AN ABSTRACT OF THE THESIS OF

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Title: LIVESTOCK UTILIZATION OF A CLEAR-CUT BURN IN NORTHEASTERN OREGON

Abstract approved: Redacted for privacy
Dr. A. H. Winward

Three five acre exclosures were established in 1964 to monitor vegetational regeneration and forage productivity on a coniferous forest site in northeastern Oregon which was clear-cut in 1963, broadcast burned and seeded in 1964. Fence design and construction to facilitate controlled early summer cattle grazing trials was completed by 1965. One exclosure, I, excluded indigenous big game species, mule deer (Odocoileus hemionus) and elk (Cervus canadensis) as well as cattle (Bos tarus); the remaining two, II and III, excluded cattle only. It had become evident by 1969 that the amount of available herbaceous forage in the game exclosure was decreasing as the amount of browse production increased. This study was set up during the summer of 1970 to quantitatively evaluate the amount, preference and nutritive value of browse utilized by cattle.

Following an early summer grazing trial, five mature cows

were placed in I from 19 August to 2 September, 1970. These animals lost an average of 6.7 pounds/day. The control group on meadow pasture lost an average of 2.3 pounds/day. The cows in I preferred herbaceous species, but as these were utilized, they grazed elderberry (Sambucus cerulea), willow (Salix ssp.), ninebark (Physocarpus malvaceus), redstem ceanothus (Ceanothus sanguineus), and snowbrush (C. velutinus) in descending order of preference. Browsing on conifers was negligible, and only 2% of the trees were injured by trampling.

Frequency and density of all plant species and cover of the shrub species were taken (in exclosures I and II) in June of 1971. Frequency data, incorporated into an association table, confirmed the presence of two plant communities, each displaying different floral composition. Shrub density on the ridge type, designated a Ponderosa pine community, was almost identical between I and II. Exclosure II, however, contained only two-thirds the cover of I. Shrub density in I of the slope type, a mixed coniferous forest community, was almost twice that of II; cover in I was four times that of II. These differences between exclosures were attributed to big game use.

Mature cows, pre-conditioned to a browse diet, were placed in I from 13 August to 27 August 1971. They gained .81 pounds/day, while the control group on an adjacent forested area lost .64

pounds/day. Elderberry, willow, redstem ceanothus, snowbrush, and ninebark was the descending order of browse preference that year. Conifer loss was restricted to only negligible trampling damage. To date, it appears that the number of conifer trees and the average tree height between I and II have not been influenced by the grazing treatments.

An indirect competition factor (similar plant species preference but at different seasons) was found to exist between the big game animals and the domestic livestock. Previous research indicates that mule deer prefer such species as ninebark, snowbrush, redstem ceanothus, oceanspray (Holodiscus discolor), and willow during the spring and early summer. The late summer grazing cows indicated a similar preference. The only direct competition (similar plant species preference during the same season) observed was in 1971 when the early summer grazing heifers made heavy utilization of ninebark.

Livestock Utilization of a Clear-cut
Burn in Northeastern Oregon

by

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INTRODUCTION

Northeastern Oregon, like most areas in the United States, is experiencing an increased demand in public land use. To compensate, a combination of occupational as well as recreational opportunities must be carefully considered and incorporated into future public and private land management planning. An efficient, economically sound multiple use program is one solution to this problem. This approach becomes even more important on deteriorated or marginally productive forest sites where land uses are not so pointedly favorable in the realization of a single end product. In eastern Oregon and Washington a sizeable acreage, broadly classified as mixed coniferous forest and located primarily on north and northeast facing slopes, falls into this category (Pettit, 1968). In spite of being located on mesic slopes with high moisture retaining soils, poor range conditions (Pickford and Reid, 1948; and Strickler, 1965) and retarded timber production (Keniston, 1968) are not uncommon on these sites. Appreciation of this situation has precipitated a considerable amount of forest-grazing research on the Hall Ranch of the Eastern Oregon Experiment Station at Union, Oregon.

Mixed coniferous forest land with a preponderance of grand fir (*Abies grandis*) as the climax forest species frequents the area. A serious production limitation is the common occurrence of diseased trees. Heart rot, caused by Indian paint fungus (Echinodontium tinctorium) in association with dwarf mistletoe (Arceuthobium americanum) account for the greatest losses (Pettit, 1968).

A managerial approach focused on enhancing forest regeneration as well as animal habitat was set up as a general area of investigation on the Hall Ranch. The primary objectives of this research were to:

(1) evaluate browse regeneration as influenced by ungulate grazing treatments following a clearcut, burn seeding operation in a mixed conifer forest site;

(2) establish a cattle browse preference list by calculating the percent utilization of current annual growth on the most abundant shrub species;

(3) interpret the grazing value of these plant species, as evidenced by animal weight fluctuations;

(4) assess the impact of these grazing treatments on established coniferous trees; and

(5) amalgamate these findings with past research in an attempt to evaluate the cattle-wildlife forage competitiveness relative to the study area.

THE STUDY AREA

This investigation was carried out on the Hall Ranch segment of the Eastern Oregon Experiment Station. The general location of the ranch is about 12 miles south-southeast of Union, Oregon; specifically, in Township 5 South, Range 41 East, Willamette Meridian, in Union County (Figure 1).

The 2,039 acre ranch, composed of dense forest, open forest, and meadow, provides summer range for some 150 animal units of the Experiment Station. The animals are released into the area in early May and removed in late November. Additional grazing pressure is exerted by indigenous big game species.

The general vegetational overstory of the ranch consists of: ponderosa pine (Pinus ponderosa), Douglas fir (Pseudotsuga menziessi), grand fir (Abies grandis) and western larch (Larix occidentalis). Snowberry (Symphoricarpos albus), oceanspray (Holodiscus discolor), ninebark (Physocarpus malvaceus), spirea (Spirea betufolia), Kentucky bluegrass (Poa pratensis), elk sedge (Carex geyeri), pinegrass (Calamagrostis rubescens), wild pea (Lathyrus sp.), and meadowrue (Thalictrum fendleri) frequently occur as understory species.

The bulk of the precipitation, approximately 30 inches annually, comes in the form of cold winter rains and snow (Figure 2).

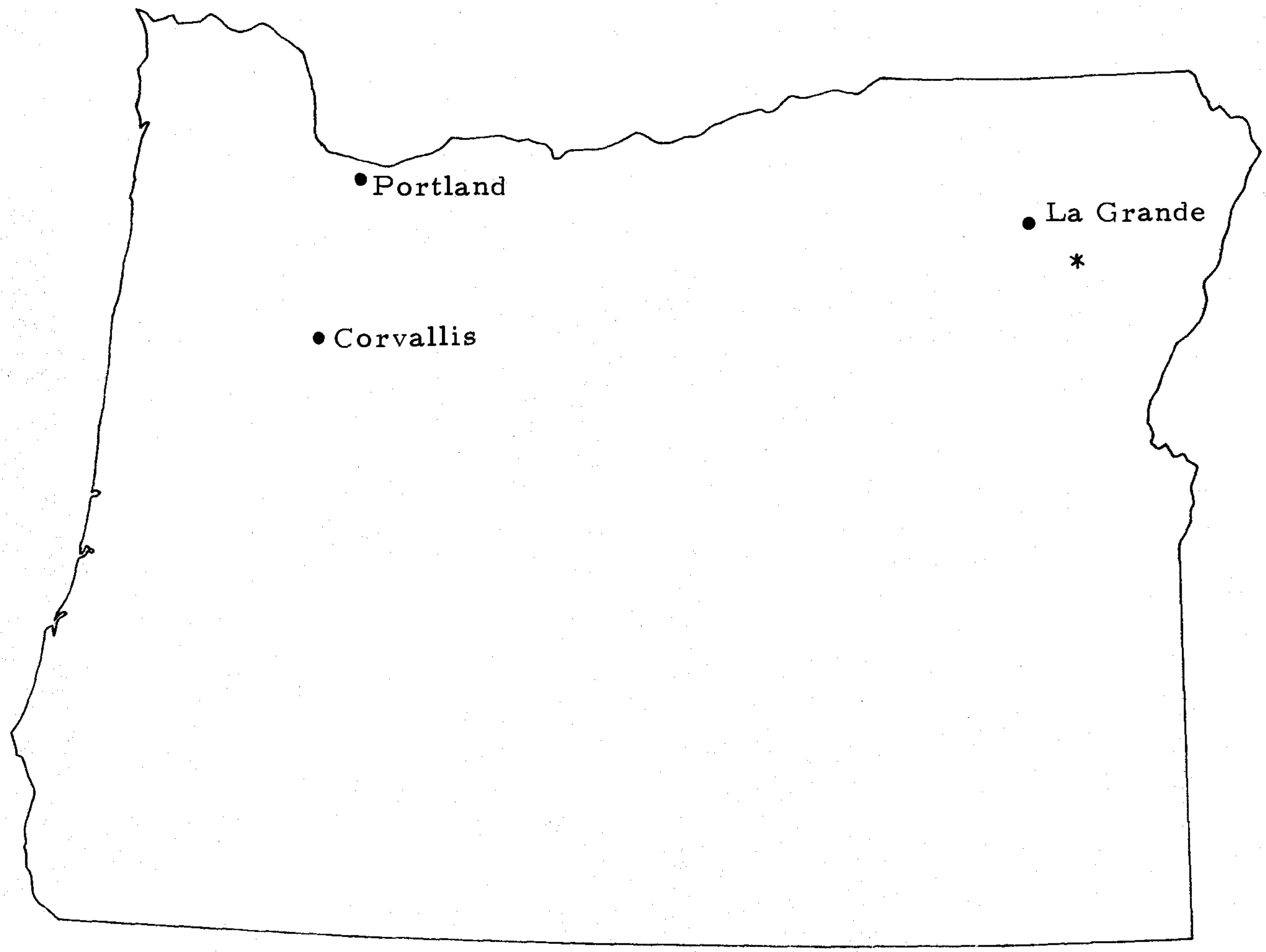

Figure 1. Location of the Eastern Oregon Experimental Station at Union, Oregon

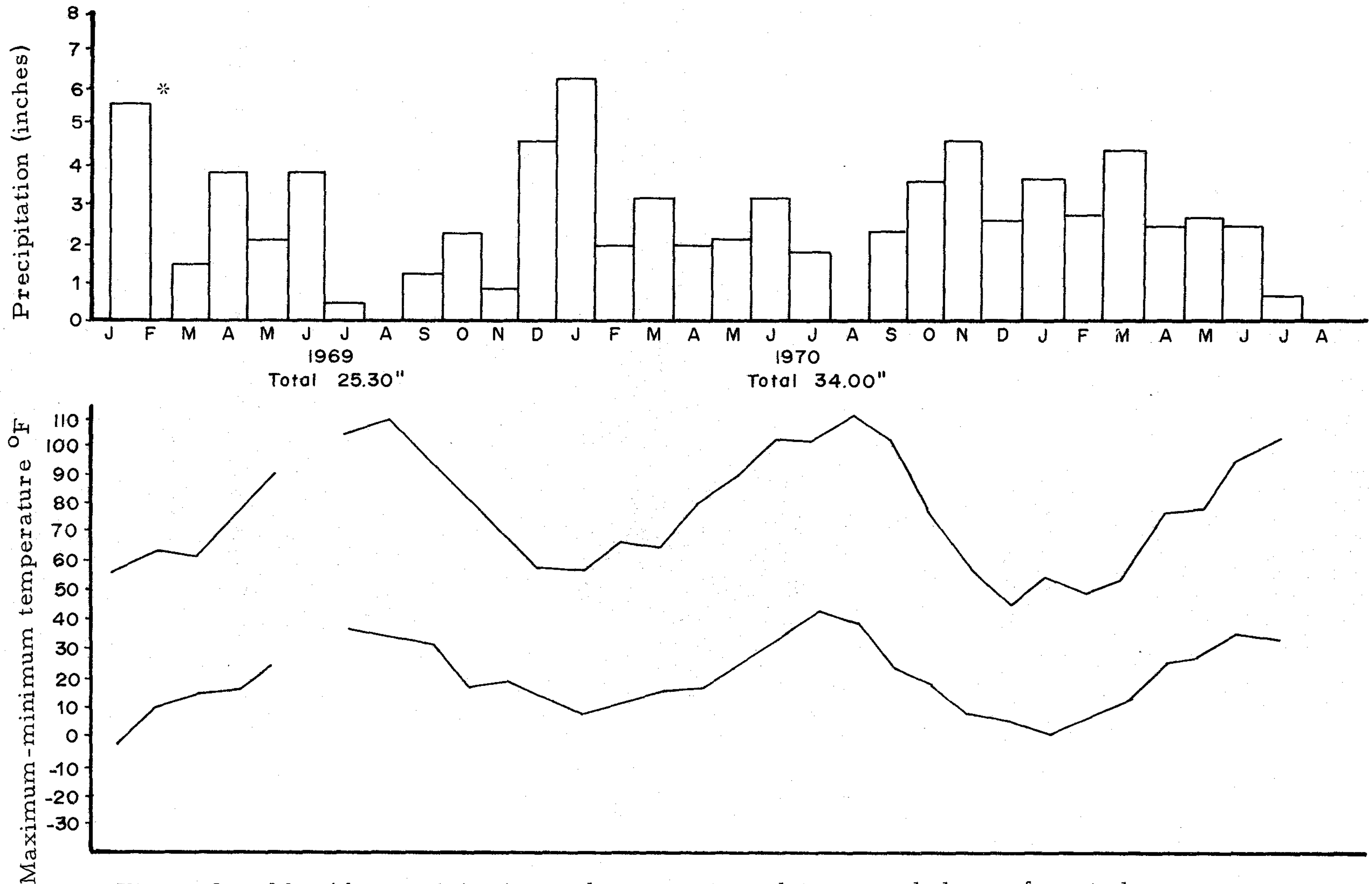

Figure 2. Monthly precipitation and temperature data recorded on a forested area adjacent to the clearcut burn.
*Frozen January 1969, thus measurements for two months combined.

Spring and fall months are cool and frequently moist and are separated by the dry, warm conditions of July and August. Air temperatures are somewhat cool throughout most of the year with highs seldom exceeding 100 degrees F. on southern exposures. Freezing temperatures may occur any month of the year but are unusual in July and August.

Catherine Creek, a major tributary of the Grande Ronde river, divides the Hall Ranch into roughly two equal parts. Elevations vary from 3, 400 feet along the creek to 4, 100 feet at the upper boundary. The study area, situated on a fault escarpment, is located on a sloping, moderately steep northeast exposure. The upper half of the slope is equivalent to a pediment backslope while the lower part could be called a pediment footslope (Pettit, 1968).

PREVIOUS WORK

Extensive and frequently drastic treatments have been associated with the study area (Figure 3). Prior to a clear-cut harvest operation in 1963 it supported a mixed conifer forest (A 315 site as designated by the Soil Conservation Service, 1956). All merchantable timber with 4-inch or greater tops was removed. The larger of the discarded material was arranged in an up-down slope manner and allowed to cure with the remaining slash. In July 1964 the entire 25 acres were broadcast burned and three five acre exclosures were established. These were in turn subdivided into five one acre plots (Figure 4). In August, each plot was further subdivided and subjected to one of the following treatments:

(1) Two 1/8 acre plots individually seeded at eight pounds per acre to: (a) blue wild rye (*Elymus glaucus*), or (b) mountain brome (*Bromus marginatus*):

(2) One 1/4 acre plot planted with a mixture of timothy (*Phleum pratense*), orchardgrass (*Dactylis glomerata*), tall oatgrass (*Arrhenatherum elatius*), smooth brome (*Bromus inermis*), and white Dutch clover, (*Trifolium repens*), at six pounds per acre, or

(3) One 1/2 acre plot untreated.

During September 1964 fences were constructed to facilitate

Figure 3. Aerial view of the 1963 clearcut study area looking east, August 1970. Exclosure I, at the bottom of the photo, is separated from exclosure II by a deer-proof fence visible in the lower 1/4 of the photo. Exclosure III is at the top of the picture.

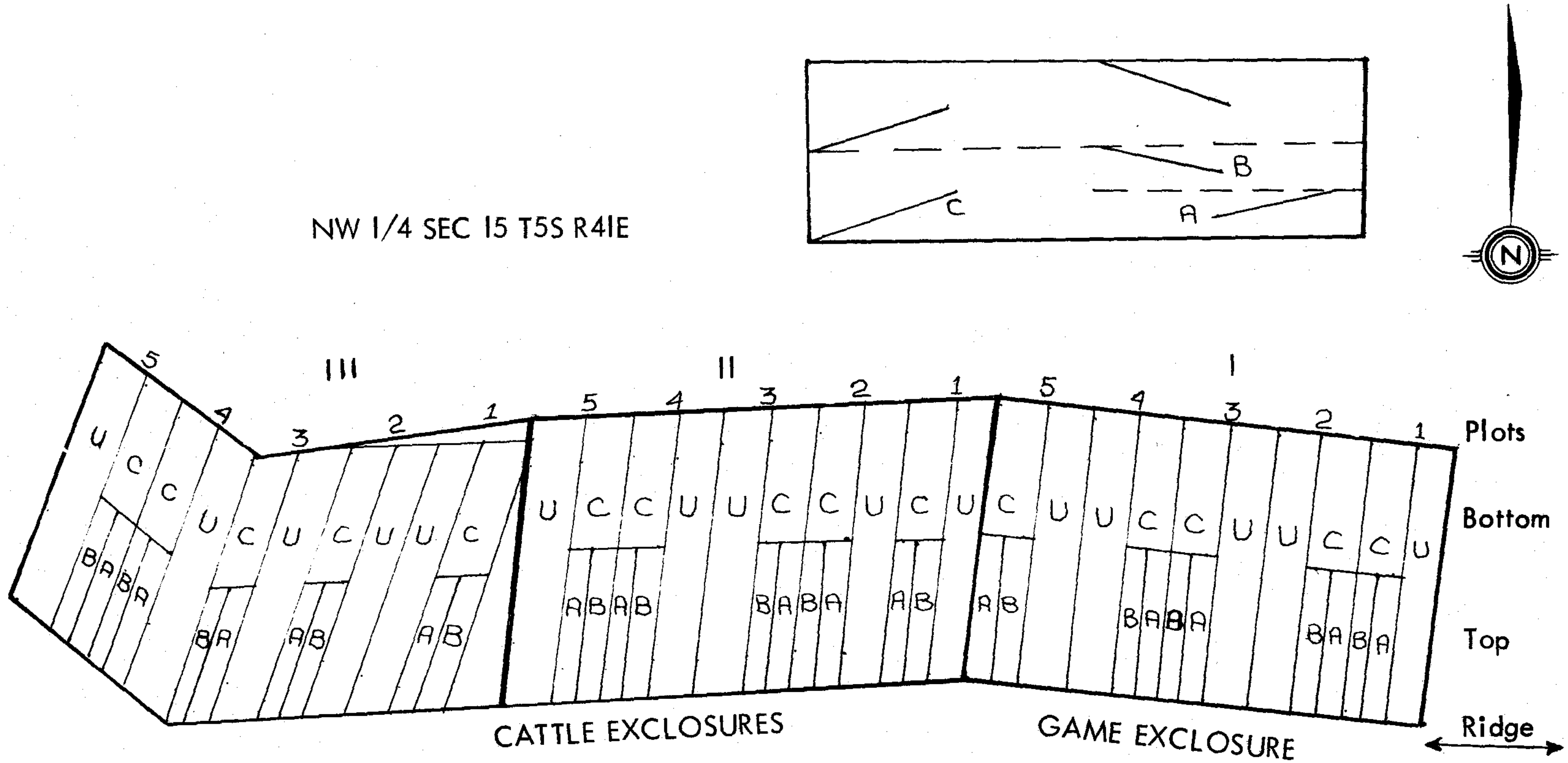

Figure 4. Field design of the study area. Seeding treatments: A = *Elymus glaucus*; B = *Bromus marginatus*; C = seeded with a mixture of *Dactylis glomerata*, *Arrhenatherum elatius*, *Phleum pratense*, *Bromus inermis*, and *Trifolium repens*; and U = unseeded (Wood, 1970). Top insert shows location of five, 100 foot belt transects randomly placed in game exclosure plot 5 (Pettit, 1968).

controlled grazing and regeneration experimentation on the clear-cut burn. Exclosure I presented a barrier to mule deer (Odocoileus hemionus) elk (Cervus canadensis) and domestic livestock (Bos tarus). The fences of exclosures II and III excluded cattle only.[1]

During the spring of 1965, two and three year-old tree seedlings were planted on four of the one acre plots within each exclosure (Figure 5). The remaining plot served as a control. Eight hundred and eighty trees per acre were planted on a six by seven foot grid. These consisted of Douglas fir, ponderosa pine, western larch and white pine (Pinus monticola). To obtain 1,000 seedlings per acre, 120 Engleman spruce (Picea englemanni), grand fir, and lodgepole pine (Pinus contorta) were added to the ridge area of the plots.

Two dissertations have been completed from studies conducted on this area, Pettit (1968) and Wood (1971). In addition, a Master of Science study was carried out during the summers of 1968 and 1969, (Green, unpublished).[2]

Pettit (1968) evaluated the compatability of grazing domestic versus wild ungulates on seeded and naturally regenerating broadcast burned treatments. To accurately record the changes in vegetation

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[1]In the remaining text exclosures I, II and III will be abbreviated I, II, III.

[2]Green, M. T. (1968-9) unpublished research data, Oregon State University, Corvallis, Oregon.

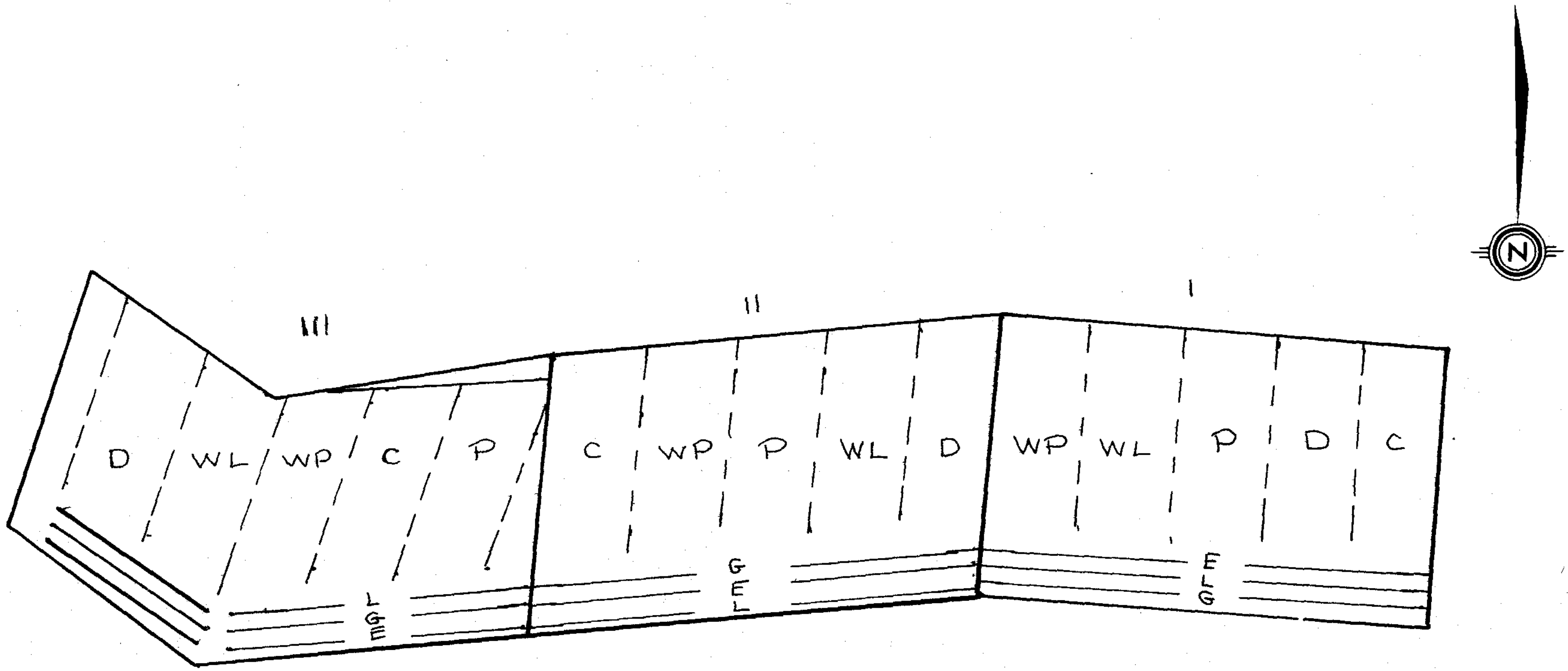

Figure 5. Conifer tree seedling location on the study area. D = Pseudotsuga menziesii; C = Control; E = Picea engelmanni; G = Abies grandis; L = Pinus contorta P = Pinus ponderosa; WL = Larix accidentalis; WP = Pinus monticola.

cover and frequency from 1965 to 1967 he established 75, one hundred foot permanent transects within the three exclosures. Bull thistle (Circium vulgare), Canada milkvetch (Astragalus canadensis) and strawberrry (Fragaria sp.) were found to be the most abundant forbs throughout the study period. Twice the shrub growth and an even greater production differential of Canada milkvetch was found to be present in the game excluded area as compared to the cattle exclosures. It was the opinion of the researcher that domestic livestock could be successfully manipulated to integrate forest and grazing management.

Wood (1971) examined the life history of Canada milkvetch and its response to range and forestry improvement practices. This early growing, atmospheric nitrogen fixing plant is typically found in disturbed soils and is a highly palatable forb to domestic and wild ruminants. It was observed that a grazing regime of cattle only, did not affect Canada milkvetch plant vigor as markedly as did cattle plus game animal use.

Wood's re-examination of segments of Pettit's (1968) transects indicated that the frequency, cover and density of Canada milkvetch on the experimental area increased rapidly from 1965 to 1967. By 1970, however, these parameters had decreased, approaching the values of 1965 in some cases.

Wood (1971) reinforced Pettit's (1968) work by stating that in order to maximize the biological potential of a given area, forestry and range improvement practices must be co-ordinated.

Climatic, geologic and edaphic phenomenon have been well documented by the above researchers as well as by Strickler (1965); Young (1965); and Young, Hedrick and Keniston (1967).

Initially, it was found that higher maximum temperatures consistently occurred in the clearcut (Pettit, 1968). Wood (1971), however, indicated that temperature deviations statistically analyzed revealed no major differences between the environment of the clearcut from that of the adjacent mature forest. He concluded that the minimum temperatures, if any, differentiated the two areas.

More total snow appeared to reach the soil surface in the clearcut than in the uncut forest (Pettit, 1968). Pettit also noted that occasional drifting accumulated this snow in I. The resulting deposition lengthened the melting period and slightly postponed the initiation of spring plant growth relative to II and III. This 2 week delay in the melting placed I in a situation more similar to the uncut areas than II and III.

The Tolo silt loam soil, inherent to the area, is capable of holding up to 60 percent moisture at saturation on an oven dry basis (Wood, 1971). Throughout the summer, grasses and forbs use less of this soil moisture than trees or browse species; the former being primarily surface moisture users while the latter obtain the bulk of their moisture from the subsoil (Pettit, 1968). Based on the abundance of herbaceous vegetation and on a differential absorption rate Pettit concluded that the clearcut vegetation utilized as much as, or more soil water than the old growth trees. In contrast, Wood (1971), stated that the mature forest utilized more soil moisture than seral, herbaceous and shrubby vegetation. He also found that in the clear-cut area grasses and forbs use less soil moisture over the growing season than either tree or browse species. His data indicated that the forage species are effective in reducing soil moisture losses via transpiration; thereby increasing the opportunity for regenerating conifers to become better established and grow with minimum competition for water, space and light.

The seasonal pattern of domestic livestock forage utilization for the study area is summarized in Figure 6. Exclosures II and III have been subjected to cattle grazing trials as well as unrestricted browsing activity from resident deer and elk. Exclosure I has been grazed exclusively by cattle with the exception of one deer grazing trial. This occurred during the spring of 1969 when eight captive yearling mule deer were experimentally introduced into this exclosure. This trial was an attempt to evaluate spring deer browsing on regenerating shrub species and established coniferous trees. Twigs on tagged plants were measured before and after grazing to determine percent utilization by deer. Green (Footnote 2, page 10) found that

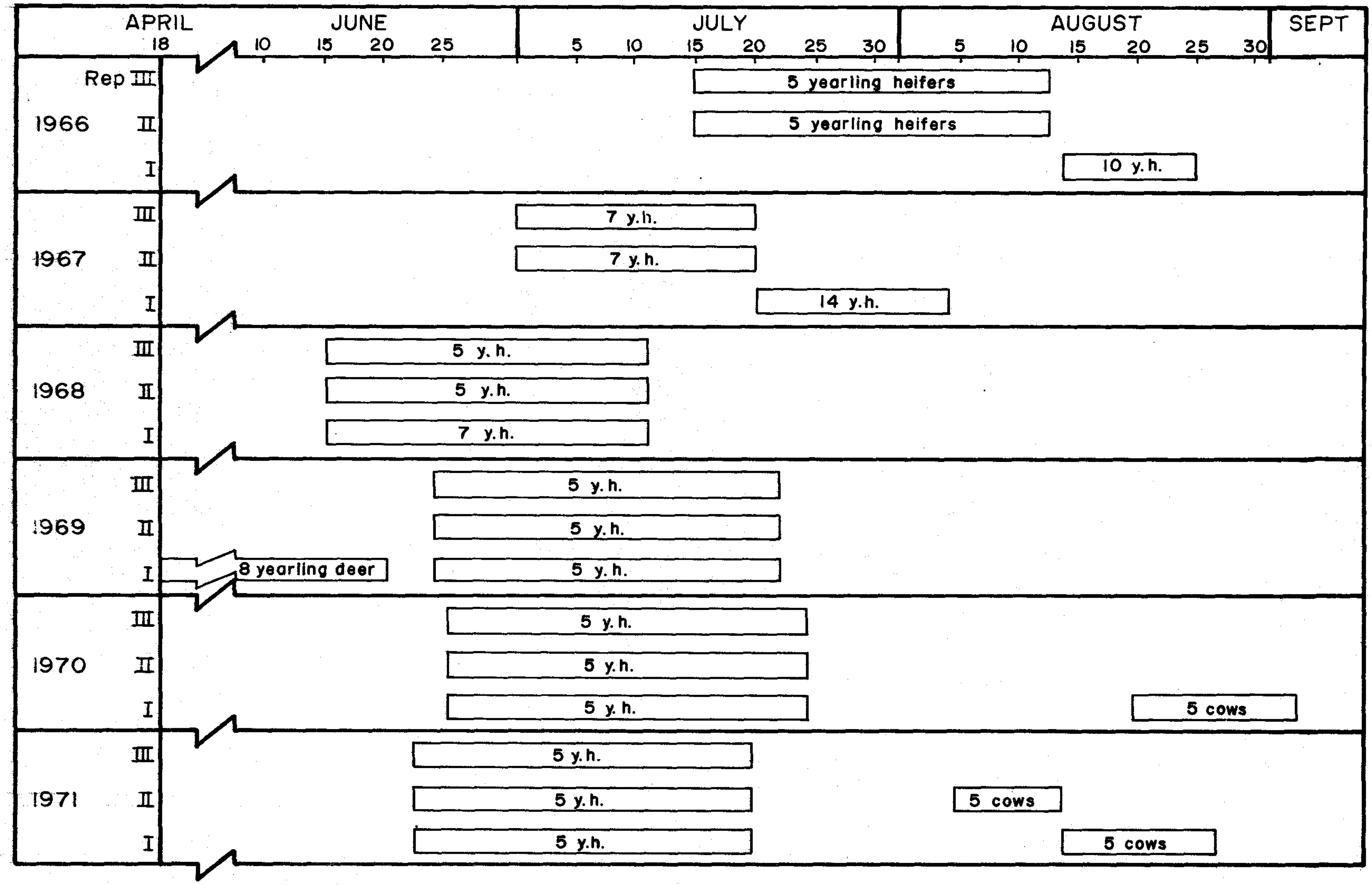

Figure 6. Animal use history of 1963 clearcut (1966-1971).

deer prefer ninebark, snowbrush, redstem ceanothus (*Ceanothus sanguineus*), ocean spray, and willow (*Salix* sp.) during the spring and early summer. These data also indicate the clearcut area is used only lightly by deer during the spring.

METHODS OF STUDY

This research has been focused on animal-vegetational relationships. Analysis necessitated segregating as well as combining both segments. The methods employed were as follows.

Photography

In August 1970, colored aerial photographs of the study area were taken from a helicopter hovering approximately 100 feet above the ground. An Asahi Pentax 35 mm Spotmatic camera, fitted with a Super-Takumar 1:1.4/50 mm lens and Kodacolor-X film was used. The camera was hand held while the oblique photographs were taken out of a side window.

A 90 x 150 foot grid was established on the ground prior to the flight. This provided nine points of reference within each exclosure which were later used to establish an accurate scale on 7 3/4" x 11" enlargements.

Scale ratio (the number of units of distance on the ground equivalent to one unit on the print), varies between photographs according to the ground elevation and tilt of the camera (Spurr, 1960). The approximate ratio on the enlargements was 1:600. Dividing by 12, this gave an approximate scale of 50 feet per inch.

Flying height, unknown at exposure time due to the irregular topography, was calculated from the ratio -

$$\frac{\text{Photographic distance}}{\text{Ground distance}} = \frac{\text{Camera focal length}}{\text{Flying height}}, \quad \text{(Spurr, 1960)}$$

On the enlargements this worked out to be:

$$\frac{3}{1800} = \frac{2}{12\ (\text{flying height})} \text{ or, flying height} = \frac{2(600)}{12} \text{ or}$$

approximately 100 feet.

Vegetation Measurements

Previous vegetation studies on this area have considered only one plant community i. e., a mixed coniferous forest type. Preliminary ground observations and limited photo interpretations from this study, however, suggested the presence of at least two distinctive communities each extending the length of the study area. On the basis of these initial observations a study was conducted to verify the two community hypothesis.

Enlargement of the 35 mm negatives into the 7 3/4" x 11" color prints facilitated the initial floristic pre-typing. With the aid of a mirror stereoscope and transparent overlays the establishment of rough type lines, representing tentative community boundaries, was carried out in the laboratory. Verification and alteration in the final placement of these lines was completed in the field based on visual observations.

Twelve of Pettit's (1968) original 25 transects in each of I and II were relocated and examined to obtain plant frequency, density and cover. Since Pettit had considered the study area one homogeneous unit, initial location of his transects was based on a random selection process. Utilization of the transects for this study presented problems since, in several cases, they dissected the community boundaries tentatively established earlier in this research. Wherever this occurred, only the portion of the line within the community being measured was used. In several cases the previously established transects had to be extended in order to complete data collection.

The same micro plot size (12" x 12") was used in this study. Sampling 100 plots per transect, however, was considered too extensive so this number was reduced to 20. Frequency data were recorded for all species encountered within the plots. Readings taken on the ridge area were determined every 2 1/2 feet since the transect length was restricted by the plant community width. Readings taken on the slope areas were made every five feet.

Cover data (line intercept) were collected on woody species only. Wherever shrubby vegetation intercepted the 50 or 100 foot line transects the species was listed and its cover recorded in tenths of feet.

Density measurements were also restricted to shrubby vegetation. Belt transects one foot wide and 50 or 100 feet long, again community dependent, established the boundaries.

Frequency data were incorporated into an association table. Once in this form data were manipulated to evaluate the possibility of existence of more than one plant community on the study area. For convenience of publication only those species occurring five or more times per transect were included in the table.

Frequency, density and cover data also were used to quantitatively evaluate the difference in browse production attributable to grazing treatment.

Animal Measurements

Pregnant heifers (yearling Hereford) have been used in I, II and III as grazing trial stock since 1965. Weight gains were recorded throughout early summer grazing trials (1966 to 1971). The Eastern Oregon Experiment Station has had the first five years of these data statistically analyzed to evaluate production variations between exclosures on an animal weight gain basis.

In an attempt to utilize an overabundance of browse in I, this research intensified the grazing pressure. Pregnant cows, whose calves had been weaned one month previous, were used in 1970 and 1971 summer grazing trials.

In 1971, ten cows, all in excellent condition, were taken from forest grazing land adjacent to the study area. Five of these animals were weighed, marked, and returned to the forested area to serve as controls. The remaining five were subjected to a pre-grazing trial adjustment period by containing them in II and III for seven days. A considerable amount of browse vegetation in conjunction with grasses and forbs was available in these two exclosures. Exposure to this situation was an attempt to facilitate rumen micro-flora adjustment to a browse diet. Fence breakage resulted in the temporary loss of three control animals, and the reluctance of one cow to enter the weighing scales resulted in incomplete data collection for this second trial.

Weight fluctuations were used to evaluate animal response to the treatments. Animals in the trials were weighed every two weeks. A holding pen adjacent to the study area was used to provide the customary overnight shrink. The pen design also enhanced the setting up of portable scales on which the animals were weighed. Data collected were analyzed in an attempt to quantify variations.

Animal-Forage Measurements

Due to the number and varied growth form of the woody species present in the study area, it was deemed necessary to accurately assess a browse species preference list and use factor.

Prior to the summer grazing trials I was divided into five plots of equal size. One transect was randomly located within each of these five plots. The transect consisted of a 400 foot tape stretched the width of the exclosure. Measurements on the tape were used to locate, as well as re-locate individual plants used in the trials. Ten twigs on 20 plants of snowbrush ceanothus, and ninebark, and ten twigs on 15 plants of wax current, willow and elderberry were tagged and measured. Consecutively numbered metal tags were wired to the plants to insure re-location. The first bud scale scars from the terminal bud on each twig were marked with colored plastic tape and their length recorded. This figure represented the current annual growth of each twig. Species preference and utilization were determined following the summer grazing trials by re-measuring the tagged twigs and calculating the amount of vegetation removed.

Conifer Measurements

From 1965 through 1971 the late Dr. R. F. Keniston of Oregon State University measured the development and mortality of a sample of the coniferous trees planted in the spring of 1965 (Figure 5). Some of these trees were available to deer and elk while others were protected. Measurements were taken on 80 trees per species in all three exclosures. The trees were relocated, observed and measured before and after each grazing trial in order to monitor the impact of the currently administered practices. Accumulated tree growth from 1965 to 1971 was analyzed to determine if any significant differences in growth could be related to grazing treatments.

Environmental Measurements

Climatic data were collected to compare temperature and precipitation during 1970 and 1971 to the local average. These measurements provided a link between the environment and plant response as based on current annual growth. They also provide a record for future research reference as well as establishing a basis for yearly production fluctuations.

Above ground temperatures were recorded in an adjacent uncut stand of timber. A Taylor maximum-minimum dial thermometer (No. 5321) placed in a white ventilated shelter three feet above the ground was used. Total precipitation was collected in an Idaho Reconnaissance Precipitation Gage.

Soil moisture measurements were obtained with buried gypsum blocks and a resistance meter. The data were collected, interpreted and reported by Pettit (1968) and Wood (1971).

RESULTS AND DISCUSSION

Photography

Although the equipment and techniques were considerably less sophisticated than those usually employed in remote sensing procedures, the photographs turned out clear with good contrast in tone and texture. Enlargement of the 35 mm negatives to 7 3/4" by 11" prints proved to be invaluable to the study. Frame overlap, sufficient to permit stereoscopic viewing, added one more very useful interpretation dimension.

Initial stereo examination of the enlargements was instrumental in the recognition and delineation of homogenous plant groupings. Based on these observations the location of community boundaries was assessed and recorded on transparent overlays. Vegetation patterns suggested the existence of at least two distinctive areas. These laboratory interpretations supported and strengthened the dual community postulation.

In the field, with the photos providing a composite view of the study area, placement of the tentatively established community borders was examined. These ground observations, based primarily on differences in floristic composition, suggested the existence of a subtle vegetation transition zone. This area, or ecotone, was the prominent feature delineated in the pre-typing operations

(Figure 7). The community boundaries, previously based on these observations, proved to be relatively accurately located. Areas of incongruity were corrected on the overlays while in the field.

Validation of the dual community hypothesis necessitated actual vegetational sampling. The photographs were also of considerable value in these data collection procedures. To obtain valid measurements it was very important to sample within homogeneous areas. The random selection process of transect location used by Pettit (1968) nullified the use of some transects where they approached or crossed the tentative boundaries. With the community borders and transect locations clearly delineated on the photograph overlay, determining transect validity became a relatively simple and precise exercise.

The future value of the photography lies in providing a basis for continued research as well as a permanent record of the study area as it appeared in 1970.

Vegetation Measurements

Analysis of presence and frequency data of 80 species (Appendix I) in an association table supported the initial two plant community observations. Examination of the final tables (Tables 1 and 2) revealed a conspicuous grouping of plant species between the ridge and slope areas. Some individuals occurring in almost every ridge transect

Figure 7. A stereo view of the ecotone separating the ridge community (on the left) from the slope community (on the right). The photographs were taken in August 1971 in Exclosure I looking west into Exclosure II.

Table 1. An association table showing percent frequency primary plant species represented within the slope and ridge areas., August, 1971.

Species	Symbol	Ridge area (Rep I)						Slope area (Rep I)					
		Transect						Transect					
		2	4	1	5	6	3	1	2	3	4	5	6
Shrubs													
Physocarpus malvaceus	Phma			60	75	65	25						
Symphoricarpos albus	Syal	35											
Spiraea betulifolia	Spbel						25						
Ribes viscosissimum	Rivi								25				
Ceanothus sanguineus	Cesa												25
Forbs													
Epilobium paniculatum	Eppa	60	55	45	70	60	55	70	65	65	60	60	70
Collinsia parviflora	Copa	80	60	65	100	75	75	35	75	55		40	
Achillia millifolium	Acmil	70	45	95		25	60	45	55	25		60	30
Arenaria macrophylla	Arma 3				70	50						30	
Circium vulgare	Civu	60	40					65	65	65	45	80	80
Frageria vesca	Frve	65					55	65	80	95		70	45
Arnica cordifolia	Arco		25	40	60		30						35
Montia perfoliata	Mope	35	50	55	50	75	50						
Viola adunca	Viada	60											
Galium triflorum	Gatr	60											
Taraxacum officinale	Taof	35											
Circium arvense	Ciar		40		30	55							
Erythronium grandiflorum	Ergrp			25		25							
Sedum lanceolatum	Sela					25	30						
Stellaria nitens	Stni					30							
Astragalus canadensis	Ascam							30		35	25	45	40
Rumex acetosella	Ruac							45		50	25		
Gnaphalium palustri	Gnpa								30	30		55	
Frageria virginiana	Frvi								30	35			
Geranium bicknellii	Gebi											25	
Grasses and Sedges													
Bromus tectorum	Brte	60	35	40	40	35	70		35	30		50	
Elymus glaucus	Elgl		70	80	90	85		100					
Deschampsia elongata	Deel		25						50			55	
Carex geyeri	Cage			55	35	25	35		30			30	
Bromus marginatus	Brma						55					30	60
Carex concinnoides	Caco							25	30	30			
Arrhenatherum elatius	Arel								35	35			
Phleum pratense	Phpr								35	45			
Festuca pacifica	Fepa								35	25		30	50
Dactylis glomerata	Dagl									40	100		
Poa pratensis	Popr												25
Calamagrostis rubescens	Caru												5

Table 1. Continued

Symbol	Ridge area (Rep II) Transect 2	4	1	5	6	3	Slope area (Rep II) Transect 1	2	3	4	5	6
Shrubs												
Phma	60	75	30	40	25							
Spbel	30		30	45		25						
Cesa	30									30		
Rivi												
Syal												
Forbs												
Eppa	60	75	100	40	75	55	95		70	65	70	70
Civu	35		55	40	60	80	50	70	80	80	75	85
Acmil	50	55	65	40	70	85	35	30		60	60	50
Copa	65	85	75	60	25	35					25	25
Arma 3	35	80		30			25	25				
Ruac			35	35		65				25	35	
Frve				65	45	30	35	85	50	55	50	50
Mope	70	30	25									
Arco		25	30	45								25
Frvi				45							30	
Gnpa					30							
Taof					25							
Ascam								35	25			30
Viada								25	35			
Grasses and Sedges												
Cage	40	75			40			25		30	30	
Elgl		30				50	90	70				70
Brma				65	45						60	
Brte	65	30	30	25	50	25				50		
Caru			30	25								
Fepa				45								
Deel					25							
Caco			35					35	30	30		25
Arel										70		
Dagl										85		
Popr											40	

were noticeably absent from transects along the slope. The presence of ninebark, birchleaf spirea, heartleaf arnica, cheatgrass and miner's lettuce, in the absence of Canada milkvetch and Northwestern sedge seems indicative of the ridge area. The reverse appears true for the slope community (Tables 1 and 2). These anomalies suggest potential differences as reflected by unique floral compositions and are indicative of separate plant communities.

Table 2. Summary of the indicator species from the association table.

Indicator Species	Ridge Community	Slope Community
Physocarpus malvaceus	Present	Absent
Spiraea betulifolia	Present	Absent
Arnica cordifolia	Present	Absent
Bromus tectorum	Present	Absent
Montia perfoliata	Present	Absent
Carex concinnoides	Absent	Present
Astragalus canadensis	Absent	Present

Several soil pits were excavated in an attempt to evaluate a soil vegetation relationship. The soil horizons did not differ from those described by Wood (1971) Appendix II. The depth of these horizons, however, did vary considerably between the ridge and slope areas. It was found that soil depth on the slope was in the order of six feet plus; with bedrock not reached in most cases. Along the ridge it was difficult to dig a pit 24 inches deep without encountering bedrock. This great difference in soil deposition along with changes in percent slope were considered to be the distinguishing environmental factors between the two communities. Differences in exposure and snow accumulation also are factors contributing to the variation in vegetation composition.

The combination of the above information and the association table data provided sufficient information to validate the two community hypothesis in this research. Nomenclature for the so derived communities was adopted from the Soil Conservation Service (1956). The slope area was designated as a 315 site (site number) or a mixed fir forest type. The ridge was classified a 214, or, a ponderosa pine Douglas fir-pinegrass site. The above names will be used in the remaining text.

Variation in vegetation on a smaller scale was noted in both plant communities. Plant speciation differences between exclosures but within communities may have been influenced by past animal use. However, the high amount of logging disturbance and resulting successional stages made it difficult to evaluate these variations on a plant community basis. Results of these past treatments are also undoubtedly reflected in the frequency data within the association table.

Density and cover data were collected in an attempt to quantify the differences, if any, attributable to ungulate grazing treatments. On a percentage basis it was found that higher shrub cover values were associated with I (Table 3). Approximately the same number of plants, 218 as opposed to 210, were recorded on the ponderosa pine community of I and II, respectively. The cover value of II, however, was only 73.7% that of I. The presence of larger shrub crowns was also confirmed in the mixed fir forest community. The cover value of I was 400% that of II and there were 84.3% more plants per acre in I than in II (Table 3). Correcting for the plant number discrepancies, the cover of II was still barely 46% that of I.

Table 3. Summary of density and cover data collected on the more abundant shrub species in I and II. Individual species contributions are recorded in Appendices III-VI.

Plant Community	Exclosure	Density (plants/sq. ft.)	Percent Cover (line intercept)
Ponderosa pine	I	218	31.6%
	II	210	23.3%
Mixed fir forest	I	188	28.1%
	II	102	6.9%

The most obvious single treatment difference between the two areas was the exclusion of wildlife from I. It follows that the lower shrub cover encountered in II may be a direct result of the inclusion of deer and elk in that particular grazing program. If this is the case, the inclusion of these animals may be an asset to conifer and seeded grass species regeneration by reducing shrub competition. It should be noted that the variation in cover values may have been slightly obscured by the deer grazing trial of 1969.

Livestock Weight Fluctuations

Analysis of yearling heifer weight gains indicated no significant differences in average daily gain between exclosures at the 5% level (McArthur, 1971).[3]

Weight fluctuations of the cattle used in the two late summer grazing trials are summarized in Table 4.

Calves had recently been weaned from the cows used in the 1970 trial so it was not considered unusual for the control animals to lose 2.3 pounds per day for the 14 day trial. However, the 6.7 pound loss per day from the animals in I was not considered a normal loss. It was speculated that the abrupt change in diet and/or its composition (browse) were the major contributing factors to these extreme losses.

In 1971 the control animals lost an average of .64 pounds per day while the test animals, on a predominantly browse diet, gained an average of .81 pounds per day. These data appear more realistic than those collected in 1970 and may be attributed to the initial good condition of these animals as well as their previous exposure to a similar habitat (forested grazing land). In addition, the pre-conditioning phase, which allowed the animals to partially adjust to a browse diet may also have facilitated these "more normal" weight changes. In consideration of these points, the weight gains of .81 pounds per

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[3] McArthur, J. A. B. 1971. Personal communication.

Table 4. Cattle weight differences in exclosure I and the control during 1970 (August 19 to September 2) and 1971 (August 6 to August 27).

1970

Control (Hall Ranch Meadow)				(Exclosure I) Clearcut			
Aug. 19	Sept. 2	Change in Weight	Percent Change	Aug. 19	Sept. 19	Change in Weight	Percent Change
1005	990	-15	-1.5	1397	1285	-112	-8.0
1110	1090	-20	-1.8	1100	1005	-95	-8.6
1215	1150	-65	-5.4	1160	1050	-110	-9.5
1175	1156	-29	-2.5	1342	1222	-120	-3.1
				1070	1037	-33	-3.1
	Total	-129	-11.2		Total	-470	-38.1
	Average	-32.3	-2.2		Average	-94	-7.6
	Average/day	- 2.3	-.15		Average/day	-6.7 lbs.	-.54

1971

Control (Adjacent Forest)				Pre-conditioning			(Exclosure I) Clearcut		
Aug. 6		Aug. 27	Change in Weight	Aug. 6	Aug. 13	Change in Weight	Aug. 27	Change in Weight	Percent Change
1505	1483	-22	-1.5	1255	1280	+25	1300	+20	+1.6
1045	*			1240	1264	+24	*		
1260	1255	-5		1290	1315	+25	1308	-7	-.5
1200	.			1260	1295	+35	1295	0	0
1275	.			1254	1260	+ 6	1292	+32	+2.5
	Total	-27	-1.9	Total		+ 115		+45	+4.6
	Average	-13.5	- .95	Average		+ 23		+11.3	+1.2
	Average/day	- .64 lbs.	- .05	Average/day		+ 3.3 lbs.		+ .81	+ .82

* Animals could not be weighed

. Animals could not be located

day seemed to suggest that properly conditioned cows could subsist on a basically browse diet.

Phenological changes were not measured in this study and may partially explain seasonal changes in the animals' diet. However, in both years it was observed that the cows preferred the grass and forb vegetation remaining after the spring grazing trials. As this forage disappeared, grazing pressure was diverted to the shrubby vegetation. By the end of the two week trial period virtually all of the grasses had been removed. It appeared that, although livestock browse utilization was feasible, it would occur only after almost complete grass removal. This is an important long term management consideration in that repeated attempts at browse utilization may exert enough pressure on the native and seeded grasses to eliminate them. For this reason, and in the interest of maximum production, use of browse may be more efficiently manipulated by the incorporation of big game species into the overall scheme.

Animal Forage Measurements

During the assessment of livestock utilization on the current annual growth of woody species in I two major problems arose: (1) It soon became evident that it was virtually impossible to distinguish the most recent bud scale scars on snowbrush. As a result the figures associated with this species relate to the percent utilization of tagged vegetation. This is in contrast to the percent utilization of the current annual growth which was determined for the other tagged species. (2) The leaves of elderberry were preferred by the foraging cows. Trampling and removal of the tagged branches necessitated computations of only percent leaf and/or leaflets removed. Utilization figures on this species, therefore, do not consider branch destruction or disappearance. Percent removal by cattle on the marked shrubs for the 1970 and 1971 seasons are presented in Table 5.

Table 5. A summary of the percent removal by cows of tagged shrubs in exclosure I for 1970 and 1971.

Species	1970	1971
Elderberry	97. 37%	94. 66%
Willow	70. 58	66. 38
Ninebark	22. 41	2. 99
Redstem	15. 80	25. 94
Snowbrush	11. 58	5. 63
Wax Currant	0. 10	0. 00
Total percent utilization of tagged shrubs	29. 30%	31. 58%

Elderberry and willow were heavily utilized during the late summer grazing trials (Figures 8 and 9). A few branches of elderberry managed to grow out of reach of the cows but this will not likely continue if late summer grazing continues. Most of the willow shrubs were well hedged and were used by the early as well as the late summer grazing livestock.

Figure 8. Cattle use on elderberry during the late summer grazing trials, August 1971.

Figure 9. Cattle use on willow during the late summer grazing trials, August 1971.

Ninebark, redstem ceanothus (Figure 10), and snowbrush provided a good source of forage for the late summer grazing animals. These three species made up the majority of the available browse and were utilized throughout the study area.

In the present stage of regeneration redstem ceanothus is growing profusely along the steeper slope of the mixed fir forest community. The overall use on this species during the second year of this study, however, was such that continued late summer utilization by cattle only may be sufficient to control its growth. As previously noted this method of control may, in turn, negate the value of redstem ceanothus as a browse species.

The variation in use on willow, elderberry, and wax currant over the two year study period was minimal. Snowbrush experienced a considerable decrease in use the second year while redstem ceanothus underwent an increase in use (Table 5).

During the initial shrub tagging procedure in 1970 very little use by heifers was noted on ninebark. However, in the second year of this study these animals inflicted moderate to heavy utilization on this species. The very light (2.99%) late summer use by cows in 1971 is no doubt a reflection of this unexplained early summer removal by heifers.

Interpretation of such short term results is difficult. They do, however, suggest that considerable fluctuations occur in seasonal

Figure 10. Cattle use on redstem ceanothus during the late summer grazing trials, August 1971.

and yearly preferences of some browse species. Elderberry, for example, was virtually ignored by the early summer grazing heifers, while late summer use by mature cows resulted in an average leaf removal of 96.02%. During the second year, snowbrush and ninebark utilization was down by 51.38% and 86.66% respectively. On the other hand, redstem ceanothus removal was up 164.17%. These fluctuations occurred despite similar climatic conditions (Figure 2) and a total consumption rate difference of only 1.28% between the two years.

Conifer Measurements

The number of survivors and the average height of samples of established conifers are summarized in Table 6.

Table 6. Survival and growth measurements (height in inches) on coniferous trees planted in the study area. The initial sample consisted of 80 trees of each species per exclosure.

	Number of Trees			Average tree height (inches)		
Species	I	II	III	I	II	III
Ponderosa pine	46	45	51	31.61	30.64	32.02
Douglas fir	49	49	54	37.37	40.02	35.28
Grand fir	29	47	12	26.29	29.20	15.35
Lodgepole pine	33	41	24	34 62	38.34	32 19
Western white pine	26	32	24	29.55	24.57	20.02
Western larch	21	24	27	53.77	56.29	53.91
Englemann spruce	19	35	2	25 76	25.51	20.00
survival	39.8%	48.8	34.6			

60% mortality 51.2 65.4

≈ 41.1 average survival
– 59.9 mortality

Survival and growth of ponderosa pine, Douglas fir, grand fir and lodgepole pine in I are similar to II and III (Table 6). Since vegetation in the first two exclosures was exposed to domestic and wild animal utilization, it appears that any influence on the development of the four tree species attributable to the presence of big game is negligible.

Lodgepole pine, grand fir and Engelmann spruce were planted along the ridge in the ponderosa pine site. This appears to be a poorly suited environment for the latter two species. Since there is more area encompassed by this plant community in II and III than in I the performance of these two species may be an indication of their growth response to site rather than their overall growth and survival capabilities as related to grazing activities.

SUMMARY

A desire to increase productivity on mixed coniferous forest sites in northeastern Oregon has established the direction of a research program at the Eastern Oregon Experiment Station. A selected site was clearcut, broadcast burned and seeded with grass and legume species. Seven varieties of coniferous trees were established within three, five acre exclosures. One exclosure (I) excluded cattle, deer, and elk, the other two (II and III), excluded cattle only. Within the three exclosures early summer domestic livestock grazing trials were incorporated while forage and conifer growth and survival were carefully monitored.

Colored photographs of the study area were taken from a helicopter. The large scale (1 inch = 50 feet) and good color qualities of the enlargements proved to be of considerable value in establishing plant community boundaries.

Frequency, density and cover measurements were collected from both exclosures (I and II). Summarization of frequency data in the form of an association table confirmed an initial postulation that at least two plant communities existed in the study area. A ponderosa pine community extended along a ridge with a mixed fir forest community occupying the downslope region. Ninebark, cheatgrass brome, and miner's lettuce were the most indicative

species of the former, Canada milkvetch and northwestern sedge were found to be indicative of the latter.

Density and cover measurements indicated that although approximately an equal number of plants existed in the two exclosures within the ponderosa pine community, II had only two-thirds the cover of I. Density in the mixed fir community of I was almost twice that of II; cover, however, was four times that of II. Cover differences between the communities was attributed to the major treatment difference--big game use.

The exclusion of big game species, in conjunction with early summer heifer grazing favored browse productivity in both communities of exclosure I. Exposure to indigenous game species reduced cover on the ponderosa pine community and both cover and density on the mixed fir community in exclosure II.

The higher browse cover and/or density values associated with I may be an important factor in the suppressed early summer livestock weight gains. This, however, does not mean reduced animal production returns. The second late summer grazing trial was successful in the realization of animal weight gains through the utilization of browse species. However, the continuation of such early and late summer grazing may impair the continued high production of the seeded grass species. From this standpoint the inclusion of deer and elk may enhance the livestock grazing.

Yearling heifers, used in the early summer grazing trials, concentrated on the abundant grasses and forbs virtually ignoring the browse vegetation. This preferential grazing plus the exclusion of deer and elk did not control browse production in I.

The addition of a late summer grazing trial using mature cows resulted in the removal of the remaining grass forcing a shift to the shrubby vegetation. Following a short pre-conditioning period to facilitate rumen microfloral adjustment, weight gains were realized on such a diet in 1971. The decreasing order of livestock preference was: elderberry, willow, ninebark, redstem ceanothus, snowbrush, and wax currant.

The long range influence of foraging domestic and wild animals on conifer regeneration appeared to be minimal under the conditions of this study. Cattle damage was negligible and occurred primarily in the form of trampling injury. There appeared to be little difference to date in either tree numbers or tree height between protected and unprotected areas. The reduction in cover and density of browse species by big game animals also appeared to have no effect on conifer development to this point. However, the successional status of herbaceous and especially shrubby vegetation in I is approaching a stage where competition with the coniferous trees may become a stronger factor than it has been in the past. Further studies should continue to follow these animal-shrub-coniferous tree interactions.

Animal-forage measurements indicated the presence of an indirect deer-cattle competition factor. Deer browse utilization occurs primarily in the early spring (mid April through May) and very late summer (September) while cattle use, on a forced basis, occurred during August. Willow, ninebark, snowbrush, and redstem ceanothus were all used by both the domestic and wild animals. Of these four browse species, direct competition was observed for ninebark only. This species, for an unknown reason, was particularly sought after by the heifers involved in the 1971 early summer grazing trial.

From the limited results of this research it appears that forestry and animal production, both domestic and wild, are compatible. Although a certain degree of conflict does exist, it is proposed that the combined returns in timber, livestock and recreational production will outweigh the benefits from any single use alternative. More detailed research particularly in the area of economics, is required to synthesize past research and evaluate the multiple use concept as it relates to these lands.

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APPENDICES

APPENDIX I. SPECIES LIST OF PLANTS FOUND IN THE STUDY AREA

Symbol[1]	Scientific Name	Common Name
Trees		
A. Sampled.		
Psmeg	Pseudotsuga menziesii glauca (Beissn.)Franco	Interior Douglas-fir
Pipo	Pinus ponderosa Laws	Ponderosa pine
Laoc	Larix occidentalis Nutt.	Western larch
B. Not sampled.		
Pien	Picea engelmannii Parry	Engelmann spruce
Pimo	Pinus monticola Dougl. ex D. Don	Western white pine
Abgr	Abies grandis (Dougl.) Lindl.	Grand fir
Pico	Pinus contorta Dougl.	Lodgepole pine
Shrubs		
A. Sampled.		
Cesa	Ceanothus sanguineus Pursh	Redstem ceanothus
Cevev	Ceanothus velutinus velutinus Dougl. ex Hook	Snowbrush ceanothus
Phma	Physocarpus malvaceus (Greene) Kuntze	Mallow ninebark
Ricec	Ribes cereum cereum Dougl.	Wax currant
Rivi	Ribes viscosissimum Pursh	Sticky currant
Rogy	Rosa gymnocarpa Nutt.	Baldhip rose
Sace	Sambucus cerulea Raf.	Blueberry elder
Salix	Salix spp.	Willow
	Spiraea betulifolia lucida (Dougl.)C. L. Hitch	Birchleaf spirea
Syal	Symphoricarpos albus (L.) Blake	Common snowberry
Hodl	Holodiscus discolor	Oceanspray
B. Not sampled.		
Amal	Amelanchier alnifolia Nutt.	Saskatoon serviceberry
Bere	Berberis repens Lindl.	Creeping western barberry
Vame	Vaccinium membranaceum Dougl. ex Hook.	Big huckleberry
Forbs		
A. Sampled.		
Acmil	Achillia millifolium lanulosa (Nutt.) Piper	Western yarrow
Aghe	Agoseris heterophylia	Annual agoseris
Anlu	Antennaria luzuloides T. & G.	Rush pussy-toes
Anor	Anenome oregana Gray	Oregon anemone
Anro	Antennaria rosea	Pink pussy-toes
Arco	Arnica cordifolia Hook.	Heartleaf arnica
Argl	Arabis glabra (L.) Bernh.	Towermustard rockcress

Arma	Arenaria macrophylla Hook.	Bigleaf sandwort
Ascam[3]	Astragalus canadensis mortonii (Nutt.) Wats.	Canada milkvetch
Ciar	Circium arvense (L.) Scop.	Canada thistle
Civu	Circium vulgare (Savi) Airy-Shaw	Bull thistle
Cogr	Collomia grandiflora Doug ex Lindl.	Large-flower collomia
Comi[2]	Collomia microsteris	Collomia
Copa	Collinsia parviflora Lindl.	Little flower collinsia
Craf	Cryptantha afinis (Gray) Greene	Slender cryptantha
Epan	Epilobium angustifolium L.	Fireweed
Epgl	Epilobium glaberrium Barb.	Smooth willow-herb
Eppa	Epilobium paniculatum Nutt. ex T. & G.	Autumn willowweed
Ergrp	Erythronium grandiflorum pallidum St. John	Pale lambstounge fawnlily
Erige	Erigeron sp.	Daisy fleabane
Frve	Frageria vesca fractcuta	Wood strawberry
Frvi	Frageria virginiana platypetala	Wild strawberry
Gatr	Galium triflorum Englem. ex Gray	Fragrant bedstraw
Gebi	Geranium bicknellii Britt.	Bicknell's geranium
Gnmi	Gnaphalium microcephalum Nutt.	Slender cudweed
Gnpa	Gnaphalium palustri Nutt.	Lowland cudweed
Lase	Lactuca serriola L.	Prickly lettuce
Lathy	Lathyrus sp.	Pea vine
Libu	Lithophragma bulbifera Rydb.	Bulblet woodland star
Lupob	Lupinus polyphyllus burkei (Wats.) C. L. Hitchc.	Washington lupine
Maex	Madia exigua (J. E. Sm.) Gray	Little tarweed
Mope	Montia perfoliata (Donn) How.	Miner's lettuce
Ospu	Osmorhiza purpurea (C. & R.) Suksd.	Purplish sweet cicely
Podo	Polygonium douglasii Greene	Douglas Knotweed
Pogl	Potentilla glandulosa Lindl.	Gland cinquefoil
Ruac	Rumex acetosella L.	Sheep sorrel
Senec	Senecio sp.	Ragwort
Stni	Stellaria nitens	Chickweed
Taof	Taraxacum officinale L.	Dandelion
Thfe	Thalictrum fendleri Engelm. ex Gray	Fendler meadowrue
Trifo	Trifolium spp.	Clover
Trdu	Tragopogon dubius Scop.	Yellow salsify
Veth	Verbascum thapsis L.	Glannel mullein
Viada	Viola adunca adunca Sm.	Hook violet

B. Not sampled.

Adbi	Adenocaulon bicolor Hook.	Trailplant
Amara	Amaranthus sp.	Pigweed
Coca	Conyza canadensis (L.) Crong	Horseweed
Descu[2]	Descuriania sp.	Tansey-mustard
Frpu	Fritellaria pudica (Pursh) Spreng.	Yellow bells
Goob	Goodyera oblongifolia Raf.	Rattlesnake plantain
Hial	Heiracium albertinum Farr.	Western hawk weed
Lepe[2]	Lepidium perfoliatum L.	Yellow-flowered peppergrass
Lumuc	Luzula multiflora comosa (F. Mey.) Fern & Wieg.	Hairy common woodrush
Nadw[2]	Nararretia dwaricata (Torr.) Greene	Short stemmed navarretia

Phhe	Phacelia heterophylla Pursh	Varied-leaf phacelia
Pima	Plantago major L.	Common plantain
Poav	Polygonium aviculare L.	Prostrate knotweed
Pogr	Potentilla gracilis Dougl. ex Hook.	Beauty cinquefoil
Polem	Polemonium sp.	Jacob's ladder
Prvu	Prunella vulgaris L.	Common selfheal
Ranum	Ranunculus sp.	Buttercup
Saoc	Sanguisorba occidentalis Nutt.	Western burnet
Sest	Sedum stenopetallum Pursh	Wormleaf stonecrop
Sial	Sisymbrium altissimum L.	Tumblemustard
Smst	Smilicina stellata (L.) Dest	False Soloman's seal
Stell	Stellaria sp.	Starwort
Vese	Veronica serphyllifolia humifosa L.	Speedwell

Carexes

A. Sampled.

Caco	Carex concinnoides Mack.	Northwestern sedge
Cage	Carex geyeri Booth	Elk sedge
Caro	Carex rossi Booth	Ross sedge

Grasses

A. Sampled.

Arel	Arrhenatherum elatius (L. O. Presl.)	Tall meadow oatgrass
Brin	Bromus inermis Leyss.	Smooth brome
Brma	Bromus marginatus Nees	Mountain brome
Brte	Bromus tectorum L.	Cheatgrass brome
Caru	Calamagrostis rubescens Fuckl.	Pinegrass
Dagl	Dactylis glomerata L.	Orchardgrass
Deel	Deschampsia elongata (Hook.) Munro ex. Benth.	Slender hairgrass
Elgl	Elymus glaucus Buckl.	Blue wildrye
Feoc	Festuca occidentalis Hook.	Western fescue
Fepa	Festuca pacifica Piper	Pacific fescue
Kocr	Koeleria cristata L.	Prairie Junegrass
Phpr	Phleum pratense L.	Timothy
Poco	Poa compressa L.	Canada bluegrass
Popr	Poa pratensis L.	Kentucky bluegrass

B. Not sampled.

Brra	Bromus racemosus L.	Smooth-flowered soft cheat
Hoju	Hordeum jubatum L.	Foxtail barley
Sihy	Sitanion hystrix (Nutt.) J. G. Sm.	Bottlebrush squirrel tail
Stcon	Stipa columbiana nelsonii (Scribn.) Hitchc.	Big subalpine needlegrass

[1] Symbols are according to Garrison, Skovlin and Poulton (1967).

APPENDIX II. DESCRIPTION OF TOLO SILT LOAM FROM EXCLOSURE III OF EXPERIMENTAL AREA (Wood, 1971).

	1-0"	Burned duff layer.
A1	0-9"	Dark brown (10YR3/3, moist), silt loam, very weak medium sub-angular structure; loose, friable, non-sticky, non-plastic; gradual smooth boundary.
C	9-25"	Dark yellowish brown (10YR4/4, moist) silt loam; structureless; loose, friable, non-sticky, non-plastic, abrupt smooth boundary.
IIB	25-42"	Dark reddish brown (5YR4/3), moist), clay loam; structureless; friable, sticky, plastic; many fine tubular pores; clear smooth boundary.
IIC	42-60"	Brown (7.5YR4/2, moist), silty clay loam; structureless; friable, sticky, plastic; many fine tubular pores.

APPENDIX III. DENSITY DATA FROM SIX 1' x 50' BELT TRANSECTS IN THE RIDGE COMMUNITY OF EXCLOSURES I AND II.

	Exclosure I							Exclosure II						
Transect	1	2	3	4	5	6	Tot.	1	2	3	4	5	6	Tot.
Species														
Ceanothus sanguineus		2	4	3		3	12	17	6	4				27
Ceanothus velutinus	4	10	1		5	2	22	1	2	2		2	2	9
Physocarpus malvaceus	31	15	13	3	30	23	115	31	35	12	13	7	4	102
Rosa gymnocarpa				1	1		2				2			2
Ribes viscosissimum			1				1							
Sambucus cerulea				1			1							
Salix sp.										1				1
Spirea betulifolia lucida	8	7	8	2	3	11	39	12	3	8	28	1	10	62
Symphoricarpos albus	4	21					25		3					3
Picea engelmannii												1		1
Pinus monticola												1		1
Pinus ponderosa				1			1							
Pseudotsuga menziesii										1	1			2
Total number of plants recorded							218							210

APPENDIX IV. COVER DATA FROM SIX 50' LINE TRANSECTS IN THE RIDGE COMMUNITY OF EXCLOSURES I AND II.

	Exclosure I							Exclosure II						
Transect	1	2	3	4	5	6	Tot.	1	2	3	4	5	6	Tot.
Species														
Ceanothus sanguineus		52	20	63			135	71	32	16				119
Ceanothus velutinus	3	103	18	3	29		156			6			4	10
Physocarpus malvaceus	133	33	66	4	188	137	561	120	227	27	46	31	12	463
Rosa gymnocarpa				8			8							
Ribes cereum cereum												42		42
Sambucus cerulea				8			8							
Spirea betulifolia lucida			12	15		7	34	16		3	22			41
Symphoricarpus albus	11	23					34							
Larix occidentalis				2			2							
Pinus ponderosa				2			2				11			11
Pseudotsuga menziesii			8				8			12				12
Total cover							948							698

APPENDIX V. DENSITY DATA FROM SIX 1' x 100' BELT TRANSECTS IN THE SLOPE COMMUNITY OF EXCLOSURES I AND II.

	Exlosure I							Exclosure II						
Transect	1	2	3	4	5	6	Tot.	1	2	3	4	5	6	Tot.
Species														
Ceanothus sanguineus	6	2	6	5	7	10	36	18	1		17	3	10	49
Ceanothus velutinus	11				1	1	13					5	4	9
Physocarpus malvaceus	13	6	1		9	6	35	3	2		2	1	2	10
Ribes viscossimum	3	11			1		15				2			2
Rosa gymnocarpa		1	1	4	1		7			1			6	2
Sambucus cerulea	1	2	3			2	8							
Salix sp.										4				4
Spirea betulifolia lucida	13	2		15	8	6	44	2			9	2	7	20
Symphoricarpos albus			1	6	4		11							
Larix occidentalis			1		1		2		1	1				2
Pinus monticola						6	6					1		1
Pinus ponderosa			4	1		2	7		1					1
Pseudotsuga menziesii	1	3					4		1					1
Total number of plants							188							102

APPENDIX VI. COVER DATA FROM SIX 100' LINE TRANSECTS IN THE SLOPE COMMUNITY OF EXCLOSURES I AND II.

	Exclosure I							Exclosure II						
Transect	1	2	3	4	5	6	Tot.	1	2	3	4	5	6	Tot.
Species														
Ceanothus sanguineus		57	208	56	99	304	724	126			155	12	74	267
Ceanothus velutinus		55		21	50	16	142					31	11	42
Physocarpus malvaceus	60	57			68	27	212	3				4		7
Ribes viscosissimum	15	144			17	32	208							
Rosa gymnocarpa		7		28	15		50						8	8
Salix sp.										7				7
Sambucus cerulea	5	6	10				21							
Spirea betulifolia lucida	13	6			3	6	28				6			6
Symphoricarpos albus		3		12	11		26							
Larix occidentalis		12			24		36		22	17				39
Pinus monticola						6	6					12		12
Pinus ponderosa		8	30	37		11	86							
Pseudotsuga menziesii	12	72					84	15		3				18
Total cover							1623							406