. Each expressed appreciation for the opportunity to compete for the privilege of participating in the 1952 camps and expressed pleasure in the competition experienced in the camp programs.

Membership committee men reported for the States of Washington, Oregon and the Province of British Columbia.

The Publicity Committee report expressed thanks for the active participation of its members in releasing news items of Section activities and announcements of coming events through news paper, trade journal and radio media.

Tom Willis, Chairman of the summer field day, outlined the successful June trip over range areas and installations in the area in the vicinity of Kamloops.

The Secretary's financial report showed the Section "in the black" by a relatively small margin of $27.94 on November 20.

The program for the meeting got under way with papers given by Scott Cooper of Burns, Oregon, on "Improving Native Meadows;" Burch H. Schneider of Pullman, Washington, on "Animal Nutrition;" James F. Ashley of Portland, Oregon, on "Winter Feeding of Big Game." The afternoon program closed following an interesting and important panel discussion on "Management of Browse Ranges." Glenn Mitchell of Seattle led the browse panel with participants Howard Hamilton of Ellensburg, Reade Brown of Walla Walla, George Garrison of LaGrande, Waldo Frandsen and Robert Mace of Portland, and Bob Olson of Pullman.

The program of the first day included a businessman's lunch jointly with the Ellensburg Junior Chamber of Commerce. Jaycee President Don Broughton and his group expressed deep interest in the American Society of Range Management and its activities. Chuck Haight reported on local and State Agriculture Committee activities and Phil Kern, member of the Northwest Section, reported on his National Agriculture Committee.

An enjoyable social hour and banquet concluded the first day. Art Miller

served as toastmaster and Pat Ford of the Washington Cattlemen's Association expressed sincere appreciation for the award given by the Pacific Northwest Section to Mr. Tim Barnard of Loomis, Washington, who was named Washington State "Range Manager of 1952."

The second day's program continued on a high plane with Herb Pollard, "A Banker's Eye View of Range Management;" Keary DeBeck, "Eliminating Excess Horses in British Columbia;" Don Hyder, "Rolling Can Be of Value in Range Reseeding;" Bill Meiners, "Developing a Ranch Program;" Seymour Murray, "The Use of Brush Beaters in Sage Removal;" and "A Review of the Sixth International Grasslands Congress" by A. L. Hafenrichter, Wayne W. Austin, John Clouston and Waldo Frandsen. This review stressed the similarity of range management problems the world over.

Executive Secretary W. T. (Terry) White gave a stimulating review of the workings of his office and among other things called attention to the number of Society members who have been called upon to serve as technical advisors abroad under the Point Four program; invited attendance at the Society's Sixth Annual Convention in Albuquerque, January 20 and 21; and expressed appreciation of the fine work done by Dr. R. S. Campbell of New Orleans as Editor of the Journal of Range Management.

The closing afternoon program included James H. McLeod of Vancouver, British Columbia, "Biological Control of Goat Weed;" James E. Blair of Los Angeles, California, "Chemical Control of Big Sagebrush," and a panel discussion led by Wilf Pendray on "Getting Improved Range Management Techniques Into Practice." This panel of range managers was made up of Russell Brown of Vantage, Washington; Jack Smith of Lancaster, Washington; Maurice McGregor of Hooper, Washington; Vernon Brink of Vancouver, British Columbia Tom Wallace of Kamloops, British; Columbia; and Tom Willis of Kamloops, British Columbia.

The program itself testifies to the activities of the Program Committee and the smoothness of the meeting prompts a well deserved thanks to Stewart Bledsoe and his Arrangements Committee.—*W. J. Anderson.*