

LIVESTOCK GRAZING, FIRE, AND THEIR INTERACTIONS
WITHIN THE DOUGLAS-FIR/NINEBARK HABITAT TYPE
OF NORTHERN IDAHO

A Thesis

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DEGREE OF MASTER OF SCIENCE

Major in Forest Resources

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By

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Preface

This thesis has been written in three sections, in agreement with my graduate committee and the University policy of accepting manuscripts in lieu of a standard thesis. The first two sections are completed journal articles and the third is a report to complete cooperative agreement supplement #78. As a result, style varies between sections with each section conforming to that required in separate journals.

Section I is composed of a manuscript which has been submitted to the editor of the Journal of Forestry. This paper was presented at the joint meeting of the American Association for the Advancement of Science and Society of American Foresters in Seattle, Washington on 14 June, 1978. The abstract was published in the Pacific Division, AAAS, Fifty-Ninth Annual Meetings Abstracts.

Section II consists of a manuscript which will be submitted to the editor of the Journal of Range Management. This paper will be presented at the joint meeting of the American Association for the Advancement of Science and Society of America in Moscow, Idaho in June, 1979. The abstract will be published in the Pacific Division, AAAS, Sixteenth Annual Meeting Abstracts.

Section III outlines a paper that has not been prepared for publication at this time, thus it is included in the Appendix. Following completion of at least one additional year of data collection and analysis, the paper will be submitted to an editor of a refereed journal for publication.

Summary

Available research clearly demonstrates that fire can have certain beneficial effects on some forested environments. Complete fire exclusion in many areas creates dangerous fuel accumulations which result in catastrophic fires, insect and disease buildup, range deterioration, changes in wildlife carrying capacity, and decreased watershed yield (Ahlgren 1974). Where fuels are permitted to accumulate, fires increase in severity and

damage, and offer much greater resistance to control (Dodge 1972). For these reasons prescribed burning, the planned ignition of grass, shrubs, or forest fuels to achieve a desired objective, is recognized as a valuable land management practice.

This practice is extremely useful in ponderosa pine (*Pinus ponderosa*) and Douglas-fir ecosystems to attain management objectives such as 1) reduction of fire hazards after logging, 2) exposure of mineral soil for seedbeds, 3) control of insects and diseases, 4) thinning of dense stands of saplings, 5) increased yield and quality of forage, 6) improvement of big game habitat, and 7) modification of species composition in different plant communities (Habeck and Mutch 1975).

Study Site

The study area is located approximately 12 miles northeast of Moscow in Latah County of northern Idaho (Fig. 1). It is in the East Hatter Creek portion of the College of Forestry, Wildlife and Range Sciences Experimental Forest. The burned plots were located inside and outside of the game enclosure of East Hatter Creek on southwest slopes of Basalt Hill with an elevation ranging from 2,800 feet to 3,300 feet. The site is situated on the west slopes of the Bitterroot Mountains in a transition zone between the main mountain range rising to the east and the Palouse Prairie lying to the West.

The history of the area is reflected by remains of railroad spur lines which provided early access for some selective timber harvesting of Ponderosa pine.

Fuel-Load Reductions Resulting from Prescribed Burning in Grazed and Ungrazed Douglas-fir Stands

G. THOMAS ZIMMERMAN AND LEON F. NEUENSCHWANDER

Abstract

Prescribed understory burning was carried out in both grazed and ungrazed Douglas-fir stands on the University of Idaho Experimental Forest. Burning conditions were moderately cool with 10-hr time-lag fuel moisture varying from 11 to 19%. Preburn and postburn fuel loadings were determined by use of the planar intersect method. Preburn data indicated greater fuel accumulations in grazed stands, 55,460 kg/ha, as compared to ungrazed stands, 44,710 kg/ha. Difficulty in achieving a satisfactory rate-of-spread and fire intensity was encountered due to the combined effects of a very dry summer followed by a wet fall. Moist conditions on the study site, lack of fine fuels, and accumulation of heavy fuels in the grazed portion produced a burn of patchy nature. Fire rate of spread varied from 0 to 183 cm/minute with flame height up to 91 cm. Result was a fuel reduction of 60.2% in the grazed stand and 35.2% in the ungrazed stand. Prolonged grazing in this area had created a dense, overstocked stand with insufficient fine fuels to carry a fire, which severely limited the effectiveness of prescribed burning.

Although it has been a practice to utilize livestock to reduce fire hazard in forest areas of the western United States (Adams 1975), little research has been done to determine the validity of this practice. The objective of this paper was to determine the effect of prescribed fire on fuel loading in both grazed and ungrazed Douglas-fir (*Pseudotsuga menziesii*) stands.

In various forested areas of the United States, livestock grazing has been a determining factor in the success of many local economies (Wahlenberg et al. 1939). Since many western ranchers have been dependent upon federal range, numerous areas capable of producing palatable forage have been grazed.

Early in this century, it was widely believed that grazing could lessen the number, intensity, and size of fires (Hatton 1920). Foresters allowed heavy grazing to reduce fire hazard and to promote tree growth without consideration for sound range and watershed management principles. Heavy grazing has been distinctly advantageous in lessening the occurrence and intensity of accidental fire, due to the reduction of herbaceous undergrowth and hastened decay of litter by trampling (Ellison 1960). However, heavy grazing has severely damaged palatable species. The amount of understory herbage utilized by grazing animals has been considerably less than the total produced, though the highly palatable plants have been selected first (Froeming 1974). As a result, these species have gradually been replaced, often by highly flammable, unpalatable species.

Available research clearly demonstrates that fire has had certain beneficial effects on some forested environments. Complete fire exclusion in many areas has created dangerous fuel accumulations

which have resulted in catastrophic fires, insect and disease build-up, range deterioration, changes in wildlife carrying capacity, and decreased watershed yield (Ahlgren 1974). Where fuels were permitted to accumulate, fires increased in severity and damage, and offered much greater resistance to control (Dodge 1972). For these reasons prescribed burning has been recognized as a valuable land management practice.

This practice has been extremely useful in ponderosa pine (*Pinus ponderosa*) and Douglas-fir ecosystems, with objectives such as (1) reduction of fire hazards after logging, (2) exposure of mineral soil for seedbeds, (3) control of insects and diseases, (4) thinning of dense stands of saplings, (5) increased yield and quality of forage, (6) improvement of big game habitat, and (7) modification of species composition in different plant communities (Habeck and Mutch 1975).

Zimmerman (1979) described the study area which is approximately 12 miles northeast of Moscow in Latah County, Idaho, on the East Hatter Creek portion of the University of Idaho Experimental Forest (Fig. 1). The specific area treated by burning was chosen because of the location of natural topographic changes which would have contributed to fire suppression strategies, if necessary, and the size of area which accommodated a concurrent big game study. Plots were located both inside and outside a big game enclosure on the southwest slopes of Basalt Hill, elevation ranging from 853 m to ~ 1006 m. Vegetation of the area was characteristic of the Douglas-fir/Ninebark (*Pseudotsuga menziesii*-*Physocarpus malvaceus*) habitat type, described by Daubenmire and Daubenmire (1968). Stages of vegetational development varied from seral to early climax with ponderosa pine and Douglas-fir equally represented.

Zimmerman (1979) studied the effect of grazing on the East Hatter Creek area. He found that grazing in the absence of fire at



Fig. 1. General location of study area.

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This research involved a cooperative study with the University of Idaho and the Fire in Multiple-Use Management, Research, Development and Application Program, USDA Forest Service, Intermountain Forest and Range Experiment Station, Northern Forest Fire Laboratory, Missoula, Montana.

the normal fire frequency of about every 22 years advanced the closure of the overstory, increased the quantity of duff and down woody fuel, and reduced the quantity of herbaceous and shrubby vegetation. He presented tree age and diameter class data suggesting that these changes occurred within the last 50 years. Before that time, the stands protected from grazing in the enclosure had similar overstory as the stands that were heavily grazed. Grazing outside the enclosure, based on U.S. Forest Service records, was heavy, with utilization averaging 85% for the last 20 years.

Methods

Prior to, during, and immediately after burning, measurements for temperature, relative humidity, wind speed, 10-hr time lag fuel moisture content, surface fine fuel moisture content, surface soil moisture content, and estimated cloud cover were collected. Samples were collected on north and south aspects under the canopy of shrubs and trees and in open areas.

Fuel-loading was measured by the planar intersect technique (Brown 1974). This technique provided the following information:

1. Weights per acre of downed woody material:
 - a. Diameter size classes: 0 to 0.6 cm
0.6 to 2.54 cm
2.54 to 7.62 cm
 - b. Sound and rotten fuel particles of diameters 7.62 cm and larger.
2. Depth of fuel and forest floor duff

Table 1. Fuel moisture and weather data for East Hatter Creek burn treatment days.¹

	Grazed		Ungrazed		
	10/5	10/21	10/5	10/6 ¹	10/17
Date of burn	10/5	10/21	10/5	10/6 ¹	10/17
Temperature (°F)	56	57	56	60	74
Relative humidity (%)	30	40	30	35	27
Wind speed (mph)	0	0-3	1	3-6	0-3
Cloud cover ²	0	.3	.3	.7	0
10-hr T.L. (%) ³	19	17	11,15 ³	12	9
Soil moisture (%)	11	12	10	10	9

¹Weather measurements taken prior to movement of cold front through area.

²Cloud cover measurements are expressed as tenths of sky obscured by clouds.

³Ten-hour time lag fuel moisture sticks were placed in an open stand (first number) and a closed stand (second number).

Weight calculations for this inventory were computed by the following simplified formulae (Brown 1974):

- a. 0 to 0.6 cm class : $W = 0.9533 \text{ nc/Nl}$
- b. 0.6 to 2.54 cm class : $W = 1.825 \text{ nc/Nl}$
- c. 2.54 to 7.62 cm class : $W = 14.52 \text{ nc/Nl}$
- d. 7.62+ cm sound : $W = 4.656 \sum d^2c/Nl$
- e. 7.62+ cm rotten : $W = 3.492 \sum d^2c/Nl$
- f. duff : $W = 14.5 \times \text{average depth}^1$

Where: n = number of pieces sampled
c = slope correction factor
Nl = total length of sampling plane
 $\sum d^2$ = sum of squared diameters

¹Formula derived from unpublished data.



Fig. 2. Typical preburned areas comparing grazed (A and B) to ungrazed (C and D) stands.

Vegetative cover was determined by the line intercept method (Daubenmire 1968). Dead and standing herbaceous vegetation (standing litter) and the O1 horizon (surface litter) were often the fuels that carried the fire. Standing and surface litter samples were collected from 20 × 50 cm (0.1 m²) quadrats, oven-dried and weighed, then converted to kilograms per hectare values.

In preparation for burning, firelines were constructed by bulldozer. Burning in the ungrazed area was initiated by firing the area adjacent to those lines and then igniting the lower portion and permitting the fire to move up hill. In the grazed stand, strip fires were used to maintain sufficient burning intensity. Fire weather, fuel moisture, and soil moisture data for each burning day are listed in Table 1.

Results

Stand Structure and Condition

Inspection of the grazed and ungrazed stands prior to burning revealed that stand structure and condition differed significantly, although they were of similar habitat type, soils, and physiography. The ungrazed stand was an open park-like forest, while the grazed stand resembled a relatively dense forest with little understory vegetation. Similar densities of large diameter trees occurred in both areas, but the stand structure of smaller trees was significantly different. Because at least one fire and no grazing occurred in one area, while no fires and continuous grazing occurred in the other, the difference between the two stands was assumed to be the result of grazing-fire interactions. The specific effects of grazing by domestic livestock in this habitat type were studied by Zimmerman (1979). In Douglas-fir habitat types of Idaho, production of forage and shrubs decreased following the closure of the overstory canopy (Froeming 1974, Zimmerman 1979).

The Douglas-fir stand that was subjected to prolonged grazing was comprised of an overstory of mixed sized Douglas-fir and ponderosa pine, and an understory ranging from needles to sparse shrubs (Fig. 2). Distribution of trees varied from overstocked sapling thickets to large and scattered sawtimber. Evidence of insect and disease damage was obvious. Understory was characterized by a general lack of both dead down woody and live fine fuels. The forest floor fuel ranged from stands of heavily cropped grasses and bare ground to needle mats and scattered shrub patches. Soil surface litter averaged 0.8 cm while the duff averaged 7.2 cm.

The stand protected from grazing appeared as a seral stage comprised of slightly more ponderosa pine than Douglas-fir. Overstory structure varied from well-stocked pole stands of fir to open, park-like stands of pine (Fig. 2). The ungrazed stand contained fewer snags, rotten stumps, and insect and disease infected trees than the grazed stand. Understory ranged from thick mats of needle to dense, vigorous stands of perennial grasses and tall shrubs.

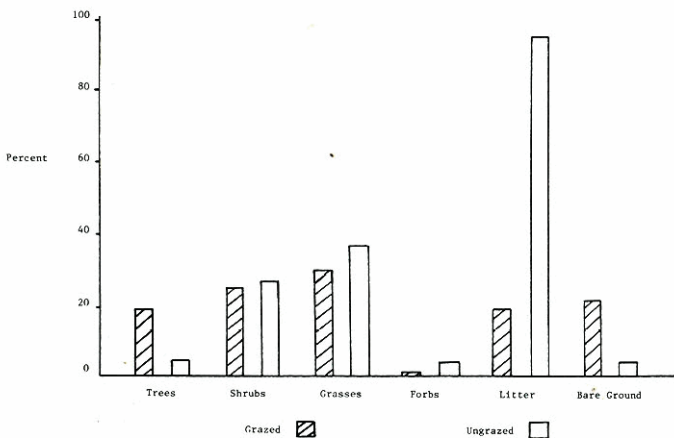


Fig. 3. Comparison of canopy coverage for grazed and ungrazed stands.

Fuel Inventory

Bare ground and canopy coverages of trees were greater and coverages of litter, forbs, grasses, and shrubs were lesser on grazed than ungrazed sites (Fig. 3). Fuel loadings, greater in grazed stands, were comprised of nearly equal distributions of fuel particles of greater and less than 2.5 cm in diameter. Preburn fuel loading in the ungrazed stand, 45,558.4 kg/ha, was not significantly different from that of the grazed stand, 36,726.4 kg/ha (Fig. 5), but was comprised almost entirely of particles less than 2.5 cm in diameter (fine fuels). Comparisons of the fine fuel loading between the two areas revealed that fine fuels made up 55% of the total preburn loading on the grazed areas; while on the ungrazed areas they represented 100 percent of the total (Fig. 4).



Fig. 4. Comparison of surface fuels in grazed and ungrazed stands.

Surface files of varying intensities were supported and carried by the quantity of fuels and continuity of fine fuels in the ungrazed stand. Within the grazed stand, the lack of fine fuels prohibited rapid movement of fire across the ground. But the presence of large size class fuels, shrubs, sapling thickets, snags, stumps, closed canopies, and lack of wind presented a significant opportunity for the development of crown fires, i.e., fuel combinations that would

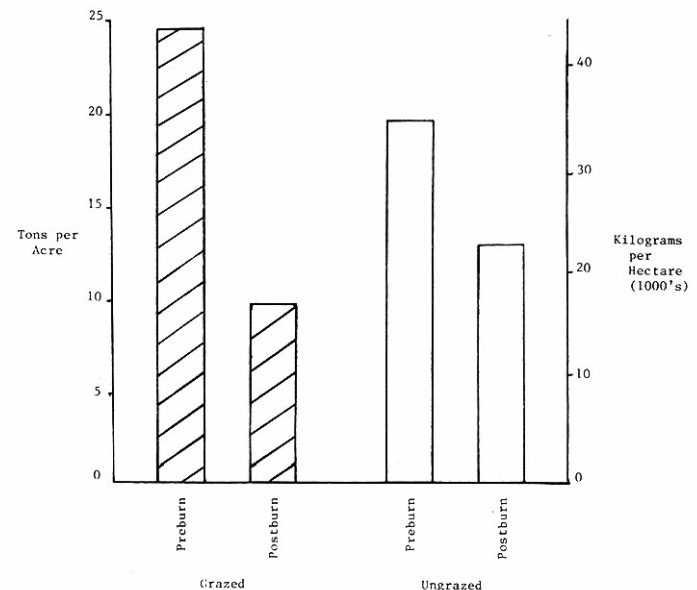


Fig. 5. Comparison of total fuel loadings before and after burning in grazed and ungrazed stands.

result in a fire ladder situation.

The two areas responded differently to prescribed fires. On the grazed site greatest reductions were observed in standing litter and all fuel sizes greater than 2.5 cm. Numerous trees up to 10 cm dbh were killed by the fire in the grazed stand. Reduction of total fuel accumulation for this area amounted to 60.2% (Fig. 5). On the ungrazed portion the highest reductions were observed in all size classes less than 2.5 cm. Total fuel reduction on this site accounted for 35.2% of the preburn total.

Fire Description

Higher fuel moisture contents on the grazed portion occurred as a result of combination of heavy fuel accumulations and a closed canopy shading. This higher fuel moisture, coupled with a lack of fine fuels, resulted in a less intense burn. The resultant, slow spreading fire burned through the grazed Douglas-fir stand at a rate of spread that ranged to .5 m/min with flame heights up to 15 cm (Fig. 6). The fire consumed the majority of larger size class fuels. Only a few healthy trees larger than 15 cm dbh were killed. This fire burned in a very patchy pattern, limited by fuel continuity and moisture content.

Quite different results were observed in the ungrazed Douglas-fir stand. As a consequence of the abundance of fine fuels, slightly lower fuel moisture content, and less canopy coverage, the fire spread rapidly, although some of the more shaded areas remained unburned. This fire consumed nearly all the fine fuels, top killed 50 to 75% of the shrubs, and scored only the lower crowns of the

trees (Fig. 6 and 7). Healthy trees with diameters greater than 15.24 cm were not harmed by the fire. Observed rate of spread in this area was from .3 to 1.8 m/min, while surface flame lengths varied up to 91 cm.

Conclusions

Heavy livestock grazing in the East Hatter Creek portion of the University of Idaho Experimental Forest resulted in increased downed woody material and early closure of tree canopies. It also tended to create ladder type fuels (Zimmerman 1979). Through reduction of herbaceous material and trampling of litter, grazing increased litter mats, number of trees, and large diameter fuels. At the same time, Zimmerman (1979) suggested that grazing was responsible for decrease in fine fuels and acceleration of plant succession. Total fuel accumulations differed slightly on grazed and ungrazed sites, but fuel size classes differed significantly. Grazed area fuels were characterized by grazed number of large size classes, while ungrazed fuels were almost entirely comprised of fuels less than 2.5 cm in diameter.

When grazed and ungrazed Douglas-fir stands were prescribed burned, fuel weight reductions were greater on the grazed site, but administering prescribed fire was more difficult on these sites. For fire to consume and spread through the heavily grazed area which is dominated by the larger diameter fuels, hotter and drier burning conditions are necessary. Such conditions may pose increased potential for the rapid movement of surface fires into the crowns

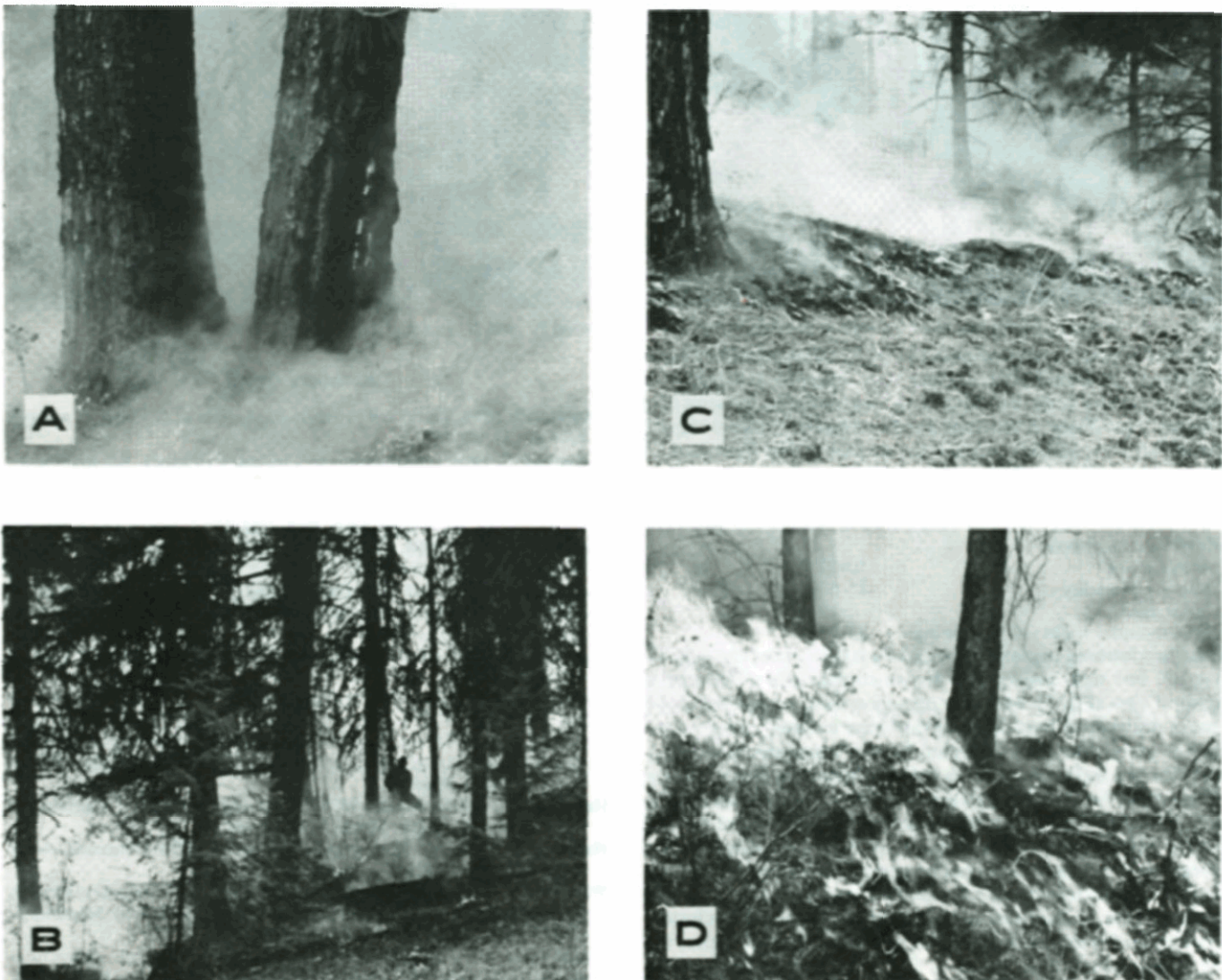


Fig. 6. Typical prescribed fire with same fire weather conditions in grazed (A and B) and ungrazed (C and D) stands.



Fig. 7. General results from prescribed burning in grazed (A and B) and ungrazed (C and D) stands.

of the larger trees. In areas dominated by small size class fuels such as those on ungrazed sites, surface fires consume a majority of available ground fuels, and fires have little potential for crowning in larger trees. Fires of this type can be expected to move rapidly through an area, quickly exhaust the surplus of fine fuels, and do little damage to larger trees.

Prescribed burning in ungrazed Douglas-fir forest stands will produce satisfactory results if strip fires are carried out under the following conditions:

Temperature	50–70° F
Relative Humidity	25–55%
Wind speed	0–10 mph
Fuel moisture sticks (10 hr time lag)	10–17%

Prescribed burning in grazed Douglas-fir stands under these conditions did not yield results of a degree comparable to burning in ungrazed sites (Fig. 7). Most fire managers have recognized that it is more difficult to burn in areas that have a closed canopy compared to areas with open canopies, but few managers have recognized that this difficulty could have been induced by heavy grazing.

Prescribed fire has advantages in many situations and limitations in others. One of the major limitations arises from the fact that the effects of livestock grazing on fuel accumulations and natural fire frequencies have not been well documented. A noticeable lack of information also has existed concerning the effects of the interaction of livestock grazing and complete fire exclusion. Data obtained from this study will not resolve these problems, but does demonstrate that, from a fire management standpoint, improper grazing can adversely alter natural fuel accumulations in Douglas-fir forest ecosystems.

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Livestock Grazing Influences on Community Structure, Fire Intensity, and Fire Frequency within the Douglas-fir/Ninebark Habitat Type

G. THOMAS ZIMMERMAN AND L.F. NEUENSCHWANDER

Abstract

Influences of livestock grazing on community structure, fire intensity, and normal fire frequency in the Douglas-fir/ninebark (*Pseudotsuga menziesii*/*Physocarpus malvaceus*) habitat type were studied at the University of Idaho's experimental forest in northern Idaho. Livestock grazing caused increased tree numbers, decreased production, cover, and frequency of major palatable grasses, and altered dominance of shrub and forb species. Grazing influences on community structure were increased accumulation of downed woody fuel in every size class, increased forest floor duff, and decreased herbaceous fuels. Livestock grazing influences were discussed in light of their significance in potential fire intensity and fire frequency in Douglas-fir forest communities.

Historically, fire exerted a strong influence on the ecology of western forest communities, and the history has been widely studied. Arno (1976) reported the significance of fire in forest development. However, little information was available on the frequency and intensity of fires in the Douglas-fir/ninebark (*Pseudotsuga menziesii*/*Physocarpus malvaceus*) habitat type. Wellner (1970) reported that these forests experienced fires that caused slight to extreme damage. Arno (1976) stated that fires in Douglas-fir forests of western Montana were frequent prior to 1900 (mean fire-free periods ranged from 7 to 19 years), and fire damage was usually not extreme. Fire was a major force in stand development, but during the last 50 years, its role has been reduced to one of minor significance because of effective fire suppression and logging activities.

Since different animals have different food preferences, seasons of use, and grazing intensities, they influence the forest community structure differently. Changes in overstory structure and in shrubby and herbaceous density and composition can affect the intensity and frequency of fires in forest communities. Grazing has exerted strong influences on the ecology of forest communities (Daubenmire 1968). Livestock grazing has been effective in reducing the fire hazard in the forests of the western United States (Adams 1975, Ingram 1931) since the early part of this century (Hatton 1920). Range managers have shown that grazing has influenced vegetal development and that it can change the path of secondary succession. Long-term interactions of livestock grazing wildfire, however, have not been reported.

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¹All scientific and common names follow Hitchcock and Cronquist (1973).

Cholewa (1977) and Froeming (1974) discussed the importance of the Douglas-fir/ninebark habitat type. These communities support vegetation which provides adequate summer forage for livestock, summer and winter browse, and both visual and thermal cover for big game. Characteristically, this vegetation is dry in late summer, creating a fuel layer of high continuity and flammability. If an adequate supply of dry fuel particles in 1-centimeter and smaller size classes is available, fire can be ignited easily and spread rapidly (Dodge 1972). Livestock grazing has eased fire ignition and spread by removing herbaceous undergrowth and reducing the number of fuel particles and by hastening decay of litter through trampling (Hatton 1920).

This study was designed to determine influences of livestock use in the Douglas-fir/ninebark habitat type of northern Idaho. Specifically, the goal was to determine changes in community structure, composition, and distribution of fuel caused by livestock grazing, and to assess the extent to which these changes modify fire frequency and intensity.

Study Area

The study was conducted in the forested hills along the western slope of the Bitterroot Mountains on the University of Idaho Experimental Forest located approximately 20 km (12 mi) northeast of Moscow in Latah County, Idaho.

Elevation of the area ranged from approximately 853 m (2,800 ft) to near 1,006 m (3,300 ft) with slopes varying from 5 to 40%. The area contained 2 main soil series. Areas with 5 to 20% slope, comprised of deep, moderately well-drained soils formed in deep loess, were classified as Carlinton silt loams. Steeper slopes, moderately well drained throughout, formed from granodiorite residuum with some loess influence, were classified as Uvi silt loams.

Vegetation of the area was characteristic of Douglas-fir/ninebark habitat type as described by Daubenmire and Daubenmire (1968). Vegetation was cover mapped by Basile (1954) and updated by Thilenius (1960). Overstories were a mixture of Douglas-fir and ponderosa pine (*Pinus ponderosa*). Understories varied greatly but were generally dominated by ninebark (*Physocarpus malvaceus*), oceanspray (*Holodiscus discolor*), and snowberry (*Symphoricarpos albus*). Graminoids, comprised primarily of pinegrass (*Calamagrostis rubescens*), elk sedge (*Carex geyeri*), bluebunch wheatgrass (*Agropyron spicatum*), and Idaho fescue (*Festuca idahoensis*), combined with an abundant number of forbs, formed the ground layer.

"High grade" logging occurred on the study area in 1925. Cutting practices ranged from light, selective cutting to clearcutting, and most of the merchantable timber was harvested regardless of

species (Basile 1954). During the early 1940's, unregulated grazing by both cattle and sheep occurred on the area. Construction of the enclosure excluded livestock, but at various locations the fence fell into disrepair and did not consistently restrict big game use of the area. Observations showed that whitetail and mule deer and elk utilized areas both inside and outside the enclosure throughout the year. From 1945 to 1967, the area was utilized by a large number of domestic livestock, and it was grazed very heavily. During this period, for 5 months each year, the stocking rate was nearly double the herbaceous carrying capacity.² In 1969 a management plan was written that provided for gradual reduction in animal numbers and for shortening the grazing season to 4 months. Currently, the area surrounding the enclosure is grazed by cattle during the spring, summer, and fall.

Utilization of the graminoids for the last 20 years averaged 85% (one animal per 13 ha) with a maximum of 99% in 1966 and a minimum of 43% in 1972 (U.S. Forest Service). Prior to 1968, utilization exceeded 90%, based on U.S. Forest Service records. Grazing records were incomplete prior to 1959 and grazing was not uniform across the study area, but the area was very heavily grazed. Browsing by big game was probably never very high in the study area and had been insignificant for the last 20 years (Thilenius and Hungerford 1967).

Organized fire protection has been provided in the area since sometime in the 1920's. The only fire on record was a wildfire that burned a small portion, about 18 ha, of the study area in 1963. Fire scars on many mature ponderosa pines were evidence that periodic, low intensity fires historically occurred in the area about every 22 years. Fire frequencies were not adequately determined for these specific stands, but in similar Douglas-fir stands of western Montana the mean fire frequency was 19 years (Arno 1976).

Methods

Vegetation was sampled in the Douglas-fir/ninebark habitat type using a series of macroplots established both inside and outside the enclosure during 1978. Each pair of grazed and ungrazed macroplots were on the same slope, aspect, and soil series. At least a 3-m distance was maintained as the minimum buffer width between plots and the enclosure fence to eliminate any bias associated with the fence right-of-way. A total of eighteen 15 × 25-cm (375 m²) macroplots were sampled. Variables measured included cover, frequency, production, number of trees, basal area, shrub density, and accumulation of downed woody fuels.

Each macroplot was further subdivided into three 5 × 25-m (125 m²) sections. Along the central section, fifty 20 × 50-cm (.1 m²) microplots were placed at 1-m intervals. In these microplots, the parameters of cover, frequency, and production were measured. Cover was estimated using 6 cover classes for plants inside the microplots (Daubenmire 1959). Rooted frequency was determined for all species. Herbaceous plant species in every third microplot were clipped, oven dried, weighed, and converted to kilograms per hectare to obtain production values. Grazing was unrestricted for the grazed plots, but very few animals were observed in the stands prior to the sampling period.

Trees were tallied by 1/2-dm diameter classes as measured at breast height (1.4 m). All trees of this height and taller were measured in the macroplot. Basal area was calculated by the formula:

$$ba = (\frac{1}{2}d)^2 \times \pi,$$

where d equals diameter at breast height (Mueller-Dombois and Ellenberg 1974). Densities of trees less than breast height and shrubs were measured in 2 belt transects, 1 × 25 m, which were located along the central 5 × 25-m section of the macroplot. Average tree ages were estimated by obtaining increment cores

from a minimum of 2 trees per diameter class in each plot and counting annual rings. Downed woody fuel accumulations were measured by the planar intersect method (Brown 1974) in two 10-m line transects. This technique provided the following information:

1. Weights per hectare of downed woody material for:
 - a. Diameter size classes 0 to 0.6 cm (0 to 0.25 inch)
0.6 to 2.54 cm (0.25 to 1 inch)
2.54 to 7.62 cm (1 to 3 inches)
 - b. Sound and rotten fuel particles of diameters of 7.62 cm larger.
 - c. Forest floor duff.
2. Depth of fuel and forest floor duff.

One-way analysis of variance and Student's *t*-test were used for statistical analyses of differences between grazed and ungrazed stands for all variables. Throughout the paper the term *significant* refers to $P < 0.05$.

Results and Discussion

Overstory Structure

The largest number of trees in both grazed and ungrazed stands were in the smaller diameter classes. As diameters increased, total number of trees decreased. Number of ponderosa pine and Douglas-fir in grazed stands were greater than in ungrazed stands in every diameter class up to 4 dm (Fig. 1, 2), but, more significantly, in the .5 to 2-dm classes. There were no large or consistent

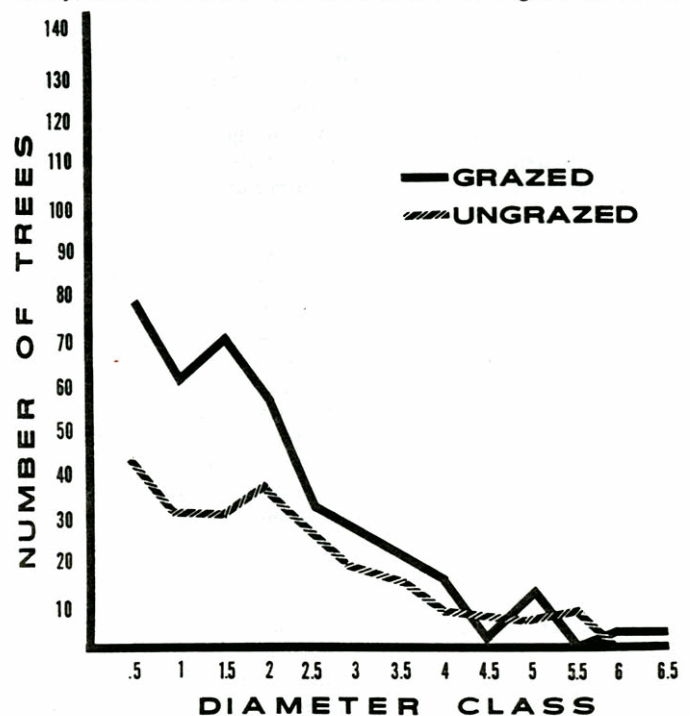


Fig. 1. Mean number of ponderosa pine trees by .5 decimeter diameter classes for grazed and ungrazed stands.

differences between the stands in the number of trees in diameter classes larger than 3 dm. In grazed stands there were more Douglas-fir trees than ponderosa pine in nearly every diameter class. In the ungrazed stand, with the exception of the .5-dm diameter class, there was a similar number of each tree species. However, in grazed stands, Douglas-fir were more abundant than ponderosa pine in the smaller size classes.

Number of Douglas-fir seedlings was about the same (1,277.6/-ha) on grazed and ungrazed stands. Number of ponderosa pine seedlings was significantly different, with only 55.6/ha on grazed stands but 555.6/ha on ungrazed stands. Many researchers have

²Flat Creek-Hatter Creek Allotment Management Plan. Cooperative plan developed by the University of Idaho, Palouse Ranger District (USFS), and Latah Soil and Water Conservation District. On file at Palouse Range Station, Potlatch, Ida.

found an increased number of seedlings following natural regeneration on moderately grazed sites in freshly cut forested stands (c.f. Adams 1975, Young et al. 1942, Tisdale 1950), but this benefit is apparently reduced for ponderosa pine when succession advances. In grazed stands, ponderosa pine regeneration was reduced as the quantity of shading and duff increased. Douglas-fir is more shade tolerant than ponderosa pine, is climaxed on these sites, and has the greater ability to regenerate in both open areas of ungrazed stands and shaded areas of grazed stands. In the long term, heavy grazing is more beneficial for Douglas-fir regeneration than for ponderosa pine.

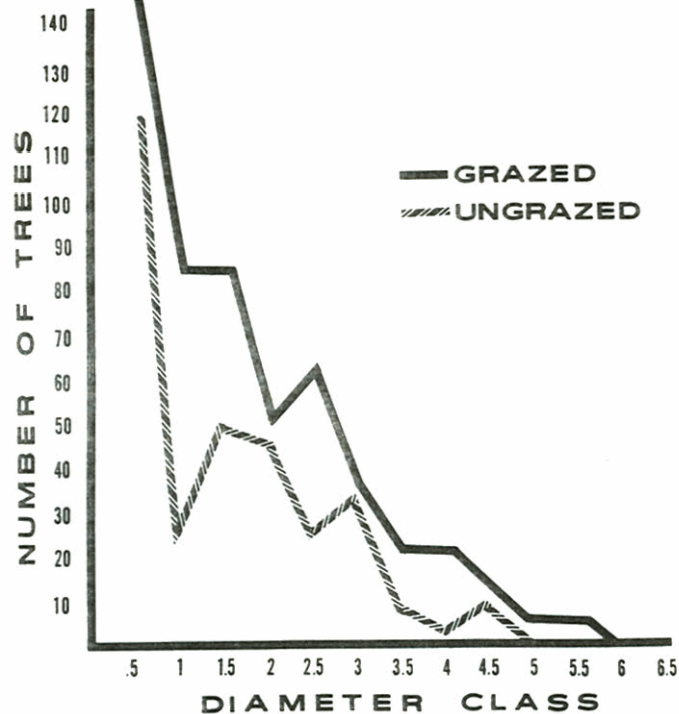


Fig. 2. Mean number of Douglas-fir by .5 decimeter diameter classes for grazed and ungrazed stands.

Increase in young tree densities has been attributed to the removal of the competing herbaceous layer by heavy grazing (Pearson 1923, Leopold 1924, Arnold 1950, Cooper 1960, Tisdale 1960, Pearson 1942, and Young et al. 1942). Weaver (1950) reported that overgrazing resulted in development of abnormally dense stands because it resulted in breakup of original sod and preparation of mineral seedbed. Rummell (1951) concluded that heavy grazing was primarily responsible for dense tree reproduction in central Washington.

In the majority of diameter classes, tree growth rates in grazed stands were slightly less than in ungrazed stands (Table 1). Lower growth rates in areas heavily grazed were reported by Adams (1975). Higher tree densities resulting from livestock grazing may have been the cause for decreased tree growth rates in grazed stands. Competition in dense stands reduced the growth and vigor of all trees, resulting in diameter growth reductions (Smith 1962).

Tree diameter classes which had the greatest difference between grazed and ungrazed stands (.5 to 2 dm), ranged in age from 16 to 56 years (Table 1). Thus, most of smaller diameter trees had become established during the past 50 years, a period of heavy grazing. Livestock grazing was probably the principal factor in creating and maintaining conditions that favored increased tree regeneration.

There was a significantly higher mean basal area in grazed stands (37 m²/ha) than in ungrazed stands (22 m²/ha) (Fig. 3). This large difference may be attributed to increased number of smaller trees in the grazed stands.

Table 1. Average tree age by diameter class for ponderosa pine and Douglas-fir in grazed and ungrazed stands.

Diameter class (.5 dm)	Age ¹			
	<i>Pinus ponderosa</i>		<i>Pseudotsuga menziesii</i> ¹	
	Grazed	Ungrazed	Grazed	Ungrazed
.5	20.25	15.67	22.14	22.50
1.0	32.20	26.67	34.86	30.00
1.5	36.50	38.00	41.33	35.60
2.0	42.71	55.75	48.83	32.20 ²
2.5	55.20	51.17	51.17	41.33
3.0	67.67	61.50	59.40	43.00
3.5	64.67	65.20	67.25	39.00
4.0	96.00	91.00*	81.00	112.00*
4.5	123.00*a	74.00*b	97.75 ^{ab}	86.50 ^b
5.0	105.33	119.00	80.00*	—
5.5	—	108.00	96.00	—
6.0	104.00*	—	—	—
6.5	165.00*	98.00*	—	—

¹Species ages followed by different letters are significantly different at the 0.05 level.
²Tree ages followed by different numbers are significantly different at the 0.05 level.

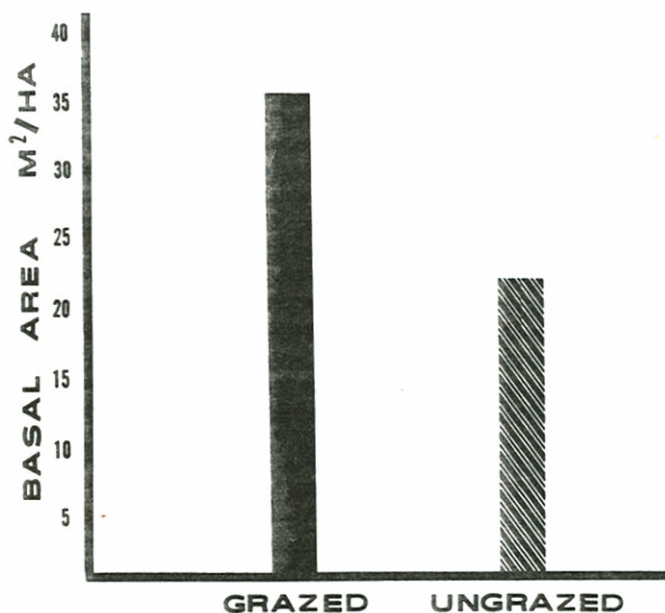


Fig. 3. Mean basal area for ponderosa pine and Douglas-fir in grazed and ungrazed stands.

Shrub Layer

Total shrub density did not differ significantly between heavily grazed and ungrazed stands, but individual species density did (Table 2). Of the 12 shrub species sampled, only 3, serviceberry (*Amelanchier alnifolia*), ninebark, and white spiraea (*Spiraea betulifolia*), had a greater density in grazed stands. Serviceberry was either very tall and out of reach of livestock and big game, or very small and unutilized. The 9 other species had greater densities in ungrazed stands, but only redstem ceanothus (*Ceanothus sanguineus*), chokecherry (*Prunus virginiana*), and yerba buena (*Satureja douglasii*) densities were significantly greater. Redstem ceanothus, apparently suppressed through heavy use by livestock and big game, was nearly absent in grazed stands. Chokecherry and scouler willow (*Salix scouleriana*) occurred in such low densities in all stands that comparisons were not meaningful. Yerba buena, kinnikinnick (*Arctostaphylos uva-ursi*), and creeping Oregon grape (*Berberis repens*), were probably less resistant to trampling by livestock due to their small size and shallow rhizomes, and were present in lesser amounts in grazed stands. Little wild rose (*Rosa gymnocarpa*) and snowberry also had higher densities in

Table 2. Numbers per hectare, percent cover, and average percent frequency for major shrub species.

Species	Number of shrubs ¹		Cover • Frequency	
	Grazed	Ungrazed	Grazed	Ungrazed
<i>Amelanchier alnifolia</i>	5622	1755*	0.3 • 2.2	0.3 • 2.0
<i>Arctostaphylos uva-ursi</i>	233	755	+ ³ • 0.4	0.2 • 2.0
<i>Berberis repens</i>	1600	1755	0.7 • 4.0	1.1 • 5.8
<i>Ceanothus sanguineus</i>	122	2033*	0.0 • 0.0	2.7 • 5.3*
<i>Holodiscus discolor</i>	522	989	0.6 • 1.3	2.6 • 4.4*
<i>Physocarpus malyaceus</i>	2077	1611	2.3 • 6.9	1.7 • 4.4
<i>Prunus virginiana</i>	0	67*	0.0 • 0.0	0.0 • 0.0
<i>Rosa gymnocarpa</i>	3489	4510	1.2 • 8.2	2.1 • 12.4*
<i>Satureja douglasii</i>	78	700*	+ • 0.4	0.5 • 3.3*
<i>Salix scouleriana</i>	67	253	0.0 • 0.0	0.2 • 0.9
<i>Spiraea betulifolia</i>	7900	5033	5.8 • 42.0	4.7 • 32.0
<i>Symphoricarpos albus</i>	9767	12377	4.6 • 26.0	7.2 • 39.3*
Total for all shrub species	31477	31838	15.8 • —	24.5* • —

¹Species means followed by an asterisk are significantly different at the 0.05 level.

²Numbers represent percent cover (first) and average frequency (second).

³Values less than 0.1 are represented by +.

ungrazed stands indicating that livestock grazing retarded their spread, possibly through rhizome damage by trampling.

Total percent cover for all shrubs was significantly lower in grazed stands (15.8%) than in ungrazed stands (24.5%) (Table 2). This reduction in cover suggested that shrub species sustained heavy use by livestock. Because of the unequal size distribution of individual plants, ninebark and white spiraea had higher cover and frequency values in grazed stands. Serviceberry had higher frequency in the grazed stands but equal cover in both grazed and ungrazed stands. All nine of the other individual species had higher cover and frequency in ungrazed stands. Five of these, redstem ceanothus, oceanspray, little wild rose, yerba buena, and snowberry were significantly higher. Krueger and Winward (1974) found similar results with oceanspray and snowberry in northeastern Oregon. They also found that ninebark had lower percent cover in stands grazed by cattle and big game in stands grazed by big game only. Redstem ceanothus occurred frequently with one of the higher cover values in the ungrazed stands, but was not encountered in microplots in grazed stands.

Herbaceous Layer

Production, percent cover, and frequency of grasses indicated that livestock grazing was a substantial influence (Table 3). Production of bluebunch wheatgrass, pinegrass, and Idaho fescue were significantly lower in grazed stands. Bluebunch wheatgrass production in grazed stands was nearly 140 times greater than that in stands grazed by livestock. Pinegrass production in grazed stands was only 28% of that found in ungrazed stands (a reduction of nearly 72%). Idaho fescue was absent in stands grazed by livestock (Evanko and Peterson 1955). Columbia brome (*Bromus vulgaris*) production was slightly less in grazed stands. Kentucky bluegrass (*Poa pratensis*) and elk sedge production increased in grazed stands and was nearly absent in ungrazed stands.

In grazed stands, cover of Columbia brome and Kentucky bluegrass was significantly higher, while cover of bluebunch wheatgrass, pinegrass, and Idaho fescue was lower. Pinegrass had the largest difference, with cover in grazed stands less than one-half the cover in ungrazed stands. Elk sedge cover was the same in grazed and ungrazed stands. In central Washington ponderosa pine stands, Rummell (1951) found that the most striking effect of heavy grazing was reduction of grasses, principally pinegrass, to half or less of the cover found in ungrazed stands. R. and J. Daubenmire (1968) reported that Kentucky bluegrass increased under heavy grazing.

Combined production of all forb species was found to be significantly lower in stands grazed by livestock (340 kg/ha) than in ungrazed stands (469 kg/ha) (Table 3). Bigleaf sandwort (*Arenaria macrophylla*) and mountain sorrel (*Rumex paucifolia*) production

was higher in grazed stands. Production of Piper's anemone (*Anemone piperi*), raceme pussytoes (*Antennaria racemosa*), showy aster (*Aster conspicuus*), pinewoods peavine (*Lathyrus bijugatus*), western starflower (*Trientalis latifolia*), American vetch (*Vicia americana*), and early blue violet (*Viola adunca*) was lower in grazed stands. No meaningful responses to grazing were found for other species.

Total forb cover was not substantially different between the stands (Table 3). However, bigleaf sandwort, heartleaf arnica (*Arnica cordifolia*), and narrowleaf collomia (*Collomia linearis*), had significantly higher cover in grazed stands. Raceme pussytoes, showy aster, mountain sweetroot (*Osmorhiza chilensis*), Gairdner's yampa (*Perideridia gairdneri*), cinquefoil (*Potentilla gracilis*), western starflower, and American vetch had significantly lower cover in grazed stands. There were no substantial differences in cover of other species.

Frequency of forb species in grazed and ungrazed stands generally followed the same trends observed in production and cover (Table 3), but some very distinct changes in species occurrence were obvious. In grazed stands, Piper's anemone and western starflower decreased markedly from (22.2% to 12.2% and from 15.6% to 3.1%, respectively) and bigleaf sandwort increased substantially (from 15.8% to 39.1%). Krueger and Winward (1975) found that frequency of forbs generally increased under heavy grazing pressure.

Fuel Accumulation

Livestock grazing did not directly alter the fuel loading. However, grazing did change the density and composition of woody and herbaceous material, which indirectly influenced the fuel accumulation. Total accumulation of downed woody material was found to be greatest in stands grazed by livestock (75,804 kg/ha compared to 53,984 kg/ha) (Fig. 4). Inspection of downed woody material accumulation by size classes revealed that stands used by livestock contained higher weights per area in every category (Fig. 4). The largest differences were found in the 7.62 cm and larger size classes, with sound particles of this size comprising 9,200 kg/ha (5.11 tons/acre) in grazed and only 3,881 kg/ha (2.16 tons/acre) in ungrazed stands. Rotten particles of this size comprised 9,759 kg/ha (5.42 tons/acre) in grazed and 5,729 kg/ha (3.81 tons/acre) in ungrazed stands. In each of the smaller size classes, grazed stands contained nearly double the amount of fuel found in ungrazed stands. Accumulations of duff comprised the highest weights per area of any single category in both grazed and ungrazed stands. Stands grazed by livestock had 52,563 kg/ha (29.2 tons/acre) of duff. Grazing has reduced duff accumulation by compacting litter and increasing the rate of decomposition of western forests (Hattin 1920, Weaver 1951). However, as tree

Table 3. Production in kilograms per hectare, percent cover, and average percent frequency for major herbaceous species.¹

	Production			Cover frequency ²		
	Grazed	Ungrazed		Grazed	Ungrazed	
Graminoids:						
<i>Agropyron spicatum</i>	0.17	23.98*	+3	0.9	0.5	10.2*
<i>Bromus vulgaris</i>	1.00	2.00	1.3	24.0	0.7	19.3*
<i>Calamagrostis rubescens</i>	47.09	165.48*	0.8	21.3	2.1	34.2*
<i>Carex geyeri</i>	114.26	57.48	2.5	49.6	2.6	44.9
<i>Festuca idahoensis</i>	0.00	10.85*	+	0.0	0.4	8.2*
<i>Poa pratensis</i>	16.95	0.00*	0.9	14.7	0.0	0.0*
Total for all graminoids	188.83	273.47	5.9	—	6.3	—
Forbs:						
<i>Achillea millefolium</i>	50.20	83.10	0.9	15.8	0.7	16.2
<i>Apocynum androsaemifolium</i>	25.30	8.20	0.4	4.7	0.5	5.3
<i>Anemone piperi</i>	1.30	4.00*	0.8	12.2	1.1	22.2
<i>Antennaria racemosa</i>	0.10	0.30*	+	0.2	0.1	1.8*
<i>Arenaria macrophylla</i>	5.20	1.90*	2.9	39.1	0.6	15.8*
<i>Arnica cordifolia</i>	6.90	6.60	2.9	27.8	1.5	26.2*
<i>Aster conspicuus</i>	0.00	4.50*	+	0.7	0.4	4.4*
<i>Collomia linearis</i>	4.20	6.90	0.2	9.8	0.1	4.4*
<i>Collinsia parviflorus</i>	0.00	0.00	0.2	6.9	0.2	8.7
<i>Cryptantha echinella</i>	41.70	34.00	0.1	1.1	+	1.6
<i>Fragaria virginiana</i>	2.00	2.70	4.2	39.8	4.9	50.7
<i>Galium boreale</i>	161.80	196.00	0.4	6.0	0.4	9.8
<i>Goodyera oblongifolia</i>	18.80	34.10	+	0.7	+	0.7
<i>Gypsophila paniculata</i>	0.20	0.30	+	1.6	+	1.1
<i>Lathyrus bijugatus</i>	3.40	7.40*	0.5	12.0	0.6	10.9
<i>Lupinus sericeus</i>	9.00	22.00	0.7	6.4	0.8	8.9
<i>Madia exigua</i>	0.10	2.40	0.2	1.8	+	3.4
<i>Osmorhiza chilensis</i>	0.03	0.12	+	1.6	0.4	6.2*
<i>Perideridia gairdneri</i>	0.30	1.00	+	0.2	0.1	2.9*
<i>Potentilla glandulosa</i>	0.00	28.70	0.3	4.0	0.4	5.8
<i>Potentilla gracilis</i>	3.20	10.00	+	0.2	0.2	1.8*
<i>Rumex acetosella</i>	0.40	0.10	+	0.9	+	0.4
<i>Rumex paucifolia</i>	1.00	0.10*	0.2	2.4	+	1.3
<i>Smilacina stellata</i>	3.20	1.30	0.7	6.0	0.4	2.4
<i>Taraxacum officinale</i>	0.20	7.30	0.3	4.0	0.2	7.1
<i>Thalictrum occidentale</i>	1.30	2.10	0.6	6.2	0.7	8.4
<i>Trientalis latifolia</i>	0.60	1.90*	0.2	3.1	0.5	15.6*
<i>Vicia americana</i>	0.00	1.30*	+	0.2	0.2	5.6*
<i>Viola adunca</i>	0.03	1.40*	0.2	3.1	0.3	8.0
Total for all forbs	340.46	469.72*	17.6	—	17.3	—

densities increased in dry Douglas-fir stands following grazing, the quantity of litter fall increased and the composition of the duff changed. Probably this created a microenvironment that was not

conductive to increased litter fall or reduced rate of decomposition. Heavily grazed stands had greater accumulations of duff and downed woody fuel suppression mortality and lower branch drop that followed the canopy closure. Heavy grazing indirectly increased the accumulation of organic debris in the grazed stands of this study.

In general, in fire-danger ratings, living fuels are burnable fine fuels when dry and are part herbaceous and part nonherbaceous material (Fosberg and Schroeder 1971). Nonherbaceous fine fuels are perennial foliage of shrubs and tree reproduction, and woody stems less than .6 cm in diameter. Herbaceous fine fuels are comprised of vegetation such as grasses, sedges, and forbs. Nonherbaceous fine fuels were not measured in this study because of sampling difficulty. Total live herbaceous fine fuels were found to be significantly lower in grazed (467 kg/ha) than in ungrazed stands (719 kg/ha) (Table 3).

Little research has been done concerning burning characteristics of living fuels, but their importance in reaction intensity and rate-of-spread has been discussed (Richards 1940, Fosberg and Schroeder 1971, Rothermel 1972). Based on fuel arrangement, Rothermel (1972) indicated that herbaceous fuels were considered as flashy and have the highest potential reaction intensity. He also showed that with the addition of wind, herbaceous fuels had the highest rate-of-spread. Richards (1940) reported that plant moisture content was the major factor controlling vegetative influence on fire

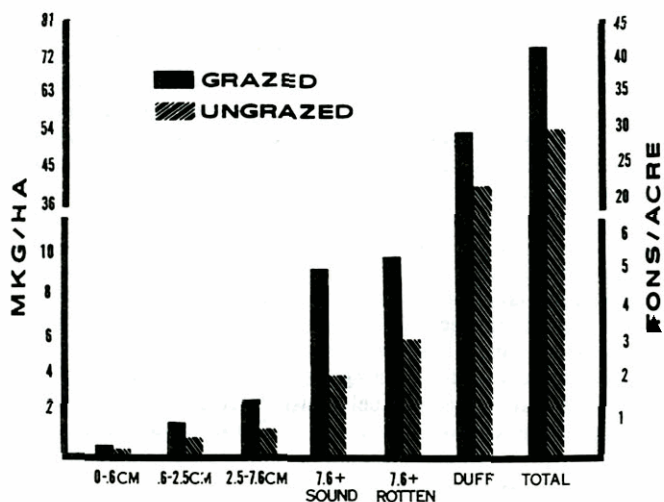


Fig. 4. Mean fuel loading by size classes for grazed and ungrazed ponderosa pine and Douglas-fir stands.

rate-of-spread. Decreased moisture content occurring during the summer resulted in increased flammability. He also found that the rates at which plants lost moisture when subjected to fire caused different fire behavior. Hatton (1920) directly attributed reductions in the incidence of fire to removal of herbaceous material and increased decomposition through trampling from grazing livestock. Jemison (1934) reported that tree canopy density significantly influenced flammability. Increasing tree canopy density reduced temperature, humidity, wind, and evaporation below the canopy, which resulted in increased moisture holding capacity of understory vegetation and reduced flammability. Thus, as livestock grazing influenced canopy density and reduced fine fuels, it also affected the ability of the forest to sustain a surface fire.

Management Implications

Livestock grazing has altered the composition and quantity of ground cover vegetation. Removal of herbaceous competition combined with exposure of mineral soil has aided in preparing stands for increased tree reproduction. Consequently, regeneration success of both ponderosa pine and Douglas-fir has increased with potentially long-lasting effects.

Douglas-fir habitat types in northern Idaho have typically supported uneven-aged forests with many age and diameter classes represented. The proportion of trees in each diameter class has remained relatively constant over time (until complete crown closure has occurred), with the diameter distribution usually taking the form of a falling exponential curve with the number of trees plotted against diameter. In grazed stands the balance in forest structure shifted so that greater numbers of trees now occur in smaller size classes. Overstocked ponderosa pine and Douglas-fir stands may stagnate, causing reductions in growth rates, and increased susceptibility to damage from insects or disease. Increased stocking levels and basal area have reduced both shrub and herbaceous layers. In the Douglas-fir/snowberry habitat type, understory production decreased as tree canopy cover increased (Froeming 1974). An inverse relationship between overstory canopy or basal area and the density or production of shrubby and herbaceous understories had been reported by researchers working under a wide variety of conditions (Arnold 1950, Tisdale 1950, Pase 1958, Cooper 1960, McConnell and Smith 1965, Hedrick et al. 1968). Also, as stocking levels increased, livestock movement became more difficult. Cattle concentrated in open areas, or along roads or fences, causing further pressure on already overused range. These concentrations may have caused trampling and compaction damage to tree reproduction.

Livestock grazing appeared to have no significant influence on density of shrubs, although it did cause significant reductions in cover and composition. Continuous heavy grazing suppressed the growth of redstem ceanothus, a browse species highly desirable and important to big game species. Thilenius (1960) found that cattle first used palatable forage grasses, then were forced to subsist on browse and forbs for the remainder of the growing season. He also found that browse species comprised the greater part of the food supply of livestock using forested ranges when the areas were overused. Thus, as tree canopy cover increased, the browse component received heavier use from grazing livestock, causing additional shrub species to be suppressed.

Generally, influence of livestock grazing on the herbaceous layer was most pronounced in production. Significant reductions were found in the major palatable grass species and in total forb production.

It appeared that livestock grazing was responsible for retrogression of plant succession within the herbaceous layer. Climax grass species were replaced by species common to seral communities. There were apparent changes in dominance of certain forb species.

In the overstory, grazing advanced succession. Ponderosa pine was the most prevalent seral tree species found in these stands, although there were occasional lodgepole pine (*Pinus contorta*).

Douglas-fir regeneration was most pronounced, and comprised the majority of trees in all of the smaller diameter classes. It appeared to be gaining dominance in the heavily grazed stands.

Modifications in plant succession were not defined as clearly in the shrub layer. Livestock showed preference for the more palatable browse species, which were commonly seral in this habitat type. In climax situations, ninebark was the principal species, with oceanspray, snowberry, and white spiraea also well represented. In stands used by livestock, ninebark had increased, although not significantly, but was not the dominant species. In the grazed stands, oceanspray and snowberry had decreased while white spiraea had increased.

Livestock grazing increased total accumulations of downed woody fuels. While it is possible that incidence of low intensity surface fires was reduced through the increase in forest canopy and removal of the herbaceous layer, this reduction may not be as significant as once thought. As the highly palatable species were selectively removed, they were replaced in lesser amounts by unpalatable and high flammable species.

Douglas-fir forest communities and environmental conditions that influenced them interacted to establish a level of duff accumulation and decomposition rates of woody material. Livestock grazing in these forests increased duff accumulation but apparently did not accelerate decomposition rates. Larger fuels and forest floor duff contributed very little to the rate-of-spread, but once ignited, persisted in the form of smoldering fires. These smoldering fires are difficult to extinguish, providing a source of burning embers for further fire spread. Thus, over long periods of time, the physical accumulation of large amounts of downed woody fuels and duff layers may induce flammability (Bloomberg 1950).

Increased total tree numbers and unpalatable shrub species, when combined with increased duff and all size classes of dead organic material, created bridges between the ground layers and tree canopies. This manner of fuel distribution is highly conducive to the vertical spread of fire through a forest canopy.

Douglas-fir/ninebark forest stands have historically experienced damage from wildfires (Wellner 1970). In western Montana, extreme fire damage was, generally, confined to northern exposures. Southern exposures experienced frequent, low intensity fires (Arno 1976). Concentrations of flashy or herbaceous fuels and moderate stocking levels permitted surface fires to pass quickly through stands, causing little damage. In the future, if grazing-induced fuel buildups and fuel ladder situations are permitted to continue, the potential destructiveness of crown carrying wildfires will increase.

Several types of forest management practices lend themselves to the mitigation of adverse fuel conditions in these stands. Prescribed understory burning can remove herbaceous fuels, reduce litter and downed woody fuel accumulations, and control excessive tree reproduction. For dense sapling and pole-sized stands, pre-commercial and commercial thinning can achieve and maintain desired stocking levels. Depending on the residual stand, prescribed burning can be used in conjunction with thinning operations to control fuel levels.

If effects of intensive grazing are allowed to continue over long periods of time, prescribed burning treatments will be difficult to administer. During attempts to carry out prescribed understory burning in grazed and ungrazed Douglas-fir stands, Zimmerman (1979) found that the 2 areas could not be burned under the same fire weather conditions. He found that temperature and moisture conditions suitable for burning quickly drying herbaceous fuels of ungrazed stands created fuel moisture conditions that severely restricted the ignition and spread of fire in the abundant, larger fuels of grazed stands. These stands only burned under dry, wild-fire weather conditions.

The influence of excessive livestock grazing on community structure in the Douglas-fir/ninebark habitat type resulted in modifications of plant cover and fuel distribution and composition.

The modifications that resulted in fuel distribution and composition were slightly less favorable to frequent surface fires, highly conducive to vertical spreading of fire, and potentially more capable of major conflagrations. Therefore, continued livestock grazing without fuel management will cause reductions in the frequency of low intensity fires, but will promote conditions that favor the occurrence of infrequent, high intensity fires.

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Zimmerman, Thomas Gordon-Livestock Grazing, Fire,
and Their Interactions Within the Douglas-fir / Ninebark
Habitat Type of Northern Idaho (1979)- SD427.G8Z5

Date: 4 April 1983

Researcher/s: Leon Nevenschwander

Project Title: Livestock Grazing, Fire, and their interactions within the

Subject: Livestock Grazing and the Effect of Fire on the vegetation within DF/Phms
Keywords: Grazing, Fire, plant response, secondary succession, successional communities
Abstract: Vegetation was measured in paired plots established in grazed and ungrazed areas of a Douglas-fir/Ninebark habitat type. Measurements taken included cover, frequency, production, number of trees, basal area, shrub density and downed woody fuel accumulation. The goal was to determine changes in community structure, composition and distribution of fuel caused by livestock grazing and to assess the extent to which these changes modify fire frequency and intensity. This area was later burned to determine fuel load reductions that could be achieved.

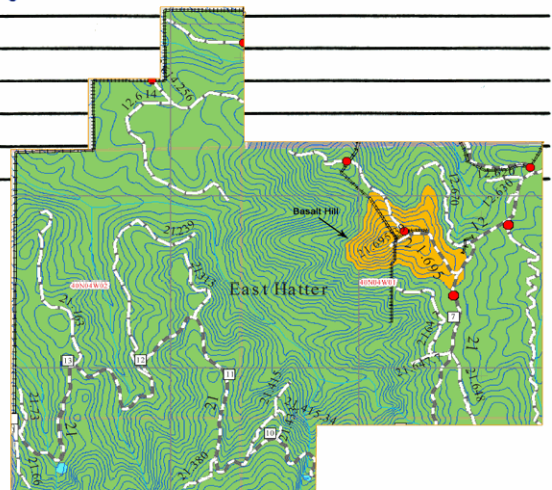
Location:

Unit of the Forest East Hatter Creek
T 40N R 4W S 1 NW¹/₄ + N¹/₂ SW¹/₄ + a little in NE¹/₄
Stand _____ Size of Area 40 acres
General Description of Area (Basalt Hill) - between upper road and draw 500' along entrance routes and exclosure boundary along north side

Plot or Area Designation: steel fence posts (plot center) - 375 plots (1m²)
corner of plots marked w/ 12" rebar stake

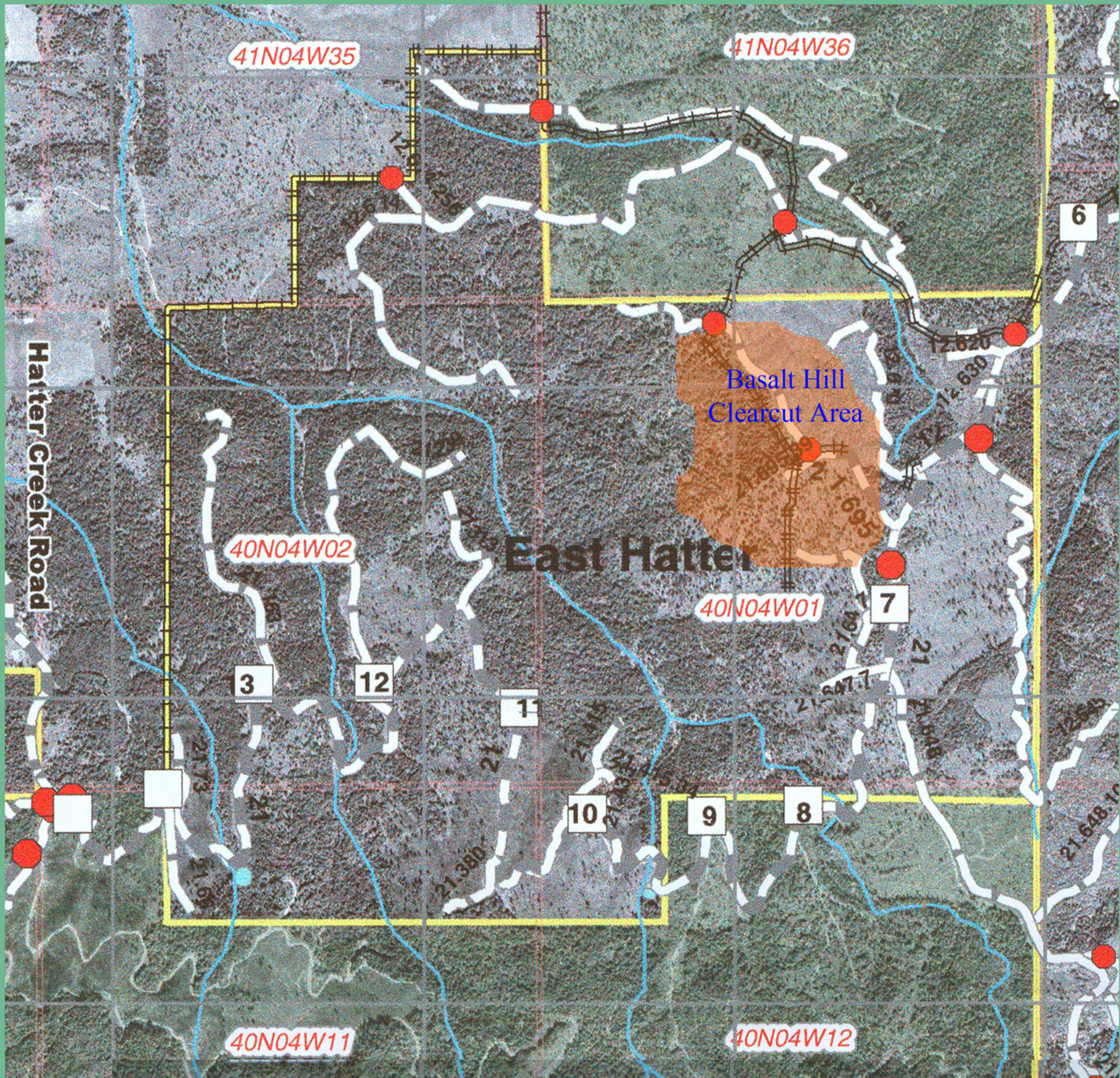
Date Begun: 1978 Jan Completion date (expected) (1998) continuing
Papers or Thesis Resulting: Livestock Grazing Influences on Community Structure, Fire Intensity and Fire Frequency within the Douglas-fir/Ninebark Habitat Type; Zimmerman and Nevenschwander. Journal of Range Mgmt. 37 (2):104-110. March 1984.
Fuel Load Reductions Resulting from Prescribed Burning in Grazed and Ungrazed Douglas-fir Stands. Zimmerman and Nevenschwander. Journal of Range Management 36(3):346-350, May 1983. (over)
Funding Source: USFS INT

Future Plans: continue to monitor stands

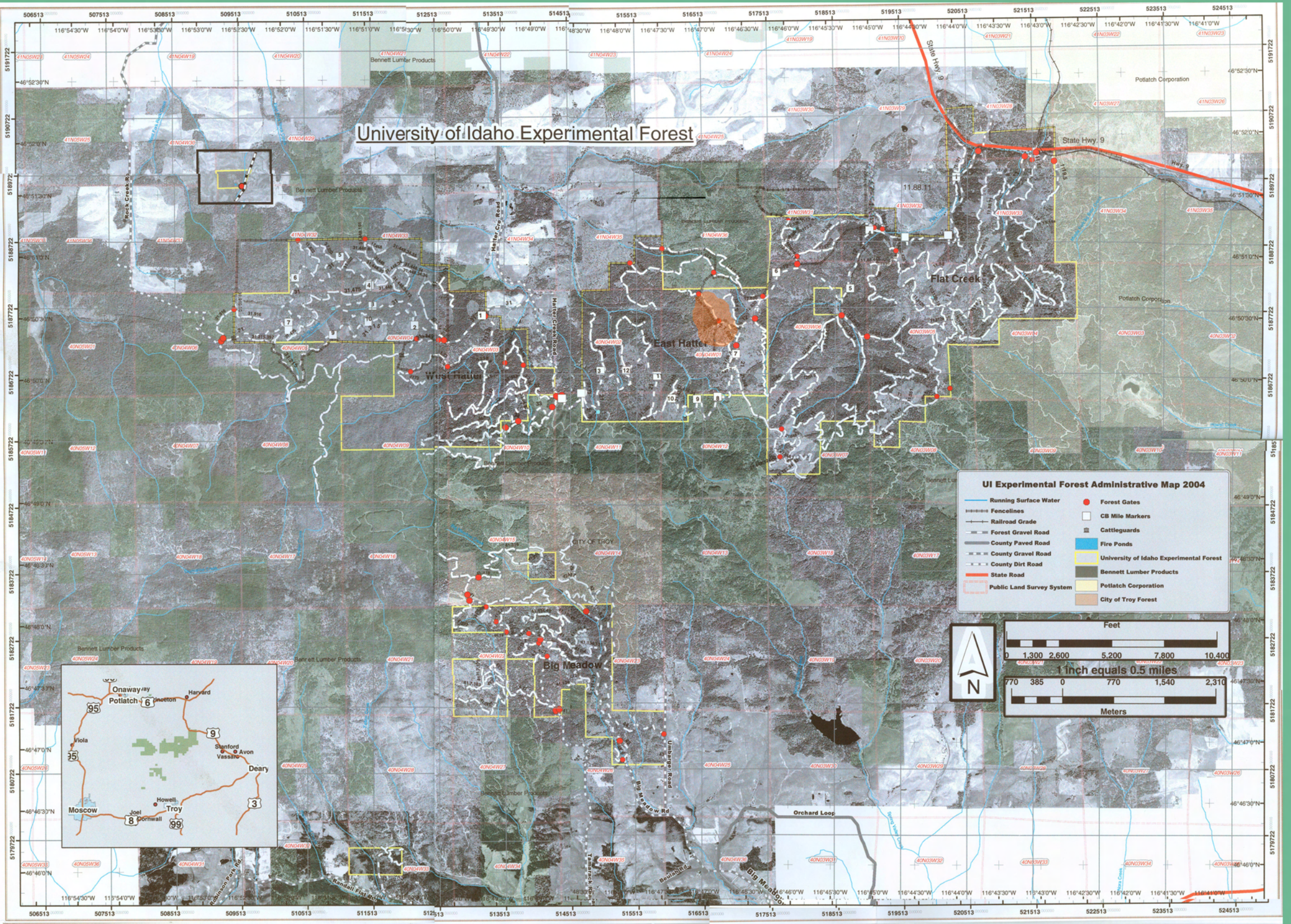


Tom Owens, Jim Peck

Habitat Selection of White tail deer in
some plots



East Hatter Creek Unit-2004 map



University of Idaho Experimental Forest Map 2004



Location of Complete Research:

Author & Title: Zimmerman, Thomas Gordon
Livestock Grazing, Fire, and Their Interactions Within the Douglas-
Fir/ Ninebark Habitat Type of Northern Idaho

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Other Sources: