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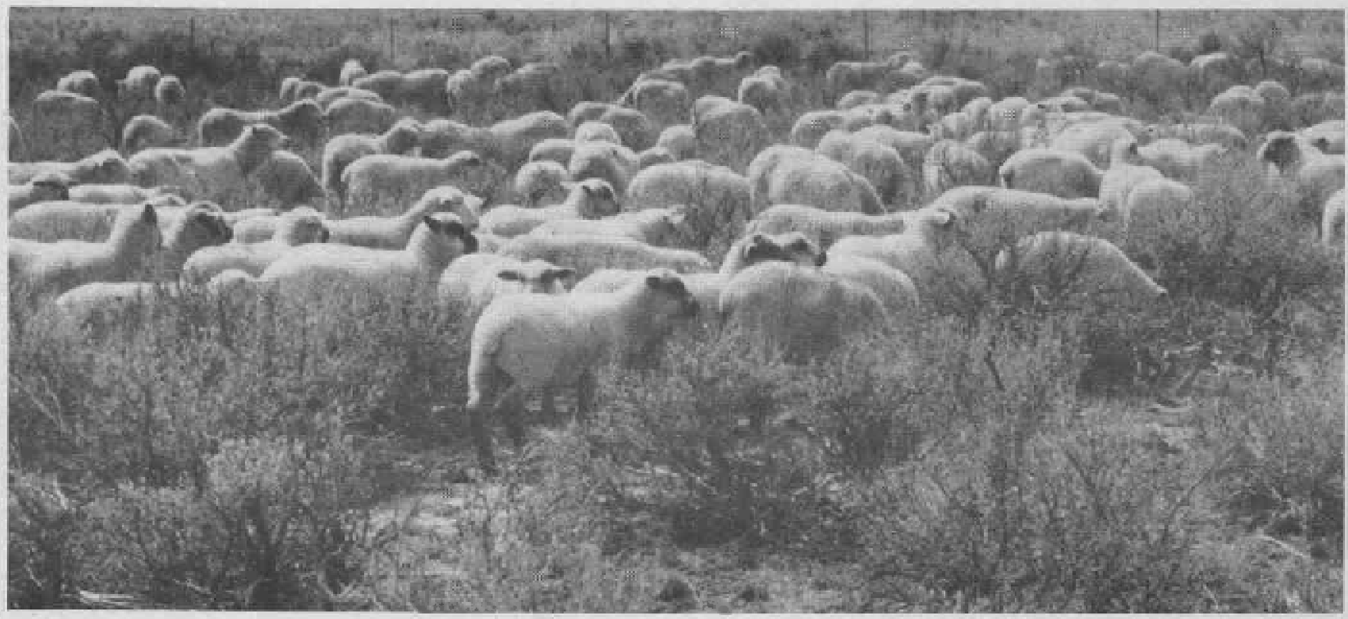

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EFFECT OF FIRE ON HERBACEOUS YIELD OF SAGEBRUSH-BUNCHGRASS RANGE

C. M. Britton and F. A. Sneva

When early settlers made their way west, some encountered vast grassland areas. These areas undoubtedly were a result of wildfires which reduced the sagebrush canopy cover, thus releasing the grasses and forbs. Fire control and, to a smaller degree, grazing have resulted in a monoculture of sagebrush on these ranges during the last 100 years.

Adequate information is available on general fire effects for most species. However, there is virtually no information available on the effects of fire on the total herbaceous production of plant communities. This study was conducted to evaluate the effects of prescribed fire on yield of a sagebrush-bunchgrass community and contrast these results to an adjacent grazed area in good condition.

METHODS AND PROCEDURES

This study was conducted at the Squaw Butte Range Unit of the Eastern Oregon Agricultural Research Center. Two adjacent areas were treated during October 1979. One area was grazed during the first two weeks of October; an adjacent area was burned during the third week of October. Approximate utilization on the grazed area was 75 percent.

Herbaceous vegetation on the areas was dominated by bluebunch wheatgrass, Thurber needlegrass, Idaho fescue, junegrass, squirreltail, lupine, and astragulus. Sagebrush was primarily basin big sagebrush and Wyoming big sagebrush. Herbaceous vegetation was sampled one growing season after treatment in September 1980. Yield estimates were obtained by clipping 20, 9.6 square foot quadrats per area. Clipped vegetation was separated into grasses and forbs, oven dried then weighed.

Conditions at the time of burning were; (1) wind speed at 6 miles per hour, (2) air temperature at 75 degrees Fahrenheit, and (3) relative humidity at 20 percent. Surface soil moisture was low at about 4 percent. Fuel moisture of leaves and small stems of the sagebrush was 49 percent. Under these conditions, only those areas with a sagebrush canopy cover of more than 20 percent burned unless the fine fuel was above 800 pounds per acre.

RESULTS AND DISCUSSION

The long held opinion that fire severely damages herbaceous vegetation was not supported by this research (Figure 1). Comparing late season grazing to burning, showed that the grazed area produced 490 pounds per acre and the burned area produced 696 pounds per acre. Although these values are not statistically different, they certainly illustrate that the first year response from burning can be positively compared to grazing.

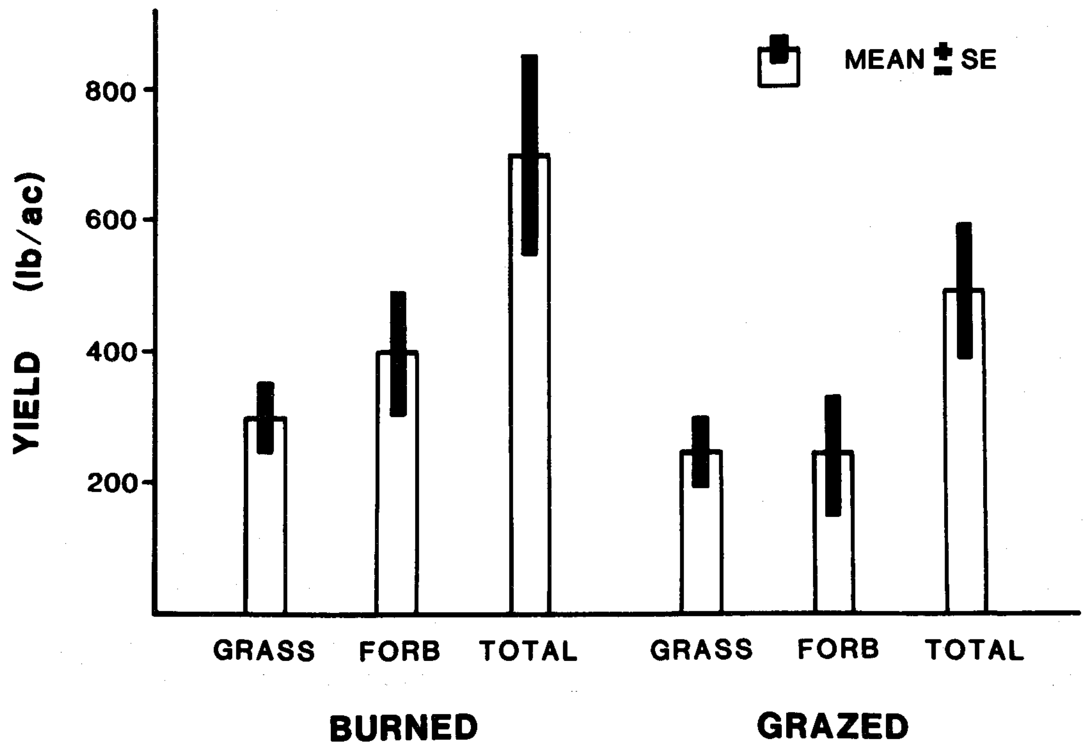

Figure 1. Yield of herbaceous vegetation for areas that were burned or grazed during October in eastern Oregon.

Yield of grasses on the burned area was 297 pounds per acre as contrasted to 244 pounds per acre for grazed area. Forb yields were 399 and 246 pounds per acre for burned and grazed areas, respectively. Therefore, the primary difference in the two treatments resulted from differential yield of forbs. Forbs that contributed most to this difference were lupine, astragalus, and ground smoke. Ground smoke was present conspicuously on the burned area although virtually absent on the grazed area.

The difference in yield of the two areas possibly can be attributed to mortality of the sagebrush on the burned plot. Grasses on the burned area stayed green about 2 weeks longer than those on the grazed area indicating a greater supply of available soil moisture. This release from competition undoubtedly benefited the herbaceous plants and this effect will continue in the future. The probable course of change in the ratio of grasses to forbs will be an increase in the yield of the grasses. Squirreltail will be the first species to reach optimum levels of production. Thurber needlegrass probably will be the last species to reach its optimum yield.

Results of the study indicated that burning sagebrush-bunchgrass range in October produced similar vegetational responses compared to those of grazing during the same period. Damage to perennial grasses, long attributed to burning, was not apparent.

EFFECTS OF EARLY SPRING GRAZING ON YAMHILL WHEAT YIELD

S. H. Sharrow

Livestock grazing of small grains during the early portion of their growing cycle is practiced to some degree wherever grain is grown. Winter through early spring grazing of winter wheat is a common practice throughout the Great Plains Region of the United States. While extensive work has been conducted to document the agronomic, economic, and animal production implications of wheat grazing in the Midwest, much less Pacific Northwest information is available.

A topic of obvious interest to wheat producers is the impact of livestock grazing on wheat yields. If you search the world literature on this subject, you will find numerous accounts of decreased grain yields under grazing, some observations that grazing had no effect on grain yields, and a few reports of increased grain yields on grazed fields. Reductions of yield as a result of grazing generally result from fewer wheat heads produced per acre. Increased yields largely are attributed to greater stooling (tillering) of grazed plants, and, therefore, more heads produced per acre or to increased resistance to lodging of potentially tall wheat plants whose height has been stunted by grazing. One unifying principle which is commonly agreed upon by all investigators is that if grazing is continued too long into the spring, animals remove the immature wheat heads and substantial reduction in grain yields can be expected. In fact, many reports of reduced grain yields under grazing probably result from grazing too late in the plant's growth cycle.

A study was conducted during 1979 and 1980 to evaluate the effects of spring grazing by sheep on the grain yield of Yamhill winter wheat. Three wheat fields near Corvallis, Oregon, were used in this study. The entire fields, with the exception of approximately one-fourth acre exclosures (for ungrazed plots in each field), were intensively grazed by sheep in mid-March both years. Adequate numbers of ewes were put into each field to graze the wheat down to a stubble height of approximately 1 1/2 inches within a 5- to 7-day grazing period. Components of yield were measured by hand-harvesting the wheat in approximately 11 yards of row from grazed and ungrazed plots in each field. All wheat harvested was sorted into straw, chaff, and grain. Plants/yard of row and tillers/plant at harvest were counted. Individual wheat heads were examined to determine spikelets/head, grains/spikelet, and seed weight.

The impacts of sheep grazing on wheat yield is summarized in Table 1. Spring grazing had no real effects on straw or chaff yield. Grain yield, however, was approximately 10 percent higher in 1979 and 27 percent higher in 1980 on grazed than on ungrazed plots. The rather large difference between grazed and ungrazed plots in 1980 probably includes some normal measurement errors. It is reasonable to expect that the actual yield increase as a result of grazing is nearer to the 10 percent observed in 1979 than to the 27 percent observed in 1980.

Table 1. Components of Yamhill Wheat Yield from Grazed (G) and Ungrazed (C) Plots

Component	1979			1980		
	G		C	G		C
Grain Yield (lbs/yard)	0.18	*	0.17	0.17	*	0.13
heads/yard	46		48	43		45
plants/yard	18		19	21		21
heads/plant	2.7		2.6	2.0		2.2
Seeds/head	43	*	39	41	*	21
seeds/spikelet	--		--	2.2		2.3
spikelets/head	--		--	19.2	*	17.3
Seed Weight (mg)	42		40	42	*	39
Straw Yield (lbs/yard)	0.15		0.14	0.17		0.14
Chaff Yield (lbs/yard)	0.04		0.03	0.04		0.03

Means with a star between them differ P .05.

In contrast to other studies, our results indicate that increased grain yields do not reflect changes in the number of heads produced per acre. We observed no differences in heads/plant, plants/yard, or heads/yard of row on grazed compared to ungrazed plots. We must conclude, therefore, that grazing did not promote increased tillering of wheat plants, as previously believed. In our case, increased grain yields resulted from more seeds produced per head of wheat. This appears to be caued by more clusters of flowers (spikelets) being produced per head on grazed plots rather than from more seeds per cluster (seeds/spikelet). The exact mechanism which produces this effect is unclear. Further investigation in this area obviously is needed to gain a clearer understanding of how early grazing effects subsequent ear development of winter wheat.

Experience gained in this study, together with reports from scientists working in other geographic areas, indicate that wheat may be grazed by livestock without reducing grain yields if grazing is terminated before the plant begins to elevate the immature wheat head (before jointing) and if an adequate length of growing season remains for the plant to recover after grazing. These conditions may be easily met west of the Cascades in Oregon and Washington. East of the Cascades, however, length of growing season may be too short to safely accommodate grazing except on very moist sites.

FOOD HABITS OF DEER AND CATTLE GRAZING IN COMMON ON A SAGEBRUSH-BUNCHGRASS RANGE IN NORTHEAST OREGON

T. O. Hilken and M. Vavra

STUDY AREA AND PROCEDURES

The study area, in the Keating Valley of Baker County, Oregon, historically was heavily grazed by cattle and sheep but not by mule deer. However, in the last 30 years there has been an increase in the number of mule deer and approximately 5,000 now use portions of the area between December and April. Cattle use occurs each spring and fall under Bureau of Land Management permits.

Three known areas where deer concentrated during the winter and cattle were grazed during the spring and fall were investigated. The vegetation of the three areas consisted of relic stands of three habitat types: (1) big sagebrush/bluebunch wheatgrass, (2) mountain big sagebrush/Idaho fescue, and (3) stiff sagebrush/Sandberg's bluegrass. Crested wheatgrass was an introduced seeded grass species and comprised more than 60 percent of the total herbaceous production where the seedings were successful. Cheatgrass brome, medusahead, Sandberg's bluegrass, and many weedy forbs such as white top, mullein, and mustards have invaded large portions of the area because of uncontrolled livestock grazing in the past and unsuccessful establishment of crested wheatgrass seedings.

Microhistological examination of feces was used to determine the botanical composition of deer and cattle diets. Deer pellet groups were collected tri-weekly during the early winter (November, December, January) and late winter (February, March, April) periods of 1978 - 1979 and 1979 - 1980. Cattle fecal groups were collected monthly during the spring (April, May, June) and fall (October, November, December) of 1979 and 1980. Kulcynski's similarity index was used to identify the extent of dietary overlap of grass species consumed by deer and cattle during the fall and spring of 1979 and 1980. Snow did not accumulate during the winter of 1979-1980 but averaged 2 to 6 inches during the winter of 1978-1979.

RESULTS AND DISCUSSION

Browse (predominantely sagebrush) was the dominant forage consumed by deer during the early winter period of 1978-1979. Grasses (predominately Sandberg's bluegrass) were the dominant forage consumed during the late winter period of 1978-1979. During the winter of 1979-1980, total browse and grasses consumed were approximately 34 percent and 48 percent of the deer diets, respectively, and there was not a significant seasonal diet change between the early and late winter sampling periods. A comparison between mean yearly differences of total grasses and browse consumed by deer revealed a significant change that can be attributed to forage availability. Cattle diets consisted of approximately 92 percent grass during the spring and 93 percent grass during the fall. There was not a significant difference between seasons and years. Dominant grasses consumed by cattle were crested wheatgrass, cheatgrass, and Sandberg's bluegrass. Forbs comprised less than 20 percent of the diets of both deer and cattle. Table 1 summarizes the dominant forages consumed by deer and cattle on the Keating study areas.

Fall dietary overlap for 1979 and 1980 was 35 percent and 34 percent, respectively, while spring overlap was 32 percent and 34 percent for the two years. Most of the dietary overlap occurred on Sandberg's bluegrass.

A 35 percent and 34 percent similarity index during the fall periods indicated that the potential for competition between deer and cattle could exist, especially when cattle and deer occur on the range together. A 31 percent and 33 percent similarity index during the spring periods was difficult to interpret because deer had migrated from the area before the time cattle were turned onto the range. However, the potential for competition could exist because less forage would be available to cattle where deer had concentrated the previous late winter period.

If intensive range/habitat management is practiced on the Keating range-lands, deer and cattle use could be compatible rather than competitive. Improved utilization of crested wheatgrass by cattle could be attained if a one-crop, two-crop system of grazing were implemented on fenced, crested wheatgrass seedings. If cattle were excluded from native range pastures and only grazed on crested wheatgrass seedings during the fall, diet overlap

Table 1. Selected plant species occurring in deer and cattle diets pooled across three study areas on the Keating rangelands

	Deer				Cattle			
	1978-1979		1979-1980		1979		1980	
Special 1/ 2/	Early	Late	Early	Late	Spring	Fall	Spring	Fall
crested wheatgrass	1	4	3	2	12	20	15	14
cheatgrass brome	1	14	24	25	17	24	23	30
Sandberg's bluegrass	1	2	4	4	23	24	23	24
Total grasses	4^{a}	32^{b}	47^{c}	50^{c}	91^{d}	93^{d}	94^{d}	95^{d}
Total forbs	20	19	18	17	7	3	5	3
sagebrush	56	40	27	31	2	3	-	1
rabbitbrush	7	5	2	1	-	-	-	-
Total browse	76^{a}	49^{b}	32^{c}	36^{c}	2	4	1	2

1/ means with different letters are significantly different.

2/ statistical tests apply only across columns.

should be minimized because deer appear to show a preference for Sandberg's bluegrass rather than crested wheatgrass. Early spring diet overlap could be minimized by grazing cattle on the crested wheatgrass pastures early and allowing time for native range to recover from late winter deer use. Late spring grazing on native range by cattle should remove the current year's herbaceous growth thereby stimulating fall regrowth and subsequently providing a palatable, seasonal nutritious forage for deer during the early winter period.

THE EFFECT OF TRACTOR LOGGING ON UNDERSTORY PRODUCTION IN EASTERN OREGON'S BLUE MOUNTAINS

M. D. Snider and R. F. Miller

The economy of eastern Oregon relies heavily on its forested lands to provide renewable resources in the form of timber and forage for livestock and big game. The passage of logging vehicles and skidded logs over the forest floor has the potential of profoundly modifying soil properties which, in turn, affect the growth of marketable trees and forage species beneath them. Timber harvesting also can alter runoff, erosion, and sedimentation characteristics of the forest watershed.

In the Pacific Northwest, research into the impact of logging on soils and plant growth, particularly tree growth, has focused on the Douglas-fir (*Pseudotsuga menziesii*) region. There has been little investigation of timber harvesting's impact on understory and soil properties east of the Cascades. Tractors have been, and will continue to be, the principal method of timber yarding in eastern Oregon.

The objective of this study was to determine the extent to which tractor logging and follow-up slash disposal influence understory production, composition, and soil features in the mixed-conifer forest. This plant community occupies extensive areas in the Blue Mountains and is economically important as a source of harvestable timber and summer range for livestock.

THE STUDY SITE

This study was conducted on a 5-acre stand near Crane Prairie on the Malheur National Forest in the southern Blue Mountains. Soil consisted of a loam and silt loam surface layer derived from recent volcanic ash, and a gravelly loam and clay loam subsoil derived from basalt and andesite. Natural mixing of these layers had occurred. Soil depth ranged from 12 to 36 inches. The site was situated on an east aspect with a slope averaging 15 percent. Elevation was 6,500 feet.

The undisturbed plant community was two-layered: ponderosa pine (Pinus ponderosa), grand fir (Abies grandis), and Douglas-fir composed the overstory. Principal understory grass forms were pinegrass (Calamagrostis rubescens) and elk sedge (Carex geyeri). Heartleaf arnica (Arnica cordifolia) was the prevalent forb. Shrubs were scarce.

Heavy overstory removal by tractor occurred in August 1974. In the summer of 1975, slash was machine-piled and burned. Logging and slash disposal machinery were not confined to skid trails; about 50 percent of the site showed some form of soil disturbance.

Skid trails, landings, and other areas of major disturbance were seeded with a mixture of orchardgrass (Dactylis glomerata), timothy (Phleum pratense), mountain bromegrass (Bromus marginatus), and intermediate wheatgrass (Agropyron intermedium).

The site was situated within a Forest Service grazing allotment. Though cattle were annually allowed into the area for summer grazing, animals were kept off the study site the summer data were collected.

EXPERIMENTAL METHODS

Soil disturbance from logging was separated into five classes:

I. NO SOIL DISTURBANCE: characterized by an intact litter layer and the presence of perennial native vegetation.

II. LIGHT TO MODERATE DISTURBANCE: where at least some of the litter layer had been removed and mineral soil exposed. This broad class included "ruts" caused by compression from tractor treads.

III. BERM: characterized by heavy soil displacement where mineral soil had been shoved into mounds.

IV. SKID TRAIL: an obvious path caused by the repeated passage of tractors and logs.

V. SLASH BURN RING: an obvious area where the soil surface had been altered by the burning of piled logging debris.

Each of the five disturbance classes was represented by 40 plots, 5.4 square feet in size, randomly located across the study site. Herbage production and composition data were collected on the 200 plots by double sampling-weight estimate technique. Plants were clipped by species, oven-dried, and weighed. Important forage species were sampled at the peak of the growing season. Shrub and tree seedling production on the site was insignificant and, therefore, ignored in determining production.

Below-ground plant biomass was obtained with a coring device from a subsample of 12 plots representing each disturbance class. Samples were taken to a depth of 4 inches, then washed, oven-dried, and weighed. Roots were not distinguished from rhizomes; nor was dead material distinguished from live. Tree roots were not segregated from the samples.

RESULTS AND DISCUSSION

As depicted in Figure 1, the great majority of forest understory biomass was concentrated below the soil surface. The principal understory species of the undisturbed community--pinegrass, elk sedge, and heartleaf arnica--are highly rhizomatous. Together these three species formed a dense mat of roots and rhizomes immediately below the surface of the forest floor. In the undisturbed class, only 8 percent of the total understory plant biomass was top growth. Compared with the undisturbed control, underground production markedly diminished in the four classes of disturbance examined.

Six years after timber harvesting, total aboveground yield of disturbance classes II (light to moderate) and III (Berm) was similar and not significantly different from the control (no disturbance). Moreover, the ratio of grasses and sedges to forbs varied little among all disturbance classes, except skid trails. As would be expected, this latter class contained a higher percentage of grasses.

Fire rings were considerably less productive than the other disturbance classes in both above- and below-ground yields. Five years after burning, the rings were producing only 44 pounds of top growth per acre. These rings typically were blanketed by a light-colored mantle of fluffy mineral "ash", several inches thick, which appeared to preclude plant establishment. Productivity of slash burn rings (which constituted about 3 percent of the study site's total area) might be greatly enhanced by mixing the surface "ash" with underlying soils through machine scarification.

An obvious conclusion from this study is that, in terms of producing forage, it is advantageous to artificially seed skid trails. Six years after tractor logging, seeded skid trails produced 65 percent more herbage than did the next most productive class, the undisturbed control.

Overall logging disturbance, in its various forms, did not appear to impair the site's understory productivity. On the other hand, all classes of disturbance exhibited profound drops in below-ground plant biomass, compared with the control. The thick mat of roots and rhizomes developed by the native undisturbed species may play an important role in soil containment. Forest managers might take this natural erosion deterrent into account when planning timber sales on areas vulnerable to erosion. For instance, tractor movement might be restricted to designated skid trails to minimize disturbance of the native understory.

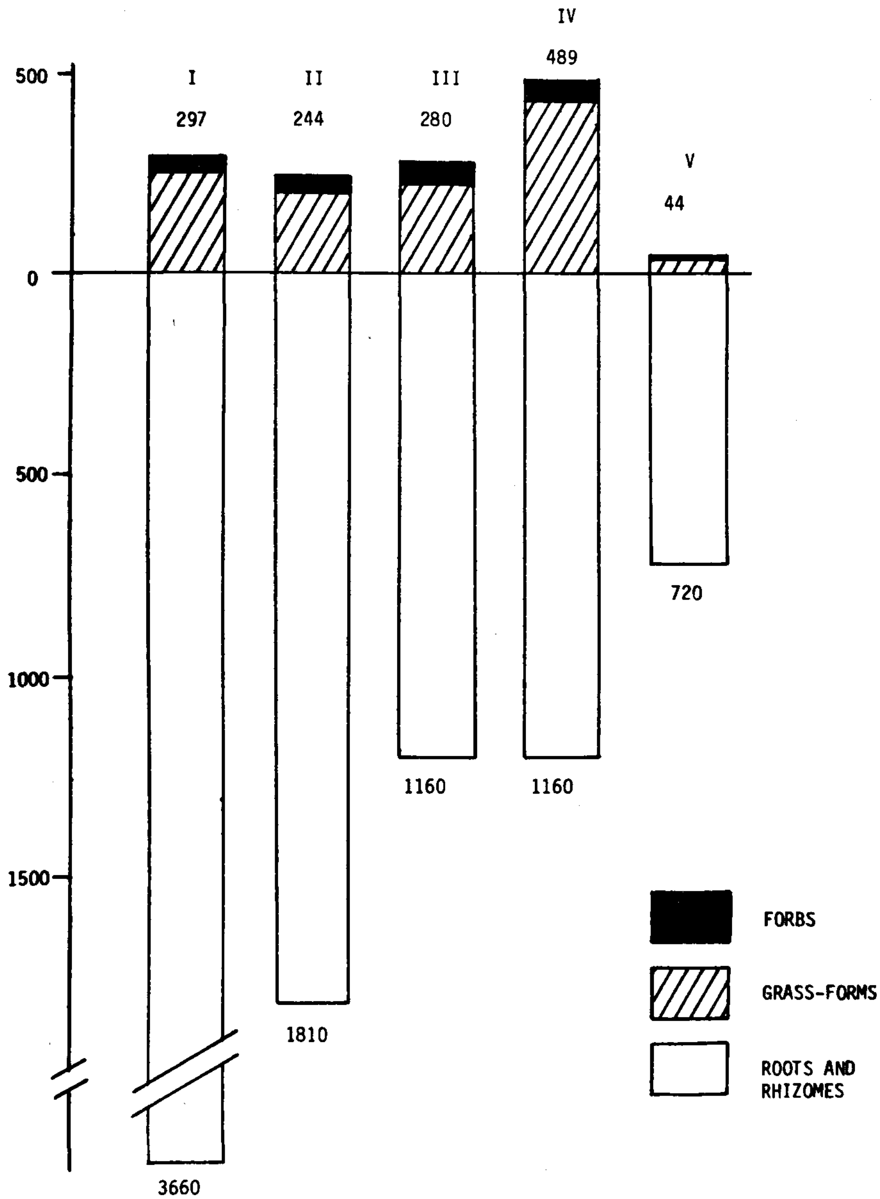

Figure 1. Total top and below-ground production (lb/acre) for each of the five soil disturbance classes resulting from tractor logging.

ROTATIONAL FORWARD GRAZING OF SHEEP ON IMPROVED PASTURES

J. R. Warner and S. H. Sharrow

In 1978, a three-year study was initiated to quantify the inherent differences in three sheep-grazing systems in western Oregon: (1) continuous grazing, (2) four-paddock rotational grazing, and (3) four-paddock rotational grazing with early weaning of the lambs--called rotational forward grazing. In the rotational grazing systems, sheep were moved from one paddock to the next every five days. Lambs in the rotational forward grazing system were weaned at approximately 14 weeks of age and placed in the paddock ahead of their dams. Then, lambs in the rotational forward grazing system always were rotated one paddock ahead of the ewes.

The grazing trials were conducted on 18 acres of gently rolling, improved pasture approximately three miles northwest of Corvallis. The average annual precipitation is just under 40 inches. Canopy cover in the early spring of 1980 was 31.9 percent tall fescue, 16.4 percent perennial ryegrass, 1.6 percent other perennial grasses, 16.3 percent annual grasses, 6.2 percent subclover, 6.8 percent other forbs, and 5.1 percent moss.

EXPERIMENTAL PROCEDURE

The study was laid out as a randomized block design with three blocks and three treatments. This made a total of nine experimental pastures--three pastures for each of the three grazing systems. As a first step in evaluating these grazing systems, we kept the stocking rate identical across all the pastures. In the 1978 grazing season and for the first five weeks of the 1980 grazing season, the stocking rate was 4 ewes and their 6 lambs per acre. Because of poor forage growing conditions in 1979 and for the duration of the 1980 grazing season, the stocking rate was reduced to 2 ewes and their twin lambs per acre. Animals were weighed and pasture data collected every 15 days on an offset schedule during the winter-through-summer grazing season.

RESULTS AND DISCUSSION

The single most important finding during the course of this study was that the rotationally grazed pastures produced considerably more forage than the continuously grazed pastures (Table 1). The rotationally grazed pastures had 17 percent more forage available to livestock than the continuously grazed pastures.

Table 1. Treatment averages for three grazing systems

	Continuous Grazing	Rotational Grazing	Rotational Forward Grazing
Forage on offer to livestock (season total), lbs/acre*	4,720	5,120	5,969
Peak lamb weights, lbs*	66.6	69.4	64.8
Final ewe weights, lbs*	130.1	133.2	137.7
Percent ground cover, June 29, 1980	87.2	91.5	93.7
Moss canopy cover, March 27, 1980	8.7	3.5	3.0
Bull thistles, plants per acre, July 21, 1980	3,350	1,696	1,739
Percent crude protein, season-long 1980 average	9.5	9.0	8.2

* Three-year average, 1978 through 1980.

Although stocking rate (number of sheep per acre) was kept the same across all the pastures, forage production and, therefore, stocking intensity (sheep per ton of forage produced) varied as a result of the grazing treatments. Sheep in the continuously grazed systems were forced to overgraze their pastures somewhat, whereas, the sheep in the rotationally grazed systems undergrazed their pastures. This situation is reflected in animal liveweights. At peak weight, lambs in the rotationally grazed pastures were 4 percent heavier than their counterparts in the continuously grazed pastures. We saw problems with the grazing strategy of weaning lambs early in the rotational forward grazing system. Although these lambs had ample high quality forage available (this was the rationale for this system--to allow the lambs first opportunity at the preferred forage before the ewes had access) they never made up for initial setbacks in weight gain from early weaning. At peak weight, the rotationally forward grazing lambs tended to be the lightest of any of the lambs on the project, averaging 6.5 percent lighter than the rotationally grazing lambs. This situation was reversed for the rotationally forward grazing ewes. Undoubtedly benefiting from the early weaning of their lambs and the abundance of forage available on their pastures, the rotationally forward grazing ewes were 6 percent heavier than the continuously grazed ewes. Wool weights averaged a little less than 6 pounds per ewe on a yearly basis and did not vary appreciably between the grazing treatments.

As indicated, the continuously grazed pastures showed signs of overgrazing. The sheep grazed these pastures very close to the ground which significantly reduced ground cover (6 percent) in June 1980 as compared to the rotationally grazed pastures. Moss took advantage of the exposed soil on continuously grazed pastures, averaging 8.7 percent canopy cover as opposed to 3.3 percent canopy cover on the rotationally grazed pastures in March 1980. Bull thistles also tended to be a greater problem on the continuously grazed pastures. In 1980, these weeds averaged more than 1,600 more plants per acre on the continuously grazed pastures than on the rotationally grazed pastures.

The greater stocking pressure on the continuously grazed pastures forced the forage plants to be in a constant state of regrowth and, therefore, the forage-on-offer was of higher quality than that available on the rotationally grazed pastures. In 1980, forage in the continuously grazed pastures averaged 10 percent greater crude protein values than forage in the rotationally grazed pastures. Higher quality of forage on continuously grazed pastures probably compensated somewhat for the lower quantity of forage on these pastures.

This experiment has demonstrated the ability of rotational grazing to dramatically increase forage production. Clearly rotational grazing has excellent potential for increasing stocking rates during the growing season. Instead of the fairly modest increase <u>per animal</u> that we found in this study for the rotational grazing system, if the stocking rate were increased to properly utilize the extra forage produced, one should expect substantial increases of animal products <u>per acre</u>.

INTERPRETING COLIFORM COUNTS IN NORTHEAST OREGON RANGELAND STREAMS

C. Bohn and J. C. Buckhouse

Because mammals may transmit pathogenic organisms through water supplies, the sanitary status of a stream is of great interest. For several decades, *Escherichia coli* have been used to indicate fecal contamination of water. The coliform organisms themselves are benign and some can be found in soil and vegetation. However, the fecal coliform group is directly related to the feces of warm-blooded animals. State and federal water quality regulations rely on total and fecal coliform sampling to indicate the probability of pathogenic organisms from fecal contamination.

The Meadow Creek study is concerned with the level of fecal contamination from cattle grazing. Meadow Creek is a second order, wildland stream on the Starkey Experimental Forest in northeastern Oregon. Streamflow ranges from 2 cfs (cubic feet per second) in late summer to 170 cfs in spring. Average stream gradient through the study area drops 50 feet/mile and the channel bottom is mostly gravelly or cobbled. Cattle have good access to the water. Douglas-fir, ponderosa pine, and meadow communities characterize the area. Small pastures along the stream have been moderately stocked since 1976 to test the effects of several grazing systems on instream coliform counts. The variable sampling results have pointed out a number of factors which should be considered to correctly interpret the impacts and trends from grazing. Examples can be drawn from the rest-rotation, deferred rotation, and season-long pastures.

Coliform concentrations are cyclic. Generally, the counts at controls were highest when sampling began July 1, although some sites peaked as late as August 7. Counts declined through the summer, reached a low by the end of August, and peaked again late in September, after fall rains and leaf-fall began. Following the pattern demonstrated in other studies, the concentration would be quite low in the winter, if sampled. (Diurnal cycles also are evident, constraining the daily sampling period for comparative samples).

Some contamination results directly from cattle standing in or adjacent to the water. However, coliform counts also relate to hydrologic events on the watershed. The events that should be considered when interpreting the data are most dramatically demonstrated by storm responses. Coliform curves at Meadow Creek peak with the hydrograph and begin to decline. Late on the hydrograph recession limb, coliform will quite often briefly increase and then drop off to original levels. Occasionally, counts at some sampling sites decrease while flow increases, possibly related to dilution. Apparently, some factor associated with the volume of flow raises the coliform count. Bottom sediment disturbances, bank flushing or runoff are all possibilities. It is generally believed that coliform bind to sediment and maintain steady-state populations. In 1970, Kunkle demonstrated the storage capacity of bottom sediments with a series of wading experiments. Although the data is not available for Meadow Creek, it is reasonable to expect coliforms to correlate with storm-associated turbidity, and slow stream segments with silty substrates to yield more coliform when disturbed than riffle areas. In fact, riffles may purify the water through aeration and increased contact with bacteria predators. Kunkle also conducted experiments which imply banks store coliform. Although it was not possible to test this on Meadow Creek, the rate of coliform increase should relate to the rate of change of wetted perimeter.

Runoff is most commonly implicated as the source of coliform during storms. Infiltration studies along Meadow Creek indicate that this storm was insufficient to produce significant runoff anywhere on the research area; in this example, overland transport simply could not have occurred on the pastures adjacent to the stream. Had runoff occurred, its contribution of coliform would depend on the coliform storage capacity of the pasture--the number of organisms produced and their survival curve--and the percent normally transported. Buckhouse and Gifford (1976) and Clemm (1977) demonstrated that fecal coliform can survive in feces for at least one year, but only 2-3 percent of them may be transported (Kunkle, 1970). Studies on overland transport are planned for Meadow Creek this summer.

Because fecal coliforms are associated with all warm-blooded animals, big game as well as cattle may impact the quality of Meadow Creek. To sort out the role of big game, a game-proof fence encloses one set of grazing systems. Preliminary analysis shows mixed results, suggesting that during the grazing season, the wildlife raise coliform counts, but after the cattle are removed, counts are comparable regardless of wildlife access. Likewise, different grazing systems do not offer clearly different responses yet.

Some other patterns are emerging from Meadow Creek, however. Overall, grazed areas have the highest counts and controls have the lowest; stream segments in pastures rested one month had counts similar to one year of rest. Ungrazed segments tend to reduce or dilute coliform concentrations, but may be more sensitive to hydrologic events than grazed stretches. Perhaps that is because ungrazed stretches have a lower baseline input and so bottom storage produces a relatively larger source. Season-long grazing has the greatest impact, but the status of deferred rotation and the rest-rotation pasture in use is not yet clear. Overall, counts seem to have increased somewhat since 1976, but the analysis is incomplete.

For monitoring trends and comparing treatments, relative coliform concentrations and factors affecting them are sufficient. Health standards, however, are not determined by relative associations but by real presence of organisms. In Oregon, standards are tailored to the expected use of each major drainage basin. As part of the Grande Ronde basin, all experimental areas of Meadow Creek have continually met recreational standards. Drinking water must be treated even in ungrazed portions.

LITERATURE CITED

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INFILTRATION, RUNOFF, AND SEDIMENT YIELD IN RELATION TO MOUNT ST. HELENS ASH DEPOSITION

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On May 18, 1980, Mount St. Helens shattered a 120 year-dormant interval with an explosive eruption that devastated most of the immediate area in a 160 degree sector north of the mountain, killing people, triggering numerous mudslides and destructive floods, and blanketing much of eastern Washington, northern Idaho, and western Montana with volcanic ash.

A joint investigation involving U.S.D.A.-SEA and Oregon State University was undertaken through the leadership of Forrest Sneva. A number of aspects of ash-related situations were examined. Physical and chemical components of the ash, dietary effects of ash ingested by rumenants, seedling emergence and plant production aspects, and watershed characteristics (sediment production and water infiltration) were evaluated.

The hydrologic portion of this effort was conducted during the late summer months. The ash had been distributed on the crested wheatgrass seeding in three replications of five treatments. The treatments were Moses Lake Ash at 89,000 pounds/acre, Moses Lake Ash at 178,000 pounds/acre, Yakima Ash at 89,000 pounds/acre, Yakima Ash at 178,000 pounds/acre, and an ash-free control.

A Rocky Mountain infiltrometer provided a simulated rainstorm. The equipment consists of a 500-gallon water storage tank, a pump and motor apparatus, which pumps water into a sprinkler and then to a series of three infiltration/runoff plots. The plots are constructed so precipitation and runoff waters can be captured and measured.

Precipitation was applied at a rate of about 4 inches for one-half hour. This intensity of storm was chosen because it simulates the sort of high intensity, low frequency convectional storms to which this area is subjected on a 50- to 75-year return frequency.

RESULTS

Dramatic differences in both infiltration and sediment were evident. Fallout location of the ash was more dramatic than was rate of application.

Yakima ash plots showed consistently higher infiltration rates than the Moses Lake plots (Figure 1). Infiltration on the two Yakima ash treatments were similar to each other, but different from the control and Moses Lake treatments. The Moses Lake infiltration trial showed Moses Lake ash to inhibit infiltration, even though both depths of Moses Lake ash were similar to each other and to the control.

Sediment production rates followed an inverse pattern compared to that of the infiltration process. This is to be expected because as infiltration rates increase, the volume of water entering the soil increases and, therefore, the amount of water running off site as overland flow decreases. With lowered infiltration rates, the reverse is true. Higher overland flows mean higher energy potentials and potentially greater erosion.

The potential sediment rates associated with the Moses Lake ash was an average of 3250 pounds/acre as compared to 676 pounds/acre on the control plots and an average of 128 pounds/acre on the Yakima sites (Figure 2). Although sediment production from the two Moses Lake treatments was similar, they were different from the control and Yakima treatments. The control and Yakima trials were similar to each other, even though the arithmetic mean shows the Yakima plots to be less erosive than the controls.

CONCLUSIONS

Differences in Mount St. Helens ash, dependent upon where it precipitated out, were more important than rates of 89,000 versus 178,000 pounds/acre deposition. The coarser Yakima ash actually served as a hydrologic enhancement over the ash-free soils of the Squaw Butte Experiment Station. The soils covered with Yakima ash had higher infiltration rates and lower potential sediment deposition values than did the ash-free control plots. Conversely, Moses Lake ash, which was finer in texture, lowered the infiltration rates and increased the potential sediment production values noted on the control plots.

Apparently the coarse textured Yakima ash provided a "mulch" which encouraged water movement into the soil and reduced particle detachment, entrainment, and potential sedimentation. The fine-textured Moses Lake ash conversely "clogged" the macro pore space within the soil profile, discouraged infiltration, encouraged surface runoff, and since the ash material was light and unconsolidated, provided a ready medium for erosion, entrainment, and potential sedimentation.

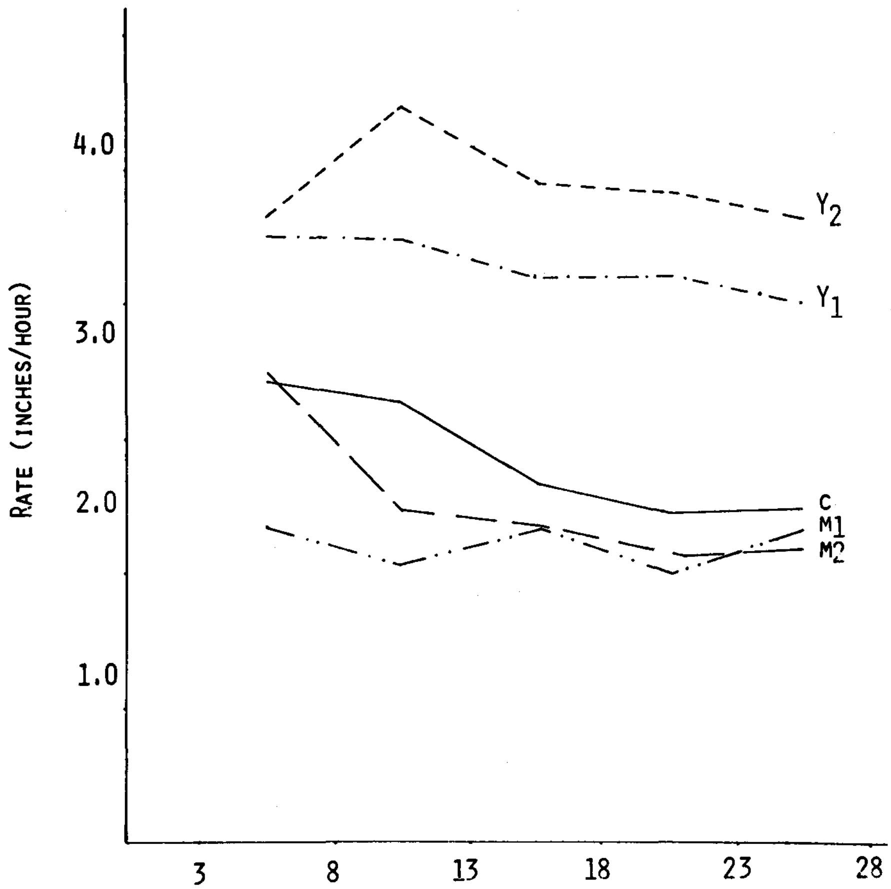

Figure 1. Infiltration rates associated with ash treatments.

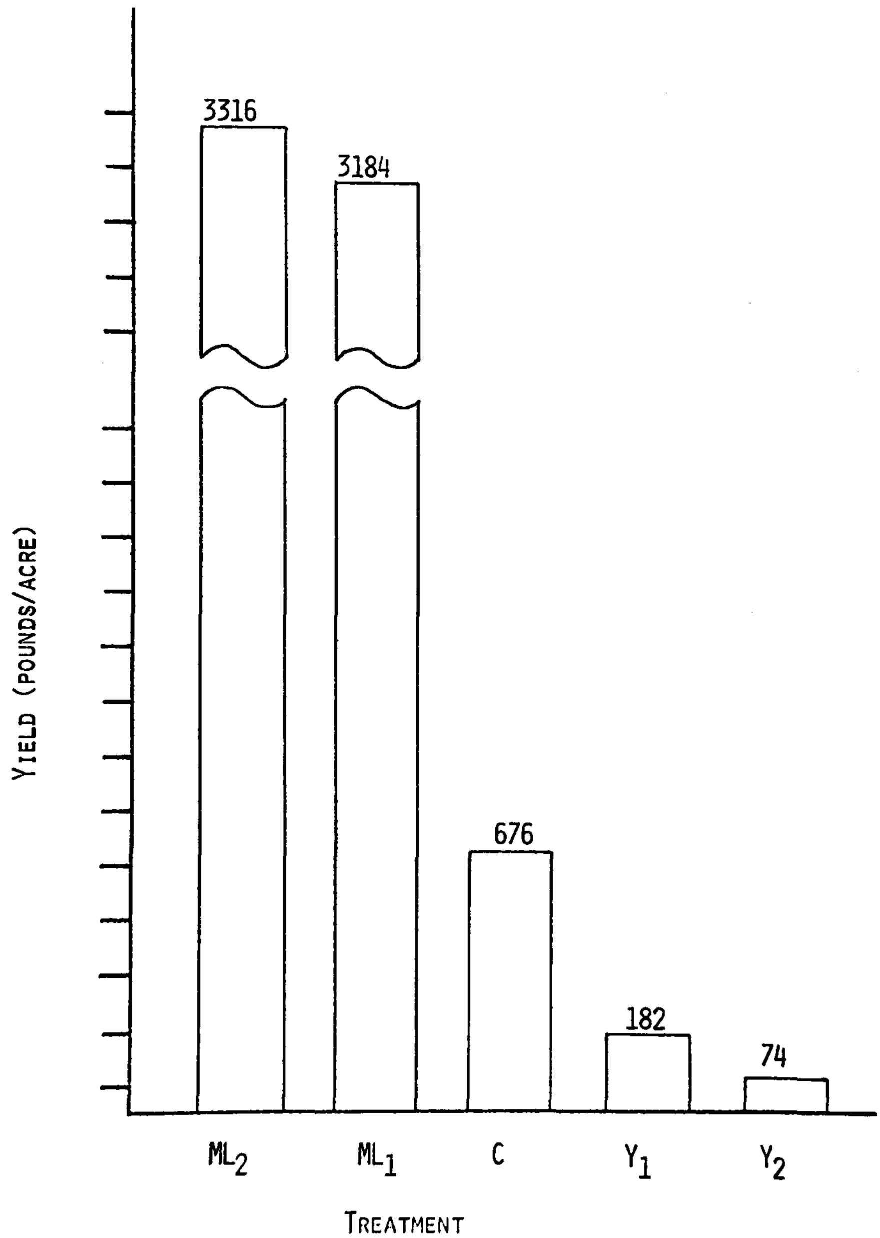

Figure 2. Potential sediment production.