Convention Issue

American Society of Range Management

The American Society of Range Management was created in 1947 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.

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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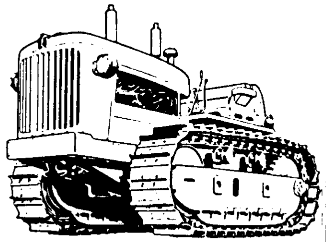

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Editorial

Objectives and Opportunities

The founders of the American Society of Range Management placed among its objectives, as a part of its constitution, the following reasons for organizing: "To stimulate discussion and understanding of scientific and practical range and pasture problems" and "to provide a medium for exchange of ideas and facts among Society members and with allied technologists. . . ." These objectives are in close harmony with the functions of Local Sections. Among other functions, Local Sections are "to study local range and pasture conservation and management problems, to cooperate . . . with other local organizations in matters of common interest, and to bring about closer personal acquaintance and a spirit of cooperation. . . ."

Clearly, the founders of our Society intended that certain definite activities be undertaken, but wisely left it to local groups to work out methods best suited to time and place. Membership in this Society, therefore, carries responsibilities and also provides opportunities for group action in matters of range management.

Under our system of range management on public lands, many of the recommendations for management practices are made by advisory boards. The board members are necessarily interested in both the science and the art of range management, as users and as advisors. These people belong in the American Society of Range Management because they can contribute toward a balanced membership.

The Sections, in turn, are uniquely fitted to be of service to advisory boards. The Society, drawing together as it does all facets of interest, training, and experience, on common ground, is collectively the broadest, most proficient, and least biased organization in its field at present. The Local Sections are one in philosophy with the Society.

Livestock advisory boards are sometimes vexed with problems of proper grazing. Are certain allotments stocked with the proper numbers, or at the best season? Is the kind of stock grazed the best suited to the allotment? Is an allotment improving, deteriorating or holding its own? What is the production of certain base property? The board needs information upon which to base its recommendation.

When a user considers that a ruling, with or without a recommendation from a board, is unfair, poorly based or prejudicial, he protests. Should his protest be rejected, he may appeal according to established legal procedure.


Joseph H. Robertson

The protest is the point at which advisory boards might occasionally use the kind of help that Local Sections are, by nature, equipped to give. Local Sections might well take the first step. They should inform advisory boards of their willingness to designate balanced committees from their membership to meet on the land in question, with a representative of the Board, the user of the land, and the technician in charge. The whole group would then work together, examining and interpreting the range. This approach could be most fruitful only if all who were concerned had a sincere desire to apply the best technical information available to the problem and come to whatever agreement the evidence supported.

To take a simple but plausible example, let us assume that a ruling on livestock numbers because of alleged range depletion was being protested on the grounds that no range depletion exists on the allotment in question. The advisory board has invited the Local Section, to which the board members belong, to appoint a committee to help study the evidence in the field. The Local Section executive committee has appointed two members of its own section and one man from the adjacent neighboring section has accepted an invitation to help. One of the three has been appointed leader. They have assembled at an appointed time and driven to the range.

It is the responsibility of the leader to see that all points of view are freely expressed and all questions considered as fully as possible in the light of the evidence spread out at their feet. Progress should be from one point of agreement to the next. All points agreed upon by the committee and the entire group should be recorded before moving to the next question. A serious effort should be made to obtain complete agreement. Interpretations of the evidence should be reconciled. Where agreement seems unlikely, the question should be held for further evidence as the group moves over the range. Walking or riding may be necessary, and committees should be selected with this in mind. Key areas may be selected by those most familiar with the allotment.

Pertinent questions to be considered would include: (1) Is this definitely the allotment in question? (2) What are its boundaries? (3) What is the season of use? (4) Has there been any change in management of the allotment recently? (5) How has precipitation compared with normal during the past year and the last ten years? (6) Which recent years have been much wetter or drier than normal, and by how much (from nearest Weather Bureau cooperator). (7) Which of the species present are the most desirable? (8) Which of the species present are the least desirable? (9) Which of the species present are represented by the most size classes? (10) Which species have fewest juveniles? (11) Are there relict or lightly used areas nearby for comparison? If so, do they contain desirable species that are absent from much of the allotment? Are litter, rill marks, pedestalled grasses more or less than on the allotment? Are seed stalks abundant on the protected area this season? Are the grasses taller than ungrazed plants on the allotment? Are there more culms per bunch?

Answers to these and many other questions can be agreed upon by direct observation. Correct interpretations in most cases will be reached through thought and discussion. Unreasonable interpretations or dogmatic statements will not be supported by sufficient evidence.

Finally, all points on which agreement was reached by (a) the whole group, (b) the committee only, and (c) neither, should be listed for future consideration and use by any who may desire to use it.

No one is naive enough to suppose that this approach will be quickly adopted or sure-fire in its operation. It does seem to the writer to be a technique that should be given a fair trial. It is hoped that it will head off some of the hearings in which chances of agreement are less than by the "on-the-ground" method proposed here.

Other opportunities for service by Local Sections might be opened up through active efforts to establish permanent lines of communication with other organizations having related interests. Among these, in addition to Grazing Advisory Boards, may be numbered the state livestock associations, the farm organizations, and the associations of Soil Conservation District Supervisors. These contacts may be effected in many ways. One suggestion is that local sections invite these organizations to send an official representative to the annual meeting of the Local Section. Possibly a reciprocal relationship of this kind could be arranged in order "to cooperate . . . with other local organizations in matters of common interest, and to bring about a closer personal acquaintance and a spirit of cooperation. . . ."

Local Sections can project their influence for range conservation into the next generation by cooperating with agencies which are working primarily with farm youth. Agricultural Extension Agents and vocational agriculture teachers are often at a loss for help in developing range management projects in the 4-H and F.F.A. programs. The Local Sections can fill a need here if they will provide local leaders for these range management projects. One or more sections have already taken this step. It will be very interesting to learn of their success. Regardless of slow progress and possible rebuffs, it would be well for all of us to keep the objectives of our Society clearly in mind, and their accomplishment as our goal.—*Joseph H. Robertson,* Associate Professor, Range Management, University of Nevada, Reno.

RANGE SOCIETY OFFICERS ELECTED FOR 1956

Officers of the American Society of Range Management elected for the year 1956 are:

President: John D. Freeman, Soil Conservation Service, Prescott, Arizona

Vice President: E. W. Tisdale, College of Forestry, University of Idaho, Moscow, Idaho

Board of Directors: 1956-58:

John M. Cross, rancher, Nanton, Alberta

Lyman L. Richwine, District Forest Ranger, Targhee National Forest, St. Anthony, Idaho

Where Are Our Future Ranchers?

CHARLES K. SKINNER, JR.

Livestock Loan Dept., Colorado National Bank, Denver, Colorado

A serious epidemic has engulfed the western United States and threatens to cause widespread damage to our overall livestock picture if remedial steps are not soon employed. The problem was dramatically brought to my attention the other day when a long-time customer of the bank, who normally exhibits little emotion even during the toughest sledding, appeared visibly shaken. When the business at hand had been fully discussed he volunteered to relate his problem. Apparently his only son, who was born and raised on his father's sizable cattle ranch, had decided to seek employment in town. The boy had just been discharged from the service and appeared ready to become a serious understudy and eventual heir to his father. Evidently, no advance notice of the boy's decision had been forthcoming. Therefore it was only natural that our sympathy was directed toward the father. If the boy left him at this time there would be little hope of finding an adequate successor to replace the father when he retired, and, in turn, an operation and physical plant worth many thousands of dollars would presumably be split up and sold to outsiders of unknown ranching and managerial abilities.

Just as it is a banker's responsibility to foster range production and development through proper lines of credit, it should also be his job to prevent potential ranch managers from deserting such a specialized field where their services are at a premium. What perplexed the father in the abovementioned example has been taking place ever since 1910 and only now are the consequences being properly scrutinized.

Some interesting observations on farm employment and production on a per-man-hour basis are given in the April 1955 issue of *Monthly Review*, published by the Federal Reserve Bank of Kansas City. In 1910 farm population was approximately 35 percent of the total U. S. population, while by 1950 it accounted for only about 17 percent of the total population. There are three reasons that explain the tremendous decrease in farm population.

1. High wages and standards of living in the city.
2. Decreased demand for farm labor resulting from increased labor productivity.
3. More rapid increase in nonfarm labor demand than could be satisfied by the natural increase in the urban labor force.

Despite the nationwide decrease in farm labor requirements, farm output has increased substantially since 1910. The rate of increase in crop productivity has been greater than for livestock production primarily because of the difficulty of adapting mechanization to livestock production.

A look into the future produces a pessimistic note. There is little evidence to substantiate the fact that this trend will subside to any great degree if a dormant attitude continues to plague us. The problem does not concern those who have already left the farms and ranches but only pertains to those who will give such a move serious consideration sometime in the future. Granted that with our depressed cattle market over the past few years coupled with uncertain governmental policies, drouth, and rising land values, the situation appears anything but rosy at present. These factors tend to limit the entry of newcomers to the livestock industry unless they are persons of financially independent means. That is why we cannot afford to lose those youngsters already situated on our ranches.

A makeshift solution would attempt to alleviate the problem by inducing the next generation to remain on ranches by means of modern, attractive and romantic surroundings. However, upon closer observation, it will be noted that the majority of ranch homes have running water, indoor toilets, gas and electrical appliances. When it comes to the attractive feature, it's quite a chore to expound upon it when some localities have breathed, swallowed and bathed in dirt and dust for the past four or five years. As for the romantic aspect of ranching, it is almost a thing of the past. Trucks and jeeps are essential equipment and the boy who thinks he can sit in a saddle all day without digging a posthole is the type of person who is better off in town to begin with. In short, a practical, realistic attitude should be developed at an early age among those who plan to make ranching a career. It is essential to separate the men from the boys.

There is no single solution to the problem of rural-urban migration. Educational policies and organizations play a profound role in molding future leaders for the livestock industry. Such projects as provided by 4-H and F.F.A. groups are certainly a step in the right direction. Available access to a county agent is essential. Our agricultural colleges are becoming a more popular faucet of range management education. The need for college graduates to fill responsible positions of leadership in agriculture cannot be overemphasized. Perhaps if these institutions of higher learning could indoctrinate a program that combined more of the actual experience with the technical side of learning, a greater insight of the problems that lay ahead might be digested by the student.

Those of us involved in livestock financing have a widespread influence upon anyone engaged in the production of meat. I think it is time we assumed more of a responsibility in generating enthusiasm among our customers and their children. We must emphasize the fact that credit and sound management go hand in hand, and that the term mortgage is not a word to be feared, but simply one that often accompanies adequate loan arrangements. It is a sound idea to allow the younger members of a borrowing family to familiarize themselves with the basic requirements that formulate a successful loan. Such terms as principal, interest, etc. should become part of their working vocabulary. If possible, marginal operators should be discouraged from borrowing, especially in lean years. A number of these operators have not shown a profit for the past few years and this is certainly a detrimental influence on those who are considering ranching or farming as a career. After all, farm income determines the farmers' ability to pay wages, and numerous talk about various men going bankrupt is not conducive to an optimistic future.

Actually, our primary responsibility, whether we are engaged in producing, feeding, financing, or teaching, is to see that stable and proper management is not only practiced but perpetuated. Now is the time to initiate such a program.

Problems of Climatic Changes[1]

RICHARD B. MILLIN

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An urgent need exists for more research on the problem of climatic changes as well as the effect of precipitation on forage production. Research men very naturally tend to follow the fields in which there is the most interest or those on which some influence can be exerted. Both range administrators and research men have failed to give these basic factors the attention they deserve. This has probably been due to the feeling that weather is relatively stable and nothing can be done about it anyhow. It is time we all realize that the climate is changing and, if we can not control it, we can plan better for it if we have a better understanding of present trends. For this we need more research on these problems. Our research men will gladly respond if we administrators and stockmen clearly outline our needs and support their efforts.

Our range management plans are based on expectations. These center around expected forage production. This production may vary from year to year or by groups of years and the variations may trend in one direction or another over longer periods of time. Studies of such variation in forage supply by Clawson (1947) pointed out the need for methods of adjusting carrying capacities to fluctuations of forage caused by periods of drought or plentiful precipitation. Clawson's work showed that, in some parts of the country, fluctuations tended to be from year to year while in other areas they occurred by groups of years.

Many Nevada range administrators have basically a difficult problem in operating on lands that in the past have been marginal and in recent years have been submarginal. Vegetation on the desert may be hardy in its resistance to drought but may be easily ruined by improper grazing, particularly during the growing season. Those who manage desert lands have more difficult problems to face than those managing lands with higher precipitation. Conversely they stand in greater need for scientific information on forage production, and particularly on the effect of precipitation on forage production and how to solve the resulting problems.

In an article entitled "What is Happening to the Weather?" in the January 1953 issue of Harper's Magazine, the climatologist C. E. P. Brooks stated that the earth's temperature had fluctuated over extended periods in recorded history though not greatly. He stated "It is not unlikely that an initial fall by five degrees below the present sufficed to account for the Great Ice Age, all the rest of the freezing up being due to the ice itself."

"As regards America, John H. Conover of the Blue Hills Meteorological Observatory recently compiled an index of the severity of winters in New England. When the irregular changes from year to year are smoothed out, he finds that the temperatures of the winter months rose steadily from 1859 to 1897 and then fluctuated from 1897 to 1950, but on the whole were still rising slowly, at least until after 1930. The ten years ending in 1949-50 averaged about four degrees F. higher than the ten years ending in 1859-60. Still more noticeable is the way in which the winters have become shorter; the time between freezing and thawing of a pond was twenty days less in the last ten years than at the turn of the century. The severity of a winter does not depend only on mean temperature; the number of cold days and the depth and persistence of the snow-cover also matter. Each of these has on the whole decreased in recent winters. Taking account of all these factors, the severity of winters at Blue Hill has lessened considerably since 1894, in spite of the fact that the snowiest winter ever experienced was in 1947-48."

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1. Paper presented at the 1954 annual meeting of the Nevada Section at Winnemucca. The author was formerly with the U. S. Bureau of Indian Affairs at Stewart, Nevada.

In closing, Brooks stated "To sum up, the temperate and polar regions have been getting warmer for many years. The process may continue or it may be reversed; the one certain thing is that it will not stand still. If it continues, the northern lands will become more habitable and productive, though probably at the expense of the drier agricultural regions further south . . ." There is considerable evidence that Nevada lies in the southern region that he mentions.

From studies of tree rings, Hardman and Reil (1936) point out a wet period in Nevada climate from 1870 to 1915 that was unequalled in the last 600 years. This was the period in which Nevada's ranching economy was being established. Following this period the climate returned to "normal" for some years, and more recently appears to be in a period of subnormal precipitation and forage production.

In attempting to study these problems we are handicapped by a total lack of forage production records and short, or relatively short, precipitation records; and data that for the most part consists of precipitation only. From this data we must try to reconstruct the history of our forage production if we are able to study past and present forage production and apply that information to range management.

A Precipitation-Forage Index

In its 1952 Annual Report, the Intermountain Forest and Range Experiment Station presented a formula for converting precipitation to forage production based on data obtained at the Desert Experimental Range at Milford, Utah. In this formula, monthly precipitation totals for October, November and December are multiplied by two; those of January, February and March by 1½; and the remainder of the year by one and the totals added. The resulting sum is multiplied by 31.44 and from that result 76.18 is subtracted. Under Milford, Utah conditions the answer in pounds of forage per acre has a probable error of plus or minus 21.33 pounds of forage or about 7 percent.

Most of Nevada's winter range forage is produced under precipitation conditions similar to those of Milford, Utah. Though the production per acre may vary it is believed that the formula provides the best estimate of potential forage and its fluctuation of any method now available. When used with existing data on precipitation, numerous comparisons may be made for analysis. One example is mentioned here although others may be of equal or even greater interest in determining individual range plans.

When the Milford formula is applied to the precipitation record of McGill, Nevada, estimated production for recent years, calculated as percentages of the 1913-52 average are as follows:

Year	Est. Production
1948	39%
1949	63
1950	38
1951	57
1952	113
1953	37

These recent years include the longest and most intense drought period in the 42-year weather record at this station. It contains three of the four years of lowest production. Next to 1934, the years 1953, 1950 and 1948 rank as the poorest in production in that order.

Nevada range conditions are generally less favorable for production than those of the Desert Experimental Range at Milford, Utah. Some of the years of low production probably resulted in practical failures of forage production rather than the 35 to 40 percent of the average as calculated.

McGill, situated at the base of the Shell Range in eastern Nevada, does not fully portray the drought farther west as demonstrated by records and observations at Schurz, Nevada. Application of the Milford formula to the precipitation record at Schurz provides the following data on estimated production based on a 32-year average:

Year	Est. Production
1946	39%
1947	22
1948	2
1949	20
1950	0
1951	55
1952	43
1953	14

The actual production from 1947 to 1952 was practically nil on the sand grass range of the Walker River Reservation, but due to favorable May rains there was a very small crop of sand grass in 1953.

These eight consecutive years of intense drought are believed to be more representative of conditions in most of Nevada than the data from McGill. In either case they give support to many other indications that Mr. Brooks' theories are actually in operation in Nevada.

Summary

We are faced with basic problems which are recognized by far too few men. They are the problems which are determining the direction and extent of our range management plans and programs. Presently far too little understanding and discussion are given to the relationship between climatic changes and range management. Research should provide more facts for the use of range administrators to use in their plans. Likewise, administrators should recognize the situation and support the research efforts needed to provide a clear understanding of the situation confronting us.

In the past we have had many range management plans ruined by these unrecognized forces. Let us now recognize them and prepare our plans to meet a situation that can be fully recognized if not accurately forecast.

LITERATURE CITED

Clawson, Marion. 1947. Sequence in variation of annual precipitation in the Western United States. Jour. Land & Publ. Utility Economics 23: 271-287.

Hardman, G. and O. E. Reil. 1936. The relationship between tree growth and stream run-off in the Truckee River Basin, California-Nevada. Nev. Agr. Expt. Sta. Bull. 141.

Brush Invasion—1500 B.C. and 1950 A.D.

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It is said that "History repeats itself." The Bible gives evidence of brush invading the Biblical lands as early as 1500 B.C. Before my eyes, 3,450 years later, I was amazed at the brush invasion in the southwestern United States.

As I traveled through Texas, New Mexico, Utah, Arizona and California, I saw millions of acres where brush was now dominant, but which once were vast areas of rich grasslands. The invasion was so complete in places, such as in south Texas, that woody species formed almost impenetrable thickets. Early American pioneers once described the same area as a "sea of grass."

The invasion has occurred so recently that there are still people alive that remember the open grassy plains.

Records and writings give fairly accurate accounts of the change.

What has happened and is happening in the Southwest is exactly what *could* have, and probably *did* happen in the Biblical lands. The Old Testament gives only hints, or scraps of information, but the story, pieced together, is there.

Abraham was a stockman. He left his home in the irrigated valley of the Tigris and Euphrates, and went westward looking for greener pastures.

The country of Canaan looked good—not yet thickly populated, only two sizable towns—Sichem and Hebron, and the rest must have been grass—otherwise why settle there? Grass was what he was seeking.

The tillers of the soil who lived in those towns were friendly towards the stockman. After all, they had not much use for all the grass around. But trouble soon started. With Abraham was his nephew, Lot. He, too, had flocks, and it soon became apparent that there was not enough feed for both of them (*Gen. 13*). This must be the first historical record of overgrazing.

So Lot chose to leave the high country near Hebron and went to graze in the rich, watered valley of the Jordan River. But he was a late arrival there—the valley was already densely populated, with many towns—and Lot became involved in a fight and was taken prisoner. Abraham came to his rescue with his armed herders—318 in all (*Gen. 14*). Quite an outfit!

At that time the mountains and slopes were treeless. Evidence of this lies in the fact that when Abraham went to obey God's command to sacrifice his only son on a mountain, he took the necessary firewood with him—he knew he would not find it on the spot. But when the whole affair ended happily with God's angel stopping him and obligingly providing a stag entangled in the brush, there is an apparent contradiction, until we notice that there is an abrupt change in style[1] at the end of the story which, the Bible scholars tell us, belongs to a much later age. Does that mean that grass was dominant when the beginning of the story was written, and brush when the second part was put down? Perhaps. (*Gen. 32.*) Certain it is that nature attempts to cover its wounds and, when man's livestock graze off the grass, weeds, which may be woody plants, invade.

Livestock operators in early Biblical times must have had large herds. For example we have some indications of the size of Jacob's operation. He offered to Esau, as a token of conciliation, the following:

Goats	20	Camels	30
Bucks	20	Cows	40
Ewes	200	Bulls	10
Rams	20	Asses	20
Donkey Colts	10		

Allowing that the animals then were smaller than now, it would amount to approximately 150 AU. It is logical to assume that it was

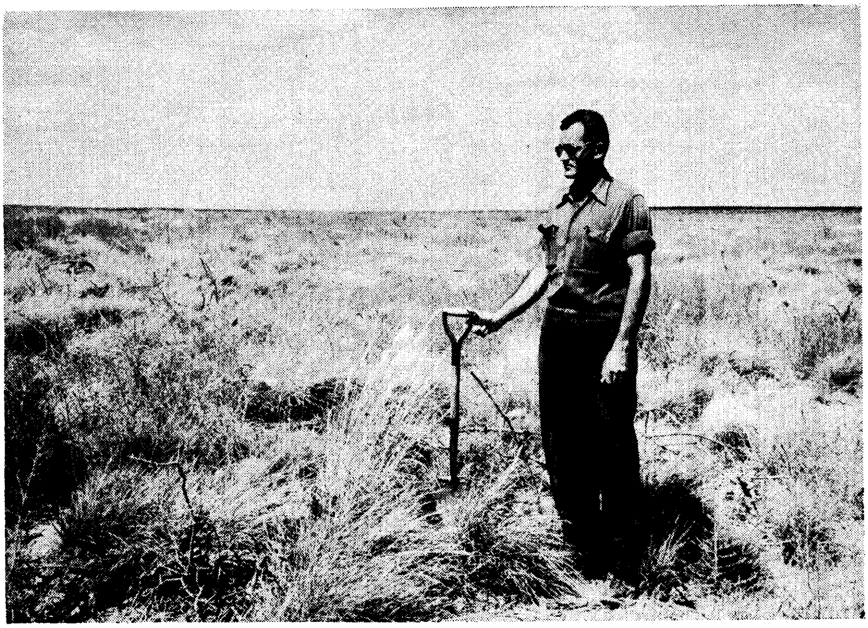

FIGURE 1. A South Texas brush-invaded range cleared of brush by root-plowing during the previous year is inspected by the author, Yaaqov Orev, while on assignment in the U. S.

1. The change consists of the use of the word "Jehovah," which is late, for the ending of the story, opposed to "Elohim," which is early, in the beginning.

one-tenth of what he had. Therefore, if he started with 1,500—150 =1,350 AU, we can safely assume a crop of 50 percent and 20 percent annual increase in size of flocks. That would mean that in 10 years his flocks and herds would number approximately 6,000 AU. And he was neither the first nor the only operator in that area of 3,000 square miles.

About 300 years after Abraham came to the land of Canaan, Jacob and his tribe were stricken by a prolonged drought. Their herds must have denuded the grazing lands. They had to seek refuge in Egypt. After 400 years of slavery, their descendants returned to Canaan. It was already densely populated, and brush was abundant—scrub oaks and pistacias. Tillers of the soil did not bother much about it—after all, they needed firewood and fiber. But it had its disadvantages—wild beasts lurked in the brush. Samson (*ca.* 1200 B.C.) had to fight a lion (which would point to a savannah type) and outlaws like Iftah and David found it easy to hide.

Sometimes, though, it profited the established authority—as when Absalom's hair got caught by a pistacia, where Jacob found and killed him (*ca.* 250 B.C.) (*Sam. II, Chap. 17*).

Even the drier parts of the country became wooded. Ezekiel (*ca.* 550 B.C.) speaks about the "forest of the Negev" (*Chap. 21*). In reality it was an Acacia scrub, and scattered Acacias are still found in that area which has 8 to 10 inches of winter rainfall.

All memory of the country once having had a grass cover was lost; today all authorities assume that the climax vegetation was oak-pistacia or Aleppo pine forest, as it appeared about 1000 B.C.

The same story was repeated all around the Mediterranean. We know of repeated incursions and invasions of nomad horsemen into Mediterranean countries. The horsemen needed grass. It is hard to imagine that they would have been attracted by thick, impenetrable "Maquis." A stockman's psychology changes little.

The first written documents we have, and the earliest literature, speak of Greece and Italy as being forested, and grazed mainly with sheep and goats; their decline being attributed to soil erosion caused by destruction of forest cover.

But the earliest written records date from approximately 1000 B.C. What about all the grazing in the Bronze Age? Can even the lightest grazing be discounted? And knowing what we know now, we may be sure that *any* grazing on natural range in the past was *overgrazing*.

Can the vegetation of the Mediterranean littoral at about 1000 B.C. be accepted as climax? Was the forest a result of grazing? Or was the so-called "forest" only scrubby woody species that invaded denuded grassland?

When I compare these two areas of the world, so distant and different, yet apparently so similar in their cause-effect relationship, several thoughts emerge.

Nature's laws do not change. There is no "unique" brush invasion in the Southwest. Similar invasions have occurred or are happening all over the world.

What happened is exactly what happens when Nature's balance is disturbed. A piece of virgin sod is broken out for cultivation, or the thick cover of grass is destroyed by grazing and drought. Almost miraculously, weeds appear.

Where did the weeds come from? In most cases, the weedy species occurred as a minor and insignificant part of the climax, or original vegetation. Perhaps they were found around animal or insect burrows, or other such disturbed spots. Seldom was the seed actually introduced from distant areas, true "invaders."

Certain of these minor plants, particularly those not grazed, found the disturbed soil to their liking. They multiplied manyfold, and spread. In some cases, cultivated fields had to be abandoned. Likewise, poisonous invaders have made rangeland almost useless, and woody species made grasslands unproductive of palatable forage.

One Texan was heard to say, while looking at a vast expanse of "chaparral," or thorny brush, "My grandfather must have been a hot-headed fool to have fought the Mexicans for this!" Yet his grandfather was fighting for, and won, rich grasslands.

These worthless plants, mesquite, juniper, burroweed, etc., aren't the real "invaders." They were there, even though in minor quantities. It is economic man that is the real *invader*. He disturbed the balance with his plow and his herds of livestock, the balance that Nature had built up for millions of years.

Research workers are looking for "the" factor responsible for brush invasion — overgrazing, drought, fire prevention, etc. It seems to me they are searching in vain. *All* the factors which contribute to economic use, taking something out and not returning anything, are responsible.

It may help to learn that the problem is not unique, and that it was inevitable. The early settlers grazed off the grass, and took no heed of the "weeds" as they appeared. Suddenly, the ranchers were confronted with the fact that the grass was gone; the weeds were there. Woody species are the most apparent weeds, though non-palatable, often poisonous herb species are also abundant. It did not take the Southwest long to realize the immensity of the problem. The realization was possible because the change occurred so rapidly.

It may be much more expensive to fight the weeds now, than it would have been to control them when they started.

There is no more Western frontier to be settled—the ranchers can't move on and leave the abused, weed-infested rangeland. The rancher has to hold on to what he has, and now pay for what his ancestors did, or did not do, to the land. It has to be done in the Old World. Now the same is having to be done in the New World.

Greater Returns from Cow-yearling Operations on Southwest Ranges

THOMAS M. STUBBLEFIELD

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Next to "death and taxes" drought is about the most certain thing in the Southwest. Ranchers there do not know when to expect one, but if they have been in business long enough they will have experienced a drought.

The Southwest rancher's biggest headache is unstable range conditions. If a rancher has a cow-calf operation, he must try to adjust the size of his breeding herd to fit the forage production of the ranch. With a great variation in seasonal and annual rainfall he finds this a difficult feat.

If he needs to increase his breeding herd, he finds that his neighbors are doing the same. If he has to reduce it, he discovers the bottom has dropped out of the cow market.

Drought has probably forced more ranchers into bankruptcy than anything else. Normally, ranchers stock their ranges to typical carrying capacity. If a rancher does this, he expects to overgraze his range in dry years and to undergraze in wet years. In dry years he feeds supplement.

He has also discovered that severe overgrazing, continued year after year, depletes his range resource—his capital investment. Even when he does not do permanent injury by overgrazing, he will delay range recovery to normal (typical carrying capacity) at the start of a wet cycle.

Cow-yearling Operations Offer Flexibility

Ranchers who have survived one or more droughts have found that FLEXIBILITY is the answer to drought. And the way it is done is for the rancher to reduce his breeding herd to the size that can be carried on his range during the dry years. When rainfall is normal or above normal, the surplus feed and grazing capacity can be grazed by yearlings.

Two big questions to be answered in changing over to a cow-yearling operation are: How will this affect the total pounds of beef produced on the range? And, more important, what effect will the change have on gross and net income? Fixed costs would be the same. However, there would be a little additional cost in a cow-yearling operation when weaner calves are wintered with supplement.

Knox (1947) found that more beef could be produced per acre by grazing yearling steers than by producing and selling weaners—32 percent more.

Reynolds (1954) reports that about 50 percent more income from 1939-1953 could have been realized by leasees on the Santa Rita Experimental Range if they had stocked their leases at a flexible rate rather than at a constant one.

McIlvain, *et al.* (1954) report that at the U. S. Southern Great Plains Field Station, Woodward, Oklahoma, only about 60 percent as much beef may be expected to be produced per unit of land on year-long grazing of breeding cows as was produced from continuous year-long grazing of steers. Heavy grazing of ranges was more detrimental to cows and calves than the same degree of grazing with steers.

Comparison of Cow-calf and Cow-yearling Operations

This paper is based on a 300-cow breeding herd and the assumption that the range is not overstocked. Table 1 shows the expected production and income from such a herd.

Table 1. Estimated production and income from a 300-cow breeding herd, 1954-55

Kind of cattle	Time of sale	Number	Average weight	Pounds of beef	Price	Income
			lbs.		*cents*	*dollars*
Calf crop from breeding herd of 300 cows (83.7%)						
Steer calves	Nov.	120	410	49,200	19	9,348.00
Steer calves	May	6	400	2,400	20	480.00
Heifer calves	Nov.	61	350	21,350	17	3,629.50
Heifer calves	May	6	340	2,040	18	367.20
Replacement cut-backs		5	610	3,050	16	488.00
Replacement cut-backs		1	650	650	13	84.50
Calf crop from 52 replacement heifers (35%)						
Steer calves	Nov.	4	410	1,640	19	311.60
Steer calves	May	5	400	2,000	20	400.00
Heifer calves	Nov.	4	350	1,400	17	238.00
Heifer calves	May	5	340	1,700	18	306.00
Total				85,430		15,652.80

Table 2. The number of animal-unit months required for a cow-calf operation of a breeding herd of 300 cows, and the number of animal-unit months required for a cow-yearling operation (300-cow breeding herd reduced 20 percent)

Kind of cattle	Number cow-calf operation	Number cow-yearling operation	Animal units required per head	Months on range	Animal-unit months cow-calf operation	Animal-unit months cow-yearling operation
Cows						
3-year olds	50	40	.95	12	570.0	456.0
4-year old & over	250	200	1.00	12	3,000.0	2,400.0
Calves	270	217	.25	6	405.0	325.2
Weaner calves	22	171	.45	6	59.4	461.4
Yearlings		171	.60	6		615.6
Replacement heifers	58	46	.45	6	156.6	124.2
Year. replacement heifers	57	46	.60	6	205.2	165.6
Long-year. repl. heifers	52	42	.75	6	234.0	189.0
2-year old repl. heifers	52	42	.85	6	265.2	214.2
Bulls	21	17	1.25	12	314.4	254.4
Total					5,209.8	5,205.6

The herd is estimated to have a calving percentage of 83.7 percent, which was the average calving percentage for a large ranch in southwestern New Mexico from 1944 through 1953. Approximately 5 percent of the calves are short-age and sold in the spring. The weights of calves used in Table 1 are actual weights at a given time for this southwestern New Mexico ranch. Breeding cows remain in the herd for 6 years; therefore, fifty 3-year-old heifers are placed in the breeding herd each year and 42 cows are sold. This allows for a death loss of approximately 2½ percent.

Eight percent of the replacements are cut back as yearlings and 2 percent are cut back as 2-year-olds. In order to place fifty 3-year-old heifers in the breeding herd each year, 58 heifer calves will have to be held back.

The bulls are turned in with the replacement heifers when they are approximately 16 months old. It is estimated that the calf crop from these heifers averages approximately 35 percent. (This is the approximate calving percentage of the replacement herd for the ranch in southwestern New Mexico.) Fifty-six percent of these calves are short-age and are sold in the spring.

At the outset it is necessary to determine how much the breeding herd would have to be reduced in order to carry the calves over to long-yearlings and still use the same amount of forage as did the cow-calf operation. Table 2 shows the animal-unit months needed for the 300-breeding-cow herd, cow-calf operation, and a 240 breeding-cow, cow-yearling operation. The forage requirements for the cows, calves, weaner calves, etc., are based on those by Vinal and Semple, 1932. This table shows that a 20 percent reduction in the size of the breeding herd will be enough to provide forage for the yearlings.

Production and Income from Cow-yearling Operation

Table 3 shows the estimated production and income from a cow-yearling operation. In this table the 300-cow breeding herd projected in Table 1 was reduced by 20 percent. Table 3 indicates that a total of 120,610 pounds of beef could be produced from a cow-yearling operation; the estimated production from the cow-calf operation in Table 1 was 85,440 pounds of beef. Thus approximately 41 percent more beef is expected to be produced from the cow-yearling operation.

The estimated income for the cow-yearling operation shown in Table 3 amounts to $20,846, or $5,193 more than the estimated income from the cow-calf operation (Table 1). The estimated prices for the calves in Table 1 were the approximate prices received for calves during the fall of 1954 with a one cent per pound increase for the short-age calves to be sold in the spring of 1955. The prices in Table 3 were the approximate prices received for yearling steers and heifers in the fall of 1954 in Arizona. There was about one-cent spread between the yearling feeders and stocker calves in favor of the calves. However, it may be that a two-cent spread is more normal than the one-cent spread. If the estimated income in Table 3 were calculated with a two-cent spread between stocker calves and yearling feeders, the total cow-yearling income would be reduced to $19,646.

The estimated average in Table 3 was determined for long-yearling steers by adding 325 pounds to the weaning weight of the steer calves. This was the average gain on the college ranch of the New Mexico Agricultural Experiment Station for the 10 years, 1937-1946. The weight for yearling heifers was estimated by adding 300 pounds of gain to the weaning weight. In the case of short-age yearling steers it is estimated that the steers gained 225 pounds from May to the middle of November, and that the short-age heifers gained 185 pounds.

Under the cow-yearling operations it is probable that the operator would feed a supplement to the weaner calves during the winter. However, it is likely that he would feed a supplement to his breeding herd most winters and a reduction in the size of the breeding herd will reduce the amount of supplement needed. If the rancher supplemented the winter range un-

Table 3. Estimated production and income from cow-yearling operation (breeding herd for cow-calf operation reduced 20 percent)

Kind of cattle	Number	Average weight	Pounds of beef	Price	Income
		lbs.		*cents*	*dollars*
Calf crop from breeding herd of 240 cows (83.7%)					
Long-yearling steers[1]	96	735	69,825	18	12,568.50
Yearling steers[2]	5	625	3,125	18	562.50
Long-yearling heifers	49	650	31,850	16	5,096.00
Yearling heifers[3]	5	520	2,600	16	416.00
Replacement cut-backs	4	610	2,440	16	390.40
Replacement cut-backs	1	650	650	13	84.50
Calf crop from 46 replacement heifers (35%)					
Long-yearling steers[1]	4	735	2,940	18	529.20
Yearling steers[2]	4	625	2,500	18	450.00
Long-yearling heifers	4	650	2,600	16	416.00
Yearling heifers[3]	4	520	2,080	16	332.80
Total			120,610		20,845.90

[1]Less 1% death loss.
[2]Yearling steers are the short-age steer calves normally sold in spring in a cow-calf operation.
[3]Yearling heifers are the short-age heifer calves normally sold in spring in a cow-calf operation.

der both types of operations, it would require approximately 6.7 more tons of cottonseed cake for the cow-yearling operation.

The rancher would, however, have some savings on a cow-yearling operation as compared to a cow-calf operation. He would need four less bulls. Since the bulls would be used for a period of five years, it is probable that he would save about $150 a year in cost of bulls. He would not have the depreciation costs on 60 cows. At the present time he would probably save around $300 a year on these depreciation costs. Thus the cost for supplemental feed for weaner calves would almost be offset by the savings on depreciation costs of the breeding herd.

Limitations

From the foregoing discussion it appears that it would be a simple matter to change from the cow-calf to a cow-yearling operation and make money. However, the actual change-over may be more difficult. In many instances the rancher is financing his production on a yearly basis and has to meet his financial obligations each fall. In order to change over to a cow-yearling operation he would have to be able to finance his production cost over a 2-year period. Assuming that range conditions were constant he would have only one-fifth as many calves but 2½ times as many cows to sell the fall he makes the transition. In many instances the return from the sale of these animals would hardly meet the obligations of many ranchers.

Also, the rancher would have to have separate pastures for his yearling heifers in order to prevent some of them from breeding. He might spay the heifers in order to get around this obstacle. However, whether or not spaying pays is not definitely known yet.

Another situation confronting ranchers is the possibility of a price decline. With present cattle numbers at an all time high, a rancher might find it more desirable to sell when he is receiving a relatively good price, rather than wait to sell a year later when he is not so sure of the price.

Summary

Maximum beef production on Southwestern ranges demands flexibility in the rate of stocking in order to adjust to variations in the amount of available range forage which result from fluctuations in rainfall. More flexibility can be obtained by reducing the size of the breeding herd so that the range forage will be adequate to carry the herd during the years that the rainfall is below normal. During the years that the rainfall is normal or above, the remaining forage can be used to graze yearlings. A 20 percent decrease in the size of the breeding herd, if the range is stocked at the typical carrying capacity, will usually provide enough forage to carry the weaner calves over to long-yearlings.

Not only will the cow-yearling operation give more flexibility in stocking, but more pounds of beef will be produced than with a cow-calf operation. Gross income will be increased, and even if there is a 2-cent spread between the price of stocker calves and long-yearlings, in favor of the stocker calves, such income should be 25 percent greater from the cow-yearling operation.

However, there are some obstacles to changing over to a cow-yearling production program. The change-over may be difficult to finance. The rancher may have to divide his pastures. There is always the danger of a price drop.

The rancher will have to take these obstacles into consideration if he is contemplating a change from a cow-calf to cow-yearling operation. Before he changes over he might also make a calculation similar to that in Tables 1 and 3 in order to estimate the profitability of such a conversion under his particular situation.

LITERATURE CITED

KNOX, J. H. 1947. The comparison of 10 years' production from range cows and yearling steers. Ranch Day, New Mexico Agr. Expt. Sta., State College, N. Mex.

MCILVAIN, E. H., *et al.* 1954. Eighteen year summary of range improvement studies at U. S. Great Plains Field Station Woodward, Oklahoma. U. S. Southern Great Plains Field Sta., Woodward, Okla.

REYNOLDS, H. G. 1954. Drought and its effect. Ranch Day, New Mexico Agr. Expt. Sta., State College, N. Mex.

VINAL, H. N. AND A. T. SEMPLE. 1932. Unit days of grazing. Jour. Amer. Soc. Agron. 24: 836-837.

Elk and Livestock Competition

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The need for proper management of the range resources of Western United States has been recognized for many years. It has only been recently realized that to secure adequate management, game populations as well as livestock numbers must be held to the limits of the food supply. Competition between livestock and game such as deer and elk on both private and public land appears to be one of the major land use problems of the West. The purpose of this paper is to present the historical, biological and economic aspects of the situation so that land managers and other interested groups may be more fully informed on this question.

At the turn of the century elk populations were at an all time low. In some areas the native population had been completely eliminated. Since 1910 big game numbers have increased as a result of public interest in wildlife conservation. Elk numbers increased from an estimated number of some 50,000 to 70,000 in 1910 to about 300,000 in 1952 (Hickie, 1953). The major increase came in the period 1920 to 1940 when the increase was about 500 percent. Between 1940 and 1952 the rate had dropped somewhat but the population is still on the rise. Hunter take is gradually increasing and is about 15 percent of the winter herd. This leaves an increment equal to from 5 to 10 percent of the winter herd as the annual rate of increase in elk numbers.

The development and use of western lands for crop production and livestock grazing resulted in the occupation of a considerable portion of the original home of elk and deer (Koch, 1941; Murie, 1951). The expansion of game populations on these lands has created conflicts of interest in the use of western range and forest lands. Leek (1911) and Graves and Nelson (1919) report the earliest occurrence of a conflict of interest. Shoemaker (1930), Roberts (1930) and Smith (1930) recognized the problem in the Southwest and in Montana prior to 1930. Pickford and Reid (1943) in Oregon report competition for forage between elk and sheep on high summer range. Olson (1945) describes how the problem developed with the Nebo herd in Utah. Craighead (1952) indicates actual and potential competition between livestock and elk in Jackson Hole, Wyoming; Mitchell and Lauckhart (1948) describe the problem of elk management in the Yakima Valley of Washington. In Montana two large acquisitions of private range land by the State Fish and Game Department were made mainly to reduce the complaints by stockmen because of elk depredations to range and hay stacks. Other states have purchased land to extend the amount of range for wintering elk (Rutherford, 1954). Late and special hunts on elk, fencing projects and even herding of elk are all examples of attempts to alleviate pressure by elk on private land (Cooney, 1952). Hall (1952) recently reported on an elk-sheep range problem area on the Sitgreaves Forest in Arizona where sheep summer range is important elk winter range. Hanson (1952) reports on the problem in Canada. These examples indicate the extent of the situation. However, it is best to point out that for the most part they are local in nature. It is a significant fact that if these problems are not solved locally they may eventually become quite extensive with unfortunate results both to livestock and game interests.

Food and Range Requirements of Elk and Livestock

An adequate understanding of the overall situation requires consideration of elk food habits and requirements and the utilization of ranges by elk. The observations of Murie (1951) in Jackson Hole, Schwartz (1943) in western Washington, Rush (1932) in Yellowstone Park, Young and Robinette (1939) in Idaho, Cowen (1947) in Alberta, De Nio (1938) in North Idaho and Montana, Cliff (1939) in Oregon and Pickford and Reid (1943) in Oregon, Schwan (1945) in Colorado all testify to the fact that elk, of all large herbivores, have perhaps the most diversified food habits. While elk are mainly grass eaters, they can do well on herbs and shrubs, adjusting to the available food supply. In winter feed studies conducted by the Montana Cooperative Wildlife Research Unit and the Montana Fish and Game Department, elk were found to have a distinct preference for hay over bunchgrass or browse. Elk calves increased in weight when hay was available in adequate amounts. Both cattle and elk were found to consume forage proportionate to their respective weights. For example, a 500 pound cow elk will eat about one-half the amount a 1,000 pound domestic cow will take (Morris and Hungerford, 1952). From lignin studies it appears that hay is more readily digested than grass and both are more digestible than browse by elk (Geis, 1954).

The ancestral home of elk appears to have been of considerable extent. In Montana, elk apparently occupied the plains, foothills and high mountains (Koch, 1941). Allred (1950) indicates that the salt desert in Wyoming was part of the winter range of elk. An early photograph of elk on salt desert in Western Colorado has been seen by the writer. Evidence of this type clearly indicates that present winter ranges are not typical, and it suggests the remarkable adaptive power of the animal. While elk herds are largely confined to forested and semiforested areas, their natural home apparently included considerable open country. However, only in the high forest country are elk in least conflict with agriculture. The use of haystacks by elk is one of the most frequent sources of conflict between ranchers and state fish and game departments. When snow deepens or temperatures drop sharply, elk will move to hay stacks even though range feed is available.

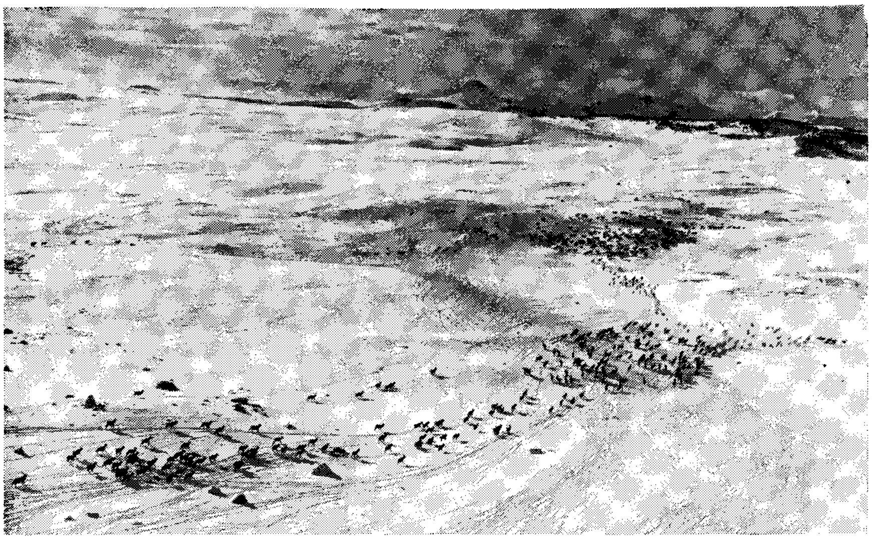

FIGURE 1. A large group of elk on winter range, Sun River Game Range. Photographed Jan. 20, 1948, by Bob Cooney, Montana Fish and Game Department.

While many individuals indicate that competition is minimized because elk will more likely use steep slopes and high ridges that are little used by cattle, existing populations of livestock and elk in many areas are competitive. Range feed is involved, range damage does occur, and elk do die of starvation. Murie (1951) states that competition will occur regardless of the fact that some areas of use do not overlap.

Economics Aspects of the Problem

Conflict of interest between livestock owners and sportsmen centers largely around the needs of elk for winter range. Elk winter range overlaps the lower portion of cattle summer range and the spring and fall range for both cattle and sheep. This seasonal range is in shortest supply for domestic livestock. While consideration is given to the needs of both elk and livestock on public lands, this is not necessarily done by the livestock operator on his own lands. Since a fair proportion of this seasonal range is privately owned, elk in many places are dependent upon the generosity of the rancher for a critical food supply.

Some sportsmen have been interested in livestock reductions on public lands to provide more feed for elk and deer. They fail to recognize that most public lands in the West are mainly suitable for summer range or too far removed from elk to relieve the problem. Further, this approach intensifies the suspicions of stockmen relative to public land management and he often acts negatively to the whole situation, (Stoddart, 1950; Carhart, 1948; Pauly, 1941; Woodward, 1953; Nichol, 1936). A sensible solution to the problem becomes submerged and lost in a flood of emotion by both interested groups. Stockmen must and do recognize that game has a place on public lands. Sportsmen must likewise realize that public land administrators have required stockmen to reduce livestock numbers for watershed and wildlife needs.

Elk occur mainly in small herds widely distributed over the West and in a few large herds such as the Sun River herd, the Northern Yellowstone and Gallatin herds of Montana, the Selway-Lochsa herd of Idaho, the Yakima and Olympic herds of Washington, and the Jackson Hole herd of Wyoming. The small herds are near their maximum population relative to the winter food supply (Rasmussen, 1949). If these are managed to restrict populations to present size through more intensive hunting, problems of small herds will be largely met. Most stockmen will accept this situation relative to their own and public lands. Haystack damage can be minimized by the use of high stack fences or baling and hauling of hay close to ranch buildings.

The problem of existing large herds will require a different solution in each case. Mitchell and Lauckhart (1948) describe a successful solution to the problem of management of one large herd, the Yakima herd. Reduction of livestock numbers on summer range was not the solution. Land acquisition of necessary winter range from sportsmen's funds provided the necessary winter range. This area should be able to supply a high level of hunting opportunity for some 1,500 to 2,000 hunters and yield 500-700 legal kill. The Sun River herd in Montana has been brought under relatively good management by a combination of land acquisition, fences and riding, so that a herd of some 3,000 elk have the finest combination of summer and winter range to be found in the West (Figure 1). This herd has been producing about 500 elk to some 1,500 hunters (Cooney, 1952). Hanscum (1952) indicates an extensive feeding program is used in Wyoming. This is at best a doubtful approach to the production of elk in small or large herds.

The Northern Yellowstone and Jackson Hole herds represent two of the largest in the country that have yet to be properly managed. Land acquisition was only a partial solution as both herds have not been brought into balance with the food supply. Harvesting has been below the annual increment. Heavy die-offs from starvation have occurred in some years. Needless to say, further removal of livestock from adjacent ranges will prolong the problem when more intensive harvesting is definitely needed (Murie, 1951; Craighead, 1952).

Those who argue that game numbers be increased on public lands as the rightful portion of the sportsman's share in the national resource must carefully consider the fact that public lands have limitations in providing winter range for game. Livestock numbers on public lands, particularly on National Forests, have steadily declined to the present time. This reduction represents a substantial number. In Montana and North Idaho, the reduction of livestock amounts to 78 percent of sheep use and 47 percent of cattle use based on 1925 numbers. Elk have increased about 356 percent and deer about 419 percent. While it is hazardous to equate feed requirements and forage use, present stocking rates of game and livestock indicate that they now share more or less equally in the forage supplied from public lands in this region. If the amount of forage used by game on private lands is included in the estimate, it would be safe to assume that the above statement is based on more than just figure juggling.

There is also the question of offsetting value of feed. Some sportsmen feel that because of the relatively low rentals on public range, ranchers should be willing to permit use on their own lands. This is at best a weak argument. Grazing permits and rental charges on public lands represent only a portion of the real costs of feed from public land. Ranches using public lands have investment costs in their own properties derived from the combined use of public and private lands. This feed is not as cheap as it appears to be. Furthermore, grazing of livestock on public land represents a legitimate business opportunity which should be recognized as such. Also many ranches have livestock that do not graze on public land but winter game on their own land. It is only when game numbers make serious inroads on feed supplies that the rancher resents their presence.

With steady increase in hunters, particularly of big game, there will be increasing demands for hunting opportunity. The sportsman interprets this to mean that more animals and more land will be needed. He fails to understand that the answer will be found mainly in good management of existing game populations.

Need for More Intensive Game Management

Game production can be increased *significantly* without interference with range livestock industry by increasing the harvest of all big game species except mountain sheep, moose and mountain goats. On the basis of the winter population of a herd, Rasmussen and Doman (1947) have calculated that the cattle industry harvests 30 percent of the herd annually while 20 percent or less of the herd is harvested from existing elk populations under present management. The annual harvest of deer is much less than 20 percent. Harvesting rates could be increased one-fifth or more on elk and as much as 100 percent on deer without increasing the present base population of either species. Another possibility for increased game production may be found by replacing elk with deer in some areas. Deer, being less competitive with cattle and consuming about one-third as much forage as elk, could supply greater hunting opportunity to more people.

In some situations it may also be desirable to increase game production, particularly of elk, by land acquisition of strategic winter range in private ownership, such as ranches with good winter range possibilities and other seasonal forage. These ranches should be characterized by having a very low percentage of land in meadows or cultivated acreage. Likewise, snow conditions should be such that standing forage will be available through the winter. Suitable ranches will be isolated from or at the margin of an extensive ranching community.

Many ranchers will object to such an approach to increased game production for reasons such as the need for expansion of existing ranches, loss of tax revenue for school districts, and increased trouble from more elk in the country. Some sportsmen will complain because money will be diverted from other game work.

These arguments can best be answered by stating that the present pattern of game and livestock production has developed under a combination of American economic and political rules, public land policies, and a frontier tradition. It implies that no single factor of the combination can govern the method of resolving the problem. Those who wish to reestablish a wilderness condition or direct the land use back to wildlife habitat should be willing to pay the price in the open market. Outdoor recreation cannot be provided by the public from federal lands alone as in the case of game. These lands are limited in their capacity to do this and also meet all demands on resources required by a growing population. Ranchers must be tolerant of attempts at acquisition of private land for game so long as they may have an opportunity to bid on the same property. Assessments on the land to meet school district costs should remove a major criticism of the loss of these lands from tax rolls.

Conclusion

In conclusion, one final point remains, how best to approach and solve a conflict of interests involving game and livestock. Here, again, some examples may illustrate possible solutions. Mitchell and Lauckhart (1948) describe a cooperative approach by bringing all interested parties together for a thorough analysis of the problem and agreement on methods of solution. Olson (1943) indicates how a "Board of Elk Control" was established in Utah to deal with the conflict between ranchers and sportsmen over big game problems. In Montana, similar steps have been taken in the Bitterroot Valley, including a series of community forums, special meetings and field trips over a period of three years. After a common understanding was reached on the overall problem of land use for water, timber, livestock and game production, a plan was developed for the best management of all the resources including game and livestock. This is the only feasible approach, with an intelligent, fair and informed public representing all interests in the land. How to get proper land and resource use is truly a "grass-roots" questions and requires a "grass-roots" approach.

LITERATURE CITED

Allred, W. J. 1950. Reestablishment of seasonal elk migration through transplanting. Trans. 15th North Amer. Wildl. Conf., pp. 597-611.

Carhart, A. H. 1948. Our public lands in jeopardy. Trans. 13th North Amer. Wildl. Conf., pp. 86-100.

Cliff, E. P. 1939. Relationship between elk and mule deer in the Blue Mountains of Oregon. Trans. 4th North Amer. Wildl. Conf., pp. 560-569.

Cooney, R. F. 1952. Elk problems in Montana. Jour. Range Mangt. 5:3-7.

Cowan, I. Mc. 1947. Range competition between mule deer, big horn sheep and elk in Jasper Park, Alberta. Trans. 12th North Amer. Wildl. Conf., pp. 223-227.

Craighead, J. J. 1952. A biological and economic appraisal of the Jackson Hole elk herd. N. Y. Zoo. Soc. and the Cons. Found.

De Nio, R. M. 1938. Elk and deer foods and feeding habits. Trans. 3rd North Amer. Wildl. Conf., pp. 421-427.

Geis, A. H. 1954. The food consumption and relative digestibility of various winter diets fed to elk under controlled conditions. Montana State University, unpubl. M. S. thesis.

Graves, H. S. and E. W. Nelson, 1919. Our national elk herds, a program for conserving elk on National forests about Yellowstone National Park. U.S. Dept. Agr. Dept. Cir. 51.

Hall, J. M. 1952. Game-livestock relationship studies in Arizona. Ariz. Game and Fish Comm.

Hanscum, C. W. 1952. Game-livestock relationships. Wyo. Wildl. 16:4-9.

Hanson, W. R. 1952. Grazing use of forest lands. For. Chron. 28:23-32.

Hickie, Paul. 1953. Inventory of big-game animals in United States, 1952. U.S. Fish and Wildlife Service Leaflet 348.

Koch, Elers. 1941. Big game in Montana from early historical records. Jour. Wildl. Mangt. 5:357-370.

Leek, S. N. 1911. The problem of elk. Colliers 46, No. 21.

Mitchell, G. E. and J. B. Lauckhart. 1948. Management of the Yakima Rocky Mountain elk herd. Trans 13th North Amer. Wildl. Conf., pp. 401-409.

Morris, M. S. and Roger Hungerford. 1952. Food consumption and weight response of elk under winter conditions. Proc. 32nd An. Conf. West. Assn. State Game and Fish Comm., pp. 185-187.

Murie, O. J. 1951. The elk of North America. Wildlife Mangt. Inst., Wash., D. C. 376 pp.

Nichol, A. A. 1936. Hunters, conservationists, game and cattlemen. Amer. Cattle Prod. 18:3-8.

Olson, O. A. 1943. Big game in multiple land use in Utah. Jour. For. 41:792-797.

———, 1945. Elk below! Stevens and Wallis.

Pauly, Sylvan J. 1941. The stockman's viewpoint on conservation. Trans. 6th North Amer. Wildl. Conf., pp. 19-23.

Pickford, G. D. and E. H. Reid. 1943. Competition of elk and domestic livestock for summer range forage. Jour. Wildl. Mangt. 7:328-332.

Rasmussen, D. I. 1949. The American elk or wapiti—today. Trans. 14th Amer. Wildlife Conf., pp. 515-525.

———, and Everett R. Doman. 1947. Planning of management programs for Western big game herds. Trans. 12th North Amer. Wildl. Con., pp. 204-211.

Roberts, P. H. 1930. The Sitgreaves elk herd. Jour. For. 28:655-658.

Rush, W. M. 1932. Northern Yellowstone elk study. Mont. Fish and Game Comm.

Rutherford, R. M. 1954. Five years of Pittman-Robertson wildlife restoration 1949-1953. Wildlife Mangt. Inst., Wash., D. C.

Schwan, H. E. 1945. Big game and livestock on the western range. Trans. 10th North Amer. Wildl. Conf., pp. 219-224.

Smith, G. A. 1930. The Sun River elk herd. Jour. For. 28:644-647.

Schwartz, J. E. 1943. Range conditions and management of the Roosevelt elk on the Olympic Peninsula. U. S. Dept. Agr. Mimeo.

Shoemaker, D. A. 1930. The Pecos elk herd. Jour. For. 28:648-654.

Stoddart, L. A. 1950. The stockman: his importance in management of land and big game. Trans. 15th North Amer. Wildl. Conf., pp. 83-92.

Woodward, H. B. 1953. Competition for public lands. Trans. 18th North Amer. Wildl. Conf., pp. 58-72.

Young, V. A. and W. L. Robinette. 1939. A study of the range habits of elk on the Selway game preserve. Univ. Idaho Bull. 34.

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AUSTRALIAN PASTURE AND RESEARCH TOUR BEING PLANNED

The Division of Plant Industry, Commonwealth Scientific and Industrial Research Organization of Australia is planning an organized tour covering the eastern pastoral areas and research centers of Australia following the Seventh International Grassland Congress to be held in New Zealand in November 1956. If sufficient interest is shown, the tour would last 10 or 11 days and include such important pasture areas as those near Brisbane, Armidale, Sydney, Canberra, Deniliquin and Melbourne.

The cost of the tour including accommodations will be about 35 pounds Australian (about $100). Transportation costs may be subsidized, in which event the cost might be reduced to 20 pounds ($56). Anyone interested should write to

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Effect on Blue Oak *(Quercus douglasii)* of 2,4-D and 2,4,5-T Concentrates Applied to Cuts in Trunks

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The blue oak *(Quercus douglasii)* is a common deciduous tree in the Sierra Nevada foothills and on the inner Coast Ranges of California. It is the main woody species on several million acres of land. Stands of blue oak may vary in density but generally consist of 50 to 200 trees per acre. The mature trees are 20 to 60 feet high. Trees sprout basally when cut, except during the late summer and early fall, when only a few will sprout.

Trees on ranch land may be disadvantageous in several ways. The forage developing beneath these trees is generally considered to be less desirable than that developing in the open. When cattle consume too many acorns they may lose weight; feeding of concentrates may then be necessary. The presence of an abundance of trees increases the difficulty of locating cattle. Removing trees may increase the flow of water from springs. For these or other reasons, ranchers often desire to reduce the number of trees on the land.

This paper reports the results of tests with 2,4-D and 2,4,5-T concentrates applied to cuts in standing trees. Exploratory tests conducted by Swezey (1953) on willow observed in 1950 stimulated interest in making a more detailed study using concentrates for killing trees. A number of factors had to be investigated in order to learn the limitations of this method; therefore, with very little background information to go on, the following studies were conducted. The use of concentrates had an obvious appeal for use in the oak woodland areas. A small volume of material that could be carried on horseback would be enough to last a worker an entire day.

Studies to be reported are on the blue oak, although some on the interior live oak *(Quercus wislizenii)* were conducted at the same time. The results on the latter species will be published at a later date.

Materials and Methods

Most of the tests reported in this paper were conducted in 1951 on the L. J. Gamble ranch in Napa County. Annual rainfall averages about 20 inches, mostly falling between November 1 and May 1.

The trees varied in diameter from 6 to 24 inches. Chemicals were introduced into the trees through cuts which were made in the trunks. The cuts were made with a shingle hatchet, having a blade 2 inches wide. A 5 ml. veterinary hypodermic syringe was used for making the applications of undiluted commercial formulations of 2,4-D and 2,4,5-T concentrates. Liquid formulations of the amines and esters of 2,4-D and 2,4,5-T, and the amine salt of MCP were used in the tests[1]. All formulations contained 4 pounds of acid equivalent per gallon and were used without dilution with water or oil (except in one experiment). Ten trees were used per treatment.

[1]*The esters of 2,4-D and 2,4,5-T (mixed propylene glycol butyl ether esters) and the amine salt of MCP (triethanolamine) were supplied by the Dow Chemical Company. The amine of 2,4-D (triethanolamine) was supplied by American Chemical Paint Company and the amine of 2,4,5-T (triethylamine) by E. I. Du Pont de Nemours and Company.*

The trees were numbered using aluminum tags nailed loosely to the trunks about 6 feet above the ground. Tags within 4 or 5 feet of the ground were often eaten by deer. Tags nailed tightly to the trees are sometimes lost because of cambial activity forcing the tags over the heads of the nails.

Results

Experiments were conducted to determine factors which might influence the results with this method of application of chemicals.

Spacing of Cuts

Data presented in Table 1 indicate the effect of various spacings of cuts on kill. Cuts spaced every 4 inches around the circumference of the tree were clearly more effective than cuts spread farther apart. Less material was necessary to effect a high percentage of kill at this spacing than in wider spacings. With 8-inch spacing, 8 ml. of 2,4,5-T were necessary to effect a 100 percent kill. Although fewer cuts were necessary than with the 4-inch spacing, the time necessary to apply 8 ml. per cut was considerably increased, since the cuts hold only 2 or 3 ml. at any one time.

The tissues below and above the cuts are the first to die, while the

Table 1. Effect of spacing of cuts on the kill of blue oak with 2,4-D and 2,4,5-T amine.*

Spacing**	Vol. of chemical applied	Trees Dead	
		2,4,5-T amine	2,4-D amine
in.	*ml./cut*	%	%
4	1	100	70
4	2	100	100
4	4	100	100
6	2	60	70
6	4	100	100
8	2	50	—
8	4	90	—
8	8	100	—
12	2	30	—
12	4	50	—
12	8	60	—

*Unless otherwise stated, the data in each table are based on 10 trees per treatment. Treatments were applied in August, 1951 and final readings were measured three years later in August 1954 unless otherwise indicated.

**Spacing indicates the distance from the center of one cut to the center of the next cut.

Table 2 Effectiveness of cut-surface treatment with 2,4-D and 2,4,5-T amines as related to height of cut.

Height of cut	2,4-D amine* Plant Kill	2,4-D amine* Basally Sprouting in 1953**	2,4,5-T amine Plant Kill	2,4,5-T amine Basally Sprouting in 1953
in.	%	%	%	%
0	100	0	100	0
6	100	0	90	0
12	70	10	100	10
24	60	50	80	10
36	60	20	100	50
48	60	20	90	50

*Volume of amine per cut was 2 ml.
**All sprouts were dead in 1954.

bark between the cuts may remain alive much longer. The broader the strip of uncut bark, the less likely it is to die. Frilling is the most certain method for killing trees, especially on vigorous sprouting species. Frilling has resulted in a kill of all blue oaks treated with 2,4-D and 2,4,5-T amines.

Height of Cut

Tests made in August 1951 to determine the effect of various heights of cuts treated with 2,4-D and 2,4,5-T amine are reported in Table 2.

Treatments with 2,4-D amine in cuts made close to the ground were more effective than those made higher on the trunks. In treatments with 2,4,5-T amine, height of cut made less difference on effectiveness.

An important advantage in making low cuts is that there is much less sprouting from the stumps. This sprouting does not appear to be important with the blue oaks, since the sprouts present the second year after the tests were made had all died by the end of the third year; however, in species which have hardier sprouts, low cutting would be necessary, since many of such sprouts would not die.

Similar tests with the ester formulations gave poorer results than with the amines. For all heights, 13 percent kill was obtained with 2,4-D ester and 41 percent with 2,4,5-T ester.

Depth of Application

The effects of various depths of application were studied in holes made at a 30° angle with a one-inch machine drill. Data in Table 3 present the results obtained with 2,4-D and 2,4,5-T amines.

Applications made 8 to 22 mm. into the wood appeared to be satisfactory with 2,4,5-T, while applications made 16 mm. and deeper appeared to be best with the 2,4-D amine. The 2,4,5-T amine was absorbed by the wood much faster than was the 2,4-D amine which was probably a factor causing its greater effectiveness at the shallower depths. At the greater depths. the penetration of the 2,4,-5-T into dry wood probably resulted in loss, making it less effective than the 2,4-D amine. Differences in the amine formulations may have been responsible for the results. The triethyl amine of 2,4,5-T is more oil-like than the alkanolamine of 2,4-D, a factor favoring penetration into wood.

Table 3. Effect of depth of application of 2,4-D and 2,4,5-T amines on killing of blue oak trees.*

Depth of hole: Total Depth	Depth of hole: Depth in wood	Plant Kill: 2,4-D amine**	Plant Kill: 2,4,5-T amine
mm.	*mm.*	%	%
11	2	0	10
16	8	40	100
24	16	80	60
32	22	100	100
51	42	100	40
76	67	80	10

*Five trees were used per treatment.
**Volume of amine used per cut was 2 ml.

The average kill obtained with the esters was much poorer than with the amines. The 2,4,5-T ester gave an average kill of 35 percent for all depths of application, while the 2,4-D ester had an average kill of only 7 percent.

The importance of depth of application has been corroborated in field trials by various individuals in California; with shallow cuts, the kills have been erratic.

Dilution with Water

It was of interest to determine whether concentrates of 2,4-D amine were more or less effective than were the same quantities of 2,4-D applied diluted with water. Table 4 summarizes an experiment conducted in 1951.

The results suggest an advantage in diluting the amine of 2,4-D when small amounts are applied to cuts; however, when the quantity of 2,4-D applied to cuts is increased to a level necessary to kill an appreciable percentage of the trees, the advantage of diluting the 2,4-D with water completely disappears. Since the use of more than 2 ml. of solution per cut requires extra time for application, no advantage is obtained by dilution of the amine with water.

Chemical Tests

The effectiveness of the amine and ester forms of 2,4-D and 2,4,5-T and the amine of MCP in a test made in August 1951 is shown in Table 5.

All chemicals except MCP were effective when used at the rate of 4 ml. per cut. Amine forms were clearly superior to esters at application volumes of 1 ml. per cut.

Table 4. Effect on plant kill of dilution with water of 2,4-D amine applied to cuts.

Concentration of 2,4-D	Vol. applied per cut	Plant Kill
lbs./gal.	*ml.*	%
4	0.25	0
4	0.5	0
4	1.0	50
4	2.0	80
2	0.5	10
2	1.0	30
2	2.0	50
2	4.0	70
1	1.0	20
1	2.0	40
1	4.0	40
1	8.0	80

Table 5. Effects of different rates of 2,4-D, 2,4,5-T and MCP applied in cuts on plant kill.*

Chemical	Volume applied per cut (ml.)				
	0.25	0.5	1.0	2.0	4.0
	percent kill				
2,4-D ester	0	0	0	20	90
2,4-D amine	0	0	70	70	90
2,4,5-T ester	0	0	10	60	90
2,4,5-T amine	0	20	50	60	100
MCP amine	0	0	0	10	40

*The chemicals were applied to cuts with a 6-inch spacing at 6 to 12 inches above the ground.

Amines of 2,4-D and 2,4,5-T had comparable effects, but the ester of 2,4,5-T was appreciably more effective than 2,4-D. MCP was almost without effects except at the highest rate of application used. Applications less than 1 ml. per cut were ineffective. The check treatments, where no chemical had been applied, were entirely healed over three years later.

Seasonal Differences in Sensitivity To 2,4-D and 2,4,5-T

The effects of season of treatment of blue oak with the amines of 2,4-D and 2,4,5-T are presented in Table 6. The most pronounced change in sensitivity took place between August 8 and November 4. These changes are probably related to variations in soil moisture and to air and soil temperatures. The average monthly temperature and total rainfall in 1951 at Winters, California (the nearest point for which weather records are available) was 75.4° F. and a trace of rain in August, 73.4° F. and 0.03 inches of rain in September, 62.2° F. and 1.07 inches of rain in October, 53.3° F. and 2.63 inches of rain in November. Total rainfall at the experimental area was probably 50 percent higher. The favorable soil moisture and reduced transpiration in November would favor root growth. Herbicidal effectiveness of 2,4-D and 2,4-5T has been found to be related to active plant growth. Soil moisture remained favorable throughout the winter and spring months, and the trees remained quite sensitive throughout this period.

Trees killed by the cut-surface method may develop sprouts but virtually all of these die. Sprouting is thus not an important problem. Most sprouting took place in late spring and decreased as the quantity of 2,4-D was increased. The amount of sprouting was similar with comparable treatments of 2,4-D and 2,4,5-T.

Discussions and Conclusions

Cut-surface treatment with 2,4-D and 2,4,5-T concentrates appears to be an effective and economical method for killing blue oak. 2,4-D amine should be used as it is cheaper and produces as good a kill as other chemicals studied.

Table 6. Effect of season of treatment on top kill and sprouting of blue oaks treated with the amines of 2,4-D and 2,4,5-T.

Date of treatment	Width of cut	2,4,5-T amine 1 ml./cut Top kill	2,4,5-T amine 1 ml./cut Sprouting	2,4-D amine 0.5 ml./cut Top kill	2,4-D amine 0.5 ml./cut Sprouting	2,4-D amine 1 ml./cut Top kill	2,4-D amine 1 ml./cut Sprouting	2,4-D amine 2 ml./cut Top kill	2,4-D amine 2 ml./cut Sprout ing
	in.	*%*		*%*		*%*		*%*	
8/ 8/51	2	50	0	0	0	70	0	60	0
10/ 6/51	2	40	10	30	10	70	0	100	10
11/ 4/51	2	90	0	90	0	100	0	100	0
12/16/51	2	100	0	80	0	100	0	100	0
2/12/52	2	70	0	100	0	100	0	100	0
3/12/52	3½	100	0	80	20	100	0	100	0
4/28/52	3½	100	0	100	0	100	0	100	0
6/ 6/52	3½	100	50	90	40	100	40	100	10
7/ 8/52	3½	80	0	70	10	80	10	80	0
Average	—	81	7	61	9	89	6	93	2

In actual practice, 2,4-D amine solution is applied by means of a pump oil-can into cuts made with a hatchet or ax. Fig. 1 shows a blue oak tree in the process of being treated, while Fig. 2 shows a tree three years after treatment. It is generally possible to work an entire day and still not use more than one or two gallons of 2,4-D amine. One gallon of chemical should be adequate to treat 300 trees one foot in diameter. The small volume of material to be carried is advantageous. This method has also been used successfully on interior live oak, digger pine (*Pinus sabiniana*), willow (*Salix* sp.) and other species.

Most experimental work on the effects of 2,4-D and 2,4,5-T (mainly esters) in frills in stems has been conducted with dilute solutions or emulsions in water or in oil (Goddard, 1954; Peevy, 1954; Arend and Coulter, 1953; McCully and Darrow, 1952). The use of concentrates (mainly amines) in cuts has been reported to be effective on digger pine by Emrick (1953), and on interior live oak by Leonard (1952).

It was found that spacing of the cuts was of considerable importance in determining effectiveness. For example, spacings every 4 inches around the trees were more effective than when the cuts were spaced 6 inches apart (center to center of the cuts). A frill was always effective and resulted in a kill of all trees treated in this manner. However, frills are not necessary for killing blue oak, but cuts should be placed close together. Frills have been best to use on vigorous sprouting species, such as interior live oak. Roberts (1954) reports that the use of frills is necessary to obtain complete topkill on several southern species.

Height above the ground at which cuts are made is a factor in control of sprouting, but does not appear to be an important factor influencing top kill. Sprouting of blue oak did not detract from the effectiveness of the method since all sprouts died within three years after treatment. In similar tests on interior live oak, some, but not all, of the sprouts had died within three years after treatment, and it is apparent that every effort should

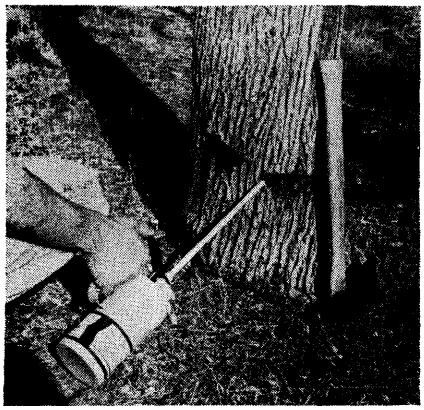

FIGURE 1. Amine of 2,4-D being applied with a pump oil-can to cuts in a blue oak tree.

be taken to avoid their being formed in the first place.

Dilution of 2,4-D and 2,4,5-T formulations with water has sometimes been practiced to allow treatment of more trees with a given quantity of chemical. The tests show that a certain minimum dosage of concentrate is required to kill the trees and dilution merely increases the difficulty of adding the required quantity of chemical. Dilution is apt to be a wasteful procedure, since the cuts may be quickly filled with the chemical, the excess draining down the outside of the bark and lost.

Depth of application studies and subsequent experience emphasize that the chemicals must be applied to the sapwood if good kills are to result.

Studies on the effect of amine and ester forms of 2,4-D and 2,4,5-T clearly showed the marked superiority of the amines over the esters This superiority is understandable, for the greater water solubility of amines becomes an important factor (since the major movement appears to be in the xylem). The superiority of the amines was emphasized by the results obtained with the depth of application studies with 2,4-D. The amine resulted in an average kill of 67 percent, while the ester resulted in only a 7 percent kill. The amines of 2,4-D and 2,4,5-T were equally effective; however, the ester of 2,4,5-T was superior to the ester of 2,4-D.

The seasonal study revealed that the trees became more sensitive in the fall of the year. This change from relative resistance (with 0.5 ml. 2,4-D amine per cut) in October to a sensitive response in November occurred under conditions when there was a complete absence of growth in the tops of the trees. Similar results were obtained with interior live oak at the same location. The increase in sensitivity took place after an estimated 1.5 inches of rain had fallen and while the air temperatures were becoming lower, thus decreasing transpiration. It is probable that roots started growing soon after the applications were made, and this made them relatively sensitive to the treatment. Root growth during the winter is common on woody

FIGURE 2. Blue oak tree three years after being treated with 2,4-D amine. Five cuts were made in the 10-inch stem, each receiving 2 ml. of amine, for a total of 10 ml. for the tree.

plants as has been shown to be true with apples and filberts by Harris (1926). The November applications showed no effect on leaves which were present at this time. With live oak, no effect on the leaves was shown until growth started in the spring. The marked effect of foliage sprays applied in the fall of the year to live oak sprouts has been reported by Emrick and Leonard (1954). These authors considered that the marked sensitivity of interior live oak in the fall of the year was due to the factors considered above. In addition to the factors already mentioned, the lower temperatures would decrease the rate of biochemical breakdown of the 2,4-D and 2,4,5-T in the plant tissues. Weintraub *et al.* (1954) have reported that 2,4-D broke down more slowly in cherry seedlings when the applications were made in November than when the applications were made in September.

Under some conditions and with some species the root pressures in the sapwood may be about neutral or positive. Under these conditions, very little amine would be drawn back into the roots and considerable sprouting would result.

The rate of dying of the tops varies with the time of the year when the applications are made. Applications made just before the new leaves develop in the spring result in the most rapid effect, while applications made in the fall result in no visible effect until growth starts the following spring.

Summary

1. The effects of cut-surface applications of 2,4-D and 2,4,5-T concentrates on blue oak were studied in relation to spacing, height, and depth of cuts, form and dilution of herbicide, and seasonal differences in sensitivity.
2. Four-inch spacing of the cuts gave the best kills with the least volume of chemical.
3. Cuts made close to the ground were slightly more effective than cuts made higher on the trunk in killing the tops, but were much more effective in preventing sprouting from the base; however, the sprouts eventually died, so the formation of sprouts was of no importance.
4. Amines of 2,4-D and 2,4,5-T were much more effective when applied to the sapwood than when they were applied to the bark.
5. Amines were considerably more effective than the esters, especially at the lower dosages used. The 2,4,5-T amine was equal to the amine of 2,4-D, while the amine of MCP was much less effective. The ester

of 2,4,5-T was superior to the ester of 2,4-D.

6. Dilution of 2,4-D amine with water gave no advantage in effectiveness. It increased the time necessary for making effective application and added to the bulk of material to be carried.

7. An abrupt increase in effectiveness took place between October 6 and November 4. The increase in effectiveness in November appears to have been associated with an increase in soil moisture and a decrease in air temperature. The trees remained sensitive throughout the winter and spring months.

LITERATURE CITED

AREND, J. L. AND L. L. COULTER. 1953. Chemical frill girdling for pine release in lower Michigan. Down to Earth. 8 (4): 2-4.

EMRICK, WALTER E. 1953. An easy way to kill your bull (digger) pines. Univ. California Ext. Service Leaflet (Madera County): 1-9.

EMRICK, W. E. AND O. A. LEONARD. 1954. Delayed kill of interior live oak by fall treatment with 2,4-D and 2,4,5-T. Jour. Range Mangt. 7: 75-76.

GODDARD, RAY E. 1954. Killing small undesirable hardwoods by use of the Cornell tool. Down to Earth 10 (2): 5.

HARRIS, G. H. 1926. The activity of apple and filbert roots especially during the winter months. Proc. Amer. Soc. Hort. Sci. 23: 414-422.

LEONARD, O. A. 1952. Result of a cut-surface experiment on interior live oak. Research Rept., 13th Western Weed Control Conference: 53-54.

MCCULLY, W. G. AND R. A. DARROW. 1952. Control of post and blackjack oaks with growth-regulator herbicides. Proc. Fifth South. Weed Conf. 137-140.

PEEVY, F. A. 1954. Woody plant control in Southern Forests. Proc. Seventh South. Weed Conf. 261-264.

ROBERTS, E. G. 1954. Frilling with and without the application of 2,4,5-T in hardwood control. Proc. Seventh South. Weed Conf. 294-296.

SWEZEY, A. W. 1953. A report of preliminary investigations of the treatment of riparian trees with 2,4-D and 2,4,5-T by basal techniques. Res. Rept. Western Weed Control Conf. 42-43.

WEINTRAUB, R. L., J. H. REINHART, R. A. SCHERFF AND L. C. SCHISLER. 1954. Metabolism of 2,4-dichlorophenoxyacetic Acid. 3. Metabolism and persistence in dormant plant tissue. Plant Physiol. 29: 303-304.

Ecology of California Grasslands

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West of the Sierra Nevada Divide in California are 17.5 million acres which contribute 80 percent of the forage for domestic livestock grazing on the State's wildlands. The area includes two vegetational types—the *grass* of 10 million acres and the *woodland-grass* of 7.5 million acres (Fig. 1). Another 25 million acres or so of wildlands in California are also grazed by livestock, but comprise only 20 percent of the forage. These acres include the chapparal type, coastal sagebrush, woodland, timber and meadow types of the mountains, portions of the desert, and the Great Basin sagebrush type east of the Sierra Nevada Divide. In addition to the wildlands, California has about 1,000,000 acres of irrigated pastures with high grazing capacity—up to three animal units per acre per month for seven months of the year.

Grass and woodland-grass ranges are used primarily for domestic livestock production, and problems in management center around this activity. A majority of the other wildlands, however, have other primary values, such as watershed, wildlife and other recreation, or timber production. The grass and woodland-grass ranges usually can be managed to the maximum for livestock, but on the other lands proper consideration must be given to the various uses, and problems in grazing are often complex and difficult (Talbot and Sampson, 1948).

The grass and woodland-grass ranges occur mainly in the plains and foothills of the San Joaquin and Sacramento valleys (Fig. 2). The grass type adjoins the valleys and is surrounded by the woodland-grass (Wieslander and Jensen, 1946). West of the grasslands are the Coast Range Mountains and the Pacific Ocean, and on the east are the Sierra Nevada Mountains. In a few places the grass type adjoins the ocean.

Climate

The climate of this area is the Mediterranean type, characterized by wet, mild winters and long, hot, dry summers (Fig. 3). It is diverse, being affected by the Coast Range Mountains which influence the air and cloud movements, and by the Pacific Ocean which has moderating effects in certain areas.

Precipitation usually begins in October or November and ends in April or early May, with about two-thirds falling from December through March. It varies in amount from about 6 inches, in the foothills surrounding the southern tip of the San Joaquin Valley and along its west side, to about 40 inches in certain portions near the Coast. From May through September there may be little or no precipitation, a desirable state of affairs from the stockman's viewpoint. At that time the forage is dry and might be leached of its soluble nutrients even by light

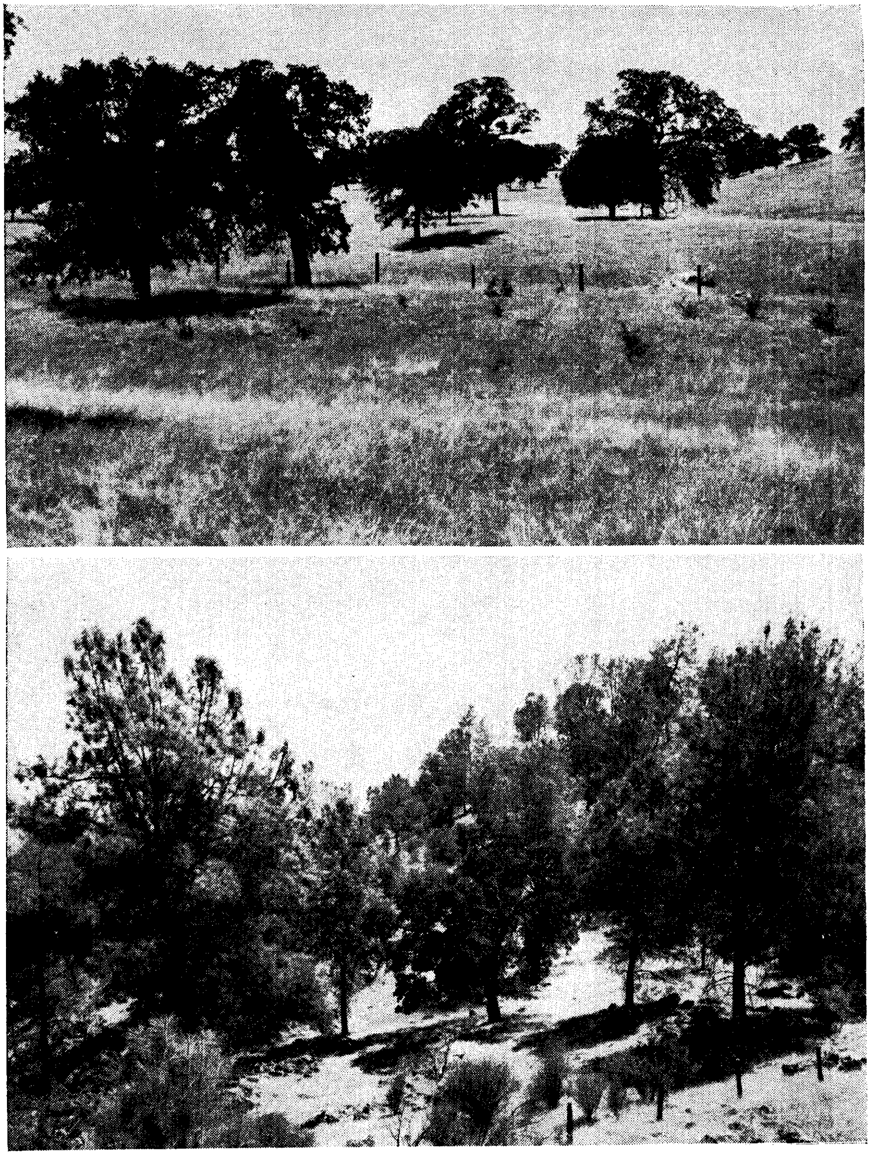

FIGURE 1. *Upper.* Grass type range grading into woodland-grass in background, as indicated by scattered blue oaks. On west-facing slope of central Sierra Nevada foothills at 500 ft. elevation. *Lower.* Woodland-grass range at the same location at 1,000 ft. elevation.

rainfall. During the dry summer period the days are mostly clear with maximum temperatures frequently above 105° F. and the relative humidity often 10 to 15 percent and sometimes lower.

Landscape and Vegetation

The grass and woodland-grass types are similar in many respects, but the latter has a landscape of scattered trees and shrubs while the other does not. In the grass type, however, scattered areas of chaparral may be found.

To the casual observer, the landscape of herbaceous vegetation appears remarkably uniform, but it is extremely diverse and composed of hundreds of species in varying amounts. It becomes green soon after the first rains, and the amount of growth is considerable in the fall months if conditions are favorable. During December, January and February, growth is slow because the minimum temperatures are near freezing. With the return of warmer weather in March the growth becomes rapid. The plants mature and dry in late April and early May, with some, but not all, of the perennials staying green slightly longer. From then until the fall rains, the landscape of dry forage is golden brown. Any green herbs are mostly summer weeds and may indicate deteriorated range conditions.

In early March the evergreen shrubs and trees of the woodland-grass type resume growth, and the deciduous plants put out new leaves soon thereafter. The shrubs and trees are green throughout the summer except for certain species, such as poison oak and California buckeye, which drop their leaves in early August.

The plants are all adapted in one way or another to the Mediterranean climate. The annual herbs grow and mature when moisture is plentiful, and are dry during the long, hot summer. The perennial grasses and forbs do likewise, being mainly dry and dormant during summer. Pine bluegrass, for example, dries equally as early as any annual and is completely dormant during the summer. This adaptation gives it an advantage over the annuals because it starts growth in the fall with less precipitation, and makes more rapid initial growth, thus placing it in a better position to compete with surrounding vegetation. The shrubs and trees are deep rooted. Some have small, thick, heavily-cutinized, evergreen leaves; others drop their leaves before the end of the extremely dry summer period.

The herbaceous vegetation is composed mainly of annuals. These and the perennials vary in percentage from place to place. Because of the great abundance of annuals, the grasslands have become known as the annual vegetation type of California (Talbot, *et al.*, 1939). In the foothills east of the San Joaquin Valley, for example, annuals comprise about 98 percent of the plant cover; perennial, grass-like plants (sedges and rushes), 1 to 4 percent; and other perennial grasses and forbs, less than 1 percent (Talbot and Biswell, 1942).

Along the coast, some of the perennials are abundant locally. The annual plant cover fluctuates greatly from year to year, depending on the weather and other growth factors, especially in the more arid portions where even normal rainfall may produce little growth (Talbot, *et al.*, 1939).

The more abundant plants on grass and woodland-grass ranges include the following (alien species indicated by *):

Annual Grasses and Forbs

*Soft chess, *Bromus mollis*
*Ripgut grass, *Bromus rigidus*
*Red brome, *Bromus rubens*
*Slender oat, *Avena barbata*
*Wild oat, *Avena fatua*
*Common foxtail, *Hordeum hystrix*
Foxtail fescue, *Festuca megalura*
*Common ryegrass, *Lolium multiflorum*
*Broadleaf filaree, *Erodium botrys*
*Red-stem filaree, *Erodium cicutarium*
*Bur clover, *Medicago hispida*
Annual clovers, *Trifolium* spp.
*Napa thistle, *Centaurea melitensis*
Tarweed, *Hemizonia* spp.
Spanish clover, *Lotus americanus*
Ground lupine, *Lupinus bicolor*

Perennial Grasses

Purple needlegrass, *Stipa pulchra*
Pine bluegrass, *Poa scabrella*
Creeping wildrye, *Elymus triticoides*
Melic grass, *Melica californica*
California oatgrass, *Danthonia californica*
Squirrel grass, *Sitanion hystrix*

Trees and Shrubs

Blue oak, *Quercus douglasii*
Interior liveoak, *Quercus wislizenii*
Buckeye, *Aesculus californica*
Digger pine, *Pinus sabiniana*
Wedgeleaf ceanothus, *Ceanothus cuneatus*
Poison oak, *Rhus diversiloba*
Hollyleaf buckthorn, *Rhamnus crocea*
Manzanita, *Arctostaphylos* spp.

Changes in the Native Grasslands

Great changes in the vegetation of California grasslands have occurred since the first Spanish Missions were established nearly 200 years ago. These have been brought about chiefly by an invasion of alien species—nearly 400 of them on grassland ranges (Robbins, 1940). Some of these are adaptable, aggressive, and widespread

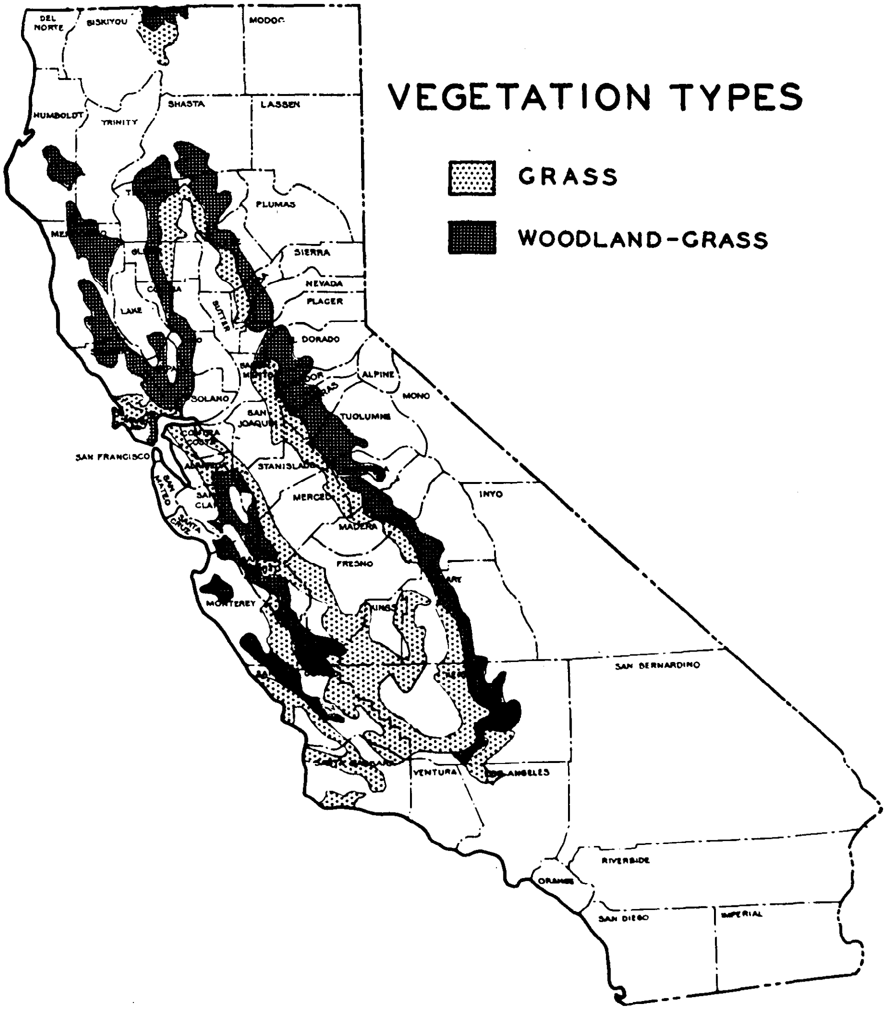

FIGURE 2. Map of California showing distribution of grass and woodland-grass ranges which provide 80 percent of the forage for domestic livestock from the State's wildlands.

while others are more limited. Usually the alien species can be expected to comprise at least 50 percent of the plant cover, but often they account for 90 percent, or even more. A majority of the aliens are annuals, although a few, such as Klamath weed *(Hypericum perforatum)*, are perennial.

The aliens came from many areas —Europe, Eastern and Western Asia, South Africa, Australia, South America and other regions of the United States. A majority were probably introduced unintentionally, but others were brought in purposely. Some of these are valuable forage plants, such as bur clover, red-stem filaree and soft chess, but others, such as Medusahead *(Elymus caput-medusa)* and Napa thistle, are among the worst of the weeds.

The introduction of aliens probably began with the Spanish Missions, and has continued to the present day. During the Mission period, 1769-1824, such important aliens as wild oats, bur clover and Napa thistle were introduced (Robbins, 1940). Examples of very recent introductions are halogeton *(Halogeton glomeratus)* and goatgrass *(Aegilops triuncialis)*. The dates of the earliest introductions were determined through studies of plant materials found in adobe bricks from the walls of old buildings, including Missions, whose construction dates were known (Hendry and Bellue, 1936). Dates of later introductions were found by such means as studies of plant collections and botanical literature.

There is considerable speculation about that portion of the native vegetation which the alien plants displaced. Was it chiefly perennial grasses, or was it native annual plants? There is no final answer to this question because early records were not made. It is possible that both types were displaced in varying degrees in different areas because there are hundreds of native annuals in the California grasslands as well as numerous perennial grasses. Perennials grasses may have decreased greatly along the Coast where conditions are most favorable for them, while native annuals may have formed most of the "lost" portion in such areas as the lower foothills of the western slope of the Sierras. It is possible also that perennial forbs, such as blue dicks *(Brodiaea capitata)*, were more plentiful and have decreased. The blue dicks has a fleshy bulb sometimes sought after by rodents. Hillsides with a plowed appearance have been observed where rodents have dug out bulbs of this species. If rodents have increased with grazing, it is possible that they have played an important role in affecting plant composition.

A few early writings (such as one by Davy in 1902), in describing the stock ranges of northwestern California, present evidence that native perennial grasses, particularly California oatgrass, were dominant and that they were displaced by aliens. Clements (1934) arrived at somewhat similar conclusions through studies of relict areas. In a railroad right-of-way near Fresno, abundant purple needlegrass was found, with the conclusion that this was the dominant grass over hundreds of miles of the San Joaquin Valley in the primitive condition. Recently, however, it has been observed that this particular species may be favored by frequent burning. Since such rights-of-way were burned almost annually at the time Clements made his observations in 1918, it leaves doubt about the value of conclusions derived from studies of these relict areas. On the other hand, Indians may have burned the grasslands at fairly frequent intervals, thereby favoring purple needlegrass. On the grass-covered slopes around Berkeley, vacant lots are burned annually for fire hazard reduction with the result that some now support large amounts of purple needlegrass.

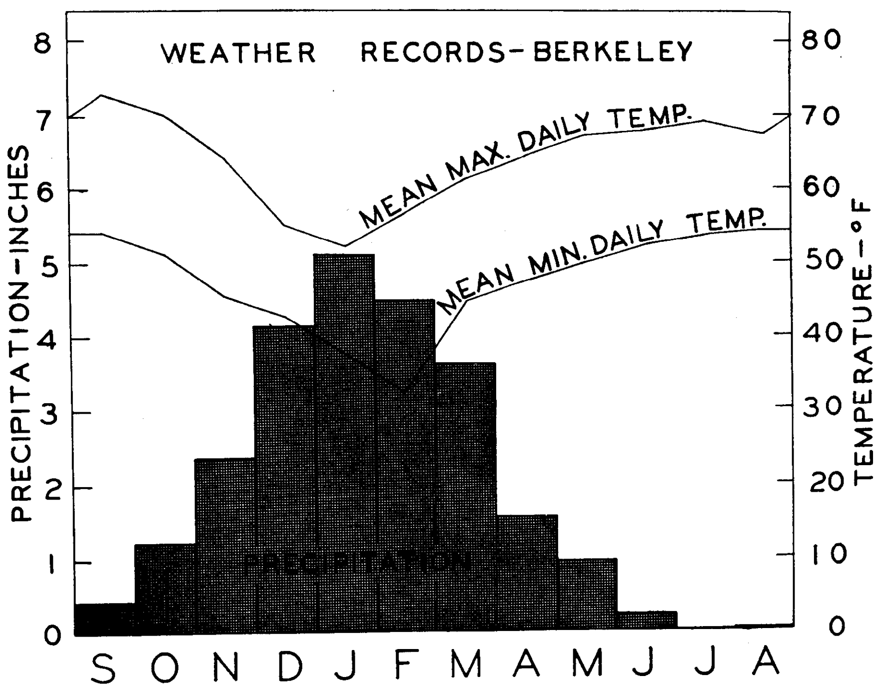

FIGURE 3. Graph of rainfall and temperatures for California grasslands. In the drier areas there may be little or no rainfall for five months of the summer, and the temperatures are considerably higher.

Importance of Soils

Much of the variability in grassland vegetation is related to differences in soils. There are many soil series; even in a square mile there might be a dozen or more. The differences to be expected in plant cover as related to soils are illustrated in Table 1. These data were obtained from a small, rectangular enclosure of less than one acre that crossed two distinct soil series. The centers of the sample plots on the two soils were not more than 100 feet apart.

Such marked differences in composition are not common to all soil series, but may be expected in places where the soils are as different as sandy loams and clays.

There is indication, although nothing very definite, that many grassland soils are gradually losing their fertility under continued cropping. This results in a thinning of the vegetation and an increase in shorter lived and more weedy species. When such areas are fertilized, remarkable changes often take place in the vegetation. For example, in one area common ryegrass and weeds were displaced almost entirely by bur clover. In another area, broadleaved filaree decreased and true clovers increased; in still another, tarweed was largely replaced by bur clover and common ryegrass.

Changes Under Grazing Protection

During the past twenty years a number of protected areas have been studied in order to record changes in vegetation when such areas are not grazed. The rapidity of change depends on rate of accumulation of mulch, weather and other factors that affect general distribution and growth of plants. An example of change and succession is illustrated in Table 2 from data reported by Talbot, Biswell, and Hormay (1939).

On fertile soils which produce large volumes of forage and mulch, the plant cover is likely to change rapidly toward ripgut grass, a tall and shade-tolerant species with seeds well equipped with barbs that take them down to mineral soil. When protection follows heavy grazing, a common pattern of change is from forbs to soft chess, to slender oat, to ripgut grass. It appears that much of the change in species composition is caused by accumulation of mulch. If the mulch is removed by hand, the plant cover may be set back to the stage of forbs. Where mulch accumulates slowly the changes in plant cover are less rapid, and the vegetation may stay in a relatively low stage of succession for many years. In certain coastal areas, the succession may go farther, and ripgut grass be displaced by creeping wildrye, a perennial grass with strong rhizomes, or by black mustard *(Brassica nigra)*, poison hemlock *(Conium maculatum)*, or other tall growing weeds.

Table 1. Example of differences in botanical composition of California grasslands as related to soils.

Plants	Laughlin sandy loam	Montezuma clay
	Percentage in forage cover.	
Perennial grasses and forbs:		
California oat-grass	1	—
Sheep sorrel, *Rumex acetosella*	7	—
English plantain, *Plantago lanceolata*	4	—
Annual grasses and forbs:		
Ripgut grass	34	2
Silver hairgrass, *Aira caryophyllea*	11	—
Foxtail fescue	11	2
Soft chess	9	2
Common ryegrass	4	20
Slender oat	4	—
Bur clover	4	40
Tarweed, *Hemizonia congesta*	—	23
Others	7	11

Table 2. Example of changes in annual vegetation of areas under protection compared with those under grazing. (1933 was a dry year; the others were normal or above in precipitation.)

Treatment	1933	1935	1937	1938	1939
	Percentage in forage cover				
Closed to livestock and rodents:					
Grasses	2	96	99	80	99
Forbs	98	4	1	20	1
Open to livestock and rodents:					
Grasses	2	21	33	57	78
Forbs	98	79	67	43	22

The idea is frequently expressed that perennial grasses will take over under grazing protection. This happens occasionally but not always. In a protected area of fertile soil near Berkeley a stand of 65 percent purple needlegrass decreased to about 10 percent after several years of protection, being crowded out chiefly by ripgut grass which was growing three or four feet tall (Sampson, 1955). In the foothills east of the San Joaquin Valley, pine bluegrass gradually decreased under protection. In another case, sods of several species transplanted into a fertile soil gradually decreased in number. There is evidence that certain of the perennial grasses, such as pine bluegrass and nodding needlegrass *(Stipa lepida)*, increase during periods of drought and also on poor soils where competition from other plants may not be so great as under more favorable conditions.

Influences of Grazing

Botanical composition of the vegetation is influenced both by intensity of grazing and the season during which the range is utilized. Moderate grazing usually gives the densest cover of forage as well as the more desirable species. Light grazing may result in too much ripgut grass for best forage, and heavy grazing may result in summer weeds, such as turkey mullein *(Eremocarpus setigerus)* and tarweeds. The latter change is explained on the basis that the forage crop heavily utilized is unable to use all the soil moisture, and the summer weeds thrive on that which remains in the soil. Moderate grazing results in more growth during winter than does close grazing (Bentley and Talbot, 1951).

A system of grazing management that provides for fairly close grazing in the early spring, followed by light grazing or complete protection as the forage crop matures, usually results in less ripgut grass and summer weeds and a larger volume of the late growing species, such as soft chess, common ryegrass, bur clover and true clovers.

The perennial grasses in the forage cover often increase, or can be maintained, under a system of grazing management that retards the growth and reproduction of annuals but favors that of the perennials. This happens where the annuals are grazed fairly close up to the time of maturity, followed by complete protection to permit the perennials to grow flower stalks and mature seed. California oatgrass, near the Coast, was shown to increase under this system of grazing from 3 percent of the cover to 15 percent in three years. A slight difference in time of maturity of the perennial and that of the annuals made it possible for the perennial to increase under this system of grazing.

Influences of Fire

Grassland fires that consume the dry vegetation and mulch have much the same effect as removing this material by grazing or by hand. Neither method destroys the seed in the ground, nor completely removes all the seed on the surface. The change in composition is usually toward forbs and other species, such as the filarees and bur clover, that do best with little mulch. If grazing should be light preceding fire on areas with abundant mulch and ripgut grass, a great change toward forbs may be expected. On the other hand, if grazing has been close, with an abundance of forbs in the cover, the effects of fire will be slight (Hervey, 1949). An example of responses of annual vegetation to fire is given in Table 3.

Table 3. Example of effect of fire in moderately grazed area near Berkeley, California.

Plant group	Unburned	Burned
	Percentage in forage cover	
Grasses	89	47
Forbs	11	53

Increase in Trees and Shrubs

Throughout the woodland-grass type, trees and shrubs have a tendency to increase in abundance. This increase is greatest where the woodland-grass joins the woodland and timber types. Here growth often becomes thick enough to choke out the herbaceous vegetation. This tendency is also found in certain areas of the grass type, but the problem is minor compared with that in woodland-grass.

Studies have shown that, where seed sources exist, seedlings of the trees and shrubs appear in considerable abundance nearly every spring, but that most of them die before the summer passes.

Several factors favor the tendency for brush to increase, while others have the opposite effect (Biswell, 1954). In addition, certain factors may cause the brush to change from one type to another. Factors favoring brush increase are: (1) single fires which usually increase germination of brush seeds and prepare seedbeds; (2) close grazing, late in the green forage period, which decreases the capacity of the herbaceous vegetation to deplete the soil of its moisture, which can be used by brush seedlings in summer; and (3) late rains that replenish soil moisture, thus favoring brush seedlings in summer. Retarding factors are: (1) a dense cover of herbaceous vegetation at maturity, which uses all soil moisture; (2) two fires in close succession, the second destroying the brush seedlings that follow the first fire; (3) browsing by deer, sheep and cattle. Factors important in causing changes in brush type are fires and differential browsing. Fires are more detrimental to non-sprouting species than to sprouting; therefore the tendency is for the sprouting plants to increase in proportion to the non-sprouting species. Browsing, of course, is more detrimental to the palatable plants than to the unpalatable. Browsing may not only kill some of the plants individually, but it also decreases competition, thereby favoring the unpalatable species. Thus, combinations of fire and browsing may result in stands of unpalatable sprouting species of little value on range lands.

In recent years, deer populations have increased throughout most of the woodland-grass type. It can be expected that during the next 20 years, with high populations of deer, successions of trees and shrubs will be considerably different than they were in the past 20 years simply because of browsing. For this reason alone, shrubs will have much greater difficulty in becoming established, and are likely to decrease in abundance.

Summary

In California, 17.5 million acres of grass and woodland-grass range provide 80 percent of the grazing on wildlands. These ranges are green in winter and golden brown in summer. The vegetation is nearly all annual, and comprised chiefly of alien species. It appears remarkably uniform to the casual observer but is, in fact, extremely variable, being influenced by differences in soils—of which there are many series and types—grazing use, and occasional fires. In the woodland-grass ranges there is a tendency for woody vegetation to increase.

LITERATURE CITED

BENTLEY, J. R. AND M. W. TALBOT. 1951. Efficient use of annual plants on cattle ranges in the California foothills. U. S. Dept. Agr. Circ. 870. 52 pp.

BISWELL, H. H. 1954. The brush control problem in California. Jour. Range Mangt. 7: 57-62.

CLEMENTS, F. E. 1934. The relict method in dynamic ecology. Jour. Ecol. 22: 39-68.

DAVY, J. B. 1902. Stock ranges of Northwestern California. U. S. Bur. Plant Indus. Bull. 12. 81 pp.

HENDRY, G. W. AND M. K. BELLUE. 1936. An approach to Southwestern agricultural history through adobe brick analysis. Reprinted from Univ. of N. Mexico Bull. The Univ. Press, Albuquerque, N. Mexico.

HERVEY, D. F. 1949. Reaction of a California annual-plant community to fire. Jour. Range Mangt. 2: 116-121.

KADISH, AMRAM. 1955. Vegetation as related to soil type. Unpublished data.

ROBBINS, W. W. 1940. Alien plants growing without cultivation in California. Calif. Agr. Expt. Sta. Bull. 637. 128 pp.

SAMPSON, A. W. 1955. Unpublished data.

TALBOT, M. W., H. H. BISWELL AND A. L. HORMAY. 1939. Fluctuations in the annual vegetation of California. Ecology 20: 394-402.

TALBOT, M. W. AND H. H. BISWELL. 1942. The forage crop and its management. *In* The San Joaquin Expt. Range, Calif. Agr. Expt. Sta. Bull. 663: 13-49.

TALBOT, M. W. AND A. W. SAMPSON. 1948. The range in California. U.S. D.A. Yearbook. U. S. Dept. Agr. 575-582.

WIESLANDER, A. E. AND H. A. JENSEN. 1946. Forest areas, timber volumes and vegetation types in California. Forest Survey Release No. 4, Calif. Forest and Range Expt. Sta., Berkeley, Calif. 66 pp.

Evaluation and Measurement of the California Annual Type

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The California annual-grass type is truly annual except for scattered individuals of a number of species of broad-leaved herbaceous plants. In very rare instances where grazing has been light or in occasional relic areas perennial grasses are found in a thin stand. A few grasslands along the coast have considerable amounts of perennial grasses.

The annual type is found in a wide variety of environmental conditions. Average precipitation may be as low as 5 inches per year in the southern end of the San Joaquin Valley or it may be as high as 80 inches along the California coast near the Oregon border. Regardless of yearly average, less than five percent occurs in the four months of June through September. Temperatures below freezing may occur any time between November and March but temperatures below zero are extremely rare. Average July temperatures may be below 60° F. along the coast to above 90° F. in the interior valley.

Soils occupied by the annual grass type are correspondingly varied. Some are prairie-like in that they are dark, slightly acid and have a high organic matter content. These are near the coast. Another group has the dark color and moderate organic matter content but with neutral surface and calcareous subsoil. These are similar to the Chernozems. A few Rendzina soils occur in the southern coast range. In the foothills and uncultivated portions of the Interior Valley the soils are usually of the noncalcic brown and desert types. Some grassland soils are deep, medium textured, friable, and support excellent forage crops while others are shallow, extremely heavy or light and low in productivity.

Characteristics of the California Annual Type

Many of the most abundant grasses such as species of *Aira, Avena, Briza, Bromus,* and *Gastridium* are introduced. Two of the annual fescues (*F. myuros* and *F. dertonensis*) are also alien while the most abundant species of this genus are considered native. The species of annual broadleaved plants among the aliens include *Spergula, Brassica, Medicago, Erodium, Centaurea, Hypochoeris* and many others. Some of the common native broadleaved plants include species of *Trifolium, Lotus, Amsinckia, Plagiobothrys, Madia* and *Orthocarpus.* In most areas of the annual type the introduced species contribute 80 percent or more of the floral composition.

Seed production in the annual type is tremendous. The average number of seeds which will germinate from one square inch of soil collected in August varies from about 20 to nearly 100. Some seeds are dormant and do not germinate for several years. A seed crop may be light due to unfavorable weather but very seldom is it too low to produce a big crop of seedlings the next year. One principle in proper management of the annual range is to graze off the seed crop before maturity of the early maturing undesirable annuals. This practice coupled with deferment in the late growing season permits the better forage plants to produce seed and thereby the range condition improves.

Seeding into the annual range is not done because of the competition from the resident annuals. When seeding is done on the better lands, a combination of cultivation ahead of seeding, and grazing afterwards, must be used to lessen the competi-

FIGURE 1. A desirable combination of soft chess, bur clover and broadleaved filaree in the California annual type. The few plants of ripgut are undesirable because of their coarse awns. Photo taken April 27, 1955, about three weeks before plant maturity.

tion. Seeding of burns is ordinarily not successful if the annuals are already present.

As one would expect from the above description the density is very high. Foliar cover on the basis of estimates and the point analyser often is 60 to 80 percent. Production frequently is above 2,000 pounds per acre. The carrying capacity of excellent annual type ranges, where the soil is good, is usually between 0.5 and 1 acre per animal unit month. With fertilization it is much higher.

Forage conditions for three seasonal periods may be considered separately. From germination in October to March green forage is present but scarce and animals are often given some hay or dry forage. During the spring ample green nutritious forage is available. Beginning in May or June the plants mature and livestock are usually supplemented with concentrates or placed on irrigated pastures.

This brief resume of the California annual type would be incomplete without mentioning the variability associated with weather and location. The crop may fail some years in the southern end of the San Joaquin Valley and be very lush other years. Along the north coast there is much less variation in yearly production. There are tremendous changes or differences in floral composition locally from one site to another, during the growing season, and from one year to the next. Californians speak of the variation in production and composition when they say, "This is a good clover year"; or "This is a good grass year."

Patterns of Vegetational Change

Three patterns or types of vegetational changes must be recognized before proper evaluation of the annual type range can be made. The first occurs through the growing season and may be illustrated by numbers of plants by species in square-inch plots. Data are from the Hopland Field Station in Mendocino County. From December of 1952 to June of 1953 soft chess (*Bromus mollis*) increased from 16 to 43 percent of the composition. At the same time the broadleaved plants decreased from 52 percent to 37 percent. Both soft chess and the broadleaved plants decreased in numbers but the decrease in soft chess was much the least. A similar pattern has existed for three years on three different sites.

The second source of change in floral composition is from one year to the next. On one set of plots where there was no grazing the variation in soft chess was from 38 to 63 percent in three years. Where there was moderate grazing the variation was from 40 to 38 percent. Generally, when soft chess was high the broadleaved plants were low and vice versa. The seasonal differences may be emphasized further by the average number of plants per square inch. On one site average numbers varied from 7 to 35 in different years. On all sites the greatest number was at least twice the lowest. However, in nearly all cases only approximately half the plants survived to produce seed. In terms of herbage production the seasonal variation was approximately 1,000 pounds per acre.

The third source of variation is directly related to the degree of grazing. This influence is exerted through the amount of plant residue present during the period from germination through the winter. Experimental plots with all residue removed have shown progressive deterioration in kinds of plants, rapidity of fall and winter growth and total herbage production. On the other hand, 700 to 1,000 pounds of residue per acre has allowed improvement in the floral composition and production on experimental plots that were in poor condition four years ago.

Evaluation of Range Condition

What does all this mean in the evaluation of range condition? First of all, if composition is the primary consideration, the examination should be near the end of the growing season when the full forage crop is present. Surveys earlier in the winter and later in the summer fail to find and give proper value to many species of broadleaved plants.

Second, composition is never the same in successive years. The exact reasons for this are not clear and only the most general relationships have been observed. Any system of range condition classification must be broad enough to include these variations.

The third point is that plant succession does occur in the annual type and therefore changes in floral composition can logically be used as a yardstick to aid in the designation of range condition. However, certain modifications in the system, as it is presently used in the Great Plains are needed. The terms "decreaser," "increaser" and "invader" do not necessarily apply because the whole flora is dominated by invaders and is likely to so remain. That is true if one considers the original climax to be perennial bunchgrass. But if the highest type of annual grassland, dominated by soft chess and ripgut, is considered "climax annual" then the principles expressed by the above three terms can be applied quite logically. When the group of commonly occurring dominants are so arranged the following listing is made.

Upper group
(*Decreasers*)
Soft chess
Ripgut
Wild oat
Slender oat
Annual rye grass
Cut-leaf filaree

Middle group
(*Increasers*)
Fescues (3 spp.)
Bur clover
Broadleaf filaree
Nit grass
Red brome

Lower group
(*Invaders*)
Hair grass
Quaking grass

Annual bluegrass
Little barley
Trifoliums
Annual lupine
Tarweed

Two points need to be made clear on this listing. Some species will be in different groups on different sites. Most of these species are present in all areas, and therefore the term "invader" may still not be precisely correct.

Certain inconsistencies between grazing value and successional tendencies of these species complicate the actual management of annual ranges. Ripgut is undesirable because of the very troublesome beard. Yet, succession toward the "climax" invariably allows it to become dominant. The only answer so far is heavy late winter and early spring use and then deferment until the seeds have fallen. Judiciously done, this allows the decreasers to be dominant with small amounts of ripgut. Broadleaf filaree is often mentioned as a desirable plant. Perhaps it is for winter feed but it soon decreases with improvement of the grass stand. The resident trifoliums do not withstand competition from the grasses and only occur where the grass stand is poor. Yet, they are usually considered desirable. To manage annual range to favor filaree and the annual clovers usually means a sacrifice in total production.

Resume

Objectives of this paper have been to:

1. Direct attention to the varied nature of California annual-grass type.

2. To show that at least three patterns of vegetational changes exist on the same plot of ground.

3. To indicate that plant succession, measured by changes in floral composition, should be the basis of evaluating range condition.

4. To warn that evaluation of certain plants contrary to the natural successional tendencies often leads to requirements in range use incompatible with maximum production.

The Phenology of Goatweed, *Hypericum perforatum*, in Relation to the Behavior of Goatweed Beetles, *Chrysolina gemellata* and *C. hyperici*, in Western Montana

Abstract of thesis submitted in partial fulfillment of the requirements for the degree of Master of Science in Forestry, Montana State University, 1955.

Goatweed, *Hypericum perforatum* L., first appeared in western Montana about 1924 and now covers a large area. Goatweed beetles, *Chrysolina gemellata* Rossi, and *C. hyperici* Forst., phytophagous insects that are host specific on goatweed, were introduced into Montana in 1948 in an attempt to control goatweed through beetle feeding. The object of the study was to observe the phenology of goatweed as it related to the phenology of the beetle, and the extent to which this relationship would enable the beetle to control the plant.

Phenology of goatweed plants in western Montana was found to be correlated with the rainfall distribution in 1954. Plant development on the grassland area started in the spring season, the plants flowered in July, and seeds began to be shed in September. Basal growth on forest and grassland areas began in midsummer and August rains caused fall growth to appear above ground about a month or six weeks later. Plant development commenced during the fall of 1953 at one of the forest areas, flowered in July and seed capsules opened in October, 1954.

Goatweed-beetle phenology followed plant development closely. Eggs appeared on the grassland area in April, new adults emerged in June and adult aestivation started in August. The aestivation period lasted four weeks. Fall eggs appeared in September and fall larvae passed their maximum density in November. On forest areas eggs and larvae were present when first observations were taken in April. New adults emerged in June. Aestivation commenced in August and lasted six weeks. Fall eggs appeared in October. Larval development was slow on forest areas and by December the larval density was less than one third the larval density on the grassland area.

Goatweed basal growth was well synchronized with larval feeding and development during both the spring and fall seasons on forest and grassland areas. New adults emerged prior to the plant flowering period and their major feeding activity was completed before large numbers of plant flowers appeared. New adult feeding was thus not well synchronized with plant flowering either on forest or grassland areas.

The length of the larval feeding period on the grassland area was 24 weeks in 1954. New adults fed for a period of 7 weeks and adults were present for a total period of 29 weeks. On forest areas larvae fed for 12 weeks and new adults for an average of 7 weeks, with adults present on the plants for a total period of 26 weeks. The population density of spring larvae was approximately equal on forest and grassland areas. The fall larval population was three times more dense on the grassland area than it was on forest areas. The population density of new adults was approximately equal on forest and grassland areas.

Plant mortality was observed on the grassland area exclusively. Goatweed stands occurring on the warmer exposures, and subjected to long periods of larval feeding by a dense larval population, suffered the greatest plant mortality. The rate of plant mortality increased when temperature was highest, soil moisture lowest, and when no beetle feeding took place.

Beetle colonies introduced into Montana have maintained themselves or increased their numbers for six years. Density-dependent factors were not important in reducing the beetle population except on a few goatweed stands on grassland that were completely defoliated. Density-independent factors reduced the beetle population by extremes of temperature and by low soil moisture conditions. The same factors governed the activity of the beetle population in time. Temperature affected the incubation period, and rainfall pattern determined the time of adult emergence from aestivation.

Goatweed mortality occurred only on those areas that were subjected to heavy larval feeding for a period of several months and closely synchronized with basal growth development. These conditions were present only on grassland goatweed stands. It seems likely that goatweed will be more easily controlled by beetle feeding on grassland than on open forest areas of western Montana.—*Howard S. Nelson,* c/o TAMS, Box 1318, Port-au-Prince, Haiti.

Range Improvement in California by Seeding Annual Clovers, Fertilization and Grazing Management

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In 1940 the Agronomy Department of the University of California began intensive investigations in range improvement. The program included testing of native and introduced species of grasses and legumes, fertilization trials and livestock manipulation.

Burle J. Jones, former Extension Agronomist, and Ben A. Madson, Professor of Agronomy, pioneered a well-organized project of adaptation trials in 40 counties of the state served by the Agricultural Extension Service. Tests were made of more than 125 species in 240 nurseries. This program continues, but after eight years of testing it was possible to draw broad lines of species adaptation (Jones and Love, 1945; Love and Jones, 1947 (revised 1952)). Bur clover (*Medicago hispida* Gaertn.), introduced into the state during the Mission period, appeared to be the most promising annual range legume on some soils in the Sacramento Valley and Sierra foothills during the early years of testing, and subclover (*Trifolium subterraneum* L.) looked good in some plots in those areas and was outstanding along the north coast.

Meanwhile in Ventura County (south coast), 1941 to 1946, sulfur applications had effected marked responses of bur clover the first year, to be followed by nearly as marked responses of grain and range forage the second and a few ensuing years (Conrad *et al.*, 1947). In consequence, about 150 exploratory trials with carriers of phosphorus, potassium and sulfur were established in 20 counties. Of the 50 tests giving good to marked responses of bur clover about 40 percent were from gypsum (carrier of sulfur), about 40 percent from treble superphosphate, and 20 percent from both. Several of the remaining sites later gave responses of bur clover when manure was applied in addition to phosphates. From a practical standpoint, however, on some reddish soils it was not possible to establish stands of bur clover even with the addition of phosphate fertilizer (Love, 1952). In 1944 rose clover (*Trifolium hirtum* All.), introduced from Turkey, was tested for the first time (Love, 1948; Love and Sumner, 1952). That year, too, several varieties of crimson clover (*Trifolium incarnatum* L.) were also tested for the first time in dryland plots in California. These clovers succeeded amazingly well on the soils that would not support good stands and growth of bur clover.

Extensive species and fertilizer tests were conducted at the Arthur Brown Hereford Ranch, Wilton, Sacramento County, California, from 1944 to 1952 to 1952 on San Joaquin soil. This is a slightly acid, shallow soil, 2.5 feet to hardpan, and was derived from granite alluvium. It had been farmed for 40 years to cereal hay, finally yielding one-half to one ton every other year with a negligible amount of low quality, volunteer pasture in alternate years. These tests showed that rose, crimson and subclovers, both the Mt. Barker and Tallarook varieties, could make a significant contribution by increasing forage production and quality. It was shown that it is economically feasible, not only to seed the clovers but also to apply adequat amounts of fertilizer. The pho phated clovers yielded about 5,00 pounds of dry forage compare with 1,300 pounds per acre on th unimproved range and about 92 pounds of protein compared wit 143 pounds per acre. Grazin trials on the 5- to 10-acre plots in dicated that about three times th original carrying capacity coul be expected (Love, 1952).

Methods

In the fall of 1950 a range im provement program involving u of these annual clovers, phospha fertilization and grazing manag ment was initiated on the France chi Ranch, Lincoln, Placer Count This program resulted direct from the research work previous discussed.

This ranch is in the 20-inch a nual rainfall zone, and over 8 percent of the rain occurs durin the months of November throug March. The soil is typical of th gently undulating terrace lan along the base of the western slop of the Sierra Nevada Mountai and is classified as Placentia gra elly loam. It is an acid so (pH 5.7) developed from grani alluvium and contains a dense cla pan at the depth of 18 to 24 inche The land had previously been use as an annual forage range wit part of it farmed annually to oa and vetch for hay.

Fifty acres, designated as fie 1, were seeded in October, 195 prior to the fall rains, with a mi ture of rose clover, crimson clove and Mt. Barker and Tallarook su clovers. The first operation wa the application of 200 pounds pe acre of single superphosphate. seedbed was prepared by diskin and seed was broadcast by plan after being inoculated with the ap propriate strain of legume bacter (Williams, Lenz, and Murph 1954). The final operation wa ringrolling to cover the seed an firm the seedbed. Field 2 and fiel 3 were seeded by the same pro cedure in the fall of 1951. In 195 an additional 130 acres in field were seeded with a homegrow mixture of rose clover and crimson clover to which Mt. Barker and Tallarook subclovers were added.

In 1952 a field on the adjacent Chamberlain Ranch was seeded by air to a mixture of the same species without seedbed preparation. The seeding and fertilization rates used in these fields are summarized in Table 1.

In each field numerous strips were left unfertilized as checks. In order to obtain a measure of forage production, botanical composition and feeding value, approximately 24 paired one-square-foot quadrats were harvested from each field in two successive years and botanically separated by hand. Field 1 was not included in this series of measurements because it was nearing the end of a grazing period at the time the quadrats were harvested.

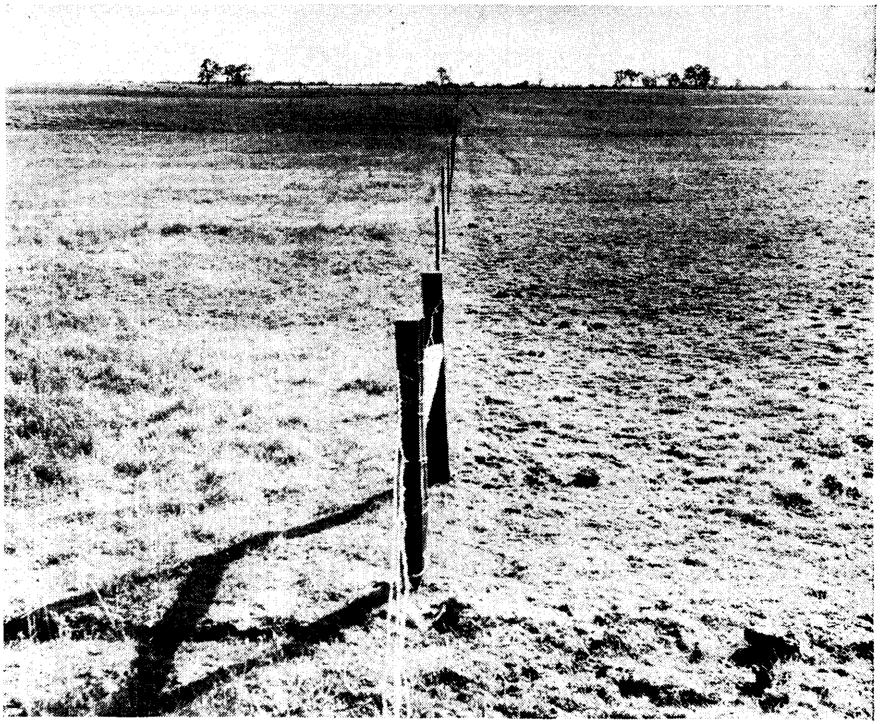

FIGURE 1. The cows have been turned into field 3, east half (*left*), after being in field 3, west half (*right*) since September 4, 1953. Photo was taken December 1, 1953. The difference in cover indicates the ready utilization of the dry clovers by beef cattle, as the whole field was seeded and fertilized with 200 pounds of single superphosphate per acre in fall 1951.

Results and Discussion

Grazing Capacity

Since this range improvement program is part of a commercial cattle operation, an important part of the information obtained is in terms of grazing capacity. Detailed records were kept of the number of head and dates turned in and out of the various pastures. This is particularly important in correlating the forage research information obtained from quadrat yields with the final test of the grazing animal.

On March 20, 1951, 50 Hereford cows with their calves were turned into field 1 which had been seeded the previous September. The clovers were getting ahead of them so an additional 100 head with their calves were turned in on April 1. When the animals were removed on April 30 there was still an abundance of feed left so that later a small seed crop of about 20 pounds per acre of rose and crimson clovers was "combined". (The subclovers set seed too low to be harvested in this manner.) In addition, from June 10 to July 1, 100 head in an adjacent irrigated pasture had free access to the 50 acres of dry clover and native grass. The cost of the seed, fertilizer and seeding operations that year was about $20 per acre. This investment was more than returned the first season. In 1952, 50 cows and their calves were carried in field 1 from March 9 to May 20 and 100 cows with their calves from May 20 to June 10. In 1953, 60 cows with their calves were turned in on February 15. Fifteen cows were removed March 10, the remainder staying on until May 22 when they were turned onto irrigated pasture, but allowed access to field 1 until June 15. The carrying capacity calculated without allowance for the grazing which was supplementary to the irrigated pasture was 3.30 animal unit months per acre in 1951, 3.47 in 1952, and 3.10 in 1953. This may be compared to the grazing capacity of 1.00 animal unit months per acre in 1950, the year prior to improvement, when 25 cows were carried two months in this field.

With the improvement program well under way, feed was plentiful enough so that fields 2 and 3 were not grazed to capacity in 1952 and 1953. During the spring of 1953

Table 1. Synopsis of seed mixtures and fertilization of four fields on the Franceschi ranch (numbered) and one field on the Chamberlain ranch, Lincoln, Placer County, California.

Field	Acreage	Seed Mixture: Rose clover	Crimson clover	Mt. Barker subclover	Tallarook subclover	Rate of superphosphate applied	Date of seeding and fertilizer applications
				(lbs./acre)		*(lbs./acre)*	
1	50	3	3	1½	1½	200	Oct. 1950
2	68	3	3	1½	1½	200	Oct. 1951
3	210	3	3	1½	1½	200	Oct. 1951
4	130	2	4	2	2	150*	Oct. 1952
Chamberlain	30	3	3	2	2	150	Oct. 1952
						300	Oct. 1953**

*Treble superphosphate.
**Fertilizer application only.

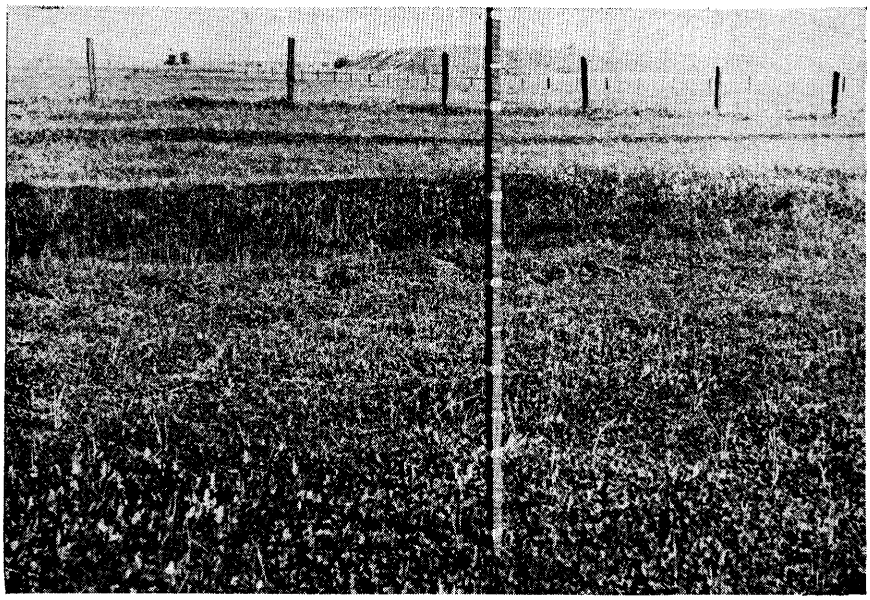

FIGURE 2. Response of seeded annual clovers to the application of phosphate fertilizer (dark strips). Photo was taken March 30, 1953 in field 3 after 40 days without rain.

field 2 was subjected to a short period of heavy grazing by 60 cows from March 10 to April 17.

Grazing was deferred on field 3 for fall dry feed and to permit a seed crop to be taken in both 1952 and 1953. Grazing use in 1952 was 105 cows from September 4 to December 8 or 1.58 animal unit months per acre after 13,000 pounds of crimson and rose clover seed had been produced. The dry feed was supplemented with one pound of cottonseed cake per head per day during the last week of grazing since the feed had been rained on by then. Early in 1953 the field was cross fenced and 105 acres produced a harvested seed crop followed by fall grazing by 85 cows from September 4 to December 1, or 2.27 animal unit months per acre. The other half was grazed lightly in the spring of 1953, seed was harvested in June, and the 85 cows were turned in on December 1 to utilize the stubble. Beef cattle utilize this dry feed to good advantage (Fig. 1).

Effect of Phosphate Fertilizer on Forage Production

Quadrats harvested during the period May 22-27, 1953, show the effect of the phosphate fertilizer on forage production, botanical composition and feeding value of the seeded range. The clovers were mature at that time with about half the heads shattering when gently hand threshed. The fertilizer had a very striking effect on dry matter production (Table 2 and Figure 2). The clovers in fields 2 and 3 were volunteer stands resulting from natural reseeding from the 1951-52 crop. The data for field 2 show the effect of fertilizer on recovery after it was grazed by 60 cows from March 10 to April 17, a grazing use of 1.12 animal unit months. There was less than a half ton of dry forage aftermath on the unfertilized strips compared with more than 1.6 tons on the fertilized areas.

Field 4 and the Chamberlain field were seeded in the fall of 1952 and grazing on both was deferred for dry feed in 1953. The forage production on field 4 when fertilized was over six times that of the check strips. The production in the Chamberlain field, although showing a highly significant response to fertilization, did not increase as much as field 4 because of the lack of seedbed preparation and the resulting poorer initial legume stand as indicated by the botanical separation data in Table 3. Nevertheless, the results were gratifying because the establishment of adequate stands without disturbing the sod eliminates the hazard of erosion, and stock are able to graze the fields during wet weather with less deterioration of the stand and soil structure than when a seedbed is prepared.

Botanical Composition

At the time the 1953 quadrats were harvested the forage was separated as rose clover, crimson clover, subclover and resident annuals. The latter group consisted mainly of broad-leaf filaree (*Erodium botrys* Bertol.), wild oats (*Avena fatua* L.), and soft chess (*Bromus mollis* L.). In all four fields the fertilizer increased the

Table 2. Effect of phosphorus fertilization on forage production on range seeded with annual clovers.

Field and Treatment	Dry Forage Harvested May 22-27, 1953	Dry Forage Harvested May 17-20, 1954
Seeded and Fertilized Fall 1951	*lbs./acre*	
Field 2		
Check	880	990
200 lbs./A superphosphate	3,280**	4,490**
Field 3		
Check	2,370	1,970
200 lbs./A superphosphate	4,360**	3,420**
Seeded and Fertilized Fall 1952		
Field 4		
Check	660	860
150 lbs./A treble superphosphate	4,190**	2,850**
Chamberlain		
Check	850	1,740**
150 lbs./A superphosphate*	2,180**	4,390**

*Additional 300 pounds of superphosphate per acre applied in fall 1953.
**Difference significant at 1% level.

Table 3. Effect of phosphorus fertilization on the botanical composition of forage on range seeded with annual clovers.

	Botanical Composition							
	Harvested May 22-27, 1953				Harvested May 17-20, 1954			
Field and Treatment	Rose clover	Crimson clover	Sub-clover	Resident Annuals	Rose clover	Crimson clover	Sub-clover	Resident Annuals
Seeded and Fertilized Fall 1951		—%—				—%—		
Field 2								
Check	16	3	5	76	35	0	1	64
200 lbs./A superphosphate	44	20	10	26	62	0	13	25
Field 3								
Check	61	22	2	15	44	4	0	52
200 lbs./A superphosphate	68	22	1	9	57	12	0	31
Seeded and Fertilized Fall 1952								
Field 4								
Check	28	16	5	51	31	8	12	49
150 lbs./A treble superphosphate	26	59	4	11	8	58	6	28
Chamberlain								
Check	22	4	2	72	69	2	1	28
200 lbs./A superphosphate*	36	9	2	53	71	12	0	17

*Additional 300 lbs./A of superphosphate applied in Fall 1953.

proportion of seeded legumes in the forage at the expense of the resident annuals. This can readily be seen in Table 3 in the columns titled "Resident Annuals". Similar increases have been obtained in the growth of resident legumes on California and Oregon ranges by Conrad (1950 and 1951), Conrad *et al.* (1947), Bentley and Green (1954) and Cooper and Sawyer (1955), using phosphorus and sulfur fertilizers.

Under conditions of low fertility rose clover was the dominant legume in all four fields. In fields 2, 3 and the Chamberlain field, the percentage of rose clover was further increased by fertilization at the expense of the resident annuals. Fertilization increased the proportion of crimson clover in all fields except field 3 where the proportion remained unchanged but still increased in absolute production since total forage increased. In field 4 crimson clover became dominant with fertilization because this seed mixture contained twice as much crimson clover as rose clover. Crimson clover did not make a very strong initial showing in the Chamberlain field where no seedbed was prepared.

Subclover was present in minor amounts irrespective of fertilization in fields 3 and 4, and the Chamberlain field. The difference in growth habit between the prostrate subclover and the upright rose and crimson clovers placed the subclover at a disadvantage under the management program in those fields involving deferred grazing and seed harvesting. In field 2, subjected to moderate spring grazing, subclover made more of a showing where fertilized.

An additional series of quadrats was harvested on May 17-20, 1954, from sites comparable to the 1953 series. Yields of forage were again markedly increased by the phosphorus fertilizer even though no reapplication was made during this season except on the Chamberlain field, which received 300 pounds per acre of single superphosphate in 1953 in addition to the initial 150 pounds applied in 1952. Forage production was much improved in the Chamberlain field over that of the previous year. It is of considerable interest to note that this field, seeded in sod, was fully as productive in the second year as field 4, seeded at the same time but on a prepared seedbed.

Yields on the fertilized strips on field 3 and 4 were less than in 1953, since both were grazed early in 1954 and the harvested quadrats were a measure of recovery. Grazing on field 2 and the Chamberlain field was deferred for dry feed in 1954.

The botanical composition data for 1954 are not quite as accurate as those for 1953 since the samples dried somewhat before the separations could be completed, and some shattering resulted. However, several trends are evident. Crimson clover was reduced in field 2 and 3 and remained substantially unchanged on the fertilized areas of field 4 and the Chamberlain field. This seems to be related to the age of the stand. Rose clover was very competitive in the Chamberlain field where it amounted to 69 and 71 percent of the forage in the check and fertilized treatments re-

Table 4. The effect of phosphorus fertilization on the composition (dry basis) of forage on range seeded with annual clovers (May 22-27, 1953 harvest). Average of all fields.

Forage	Treatment	Protein	Fiber	Fat	Ash	N Free Extract	Phosphorus	Calcium
					—%—			
Clovers	Check	12.1	30.6	1.7	5.5	49.6	.098	1.37
	Fert.	14.3	30.8	1.7	4.9	48.5	.144	1.37
Resident annuals	Check	6.6	30.0	1.9	6.9	54.6	.103	1.56
	Fert.	8.2	29.2	1.8	7.1	53.7	.120	1.58
Total feed	Check	9.0	30.6	1.8	6.2	52.5	.099	1.46
	Fert.	13.1	30.6	1.6	5.3	49.4	.136	1.40

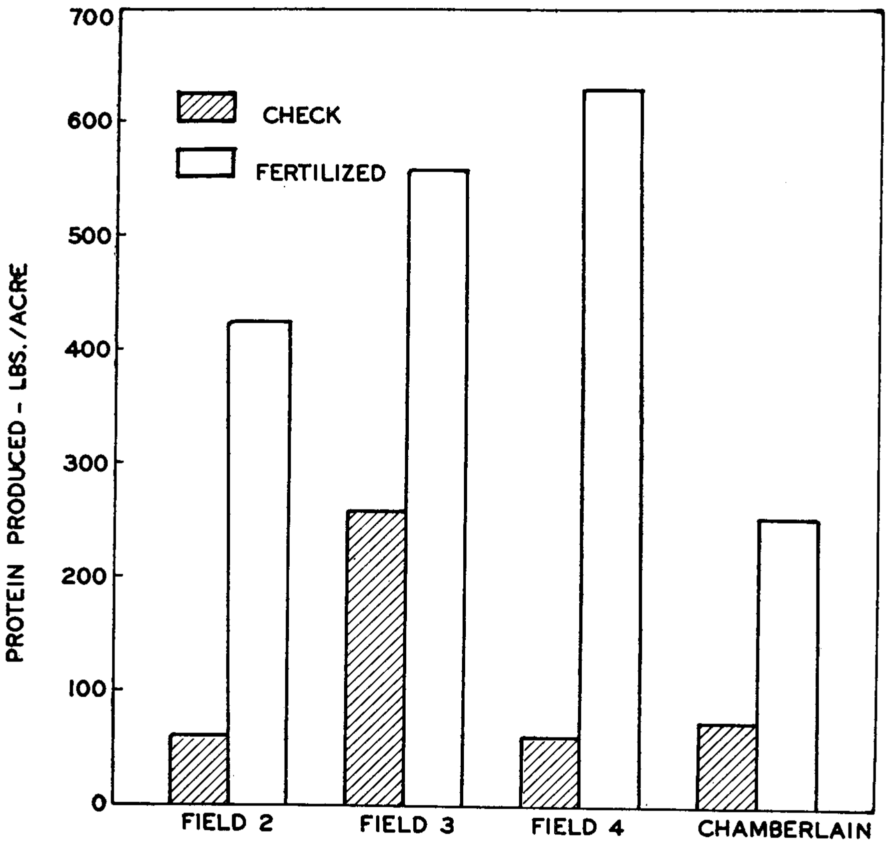

FIGURE 3. The effect of phosphorus fertilization on the production of protein by range seeded with annual clovers (harvested May 22-27, 1953). Fields 2 and 3 received 200 pounds of single superphosphate in the fall 1951; field 4, 150 pounds of treble superphosphate, and the Chamberlain field 150 pounds of single superphosphate per acre in the fall 1952.

spectively, a large increase over the previous year.

Forage Quality

The feed composition of the 1953 quadrat samples was analyzed by species. The average composition for each field and treatment was weighted by the proportion accounted for by each of the botanical separates. In every field crude protein was increased. The phosphorus-fertilized areas averaged 13.1 percent protein compared to 9.0 percent for the check treatment (Table 4). This highly significant effect is a contrast to the results of application of nitrogen and phosphorus fertilizer (16-20-0) to native range by Hoglund, Miller, and Hafenrichter (1952) which caused a slight decrease in the percentage of protein, apparently the result of stimulation of non-legumes by the nitrogen.

The importance of the increase in protein is emphasized when it is considered with the increased forage production resulting from fertilization. Total protein per acre was increased from two times in field 3 to nine times in field 4 (Fig. 3). This increase in production of the protein fraction of the feed has been an important factor in increasing the grazing capacity of this range.

The protein content of the feed was not only increased on the fertilized strips by the increased proportion of clovers, but also by the significant increase in percentage protein in the clovers (Table 4). The resident annuals also appeared to increase in protein but the difference is not statistically significant. The quality of the feed prior to the introduction of the clovers and use of fertilizer is indicated by the average composition of the unfertilized resident annuals. At the stage of maturity when sampled they were supplying a level of nutrition which would have required the addition of a protein supplement.

The values for crude fiber, fat, ash and calcium were not consistently affected by fertilization.

The phosphorus level of feed grown on this soil when unfertilized is inadequate for livestock well-being. The range improvement operations of seeding legumes and phosphorus fertilization increased the phosphorus in the feed significantly. This was in large part the result of the response of the clovers, since their phosphorus content was increased more than that of the resident annuals.

Effect of Livestock Use

The idea of concentrating the grazing of animals in weedy fields in the early spring to discourage the undesirable annuals and encourage the more desirable species was first suggested by Love (1944) and Jones and Love (1945). Intensive research on a private ranch, conducted over a period of eight years, served to bring out the practical aspects of this idea on arable land (Love, 1952). The work conducted on cleared and seeded brushlands confirmed the practice even further (Love and Jones, 1947).

The relative ease of establishment of seeded species in brush burns is due in no small measure to the complete lack of competition by resident herbaceous species. The relative difficulty encountered in areas with an herbaceous cover is primarily due to that cover. There can be no question but that "the better the seedbed, the better the stand." However, it is not always economical to have a clean seedbed for dryland range plantings. It might take several years of cropping or fallow, and the yields would not justify the expense. Furthermore, cultivation for two or three consecutive years would subject the soil to erosion hazards, since much of this arable rangeland is classified as Class IV land. Therefore, one is faced with the facts that (1) resident annuals are present in most seedings, and (2) annuals develop faster than most seeded species. A heavy concentration of stock in early spring not only reduces this competition by weedy annuals but converts them into meat or wool when palatable and nutritious.

The Franceschi program began prior to initiation of the research on the ranch. It was noted, however, that field 1 was very weedy in the seeding year. Two exclosures, 12 feet square, were placed in the field. In these the clovers suffered from the severe competition of the resident annual grasses, whereas in the field a good stand of seeded clovers developed the first year. The grazing load of better than three animal-unit-months per acre in early spring favored the legumes, and the continuation of this practice for three seasons resulted in the dominance of subclover over rose and crimson clover. In the phosphated strips in fields 2, 3 and 4, which were relatively clean, deferring the grazing had no deleterious effect on the clovers.

In the unfertilized strips in fields 2 and 4, and in both the fertilized and unfertilized strips in the Chamberlain field, an early grazing during the seeding year would have been helpful to the clovers.

Summary

A range improvement program involving the seeding of adapted clovers, phosphorus fertilization and grazing management on over 500 acres was carried out over a five-year period. Grazing records and quadrat harvests demonstrate the marked success of the improvement methods. The grazing capacity of the range was increased three-fold by the improvement of both the bulk and the quality of the feed.

The seeded legumes, rose, crimson and subclovers, were able to make better use of nutrients supplied in phosphate fertilizers than were the resident species. As a result of the improved level of fertility the clovers produced a feed high in protein and also improved the phosphorus content of the feed. Botanical composition records demonstrate the ability of a mixture of annual clovers of varying growth habit to survive and produce under a variety of grazing conditions.

Since it is almost impossible to have range land in a Mediterranean-type climate completely free of weeds before seeding, a concentrated grazing by livestock or a mowing is usually imperative the first spring.

The use of a mixture of annual clovers of varying growth habit allows much greater latitude of adjustment of livestock use than is otherwise possible.

LITERATURE CITED

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

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

———. 1951. Fertilization of range forage. Calif. Agr. 5(2): 3-4.

———, H. L. Hall and B. A. Chaugule. 1947. Sulfur fertilization of legumes in the Upper Ojai Valley, California, and the resulting effects on the following non-legumes. Soil Sci. Soc. Amer. Proc. 12: 275-278.

Cooper, C. S. and W. A. Sawyer. 1955. Fertilization of mountain meadows in eastern Oregon. Jour. Range Mangt. 8: 20-22.

Hoglund, O. K., H. W. Miller and A. L. Hafenrichter. 1952. Application of fertilizers to aid conservation on annual forage range. Jour. Range Mangt. 5: 55-61.

Jones, B. J. and R. M. Love. 1945. Improving California ranges. Calif. Agr. Ext. Serv. Circ. 129. 48 pp.

Love, R. M. 1944. Preliminary trials on the effect of management on the establishment of perennial grasses and legumes at Davis, California. Jour. Amer. Soc. Agron. 36: 699-703.

———. 1948. Eight new forage plants developed for California ranges. Calif. Agr. 2 (1): 7, 14.

———. 1952. Range improvement experiments at the Arthur E. Brown Ranch, California. Jour. Range Mangt. 5: 120-123.

———, and B. J. Jones. 1947. Improving California ranges. Calif. Agr. Ext. Serv. Circ. 371. 38 pp. Rev. 1952.

———, and D. C. Sumner. 1952. Rose clover, a new winter legume. Calif. Agr. Expt. Sta. Circ. 407. 12 pp.

Williams, W. A., J. V. Lenz and A. H. Murphy. 1954. Nature of beneficial effect of subterranean clover straw on establishment of subterranean clover. Agron. Jour. 46: 95-96.

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The Ecology of *Halogeton glomeratus* on Wyoming Rangelands

Abstract of thesis submitted in partial fulfillment of the requirements for the degree of Master of Science in Range Management, University of Wyoming, 1955.

Studies were conducted during 1954 and 1955 on the ecology, anatomy and physiology of halogeton.

Anatomically, halogeton is similar to other Chenopodiaceae. The hypocotyl is characterized by an anomalous secondary thickening in which several layers of cambium are active and form concentric arcs of vascular tissue. The stem is characterized by the formation of a secondary cambium that gives rise to vascular tissue. The leaf is round in cross-section and contains accumulations of druse crystals of oxalate compounds. Two types of seed are produced—black, highly viable, mature seed and brown, immature seed of greatly reduced viability.

Ecologically, halogeton occurs where conditions exist in plant communities that allow it to supercede missing vegetation. Where ground cover of perennial grasses and shrubs was 22.5 percent or more, the amount and type of native vegetation excluded halogeton. In similar overgrazed areas in which plant cover had been depleted to 8.7 percent by overgrazing, halogeton made up nearly 50 percent of the total plant cover. However, plants such as *Elymus junceus, Malvastrum coccineum and Agropyron cristatum* in stands of 5 to 10 percent cover appeared to serve as a competitive deterrent to the invasion of halogeton. Below ground, halogeton is in direct competition with other annuals. With its relatively shallow root system, halogeton has difficulty surviving among perennial plants with vigorous root systems at comparable depths.—Frank L. Rauchfuss. Wyoming Agricultural Experiment Station, Laramie, Wyoming.

Herbage Response to Sagebrush Spraying

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Information that is presently available makes chemical control of sagebrush *(Artemisia tridentata)* a practical operation. Yet additional information is needed regarding ecological responses to assure that the practice of spraying for sagebrush control will be used wisely.

The economy of brush control must be determined by the amount of forage and meat products gained; however, the principal objective in brush control should be an upgrade in range condition. An evaluation of returns consistent with this management objective will require a long period of study, but the practical application of chemical control methods will not wait for such extensive experimentation. Therefore, sagebrush control measures must be undertaken in a manner consistent with present knowledge.

Information from previous work and experience has been evaluated in terms of how, when, why, and where to control sagebrush in a recent bulletin by Pechanec and others (1954). Preliminary details of herbage response to chemical sagebrush control, and its relation to site selection, will contribute to this back-log of information.

The present paper presents three years of results in herbage response to sagebrush spraying. The amount of forage and meat products resulting from sagebrush control, and the range condition at the time of spraying will be of interest to others contemplating control of big sagebrush by spraying. Perhaps the information most new to the sagebrush-bunchgrass range is the apparent source of herbage response, and the implications it proposes regarding range ecology.

Experimental Methods

One-tenth acre plots were established in 1951 to compare herbage response following sagebrush control by spraying 1 pound per acre of 2,4,5-T butyl ester with that following sagebrush eradication by grubbing and on untreated areas. The experiment was in randomized blocks with two replications. Ten permanent 9.6 square-foot samples were established on each plot from which herbage yields by species were obtained. Five permanent 100-foot lines were established on each plot to obtain basal intercept measures on the bunchgrasses and crown intercept measures on big sagebrush. Plaster of Paris blocks were planted at five locations on each plot at depths of 6 to 18 inches to obtain resistance readings of available soil moisture (Bouyoucos, 1950).

The 40-acre range pasture in which the plots were located was sprayed for sagebrush control in 1952 with two pounds per acre of 2,4-D butyl ester. Herbage response and trends on the entire area are of interest as verification of results on the plots. Grazing by yearlings was permitted on the pasture in August each year. Herbage production was sampled before grazing, and the yearlings were weighed on and off to obtain animal performance.

Pre-treatment inventory results as presented in the following tables appear to justify a range condition rating of fair with respect to bunchgrass density and composition. Average annual precipitation is nearly 11 inches, with over half of that amount received in the form of snow.

Results

Herbage Yields

In the three years following sagebrush treatments, sprayed plots have produced 882 pounds per acre more grass and 1,226 pounds per acre more total herbage than untreated plots (Table 1). Grubbed plots responded differently insofar as weeds were concerned. Those plots have produced, in the three years following treatment, 841 pounds per acre more grass and 1,507 pounds per acre more total herbage than untreated plots.

Spraying restricted the growth of weeds (mostly *Lupinus caudatus*) in the spraying year, but complete kill was not observed for any of the weed species. In the year after spraying the yield of weeds was slightly higher on sprayed plots than on untreated plots, but was considerably lower than that on grubbed plots. An enormous increase in weed herbage occurred in 1953 (Figure 1), which was a very wet year with total precipitation of 15.68 inches and a growing season (April, May, and June) precipitation of 6.60 inches. Beginning in 1953 the weeds were divided into legume and non-legume herbage. Weed yields were down in 1954, which was abnormally dry with a total precipitation of 6.77 inches and a growing season precipitation of 2.74 inches.

Grass yields have been about the same for spraying and grubbing. Highest yields were obtained in the year following treatment, and have dropped a little in the past two years. It seems peculiar that grass yields dropped in the wet season of 1953 below those of 1952 (which was a little drier than normal with total precipitation of 9.87 inches and a growing season precipitation of 2.73 inches). This suggests that the source of response to sagebrush reduction was something more than release in competition for moisture. The

1 The Squaw Butte-Harney Experiment Station is operated jointly by the Bureau of Land Management, U. S. Department of the Interior, and the Oregon Agricultural Experiment Station, Oregon State College, Corvallis, Oregon. This report is published as Technical Paper No. 941 with approval of the Director, Oregon Agricultural Experiment Station.

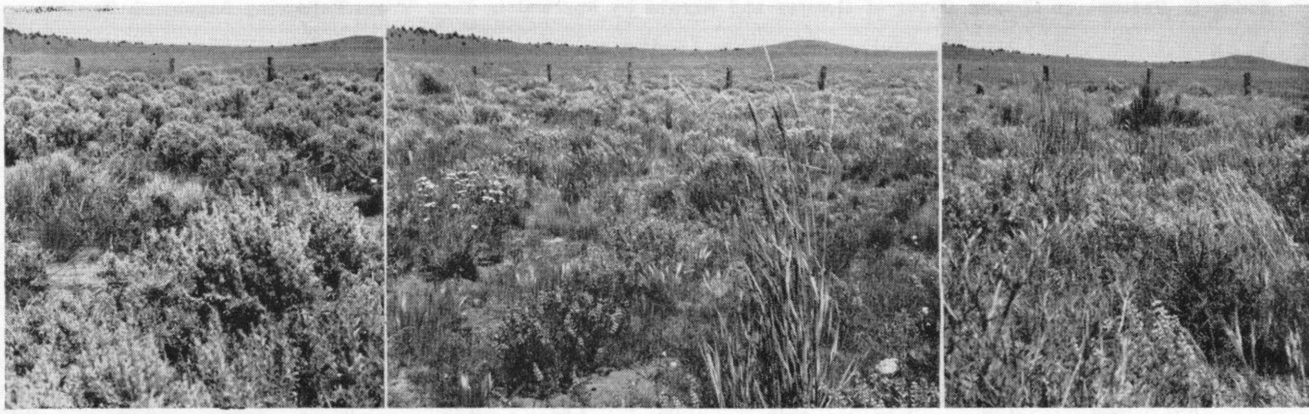

FIGURE 1. Untreated, grubbed and sprayed plots as they appeared in July, 1953, showing response to treatment made in 1951.

suggestion is supported by observation of growth performance. Under the sagebrush the grasses were extremely weak in color, growth, and heading, but on treated plots the grasses were bright green in color, and were strong in growth and heading.

Individual grass species responded differently to sagebrush control measures. Squirreltail (*Sitanion hystrix*) and June grass (*Koeleria cristata*) have responded more than other grasses. Their trends in yields in the past three years are intriguing. Squirreltail was especially strong in the wet season of 1953, while June grass dropped in yield on all plots below 1952 production. In 1954 yields of squirreltail dropped on all plots and June grass increased.

Percentage Ground Cover

Spraying reduced the percentage of ground covered by live sagebrush crown 91 percent (Table 2). In the past three years the portions of crowns not killed by the herbicide have grown some and in 1954 covered 17 percent as much ground area as the original stand. Grubbing removed all the sagebrush, but a few seedlings have become established on those plots. By numbers of plants intercepted, spraying reduced the stand of sagebrush 83 percent.

The percentage basal ground cover of bunchgrasses has increased by about one-third on treated plots, as compared with untreated plots. Most of the increase occurred in the first year; although, smaller increases have been measured in subsequent years.

Percentage ground cover by species parallels closely the trends found in herbage yields. Of particular interest is the increase in squirreltail in 1953 accompanied by a decrease in June grass. In 1954 squirreltail dropped in basal cover to about 65 percent of the comparable measure in 1953, but June grass increased about 25 percent.

The total numbers of bunchgrasses intercepted have increased 7, 30 and 36 percent respectively on untreated, sprayed, and grubbed plots. By individual species the trends in numbers of grasses intercepted have paralleled closely the trends in herbage yields and percentage ground cover. The total number of grasses did not

Table 1. Herbage Yields by Species[1] in Four Years Following Sagebrush Control

Sagebrush		Grasses								Weeds			Herbage
Treatment	Year	Asp	Fid	Sth	Shy	Kcr	Bte	Other	Total	Legume	Non-Legume	Total	Total
		(air dry herbage[2] in pounds per acre)											
Untreated	1951	5	3	28	6	40	—	11	93	—	—	26	119
	1952	5	4	40	8	83	—	19	159	—	—	14	173
	1953	4	3	30	18	71	2	1	128	92	0	92	220
	1954	2	4	28	14	107	0	11	166	11	0	11	177
Sprayed	1951	38	10	9	46	55	—	15	173	—	—	4	177
	1952	51	21	13	137	139	—	140	501	—	—	27	528
	1953	53	10	8	137	104	122	8	422	296	60	365	807
	1954	40	9	7	117	131	64	24	392	69	0	69	461
Grubbed	1951	29	0	28	9	72	—	38	174	—	—	62	236
	1952	59	0	60	50	198	—	107	472	—	—	164	636
	1953	48	3	40	102	111	69	34	409	461	81	542	951
	1954	24	3	42	85	151	85	23	413	77	0	77	490

[1]The species segregated were as follows:
Asp—*Agropyron spicatum*, bluebunch wheatgrass
Fid—*Festuca idahoensis*, Idaho fescue
Sth—*Stipa thurberiana*, Thurber's needlegrass
Shy—*Sitanion hystrix*, squirreltail
Kcr—*Koeleria cristata*, June grass
Bte—*Bromus tectorum*, cheatgrass
Legume—mostly *Lupinus caudatus*

[2]Herbage samples were air dried in 1951 and 1952, but in 1953 and 1954 were oven dried and the herbage weights were converted to 10 percent moisture for reporting as air-dry values.

Table 2. Percentage Ground Cover of Grasses and Shrubs by Species[1] in Four Years Following Sagebrush Control

Sagebrush Treatment	Year	Grasses								Shrubs	
		Asp	Fid	Sth	Shy	Kcr	Pse	Other	Total	CHR	Atr
		% basal intercept								% crown intercept	
Untreated	1951	0.84	0.04	0.57	0.08	0.75	0.45	0.05	2.79	0	21.20
	1952	0.41	0.13	0.66	0.36	1.23	0.48	0.03	3.30	0	19.75
	1953	0.45	0.05	0.82	0.65	1.30	0.46	0.06	3.79	0	20.24
	1954	0.34	0.08	0.86	0.28	1.51	0.60	0.02	3.69	0	18.06
Sprayed	1951	0.78	0.16	0.09	0.07	0.78	0.21	0.48	2.57	0.30	24.05
	1952	0.69	0.19	0.20	0.78	1.62	0.43	0.43	4.34	0	2.06
	1953	0.99	0.15	0.34	1.17	0.99	0.30	0.77	4.72	0	3.88
	1954	0.73	0.35	0.31	0.74	1.48	0.44	0.96	5.01	0.05	4.03
Grubbed	1951	0.67	0.10	0.18	0.10	0.63	0.57	0.07	2.33	0.35	23.39
	1952	0.64	0.20	0.35	0.49	1.47	0.67	0.06	3.89	0	0.04
	1953	0.76	0.18	0.45	1.05	1.86	0.75	0	5.05	0.18	0.17
	1954	0.84	0.12	0.28	0.73	2.08	0.93	0.10	5.08	0.16	0.25

[1]Species same as in Table 1, and
Pse—*Poa secunda,* Sandberg bluegrass
CHR—*Chrysothamnus spp.,* Rabbitbrush
Atr—*Artemisia tridentata,* Big sagebrush

change much from 1953 to 1954, but the abundance of squirreltail was reduced markedly and that of June grass increased. The average size (intercept) of individual clumps of these two species was uniformly less in 1954 than in 1953.

Available Soil Moisture and Nitrate

The differences in moisture trends among treatments have been especially interesting. In the first year following treatment, soil moisture levels started slightly higher and growing season precipitation was more effective on treated plots; nevertheless, the moisture depletion rate was somewhat faster than on untreated plots. In subsequent years the differences in moisture depletion became more clear. By the third year after treatment, the earlier depletion of soil moisture on treated plots was quite striking (Figure 2).

In part, the differences in soil moisture were due to differences in retention of precipitation. Snow was more effectively held on sprayed and untreated plots than on grubbed plots due to the brush cover; but rain during the growing season was more effective on treated plots due to reduced interception and evaporation, with but little difference between grubbing and spraying in this respect. The over-all retention of precipitation was clearly better on sprayed plots than on plots grubbed or untreated.

There were also differences among treatments in the demand placed upon soil moisture. This difference in demand is visualized in the rates of soil moisture depletion. It seems peculiar that the demand for moisture was stronger on treated plots than on untreated plots which retained all the vegetation.

In 1954 determinations were made of soil nitrate in the surface six inches of soil using a LaMotte quick-test kit. Available soil nitrate in the surface six inches of soil on untreated plots dropped from six parts per million on June 8 to 3 p.p.m. on July 5, while soils from treated plots increased in nitrate content from 5 to 10 p.p.m. It appears that big sagebrush is a strong competitor for soil nitrogen.

Production and Trends on 40-Acre Sprayed Range

In the past two years this pasture has produced a total of about 650 pounds more forage per acre, and over twenty pounds more beef per acre than was obtained before spraying (Table 3).

With the value of increased yearling gains rated at 18 cents per pound, the return has been over $4 per acre in two years. After suitable deductions for operating expenses, the increased beef production should redeem the cost of spraying (about $3 per acre) within five years.

In 1953, the first year after spraying, the aspect of mature herbage was predominantly squirreltail. In 1954 squirreltail did not dominate the aspect and appeared to be dropping out, but June grass increased in composition by weight from 28 percent in 1953 to 36 percent in 1954.

Discussion

Sagebrush control on sagebrush-bunchgrass range in fair condition gave about three-fold increase in herbage production. The higher production was due in part to an increase in numbers of grasses and an increase in basal size, but was primarily due to more vigorous and higher growth. A release in moisture competition was evident in soil moisture levels during the spring of the first year after treatments. Other evidence of im-

Table 3. Herbage and Beef Production on 40-Acre Range Sprayed in 1952

Year	Air-dry herbage	Yearling-days of grazing	Average daily gain	Beef gain
	lbs./acre	*no.*	*lbs.*	*lbs./acre*
1951	280	406	0.58	5.6
1952	305	450	0.74	8.4
1953	723	1146	0.62	17.6
1954	536	640	1.37	21.9

[1]Grazing was allowed only in the month of August. The yearlings were weighed individually on and off the pasture after shrinking off feed and water for 12 hours.

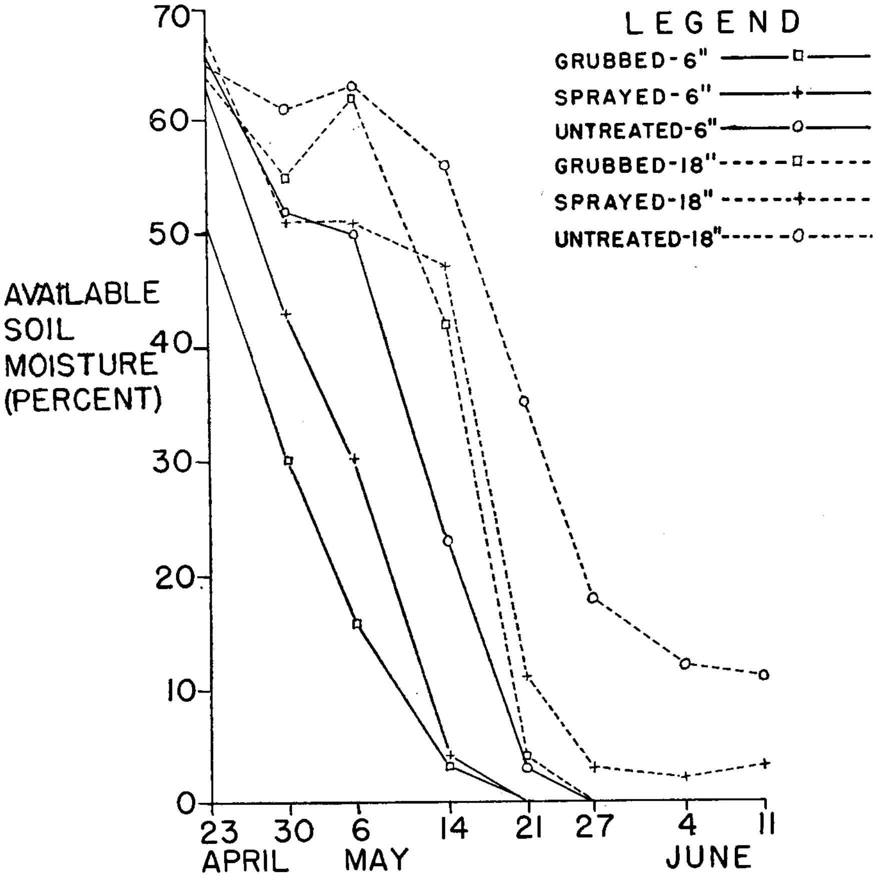

FIGURE 2. Soil moisture trends in 1954 on grubbed, sprayed and untreated plots at depths of 6 and 18 inches.

proved moisture relations on sprayed plots was found in better retention of precipitation. However, the trends in moisture depletion have been faster on treated than on untreated plots.

Those results and observations indicate that release in the competition for soil nitrogen was profoundly important in the response to sagebrush control. Soil nitrate trends in the upper six inches of soils from those plots gave direct evidence of such release. Other evidence is found in the high protein content of big sagebrush and its tremendous response to nitrogen fertilization on other plots (unpublished data).

It is thus concluded that the bunchgrasses have relative advantage over sagebrush in moisture competition (Robertson, 1947), but sagebrush has relative advantage over the grasses in competition for soil nitrogen. With better nitrate relations, the grasses could manifest their advantage. Under those conditions sagebrush reproduction would face more difficulty in establishment than under a stand of sagebrush. When the relative advantage held by the grasses is reduced by too-early grazing in the spring or close grazing at any time in the growing season, the opportunity for sagebrush reproduction increases. Once the sagebrush becomes dense, its relative advantage in nitrogen competition appears to supercede the relative advantage held by the grasses.

The balance in soil moisture and nitrogen may be the primary factor which determines the status of competitive advantage. Thus, there is a basis for appreciation of soil and climatic differences in the competitive relations between grasses and sagebrush. On a climatic basis low growing-season precipitation limits the opportunity for nitrification and should make it easier for the sagebrush advantage in nitrogen competition to supersede the grass advantage in moisture competition. Geographically, the occurrence of big sagebrush is largely in the areas of low growing-season precipitation. Under conditions of high growing-season precipitation, soil nitrogen levels may not become critical, and the competitive relation may depend upon relative advantage in competition for moisture.

In undertaking a program of sagebrush control to gain an upgrade in range condition, grazing should be deferred to grass maturity in the year of treatment, and especially so in the year after treatment. Maximum grass vigor is necessary, if the advantage in competition is to be tipped back to the grasses and the opportunity for sagebrush re-invasion is to be restricted. In subsequent years, grazing management should be planned to prevent too-early grazing, and close grazing at any time during the growing season.

Successful range improvement will depend largely upon the selection of areas which support a sufficient understory of grasses. In general, the deeper-rooted bunchgrasses should be frequent enough that one can walk along stepping from grass to grass without too many misses. It should also be noted that the earliest-growing grasses in the spring made the biggest response initially, then started giving way slowly to the more dominant species. An early closing of the community to sagebrush re-invasion may be obtained with those early-growing grasses, and site selection for their presence may also be important to successful range improvement through sagebrush control.

Summary

1. Herbage response to big sagebrush control measures was evaluated on untreated, sprayed and grubbed plots prepared in May 1951. In 1952-54 inclusive the sprayed plots produced 882 pounds per acre more grass and 1,226 pounds per acre more total herbage than untreated plots. Grubbed plots in the

same three years produced 841 pounds more grass and 1,507 pounds more total herbage than untreated plots.

2. Herbage yields, basal intercepts and numbers of plants by species show that *Sitanion hystrix* and *Koeleria cristata* responded more than other grasses to sagebrush control.
3. Soil moisture was depleted more slowly on untreated plots than on treated plots.
4. A 40-acre pasture sprayed for brush control in May 1952 produced in 1953 and 1954 over twice as much forage and beef as was obtained before spraying.
5. The herbage responses obtained are interpreted as indicative of the importance of soil moisture-soil nitrate balance in the competition between big sagebrush and native bunchgrasses.
6. A sagebrush-bunchgrass range in fair condition, with deep-rooted bunchgrasses yielding about 150 pounds per acre, is suited to profitable improvement by chemical control of big sagebrush.

LITERATURE CITED

BOUYOUCOS, GEORGE J. 1950. A practical soil moisture meter as a scientific guide to irrigation practices. Agron. Jour. 42 (2): 104-107.

PECHANEC, J. F., *et al.* 1954. Controlling sagebrush on range lands. U. S. Dept. Agr. Farmers' Bull. 2072.

ROBERTSON, J. H. 1947. Response of range grasses to different intensities of competition with sagebrush (*Artemisia tridentata* Nutt.). Ecology 28 (1): 1-16.

Effect of 2,4-D on Forbs and Shrubs Associated with Big Sagebrush

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In recent years considerable attention has been given to the control of big sagebrush (*Artemisia tridentata*) by spraying with 2,4-D. In California, Cornelius and Graham (1951) obtained an 85-percent kill of big sagebrush and a large increase in native perennial grasses through application of one pound of 2,4-D butyl ester per acre in late June. Studies in Wyoming (Hull *et al.*, 1952) indicate that at least 75 percent of a big sagebrush stand can be killed by application of two pounds of 2,4-D isopropyl ester per acre, thus allowing native grass production to double or triple. Hyder (1953) reported that a May application of from one to three pounds of 2,4-D butyl ester per acre in eastern Oregon caused the death of about 85 percent of the sagebrush. Unpublished studies by the authors in eastern Idaho have shown that both ethyl and butoxy ethanol esters of 2,4-D are also effective in sagebrush control, often killing more than 90 percent of the plants when applied at 1½ or 2 pounds per acre in late May or early June. It is apparent, then, that various esters of 2,4-D when applied in sufficient quantity at the proper season can effectively thin a stand of big sagebrush and allow a substantial increase in native grasses.

Despite the fact that many sagebrush-grass ranges also support considerable amounts of forbs and other shrubs that are valuable as forage, especially for sheep and big game, little is known about the effect of 2,4-D on these associated species. Bohmont (1954) has reported the effects of this chemical on a few forbs growing with sagebrush in northern Wyoming, but no information is available on shrubs or on many forbs important in other areas. Such information is urgently needed because of the current popularity of sagebrush control by spraying with 2,4-D. For example, in Clark County, Idaho alone, approximately 15,000 acres of rangeland have been sprayed since 1951. Although much good has been accomplished, damage to some of the desirable forage species has been severe. In order to provide a basis for more effective range improvement through the use of herbicides, an effort was made during the summer of 1954 to learn the effect of 2,4D on forbs and shrubs commonly associated with big sagebrush in eastern Idaho. The authors are indebted to personnel of the Targhee National Forest, particularly Ranger Lyman L. Richwine, and to several Clark County ranchers for making the sprayed areas available for study.

Methods

Since extensive areas of recently sprayed sagebrush range were readily accessible, it was possible to select a number of areas that could be directly compared with adjacent unsprayed range. Most of the areas selected were several hundred acres in extent and had been sprayed within the last three years. In these large-scale aerial sprayings, both ethyl and isopropyl esters of 2,4-D had been used at rates of 1½ and 2 pounds acid equivalent per acre. Ethyl and isopropyl esters of 2,4-D were apparently equally effective in killing sagebrush, and 2 pounds of 2,4-D was usually more effective than 1½ pounds. Sites selected for sampling were restricted to those areas where at least two-thirds of the sagebrush plants were judged to have been killed. Thus the effect on associated species was observed only on those sprayed areas where there was a satisfactory kill of sagebrush.

In all, 12 separate areas were examined. On 7 of these, both live and dead plants were counted on belt transects or circular plots on both sprayed and unsprayed portions so that a minimum of 1,000

Table 1. Mortality of forbs on 12 areas in eastern Idaho sprayed with 2,4-D to control big sagebrush.

Species	Areas*												Summary
	1	2	3	4	5	6	7	8	9	10	11	12	
Achillea lanulosa	U	U		M	U			U	U	U	U	U	Unharmed
Agastache urticifolia				L									Light
Agoseris spp.			H	H							U		Moderate
Antennaria microphylla	M		U					U					Light
Aplopappus sp.								U					Unharmed
Arnica fulgens	L												Light
Astragalus convallarius	U												Unharmed
Astragalus miser praeteritus	U	U											Unharmed
Astragalus salinus	U												Unharmed
Astragalus stenophyllus	H												Heavy
Balsamorhiza sagittata		H		H						H			Heavy
Calochortus macrocarpus								U					Unharmed
Castilleja spp.	H	H	H										Heavy
Comandra umbellata	U	M											Light
Crepis acuminata	U	U		U									Unharmed
Delphinium depauperatum								U					Unharmed
Delphinium glaucescens						U							Unharmed
Erigeron corymbosus	L			U	U								Light
Eriogonum heracleoides	U	L	M	M	U			M	U			U	Light
Eriogonum ovalifolium	U												Unharmed
Geranium viscosissimum				U				U	U				Unharmed
Helianthella uniflora		H		H					H	M			Heavy
Linum lewisii								U					Unharmed
Lithospermum ruderale		M											Moderate
Lupinus caudatus		H	H	H	H	H			H	M	M	L	Heavy
Lupinus leucophyllus	M												Moderate
Mertensia oblongifolia	H												Heavy
Penstemon radicosus	U	L											Light
Penstemon spp.			H										Heavy
Perideridia gairdneri								U					Unharmed
Phlox canescens							L						Light
Potentilla spp.			H	H				H	H	H	U		Heavy
Rumex sp.					U								Unharmed
Senecio integerrimus	U	U	L	M							U		Light
Sieversia ciliata			H	H									Heavy
Solidago sp.								U					Unharmed
Viola spp.			U	L									Light
Zigadenus paniculatus	H								H				Heavy

*Results on areas 1 to 7 based on quantitative data, those on areas 8 to 12 based on qualitative ratings.

square feet was included in each sample. On the remainder, injury to the various species was described by adjective ratings after carefully observing sprayed and adjacent unsprayed areas.

Results and Discussion

Effects of 2,4-D on forbs and shrubs associated with big sagebrush are indicated in Tables 1 and 2. For ease in interpretation, adjective ratings have been substituted for quantitative data so that degree of damage on all areas is recorded as: unharmed, light (1- to 33-percent kill), moderate (34- to 66-percent kill), and heavy (67- to 100-percent kill). No attempt was made to segregate species that may have benefited from the treatment; these are included in the "unharmed" category.

Of the 38 forbs occurring on the study areas, 15 were generally unharmed, 10 were lightly damaged, 3 were moderately damaged, and 10 were heavily damaged (Table 1). Although there were some discrepancies between areas, most of the results were fairly consistent. Among those species moderately or severely damaged are such important forage species as arrowleaf balsamroot (*Balsamorhiza sagittata*), milkvetch (*Astragalus stenophyllus*), oneflower sunflower (*Helianthella uniflora*), lupines (*Lupinus caudatus* and *L. leucophyllus*), and bluebell (*Mertensia oblongifolia*). Hawksbeard (*Crepis acuminata*), geranium (*Geranium viscosissimum*), matroot penstemon (*Penstemon radicosus*), and groundsel (*Senecio integerrimus*) are also important forage plants, but these were unharmed or only slightly damaged. Groundsel, however, is a species that matures and dries very early in the growing season, and it is possible that earlier spraying might be very injurious. Of the major poisonous species, deathcamas (*Zigadenus paniculatus*) was severely damaged by 2,4-D, whereas larkspurs (*Delphinium depauperatum* and *D. glaucescens*) were apparently unharmed. It is worthy of note that wyethia (*Wyethia amplexicaulis* and *W. helianthoides*), an undesirable forb often associated with big sagebrush in mountainous areas, can be effectively eradicated by spraying with 2,4-D (Mueggler and Blaisdell, 1951).

Mortality of shrubs and trees was much lower than that of forbs (Table 2). Twelve of the 15 species associated with big sagebrush were unharmed or but lightly damaged, and only three were injured severely. Damage to serviceberry (*Amelanchier alnifolia*) and threetip sagebrush (*Artemisia tripartita*) was heavy, and damage to silver sagebrush (*Artemisia cana*) was moderate. Silver sagebrush showed greater resistance to 2,4-D than did other species of *Artemisia* which agrees with observations by Cornelius and Graham (1951). As previously mentioned, at least two thirds of the big sagebrush plants were killed on all areas examined; kills on sites 1 to 5 where quantitative data were collected being 66, 92, 100, 99, and 86 percent, respectively.

Actual damage to many shrubs was much greater than indicated

Table 2. Mortality of shrubs and trees on 12 areas in eastern Idaho sprayed with 2,4-D to control big sagebrush.

Species	Areas*												Summary
	1	2	3	4	5	6	7	8	9	10	11	12	
Amelanchier alnifolia	...	H	...	M	...	...	...	...	...	...	...	...	Heavy
Artemisia cana	...	...	...	...	...	...	...	M	...	...	...	...	Moderate
Artemisia tripartita	...	...	...	...	...	...	H	...	...	...	...	...	Heavy
Ceanothus velutinus	...	...	...	U	...	...	...	...	...	...	...	U	Unharmed†
Chrysothamnus puberulus	M	L	...	U	...	L	U	...	...	...	...	...	Light†
Opuntia polyacantha	...	...	...	...	...	...	...	...	...	...	...	U	Unharmed
Pinus contorta	...	...	...	...	...	...	...	L	...	...	...	...	Light
Populus tremuloides	...	...	...	...	...	...	...	L	L	...	...	...	Light†
Potentilla fruticosa	...	...	...	...	...	...	...	U	...	...	...	...	Unharmed
Prunus virginiana	...	...	...	L	...	...	...	...	...	...	...	...	Light†
Pseudotsuga taxifolia	...	...	...	U	...	...	...	U	...	...	...	...	Unharmed
Purshia tridentata	U	U	...	L	...	...	U	...	...	...	...	U	Unharmed
Salix spp.	...	...	...	...	...	...	...	L	...	...	...	...	Light†
Symphoricarpos oreophilus	...	L	...	L	...	...	...	...	...	...	...	...	Light†
Tetradymia canescens inermis	U	U	...	...	...	...	U	...	...	...	...	U	Unharmed

*Results on areas 1 to 7 based on quantitative data, those on areas 8 to 12 based on qualitative ratings.
†Severe damage to aerial portions, but few plants completely killed—almost all sprouted profusely.

in Table 2 because the data refer only to percent of plants completely killed. Almost all the aerial portions of snowbrush (*Ceanothus velutinus*), downy rabbitbrush (*Chrysothamnus puberulus*), aspen (*Populus tremuloides*), chokecherry (*Prunus virginiana*), willows (*Salix* spp.), and snowberry (*Symphoricarpos oreophilus*) were killed by spraying. Although a high proportion of these species sprouted vigorously, production of herbage and seed will be greatly reduced for a period of several years.

Bitterbrush (*Purshia tridentata*), a particularly valuable forage species for both livestock and big game, was apparently little affected by spraying. On one area a few dead plants were found, but grazing pressure was very heavy here and probably was the cause of the bitterbrush mortality, since no damage was noted on four other areas. Douglas-fir (*Pseudotsuga taxifolia*) showed no damage whatsoever, but portions of many crowns of lodgepole pine (*Pinus contorta*) were injured and an occasional plant was killed outright. The two least desirable species, prickly pear (*Opuntia polyacantha*) and horsebrush (*Tetradymia canescens* var. *inermis*) were completely unharmed by the 2,4-D.

The differences in response of various associated forbs and shrubs indicate a need for careful consideration of vegetal composition when planning range improvement by spraying with 2,4-D to control big sagebrush. Indiscriminate spraying may entirely destroy many desirable species and allow their replacement by inferior species not damaged by 2,4-D, or by invasion of undesirable annuals. In such cases, artificial seeding may be necessary to insure satisfactory results. Also, total forage production may be seriously reduced for a period of several years. This is especially probable on sheep ranges where forbs supply a large portion of the forage or on winter big-game range where tops of shrubs are killed and the sprouting portions are buried beneath the snow. At any rate, vegetal composition, class of animals using the range, and season of use are all important factors that should receive attention before spraying.

Summary

In order to provide information on the effect of 2,4-D on forbs, shrubs and trees commonly associated with big sagebrush, 12 large areas of sprayed sagebrush range in eastern Idaho were examined during 1954, and these were compared with adjacent unsprayed range.

Thirteen of the 38 forbs occurring on the study areas were moderately or severely damaged. Among these were such important forage species as arrowleaf balsamroot, milkvetch, oneflower sunflower, lupines and bluebell. Hawksbeard, geranium, penstemon and groundsel, also important forage plants, were unharmed or only slightly damaged.

Of the 15 shrubs and trees present, only serviceberry, threetip sagebrush and silver sagebrush (in addition to big sagebrush) suffered moderate or heavy mortality. Aerial portions of snowbrush, downy rabbitbrush, aspen, chokecherry, willows and snowberry were mostly killed, but a high proportion of these species sprouted profusely. Bitterbrush, a particularly valuable forage species, was unharmed or only slightly damaged.

Because of the differences in response of various associated forbs, shrubs and trees, vegetal composition should always be considered when planning sagebrush control by spraying with 2,4-D. The range manager should be aware of possible deleterious effects of spraying upon desirable species and balance this against the probable benefits resulting from sagebrush control.

LITERATURE CITED

Bohmont, Dale W. 1954. Chemical control of big sagebrush. Wyo. Agr. Expt. Sta. Mimeo. Circ. 39. 9 pp.

Cornelius, Donald R. and Charles A. Graham. 1951. Selective herbicides for improving California forest ranges. Jour. Range Mangt. 4: 95-100.

Hull, A. C. Jr., N. A. Kissinger and W. T. Vaughn. 1952. Chemical control of big sagebrush in Wyoming. Jour. Range Mangt. 5: 398-402.

Hyder, Donald N. 1953. Controlling big sagebrush with growth regulators. Jour. Range Mangt. 6: 109-116.

Mueggler, Walter F. and James P. Blaisdell. 1951. Replacing wyethia with desirable forage species. Jour. Range Mangt. 4: 143-150.

The Use of Regression in Range Research[1]

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There are two kinds of tools which range technicians can carry with them when they do research—mechanical and statistical. Some mechanical tools are simple. The simple ones may be crude, such as an ax handle for measuring stubble heights, or more refined, such as a meter stick. The complicated tools, like the capacitance meter, are designed for the task of taking measurements accurately and objectively, yet cheaply and easily. Statistical tools have a parallel classification. Some of the simple ones are crude, such as the use of the average to describe a population, and some are more refined—affixing the fiducial limits to the average. The complicated statistical methods are powerful tools for the analysis of data after the measurements have been taken. They increase the precision of research and facilitate the interpretation of experimental results and survey data.

Regression analyses are statistical methods which fit into the category just described. They are useful in their simplest form—linear regression—but even more useful with the complexity of multiple regression. Certain uses of regression are made-to-order for many problems in the field of range management. Studies of forage utilization, grazing management, reseeding, fertilization, brush control, chemical analyses, digestion trials, range economics—each of these brings to mind a large number of perfect set-ups for regression analyses.

Regression is perhaps better understood when illustrated than when defined. Most people are acquainted with the concept of regression even though they do not realize it is that. On the penny scale outside of the drug store is a table reading something like this:

MEN

HEIGHT	*WEIGHT*
5′2″	130 lbs.
5′3″	134
5′4″	139
5′5″	144
5′6″	148
5′7″	153
5′8″	158
5′9″	164
5′10″	168
5′11″	172
6′0″	177
6′1″	182
6′2″	187

This table shows the *regression* of weight on height for the human adult male population. It is useful to express this graphically in the form of a *regression line,* which is the heavy diagonal line in Fig. 1. There is an *independent variable:* height. This is arrayed along the horizontal axis. The *dependent variable,* weight, is perpendicular to this. The idea of independence and dependence usually, but not necessarily, denotes cause and effect. The height which a person has attained, which in turn is dependent on other factors such as age, heredity, or childhood diet, determines to a large extent what he weighs.

The independent variables are fixed. They can be selected, that is, they do not have to be taken at random. Now, in our example, there is a distribution of weights for any selected height. The distribution has a mean that is actually the average weight for all men of this height.

The data in Fig. 1 make up a *scatter diagram.* Plotted are the heights and weights of 17 range technicians residing in the Berkeley, California area. The finer diagonal line is the regression line computed from the 17 positions on the graph. This line represents the average weight-per-height of these individuals better than any other straight line we could draw. The line was determined by the *method of least squares,* which simply means that if we sum the squares of each of the 17 distances from the points up to or down to the line, that sum is smaller than the sum for any other line.

With this knowledge of the characteristics of independent and dependent variables and the meaning of regression, little imagination is needed to visualize relationships between rate of seeding and density of grass, rate of nitrogen application and yield of forage, age of ruminant and digestibility, and so on for any biological attribute that is affected by measurable environmental phenomena.

As used in the height-weight example, regression is simple, but it can be extended to six or more uses. These are: (1) predicting an unknown value of a dependent variable by interpolation or extrapolation of data; (2) estimating a difficultly obtained value of a char-

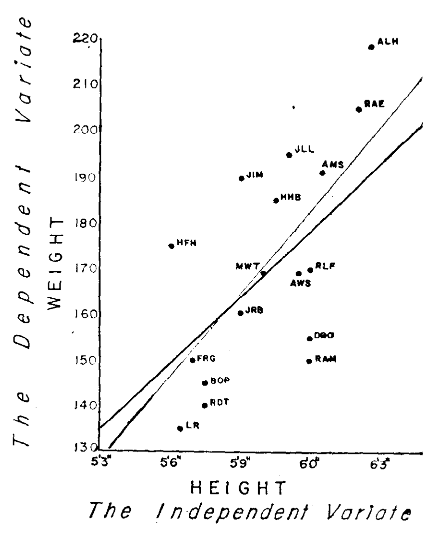

FIGURE 1. Regression of weight on height for the American adult male population (*heavy line*) and for 17 Berkeley, California range technicians (*light line*).

1. *Paper presented at the Eighth Annual Meeting of the American Society of Range Management, January 25-28, 1955, San Jose, California.*

acteristic more precisely by measuring an auxiliary variate which can be found quickly and cheaply; (3) reducing the error variance of designed experiments and increasing the relative information through statistical control; (4) determining the degree of independence of a factor; (5) testing the form of a relationship, whether linear or exponential (curvilinear); and (6) determining the proportion of the increase or decrease of a dependent variable which is contributed by each of several measurable independent factors.

The object is not to go into the statistical aspects of regression, but merely to point out, with appropriate examples, the ways in which regression can be applied to range research.

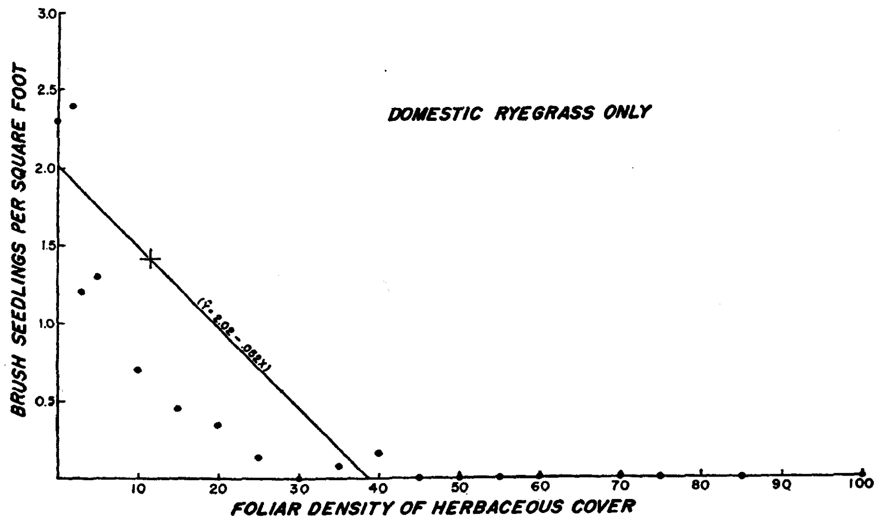

FIGURE 2. Regression of number of brush seedlings per square foot surviving the first summer of growth on foliar density of ryegrass (*from Schultz, Launchbaugh, and Biswell, 1955*).

Predicting Unknown Values

The man at the carnival who can guess your weight within two pounds has had much experience at that game. He sizes up his sucker, height being an important factor in formulating his prediction, and allows a four pound leeway (confidence limit). The greater his length of experience, the narrower he can make his confidence limits and still operate his concession at a good profit.

A regression equation is a mass of past experience expressed in algebraic form. It can be used to predict what will happen under certain specified conditions. The accuracy of the prediction is entirely dependent upon the breadth of the past experience. Thus, the larger the sample used in the compilation of the equation, the narrower the confidence limits may be. Confidence limits are an expression of the number of chances out of a hundred that your prediction will be right.

Using the regression lines in Fig. 1, if you know of a man who is 6 feet tall, you can guess his weight to be 178 pounds plus or minus a few pounds. The wider this leeway, the greater proportion of time you will be right. Now if you learn that he is a Berkeley range technician he is likely to be five pounds heavier, but you can't say this with too much confidence since there were only 17 men in this sample compared to the thousands involved in the other regression line. Moreover, it is safer to predict weights on range men between the heights of LR and ALH *(interpolation)* than beyond those extremes *(extrapolation)*, for reasons given later.

Another way to use the regression line is to determine what the normal or expected weight should be, then compare this with the actual. If the deviation is great, it may be well to look for reasons. Note that comparison with the sample mean weight does not yield such insight. For example, HFH is only four pounds over the group or population average weight of 171 pounds but for his height he is 28 pounds over while RAM is 21 pounds under the population average and 35 pounds under the average for his height. If the data represented 17 pigs, the farmer who owned them might use this information and select the HFH, JIM, and ALH types for breeding stock and deworm those way off the line in the lower right corner.

The divergence of two regression lines is sometimes of interest. The reasons why, among these research men, the ectomorphs are more ectomorphic and the "heavyweights" are heavier than generally found in the adult American male population may be supplied with a few more independent variables or they may have Freudian explanations. At least, in this case, height does not explain everything. Most likely, the two lines in Fig. 1 are not significantly different.

Bona fide range problems find the most common and practical use of regression to be in its predictive value. Ordinarily you predict the unknown dependent variable when the size of the independent variable is stipulated. A graph using some familiar data on the grass density-brush seedling relationship (Schultz, Launchbaugh, and Biswell 1955) will illustrate how this can be done in reverse (Fig. 2). Each increment of density of ryegrass is associated with an increase in mortality of the brush seedlings. On the average, at 38 percent density, mortality is 100 percent. Suppose we would like to maintain about one seedling per 10 square feet for browse, what should we strive for in grass density? The answer can be interpolated from the graph.

Regression Estimates

Sometimes we are interested in a measurement which is extremely

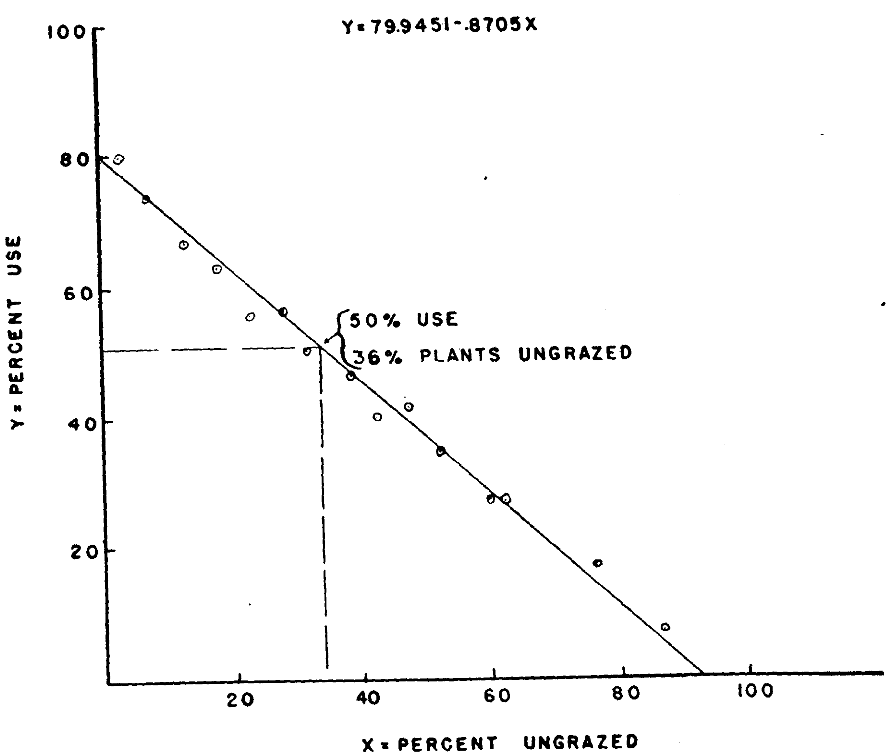

FIGURE 3. Percent use as determined by the weight of herbage removed in relation to percent of ungrazed plants of all important grasses on the Santa Rita Experimental Range, Tucson, Arizona. The circles are observations of ungrazed plants grouped by 5 percent intervals (*from Roach, 1950*).

costly to obtain with any degree of accuracy. Protein analyses, for example, take a lot of time and the equipment necessary to run them is not always available. Measures of range utilization are difficult to get in terms in which a range technician or a rancher may have confidence. Use of the linear *regression estimate* increases the precision and decreases the cost. By measuring an auxiliary variate which can be found quickly and cheaply, we can estimate more precisely the value of a characteristic obtained with great difficulty. We do not have any interest in this auxiliary variate itself; we are interested only as it is related to the dependent variate in question.

Let us illustrate this principle with two examples. It would be well to have a quick method of estimating crude protein in range forage. Ranchers could use it to decide when supplemental feeding should be started and the amount of supplement needed. A close relationship has been found between the crude protein in forage on longleaf-pine bluestem ranges in Louisiana and the free moisture in that forage (Campbell and Cassady 1954). Free moisture is relatively easy to determine. This relationship can be expressed in the form of a regression line. When used in conjunction with the known protein requirements of beef cattle, the moisture content of the forage will indicate the amount of protein that must be supplemented.

The other example is one of estimating perennial grass utilization on semidesert ranges by percentage of ungrazed plants (Roach 1950). After establishing the relationship between the percent of plants grazed and the percent utilization as a whole (Fig. 3), the latter value can be estimated merely by counting the number of grazed and ungrazed plants on representative samples. Roach claims that this simple method, when compared with the height-weight method, cuts field time by half and office computation time by at least three fourths; and it gives utilization estimates within 5 percent of those gotten the other way. The percentage of ungrazed plants itself is of no interest except that it helps to estimate utilization.

Statistical Control

Plant physiologists who are bequeathed with unlimited funds have elaborate laboratories and greenhouses where nearly every essential feature of the environment can be controlled. Thus, an experiment can be reduced to only one variable such as growth. With complete control over all factors, there should, theoretically, be no unexplained error encountered in the experimentation. Range ecologists have two strikes against them—they never are bequeathed with unlimited funds and if they were, they would fall short in controlling most factors of the outdoor environment, as the rainmakers can attest. So their research is redolent with what is called experimental error.

While he cannot control the factors, the range ecologist can often measure them and these measurements enable him to use regression for increasing the information available in his data. This is statistical control. In fact, the ecologist may be better off than the physiologist because in many cases statististical control is more desirable than experimental control. First, the actual situation is studied, not one produced artificially; secondly, a far greater range of observations can be made which broadens the foundation for inference; and finally, one learns how two quantities instead of one vary, singly and together—the factorial approach.

All this can be illustrated with some data on brush seedlings that are competing with certain species of annual grasses (Table 1). The table is excerpted from one containing many other species of grasses and legumes.

The number of brush seedlings per 100 square feet remaining alive after growing one season with these annual grasses varied with the grass species—significantly. But the number of brush seedlings that came up on these plots was not the same. Stated anthropomorphically, it is harder for cereal rye to reduce 275 seedlings to 0 than for ryegrass to reduce 125 since 125 is already much closer to 0. (Biologically, this premise may be incorrect because intraspecific competition may be greater among the 275.) Because of the uncontrollable discrepance in numbers, the original seedlings were counted and this auxiliary variate was used to adjust the fall numbers. Column 3, after the adjustment, shows the number of seedlings which would occur in fall if the same number had started on all the plots in the spring.

Some grasses grow better than others on different sites so grass species occur at varying densities. Would these species be equally good competitors if they grew at equal densities? Again, column 3 was adjusted so that column 4 shows the numbers of seedlings that would occur if the original seedling numbers were the same and the grass densities the same. Now, two variables have been controlled. We have divested the species of extraneous factors and perhaps we can compare them strictly on the basis of some physiological character such as transpiration ratio.

The method whereby these adjustments are made is called *analysis of covariance.* Other examples and explanations of the method are in the range literature (Pechanec 1941; Blaisdell 1953).

Test for Independence

One cannot always be sure that one factor is dependent on another even though logic says they are, and conversely, that two factors are independent when no cause and effect are indicated. It is a matter of degree. There is a statistical test which gives you reason to say, at a given level of significance, that one variable is independent of another, or that one is dependent on the other. We can say that in the height and weight example, weight of range technicians is dependent on their height, and be right in saying that unless a 1 out of 25 chance has come about.

Table 1. Number of brush seedlings established in competition with annual grasses

Competing Species	Number of Brush Seedlings per 100 Sq. Ft.			
	(1) Spring Count	(2) Fall Count	(3) After 1st Adjustment	(4) After 2nd Adjustmen
Cereal Rye	275	10	1	1
Red Brome	233	14	9	13
Annual Ryegrass	125	4	7	17
Rose Clover	152	14	16	27
Soft Chess	163	37	36	33
Check	177	47	45	32

The statement was made earlie that a relationship of dependenc may exist but it may not necessar ily mean that a cause and effec relationship exists. Any relation ship can be a tool for predictio or analysis purposes but the de cision as to whether it is causal o not comes only after detailed re

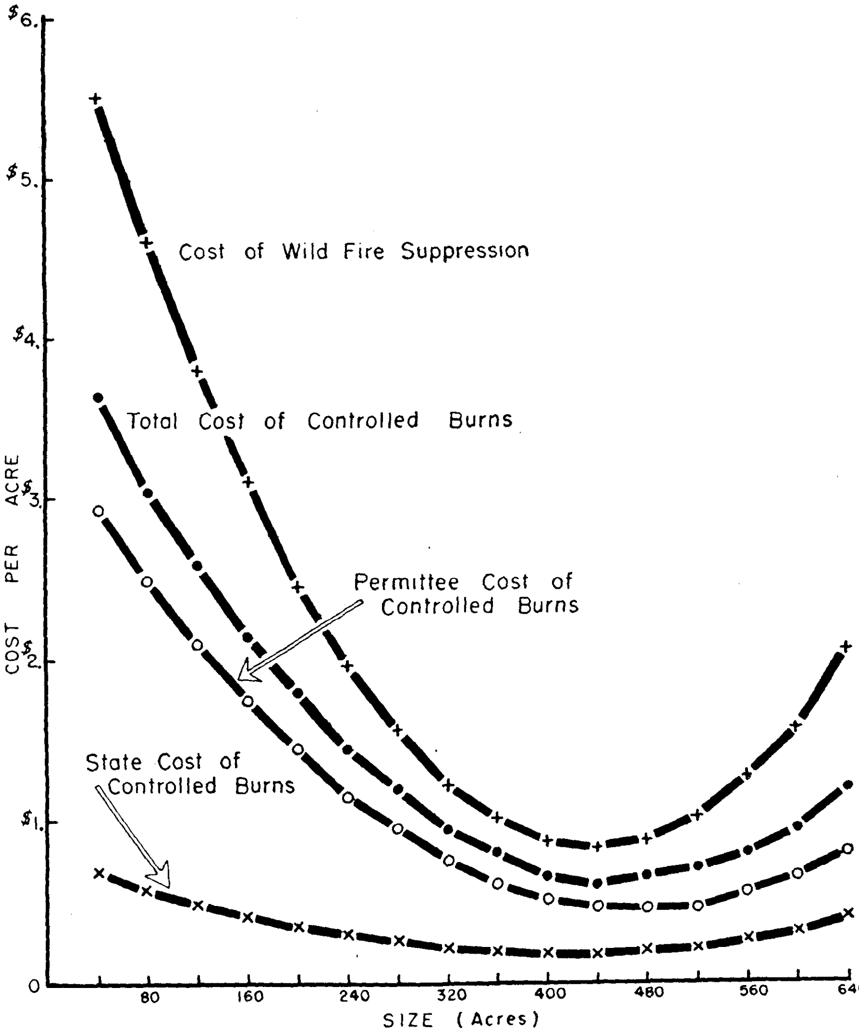

FIGURE 4. Comparison of costs of controlled burns and of wild fire suppression i northern California, 1947-1948 (*from Sampson and Burcham, 1954*).

search of the biological or logical kind rather than from mathematical manipulation of data.

An example of the question of dependence can be illustrated with data taken from an article on costs of controlled brush burning (Sampson and Burcham 1954). Fig. 4 is reproduced from this article. The second curve from the top implies that if a certain size of area is controlled burned, say, for example, 280 acres, it will cost about $1.20 per acre. In short, the cost per acre is directly dependent on size of burn. The top curve implies that this is also true of wildfires. However, it is much more reasonable to assume that the size of the wildfire is dependent on the amount of money devoted to its suppression. Thus, while the curve drawn for "cost of wildfire suppression" is not invalidated for predictive purposes, there may be some theoretical objections to comparing it with the curve for "total cost of controlled burns."

Test for Linearity of Regression

Not always do two variables go off in the same direction as do height and weight. Especially in biological phenomena, sigmoid, bell-shaped, or cyclic relationships are found. With growth phenomena a factor may increase the rate of growth until that factor has reached an optimum magnitude, and then growth decelerates. This relationship is also described by a regression line but a curved instead of a straight one. A curvilinear regression equation is difficult to compute, but from the practical as well as the academic viewpoint it is important to know whether a relationship is curvilinear or actually linear.

This can be illustrated with a hypothetical fertilizer experiment (Fig. 5). Six rates of nitrogen were applied to replicated plots, 0 to 500 pounds per acre in 100 pound increments. Forage production for each plot has been plotted on the graph. The broken line connects the averages for the treatments. Linear regression tells us

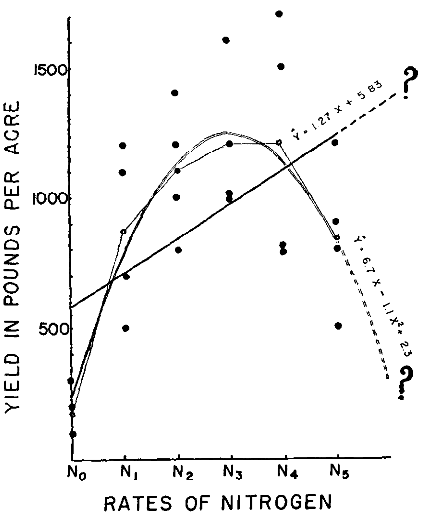

FIGURE 5. Regression of forage yield on rates of nitrogen fertilizer application for a hypothetical experiment. Dots are individual plot yields; circles connected by broken line are treatment means; solid straight line, linear regression line; double line, curvilinear or quadratic regression line; dotted lines, projections or predictions beyond the highest treatment level (extrapolation).

—if we allow ourselves to extrapolate—that if we were to apply 1000 pounds of nitrogen per acre we could increase our yield over the control (N) by 315 percent; curvilinear regression tells us that we could expect no yield at all after applying 700 pounds of nitrogen. Which is right?

A statistical test indicates that the regression in this case is quadratic (one-humped). One can readily understand that if more nitrogen is added without adding additional amounts of phosphorus, potassium, or water, not only will the extra nitrogen do no good but it will actually even have a depressing effect on the yield.

This test for linearity, then, is a useful tool for many aspects of range research. Straight line relationships are the exception rather than the rule where growth phenomena are involved.

Multiple Regression

Why are two plants not exactly alike even when they are of the same species and grow only 12 inches apart? A host of factors contribute to their difference. Among these are the number of hours head start one had as a seedling, the difference in food reserves in the seed, amount of time one is in the shade of the other, and so on. Conceivably 480 or more measurements of that nature would explain quite fully the variation between the two plants. Let us extend this idea to a current problem in game range management.

It would be easy to determine the production of available deer browse if we knew that all brush plants produced the same amount of forage: simply count the plants and multiply by the weight produced per plant. Chamise plants in the brushlands of northern California grow on varied sites and their size and vigor vary so much that an extremely large and costly sample must be taken to yield a reliable answer. Nor is it a simple matter to clip the available forage on a single bush. It might be better to choose a number of other characteristics of the plant, preferably some that can be measured easily and with objectivity, find out how much each contributes to the total variation in browse production between plants. The few characteristics which contribute the most can then be used in range investigations to determine browse production.

To illustrate, the following "independent" variables were measured on each of 32 chamise plants: average height (X_1), number of live stems (X_2), foliage crown diameter (X_3), root crown diameter (X_4), length of average leader (X_5), and length of longest leader (X_6). The dependent varible was available annual growth (Y). Many hours of calculations resulted in this equation:

$$\underset{\text{(predicted)}}{\text{Y}} = -366.60 - 23.35X_1 + 7.60X_2 + 1.86X_3 - 37.96X_4 + 5.15X_5 + 69.77X_6.$$

This equation is so impressive that it cannot be presented in graphical form since our comprehension is limited to three dimensions. The variables X_2, X_3, X_5, and X_6 are associated with vigor;

any increase in either of these will increase Y. The variable X_1 is negative; any height over 4 feet is superfluous for deer, since they browse only to that height. Indeed, shorter plants provide a top surface in addition to the sides where browse is available. The large and negative X_4 is a function of age. When all other factors are held constant, the plant with the larger root crown is the older, more decadent, and less productive. This fact was not readily discernible from routine methods of analyzing the data, e. g., correlation.

The six measurements account for only 38 percent of the variability. Most of the other 62 percent lies in the remaining 473 characteristics which could be measured and analyzed simultaneously with standard IBM machines.

It is not difficult to see how both fundamental and practical range problems can be clarified by the approach of multiple regression. The multitude of factors contributing to the processes which we call competition, soil formation, or plant succession, and the many forces and conditions that influence animal production, plant vigor, or the economics of range management are still too much a matter of subjective debate. If these factors are real, they are measurable; and, if measurable, they are interpretable. Multiple regression affords a good way to interpret them.

To conclude with the same whimsical example with which we began, multiple regression would permit us to predict with great accuracy the weights of Berkeley range technicians. For, besides height, their weights are dependent on age, amount of field work or desk work they do, size of their expense accounts, number of milk shakes they imbibe, and so on, until all the variation in their weights is accounted for.

Six ways in which regression can be used in range research have been discussed. There are others that may well be applicable in this field although not widely used. Numerous textbooks explain how to do the calculations but that has not been in the scope of this paper.

LITERATURE CITED

Blaisdell, James P. 1953. Ecological effects of planned burning of sagebrush-grass range on the upper Snake River plains. U. S. Dept. Agr. Tech. Bull. 1075. 39 pp.

Campbell, R. S. and J. T. Cassady. 1954. Moisture and protein in forage on Louisiana forest ranges. Jour. Range Mangt. 7(1): 41-42.

Pechanec, J. F. 1941. Application of analysis of covariance to range research data. Intermtn. Forest and Range Expt. Sta. Tech. Note 1. 21 pp.

Roach, Mack E. 1950. Estimating perennial grass utilization on semidesert cattle ranges by percentage of ungrazed plants. Jour. Range Mangt. 3(3): 182-185.

Sampson, A. W. and L. T. Burcham. 1954. Costs and returns of controlled brush burning for range improvement in northern California. Calif. Div. of Forestry Range Improvement Studies No. 1. 41 pp.

Schultz, A. M., J. L. Launchbaugh and H. H. Biswell. 1955. Relationship between grass density and brush seedling survival. Ecology 36(2):226-238.

Some Effects of Date of Planting, Depth of Planting and Fertilization on the Performance of Five Important Native Grasses of Texas

Abstract of thesis submitted in partial fulfillment of the requirements for the degree of Master of Science, Department of Range & Forestry, Agricultural & Mechanical College of Texas, 1955.

Five important range grasses of Texas were planted during the fall and winter of 1953-54, on an abandoned cultivated field near College Station, Texas. Plantings of big bluestem, silver bluestem, Indian grass, side-oats grama, and little bluestem were made on four dates: November 21, January 2, February 6 and March 5. Plantings were made of each species on the surface and at depths of ¼, ½, ¾, 1 and 1½ inches. On May 27, three fertilizer treatments were made: top dressing, band dressing applied at the rate of 90-45-0 per acre and no fertilizer. All plots were weeded at various intervals.

Plantings of big bluestem resulted in relatively poor stands with few plants. A majority of these plants resulted from the February and March plantings. Establishment of plants was greatest for the ¼- and ½-inch depth plantings.

Relatively large numbers of silver bluestem plants were established at all planting dates, with maximum in March and minimum in February. Planting at depths of ¼ and ½ inch resulted in greater establishment than at other depths. Planting at 1½-inch depth resulted in failure for all dates of planting.

Indian grass produced a comparatively substantial number of plants for all dates of planting. This grass showed the least variation in plant numbers for the various dates of planting of all the grasses observed. Plantings at depths of ¼, ½ and ¾ inch resulted in from fair to excellent stands for all dates of planting. All 1½-inch depth plantings rated poor. Results from surface plantings were erratic, and ranged from no plants to good stands.

Side-oats grama produced the greatest number of plants of any of the grasses. The November and January plantings resulted in poor emergence whereas the February and March plantings resulted in good to excellent emergence. Planting depths from ¼ to 1 inch for the February and March plantings resulted in stands that rated excellent. Surface plantings rated fair to excellent. Planting depths of 1½ inch resulted in poor stands for all dates of planting.

Counts of little bluestem were considerably higher for the February and March plantings than for the November and January plantings. Planting depths of ¼ and ½ inch for this grass resulted in the best stands of any of the depths. Surface and ¾-inch depths resulted in poor to fair stands, 1-inch depths in poor to no stands, and 1½-inch depths in no stands.

Fertilizer applied as a top dressing to the five grasses appeared to give better results, as related to height of plant and herbage production per foot of vegetation, than the band dressing and no fertilizer. Big bluestem was the only grass not reflecting these results. Indications were that band dressing was slightly less favorable than no fertilizer. This may have been due to poor soil moisture conditions at the time of application and for a considerable period thereafter.—James E. Anderson, Department of Animal Husbandry, New Mexico Agricultural & Mechanical College, State College, New Mexico.

Report on 1955 Meeting of the National Conference on FAO

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FAO's First Ten Years

The Food and Agricultural Organization, one of the 11 specialized agencies of the United Nations, was organized on October 16, 1945. The organization has grown from 42 member nations to 71. It is the only international agency set up to deal directly with the immediate and long-range problems of food and farming over the world. Its objectives, as stated in the Constitution, are 1) raising levels of nutrition and the standards of living of peoples, 2) securing improvements in the efficiency of the production and distribution of all food and agricultural products, 3) improving the conditions of rural populations, and 4) thus contributing toward an expanding world economy.

In order to carry out these objectives, the work of FAO is divided into three principal categories: 1) collect, analyze, and distribute to member nations the basic facts on food and agriculture, forestry, and fisheries; 2) promote concerted national and international action by recommending definite ways and means for putting the latest facts and scientific methods to use; and, 3) give technical assistance to member countries requesting it.

The first objective of FAO was to greatly expand food production. It was soon found necessary to support and stimulate research and tests to find ways of adapting basic knowledge for use in countries where the needs were greatest. In Oriental regions where rice is the most important food, comprehensive programs of rice breeding for the development of more productive varieties were started. In Europe livestock production has been stimulated through the development of hybrid maize. In the control of insect pests, the use of new insecticides has brought about better control of the locust in the Middle East. A widespread and prolonged desert locust outbreak extending from northern Africa across southern Asia has been brought under such successful control that practically no loss of food crops has occurred. FAO has helped in the control of animal diseases, particularly rinderpest and foot-and-mouth disease. Technical conferences of research and production specialists from many countries, and the publication of a number of valuable handbooks have been accomplished. Great progress has been made in changing primitive and inefficient methods of cultivation to more productive types of agriculture. In recent years production has more than kept pace with population growth.

In range and pasture management both the agriculture and forestry divisions are working on a coordinated program. This is bringing about a world-wide understanding of the problems and wider application of management practices. FAO has published a booklet on the grasslands of the world. It has formulated a world-wide policy for forest grazing. It has held several regional conferences on problems of range, pasture, and animal production problems. These conferences of governmental representatives have been concerned with both research and practical application of the research findings.

Annual Meeting of the National Conference on FAO

The annual meeting of the National Conference was held on October 12, 1955, at the University of Maryland under the chairmanship of James M. Gwin. The program included discussions on the following topics: points of interest to the United States in the forthcoming International Conference of FAO in Rome, general agricultural policy, production and consumption, commodity problems, the general FAO program and budgets, and the role of FAO. One of the important objectives of the meeting was to give suggestions to the delegates who will be going to the International Conference. At the luncheon Earl L. Butz, Assistant Secretary of Agriculture, spoke on the topic, U. S. Agriculture and FAO.

It was stressed that additional attention should be given to the so-called surplus production problem. Methods of increasing consumption in underdeveloped countries may be found. The distribution of surplus commodities may be an important way of aiding in the development of these countries. Some of these countries have resources of strategic materials lacking in the U. S. Foreign currencies accepted in exchange for surplus commodities might be used to produce strategic materials more efficiently than at present and to furnish them to the U. S. Other ways may be found whereby the distribution of surplus commodities may aid in the development of the foreign country and the U. S. benefit at the same time.

Efficiency of production of agricultural commodities must not be neglected, but greater emphasis is needed than in the past upon their distribution and consumption. In some underdeveloped countries there are many illiterate farmers. The first task there is education, so they will understand the use of modern production and marketing methods.

FAO is concerned with the relationship of agricultural resources to growing populations, with the peaceful uses of atomic energy, with the establishment of technical aid programs on a permanent basis rather than year-by-year, and in the coordination of specialized agencies carrying on related work. It is realized that the objectives involved in the improvement of rural populations and raising the living standards of all peoples are so great that one organization cannot do the job alone. It takes the coordination and cooperation of many agencies, governments, and peoples.

The present budget of FAO is $6 million. An increase of about $1 million is proposed for the next fiscal year. The contribution of the U. S. is limited at present by act of Congress to $2 million. In addition to the $6 million, FAO received for the year 1955-56 $7.5 million from the United Nations to aid in the Technical Assistance Programs.

BOOK REVIEWS

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Forestry Handbook. Edited by Reginald D. Forbes and Arthur B. Meyer. *The Ronald Press Co., New York. 1212 pages. 1955. $15.00.*

The publication of the *Forestry Handbook* represents the culmination of six years of work by more than one-hundred foresters under the sponsorship of the Society of American Foresters. It fills a need long recognized by the forestry profession for a reference handbook dealing with the field of forestry and those allied specializations commonly encountered by wildland managers. In covering the broad array of factual material used in the practice of forestry and land management nearly 300 charts and over 100 tables are employed. Excellent bibliographies are included at the end of each section.

For easy access to needed facts, the handbook is divided into twenty-three sections, eleven of which deal directly with forestry; four with the management of wildlife resources other than timber; and eight which treat basic subjects of importance to everyone engaged in the management of natural resources.

In the forestry sections, the practicing forester will find the concise write-ups and detailed tabulations a source of helpful data in convenient form for ready reference. These sections will also be of great value to the practitioner of allied professions when he is called upon to do an occasional forestry job or asked for advice or assistance on a forestry matter. A quick reference to one of the forestry sections can span the years that have elapsed since college days. Section headings include forest measurements, volume tables, yield and stocking, cutting budget and annual cut, silvics and silviculture, protection against fire, protection against insects, wood utilization and wood technology, economics and finance, logging, and chemistry and physics of wood.

The forest wildlife section tabulates life histories for game mammals, fur bearers, predators, important rodents, game birds and fish. Census methods are outlined for important game animals. Methods of determining game feed utilization are given. Repellants and poison baits are listed and discussed. Practices for improving game habitat, and food and water supplies are listed, including inland fisheries management techniques.

The single section covering the field of range management, while brief, is comprehensive. Rangelands and range management are defined, followed by discussions of rangeland soils and types of range vegetation. Ecological techniques for the study of vegetation, range survey methods and range utilization are described in some detail. Included with the range livestock breeds, nutrition and supplemental feeding are tables showing deficiencies in range forage, analyses of common feeds, and nutrient requirements and daily feed rations of livestock. The management discussion includes kinds of livestock, rate of stocking, condition and trend of ranges, economics, and a tabulation of indicators of range decline and recovery. A wide variety of range improvements are illustrated. Briefly described are prescribed burning in the South, control of brush, stock poisoning plants, range reseeding, and rodents and predators.

The watershed management section goes into the hydrologic cycle, precipitation, transpiration, evaporation, infiltration, soil moisture, runoff and stream-flow, erosion, use of water, and water units and measurements. Drawings and illustrations are effectively used. Tabulations are given on evaporation, water absorption, holding capacity of soils, use of water, water velocities, discharge capacities of spillways, wiers, pipes and culverts and discharge volume equivalents. Many useful concepts are dealt with and a wealth of factual data relative to water, its characteristics and management are given.

Forest recreation is divided into four main parts, namely: Cultural Treatments, Development of Policies and Standards, Facilities and Maintenance, Characteristics and Uses of Vegetation.

The eight sections dealing with basic subjects include a wide variety of information. *Geology and soils* includes discussions of the origin of soils and their classification, soil horizons, and forest humus. Some detail is given on soil factors influencing forest growth and on forest nursery soils, and their treatment. The short section contains much basic information useful to the land manager. The *surveying* section contains a practical coverage of maps, surveys, instruments and methods used in land measurement. Considerable detail is given on road curves, location, construction and maintenance. Recognition is given to the importance of bridges by the detail in which design, capacities and construction are covered. *Materials, structures and facilities* describes many of the common building materials together with methods of use and tables of specifications. Drawings and illustrations of rigging equipment are shown. A series of plans for recreation structures and facilities is included.

Since World War II, the use of aerial photographs in mapping, forestry and range management has increased rapidly. The section on *aerial photography* presents a good introduction for persons unfamiliar with the use of aerial photographs and a source of reference for those who have some familiarity with their use. Presented in varying detail are: uses in forestry, specifications, stereoscopy, measuring photographs, map making, stand classification, combining aerial and ground survey, and direct volume estimates. The subject of *communications* includes a brief description of radio communications and a more detailed account of telephone systems. The handbook closes with a section on *chemical and physical tables and definitions* and another giving *mathematical formulas and definitions.*

All technicians and managers of wildlands will find this handbook a useful reference tool in their work.—*J. A. Egan,* Regional Office, Southwestern Region, Forest Service, Albuquerque, New Mexico.

* * *

Grassland Farming. By George H. Serviss and Gilbert H. Ahlgren. *John Wiley & Sons, Inc., New York. 146 pages. 1955. Illus. $2.96.*

This delightful little book accomplishes its announced purpose admirably. It was prepared for use in senior high schools, technical institutions, and junior colleges, and for use by farm operators and managers. It is easy reading throughout and thoroughly up to date in its content and point of view.

The content of the book is reflected in the chapter headings: 1. Growing grassland crops, 2. Using forage in livestock feeding, 3. Growing forage for profit, 4. Selecting legumes, 5. Selecting grasses, 6. Choosing seed and establishing seedlings, 7. Adding lime and fertilizer, 8. Managing pastures, 9. Managing hay crops, 10. Preserving forage, 11. Conservation cropping, and 12. Equipping the grassland farm. The subject matter for each of the chapters is well selected, but the chapter titles do not do justice to the wealth of material in the chapters.

The format and make-up of the book are good. The presentation is logical. The text contains a few simple, effective tables and good photogrgaphs. Some of the references given at the close of each chapter might be difficult for schools to obtain, even though they are well selected. Teachers in the schools for which the text was written can make good use of the book, particularly if they had had actual field experience.

The book is written primarily from an eastern point of view. The few excursions into the West are brief and incomplete. None of the chapters give consideration to range management. Even the chapter of "Selecting Grasses" does not mention such an important and widely used grass as crested wheatgrass. Varieties of some grasses are listed, but no mention is made of the use of certified seed. Special mention should be made of the consideration given to forage crops for their use in modern American agriculture, such as is found in the chapter entitled "Conservation Cropping."—*A. L. Hafenrichter,* Soil Conservation Service, Portland, Oregon.

* * *

Hugh Roy Cullen—A Story of American Opportunity. By Ed Kilman and Theon Wright. *Prentice-Hall, Inc., New York. 369 pages. 1954. $4.00.*

This book is a biography of Hugh Roy Cullen—Texas oilman and philanthropist. Chapter 1 presents the drama of July, 1930, at which time a great pool of oil was discovered under Rabb's Ridge, fifty miles southwest of Houston. Because of this fabulous discovery, Mr. Cullen became the "King of the Wildcatters" and accumulated a billion-dollar fortune. With this serving to introduce the man, the book retraces Mr. Cullen's very active life as first a cotton broker, then a real estate man and finally as an oil producer. Many of the trials and tribulations involved in cotton-buying and in "wildcatting" are vividly portrayed in the book and clearly depict the tenaciousness of Mr. Cullen. As his lot became more favorable, he took a very keen and active part in the defense of his political beliefs.

Excerpts of the many communications with persons high in both Texas and national government circles are included in the book. Mr. Cullen is well-known for his many philanthropies directed towards the sharing of his good fortune with others. The book tells of many of his generous donations to the University of Houston, various hospitals and other worthy organizations .

Although the biography of Hugh Roy Cullen has little to offer directly to the field of range management, it perhaps exemplifies the type of rugged individualism characteristic of pioneers in any field and of which America is proud.—*David Wilson,* Assistant Professor of Range Management, University of Arizona, Tucson, Arizona.

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An Evaluation of Selected Reseeded Areas in Southern Idaho in Terms of Production, Utilization and Related Factors

Abstract of thesis submitted in partial fulfillment of the requirements for the degree of Master of Science in Forestry, University of Idaho, 1955.

Studies of production, utilization and related factors were conducted in 1953 and 1954 on eight reseeded areas in southern Idaho as the initial phase of an overall evaluation of range improvement practices.

Methods included an adaptation of the "before and after" procedure for determining yield and utilization permanent quadrat studies to observe changes in vegetational cover, and chemical analysis of forage.

Production of seeded stands was widely variable due to such factors as past grazing use, soil conditions and other site factors. Yields varied with age of stand, method of establishment and climatic fluctuations, particularly in seasonal and annual rainfall. Three-year-old stands of crested wheatgrass produced from 300 to 1,000 pounds of forage per acre in contrast to yields of 35 to 70 pounds on depleted native range where sagebrush predominated.

Utilization of seeded stands varied markedly with distance from water, indicating that improper distribution of animals is often a major problem on large-scale seedings. Non-uniform use in some may be due to the presence of saline areas attractive to livestock.

Plants of crested wheatgrass increased in basal area and diminished in number per unit area over the 2-year study period, resulting in a general increase in basal ground cover.

Limited studies of forage nutrients showed wide seasonal variations. Protein decreased significantly in collections made before and after grazing as influenced by animal selectivity and weathering.—James W. Barnett.

CURRENT LITERATURE

Edited by Arnold M. Schultz, School of Forestry, University of California, Berkeley, California

RANGE PLANTS

Forage value, chemical composition, ecology, physiology, systematics, genetics

Beetle, Alan A. The four subfamilies of the Gramineae. *Bull. Torrey Bot. Club 82 (3): 196-197. May 1955.* (Univ. of Wyoming, Laramie)

Duncan, Wilbur H., Paul L. Piercy and Robert J. Starling. Toxicological studies of southeastern plants. I. Leguminosae. *Econ. Bot. 9 (3): 243-255. July-Sept. 1955.* (Univ. of Georgia, Athens)

Fox, R. L. and R. C. Lipps. Influence of soil—profile characteristics upon the distribution of roots and nodules on alfalfa and sweetclover. *Agron. Jour. 47 (8): 361-367. Aug. 1955.* (Univ. of Nebraska, Lincoln)

Kinbacher, E. J. and Horton M. Laude. Frost heaving of seedlings in the laboratory. *Agron. Jour. 47 (9): 415-418. Sept. 1955.* (Univ. of California, Davis)

Knoblauch, H. C., G. H. Ahlgren and H. W. Gausman. Persistence of timothy as determined by physiological response to different management systems. *Agron. Jour. 47 (9): 434-439. Sept. 1955.* (Rutgers Univ., New Brunswick, N. J.)

Mead, H. W. The effect of fungicides on seedling diseases of legumes and grasses in Saskatchewan. *Canad. Jour. Agr. Sci. 35 (4): 329-336. July-Aug. 1955.* (Plant Pathology Laboratory, Saskatoon, Sask.)

Mitchell, K. J. Growth of pasture species. II. Perennial ryegrass *(Lolium perenne)*, cocksfoot *(Dactylis glomerata)* and paspalum *(Paspalum dilatatum)*. *New Zeal. Jour. Sci. Technol. (A) 37 (1): 8-26. June 1955.* (Grasslands Div., Dept. of Scientific and Industrial Research, Palmerston North, N. Z.)

Mitchell, K. J. and S. T. J. Coles. Effects of defoliation and shading on short-rotation ryegrass. *New Zeal. Jour. Sci. Technol. (A) 36 (6): 586-604. Apr. 1955.*

Stitt, R. E. Yields of grass species and varieties under irrigation in Montana. *Montana Agr. Expt. Sta. Bull. 508. 38 pp. Apr. 1955.* (Mont. State Coll., Bozeman)

Watkins, W. E. Digestibility of range grasses and grass-legume mixtures. *New Mexico Agr. Expt. Sta. Bull. 400. 21 pp. July 1955.* (New Mexico A. and M. Coll., Las Cruces)

Westbrooks, Fred E. and Milo B. Tesar. Tap root survival of Ladino clover. *Agron. Jour. 47 (9): 403-410. Sept. 1955.* (Mich. State Univ., East Lansing)

RANGE IMPROVEMENT

Artificial revegetation, noxious plant control, mechanical improvements, fertilization

Coppock, Raymond. From dryland to rangeland. *West. Livestock Jour. 33 (51): 43, 94. Sept. 1955.*

Dobson, S. H. and E. T. York, Jr. Prepare now for future forage needs. *Plant Food Rev. 1 (2): 12-14. Fall 1955.* (North Carolina State Coll., Raleigh)

Krall, James L. Chemicals and competitive crops for the control of leafy spurge in central Montana. *Mont. Agr. Expt. Sta. Bull. 510. 15 pp. May 1955.* (Mont. State Coll., Bozeman)

Palmer, Ernest J. Can we control halogeton? *Our Public Lands 5 (1): 4-5, 18-19, 22-23. Jan. 1955.* (Bur. Land Mangt.)

Pierson, Royale K. Idaho's arid range tests aerial seeding. *Our Public Lands 5 (2): 6-7, 12. Apr.-May-June 1955.* (Bur. Land Mangt.)

Shally, Vince and Homer Marion. Ready water—cow guzzlers. *West. Livestock Jour. 33 (57): 47, 121. Oct. 1955.* (Soil Conserv. Service, Monterey Co., Calif.)

Walker, A. H. More grass from controlling trees and brush with chemicals. *Texas Agr. Expt. Sta. Bull. B-800. 8 pp. Mar. 1955.* (Texas Agr. Ext. Serv., College Station)

RANGE INFLUENCES

Erosion, forests, watersheds, wildlife, soils

Atkins, M. D. and M. Wertzberger. Plant the "go-back land" to grass. *Jour. Soil and Water Conserv. 10 (5): 233-235. Sept. 1955.* (Soil Conserv. Service, Manhattan, Kans.)

Chepil, W. S. Factors that influence clod structure and erodibility of soil by wind: IV. Sand, silt, and clay. *Soil Sci. 80 (2): 155-162. Aug. 1955.* (U. S. Dept. Agr., Manhattan, Kans.)

Hellmers, Henry, James F. Bonner and John M. Kelleher. Soil fertility: a watershed management problem in the San Gabriel Mountains of southern California. *Soil Sci. 80 (3): 189-197. Sept. 1955.* (Calif. Forest and Range Expt. Sta., Glendora and Calif. Inst. of Technology, Pasadena)

Hill, Ralph R. and Erwin L. Boeker. Hunting seasons and forest fires in Colorado. *Jour. Forestry 53 (10):*

707-710. Oct. 1955. (U. S. Forest Service and Colo. Game and Fish Dept.)

Kittredge, Joseph. Some characteristics of forest floors from a variety of forest types in California. *Jour. Forestry 53 (9): 645-647. Sept. 1955.* (Univ. of California, Berkeley)

Miller, David H. Snow cover and climate in the Sierra Nevada, California. *Univ. Calif. Publ. Geog. 11. 218 pp.* (Berkeley)

Veihmeyer, F. J. and A. H. Hendrickson. Rates of evaporation from wet and dry soils and their significance. *Soil Sci. 80 (1): 61-67. July 1955.* (Univ. of California, Davis)

RANGE LIVESTOCK MANAGEMENT

Production, feeding, pests and diseases, history

Bennett, James A. and Doyle J. Matthews. Performance testing studies with beef cattle. *Utah Agr. Expt. Sta. Bull. 377. 15 pp. June 1955.* (Utah State Agr. Coll., Logan)

Burns, R. H. The sheep family. *Wyoming Agr. Expt. Sta. Circ. 61. 4 pp. June 1955.* (Laramie)

Ferguson, W. S. and R. A. Terry. Bloat investigations. *Jour. Agr. Sci. 46 (2): 257-261. Aug. 1955.* (Imperial Chemical Industries, Ltd., Jealott's Hill Research Sta., Bracknell, Berks.)

Harshfield, G. S., F. N. Carlson and T. A. Dorsey. Observations on parasitism in sheep in northwestern South Dakota. *South Dakota Agr. Expt. Sta. Bull. 447. 19 pp. May 1955.* (S. D. State College, Brookings)

Sperry, O. E., R. D. Turk, G. O. Hoffman and F. B. Stroud. Photosensitization of cattle in Texas. *Texas Agr. Expt. Sta. Bull. 812. 8 pp. July 1955.* (Texas A. and M. Coll., College Station)

RANGE AND LIVESTOCK ECONOMICS

Land utilization and administration, production costs, marketing, ranch organization

Kifer, Russell and Harold Tysk. Scattered tracts go on the auction block. *Our Public Lands 5 (3): 4-5, 20-21. July-Aug.-Sept. 1955.* (Bur. Land Mangt., Denver, Colo.)

Landstrom, Karl S. Acquired lands cost government $2.2 billion. *Our Public Lands 5 (3): 3, 19. July-Aug.-Sept. 1955.* (Bur. Land Mangt., Washington, D. C.)

Peterson, G. A. Selection of maximum profit combinations of livestock enterprises and crop rotations. *Jour. Farm Econ. 37 (3): 546-554. Aug. 1955.* (Univ. of Illinois, Urbana)

Pierson, Royale K. Coordinated land use planning. *Our Public Lands 5 (3): 9, 23. July-Aug.-Sept. 1955.* (Bur. Land Mangt.)

Williams, Ellis T. National forest contributions to local governments. *Land Econ. 31 (3): 204-214. Aug. 1955.* (U. S. Forest Service, Washington, D. C.)

RANGE EDUCATION AND RESEARCH

Bibliographies, methods, equipment

Beetle, Alan A. Introductory bibliographies in range management and plant ecology. V. Range management literature and where to find it. *Wyoming Range Mangt. 86. 2 pp. mimeo. Oct. 1955.* (Laramie)

Elam, F. Leland. Profitable ideas and inventions. *West. Livestock Jour. 33 (57): 44-45, 92, 95. Oct. 1955.*

Lynd, J. Q. A scale rack and procedure for rapid, precise cattle weights. *Agron. Jour. 47 (9): 440. Sept. 1955.* (Oklahoma A. and M. Coll., Stillwater)

Schuurman, J. J. and M. A. J. Goedewaagen. A new method for the simultaneous preservation of profiles and root systems. *Plant and Soil 4 (4): 373-381. Aug. 1955.* (Agr. Expt. Sta. and Inst. for Soil Research, Groningen, the Netherlands)

Thompson, N. R., R. E. Blaser, G. C. Graf and C. Y. Kramer. Application of a Latin square change-over design to dairy cattle grazing experiments. *Jour. Dairy Sci. 38 (9): 991-996. Sept. 1955.* (Virginia Polytechnic Inst., Blacksburg)

Winkworth, R. E. The use of point quadrats for the analysis of heathland. *Austral. Jour. Bot. 3 (1): 68-81. May 1955.* (Univ. of Melbourne, Victoria)

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DID YOU FORGET TO MAIL YOUR 1956 DUES?

If you have overlooked paying your 1956 dues, we urge you to mail them promptly to the Executive Secretary, 2443 N.E. Tenth Ave., Portland 12, Oregon. Prompt payment will avoid suspension as of February 15 and will save your society expense.

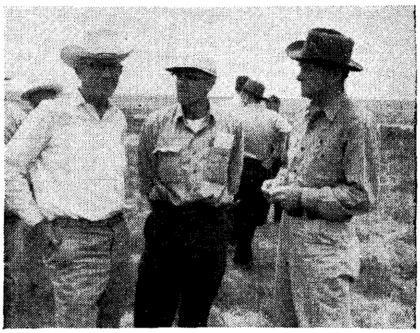
The Board of Directors

COLORADO

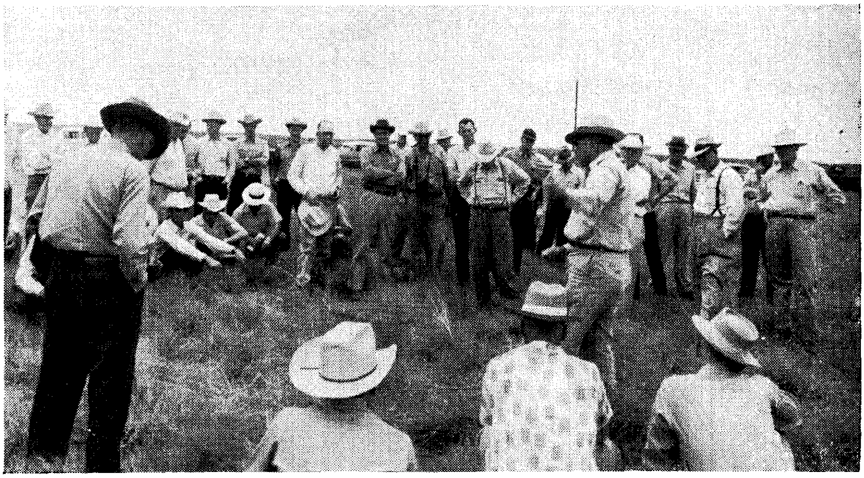
The field meetings of the Colorado Section during the past summer have been held in Eastern Colorado with excellent attendance at both meetings.

The Southeast field meeting was held June 24 and 25 at Lamar and Springfield, with about 60 persons attending. On-the-ground observations of successful revegetation work were made on a tour of the Springfield Land Utilization Project on June 24. The business meeting held that evening was highlighted by a talk given by "RED" ATKINS, President of the Society. Red emphasized the need for proper management of ranches, range and resources. Good movies shown by the Colorado Game and Fish Department completed the program. The tour on June 25 was made on the RAY MCMILLAN Ranch, where results of range reseeding and meadow improvement were observed. The importance of the integration of livestock management and proper range utilization in a planned year-long operation was emphasized.

The Northeast field meeting was held on the evening of September 22 and on September 23 at Sterling. The evening meeting was in cooperation with the Northeast Colorado Cattlemen's Association. An excellent program followed the banquet included talks on "Basic principles of determining range carrying capacity" by FRED H. KENNEDY, Colorado Section Chairman; "How grass grows" by CLINT WASSER, Dean of Range & Forestry at Colorado A. & M.; "Range site and condition classes" by CARL S. FONTE, Soil Conservation Service; and "Practical application of range management in ranching" by KENNETH CONRAD, rancher.



"Red" Atkins, President of A.S.R.M.; Joe Jensen, program committee co-chairman, Colorado Section; and Fred Kennedy, Chairman of Colorado Section at the Springfield field meeting, June 24.



Colorado Section members at the Springfield Land Utilization Project during the Southeast Meeting, June 24.

The field tour on the 23rd was a visit to the "Tamarack" Ranch owned by the Colorado Game and Fish Department. The ranch is operated by the SPRAGUE BROTHERS under the provisions of a management operation and plan worked out by the Sprague Brothers and the Game and Fish Department. The tour included a grass identification contest to acquaint members with the principal grasses of the area. Inspection of the ranch pastures definitely indicated the improvement possible on native ranges under proper range management and use. The requirement of water to secure proper livestock distribution and management was stressed. The meeting was well attended with a large representation of local ranchers.—*Warren L. Gray.*

IDAHO

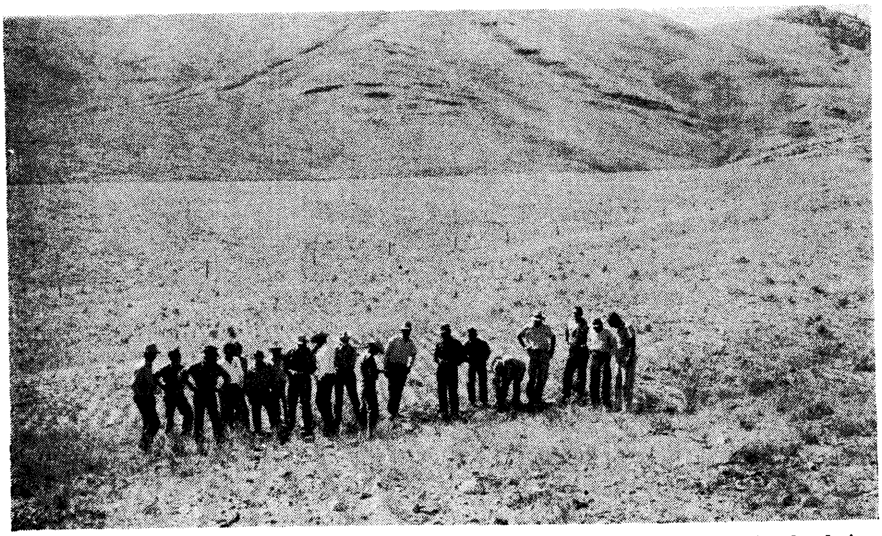
Eastern Idaho Chapter

A tour of the Eastern Idaho Chapter of the Idaho Section was held September 2, 1955, with 25 members and friends present. The tour started at Darlington, Idaho with a trip over the irrigated pastures and range reseedings on the HAROLD SMITH Ranch. HAROLD SMITH was the first winner of the Pacific Northwest Grassman-of-the-Year Contest. Before reseeding his range areas, SMITH experienced much difficulty in keeping his irrigation canals free of debris; after establishment of the grass stand, very little debris has collected in the canal in spite of several severe storms.

Other areas visited on the tour included seedings on the ranches of EARL SMITH, brother of Harold; HOOT ANDERSON; the Copper Basin Cattle Association; a 1,100-acre seeding made by the Bureau of Land Management in 1954; and the Fox Creek reseeding on the Challis National Forest. SETH BURSTEDT, rancher and past Chairman of the Idaho Cattlemen's Association said that he felt meetings such as this were highly beneficial and should be attended by more ranchers.—*Peter W. Taylor.*

KANSAS-OKLAHOMA

The annual fall meeting of the Kansas-Oklahoma Section was held at Cheyenne, Oklahoma, September 23-24. BOB WRIGHT and his able crewmen FRED WHITTINGTON, CHICK LOWRY, I. C. THURMOND and ORVILLE TATE had a bang-up program arranged. More than 100 men attended the Friday night banquet of charcoal-broiled steak.



Crested wheatgrass seeding on the Harold Smith Ranch at Darlington, Idaho being checked by members of the Eastern Idaho Chapter on a range tour, September 2. Smith was first winner of the Pacific Northwest Grassman-of-the-Year Contest.

Main speaker for the evening was E. E. CLARK, JR., Investment Supervisor for the Kansas City Life Insurance Company for Texas, New Mexico and Arizona. CLARK states that, over the years, ranch loans have been sounder than farm loans, with fewer foreclosures. With four examples he showed how sound range management pays off and how carefully management is considered by a loan company in determining the amount of loans to an operator. He stressed thinking in terms of investment per cow or per head rather than per acre, showing how inflated land prices differ from their true worth in terms of carrying capacity.

A fine demonstration of pastures and pasture management was given as part of the program by two 4-H Club boys from Indiahoma, Oklahoma. Recognition was also given to local boys who placed high in the national range judging contest at Oklahoma City last spring.

On Saturday the group toured private and public grazing land in the vicinity of Cheyenne. One stop of particular interest was the BOB SPROWLS Ranch on which cattle numbers on 2,960 acres of upland and red shale sites were reduced from 168 in 1952 to 100 in 1954 with a consequent increase in calf crop from 44 to 80 percent and calf production from 28,600 to 34,040 pounds. Another interesting stop was made on the A. L. THURMOND Ranch where shinnery oak experiments are being conducted by the U. S. Southern Great Plains Field Station. Two consecutive years of spraying with one pound of 2,4-D low-volatile ester in three gallons of diesel oil per acre gave good topkill and grass was growing well among the defoliated oak stubble.

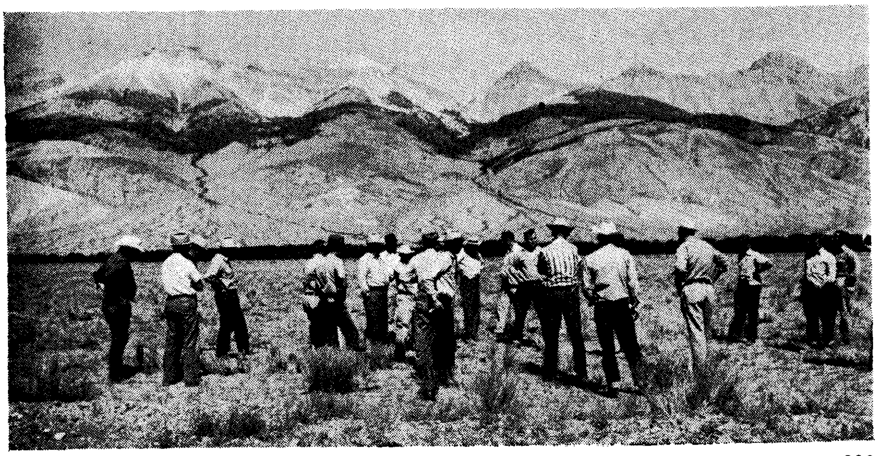
After a lunch on the DICK TURNER Ranch, R. E. CORTNEY of the U. S. Forest Service at Albuquerque, New Mexico spoke to members on the historical background of grazing on National Forests and some of the management problems such as reseeding and extreme variations in habitat sites.—*W. R. Kneebone,* Secretary-Treasurer.

NEBRASKA

The Nebraska Section sponsored a field tour in Jefferson County on August 25, 1955 attended by about 45 people. The first stop was on the farm of HAROLD HUMMEL on which certified switchgrass seed is grown, with yields as high as 425 lbs. per acre. Dr. E. C. CONARD of the University of Nebraska discussed some of the problems connected with grass production and harvesting. Hummel's management practices include planting in 40-inch rows, fertilization with nitrogen in the fall, incorporation of vegetative growth and residue into the soil and the use of terraces and contour rows for maximum conservation of moisture.

Observations were also made on LOUIS GOMBERT's farm of switchgrass and Indian grass planted during the past spring. On the STONE farm near Fairbury, the group inspected a pasture treatment plot put out cooperatively by the County Extension Agent and the Jefferson County Soil Conservation District. MARVIN HOLLINGSHEAD, Unit Conservationist, described the treatments consisting of introduction of trefoil with and without fertilization and deferred grazing. Big bluestem and sideoats grama made a conspicuous showing on the plots. Deferment of grazing gave grasses vigor to crowd out ironweed and other weeds.

At the HARRY BAKEWELL pastures southeast of Fairbury, E. J. DYKSTERHUIS, Range Conservationist of the SCS, led the discussion on the pastures judged to be in good and excellent range conditions Mr. BAKEWELL is a firm believer in proper stocking as evidenced by the good supply of forage on the ground during a dry year. Fields seeded to bromegrass were grazed during late April and



Eastern Idaho Chapter members inspecting the crested wheatgrass reseeding on 800 acres made in 1950 by the Copper Basin Cattle Association near the Big Lost River Mountains, September 2.

early May, after which native grass was used as forage.

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Another field day of the Nebraska Section was held at Mullen, September 21, and was attended by 25 members of the Sandhills area. At the morning session, SELVESTER VANDERBEEK, SCS, showed colored slides of grazing areas and plants. DEAN HIGGINS, Section Chairman and range specialist, SCS, outlined the program for the remainder of the year. GEORGE WISEMAN, Manager of the National Wildlife Refuge at Valentine, discussed range management on the refuge, indicating that grazing capacity had been increased by proper management.

SID SALZMAN, past chairman and rancher from Ainsworth, stressed the bad effects of mowing aftermath on wet meadows and discussed the advantages of wet-meadow fertilization. At the WALTER CRAIN Ranch, CHARLES MOWRY, SCS technician from Halsey, conducted an identification contest of range plants. DEAN HIGGINS, DON BURZLAFF, Range Specialist of the University of Nebraska, and GEORGE WISEMAN led a discussion of utilization, range site classification and condition class of a grazed pasture. Ranchers DON COX of Mullen and ALVO CRAWFORD of Seneca and DALE LANGFORD, County Agent, assisted on the program committee. — *Selvester Vanderbeek.*

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Nebraska Section members discussing grasses found on excellent condition range on a silty site in the 20-24 inch precipitation belt. D. L. Higgins, Range Conservationist, SCS, Chadron, leading the discussion.

"Seventy-five pounds heavier calves and no worry in the drought year about not having enough grass to carry through"—is the way ROBERT HAM of Farnum summarized his experience with properly stocking his leased native grassland. HAM made these statements as he proudly showed his herds of well-fleshed cows, calves and yearlings to a group of 30 Nebraska Section members in a tour on the Medicine Creek Reservoir, northeast of Bartley, September 30, 1955. The tour was sponsored by the Nebraska Section in cooperation with the Soil Conservation Districts and County Extension Agents of Red Willow and Frontier Counties, the Nebraska Game Forestation and Parks Commission and the U. S. Bureau of Reclamation.

On a pasture in excellent range condition, DEAN HIGGINS, SCS Range Conservationist, pointed out important species such as big and little bluestem, sideoats grama, western wheatgrass and tall dropseed on this thin loess site. At another pasture leased by Mr. HAM from the State Game Commission, L. F. BREDEMEIER, SCS Range Conservationist, reviewed the improvement in condition of the area since 1952 at which time he had conducted a survey of the pasture and had recommended management and stocking practices. ED CASSELL, Reservoir Area Supervisor for the Game Commission, stated that improvement had resulted principally from controlled grazing. Attention of the group was called to situations in which invading western wheatgrass increased productivity and to other areas on better sites in which big bluestem and switchgrass were replacing western wheatgrass as a result of proper stocking.—*L. F. Bredemeier.*

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"Range Management and Cattle Gains" was the theme of the two-day annual meeting and field days held at Ft. Robinson, October 7-8, 1955, under the direction of DEAN HIGGINS, Chairman and the able assistance of the Section Council. The program started with a tour of the V. C. KENNEDY Hereford Ranch north of Harrison. Mr. KENNEDY, assisted by RALPH GRENIER, SCS, gave more than 50 members and guests a very interesting and profitable afternoon in a tour of rolling hill pastures with a top herd and splendid calf crop showing the results of good management. L. F. BREDEMEIER, SCS, and DONALD BURZLAFF, Extension Service, led discussions on range condition and trends.

Following a ranch-style steak dinner at Comanche Hall in Ft. Robinson, GEORGE WISEMAN, Section Vice-Chairman, served as master of ceremonies for the evening program. BILL ALLRED, Past President of the Society, gave a fine talk on the organization of the national range society and the development of the sections. SELVESTER VANDERBEEK carried off top honors with a splendid entry of colored slides portraying native plants and range scenes in the photo contest.

On October 8, the group toured the Beef Cattle Research Station under the guidance of Dr. ROBERT KOCH, Superintendent, and ERVIN SCHLEICHER, Herd Manager. At the final session in the high school auditorium at Crawford, Dr. KOCH led off with a discussion of the work of the Research Station. The topic "Good range management and what it means to the rancher" was presented by KENNETH CONRAD, Colorado rancher and member of the Society Board of Directors. The program was well summed up by a ranch panel led by SID SALZMAN and including ranchers O. B. WADDILL of Gordon, HENRY COX of Wray, Colorado.—*Dean Higgins.*

Newly-elected officers of the Nebraska Section for 1956 are: *Chairman:* GEORGE WISEMAN, U. S.

Fish & Wildlife Service, Valentine
Vice-Chairman: DONALD BURZLAFF, Extension Service, University of Nebraska, Lincoln
Council: RALPH A. BAKER, rancher, Valentine; DON SYLVESTER, Soil Conservation Service, Valentine.

NORTHERN GREAT PLAINS

Officers and Council serving for the year 1955 have been:
Chairman: LES ALBEE, SCS, Rapid City, South Dakota
Vice-Chairman: MONS. L. TEIGEN, Agricultural Research Service, Miles City, Montana
Sec'y-Treasurer: GEORGE A. ROGLER, U. S. Field Station, Mandan, North Dakota
Council: J. B. CAMPBELL, Past Chairman, Dominion Expt. Station, Swift Current, Saskatchewan; KARL G. PARKER, Montana Agr. Extension Serv., Bozeman, Montana; JOE W. TURELLE, SCS, Bismarck, North Dakota; BURTON B. BREWSTER, U Ranch, Birney, Montana; DANIEL A. FULTON, rancher, Ismay, Montana.

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The Dickinson Experiment Station and the Northern Great Plains Field Station at Mandan, North Dakota were hosts to the first annual meeting of the ASRM to be held in North Dakota, September 12-13, 1955. RAYMOND DOUGLAS, Superintendent, LARKIN LANGFORD, Animal Husbandman, and WARREN WHITMAN, Professor of Botany at N. Dakota Agr. College, welcomed the 28 members and friends to the Dickinson Experiment Station, and reviewed its history and work. LLOYD GOOD, Forest Service, Dickinson, reviewed the Land Utilization Projects in North Dakota which he serves as range manager.

Dr. WHITMAN showed the group the tame and native grass and legume studies and the effects of nitrogen fertilizer on crested wheatgrass. Alfalfa with crested wheatgrass increased the gain per acre with steers for a 51-day grazing season by 43 percent compared with crested wheatgrass alone. WHITMAN reported on clipping studies which indicated that 60 percent of forage yields on western North Dakota ranges consist of two cool season grasses, western wheatgrass and needle-and-thread.

The annual banquet and business meeting were held in Mandan at the Lewis and Clark Hotel. On Tuesday, September 13, GEORGE ROGLER of the Northern Great Plains Field Station reviewed the work of the station and with RUSSELL LORENZ showed the group the irrigated forage work and grass breeding studies. New grass developments seen included Nordan crested wheatgrass, a new green stipagrass, hybrids of green needle and Indian ricegrass and superior strains of Russian wildrye.

Considerable time was spent going over the heavy grazed pasture included in studies of native pasture initiated on the station in 1915. The pasture was in relatively good condition after many years of heavy grazing and had a higher density than that of the moderately grazed pasture. Blue grama and threadleaf sedge comprised the major portion of the vegetation but there were still remnants of midgrasses western wheatgrass and needlegrass. Gains per acre on the heavy grazed pasture had been much higher than on the moderately grazed pasture. Plots on the heavy grazed pasture showed a striking response to applications of nitrogen with a more rapid recovery of western wheatgrass and needlegrass than on unfertilized areas.

The group inspected a new series of seeded pastures which will be grazed in 1956, consisting of crested wheatgrass alone and with alfalfa, 40 pounds and 80 pounds of nitrogen applied annually.—*Les Albee,* Chairman.

New Publications of Interest

Agricultural Regions of the United States. By Ladd Haystead and Gilbert C. Fite. *Univ. of Oklahoma Press, Norman, Oklahoma. 288 pages. 1955. $4.00.*

Breeding Beef Cattle for Unfavorable Environments. Edited by Albert O. Rhoad. *Univ. of Texas Press, Austin, Texas. 248 pages. 1955. $4.75.*

Cattle and Men. By Charles W. Towne and Edward N. Wentworth. *Univ. of Oklahoma Press, Norman, Oklahoma. 304 pages. 1955. $4.00.*

Elements of Soil Conservation. By Hugh M. Bennett. *McGraw-Hill Book Co., N. Y. 514 pages. 1955. 2nd ed. $7.50.*

Farm Machinery and Equipment. By Harris P. Smith. *McGraw-Hill Book Co., N. Y. 514 pages. 1955. 4th ed. $7.50.*

Farm Service Buildings. By Harold E. Gray. *McGraw-Hill Book Co., N. Y. 458 pages. 1955. $7.50.*

Grassland-Livestock Handbook. By the Joint Committee on Grassland Farming. *Univ. of Oklahoma Press, Norman, Oklahoma. 48 pages. 1955. $0.50.*

Handbook of Food and Agriculture. Edited by Fred C. Blanck. *Reinhold Book Div., N. Y. Over 1,000 pages. 1955. $12.50.*

Marketing Farm Products—Economic Analysis. By Geoffrey S. Shepherd. *Iowa State College Press, Ames, Iowa. 497 pages. 1955. $6.25.*

Physiology of Domestic Animals. By H. H. Dukes. *Comstock Publishing Associates, N. Y. 1,032 pages. 1955. 7th ed. $9.75.*

Plant Ecology, Proceedings of Montpellier Symposium (English and French). By United Nations Educational, Scientific and Cultural Organization. *Columbia Univ. Press, N. Y. 126 pages. 1955. $3.00.*

Plant Ecology, Reviews of Research. By United Nations Educational, Scientific and Cultural Organization. *Columbia Univ. Press, N. Y. 377 pages. 1955. $7.00.*

Topsoil and Civilization. By Tom Dale and Vernon G. Carter. *Univ. of Oklahoma Press, Norman, Oklahoma. 320 pages. 1955. $3.95.*

Trees and Shrubs of the Upper Midwest. By Carl O. Rosendahl. *Univ. of Minnesota Press, Minneapolis, Minn. 411 pages. 1955. $6.00.*

PROGRAM

Ninth Annual Meeting
American Society of Range Management
Shirley-Savoy Hotel, Denver, Colorado, January 23-27, 1956

Monday, January 23

Board of Directors Meeting

Tuesday, January 24

Section Chairmen Meeting

Technical Session: *Control of Undesirable Vegetation*

Chairman: Hudson G. Reynolds, Rocky Mtn. Forest & Range Expt. Sta.

Range Weeds and Range Management, Dr. E. W. Tisdale, Univ. of Idaho.

Progress and Problems in the Use of Herbicides in Control of Undesirable Range Plants. Dr. Marion W. Parker, Chief, Weed Investigations, Agricultural Research Service, Beltsville, Md.

Controlled Burning in Forests. Effects on Reproduction, Grazing and Water Yield. Joe A. Wagner, Bureau of Indian Affairs, Phoenix, Ariz.

Use of Fire in Improving Grazing Values on Jungled-up Timbered Range. Geo. A. Garrison, Pacific Northwest For. & Range Expt. Sta.

Revegetation of Big Dalton Fire. Geo. F. Roskie, Los Padres Natl. Forest, Santa Barbara, Calif.

The Influence of Management on Seedings of Perennials in the Annual Forage Range Area. H. W. Miller and A. L. Hafenrichter, Soil Conservation Service, Portland, Ore.

Classification of Wildlands for their Best Use

Desirability for Such Classification. Harold Hochmuth, Bureau of Land Management, Washington, D. C., *Panel Chairman*

Plant-Soil Relationships. E. Wm. Anderson, Soil Conservation Service, Pendleton, Ore.

Classification of Wildlands in the Sagebrush-grass Region. Dr. Chas. E. Poulton, Oregon State Coll.

Classification of Wildlands in the Pacific Northwest. Wm. M. Johnson, Soil Conservation Service, Berkeley, Calif., and Rudolph Mako, Soil Conservation Service, Pendleton, Ore.

Ecological Classification of Range Lands. Dr. H. C. Hanson, Catholic Univ. of America

Evening

General Business Meeting

Wednesday, January 25

Morning

Administration & Management of Public Range Lands

Chairman: Incoming Vice President

President's Address. A. P. Atkins, Guymon, Okla.

Keynote Addresses.

W. E. Morgan, President, Colorado A. & M. College, Fort Collins, Colo.

Wesley A. D'Ewart, Assistant Secretary of the Interior for Public Land Management, Washington, D. C.

Ervin L. Peterson, Assistant Secretary of Agriculture, Washington, D. C.

Administration of Canadian, State and Provincial Lands. T. G. Willis, Dominion Range Expt. Sta., Kamloops, Brit. Columbia

Management of Hawaiian Rangelands. E. V. Hosaka, Univ. of Hawaii.

Afternoon

Coordinating and Harmonizing the Multiple Uses in Watershed Resources

Chairman: Wallace R. Hanson, Eastern Rockies Forestry Conservation Board, Calgary, Alberta

Watershed Resources in Relationship to Municipal and Domestic Uses. Ed Johnson, Governor of Colorado

Trees versus Water and Grass. D. W. Wingfield, Rimrock, Ariz.

Game and Recreation Needs. C. R. Gutermuth, Wildlife Management Institute, Washington, D. C.

Forestry's Place in Watershed Management. Geo. W. Craddock, Intermountain Forest & Range Expt. Sta.

Ranchers' and Stockmen's Stake. Leavitt Booth, Farmers Home Administration, Denver, Colo.

The Opportunity for Watershed Development Provided Under Public Law 566, Watershed Protection and Flood Prevention Act. Carl B. Brown, Soil Conservation Service, Washington, D. C.

Impact of Mineral Investigations and Exploitations on Surface Uses. Hale C. Tognoni, Arizona State Law Commission, Phoenix, Arizona

Evening

Photographic and Kodachrome Slide Contest. Colored Movie: Range Practices in Marsh and Longleaf Pine Lands. Mark Richard, Gulf Coast Soil Conservation District, Cameron Parish, Louisiana

Thursday, January 26

Morning

How Grass Grows and the Influence of Growth Habits on Utilization Measures of Productivity

Chairman: Ben A. Madson, University of California

Elementary Morphology of Grass Growth and How It Affects Utilization. C. A. Rechenthin, Soil Conservation Service, San Angelo, Tex.

Food Reserves in Grasses and Their Effect on Seasonal Utilization. Raymond Price, Rocky Mtn. Forest & Range Expt. Sta.

How Growth Requirements of Range Plants Determine Sound Grazing Management. A. L. Hormay, California For. & Range Expt. Sta.

What the Rancher Wants to Know About Productivity of Ranges—Pounds of Forage and Pounds of Livestock Produced. Marvin Kniese, Wray, Colo.

Digestibility of Range and Pasture Forage Under Grazing Conditions. Dr. C. Wayne Cook, Utah State Agr. College

Need of a Unified System for Measuring Range Productivity. M. D. Burdick, Soil Conservation Service, Great Falls, Mont.

Evaluation of Grazing Lands Based on Animal Production. Neil C. Frischknecht, Intermtn. For. & Range Expt. Sta.

Afternoon

Field Trips. Bureau of Reclamation Laboratories at Federal Center or Safeway Distribution Center

Evening

Annual Banquet. Toastmaster, Judge Mortimer Stone, Denver, Colo.

Friday, January 27

Morning

Possibilities and Economics of Improving Range Land

Chairman: Frank C. Armer, Phoenix, Arizona

In the Pacific Northwest. Willard Bunch, Durkee, Oregon

In the Southwest. Bernie VanderWagen, Gallup, N. Mex.

In the Northern Great Plains. Francis Murphy, Colorado Cattle Growers, Spicer, Colo.

In the Southern Great Plains. G. O. Hedrick, Walnut Springs, Texas

In the Intermountain and Great Basin. Wm. S. Young, Wanship, Utah

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Grazing Capacity of Longleaf-Slash Pine Forests. Lowell K. Halls, Georgia Coastal Plain Expt. Sta., Tifton, Ga.

Management Pays on the Starkey in Eastern Oregon. Richard S. Driscoll, Pacific Northwest Forest & Range Expt. Sta.

Juniper Control in Arizona: Methods, Costs, Benefits. Joseph F. Arnold, Central States Forest Expt. Sta., Columbia, Mo.

Range Fertilization Trials. Dr. Wm. E. Martin, Univ. of California

Afternoon

Education for Range Management

Chairman: C. H. Wasser, Dean, School of Forestry & Range Management, Colorado A. & M. College.

Integration of Range Management and Animal Husbandry Training. Dr. Charles E. Poulton, Oregon State College.

College Training in Range Management. Dr. E. W. Tisdale, Univ. of Idaho.

Animal Science Training for Range Livestock Students. Dr. T. B. Keith, Univ. of Idaho.

College Training for the Range Management Student, a Prospective Employee. David F. Costello, Pacific Northwest Forest & Range Expt. Sta.

Technical Training Needs of the Livestock Producer. J. W. Southworth, Rancher, Seneca, Oregon

Grazing Effects on Forestry

The Place of Game in the Multiple Use of Southeastern Ranges. H. D. Burke, Southern Forest Exp. Sta.

Compatablity of Farm Forestry and Sheep Grazing in Willamette Valley. Fred Hall, Oregon

Management of Sheep on Fenced Pastures in Southern Oregon. John Landers, Oregon State College

Additional Student Papers (not scheduled)

Various Factors Affecting the Growth of White Sage. Gerald S. Strickler, Univ. of Nevada.

Evaluation of Large-scale Halogeton Control Measures in Nevada. R. Keith Miller, Univ. of Nevada.

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Notes Concerning the National Collegiate Plant Judging Contest

In the interest of improving the plant list used in the National Judging Contest, an analysis was made of the occurrence by state of the plants tentatively listed for the 1956 judging contest. This list is essentially the same as that used in 1954 and 1955. Distributions were recorded for the 17 states conventionally recognized as "the western states". The data, obtained from the references indicated, may not be entirely complete but are sufficiently accurate to indicate the general pattern of occurrence of the 144 contest plants in the western states.

The accompanying table shows the representation of all plants by percent in each state and a breakdown of the percent representation of the 76 grasses, 31 forbs, and 37 woody plants of the contest list.

The inequitable representation of certain state floras by the contest plants is apparent. Colorado, Arizona and New Mexico are relatively "over represented" and North Dakota, Washington, Nebraska, Kansas and Oklahoma are "under represented." Oklahoma is at the bottom of both the grass and woody plant lists, with 34 out of 76 and 7 out of 37 respectively, and second from the bottom of the forb list with 15 out of 31. Despite the obvious difficulties of equalizing the representation by states, it is desirable that a better balance be obtained. This may necessitate the use of more plants of relatively localized distribution than has been done in the past.

State	% of total plants	% of grasses	% of forbs	% of woody plants
Colorado	83	84	90	73
Arizona	78	78	77	78
New Mexico	78	78	81	75
California	64	62	61	70
Utah	63	66	55	64
Wyoming	63	67	65	51
Montana	62	63	65	56
Texas	61	63	61	57
Idaho	58	55	74	51
South Dakota	52	58	61	32
Oregon	52	55	48	49
Nevada	51	58	35	48
North Dakota	47	50	55	35
Washington	47	53	45	35
Nebraska	46	51	52	29
Kansas	44	50	52	24
Oklahoma	39	45	48	18

REFERENCES

DAVIS, R. J. 1952. Flora of Idaho.

DAYTON, W. A. *et al.* 1953. Check List of Native and Naturalized Trees of the United States (including Alaska).

FERNALD, M. L. 1950. Gray's Manual of Botany.

HARRINGTON, H. D. 1954. Manual of the Plants of Colorado.

HITCHCOCK, A. S. 1951. Manual of the Grasses of the United States (Revised ed.).

JEPSON, W. L. 1923-1925. Manual of Flowering Plants of California.

KEARNEY, T. H. AND R. H. PEEBLES. 1951. Arizona Flora.

RYDBERG, P. A. 1932. Flora of the Prairies and Plains of Central North America.

ST. JOHN, HAROLD. 1929. Flora of Southeastern Washington.

U. S. FOREST SERVICE. 1937. Range Plant Handbook.

Frank W. Gould and Donald L. Huss, Department of Range & Forestry, A. & M. College of Texas, College Station, Texas

PHOTOGRAPH CONTEST

Ninth Annual Meeting of the American Society of Range Management

Members of the Society may enter photographs in any of the following classes:

1. Black and white
   a. Range plants or types
   b. Range conditions or utilization
   c. Range improvement or management practices
   d. Range or ranch scenes
2. Color slides

All entries of black and white photographs should be 8 x 10 inches or larger, with non-glossy surface. Entries should be mounted, with borders at least three inches wide but without frames. A description, 50 words or less in length, typed on a separate sheet, should be attached to the photo mount to be visible. Also, the contestant's name and address should be attached but not visible to the voters until after competition.

Entries will be numbered and voted upon by members attending the meeting to determine the highest in each class and the grand champion.

Photographs are to be taken to and from the display booth by the contestant or someone attending the meeting whom he has designated. An individual may have a maximum of five exhibits but not more than one in each category.—Elbert H. Reid, Chairman, Displays and Contest Committee.

Ecology of Plant Distribution on the Salt-Deserts of Utah

Abstract of dissertation submitted in partial fulfillment of the requirements for the degree of Doctor of Philosophy in Range Management, Utah State Agricultural College, 1955.

During the summers of 1953 and 1954 studies were conducted on the salt-desert ranges of Utah to obtain information contributing to a better understanding of why some of the desert plants grow where they do, and what role soils play in plant distribution. Shrub types studied were sagebrush, winterfat, shadscale, Nuttall's saltbrush and greasewood. These types tend to zone out into pure stands separated from other pure stands by alternes or narrow transition zones.

The edaphic factor was considered of primary importance in the distribution of these shrub types. To determine whether changes in soil characteristics occurred concomitantly with changes in vegetation type, intensive soil studies were made in ten areas on the salt-deserts for each of the five species. To ascertain whether significant variation in the soil existed within areas occupied by pure stands, soil samples were taken from near the periphery of each area as well as in the center.

Trenches 7.5 feet deep were dug in each of the types to allow a critical study of the soil profile. Soil samples for chemical analysis were collected from each layer of the profile. To ascertain whether abrupt changes in soil characteristics occurred concomitantly with changes in vegetation type, trenches also were dug across alternes.

Soil samples were collected for extensive physical and chemical analyses during the summer of 1954 from four depths: 0 to 6, 6 to 18, 18 to 36, and 36 to 60 inches.

A significant difference between plant types was found for only five of the edaphic factors studied. Soils under the five plant types differed significantly in total soluble salt, saturation extract conductivity, exchangeable sodium, ⅓ atmosphere percentage, and soluble sodium.

Nuttall's saltbush, greasewood and shadscale were found on soils with the highest salt content with averages of 0.89, 0.83 and 0.53 percent respectively. In addition these species had the highest range in this respect. Sagebrush and winterfat were found on soils with the lowest average salt content with 0.32 and 0.36 percent respectively and also with the lowest range in this respect. As expected, the saturation extract conductivity of the soils varied in a similar manner as the total soluble salts. Soils under greasewood had the highest mean value for exchangeable sodium with 4.8 milliequivalents per 100 grams soil. Nuttall's saltbush, shadscale, sagebrush, and winterfat followed in decreasing amounts with 4.3, 3.7, 2.6 and 2.5 milliequivalents per 100 grams soil respectively. The field moisture capacity is a reflection of soil texture. Sagebrush was growing on soils with a mean ⅓ atmosphere percentage of 28.7. One-third atmosphere percentages for the other types were 28.5, 27.8, 24.4, and 23.7 for greasewood, Nuttall's saltbush, shadscale and winterfat respectively. The five types varied significantly from each other in amount of soluble sodium from 719 parts per million for sagebrush to 2,215 parts per million for Nuttall's saltbush.

All species had a relatively wide range for each of the significant soil factors. Although the means frequently differed significantly, there was a common range for all species for all soil factors studied.

Statistical analysis showed little correlation between the various soil factors and basal density of plants occupying each area. Chemical analysis of the current year growth was found to be an unreliable index to soil characteristics.

The wide tolerence range of the species studied for edaphic factors suggests the presence of ecotypic variation.—Dillard H. Gates, Range Conservationist, U. S. Southern Great Plains Station, Woodward, Oklahoma.

NEWS AND NOTES

Forestry Research Assessed

The Society of American Foresters has announced the publication of "Forestry and Related Research in North America" by FRANK H. KAUFERT and WM. H. CUMMINGS, a report of a study conducted by the Society under a grant from the Rockefeller Foundation. The study had as its objectives, "(1) reviewing the progress in forestry and related research in North America during the past quarter century, (2) determining the present status of research by all agencies, (3) assessing the adequacy of present research, and (4) formulating recommendations and goals for the next quarter century." Forestry and related research are reviewed for the United States, Canada and Mexico in the publication available through the Society office in the Mills Building in Washington, D. C. at $5.00.

Hafenrichter Named Fellow in Agronomy Society

Dr. A. L. HAFENRICHTER, who has been in the service of the U. S. Dept. of Agriculture for almost a quarter century, was recently elected a Fellow in the American Society of Agronomy at its Davis, California meeting. He has been Plant Materials Technician (Western) for the Soil Conservation Service since 1954 and is stationed at Portland. Prior to this time he was in charge of SCS nurseries in the Pacific Coast region.

HAFENRICHTER entered the Department of Agriculture in 1923 for three years of summer work after he graduated from Northwestern College. Later he earned his Ph.D. at the University of Illinois. Starting in 1926 he was a member of the faculty at Baker University and Carnegie Institution of Washington for four years and at the State College of Washington for a like period. He then entered the U. S. Department of Interior for two years work in the Soil Erosion Service before returning to the Department of Agriculture to begin his Pacific Coast work. HAFENRICHTER is the author of more than 30 publications and is a national expert on the selection and increase of introduced and adapted grasses for the improvement of ranges, pastures and meadows in the Northwest.

Blando Brome Released in California

Blando brome, an improved strain of soft chess (*Bromus mollis*) is approved for certification in California and certified seed will be on the market by the fall of 1956, announced H. W. MILLER, Plant Materials Specialist of the Soil Conservation Service Nursery at Pleasanton, California. The new brome is recommended for converting grain land to range on sites and areas unsuited to perennial grasses or where it is desirable to have a mixture of an annual grass with perennials.

Blando brome outperformed other strains tested during unfavorable years with its consistent seed and forage production, early maturity, sub-erect growth habit and strong seedling vigor. It is adapted to the winter annual range area in California.

Succession of Regional Forester Transfers in U. S. Forest Service

CLARE W. HENDEE, Regional Forester of the California Region, recently transferred to the Washington Office as Assistant Chief of the Forest Service, following the appointment of EARL W. LOVERIDGE as agricultural attaché at Bogota, Colombia. Replacing Mr. HENDEE in the California office at San Francisco is CHARLES A. CONNAUGHTON, formerly Regional Forester for the Southern Region. C. OTTO LINDH of Albuquerque, New Mexico, Regional Forester for the Southwestern Region, went to Atlanta, Georgia to replace CONNAUGHTON. The Albuquerque position as Regional Forester for the Southwestern Region has been filled by FRED H. KENNEDY of Denver, formerly chief of the Division of Range Management in the Rocky Mountain Region.

Anderson New Special Assistant to Secretary of Agriculture

JACK Z. ANDERSON of San Juan Bautista, California has been named Special Assistant to Secretary of Agriculture BENSON, succeeding WESLEY A. D'EWART who is now Assistant Secretary of the Interior. ANDERSON will serve as liaison between Congress and the U. S. Department of Agriculture, carrying the Department's viewpoints to Congress and providing the Department with Congressional viewpoints on policy and other developments in agriculture.

Herman Oliver Featured in FORTNIGHT *Story*

HERMAN OLIVER, Oregon rancher, who at 70 is perhaps his native state's best known career cattleman, is the subject of the feature story of a recent issue of FORTNIGHT magazine. The article pays tribute to Oliver's courage, civic-mindedness and humanness in his biographical sketch.

Pacific Northwest "Grassman of the Year" Honors Won by Lloyd Gift

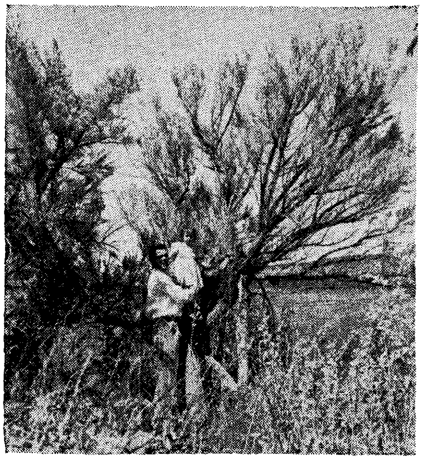
The Pacific Northwest region's most coveted farm honor, "Grassman of the Year", was awarded to LLOYD GIFT of Bonanza, Oregon by the sponsor, Portland Chamber of Commerce, November 7, 1955. GIFT, also named Oregon grassman for the year 1955, is a member of the American Society of Range Management.

This year's award was the first to be given for the improvement of an extensive acreage of low-grade range land through good grazing management, reseeding and water spreading. GIFT'S careful management has greatly increased the grazing capacity of his 6,000 acres of scab-rock range, normally requiring 40 acres to support an animal unit.

Ralph W. Snyder Named Washington "Cattleman of the Year"

RALPH W. SNYDER AND SONS, operators of the Bar U Ranch in Adams County, Washington, were awarded the coveted "Cattleman of the Year" trophy, sponsored by the Washington Cattlemen's Association at its annual convention, November 10, 1955.

Balanced, well-planned management of livestock on native range, grain, irrigated pastures and feedlot served as the basis for the honor. The elder SNYDER acts as business manager and oversees the cattle enterprises on the 10,000 acre ranch. Young BILL SNYDER and son-in-law DICK COON handle the wheat farming, irrigation, pastures and feeding on the 2,500 acres under cultivation.



Is This the Largest Sagebrush Plant?

A plant of big sagebrush *(Artemisia tridentata)*, on the Lester Little Ranch about 12 miles east of Kanab, Utah, near the Arizona boundary, growing in deep silty alluvial soil. Total height of plant, 15 feet, 7 inches; diameter of unbranched stem at one foot height, 8.9 inches. Age of an adjacent 13 foot specimen, 21 years. Is this a record?—Charles P. Pase, U. S. Forest Service, Rimrock, Arizona.

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RANGE MEN ABROAD

MARVIN KLEMME completed his assignment as Forestry and Range Management Specialist for the International Cooperation Administration Operation Mission to Greece in November, 1955. After spending several months "home leave" in Washington and Oregon, KLEMME anticipates reassignment with the technical assistance program in Africa, working out of headquarters in Monrovia, Liberia. While on the Greece assignment, KLEMME spent a one-month detail in Angola or Portuguese West Africa.

H. E. SCHWAN and MRS. SCHWAN recently returned to the United States from Baghdad, on home leave after more than two years overseas as range management specialist with the I. C. A. Mission in Iraq. He will return to Baghdad for a second tour of duty.

Prior to his assignment overseas, SCHWAN served with the U. S. Forest Service in Denver, in charge of range surveys, studies and training. In June, 1953 he accepted an assignment as range specialist with the U. S. Mission in Saudi Arabia and transferred to the Mission in Iraq in 1954. HERB has been assisting the Iraq Government in drafting legislation providing for a range management organization and for the protection and improvement of ranges and wildlife resources. A program of controlled use of wells, hay production and extensive development of irrigated pastures has been advocated.

WALTER M. NIXON has recently returned from a two-year assignment as Agronomist with the International Cooperation Administration in Turkey. NIXON has returned to work with the Soil Conservation Service as Washington Field Agronomist He is stationed at Lincoln, Nebraska and will work throughout Nebraska, North and South Dakota, Montana and Wyoming.

IN THE FIELD

HENRY M. KILPATRICK has been named Extension Range Conservationist in the Nevada Agricultural Extension Service with headquarters at Reno. KILPATRICK obtained his undergraduate training in range management at Montana State College and his M.S. degree in the Dept. of Range & Forestry at Texas A. & M. College in 1955.

HUDSON G. REYNOLDS, who has been in charge of range research for the Forest Service at Tucson, Arizona, has transferred to Tempe, Arizona as research center leader for that field unit of the Rocky Mountain Forest and Range Experiment Station.

LYNN R. MONTGOMERY transferred recently from South Dakota to New Town, North Dakota as Range Conservationist for the Bureau of Indian Affairs.

S. CLARK MARTIN of the Rocky Mountain Forest and Range Experiment Station stationed at Laramie, Wyoming, transferred to Tucson, Arizona as research center leader of the Tucson Field Unit. MARTIN, formerly in charge of range research for the Central States Forest Experiment Station in the Missouri Ozarks, transferred to Laramie in September, 1955.

Bureau of Land Management range men detailed to the Washington office for a six-week period for participation in training programs and preparation of range manuals include HOWARD DELANO, Range Manager Burns, Oregon; MAURICE MARCH, Assistant Range & Forestry Officer, Denver, Colorado; LOWELL UDY, Range Conservationist, Boise, Idaho; BEN MARKHAM, Range Conservationist, Salt Lake City, Utah; DICK ANGLE Agricultural Engineer, Albuquerque New Mexico; DONALD HUNTER, Agricultural Engineer, Utah.

WALLACE M. JOHNSON, range management research project leader at th Manitou Experimental Forest in Colorado for the past nine years, has transferred to Laramie, Wyoming, where h will be in charge of the range researcl program in Wyoming for the Rock Mountain Forest and Range Experiment Station.

WALTER O. HANSON, staff assistan on the Black Hills National Fores South Dakota, has been promoted t head wildlife activities in the Divisio of Wildlife and Range Managemen in the Pacific Northwest Region of th

Forest Service. He succeeds WILLIAM W. HUBER, who was recently transferred to Washington, D. C.

FRED H KENNEDY of Denver, Chief of the Division of Range Management in the Rocky Mountain Region of the U. S. Forest Service, has transferred to Albuquerque, New Mexico, as the new Regional Forester for the Southwest Region. KENNEDY is a veteran of 26 years' service as a range research and management specialist for the Forest Service. In the Southwest Region he will be responsible for national forest administration in an area where more than two million head of livestock graze under permit on national forest lands.

RAYMOND R. BEST, BLM State Supervisor for Wyoming with jurisdiction over activities in Kansas, Wyoming and Nebraska since 1954, has transferred to Sacramento, California to succeed LUTHER T. HOFFMAN as BLM State Supervisor for California. LOWELL M. PUCKETT, who has been Regional and Area Administrator for Alaska in BLM Area 4 since 1947, will succeed BEST as State Supervisor for the Wyoming State Office.

LUTHER T. HOFFMAN, BLM, was transferred to Washington, D. C. as Supervisor of the Eastern States Office which embraces Federal land activities in 34 Eastern states. HOFFMAN has been California State Supervisor since 1954.

BASIL K. CRANE, Supervisor of the Grand Mesa-Uncompahgre National Forest, Colorado, has been named Assistant Regional Forester in charge of the Division of Range and Wildlife Management of the Rocky Mountain Region of the Forest Service, succeeding FRED H. KENNEDY.

JESSE M. HONEYWELL was made Area 4 Administrator for BLM in the Territory of Alaska. He has served as Washington State Supervisor since 1954. The range program in Alaska has been strengthened by the transfer of R. E. (GENE) WUNDERLICH to Anchorage where he is in charge of the Bureau's Alaska range management work.

JOHN M. FENLEY, County Agricultural Agent at Las Vegas, Nevada, has accepted a fellowship from the Ford Foundation for a year of graduate study in Extension Education at Cornell University. FENLEY is one of a group of 15 agents thus honored, 8 from the United States and 7 from foreign countries.

FENLEY'S address for the coming year will be 105 De Witt Place, Ithaca, New York.

In Memoriam

Dr. ROBERT M. SALTER, Chief of the Soil and Water Conservation Branch of the Agricultural Research Service, died September 13, 1955 at the age of 63.

In 1941 Dr. SALTER entered the U. S. Department of Agriculture after a career in research, teaching and administration in several of the state colleges and experiment stations. He became Chief of the Soil Conservation Service in 1951 after having been head of the Bureau of Plant Industry, Soils and Agricultural Engineering. In 1953 he transferred for health reasons to the position held at his death.

In his earlier career Dr. SALTER served as professor of soils at Ohio State University, later heading the agronomic research for the Ohio Agricultural Experiment Station. He was chairman of the University agronomy department in 1929 and before joining the U. S. Department of Agriculture served for a year as director of the North Carolina Agricultural Experiment Station.

Dr. SALTER had been a member of the American Society of Range Management since 1949.

Range School Roundup

DWIGHT KIMSEY and KENDALL JOHNSON, graduates in June, 1955 from the University of Wyoming, are currently engaged in graduate work at the University of Idaho.

FRANCIS M. CHURCHILL of the Department of Agriculture, Abilene Christian College at Abilene, Texas, received his Ph.D. in Range Management from the University of Wyoming this past summer.

Prof. DUWAYNE GOODWIN, formerly with the Range Department at the University of Nevada, joined the staff at Utah State Agricultural College, October, 1955 to teach Range Forage Plants and Watershed Management.

GRANT HARRIS has become fulltime Extension Range and Forest Specialist at Utah State Agricultural College. HARRIS organized a Conservation Camp this past summer for boys between the ages of 15 and 19, in cooperation with the Utah Section. Fifty boys attended the camp in Logan Canyon and received technical training in Range Management and other land utilization problems.

ARTHUR SMITH has become a fulltime research man at Utah State Agricultural College working on problems pertaining to range livestock and big game competition in cooperation with the Utah State Fish and Game Department.

FRANK RAUCHFUSS, M.S. in Range Management from Wyoming in June, 1955, is currently doing research on halogeton problems for the University of Wyoming.

Dr. LOREN D. POTTER, of the Department of Botany at North Dakota Agricultural College, is on a year's leave of absence to conduct vegetational studies in the San Augustine Plain of New Mexico under a grant from the National Science Foundation.

Prof. F. A. BRANSON of the Range Management Department at Montana State College has completed an extended trip through the West and Southwest to study range types and to develop the collection of range plants at the college.

WILLIAM LAYCOCK, M.S. from Wyoming, is doing graduate work toward a Ph.D. in plant ecology at Rutgers University.

ZENE BOHRER, graduate in range management at Wyoming, is working on a graduate problem at the Squaw Butte-Harney Experimental Range in Burns, Oregon.