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Scientific names for plants mentioned in this special report are listed on pages 45 and 46.

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ECONOMICS OF SPARYING SAGEBRUSH

E. Schmisseur and R. F. Miller

Various subspecies of big sagebrush have been successfully controlled throughout its range with different forms of 2,4-dichlorophenoxy acetic acid. Although response of vegetation after spraying is documented, evaluation of costs-benefits is scarce. Anticipated forage responses and the economics of spraying sagebrush on native and seeded high desert and foothill ranges of eastern Oregon are briefly reviewed here. In addition, some of the important factors affecting the economics of sagebrush spraying are identified and discussed. Forage responses were obtained from a survey of spray research applicable to eastern Oregon rangelands.

FACTORS INFLUENCING ECONOMICS OF SPRAYING

Although temperature and precipitation play a major role in influencing the forage response after sagebrush control, understory present before spraying, effectiveness of the spray treatment, and follow-up management strongly influence the economics of spraying. Each of these factors is discussed here.

Prior Understory

Increased production from sagebrush control comes, in part, from new plants, but the major increase in productivity generally is from an increase in vigor and size of existing vegetation. Thus, it is critical that an adequate population of desirable forage species be present on a site before treatment. Therefore, the forage species can reoccupy the area after the removal of undesirable species. If desirable forage species persist at a low level in the understory, these species will account for only a small amount of the increased production. Increases in understory productivity on sites in poor condition frequently are due to such species as cheatgrass. As a rule of thumb, 165 pounds of desirable forage per acre generally is believed necessary to attain a successful release of these species. Another rule of thumb is that there be at least one desirable bunchgrass to every 10 square feet for spraying of native range to be practical. This rule may not be valid, however, when competitive nondesirable species that are not affected by the herbicide such as Sandberg bluegrass are present.

Effectiveness of Spray Treatment

It is important to achieve a good sagebrush kill as forage response is clearly related to the effectiveness of the spray treatment. Research indicates that surviving sagebrush suppress grass production most proportionately. In one research trial, typical of most others, an average yield response of 135, 308, and 692 pounds per acre was associated with a 50, 75, and 100 percent sagebrush kill, respectively.

Effectiveness of the spray treatment also influences the effective life of the treatment as surviving sagebrush are a seed source of reinvading sagebrush. On the Oregon high desert, sagebrush reestablishment after an initial kill of about 95 percent was held in check the first 10 years after treatment. Other spray research has shown a 15-year expected treatment life. On the other hand, sites with a 20 to 40 percent sagebrush survival required a second spraying seven to eight years later.

Follow-up Management

Some researchers have tried to evaluate the impact of grazing on the life of the treatment with variable results. As long as proper management is implemented to maintain a vigorous understory, grazing should have little effect on rates of sagebrush return. Deferment of grazing after spraying appears to have no clear-cut effect on sagebrush reestablishment. Overgrazing, however, promotes sagebrush reestablishment. Overgrazed range relinquishes both soil moisture and sunlight to sagebrush seeds. Greater sunlight intensity results in higher soil temperature and a more suitable microclimate for sagebrush establishment.

RESPONSES AND ECONOMICS

The primary objective of spraying sagebrush is increased forage production at competitive costs. Anticipated forage responses and the economics of spraying sagebrush on native and seeded high desert and foothill ranges are identified here.

High Desert Range

On native range of the Oregon high desert, annual increases in forage production have been reported to vary from about 60 to 700 pounds per acre. An average forage response, however, is about 282 pounds per acre per year during the first five post treatment years and 266 pounds thereafter until at least the 15th post treatment year. At this response level, with forage valued at $6.67 per AUM discounted at 15 percent interest, forage responses could justify a maximum spraying cost of about $16 per acre and still earn a 15 percent return on investment.

Yield responses on crested wheatgrass range have been reported to range up to 1,435 pounds per acre. An average forage response of about 321 pounds per acre through the 15th post treatment year generally is more typical. At this response level, responses could justify a maximum spraying cost of about $19.00 per acre.

Foothill Range

On native foothill range, forage responses have varied from 90 to 560 pounds per acre. An average response is typically about 275 pounds per acre. This response, with an effective spray treatment, could last through the 15th post-treatment year. At this response level, with forage valued at $6.67 per AUM discounted at 15 percent interest, increased production could justify a maximum spraying cost of about $16 per acre and still earn a 15 percent return on investment.

On crested wheatgrass foothill range, yield increases attributed to spraying averaged about 531 pounds per acre. This response should last through the 15th post-treatment year with an effective spray treatment. Given this response, a maximum spraying cost of about $31 per acre is justified.

SEASONAL FLAMMABILITY OF BIG SAGEBRUSH AND WESTERN JUNIPER FOLIAGE

P. Hefner, R. G. Clark, and C. M. Britton

Fuel moisture changes and the resultant effect on relative flammability of sagebrush and western juniper foliage represent important parameters in predicting success of prescribed burns. Little is known about big sagebrush and juniper foliage moisture and their seasonal patterns. For most species, early spring represents a low foliage moisture content which increases as the growing season progresses. This is followed by decreasing foliage moisture during the dry period which persists until late summer or until fall precipitation.

This study was initiated to determine the seasonal change in foliage flammability indices. Associated foliage moisture and soil moisture contents also were studied to document seasonal patterns and their relation to flammability.

METHODS AND PROCEDURES

This study was initiated in the spring of 1978 and conducted at the Squaw Butte Range located 40 miles west of Burns, Oregon while the 1979 data were collected from plots five miles north of Hines, Oregon. Foliage samples, soil moisture samples, and ignition times were collected bimonthly from April 1 to October 1 of 1978 and 1979.

Ten individual plants of juniper and big sagebrush were marked and samples of the terminal four inches of branches were removed for evaluations. Subsamples were weighed, oven dried, and weighed to determine moisture content.

Flammability testing consisted of duplicate subsamples being burned in a propane burner at a given height above the flame. Subsamples were timed to determine the length of preheating required for ignition. At time of sample collection, soil samples were taken in the surface 10 inches for gravimetric determination of moisture content. All data were averaged over the two study years.

RESULTS AND DISCUSSION

Actual foliage moisture content of both species varied over the study period but followed the same basic curve (Figure 1). Juniper moisture content ranged from a low of 63 percent to a high of 98 percent. The lows occurred early in the spring and again late in the fall. This curve indicated that even lower moistures might occur during winter. Big sagebrush followed the same pattern with low moisture contents in spring and fall with a peak in early summer. This range in moisture content was considerably greater than juniper, 50 percent for a low and 155 percent for a high. This indicated the optimum burning period to be late summer to early fall, for both species, with a possibility for early spring burning.

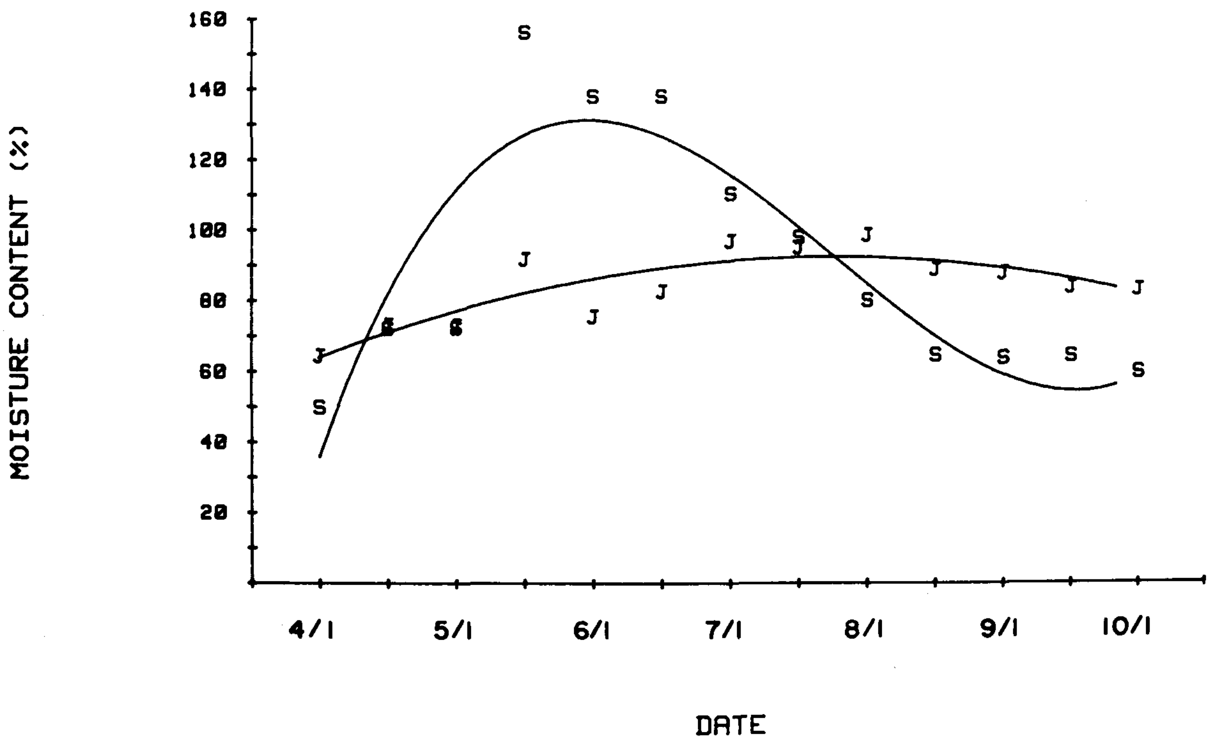

Figure 1. Changes in percent foliage moisture content of big sagebrush (S) and western juniper (J) averaged over 1978 and 1979.

Ignition index for juniper and big sagebrush foliage exhibited seasonal variations (Figure 2). Big sagebrush ignition time was high at 40 to 50 seconds from early May to mid-June and decreased rapidly to less than 20 seconds from early July to October. Short ignition times also were measured in early April. A similar pattern of change was seen in sagebrush foliage moisture content and a good degree of correlation (r=0.66) was apparent.

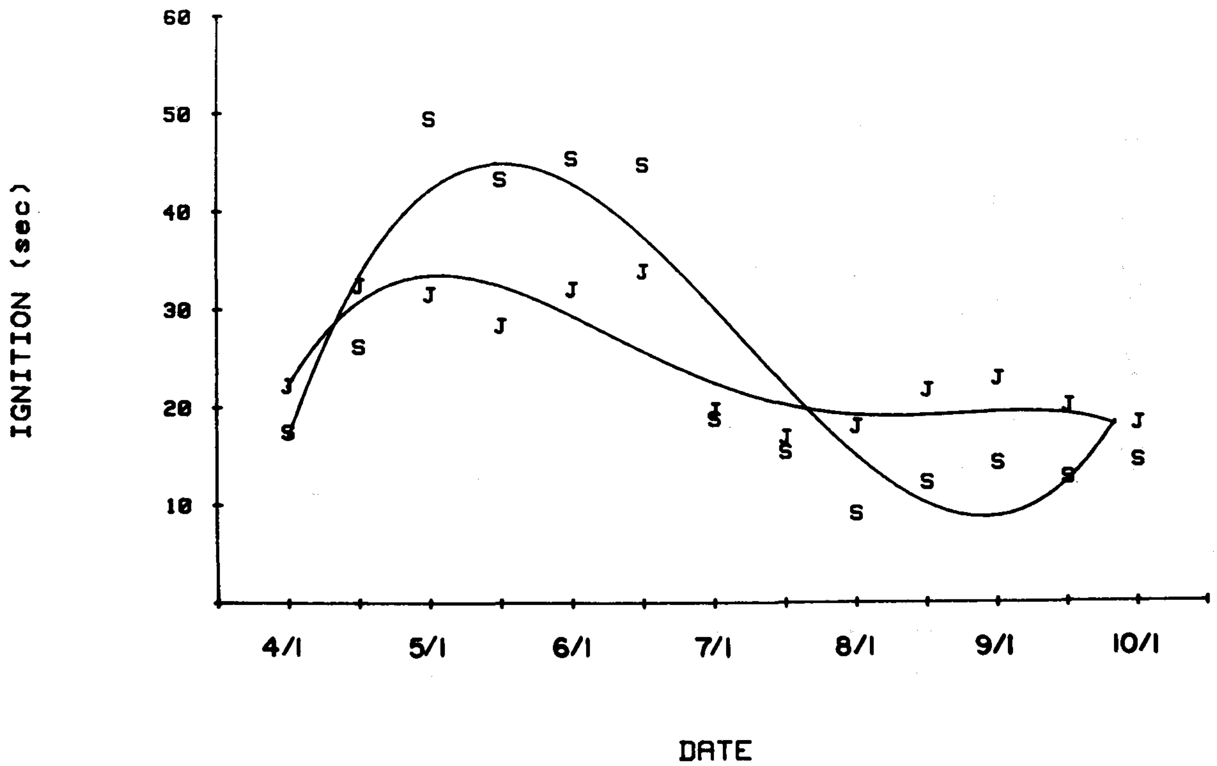

Figure 2. Foliage ignition indices as measured in seconds for big sagebrush (S) and western juniper (J) averaged over 1978 and 1979.

The change in ignition index for juniper was smaller than for big sagebrush, although the pattern was similar. This smaller degree of change also was apparent in the foliage moisture content. Air temperature was an important factor in juniper ignition. As air temperature increased the ignition time decreased which was reflected in a correlation coefficient of r=-0.72. This impact of air temperature was not reflected in big sagebrush ignition.

Soil moisture content is the driving force of foliage moisture content. This is only true during the growing season. Soil moisture was high in early April (Figure 3), but the plants had not started active growth and their moisture contents were low. By mid-May, foliage moisture was high which accounted, in part, for the decreasing soil moisture. This relationship was most apparent for big sagebrush. Through the summer dry period, soil moisture continued to decrease until precipitation in mid-August.

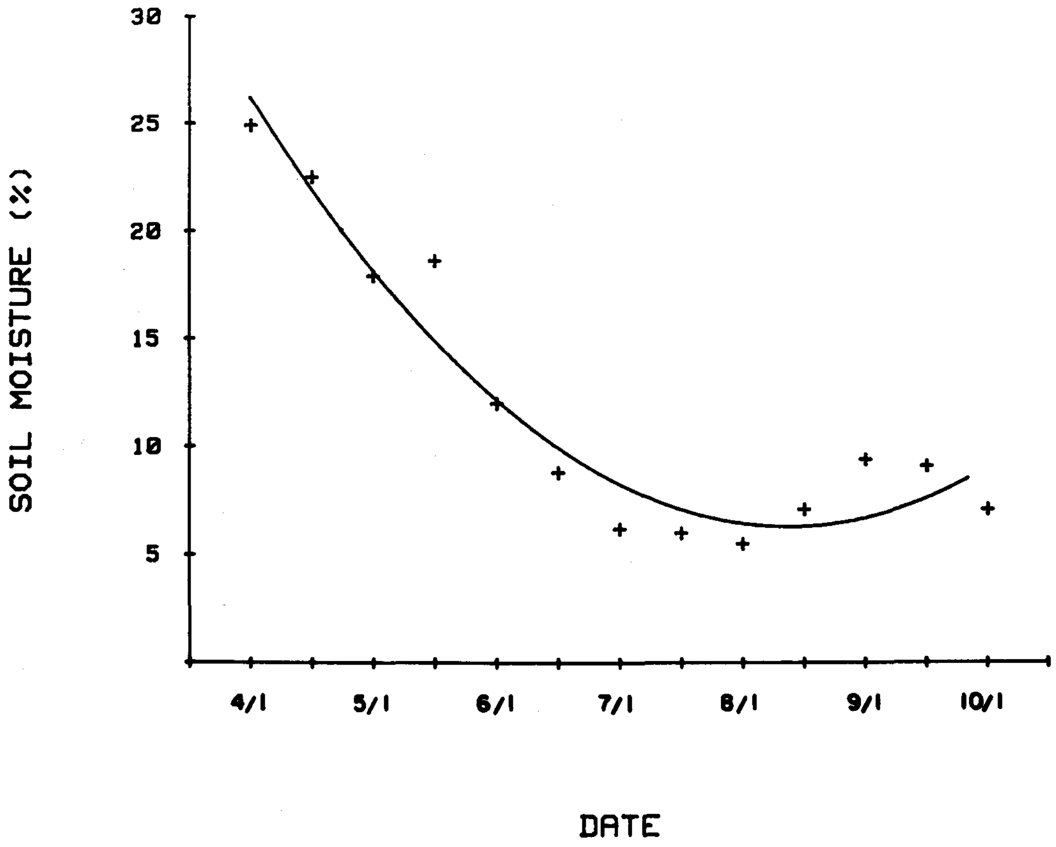

Figure 3. Percent soil moisture of the surface 10 inches averaged over 1978 and 1979.

Results of this investigation indicate that highest ignition probabilities and the possibility of conducting prescribed burns begin in early-July and continue into October. Even though soil moisture is high in April, ignition times indicate a short of time is suitable for conducting prescribed burns.

BURNING, HAYING, GRAZING, AND NON-USE OF FLOOD MEADOW VEGETATION

C. M. Britton, J. E. Cornely, and F. A. Sneva

Flood meadow vegetation responds rapidly to land use practices. These responses are most easily observed in changes in yield and structure of this production. Management of flood meadow vegetation at the Malheur National Wildlife Refuge is critical to the long term objective of maintaining quality waterfowl habitat.

The objectives of this study were to evaluate the vegetative response to burning, and grazing plots which had been in non-use for three years and contrasting the response to haying and non-use of native flood meadows. Evaluations were made to determine herbage yield, crude protein, and structural attributes of the vegetation.

EXPERIMENTAL PROCEDURES

The study area was located on the Malheur National Wildlife Refuge, about 30 miles south of Burns, Oregon. A portion of a field with a history of being hayed was divided. One half continued to be hayed while the other was placed in non-use for a period covering three growing seasons. In fall of 1978, the non-use area was separated into plots which were burned, grazed, and left in non-use. Burning was done in early November. The burned and non-use plots were fenced, then yearling cattle grazed the hay aftermath and plot which had not been used for three years.

Herbage yield was estimated by clipping 15 quadrats on each area. After weighing, crude protein concentration was determined. Structure of the vegetation was measured using a modified Robel pole technique. Structural attributes measured included average height of vegetation and height at which the vegetation totally obstructed the pole. Twenty measurements were made in each plot. All measurements were made at peak standing crop which occurred during mid-July.

RESULTS AND DISCUSSION

Predictably, non-use resulted in the lowest herbage yield as compared to the other treatments (Figure 1). Herbage yield for the non-use plot was about 4,850 pounds per acre, or about 1,000 pounds per acre more than had been measured for the previous two years. It appeared that the low production of the previous two-year period resulted in a reduction in ground litter accumulation thus enabling a small increase in yield.

Grazing and haying resulted in about the same yield at 6,330 and 6,500 pounds per acre, respectively. The area grazed had about 7,000 pounds per acre of litter and current years production. Grazing which removed about 60 percent of this material, and physically altered the arrangement of the remaining vegetation produced the increased yield.

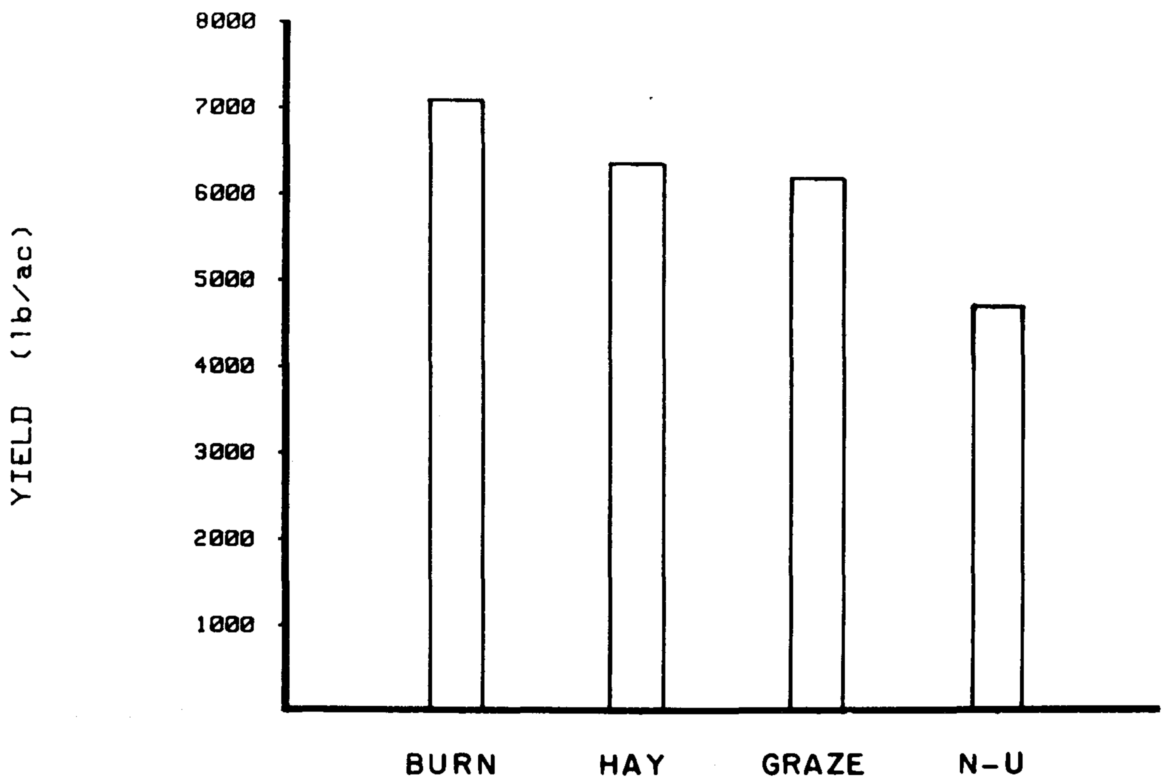

Figure 1. Average yield of herbage as measured one growing season after burn, hay, graze, and non-use (N-U) treatments.

The burned plot produced the most herbage with a yield of 7,230 pounds per acre. This result was surprising because some plant mortality was expected from burning. Although some mortality did occur, the plants that remained were larger and more productive.

The structure of the vegetation also was altered by the treatments (Figure 2). Burning produced the greatest maximum height at 49 inches but the lowest 100 percent obstruction height at 26 inches. This was probably because of the higher proportion of grass which resulted from burning. Grazing resulted in the highest 100 percent obstruction height with 33 inches. Non-use produced the lowest maximum height and 100 percent obstruction height at 40 and 26 inches, respectively. Haying resulted in intermediate values.

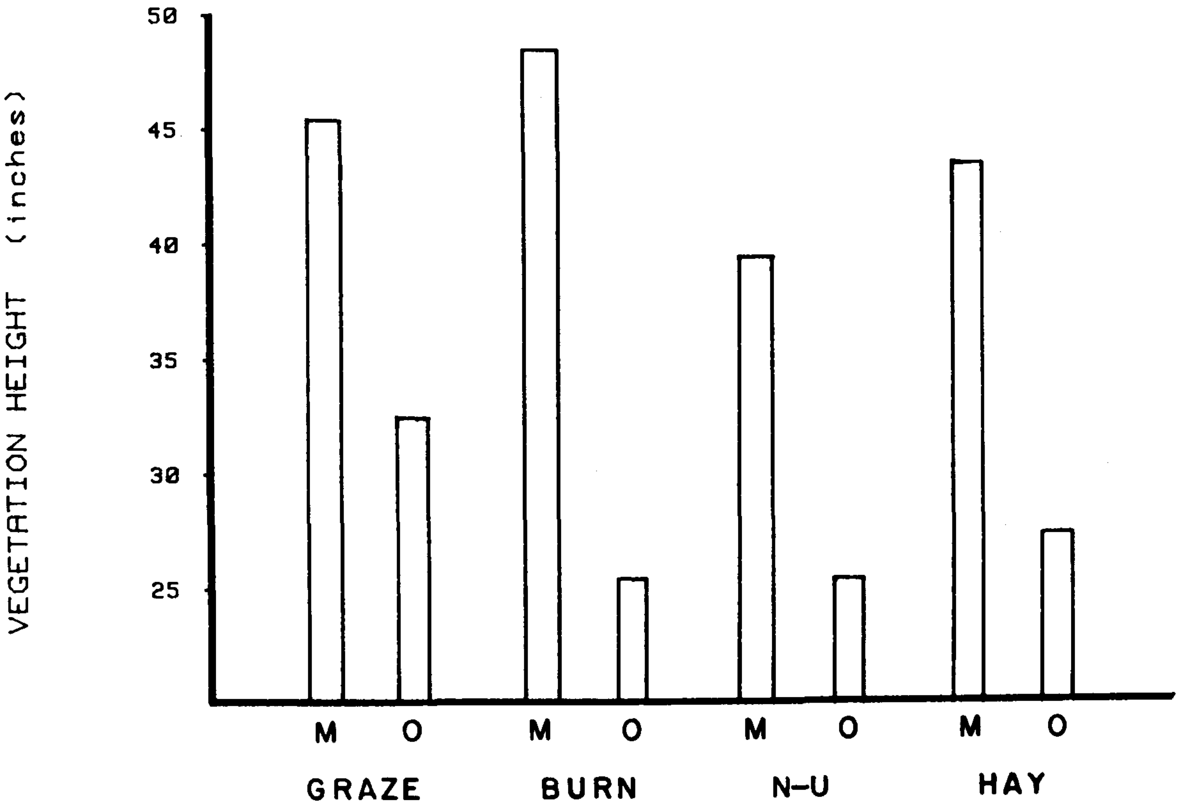

Figure 2. Average maximum vegetation height (M) and height of 100 percent obstruction (O) measured one growing season after treatments.

Crude protein determinations were made on the herbage harvested at peak stand crop. Only small differences were found, with the lowest average from the burned plot at 6.04 percent. Herbage from the hayed and non-use plots was similar at 6.33 and 6.42 percent, respectively. The highest crude protein was measured from the grazed plot at 6.82 percent. Crude protein concentration from the burned plot was lowest, probably because this area started growing about two weeks earlier than the others. Therefore, the plants were advanced in development when harvested.

Based on this study, burning provides the greatest maximum height and yield of vegetation after three years of non-use. Burning did not produce highest 100 percent obstruction height, a desirable waterfowl habitat characteristic. Evaluating all vegetative characteristics measured showed grazing produced the most desirable overall response assuming that the 100 percent obstruction height is a critical parameter.

FORTY YEARS - INSIDE AND OUT

F. A. Sneva, L. R. Rittenhouse, and P. T. Tueller

In the mid-1930s with the drought intensifying poor forage conditions on the eastern Oregon rangelands, the Squaw Butte Experiment Station came into existence. In 1936-37, 13, 5-acre cattle exclosures were constructed inside the larger pasture units that partitioned the 16,000 acre big sagebrush-bunchgrass summer range unit. A cattle management program was initiated at that time. The object was to show how, through management, the rangelands of eastern Oregon could be improved. By the late 1940s, those involved with the program at the station recognized that neither management nor total protection (for the exclosures had not yet become a waving field of grass) was a viable way to improve the sagebrush range.

In the subsequent decade, the manipulation of these sagebrush rangelands either by plowing and seeding or by brush control with 2,4-D resulted in significant increases in production on the treated areas and brought substantial relief in grazing pressures on unimproved ranges. In that same decade the vegetation inside the exclosures did not alter greatly. With more than 20 years of complete protection, there had been no significant reduction in sagebrush nor substantial increase in grass composition.

By the mid-1970s, the areas improved through seeding and brush control in the 1950s were again being overrun by sagebrush despite management efforts to provide optimum competition against brush return. Unimproved sagebrush ranges under grazing continued to produce no better or no worse than in the 1950s. In the exclosures, as much sagebrush was inside as was outside. And the grasses inside the exclosures, except for the presence of old forage, differed little from that growing outside the exclosures which had been subjected to grazing in nearly every year since 1936.

Why, after 40 years of protection from grazing has not greater improvement inside the exclosures occurred? Why, with 40 years of grazing have not unimproved ranges deteriorated? Why, with what we believe to be optimum management practice, does sagebrush increase on improved areas? The data from permanent plots inside and outside the exclosures and measured in 1937, 1960, and 1974, the history of grazing use prior to 1936 and after the station was built, and our increased ecological knowledge of the vegetation and its responses help us to understand why change has not been more dramatic.

Figure 1 shows the mean frequency of occurrence for big sagebrush and grass for 1937, 1960, and 1974. Between 1937 and 1960, there was an increase in perennial grass frequency but it increased alike inside and outside the exclosures. Change in sagebrush frequency was small during this period and also did not differ greatly from inside to outside. We believe the increase in grass frequency was the result of 1) improving climatic condition, 2) a change of land use from a sheep lambing area to a spring-summer-fall cattle operation, and 3) a considerable reduction in grazing pressure. The combination of the last two probably provided so great a relief to the vegetational system that response to that relief was as great as no grazing at all. The upper limit to which the grass could respond was limited by the sagebrush community and because it had not been influenced by protection nor by grazing a common constraint was in effect both inside and outside the exclosures. There is evidence from other studies at Squaw Butte that the upper limit of response (as measured in 1960) may have and probably did occur in the early 1950s.

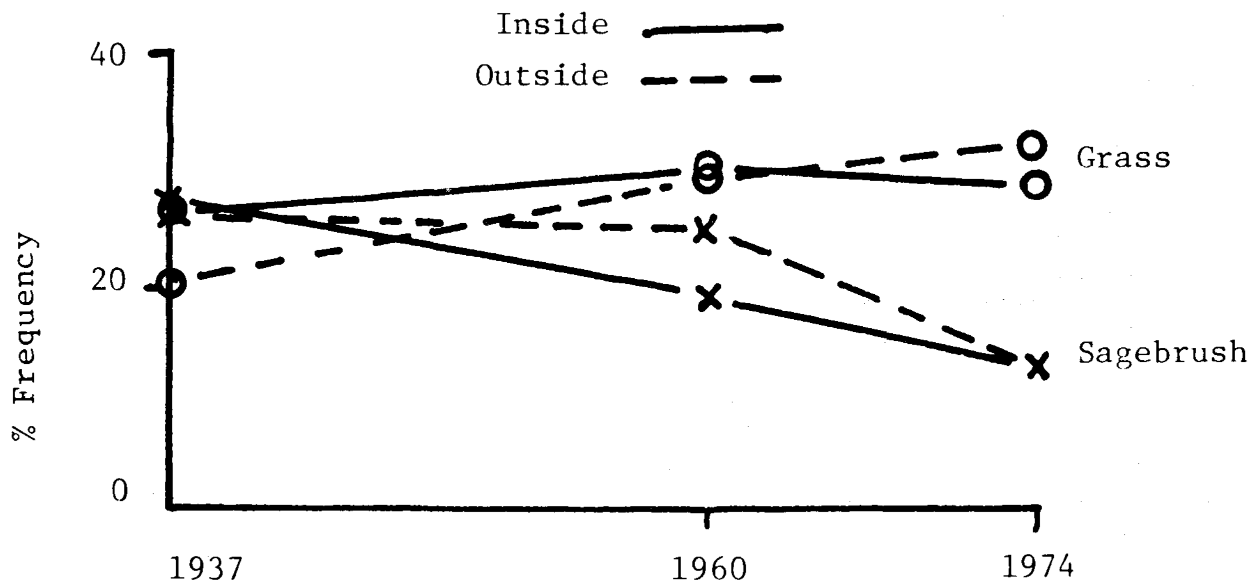

Figure 1. Mean frequency of grass and of sagebrush for nine exclosures at Squaw Butte in the big sagebrush habitat.

Sagebrush declined between 1960 and 1974, both inside and outside the exclosures but somewhat more sharply in the grazed areas. Declines of sagebrush in this period are believed to have resulted from the sagebrush defoliator moth that was prevelant throughout the Great Basin from 1962 to 1965. Total grazing use during this period was nearly double that of the 1937 to 1960 years yet because of increased production remained near 50 percent utilization, and grass response remained quite stable both inside and outside the exclosures. The increased animal use during this period came primarily from the crested wheatgrass seedings, the brush controlled areas, and the management of the total area to provide optimum use of unimproved ranges.

Strong grass increases, despite a reduction in sagebrush frequency during this latter period, did not occur. It is inferred that this sagebrush community is a mature, stagnated stand and totally dominates. Partial reduction of the population numbers may not have resulted in a similar reduction in competition; thus, the common constraint for further grass increase still remained both inside and outside the exclosures. Grass frequency in grazed areas, despite an increase in animal use during this period, was not altered. This suggests that the grazing pressure exerted in those years was not strongly interacting between the grass and sagebrush competition battle in the natural brush ranges.

The exclosures at Squaw Butte and the vegetation response to grazing outside those exclosures and to total protection inside the exclosures for nearly 40 years lead us to believe that:

1) Man's activity on the sagebrush ranges through grazing of domestic animals reduced the grass component, increased the brush species and thereby reduced the opportunity for wild fires and through his direct efforts of preventing, containing, and extinguishing wild fires has produced an over-mature, stagnated sagebrush community that totally dominates the brush-grass system,

2) This stagnated system is relatively unresponsive to management by grazing alone as the grazing impacts essentially on the grass species - the upper limit of grass improvement is dictated by the sagebrush community and that limit is low when compared with the land's potential for grass when a significant portion of the brush is removed,

3) Protection alone or grazing management alone ultimately may bring about a slightly more favorable sagebrush-grass composition but the indications are that such will not occur in our lifetime, nor in the lifetime of our sons and daughters,

4) Man's action in the early history of the sagebrush range caused a degradation of the range from whatever condition then existed (and we are not all in accord as to what that condition actually was),

5) Man's actions today and tomorrow can move the present sagebrush-grass conditions towards that which existed more rapidly than can nature if he is allowed to do so.

FORAGE QUALITY OF CEREAL AFTERMATH

R. F. Miller and C. Mee

The purpose of this study was to evaluate nutritive variability of cereal residues used for forage and determine some of the important parameters affecting nutrient quality. Despite its widespread use, little research has been conducted on factors affecting cereal residue forage quality. Various researchers have reported considerable variability in straw quality. Additionally, many Northwest farmers have observed increased residue use by livestock on the harsher sites. Also, although grazing animals are quite selective in plant materials they consume, only limited work has been done to analyze nutrient quality in the various components of cereal residues.

The objectives of this study were to: (1) determine the percent crude protein and digestibility of leaves, culms, and chaff of bearded soft white winter wheat, club wheat, and barley; (2) determine stubble yield and proportion of leaves to culms of these three cereal types; and (3) determine the effect of site potential (based on grain production), and season on nutrient. quality and yield of culms, leaves, and chaff.

STUDY AREA AND PROCEDURES

The study area was in Sherman County in north central Oregon. Annual precipitation occurs from October to March and averages 10 inches. The more productive cereal-producing sites are on Walla Walla silt loams averaging 47 inches or more in depth. The lower potential grain-producing sites generally are found on Condon silt loam ranging from 30 to 47 inches in depth. The tall bearded wheats are grown on the more productive areas while the club wheats are grown on less productive sites. Since precipitation is limited, cereal growers use the summer fallow system. Wheat production varies throughout the county from 16 bushels on the shallow soils to 60 bushels on the deeper soils.

Cereal stubble is used by livestock (primarily dry pregnant cows) from October or November until February or March. Cattle stay on the stubble from one to four months depending on availability and cost of other feed, calving, and other factors. Cattle usually are given a liquid protein supplement while grazing stubble, though alfalfa or other protein sources sometimes are used.

The study was conducted from August 1977 to March 1979. The three cereals studied -- tall bearded wheat, club wheat, and barley -- were sampled three times each year corresponding to the beginning, middle, and end of the stubble grazing season. For each cereal, a high and low production site was sampled. After sampling, all materials were separated into leaves, culms and chaff. Percent crude protein and *in vitro* dry matter digestibility were measured to evaluate forage quality.

Site potential and date effects on percent crude protein and *in vitro* dry matter digestibility for each plant part of each variety for each year were examined with a 2-way analysis of variance. A split-plot design was used with site potential nested within dates.

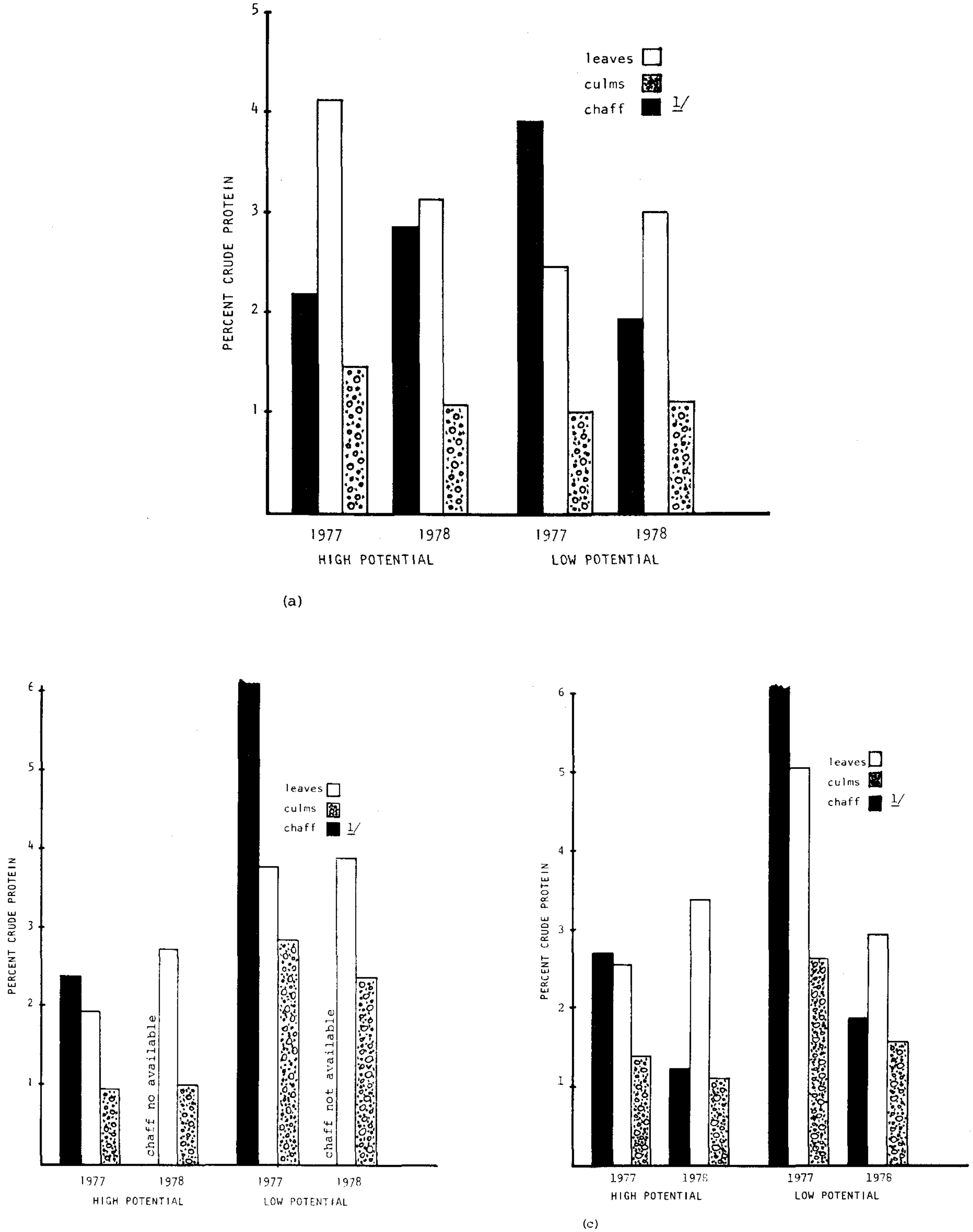

Figure 1. Percent crude protein in leaves, culms, and chaff on high and low producing sites in 1977 and 1978 for; (a) white winter wheat, (b) club wheat, and (c) barley.

1/ Crude protein in chaff is for first sampling date only.

RESULTS AND DISCUSSION

Levels of crude protein were influenced by site potential and fertilization (Figure 1 a, b, and c). When fertilizer treatments were held constant for both high and low potential sites, crude protein levels in all three cereal types were significantly higher on the low potential sites. However, in the case of barley in 1978 and white wheat in 1977 and 1978 where only the high potential sites were fertilized, this relationship did not hold true. Application of nitrogen fertilizers to the higher producing sites increased crude protein concentrations in residues to comparable levels to the low potential sites. The only exception was the crude protein content in white wheat leaves in 1977 which was significantly greater on the high potential site. The same pattern of crude protein content as affected by site potential and fertilization was found for chaff.

Crude protein levels were consistently higher in leaves and chaff as compared to culms in all three cereal types on high and low potential sites. Averaging across site and season, crude protein levels ranged from 1.2 to 2.1 percent in culms, 3.0 to 4.1 percent in leaves, and 2.0 to 4.6 percent in chaff. Before fall rains, crude protein content in the leaves of club wheat and barley on the low potential sites ranged as high as 8 and 9 percent, respectively.

The role of season as it related to crude protein content in cereal residues was important in affecting leaf availability and when crude protein levels occurred in various components of the aftermath. After the first rains, a large portion of the leaf biomass was altered from standing crop residue to litter. Also, crude protein levels exceeding 6 percent (chaff and leaves of club wheat and barley on the low potential sites) decreased rapidly with the onset of winter weather conditions. Season had little effect on crude protein levels (ranging from 1.0 to 3.8 percent) in the remaining residue materials.

Digestibility averaged across sites and season ranged from 20 to 30 percent for the three cereal types. These values are comparable to other values reported in the literature which vary from 23 percent to 48 percent. As in this study, low digestibility values were reported with only one day of digestion (*in vitro* technique). Higher values are reported with 2, 3, and in some cases up to 6 days of digestion. The values reported in this paper probably are somewhat conservative since passage of cereal residue takes approximately two days.

The parameters measured did not appear to have any significant effects on the percent digestibility of cereal residue. The greatest difference occurred between years. However, values of digestibility varied little between cereal types, site potential, season, and plant parts.

Another important consideration relating to forage quality of cereal residues is leaf/culm ratios. Yields of standing cereal stubble on high production sites averaged 625 pounds per acre more than on low producing sites. However, a smaller proportion of this was leaves. Leaf/culm ratios were consistently higher on low producing sites. Leaf production made up from 15 to 29 percent and 26 to 36 percent of the total stubble production on high and low producing sites, respectively.

Crude protein content was found to be significantly related to site potential and fertilization practices. Cereal aftermath on low producing sites will contain higher levels of crude protein unless nitrogen fertilizer is applied to the high producing sites. Although less stubble is produced on the low sites, a higher proportion of leaf material is available for animal use. Leaf and chaff were consistently higher in crude protein than culms. Digestibility was not affected by any of the parameters measured.

SEDIMENT POTENTIALS AND HIGH INTENSITY STORMS ON RANGELANDS

J. C. Buckhouse and J. L. Mattison

A number of rangeland ecosystems are found distributed across eastern Oregon and the Great Basin states of the western United States. In this paper we intend to use central Oregon's Bear Creek Watershed as an example of the kinds of sediment production one might expect under a number of these ecosystems.

DESCRIPTION OF THE AREA

The Bear Creek Watershed, in central Oregon 40 miles east of Bend, covers approximately 131,000 acres in the southwestern corner of Crook County. Bear Creek is a tributary of the Upper Crooked River drainage, with runoff storage in the Prineville Reservoir. The area has a semiarid climate with most precipitation occurring during winter and spring. High intensity summer convectional storms also occur. The mean annual precipitation is approximately 10 inches.

The vegetation types are dominated by various combinations of western juniper, big sagebrush and the bunchgrasses, Idaho fescue, bluebunch wheatgrass, and Sandberg bluegrass. A mixed forest managed for ponderosa pine is found in the higher elevations. Bare ground often comprises more than 40 percent of the ground cover in the nonforested areas. Sheet, rill, and gully erosion are extensive in several locations and streambank erosion occurs along nearly 75 percent of Bear Creek's main channel.

The soils in this watershed reflect a volcanic origin, either basalt or associated proclastic materials. Marine sedimentary clays from the Clarno and John Day formations occur scattered throughout the area.

The majority of the watershed is in public ownership, with the Forest Service managing the mixed forest in the eastern sector and the Bureau of

Land Management administering the juniper shrublands in the middle and western sectors. Private ownership is scattered but occurs predominately in the southeastern portion and in the bottomlands along Bear Creek and its tributaries.

The Bureau of Land Management has classified the Bear Creek Watershed as one of the most critical areas in the Prineville District because of the high percentage of bare ground cover and the sediment loads it contributes to the Prineville Reservoir.

METHODS

The macroplot design was used for vegetation sampling and incorporated four transects with 10 microplots per transect for frequency sampling. Shrub density and intercept cover and tree cover also were measured within the macroplot and the cover components within the sediment plots were estimated. Soils were generally described and then verified by BLM soil scientist, Darwin Jeppesen.

Sediment production was obtained, using a Rocky Mountain Infiltrometer to simulate a high intensity rainstorm (4 inches per hour) and collecting the rainfall and runoff. From the runoff containing the sediment, a sample was taken to represent an average amount of material per unit of runoff. The sediment plots were located systematically around the perimeter of the macroplot, with six replications of three observations used to describe a vegetation-soil unit. In forest and bare ground areas where observation plot was essentially the same in ground cover, only three replications were used. The vegetation-soil units that are similar in potential vegetation and soil comprise the Ecologic Land Unit.

During the summers of 1975 and 1976, we applied these high intensity 28-minute storms to 468 different sediment plots. These plots were located with seven ecological land unit classifications and were further refined into 10 tentative habitat types based on an association table developed from vegetation and soils field data.

RESULTS AND DISCUSSION

Table 1 shows the relationships between the ecological land units and their associated sediment potentials. It also demonstrates how a clearer picture can be obtained by following the ecological classification to a finer resolution.

It is apparent that the highest erosion is occurring in areas associated with western juniper. This seems to be particularly true in those instances where western juniper is invading into steppe areas. This may be related to one or more of several phenomena operating in juniper systems. It may be partially because of the nature of juniper's growth habit, with extensive lateral roots occuping a rather large land area surrounding the tree and therefore lower competition from other plants; and/or it may be because of an overgrazing and/or fire suppression history which has encouraged juniper invasion and discouraged other species.

Table 1. Mean sediment potentials for selected ecological land units and habitat types within the Bear Creek Watershed

Ecological land unit habitat type	Sediment production (pounds per acre)
MIXED FOREST	169
Douglas-fir/pinegrass h.t.	42
Ponderosa pine/Idaho fescue h.t.	295
LOW SAGEBRUSH	660
Low sagebrush/Idaho fescue-bluebunch wheatgrass h.t.	660
SANDY SHRUBLAND	700
Big sagebrush/needle-and-thread h.t.	700
ADOBELAND	700
Bluebunch wheatgrass-Sandberg bluegrass h.t.	700
BIG SAGEBRUSH	1,282
Big sagebrush/Idaho fescue-bluebunch wheatgrass h.t. without western juniper	815
Big sagebrush/Idaho fescue-bluebunch wheatgrass h.t. with invading western juniper	1,749
JUNIPER WOODLAND	1,459
Western juniper/big sagebrush/Idaho fescue-bluebunch wheatgrass h.t.	2,598
Western juniper/big sagebrush/Idaho fescue-bluebunch wheatgrass h.t. Thurber needlegrass phase	367
Western juniper/Thurber needlegrass h.t.	1,372
MIXED STEPPE	2,052
Western juniper/mountain big sagebrush/Idaho fescue h.t.	3,679
Mountain big sagebrush/Idaho fescue h.t.	425

CONCLUSIONS

Mean sediment potentials produced on ecological land units ranged from 169 pounds per acre in the mixed forest to 2,052 pounds per acre on the mixed steppe. Potential for soil loss in relation to intense rainfall was highly variable among habitat types, with means ranging from 42 to 3,679 pounds per acre. Our results indicate that with increasing ecological interpretation, including habitat type and range condition, a more reliable index of soil erodability can be developed.

REMOTE SENSING INVENTORY OF ELK HABITAT IN THE BLUE MOUNTAINS

D. A. Leckenby and D. L. Isaacson

An inventory of forest and grassland vegetation types that provide elk cover and forage was developed with remotely sensed data from the Blue Mountains. Elk habitat was measured by mapping cover and forage extent in two locations: 1) a northern area of 125,000 acres along the south fork of the Walla Walla River and around Jubilee Lake; 2) a southern area of 264,000 acres around Bridge Creek Flats and along the north fork of the John Day River. Fall herds occupying the management units containing the north and south study areas are estimated at 3,650 and 6,220 adult elk, respectively.

Forest and grasslands within both study areas are representative of elk-habitat classes found throughout the Blue Mountains. Mixed conifer is the most abundant tree-dominated resource class throughout these areas. Spruce-fir is of secondary extent in the north, lodgepole pine in the south. Bluebunch wheatgrass is the prevalent grass-forb resource class of elk winter ranges, but created grass-forb classes are prominent in logged areas of summer ranges. Elk use these and other resource classes primarily for either cover or forage depending on their extent, intermixture, and structure (tree height and canopy closures are structural qualities).

METHODS

The inventory first involved documenting actual use by elk of various habitats. Elk were tagged with radios, followed, and their activity was observed to record specific use of all habitats throughout the year. Temperature, wind, and other specific environmental conditions within the habitats were noted during use. Elk behavior was analyzed with habitat structure, plant composition, and weather conditions. Observed patterns of habitat use were compared with relationship published by Thomas *et al.* (1979)[1].

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[1]Thomas, J. E., ed. 1979. Wildlife Habitats in Managed Forests - The Blue Mountains of Oregon and Washington. USDA Forest Agriculture Handbook No. 553.

The inventory of cover and forage areas was performed using remote sensing information from a LANDSAT satellite and from aerial photography. First, the satellite data were anlayzed to identify different spectral classes of reflected solar energy over the whole of both study areas. Each data element, approximately 1.1 acres in size, was sorted and assigned to one of 60 classes to construct an areawide spectral class map. Second, resource classes were identified on large-scale, 1:6000, color-infrared aerial photographs which covered 5000 ± acre sample of each area. Third, spectral classes were compared with resource classes over the same ground areas to determine association of spectral classes with resource classes. Fourth, several spectral classes were combined into elk-habitat classes on the basis of similarity of stand height, canopy closure, and number of vegetation layers. General habitat maps were then constructed from the processed satellite data.

In summary, spectral classes determined from LANDSAT data were associated with resource classes recognized from aerial photographs and then were condensed into habitat classes that elk were observed to use, for either forage or cover (Table 1). Maps and acreage tables of spectral, resource, and habitat classes for both study areas were saved on computer files. Data from small areas can now be retrieved for detailed study and data from larger portions could be regrouped and manipulated for further evaluation.

VERIFICATION OF RESULTS

Ground identification of resource and habitat classes which occur in the Blue Mountains has been compared with the computer-determined spectral classes. Overall, the habitat map is realistic and the detail in specific, well-known areas is more than adequate. Based on experience with other land cover inventories, 75 percent of the area on computer-derived maps accurately represent actual land cover.

Further evaluations are designed to estimate accuracy levels. About 500 descriptions of habitat structure and composition obtained from stands where elk were observed are to be compared with spectral classes in each area. These comparisons of areas occupied by elk with the same areas on the satellite maps provide quantitative assessment of accuracy and error so the land manager can evaluate the impacts of various degrees of error in the context of specific resource-management decisions.

HABITAT MANAGEMENT APPLICATIONS

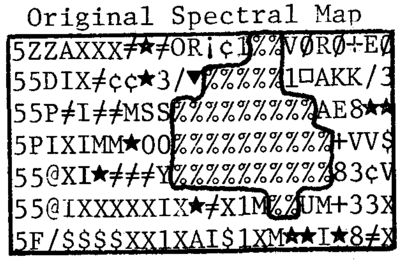
The elk-habitat, resource, and spectral maps based on LANDSAT data can be displayed and manipulated for input into the land-management decision-making process. This habitat information can be used for monitoring habitat status and change because it is a numerical record tied to geographic coordinates and it is stored on and accessible from a computer. The research data have been extended to mapping of elk habitats in the Heppner wildlife management unit. Oregon Department of Fish and Wildlife and U.S. Forest Service managers are using the research information in land-use planning dialogues. The habitat maps and acreage tables can become a monitoring basis for maintenance of elk herds through planned manipulations of cover-forage areas and ratios. The measurement of elk habitat distribution and cover-forage area ratios over time provides managers and planners with heretofore unavailable data. Such data are necessary for informed management decisions that will allow Oregonians to have productive elk habitat as well as time and forage resources.

Table 1. Spectral and cover classes for Walla Walla elk range

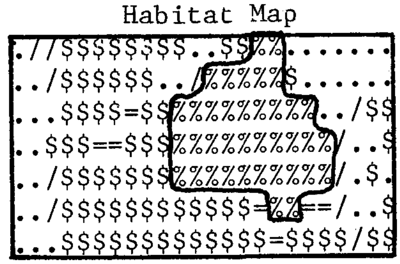
Original spectral classes	Habitat type	Cover map symbol
A B C E F K L P R U V W Ø 5 6 7 ¡ □ ▼ √ 3 /	Forage	•
D G H N T Z 2 4 8 9 * # @ + =	Forage-Hiding	/
I O Q S X Y $ ≠ ¢ ★ ¥ 1	Thermal	$
J M	Thermal-Hiding	=
%	Water, misc.	%

Example map*

Original Spectral Map



Habitat Map



*outlined area is Langdon Lake in northeastern Umatilla County

SHEEP AND DEER GRAZING ON LODGEPOLE PINE PLANTATIONS

A. H. Winward and David P. Rudeen

The pumice region of central Oregon covers a little more than two million acres, most of it covered by ponderosa pine or lodgepole pine. Most of this area is administered by the U.S. Forest Service. Livestock grazing has been carried on intermittently since the late 1800s. Differences of opinion between professional foresters and graziers as well as occasional browsing damage to pine seedlings have resulted in livestock grazing being maintained at a level below its optimal potential.

This study was designed to quantify tree damage by sheep and deer as influenced by season of grazing and forage conditions. Sampling areas were in Klamath County, Oregon, at the eastern edge of the Chemult District of the Winema National Forest. All study plots were established on the lodgepole pine/bitterbrush/western needlegrass habitat type since it comprises such a large percentage of the pumice region.

EXPERIMENTAL PROCEDURES

Four forage classes were established in order to evaluate the effect of associated forage on tree browsing.

High Shrub - High Herbaceous (HS-HH) ---- (>1400 shrubs/ac >67 lb/ac)
High Shrub - Low Herbaceous (HS-LH) ---- (>1400 shrubs/ac, <67 lb/ac)
Low Shrub - High Herbaceous (LS-HH) ---- (<1400 shrubs/ac, >67 lb/ac)
Low Shrub - Low Herbaceous (LS-LH) ---- (<1400 shrubs/ac, <67 lb/ac)

Two sites for each forage class were sampled in two geographic areas (Bootleg and Jack Creek) for a total of four sites per forage class or 16 sites total. Ten transects, each 100 feet long, were randomly located in each site for a total of 80 transects per area or 160 total. Shrub density and herbaceous production were measured solely to categorize sites into forage classes. Density was measured at the beginning of each field season and herbaceous production was measured not more than three days before sheep grazing.

One hundred lodgepole pine seedlings were selected and tagged in each forage class for a total of 400 trees per geographic area. Criteria for selection were two-fold. First, trees had to be the nearest healthy seedling to each 20-foot point along each transect. Second, the seedlings had to be three feet or less in height.

Each seedling was checked the day before sheep were to graze through the area. This was done to establish some degree of certainty that any new browsing which might occur the next day was indeeed attributable to sheep and not to deer from some previous time. The day after sheep grazed through a sampling area, each seedling was checked again. Any evidence of new browsing was then attributed to sheep.

The sheep band consisted of 2,250 ewes and lambs. The herder was instructed to graze the sheep through the plantations in the same manner as he would a forested area of comparable size.

RESULTS AND DISCUSSION

Only two of the 800 tagged seedlings were browsed by sheep during the 1975 trials and 38 seedlings during the 1976 trials (Table 1). No seedlings were browsed by sheep after July 19 either year.

Table 1. Number of lodgepole pine seedlings browsed by sheep during the combined 1975 and 1976 grazing seasons

June 30	July 19	July 29	August 10	August 28	September 16
38	2	0	0	0	0

Sheep normally did not browse seedlings in areas of high shrub density (Table 2) but did in areas of low shrub density. In areas of low shrub density, seedling browsing was reduced by high herbaceous production.

Table 2. Number of pine seedlings browsed by sheep by forage class

	Forage Class			
	HS-HH	HS-LH	LS-HH	LS-LH
1975	0	0	2	0
1976	3	0	9	26

Deer browsed an average of 13.7 percent of the seedlings each year from 1973 through 1976.[1] (Table 3).

There was some indication that progressively more tree browsing by deer occurred as total forage decreased (Table 4).

Sheep did not show a preference for planted versus naturally regenerating seedlings. Deer, however, exhibited a marked preference for planted seedlings.

[1]The Chemult Ranger District had data available on deer browsing for 1973 and 1974. These data have been included with data from this study.

Table 3. Total number and percent of seedlings browsed by deer between 1973 and 1976.

	Seedlings browsed	Percent
1973	35	4.4
1974	280	35.0
1975	59	7.4
1976	65	8.1
	Mean/year	13.7

Table 4. Total number of lodgepole pine seedlings browsed by deer by forage class, 1973-1976

	Forage Class			
	HS-HH	HS-LH	LS-HH	LS-LH
Seedlings browsed	92	102	104	141

Management recommendations based on results of this study include:

(1) Allow sheep to graze lodgepole pine plantation in the Oregon Pumice Region after mid-July.

(2) Implement logging techniques which will reduce damage to the shrub component of the vegetation, primarily bitterbrush.

(3) Reduce the intensity of slash removal after logging, again to reduce damage to bitterbrush.

ROTATIONAL GRAZING FOR FARM FLOCKS

S. H. Sharrow and J. R. Warner

The production and efficient utilization of forage are important components of many farm flock operations. Much information on how to increase forage production has been accumulated over the last 50 years, but about how to increase forage production, much less information is available concerning how to most efficiently convert this forage into saleable animal products. Unfortunately, the conversion of forage into animal products is a complex process involving numerous plant as well as animal factors. Through grazing management, we attempt to reconcile the needs of the pasture with those of the grazing animal in such a way that we optimize the productivity of both. Over the years, many grazing management systems have been proposed. One of these, rotational grazing, has proven useful as an alternative to continuous grazing in Australia, New Zealand, Ireland, and Rhodesia, as well as in the United States.

In rotational grazing, animals are periodically moved from one paddock to the next during the grazing season. An individual paddock is grazed several times during the season with a period of non-use between grazing periods. The resulting pattern of pasture utilization is designed to reduce animal selectivity by forcing the animals to consume most of the forage produced in a paddock before they are moved to a fresh paddock. Rotational grazing has been credited with increasing pasture production, increasing livestock productivity, and maintaining high condition of native range.

Livestock performance under rotational grazing, however, is only superior to continuous grazing where stocking rates are moderate to heavy. When feed is plentiful, an animal's genetic potential limits its productivity. Thus, pasture management and forage production have little impact on individual animal performance. Under moderate to heavy stocking rates, however, forage availability tends to limit animal production, and grazing management becomes important.

A study was initiated in 1978 to compare continuous grazing (CG) with two types of rotational grazing systems, 1) rotational grazing (RG) and 2) rotational forward grazing (RFG). Although this study was conducted in western Oregon, the basic reactions of the pastures and the animals to rotational grazing systems are believed to apply to meadows in eastern Oregon as well. This belief is on upon considerable experience both in the United States and overseas, indicating that the principles of rotational grazing are applicable to a wide range of pasture types and grazing animals.

EXPERIMENTAL PROCEDURE

Nine, 2-acre improved pastures in the foothills of the coastal mountain range, approximately two miles northwest of Corvallis, Oregon, were divided into three blocks of three pastures each based on their estimated forage productivity. Species composition of the pasture in 1978 was 30 percent annual grasses, and 9 percent other forbs. All pastures were grazed from the spring through summer (approximately March through August) each year. The stocking rate in 1978 was four ewes and their lambs per acre. In 1979, mortality of pasture plants, especially clover, during an exceptionally cold winter lowered the total forage production. Therefore, the 1979 stocking rate was lowered to two ewes and their lambs per acre in keeping with the lower amount of forage available.

One pasture in each block was assigned to each of three grazing management systems. Under continuous grazing, sheep had season-long access to their entire pasture. Each rotational pasture (RG and RFG) was subdivided into four paddocks. Animals were sequentially moved from one paddock to the next every five days. This resulted in intensive grazing of RG paddocks for five days followed by a 15-day non-use period before the paddock was grazed again. Rotational forward grazing (RFG) was practiced by weaning the lambs at 10 to 12 weeks of age and placing them one paddock ahead of the ewes in the rotational pattern.

RESULTS AND DISCUSSION

Forage production in 1978 for the continuously grazed pastures was 5,502 pounds per acre compared to 6,020 pounds per acre for rotationally grazed pastures (average of RG and RFG). However, 1979 forage production was much lower, 2,857 and 3,375 pounds per acre for the continuously grazed and the rotationally grazed pastures, respectively. In both years, rotational grazing increased forage production by approximately 517 pounds per acre over that achieved under continuous grazing.

Sheep liveweight data for 1978 and 1979 are shown in Table 1. Although no dramatic differences in peak liveweights of ewes or lambs were evident in 1978, there was a tendency for RFG ewes to benefit from the early weaning of their lambs. As the grazing season progressed in 1979, however, RFG ewes in Blocks 1 and 3 (the low forage-producing blocks) performed consistently better than the CG ewes. Peak ewe liveweights in these pastures were 13 percent greater under RFG than under CG systems. Similarily, as the grazing season progressed in 1979, the RG lambs performed consistently better than CG lambs in Blocks 1 and 3. Peak lamb liveweights in these pastures were 25 percent under RG than under CG systems. However, no consistent benefit was noted for RFG lambs over either CG or RG lambs.

The above observations indicate that when forage production is high relative to forage demand by livestock, as occurred in all pastures during 1978 and in Block 2 pastures in 1979, grazing management systems have little impact upon individual animal performance. In this experiment, ample forage was available regardless of the management system and the observed increase in forage production under rotational grazing systems was largely unused by the sheep. However, when forage production does not exceed demand, such as occurred in Block 1 and 3 pastures in 1979, grazing management can be used effectively to influence animal performance. In these pastures, there was a marked improvement in the liveweight gains of the RFG ewes together with both the RG ewes and the RG lambs over their CG contemporaries. The average 517 pounds per acre increase in forage available in the rotationally grazed pastures (RG and RFG) undoubtedly benefited these ewes and their lambs. Cessation of the nutritional demands of lactation by early weaning of their lambs was a further advantage for the RFG ewes. However, the RFG lambs did not fare as well as the RG lambs, perhaps because of the social stress involved in early weaning. It is possible that with a longer, green feed period than was available on this study site, or with earlier lambing, the RFG lambs may show compensatory gains which would allow them to equal or outperform their RG counterparts. Another management alternative which has not been examined in this study is to wean lambs early and then move them to another pasture of exceptional quality such as alfalfa or irrigated pasture.

Table 1. Peak ewe and lamb liveweights (pounds) under Continuous Grazing (CG), Rotational Grazing (RG), and Rotational Forward Grazing (RFG)

	Grazing Management System					
	CG		RR		RFG	
	Ewe	Lamb	Ewe	Lamb	Ewe	Lamb
1978						
Block 1	133.6	76.6	134.7	77.0	136.5	75.9
Block 2	143.3	77.4	140.2	77.6	152.4	77.8
Block 3	135.2	71.4	134.9	75.6	134.5	70.6
1979						
Block 1	125.5	54.9	142.4	67.7	142.9	53.1
Block 2	137.8	60.6	130.1	57.1	136.9	55.1
Block 3	113.1	45.4	123.5	57.6	128.1	58.2

THE EFFECT OF GRAZING ON SURVIVAL AND GROWTH OF TREES PLANTED IN A NORTHEAST OREGON CLEARCUT

W. P. Wheeler, W. C. Krueger and M. Vavra

Large areas of forest land are grazed or have potential for grazing throughout eastern Oregon, the Inland Empire, and much of the montane western United States. Rarely has there been an attempt to fully integrate production of timber and red meat on these lands. Depending on background and philosophy of owners or managers, too frequently there has been a tendency to either advocate exclusion from or allow uncontrolled entry of grazing animals to these lands. Demands for both food and fiber are increasing and will continue to increase in the future. To meet this demand, coordination of resource production and use is essential.

The objective of this study was to determine the feasibility of interim grazing of forested land from immediate post-logging to tree canopy closure and the effect of such grazing on survival and growth of forest regeneration from planted coniferous tree stock.

EXPERIMENTAL PROCEDURE

A 30-acre tract of mixed coniferous forest (predominately grand fir - mountain lover habitat) on the Hall Ranch of the Eastern Oregon Agricultural Research Center was clearcut in the summer of 1963 and broadcast burned in the summer of 1964. Residual cull logs were oriented perpendicular to the prevailing slope. Within this tract, three 5-acre pastures were fenced to exclude cattle. In addition, one of the three pastures was fenced to exclude big game.

In the fall of 1964, all three pastures were seeded to grass utilizing a split-plot design (seeded vs. unseeded) on a random basis. Each plot was 0.5 acre and oriented perpendicular to the slope. Forage species were seeded on the lower half of each treatment at a rate of six pounds per acre with a mixture including orchardgrass, tall oatgrass, timothy, smooth brome, and white clover. The upper half of each plot designated for seeding was further divided longitudinally into two equal subplots, one seeded to blue wildrye and the other to mountain brome at the rate of eight pounds per acre.

In the spring of 1965, coniferous seedlings (2-0 and 3-0 stock) from the U.S. Forest Service Nursery in Coeur d'Alene, Idaho, were planted in each pasture on a random block basis at the rate of 1,000 trees per acre. (Figure 1). Species planted were: ponderosa pine, Douglas-fir, western larch, and western white pine. Spacing was six feet within rows with rows oriented across the slope and seven feet apart.

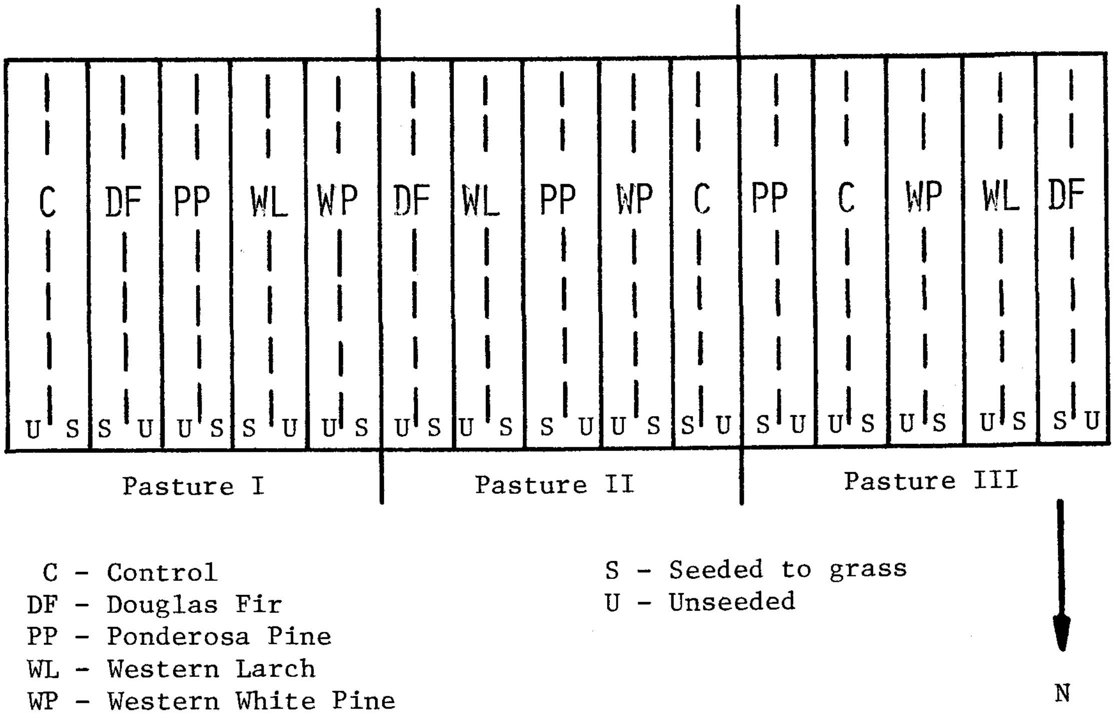


Figure 1. Field design of tree plantations on the Hall Ranch of the Eastern Oregon Agricultural Research Center.

Cattle grazing was initiated in July 1966 with the introduction of five yearling heifers annually in each pasture until 1972 when cattle grazing in Pasture III was discontinued. Grazing was continued in Pastures I and II on an annual basis until 1977. Therefore, grazing treatments were, Pasture I grazed by cattle, Pasture II grazed by cattle and game, and Pasture III grazed only by game. Cattle dispersion was affected by development of the water source at the ridge top and placement of salt blocks at the base of the slope. Cattle entry into ~~cattle into~~ the pastures was timed with the phenology of forage and tree species - - varying from June 15 to July 15 each year. Cattle remained on pasture for approximately one month.

Records of survival and height growth of planted coniferous seedlings were tallied twice annually - prior to and at the conclusion of grazing - - from 1966 through 1977. In addition, evidence of seedling damage and probable causes of mortality were recorded from the time of planting (1965) to 1978.

RESULTS AND DISCUSSION

Data on survival and height growth by pastures of the four coniferous tree species planted on the 1963 clearcut of the Hall Ranch are given in Table 1. As indicated, survival of all four species in Pasture I, which was fenced to exclude big game, is significantly lower than in the other two pastures. Shrub species including: redstem ceanothus, snowbrush ceanothus, mallow ninebark, birchleaf spirea, and common snowberry were abundant in Pasture I, producing a vigorous and almost impassable brushy stand to the detriment of the planted conifers and movement of cattle. There is little doubt that this condition contributed significantly to tree mortality. Many planted conifers were suppressed and died in the early years of the study.

Table 1. Average survival (percent) and height growth (feet) of planted trees on three grazed pastures of the Hall Ranch

	Cattle (Pasture I)		Cattle & Game (Pasture II)		Game (Pasture III)	
Species	Survival	Height	Survival	Height	Survival	Height
Douglas-fir	34	8.84	47*	10.14**	44	9.00
Ponderosa pine	36	7.67	41	9.49**	55**	8.74
Western larch	12	14.69	19	14.37	20**	11.31
Western white pine	12	7.44**	32**	6.76	26	5.20

*significant at the 1.0% level **significant at the 0.5% level

Of the four tree species planted, Douglas-fir and ponderosa pine responded most favorably in all three pastures. Western white pine is not indigenous to the study area and is not found occurring naturally in the surrounding area. Western larch, although part of the overstory plant community adjacent to the study area, did not respond well. Failure of this species most likely was because of poor seedling stock and/or the fact that western larch nursery stock traditionally is spindly and of low caliber compared to the other planted tree species. It is thus quite susceptible to loss from trampling and competing vegetation, particularly brush species.

Rodent activity was most pronounced in Pasture I where improved habitat for gophers and porcupine prevailed. Mortality and/or poor growth rate of ponderosa pine can be attriuted in part to depredations by porcupines in Pasture I.

Mortality of planted conifers traditionally is most pronounced during the first three to four years after planting. Data from the Hall Ranch study show little exception to this pattern. Most losses were caused by drought and rodent activity. Trampling of trees by livestock, where it could be positively identified as such, accounted for eight percent of total seedling mortality and was of no significance after the fourth year of the study. Browsing and uprooting of seedlings by big game and rodent activity accounted for 18 percent of the mortality in Pastures II and III. Although there was some damage and subsequent loss in growth increment from horn rubbing in Pastures II and III, this was minimal. Drought was responsible for more than 50 percent of total seedling mortality occurring on all three pastures.

Of particular interest is the fact that there was no significant difference in survival or height by tree species between plots which had been seeded to grass and those which were left unseeded in any of the three pastures. Apparently, grazing by the cattle reduced transpirational surface of forage plants to the point where moisture stress was relatively uniform between seeded and unseeded plots.

Tree seedlings are rarely planted at the initial density used in this study. The fact that they were was because of the anticipation of losses greater than those which actually occurred. Planting density usually ranges from 325 to 450 trees per acre with an acceptable mortality of 20 to 25 percent. Survival rates of the two major species in this study (Douglas-fir and ponderosa pine) are wholly acceptable. In addition, growth increment compares favorably with that of natural regeneration of the same species outside the exclosures.

Results of this study and our experiences indicate that survival and growth of planted indigenous timber species and grazing can be compatible if the following conditions are met.

1) Entry and removal of cattle must be accomplished at the proper time (i.e. proper attention paid to the phenological stage of both forage and tree species and no more than 80 percent of the forage species utilized).

2) Provision must be made for dispersal of grazing animals through fencing or riding, and location of water and salt.

3) Preferred forage species should be available in reasonable abundance. If not present, the plantation site should be burned and seeded to adapted bunchgrasses the fall preceding spring planting of tree seedling stock. Tree planting should not be delayed beyond this time.

4) Competition from brush species must be reduced through the use of selective herbicides or big game animals should not be excluded from the plantation.

PLANT SUCCESSION AS INFLUENCED BY HABITAT TYPE, GRAZING MANAGEMENT, AND RESEEDING ON A NORTHEAST OREGON CLEARCUT

W. C. Krueger, M. Vavra, and W. P. Wheeler

This study is a part of a larger research effort outlined in the previous report by Wheeler, Krueger, and Vavra. To evaluate specific vegetation responses to management activities, a detailed study of vegetation in the clearcut is being conducted. This report describes the plant community development with respect to habitat type (site), grazing and reseeding 14 years after initial harvest.

EXPERIMENTAL PROCEDURE

Each of the 5-acre pastures was sampled according to specific treatments applied or to existing habitat type differences. The upper slope within each pasture is a Douglas-fir/ninebark habitat type and the lower slope is a grand fir/mountain lover habitat type. These sites correspond closely with the ponderosa pine-Douglas-fir/ninebark and white fir/twinflower-forb community types identified by Dr. Frederick Hall in the nearby Blue Mountains.

Seeding of forage in alternate plots as well as cattle and big game grazing followed the design in the previous paper by Wheeler, Krueger, and Vavra. The grand fir/mountain lover habitat type was seeded with the forage mixture and the Douglas-fir/ninebark habitat type was seeded to blue wildrye and to mountain brome.

Distribution of plants within each of the three pastures on the clearcut was determined in July 1977 through sampling for presence of all plant species in a series of 2-square-foot quadrats. Each replication of each treatment was sampled with two transects of 10 quadrats for a total of 150 quadrats examined. Treatments were: two habitat types, three grazing treatments, and four seeding treatments. Differences in frequency of all plant species in each treatment were determined using a factorial analysis of variance and means were separated with Tukey's w-procedure. All differences referred to in this report are significant at $P<.05$.

RESULTS AND DISCUSSION

During the 1977 sampling, 100 plant species were encountered. Of these, 43 species were present with high enough frequency to permit statistical analysis. Evaluation of plant community change was based on reaction of these 43 species to the various treatments (Table 1).

Table 1. Average percent frequency of 43 plant species according to treatment

SPECIES	Average Percent Frequency: Cattle Grazing	Big game Grazing	Dual Grazing	Seeded	Unseeded	Grand fir h.t.	Douglas fir h.t.
GRAMINOIDS							
Tall oatgrass (S)[1/]	53	56	58	71	53	—[2/]	—
Smooth brome (S)	11	14	4	35	3	—	—
Mountain brome (S)	9	14	18	20	12	—	—
Cheatgrass	3	t[3/]	2	t	3	2	2
Northwest sedge	19	29	32	25	29	30	24
Elk sedge	26	66	47	42	53	44	48
Ross sedge	t	9	7	2	6	6	5
Pinegrass	6	14	17	13	11	5	17
Orchardgrass (S)	28	22	24	82	10	—	—
Blue wildrye (S)	33	31	44	73	27	—	—
Small fescue	4	2	3	3	3	2	3
Western fescue	16	23	32	21	28	24	23
Hairy common woodrush	0	7	4	4	4	5	3
Timothy (S)	30	11	20	47	14	—	--
Kentucky bluegrass	38	61	35	38	55	37	49
Tall trisetum	3	8	5	3	8	4	6
FORBS							
Western yarrow	41	50	55	50	45	44	52
Bigflower agoseris	2	2	4	3	2	t	4
Rose pussytoes	2	6	5	4	5	5	7
Heartleaf arnica	26	15	31	25	23	16	31
Broadleaf arnica	2	1	5	2	3	4	2
Canada milkvetch	29	38	26	29	35	49	19
Canada thistle	4	8	2	5	5	5	4
Bull thistle	4	6	2	5	3	3	5
Wood strawberry	36	73	82	60	69	73	57
Blueleaf strawberry	44	86	84	68	77	84	63
Northern bedstraw	3	2	3	3	3	1	4
Peavine	t	3	12	6	4	1	8
Northwest cinquefoil	1	t	2	1	1	2	t
Sheep sorrel	2	3	2	3	2	3	2
Chickweed	1	4	5	4	1	3	3
Western meadowrue	2	1	4	3	2	1	3
White clover (S)	1	4	16	7	7	—	--
SHRUBS & TREES							
Redstem ceanothus	27	6	3	12	12	4	17
Snowbrush	37	12	11	21	18	11	26
Oceanspray	8	1	7	5	6	1	8
Western larch	1	1	2	1	1	1	1
Ninebark	35	13	11	19	20	9	27
Ponderosa pine	2	3	6	4	3	5	4
Douglas-fir	1	2	2	2	1	1	2
Baldhip rose	3	4	3	3	4	3	4
Birchleaf spirea	18	11	7	12	12	6	16
Snowberry	20	9	12	14	13	8	17

1/ (S) - Species seeded in clearcut

2/ Comparison not valid because of confounding with seeding treatment

3/ t = less than 1%

Eight species did not react differentially to habitat type, seeding of forage species, or grazing treatment. These were small fescue, rose pussytoes, broadleaf arnica, bull thistle, sheep sorrel, western larch, Douglas-fir, and baldhip rose. All these plants were minor species throughout the various plant communities on the clearcut and the lack of measured response may be as much a function of the small sample size as their possible independence to the treatments.

In Pasture I, no big game grazing was allowed; cattle and big game grazed in Pasture II. This resulted in a general dominance of shrubs throughout the Douglas-fir/ninebark habitat type in Pasture I. Vegetation changes that indicated suppression of various plants in the area grazed only by cattle when compared to that grazed by cattle and big game suggested the reduction was caused by to competition from shrubs, rather than grazing pressure. Plants that were reduced in frequency by shrub domination included all the sedges, mountain brome, pinegrass, blue wildrye, western fescue, hairy common woodrush, western yarrow, both strawberries, peavine, chickweed, and ponderosa pine.

Grazing by both cattle and big game resulted in a reduction of smooth brome, heartleaf arnica, and oceanspray. Under dual grazing western fescue, cheatgrass, Canada milkvetch, and Canada thistle increased. The weedy plants, Canada thistle and cheatgrass were low in frequency throughout all treatments.

Elimination of cattle grazing and full use by big game (Pasture III) enhanced the environment of Kentucky bluegrass, tall trisetum, peavine, northwest cinquefoil, western meadowrue, and white clover. Elimination of big game with controlled cattle grazing favored timothy, cheatgrass, redstem ceanothus, snowbrush, ninebark, birchleaf spirea, and snowberry.

The habitat types controlled distribution of certain plants. Pinegrass, bigflower agoseris, heartleaf arnica, northern bedstraw, peavine, redstem ceanothus, snowbrush, oceanspray, ninebark, birchleaf spirea, and snowberry were all more abundant on the Douglas-fir/ninebark habitat type. While Canada milkvetch, the strawberries, and northwest cinquefoil were more abundant on the grand fir/mountain lover habitat type, the 28 other plants were not distributed differently on the two habitat types.

Seeding was also a major force in directing development of the various plant communities on the clearcut. Many plants, however, were not influenced by the seeding treatments. These were bigflower agoseris, heartleaf arnica, Canada milkvetch, northern bedstraw, peavine, northwest cinquefoil, and all shrubs except ninebark. All seeded species were most abundant in plots where they were seeded and, additionally, western yarrow favored this situation. Seeded species dispersed into unseeded areas to a limited extent, but only tall oatgrass dispersed extensively. Seeding did not exclude any resident graminoids but reduced the frequency of mountain brome (on the grand fir/mountain lover habitat type), elk sedge, ross sedge, pinegrass, western fescue, Kentucky bluegrass and tall trisetum. Of the forbs, only the strawberies, peavine and Canada milkvetch were depressed by seeding. Ninebark frequency also was higher in unseeded locations. Responses of forbs and shrubs related to seeding were valid, but absolute differences were not great.

CONCLUSIONS

1. Each treatment or combination of treatments directed plant succession toward a different mixture of plant species. To some degree, plant succession can be managed to produce a predetermined plant community.

2. Habitat type influences directed development of plant communities independent of other treatments but more than half the species were not differentially influenced by habitat type.

3. Big game grazing had more influence on succession than cattle grazing probably because of the interaction with shrubs and their domination of the Douglas-fir/ninebark habitat type.

4. Seeding of introduced species did not reduce distribution of shrubs or most forbs and only tall oatgrass moved into unseeded areas in large amounts.

CATTLE GRAZING POTENTIAL ON CLEARCUTS

M. Vavra, W. C. Krueger, and W. P. Wheeler

Previous reports have indicated the need for integrating forest and livestock production in the Northwest. This study was conducted to evaluate potentials for beef cattle production on clearcuts. The clearcut studied has been described by Wheeler, Krueger, and Vavra in a previous paper. The 5-acre pastures had been grazed by cattle since 1966. Cattle were stocked at the rate of five yearlings per pasture per month. Grazing was initiated each year from June 25 to July 15 and lasted for one month. In this study, Pasture I (big game excluded) and Pasture II (grazed in common by cattle and big game) were used.

EXPERIMENTAL PROCEDURE

Five steers, two with esophageal fistulas and two trained to carry total fecal collection devices grazed each pasture. The grazing season lasted from July 6 to August 9, 1972, and from July 13 to August 10, 1973. The grazing period was shorter in 1973 because of drought conditions. Two esophageal fistula collections and two 24-hour fecal collections were made per week during the grazing periods. Diet samples collected from esophageal fistulated animals were analyzed for crude protein, acid detergent fiber, lignin, and *in vitro* digestiblity. Total fecal collections were used in estimating dry matter intake. Additionally, diet samples were analyzed for plant species composition to determine animal preference.

RESULTS AND DISCUSSION

Clearcutting mixed coniferous forests followed by reseeding forage species commonly results in a 20-fold increase in forage production. With a dense overstory, mixed conifer sites normally produce about 50 pounds per acre of understory vegetation. After logging and reseeding, 800 to 1,000 pounds per acre may be produced. Of this, about 60 percent is grass, 30 percent forbs, and 10 percent shrubs. This mixture of grasses, forbs, and shrubs is maintained by the combination of cattle and big game grazing. When big game are excluded, shrubs may increase 15 fold. Grass production suffers from the increased competition by the shrubs.

Quality of the diet of grazing cattle is influenced by forage availability. Crude protein content of the diet was adequate to meet requirements on both pastures during both years (Table 1).

Table 1. Diet quality and intake of steers

	Protein (%)	Fiber (%)	Lignin (%)	Digestibility (%)	Dry matter intake (lb/day)
1972					
Pasture I	9.7	48.3	15.0	53.8	14.1
Pasture II	9.1	47.8	13.8	54.6	15.0
1973					
Pasture I	9.8	52.5	20.9	44.7	13.0
Pasture II	7.9	53.0	14.1	52.8	15.8

Lignin is an indigestible compound found in plants which increases as the plant matures, in the case of herbaceous vegetation, and increases with age of the stem in woody plants. Shrubs have much higher lignin levels than do grasses. In 1973, cattle in Pasture I consumed 45 percent of their diets as shrubs (Table 2). Lignin levels were correspondingly higher in Pasture I (20.9 percent vs 14.1 percent in Pasture II). Consumption of this much indigestible material decreased digestibility of the diet and dry matter intake.

Because Pasture I contained more shrub and less grass biomass, the available preferred forage of cattle (grasses) becomes limiting toward the end of the grazing period. This becomes particularly acute in drought years like 1973. Cattle were forced to consume more shrubs in Pasture I in 1973 (Table 2) and diet, intake and, therefore, average daily gain suffered. When stocking rates are heavy or during drought years when forage becomes limiting, cattle normally shift their diets to increased shrub consumption. Production in yearlings can decrease because energy intake becomes limited. Cattle, however, shift their diets to increased shrub consumption. Production in yearlings can decrease because energy intake becomes limited. Cattle, however, normally consume some shrubs in the diet particularly as the grasses become more mature and dry. Shrub consumption of 20 to 25 percent (Table 2) is considered about normal and has been noted in other studies.

Table 2. Percent of each forage class found in steer diets

	Grass	Forb	Browse
1972			
Pasture I	67	10	23
Pasture II	65	11	24
1973			
Pasture I	45	10	45
Pasture II	68	10	22

Quality of cattle diets will also be influenced by the time of year the clearcut is grazed. Initiation of grazing the clearcut has varied annually. Cattle may be turned out in late June, but in some years this has been delayed until mid-July. In years of earlier turnout gains have approached 2 pounds per head per day. Later turnouts onto a more mature and hence lower quality forage results in gains of 1.25 pounds per day.

At no time during the study did cattle diets contain evidence of conifer consumption. During the drought year of 1973, in Pasture I, where preferred forage was limited, cattle increased consumption of shrubs but still avoided any consumption of the tree needles or buds even though branches and lateral buds were available.

GRAZING MANAGEMENT OF CRESTED WHEATGRASS RANGE FOR YEARLING STEERS

D. A. Daugherty, C. M. Britton, and H. A. Turner

Improved crested wheatgrass ranges of eastern Oregon have a growing season of April, May, and June. The forage is of high nutritive value early in the season but decreases rapidly in digestible protein and energy with increasing maturity. A grazing management plan should consider the seasonal quality and quantity of forage resources and adapt them to animal requirements to obtain maximal forage utilization and animal production.

Young, rapidly growing animals can best utilize the early season high quality forage and yearling steers will maintain gains of two pounds per day or better through mid-June. After this time, the decreasing forage quality reduces gains. A problem with crested wheatgrass is the high stem to leaf ratio and the development of stiff, unpalatable culms with increasing maturity. A grazing program designed to remove 30 to 50 percent of the available forage on a field and then moving to a fresh field should increase the animals selectivity for the higher quality forage parts (leaves) and result in a higher level of gain. The following studies were conducted to evaluate such a grazing program.

EXPERIMENTAL PROCEDURE

Thirty yearling Hereford-Angus steers were used in grazing trials on crested wheatgrass for two successive years to determine differences in steer gains between grazing treatments. Grazing treatments started in early May and consisted of either continuous grazing or movement to a fresh field after removing one-third of the available forage in the current field (short duration or cream grazing). Steers on both grazing treatments were fed a daily supplement developed at Squaw Butte to account for decreasing forage quality and to maintain steer gains through the spring and summer at two pounds per day or better. Steer weights were taken at the beginning and ending of the grazing season for Trial 1 and additional weights were taken at monthly intervals during Trial 2.

Forage production was sampled by hand clipping 20 quadrats in each study field before and after grazing. Additional samples were clipped at monthly intervals in the continuously grazed field and in eight 10 by 100 foot exclosures randomly located across all study fields. Pasture movement dates were determined from clipping estimates of available forage just before grazing and the estimated consumption of steers.

RESULTS

The forage growth curves for Trial 1 (1978) and Trial 2 (1979) are shown in Figure 1. Forage production in 1979 was 130 percent of the average year because of the above average spring precipitation. A more typical to slightly below average forage year is represented by the 1979 growth curve. Growth peaked in early July of 1979 but the precipitation pattern of 1978 delayed the peak two to three weeks. An important consideration to the range manager is the loss of forage dry matter after growth has stopped. This dry matter loss, mainly from leaf shatter, causes a considerable nutrient and digestibility loss. Grazing most of the forage before leaf shatter (August 1) is more efficient utilization.

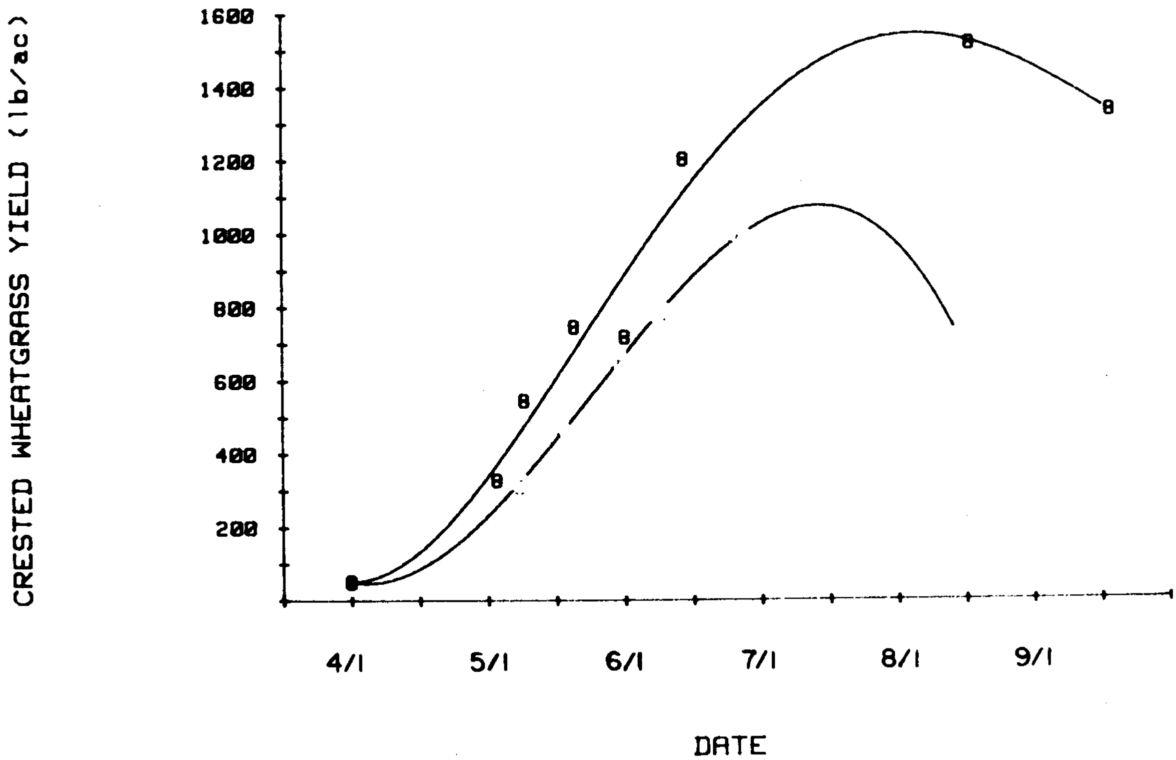


Figure 1. Crested wheatgrass yields for 1978 (8) and 1979 (9).

The short duration grazing treatment increased steer average daily gains (ADG) over the continuous grazing treatment by .23 and .17 pounds per day for Trials 1 and 2, respectively. Steer rate of gain curves for the continuous (C) and short duration (S) grazing treatments of Trial 2 are shown in Figure 2. Average daily gains were reduced during the first half of the grazing season by the short duration grazing treatment. Similar gains were expected during this period since both treatment groups had access to an abundance of high quality forage. The gain response probably is from management factors. The short duration grazing treatment utilized four small fields (16 to 23 acres) followed by a larger field (69 acres) and pasture movement was frequent (8 to 17 days). This contrasted the continuous grazing treatment where steers grazed the same field (72 acres) for the duration of the grazing season. The frequent movements on the short duration treatment, generally early in the morning (a peak grazing time), reduced grazing time by the steers. After movement, the steers walked the fences of the new field, reducing grazing time and walking off weight. The ADG's were considerably higher during the last 45 days of the grazing season on the short duration grazing treatment. This period represents the grazing time of 49 days after the last movement. The increased ADG during the final 45 days resulted in higher overall ADG for the short duration grazing treatment.

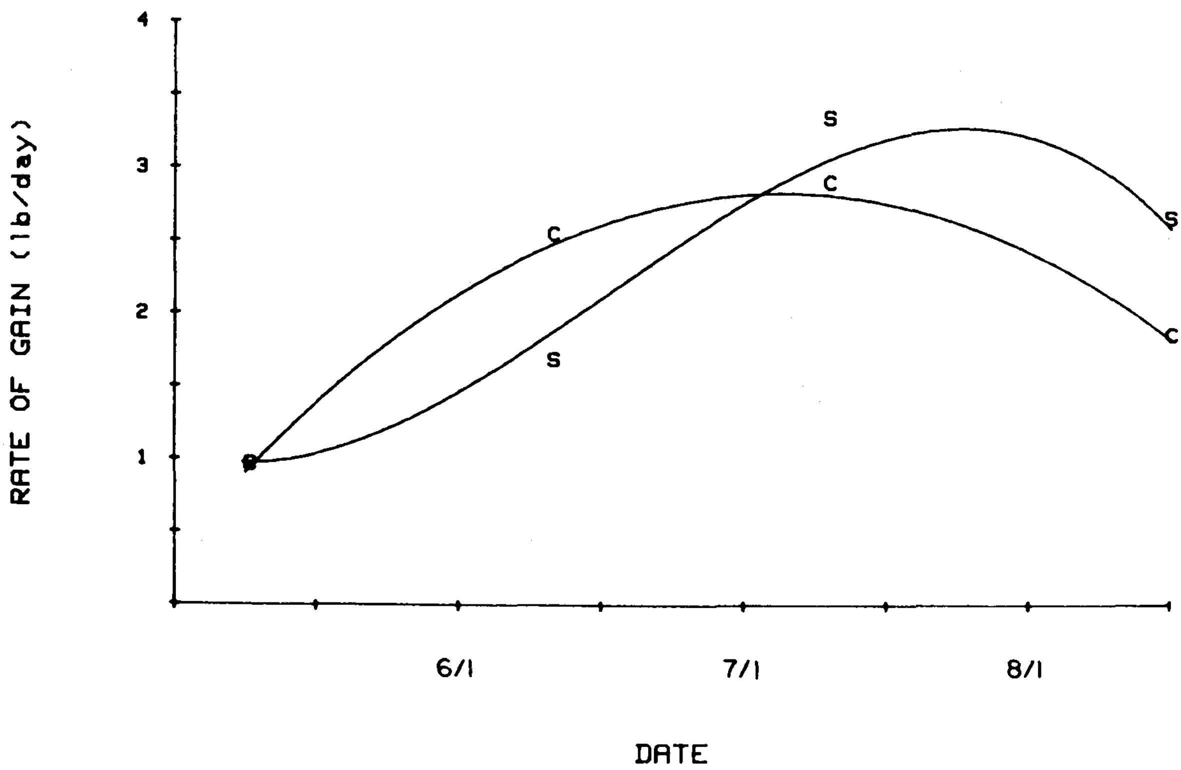


Figure 2. Rate of gain curves for the continuous (C) and short duration (S) grazing treatments.

The short duration grazing treatment also produced heavier steers at the end of the grazing season. However, this weight response came late in the grazing season because of the earlier reduced ADG (Figure 3).

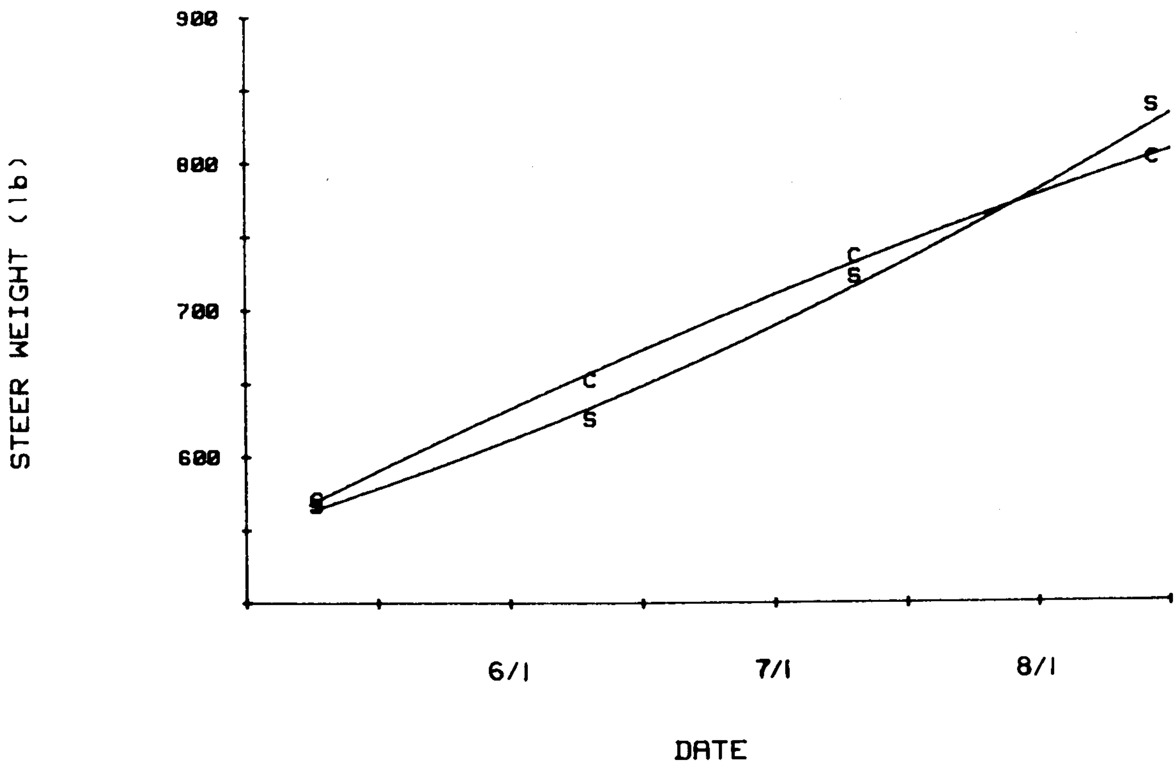


Figure 3. Steer growth curves for the continuous (C) and short duration (S) grazing treatments.

DISCUSSION

The results of these trials indicate that short duration grazing by yearlings will result in increased ADG and steer weight compared to continuous grazing. However, the grazing management in these studies should be modified. Reversing the order of grazing the short duration fields should result in similar gains by the steers during the early grazing season. The last field grazed in these studies was nearly equal in size to the continuously grazed field. Starting the short duration grazing treatment on the larger field would reduce the frequency of movements since forage yields would be greater on the smaller acreage fields by the time the steers were moved to them.

The reduction in early movements on the short duration grazing treatment should result in equal gains early in the season and still allow an increased forage selectivity later in the season. This may result in even heavier steers for the short duration grazing treatment. However, in the present trials there may have been some compensatory gains by steers late in the grazing season because of the lower early season gains. Any compensatory effect would be expected to be removed by reversing the grazing order of the short duration fields.

Further research is needed to determine the effects of reducing the frequency of early season movements. The most feasible grazing plan may be to continuously graze large fields through June and then start short duration grazing to increase the animals selectivity of higher quality forage.

FEDERAL LAND USE POLICY: IMPROVING CITIZEN PARTICIPATION PROJECT - AN OVERVIEW

L. Malin and T. E. Bedell

Public involvement, public participation, citizen involvement, and citizen participation all refer to the process which uses public opinion in planning programs of government agencies. Public involvement is required to be an integral step in preparing of land use plans of federal agencies. Both the U.S. Forest Service and Bureau of Land Management operate under legislation that emphasizes the importance of public involvement by requiring such activity to occur early and throughout the planning process. If public involvement is viewed as a process for reaching better and more widely accepted decisions, can be reached, then it is important for extension educators to be aware of planning programs used by the federal agencies. It is particularly important to be aware of time sequences in the process and to know when public participation opportunities occur.

At Oregon State University, a SEA-Extension-funded cooperative project between the Rangeland Resources Program and the Department of Agriculture and Resource Economics is well into its second year. The primary objective of the Federal Land Use Policy: Improving Citizen Participation project is to make citizen participation in federal land use planning programs more effective.

This project is concerned with the public involvement processes used by the Bureau of Land Management and the U.S. Forest Service. These two agencies manage public rangelands, and their land use allocation decisions have major effects on local rural communities as well as metropolitan communities generally located some distance from the land in question.

The Federal Land Use Policy project has a working advisory board of 12 extension specialists in range management, agricultural economics, and policy, which represent the other 10 western public land states. One goal of the project is to have materials and techniques developed in Oregon which will be applicable in the other states. Advisory board members are involved with federal land use issues; with only slight modification, the workshop formats, and the written and the audio-visual materials should be useful to specialists setting up similar programs in their states.

Educational materials developed as part of the first year's activities of the project include:

(1) An Annotated Bibliography of Federal Land Use Issues and Public Involvement. The bibliography is intended for use by individuals and groups in their efforts to become more effectively involved in federal land use decisionmaking.

(2) Two papers which describe the planning processes used by the U.S. Forest Service and the Bureau of Land Management. Each paper discusses the new planning systems that both agencies have recently adopted and provides citizens with an easily understood outline of the overall planning system used by the agencies.

(3) A short paper dealing with the history of rangeland policy.

(4) A synopsis of major pieces of legislation that affect federal land use planning. This synopsis provides short explanations of the major points in public land legislation. Its purpose is to provide citizens with an easy way to understand which laws affect federal land use and why.

(5) Several slide/tape programs, one a summary describing the U.S. Forest Service and Bureau of Land Management's planning programs.

(6) A Directory to Groups and Organizations Concerned with Public Land Management in Oregon. The Directory provides factual Oregon information to citizens, groups, organizations, and public land agencies.

(7) A Guide to the Basics of the Environmental Impact Statement Process will provide a step-by-step guide to the development of environmental impact statements the Bureau of Land Management and U.S. Forest Service, highlighting opportunities for public involvement.

(8) A Citizens Guide to Participation in Federal Land Use Planning. This will provide citizens with practical information about how to get involved in federal land use planning and how to be more effective.

(9) Public Perceptions of Federal Land Use Decisions Making in Oregon. This paper discusses the results of a statewide survey of 800 people during the summer of 1979 by a professional opinion research company.

Most of these will be in the form of Western Regional Extension publications, OSU Extension Circulars, Fact Sheets, and Bulletins. These background materials will be used as the factual basis for the project's second year activities--a series of workshops during the spring of 1980 in Oregon. The target audience includes ranchers, environmentalists, resource-oriented groups, and citizens. The goal is to have participants learn how to make their input most effective.

Since the BLM manages the vast majority of the rangeland in the West, four of the six scheduled workshops were focused on some part of BLM's planning process. In the workshops, the major emphasis was on teaching participants about planning processes used by federal agencies and how citizens can best participate. To make the workshops interesting to the public, local issues of concern were selected as the subject for the program. Elements of federal land use decisionmaking were discussed as a part of the locally relevant subject matter. Local economic impacts of federal land use decisions were addressed in each program.

The workshops were experimental. Different program formats, different speakers, different locations, and differing subject matters were used to discuss the same basic topic: the planning process and how the public can become involved. Different workshop techniques were tested to enable us to report which techniques seem most successful and why.

In August, a Federal Land Use Policy Symposium will be held in Portland. Total findings of the project will be presented, including publications, workshop critiques and evaluations, and suggested formats for similar programs in other states. The major purpose of the symposium is to convey materials developed at Oregon State University to key extension, academic, agency, and special interest group personnel from other western states so similar programs will be offered outside Oregon. Anyone interested in the problem of public involvement in federal land planning is invited to attend and should contact the Federal Land Use Policy Project, Rangeland Resource Program, Oregon State University, Corvallis.

Scientific names of plants mentioned in this Special Report

GRASSES

Blue wildrye	*Elymus glaucus*
Bluebunch wheatgrass	*Agropyron spicatum*
Cheatgrass	*Bromus tectorum*
Crested wheatgrass	*Agropyron desertorum*
Idaho fescue	*Festuca idahoensis*
Kentucky Bluegrass	*Poa pratensis*
Mountain brome	*Bromus marginatus*
Needle-and-thread	*Stipa comata*
Orchardgrass	*Dactylis glomerata*
Perennial ryegrass	*Lolium perenne*
Pinegrass	*Calamagrostis rubescens*
Sandberg bluegrass	*Poa sanbergii*
Small fescue	*Festuca microstachys*
Smooth brome	*Bromus inermis*
Tall fescue	*Festuca arundinacea*
Tall oatgrass	*Arrhenatherum elatius*
Tall trisetum	*Trisetum canescens*
Thurber needlegrass	*Stipa thurberiana*
Timothy	*Phleum pratense*
Western fescue	*Festuca occidentalis*
Western needlegrass	*Stipa occidentalis*

FORBS

Bigflower agoseris	*Agoseris grandiflora*
Blueleaf strawberry	*Fragaria virginiana*
Broadleaf arnica	*Arnica latifolia*
Bull thistle	*Cirsium vulgare*
Canada milkvetch	*Astragalus canadensis mortoni*
Canada thistle	*Cirsium arvense*
Chickweed	*Stellaria nitens*
Heartleaf arnica	*Arnica cordifolia*
Northern bedstraw	*Galium boreale*
Northwest cinquefoil	*Potentilla gracilis*
Peavine	*Lathyrus nevadensis*
Rose pussytoes	*Antennaria rosea*
Sheep sorrel	*Rumex acetosella*
Subclover	*Trifolium subterraneum*
Western meadowrue	*Thalictrum occidentale*
Western yarrow	*Achillea millefolium lanulosa*
White clover	*Trifolium repens*
Wood strawberry	*Fragaria vesca*

SEDGES AND RUSHES

Elk sedge	*Carex geyeri*
Hairy common woodrush	*Luzula multiflora comosa*
Northwest sedge	*Carex concinnoides*
Ross sedge	*Carex rossi*

TREES

Douglas-fir	*Pseudotsuga menziesii*
Grand fir	*Abies grandis*
Lodgepole pine	*Pinus contorta*
Ponderosa pine	*Pinus ponderosa*
Western juniper	*Juniperus occidentalis*
Western larch	*Larix occidentalis*
Western white pine	*Pinus monticola*

SHRUBS

Baldhip rose	*Rosa gymnocarpa*
Big sagebrush	*Artemisia tridentata*
Birchleaf spirea	*Spiraea betulifolia lucida*
Bitterbrush	*Purshia tridentata*
Common snowberry	*Symphoricarpos albus*
Low sagebrush	*Artemisia arbuscula*
Mallow ninebark	*Physocarpus malvaceus*
Mountain big sagebrush	*Artemisia tridentata* subsp. *vaseyana*
Mountain lover	*Pachistima myrsinites*
Oceanspray	*Holodiscus discolor*
Redstem ceanothus	*Ceanothus sanguineus*
Snowbrush ceanothus	*Ceanothus velutinus*
Twinflower	*Linnaea borealis*

PREVIOUS RANGELAND MANAGEMENT
PROGRESS REPORT

This progress report is available upon request from the Squaw Butte Experiment Station, P. O. Box 833, Burns, Oregon 97720.