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Forage production and utilization in western Montana clearcuts

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FORAGE PRODUCTION AND UTILIZATION
IN WESTERN MONTANA CLEARCUTS

By

Burton P. Lewis

B.S.R.M. Washington State University, 1965

Presented in partial fulfillment of the requirements for the degree of

Master of Science in Forestry

UNIVERSITY OF MONTANA

1967

Approved by:

Chairman, Board of Examiners

Dean, Graduate School

JUL 6 1967
ACKNOWLEDGEMENTS

The writer wishes to express his appreciation for the financial support provided by the McIntire-Stennis Forest Research Act and made available through the Montana Forest and Conservation Experiment Station. Also, for the equipment and facilities provided by the School of Forestry, University of Montana.

To Dr. Lee Eddleman for his conscientious help with all phases of this study. My appreciation to Professor Melvin Morris for helping with the preparation of the manuscript and for his many helpful suggestions throughout the course of this study. My gratitude to Dr. Lee Eddleman, Professors Melvin Morris and Robert Steele and Dr. James Habeck of the examining committee for their comments and criticism of the manuscript.

Special thanks to Roy Snyder and Ronald Ries for their help in the field. This study would not have been possible without the assistance of Roy Snyder with all of the field work and whose criticism and suggestions on all phases of this study were most helpful.

I am deeply grateful to my wife, Adele, for her continuous help and encouragement during the course of this study.
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INTRODUCTION

Western Montana has a wide variety of grazing lands varying from irrigated pastures and open low-elevation grasslands to the forested ranges and high mountain meadows. Although the irrigated pastures and low-elevation grasslands are the primary forage producing areas, they cannot produce all of the forage needed to sustain the area's cattle herds throughout the year. Thus, the cattle are dependent on the forested ranges for part of their annual forage supply.

The forested ranges in Western Montana consist of two types which can be classified as permanent or transitory forest ranges (Mueggler, 1962). The permanent forest range is characterized by an open overstory of ponderosa pine with an understory of bunchgrass and shrubby species. This forest type produces a permanent forage supply which is used by livestock during the spring-summer-fall grazing season. However, this type makes up only 16 per cent of the forested areas in Western Montana and cannot supply all of the necessary forage (Morris, 1945).

The transitory forest ranges occur in dense stands of Douglas-fir and larch, spruce and subalpine fir or associated forest types. Although most of the forested ranges in Western Montana are of this type, they support dense timber stands and produce little palatable forage for cattle. Most of the grazing in this zone occurs on dry parks, meadows and glades or on areas that have been logged or burned (Morris, 1947). Since almost all of the natural openings that are available to cattle are heavily grazed, burning or logging present the only major opportunity
to increase the grazing value of these forested areas. After being opened up through logging or burning these areas are available for use by cattle for a number of years until the forest regeneration closes over the areas.

The effect of logging on vegetation and site conditions, as well as succession on cutover areas, has been studied by several investigators. However, little work has been done on the productivity of cutover areas from a grazing standpoint and no work has been done in the fir-larch and spruce-fir zones, which make up most of the transitory forest ranges in Western Montana.

The objective of this study is to determine the grazing value of clearcut in the fir-larch and spruce-fir forest zones. To accomplish this, it will be necessary to determine the amount and kind of vegetation that occurs on clearcuts in the fir-larch and spruce-fir zones; to determine the amount of use cattle are currently making of these clearcuts; and the preference of cattle for certain species and groups of species that occur on the clearcuts selected for study.
Numerous studies have been conducted on cutover areas. Generally the results of these studies fall in one or more of the following categories: the initial effect of logging disturbances on understory vegetation and site; the effect of slash cover on vegetation and accessibility of forage; the use of fire for the reduction of slash accumulations and its subsequent effect on the residual timber stand; the plant succession on cutover areas; and the effect of reduced competition from the forest overstory on the understory vegetation. These factors influence the vegetation that occurs on cutover areas and the availability of this vegetation as forage for cattle. In addition, several other studies have been conducted on the distribution of cattle on forest ranges and cutover areas and the preference of cattle for various species that occur on these areas.

Initial Effects of Clear-cutting

Many observers reported that, on the average, tractor logging destroyed 25 to 30 per cent of the herbaceous and shrubby vegetation. Fowells and Shubert (1951) observed that ground skidding with a crawler tractor denuded 22 per cent of the ground surface in ponderosa pine-fir stands in California. Tractor logging, when compared with cable logging of ponderosa pine forest in Washington and Oregon, was found to denude the herbaceous and shrubby vegetation from an average of 21 per cent of the ground and covered 15 per cent more with slash. Deep soil disturbance
occurred on 15 per cent of the area logged by tractors, but only 1.9 per cent of the area logged by cable (Garrison and Rummell, 1951). Dyrness (1965b), investigating the effect of logging and burning on understory vegetation in the Douglas-fir forests of the Western Cascades, noted that both high-lead and tractor logging slightly disturbed 23 per cent of the area and deeply disturbed 9 per cent. Tractor logging compacted 27 per cent of the area while high-lead logging compacted only 9 per cent.

Steepness of slope was found to greatly influence the amount of site disturbance by logging. Areas with slopes of 40 per cent or more had a much higher incidence (2.8 times) of deep soil disturbance than did plots less than 40 per cent (Garrison and Rummell, 1951). However, Dyrness (1965b) found that if slopes did not exceed 20 to 30 per cent and skidroads were located on the contour the effects of this disturbance could be minimized.

Garrison and Rummell's (1951) study on the initial effects of logging disturbance in Eastern Oregon and Washington showed that grasses and grasslike plants were more susceptible to logging damage than were some of the more deeply rooted and rhizomatous weeds and shrubs. Reynolds (1961) attributed the increase in forbs and aspen sprouts and the decrease in sedges and perennial grasses the first year after selective logging of a ponderosa pine forest in Arizona to a difference in resistance to mechanical disturbances during logging. He found that logging stimulated the development of aspen sprouts. Similarly, Dyrness (1965b) found the cover of all species was greatly decreased by logging but low shrubs withstood logging better than taller ones. He concluded from the
results of the first postlogging sample that very few invading plants were present and, consequently, almost all vegetation encountered was a remnant from the pre-existing stand.

Succession on Cutover Areas

Dyrness (1965a) found the disturbance history to be at least as important as the original species composition of the understory stand in determining plant distribution on cutover areas in the Douglas-fir zone in the Western Cascades. He concluded that, as plant succession advances, the influence of logging and slash burning disturbance will decrease and other site factors such as soil characteristics and aspect will become increasingly important in controlling plant cover.

The natural recovery of vegetation on areas with deep soil disturbance was found to be slow (Garrison and Himmell, 1951). Garrison (1960), while studying cutover ponderosa pine forests in Eastern Washington, found similar results. He estimated that vegetation recovery on severely skidded trails by the seventh year after logging was arrested at a stage about equal to that existing 2 years after logging on the less severely disturbed areas. The slow recovery of these areas was attributed to the severe soil disturbances, compacted surface horizons, and reduced vegetative cover on these areas. Similarly, Dyrness (1965a) found the plant cover on largely undisturbed areas to be 28.4 per cent, 9 per cent on slightly disturbed areas and only 1.6 per cent on deeply disturbed or compacted plots. He concluded that the degree of disturbance exerts a major influence on the amount of vegetation present during the first 2 years following logging.
Isaac (1943) found that the rate of development of herbaceous and shrubby vegetation on cutover areas in the Douglas-fir zone in Washington and Oregon was influenced by site quality, intensity of slash fires, repeated burns, species present, and annual weather variations. Succession on these areas appeared to follow certain trends; however, the rate of development and species composition varied between clearcuts. The vegetation that returned following clear-cutting included species from two sources, namely, species from the original forest where underground parts survived the logging disturbances and invading species that did not occur in the shade of the original forest. The total cover was found to reach its first peak at about the third year, because of the rapid development of annuals and perennials that had wind-blowed seed and thrived in the ash of slash fires; then as these declined or disappeared there was a slight drop in total cover until they were gradually replaced by the more lasting perennials and the gradual growth of woody shrubs.

Garrison (1960) found that the early vegetative recovery on cut-over ponderosa pine forests in Eastern Washington was dominated by forbs, especially those plants with good systems of rhizomes and runners such as Achillea millefolium, various species of Lupinus, Fragaria, and two species of Hieracium. Most of these species were not abundant before logging. Similarly, Dyrness (1965a) found that as succession advanced some minor species in the understory stand substantially increased their coverage and the herbaceous cover was increased by a number of invading species. By the fourth year after logging Garrison (1960) reported that the forbs had reached their maximum development and were abundant and disproportionately represented in comparison to their original status.
The cover of grasses and shrubs were 22 and 14 per cent, respectively, below their original amounts. *Calamagrostis rubescens* and *Carex geyeri* were the major representatives of the grass group. By the seventh year after logging the forb group continued to be an abnormally large part of the understory, although some forbs, notably *Fragaria* spp., declined. By this time the grasses and shrubs were almost restored to their original density.

Rummell and Holscher (1955) reported that, following logging of ponderosa pine forests in Eastern Oregon and Washington, it took 4 years for the vegetation to regain its original cover. The native vegetation following logging consisted largely of aggressive species such as *Achillea millefolium*, *Arnica cordifolia*, and *Cirsium* spp. Terwilliger (1961) found similar results on cutover lodgepole pine forests in the Central Rockies. However, by 5 years after logging *Carex geyeri* usually spread and became the dominant forage plant.

Arnold (1953), reporting on heavy selection logging in a ponderosa pine forest in Arizona, found that the herbaceous plant cover increased very little in the 5 years following logging. The overall effect of the canopy release was more than cancelled by the effect of surface disturbances and heavy slash accumulations on the better perennial bunchgrasses. The greatest loss in cover of these bunchgrasses occurred on logging roads and skid trails or on areas covered by heavy slash accumulations. However, Pase (1958), while working in the ponderosa pine zone in South Dakota and Wyoming, and Reynolds (1961), working in the ponderosa pine zone in Arizona, found that all classes of understory vegetation increased as crown cover decreased. Grasses showed the greater response, forbs next, and shrubs showed the least response (Pase, 1958).
Reynolds (1962 and 1961) found that forbs and aspen sprouts increased while sedges and perennial grasses decreased the first year after selective logging of a ponderosa pine forest in Arizona. From the second to the sixth year all classes (grasses, sedges, forbs and shrubs) except sedges increased annually. Thereafter all classes declined. Sedges were the only forage class that produced less on the logged area. He concluded that selection cutting appeared to increase forbs in the area influenced by canopy and root systems. Baskett, Dunkerson, and Martin (1958) found similar results of selection cutting of a white oak forest in Missouri.

Effects of Burning on Vegetation

Several investigators studying the effect of burning on vegetation found that fire temporarily affected the vigor of perennial grasses and forbs and that desirable grasses were reduced in density while forbs ultimately increased in density (Pechanic, Stewart, and Blaisdell, 1958; Blaisdell, 1950). Similarly, Humes (1957) found that burning increased the mortality of grasses and caused partial crown damage. In addition, the moisture content was lower in plants on the burned areas, which caused them to cure earlier than the plants on the unburned areas. This is probably due to the blackening effect of fire and its subsequent effect on soil surface temperatures and moisture content. Mueggler and Blaisdell (1958) reported that Carex geyeri was severely damaged by burning but species of Lupinus were benefitted by the reduced competition.

Weaver (1951 and 1959), while studying the effect of burning on ponderosa pine understory in Eastern Washington, found that fire may
stimulate *Calamagrostis rubescens* and that the growth of other perennial grasses was vigorous. Severe burns caused temporary damage to *Calamagrostis rubescens* and 3 or 4 years were required for it to recapture these spots. He concluded that perennial grasses were disappearing because of fire control and heavy grazing and that subsequent burns at intervals of several years may check the encroachment of shrubs and timber reproduction and encourage the grasses.

Dyrness (1965a) found the intensity of burning to greatly influence the amount of plant cover on an area. The first growing season after slash burning, total plant cover averaged 41.7 per cent on unburned plots, 6.8 per cent on lightly burned plots, and 1.1 per cent on severely burned plots, indicating almost no recovery the first growing season following this severe disturbance.

The effect of broadcast burning, a common practice of destroying logging slash following clear-cutting, was studied by Morris (1958) and Steen (1966) for the Douglas-fir region of Washington and Oregon. Brush species covered a greater part of the unburned than burned ground for at least 5 to 7 years after logging. After 7 years the differences in brush cover on burned and unburned areas became less until, by 11 to 16 years, they were about the same. Apparently the first brush species to become dominant is most likely to remain dominant for at least 10 years (Steen, 1966). The total area shaded by herbaceous species was similar for burned and unburned areas but the species of perennial and annual *Epilobium* as well as *Rubus macropetalus* were present in similar amounts on both the burned and unburned areas. *Senecio sylvaticus* occurred in greater amounts on the burned than on the unburned areas while *Linnaea*
borealis was much more abundant on the unburned than on the burned areas (Morris, 1958). Similar results were found by Steen (1966).

**Effects of Slash on Vegetation**

The effect of slash on vegetation was studied by Arnold (1953), Pase (1958), and Reynolds (1966). Arnold (1953) found that heavy accumulations of slash after logging caused a great increase in perennial weeds (2 times) and annual grasses and weeds (5.5 times) with a corresponding decrease in perennial grasses (40 per cent). The total herbaceous cover remained unchanged during the period of this study. Pase (1958) found that herbage production decreased as the amount of dead needles and litter increased under unlogged ponderosa pine forests in Wyoming and South Dakota. Reynolds (1966c), however, concluded that slash cleanup on selectively logged ponderosa pine forests in Arizona had no measurable effect upon total herbage production or on the proportion of grasses, forbs, and shrubs in the understory vegetation.

**Productivity of Cutover Areas and Duration of Effect of Clear-cutting**

The amount of vegetation produced on clearcuts as compared to that produced under uncut forests has been measured by several investigators. Pase (1958) found that clearcuts produced 2,160 pounds of air-dry plant material per acre while a timber stand with a crown cover of 70 per cent produced only 40 pounds per acre. Pickford and Ried (1948) found that unlogged pinegrass-elk sedge range in Eastern Oregon produced 756 pounds of green forage per acre. Hopkins (1952) found that cutover areas of longleaf pine produced about 1 ton per acre while full stocked pole stands averaged 100 pounds per acre.
The duration of the effect of clear-cutting on understory vegetation has been studied by several investigators. Reynolds (1961) reported that the production of understory vegetation on selectively logged ponderosa pine lands on the North Kaibab in Arizona was expected to exceed that on unlogged lands for a period of 11 to 15 years. Pengally (1953) found that browse production reached a peak 10 to 15 years following logging and decreased gradually thereafter until conifers again dominated. According to Steen (1966), production of shrubby plants reached their peak 11 to 16 years following logging in the Douglas-fir region of Washington and Oregon.

The effect of selection logging was found to reach a peak by 6 years after logging; thereafter the production of grasses, sedges, forbs, and shrubs declined. The effect was still noticeable, however, 9 years after logging (Reynolds, 1961; Baskett, Dunkerson, and Martin, 1958).

**Cattle Distribution**

Several factors have been found to influence the distribution of grazing cattle. According to Morris (1947), steep slopes, heavy timber stands and large areas of poor forage contributed to poor distribution. Mueggler (1965) found cattle distribution to vary with steepness of slope and distance up the slope. On a 10 per cent slope where access is only from the bottom, 75 per cent of the cattle use is likely to be within 810 yards of the foot of the slope. However, on a 60 per cent slope, 75 per cent of the use is likely to be within 35 yards of the bottom.

Logging slash is another important factor that materially affects livestock distribution. Weidman (1936) warned that masses of slash left
following logging in the Pacific Northwest reduced available livestock forage for several years and caused livestock concentrations in openings with resultant overgrazing. In California, Sindel (1963) found that adequate reduction of deerbrush sprouts by cattle was generally limited to those areas relatively free of residual dead brush, downed logs, and other obstacles. According to Reynolds (1966c), cattle using selectively logged ponderosa pine forests in Arizona preferred areas cleared of slash over areas not cleared of slash while deer preferred areas where slash was undisturbed. He found that forage variations did not explain the differences in cattle and deer use and concluded that the physical obstacles of slash may have contributed to this difference. While the slash presented an access obstacle to cattle, the deer might have felt more conspicuous in areas cleared of slash. Similarly, Glending (1944) stated that cattle using pine-dunchgrass ranges in Arizona preferred areas with lesser amounts of dead needles and other plant litter.

Reynolds (1966b, 1962, 1961) studied the relative use of elk, deer, and cattle in relation to natural and created openings in the spruce-subalpine fir zone in Arizona. He found that cattle preferred natural openings to created openings and that the relative use by cattle was more abundant (3 to 4½ times) in natural openings than within adjacent forest, while the use of created openings and adjacent forest were about the same. The elk and deer preferred created openings to natural openings with elk using both forest and openings in equal amounts and deer preferring forest to openings. He concluded that the difference in relative use was due to the fact that cattle preferred perennial grasses, which made up 98 per cent of the vegetative cover on natural
openings, while deer preferred forbs, which made up 68 per cent of the composition in created openings and most of the palatable forage in the forest. Also, the physical obstacle of slash and debris that occurred on the clearcuts may have reduced utilization by cattle.

In a similar study on a selectively logged ponderosa pine forest in Arizona, Reynolds (1966a, and 1962) found that the relative use by deer in forest and openings averaged about the same, whereas dropping groups by elk and cattle were more numerous in openings than in the forest. The heaviest use by elk and cattle was associated with perennial grasses while the greatest use by deer was associated with forbs. Cattle were found to use all sizes of forest openings but relative use by deer and elk declined sharply as size of opening increased (Reynolds, 1966a).

Cattle Preference

Reppert (1960), reporting on the preference of grazing heifers in the sandhills of Northeastern Colorado, found that they showed a variable preference for different species at different times of the year. Cully (1937) in Arizona and Moorefield and Hopkins (1951) in Kansas reported that preference was primarily influenced by summer temperature and the stage of growth of the plant.

Hopkins (1952), studying the grazing habits of cattle in the longleaf pine region, found that cattle congregated on fresh burns since burning removed old, rough herbage and promoted the growth of green herbage. Shepherd, Southwell, and Stephenson (1953) found that from March to September cattle spent a high proportion of their time, while
grazing longleaf-slash pine forests, on current prescribed winter burns even though the areas were closely grazed and forage was limited. Humes (1957) found that livestock preferred burned to unburned bunchgrass ranges in Western Montana. He attributed this to a possible increase in palatability of the forage on the burned areas.

Pase (1958) found that cattle tended to avoid shade-grown vegetation where possible even though palatable species were present. Similarly, Reynolds (1966b) found that the greatest cattle use was associated with natural openings and perennial grasses. However, Harris (1954), studying forage utilization on ponderosa pine ranges in Eastern Oregon, found that cattle showed no preference for forage growing under the open stands of ponderosa pine to that under the more dense mixed forest stands. He reported that elk sedge was used 29 per cent on pine-bunchgrass range and 28 per cent on pinegrass-elk sedge range. Pinegrass, abundant on pinegrass-elk sedge range and relatively scarce on pine-bunchgrass range, was used equally on both areas, although to a much lesser extent (9 and 12 per cent, respectively). Pickford and Reid (1948) concluded from their study of cattle utilization on ponderosa pine ranges in Eastern Oregon that Calamagrostis rubescens and Arnica cordifolia are better forage plants in the denser timber, possibly because they retain moisture longer and do not toughen as quickly as in the less wooded pine-bunchgrass areas.

Several investigators, studying forage utilization on summer cattle ranges, have found the grasses and grasslike plants to be the most important forage species. Of these, Calamagrostis rubescens and Carex geyeri are the most valuable (Harris, 1954; Pickford and Reid,
Pickford and Reid (1948) reported that Carex geyeri and Calamagrostis rubescens made up 30 per cent of the total vegetation and 57 per cent of the total forage on ponderosa pine ranges in Oregon. Tisdale (1950), working in British Columbia, found that in the Douglas-fir zone the principle herbaceous species was Calamagrostis rubescens which commonly comprised 40 to 50 per cent of the forage yield. In Oregon, weeds and shrubs were found to make up more than one-half of the vegetation but provided less than 27 per cent of the forage utilized by cattle. Hieracium spp. and Arnica cordifolia were found to be the leading forage producers among the forbs. None of the shrubs combined sufficient abundance and palatability to be important as forage (Pickford and Reid, 1948).

Harris (1954), studying forage utilization on ponderosa pine ranges in Eastern Oregon, found that the highest use of elk sedge (40 per cent) occurred when grassland production was low. During drought years cattle were forced to use more timber forage to satisfy their needs. During wet years the use of timber forage dropped sharply. He concluded that the extent to which cattle grazed timbered range when given free choice was dependent upon many things. When there was an abundance of forage on the grasslands, cattle grazed the timbered range only to the extent required to escape heat and flies. When grassland forage dried early in the season, cattle used the greener, more succulent timber forage.

Morris (1947) while describing forest grazing in Western Montana, listed the important forage species in the larch-fir zone as Carex geyeri, Arnica cordifolia, Festuca idahoensis, Lupinus spp., and Salix spp., and in the subalpine zone as Bromus carinatus, Senecio triangularis, Carex geyeri, Agrostis alba, and Mertensia ciliata. Calamagrostis
rubescens, Lupinus spp., Spiraea spp., Ceanothus velutinus, Vaccinium scoparium, and Symphoricarpos albus occupied extensive areas, but were of little forage value. He concluded that pinegrass ranges were little used even in areas of level terrain.
DESCRIPTION OF THE STUDY AREA

Location

The study area is located within the exterior boundaries of the Lolo National Forest in Western Montana. The 14 clearcut locations sampled in this study are within a 40-mile radius of Missoula, Montana. Eight of these clearcuts occur on private land owned by the Anaconda Copper Mining Company and the other six occur on national forest land.

Figure 1 is a map of the study area showing the location of each clearcut.

Description of Clearcuts

To aid in identification, each clearcut with the exception of those in the Gold Creek drainage, was given the name of the drainage in which it occurs or of a nearby prominent land-mark. Since 7 of the 14 clearcuts occur in the Gold Creek drainage, these were numbered 1 through 7, in the order in which they were sampled. Future reference to each clearcut will be made by its specific name or number.

The Edith Peak, Granite Creek, Lee Creek and Lost Park clearcuts are in the Picea engelmanni-Abies lasiocarpa/Menziesia ferruginea association within the Picea/Abies zone as described by Daubenmire (1952) (Fig. 2). This association will hereafter be referred to as the spruce-fir zone. The Pseudotsuga menziesii/Calamagrostis rubescens and the Pseudotsuga menziesii/Physocarpus malvaceus associations occur within P. menziesii zone in Western Montana. The 10 clearcuts studied within
Figure 1. Map of Western Montana showing the location of each clearcut.
this zone all occur in the *P. menziesii/C. rubescens* association (Fig. 3). This association occurs on the more mesic sites in the *P. menziesii* zone and as a result contains species such as *Xerophyllum tenax* which are not usually considered to be important in this zone. Although Daubenmire (1952) considered *Larix occidentalis* to be a seral overstory species in this zone it occurred as a dominant species in the forest overstory surrounding each clearcut sampled. Therefore, this zone will hereafter be referred to as the fir-larch zone.

Although widely spaced in relation to the study area, the Edith Peak, Granite Creek, Lost Park and Lee Creek clearcuts are generally similar in appearance. However, there are some dissimilarities. The narrow band of the spruce-fir zone in which the Lee Creek clearcut is found, occurs in a creek bottom and can be considered a physiographic climax (Daubenmire, 1952). The upper portion of this clearcut occupies the ecotone between the spruce-fir and fir-larch zones. The remaining three clearcuts occur in climatic climax areas of the spruce-fir zone. Other minor differences between these clearcuts were noted. The Edith Peak and Lost Park clearcuts contain "boggy" patches of standing water which are dominated by sedges and rushes. The Lee Creek and Granite Creek cutover areas appear to be better drained and are relatively free of these "boggy" areas. In addition, the residual forest surrounding the Granite Creek clearcut was selectively logged, leaving a much more open stand than that which surrounds the other three clearcuts in this zone. Figures 4, 5, and 6 are general views of the Edith Peak, Granite Creek, and Lost Park clearcuts, respectively. Table 1 gives the physical characteristics, history and location of each clearcut that was studied in the spruce-fir and fir-larch zones.
Table 1. The physical characteristics, history and location of each clearcut.

<table>
<thead>
<tr>
<th>Clearcut</th>
<th>Elev. Feet</th>
<th>% Slope</th>
<th>Exposure in Deg.</th>
<th>Slash Treatment</th>
<th>Slash Intensity</th>
<th>Degree of Grazing by Cattle</th>
<th>Size of Clearcut in Acres</th>
<th>Year of Logging</th>
<th>Location</th>
</tr>
</thead>
<tbody>
<tr>
<td>Edith Peak</td>
<td>6,100</td>
<td>15%</td>
<td>180°</td>
<td>Burned in rows</td>
<td>Light</td>
<td>Ungrazed</td>
<td>120*</td>
<td>1959</td>
<td>NE \frac{1}{4}, Sec 24</td>
</tr>
<tr>
<td>Granite Creek</td>
<td>5,875</td>
<td>10%</td>
<td>128°</td>
<td>Burned in rows</td>
<td>Light</td>
<td>Ungrazed</td>
<td>20*</td>
<td>1956</td>
<td>NW \frac{3}{4}, Sec 23</td>
</tr>
<tr>
<td>Lee Creek</td>
<td>5,160</td>
<td>15%</td>
<td>300°</td>
<td>Broadcast burned</td>
<td>Light</td>
<td>Ungrazed</td>
<td>15*</td>
<td>1956</td>
<td>Sec 31</td>
</tr>
<tr>
<td>Lost Park</td>
<td>5,750</td>
<td>0-15%</td>
<td>58°</td>
<td>Piled in rows</td>
<td>Heavy</td>
<td>Ungrazed</td>
<td>40*</td>
<td>1961</td>
<td>NE \frac{1}{4}, Sec 4</td>
</tr>
<tr>
<td>Bear Creek</td>
<td>5,060</td>
<td>10%</td>
<td>115°</td>
<td>Broadcast burned</td>
<td>Moderate to heavy</td>
<td>Light to heavy</td>
<td>110</td>
<td>1961</td>
<td>Sec 14</td>
</tr>
<tr>
<td>Blue Mountain</td>
<td>5,485</td>
<td>25%</td>
<td>62°</td>
<td>Burned in rows</td>
<td>Light</td>
<td>Moderate</td>
<td>81</td>
<td>1962</td>
<td>Sec 7</td>
</tr>
<tr>
<td>Gold Creek #1</td>
<td>4,525</td>
<td>14%</td>
<td>75°</td>
<td>Broadcast burned</td>
<td>Moderate</td>
<td>Ungrazed</td>
<td>79</td>
<td>1962</td>
<td>Sec 7, T12N, R20W</td>
</tr>
<tr>
<td>Gold Creek #2</td>
<td>4,750</td>
<td>15%</td>
<td>75°</td>
<td>Broadcast burned</td>
<td>Moderate</td>
<td>Ungrazed</td>
<td>110</td>
<td>1961</td>
<td>Sec 11,14</td>
</tr>
<tr>
<td>Gold Creek #3</td>
<td>4,650</td>
<td>5%</td>
<td>270°</td>
<td>Burned by wildfire</td>
<td>Light</td>
<td>Ungrazed</td>
<td>15</td>
<td>1961</td>
<td>Sec 31</td>
</tr>
<tr>
<td>Gold Creek #4</td>
<td>4,400</td>
<td>15%</td>
<td>250°</td>
<td>Broadcast burned</td>
<td>Heavy</td>
<td>Light</td>
<td>50*</td>
<td>1961</td>
<td>Sec 25</td>
</tr>
<tr>
<td>Gold Creek #5</td>
<td>4,000</td>
<td>15%</td>
<td>50°</td>
<td>Broadcast burned</td>
<td>Moderate</td>
<td>Light</td>
<td>75*</td>
<td>1962</td>
<td>Sec 1,2</td>
</tr>
<tr>
<td>Gold Creek #6</td>
<td>4,500</td>
<td>8%</td>
<td>125°</td>
<td>Broadcast burned</td>
<td>Moderate</td>
<td>Light</td>
<td>85*</td>
<td>1962</td>
<td>Sec 2, T14N, R17W</td>
</tr>
<tr>
<td>Gold Creek #7</td>
<td>4,200</td>
<td>10%</td>
<td>270°</td>
<td>Burned by wildfire</td>
<td>Heavy</td>
<td>Ungrazed</td>
<td>30*</td>
<td>1961</td>
<td>Sec 31</td>
</tr>
<tr>
<td>Ninemile</td>
<td>4,375</td>
<td>5%</td>
<td>220°</td>
<td>Burned in rows</td>
<td>Light</td>
<td>Light</td>
<td>50*</td>
<td>1962</td>
<td>SE \frac{1}{4}, Sec 24</td>
</tr>
</tbody>
</table>

* Estimated acreage
All of the clearcuts in the fir-larch zone occur in stands that can be considered climatic climax (Daubenmire, 1952). However, several clearcuts in this zone have some distinguishing characteristics. Most of the area of Gold Creek No. 3 was severely burned during a wildfire in 1961. This cutover area shows signs of accelerated erosion that is not evident on any of the other clearcuts studied. Similarly, Gold Creek No. 7, which was burned in the same fire, was salvage logged after the fire and, since it was not reburned, is covered with heavy accumulations of slash. The Ninemile clearcut is distinguished for another reason. Preliminary observation revealed the presence of a number of introduced species of grasses which are not present on the other clearcuts. Figures 7, 8, and 9 are general views of several clearcuts in this zone.

Slash accumulations varied between clearcuts and methods of disposal. On the Lost Park clearcut the slash was piled in rows but was never burned. This left a pattern of heavy and light slash accumulations over the entire area (Fig. 6). Similarly, on the Edith Peak, Granite Creek, Blue Mountain and Ninemile clearcuts the slash was piled in rows prior to burning. After burning, this group as a whole had the least amount of slash with the only slash accumulations being incompletely burned logs in the rows (Figs. 10 and 11). Gold Creek No. 3 was severely burned by wildfire and was almost completely covered with slash. The remainder of the clearcuts were subject to prescribed burning after clear-cutting. Of these, Gold Creek No. 4 had heavy slash accumulations over most of its area while on the remaining six clearcuts the slash intensity varied from generally light to local heavy accumulations.
The four clearcuts that were examined in the spruce-fir zone were not grazed by cattle. The isolated position of these cutover areas likely explains this lack of grazing use. This zone is usually higher in elevation than the fir-larch zone and the distance along access roads is, by necessity, usually long.

On the 10 clearcuts in the fir-larch zone the intensity of grazing varied from non-existent to locally heavy. Gold Creek No. 1, 2, 3, and 7 showed no evidence of being used by cattle. Gold Creek No. 4, 5, and 6 were lightly grazed. Gold Creek No. 4 was covered with such heavy accumulations of slash that extensive grazing was physically limited. A possible explanation for the light use of Gold Creek No. 5 and 6 was their close association to blue-grass bottoms. Poa protense, the dominant species on these bottoms, comprises 8 to 10 per cent of the vegetation in this area but makes up about 90 per cent of the forage utilized (Morris, 1945). Both Ninemile and Blue Mountain received heavier grazing pressure than the above clearcuts. A small herd of cattle stayed on the Blue Mountain clearcut during the summer and moderately grazed over most of its area.

Of the 14 clearcuts studied, Bear Creek received the heaviest grazing pressure. A saltground located on its upper edge and a spring which occurred on the lower edge probably served to hold the cattle in this area.

Soils and Climate

The soils of the study area closely resemble the brown podzolic and gray wooded great soil groups as described by the Soil Conservation...
Service (1960). The four clearcuts in the spruce-fir zone are associated with brown podzolic soils formed in weathered granite or argillite (Fig. 12). The 10 remaining clearcuts in the fir-larch zone occur on soils of the gray wooded group (Fig. 13). The coarse fragments associated with these soils are mainly red and green argillite, quartzite, sandstone and shale and occur mostly in alluvial or glacial deposits.

Climatological records are available from two locations within the study area. One station, at an elevation of 3,190 feet, is located at the Missoula County Airport. The second station, at 4,200 feet, is located at the Greenough Post Office, approximately 30 miles east of Missoula in the Blackfoot Valley. Precipitation records dating back to 1886 are available from the Missoula station, while records from the Greenough Post Office date back only 7 years.

The average annual precipitation at Missoula is 13.8 inches and at the Greenough Post Office it is 17.6 inches. Near Missoula, the heaviest precipitation comes during May and June with average rainfall of about 2 inches in each of these months (U.S. Weather Bureau, 1965). At Greenough the wettest months are April, May and June with April and May averaging about 1.6 inches and June about 2.3 inches of precipitation (Steel, 1965). Total annual snowfall averages 48.5 inches at Missoula and 57.7 inches at Greenough.

The prevailing wind over Western Montana is from the west and southwest during the spring and summer months, and from the west and northwest during the winter months (U.S. Weather Bureau, 1965). This air must pass over the Bitterroot Range before reaching the Missoula area and loses much of its precipitation on the western slopes of this range.
This accounts for the low average precipitation that is recorded for Missoula and the surrounding valleys.

As a result, the climatological data from the Missoula and Greenough weather stations cannot be applied directly to the individual clearcuts, since they are located in the surrounding mountains. These data are useful, however, in indicating general precipitation trends that occurred during the period of this study. Precipitation during 1965 was found to be above average. At Missoula, the total precipitation during this period was 4 inches above average, while at Greenough it was 6.5 inches above average. Precipitation during 1966 was found to be below normal with a precipitation deficit of 2.7 inches at Missoula and 1.4 inches at the Greenough Post Office.

In addition, limited records are available from a precipitation gauge located on Point Six 18 miles northwest of Missoula at 7,000 feet in elevation. This gauge is read once a year and indicates that the total yearly precipitation at this location is approximately 50 inches. Since the lowest clearcuts studied are higher in elevation than the Greenough Post Office and the highest clearcuts are at an elevation of almost 7,000 feet, it can be assumed that the study area receives from 20 to 50 inches of precipitation annually. The precipitation any one clearcut receives is dependent to a large extent on its elevation and the surrounding topography.
Figure 2. A stand representative of the *Picea engelmannii*-Abies lasiocarpa*/Menziesia ferruginea* association. Photograph taken adjacent to the Lost Park clearcut. Associated understory species were *Xerophyllum tenax*, *Vaccinium scoparium* and *Vaccinium* spp.

Figure 3. A stand adjacent to the Bear Creek clearcut representing the *Pseudotsuga menziesii*/Calamagrostis rubescens* association. Associated understory species were *Carex geyeri*, *Xerophyllum tenax*, *Arnica cordifolia*, *Lupinus* spp. and *Vaccinium* spp.

Figure 4. A general view of the Edith Peak clearcut. This clearcut occurred in the spruce-fir zone at 6,100 feet in elevation. The slash was piled and burned and as a result this clearcut is almost entirely free of slash accumulations.
Figure 5. General view of the Granite Creek clearcut. Note the selectively logged residual forest surrounding this clearcut which occurred in the spruce-fir zone at an elevation of 5,900 feet. As a result of the slash being piled in rows and burned this clearcut is free of heavy slash accumulations.

Figure 6. General view of the Lost Park clearcut. This clearcut occurs in the spruce-fir zone at an elevation of 5,750 feet. The slash was piled in rows but was never burned resulting in heavy accumulations on this cutover area.

Figure 7. General view of the Blue Mountain clearcut. This clearcut occurs in the fir-larch zone at an elevation of 5,500 feet. A small herd of cattle was present on this clearcut throughout the summer months.
Figure 8. General view of the Gold Creek No. 2 clearcut. This clearcut occurred in the fir-larch zone at an elevation of 4,750 feet. Photograph taken early in June shows Xerophyllum tenax in the flowering stage and indicates the abundance of this species on these cutover areas.

Figure 9. General view of the Bear Creek clearcut. This clearcut occurred in the fir-larch zone at an elevation of 5,060 feet. Photograph taken near saltground which served to attract and hold cattle to this area.

Figure 10. General view of the rows of burned slash on the Ninemile clearcut. This clearcut occurred in the fir-larch zone at an elevation of 4,375 feet. Piling and burning of slash created alternating rows of heavy slash accumulations and slash-free areas.
Figure 11. Close-up view of the slash-free areas between the rows of burned slash on the Ninemile clearcut. These areas are easily used by cattle and produce relatively large amounts of palatable forage.

Figure 12. A close-up view of the brown podzolic soil found in the spruce-fir zone. Parent material was weathered argillite. Photograph taken on Edith Peak clearcut.

Figure 13. A profile of the gray wooded soil found in the fir-larch zone. Rounded fragments of argillite indicate glacial or alluvial origin of parent material. Photograph taken on Gold Creek No. 2 clearcut.
METHODS AND PROCEDURES

Field Methods

The months of June through August, 1965 and 1966, were spent selecting and sampling cutover areas in Western Montana. Four clearcuts in the spruce-fir zone and 10 in the fir-larch zone were selected for study. The vegetation that occurred on these cutover areas was described in terms of canopy-coverage and herbage yield in pounds per acre. To describe the stand in which each clearcut occurred the forest understory adjacent to each cutover area was sampled in terms of canopy-coverage. The amount of cattle use was measured to determine the degree to which these clearcuts are grazed by cattle and their preference for certain species and groups of species. In addition, the soils and physical characteristics of each cutover area were described.

Selection of each clearcut to be studied was based on predetermined criteria of which forest type was of fundamental importance. Selection of clearcuts was limited to those which occur within the spruce-fir zone characterized by an overstory of *Picea engelmannii* and *Abies lasiocarpa* with a prominent understory of *Menziesia ferruginea* or within the fir-larch zone with an overstory of *Pseudotsuga menziesii* and *Larix occidentalis* and an understory of *Calamagrostis rubescens* and *Arnica cordifolia*. The relative abundance of clearcuts within each of these zones accounted for the selection of four clearcuts in the spruce-subalpine fir zone and 10 clearcuts within the larch-fir zone.
Selection of clearcuts within each zone was based on the age of the clearcut, steepness of slope, amount of slash material, and accessibility to cattle. The age of the clearcut was the most important of these criteria. It was felt that at least 3 or 4 years should have elapsed since clear-cutting to ensure that the vegetation had enough time to re-establish itself after the initial cutting disturbances. However, on clearcuts older than 10 years, succession favoring brush species and conifer regeneration appeared to have advanced to a stage that would limit cattle use, especially in the spruce-subalpine fir zone; therefore, these clearcuts were not selected. In addition, any factor such as steepness of slope and excessive amounts of slash which limited cattle use, were used to eliminate clearcuts from selection.

Canopy-coverage was taken with a 1 square foot quadrat. Canopy-coverage for each species that occurred within each plot was estimated. The number of quadrats used on each cutover area varied from 100 to 200, depending on the size of the cutover area and the homogeneity of the vegetation. Decisions on the number of quadrats to be used on any one clearcut were based on presampling examination of each clearcut and preliminary statistical analysis of the data. In some instances it was necessary to return to a clearcut and take an additional number of plots.

Twenty quadrats were spaced at 10-step intervals along a transect. The number of transects used for each clearcut varied from 5 to 10 depending on the number of quadrats used. These transects were systematically located so that they covered each clearcut as evenly as possible.
On the Edith Peak, Granite Creek, and Ninemile clearcuts the slash was piled in rows before burning. This left a pattern of alternating burned and unburned areas which were easily stratified into treatments before sampling. On these three clearcuts the burned and unburned areas were sampled separately by the above method. On the remaining 11 clearcuts, burning occurred in scattered patches over each cutover area. No effort was made to stratify these clearcuts into burned and unburned areas before sampling. Thus, each of the remaining 11 clearcuts were sampled as a unit and the canopy-coverage associated with each is an average for the whole clearcut irrespective of the treatment any small part may have received.

Techniques similar to those employed on the clearcuts were used to sample the canopy-coverage of understory vegetation adjacent to each clearcut. Transects of 20 quadrats each were placed parallel to the clearcut edge and just deep enough into the bordering forest to minimize any effect clear-cutting might have on associated understory vegetation. Where possible the transects were spaced so that the sample extended around the entire clearcut border.

Data to determine herbage production in pounds per acre were collected from a 1 by 4.8 foot plot. This size and shape of plot was selected for several reasons. The total area defined by the plot frame is small enough to be seen at one time so that the vegetation falling within the plot can be accurately measured, especially when the values being determined are estimated. Since the total area of this plot measures 4.8 square feet the field weights, obtained in grams, can be easily converted into pounds per acre. Also, the long narrow shape of this
plot is considered to be more accurate for sampling heterogeneous vegetation such as that which occurs on the cutover areas.

During August, 1965, the four clearcuts in the spruce-fir zone were sampled. The current year's growth of the vegetation occurring within each quadrat was clipped and weighed to the nearest gram. The important species were weighed and recorded separately, while the minor species were grouped into the appropriate classes before weighing. These classes were: other grasses; other grasslike plants; other forbs; and other shrubs. With the exception of the Edith Peak clearcut, 20 quadrats were used to sample each cutover area. Four quadrats were spaced 50 steps apart along each of 5 transects. The transects were systematically placed at equal intervals throughout each clearcut. The results of this sampling gave the average production for each cutover area irrespective of local differences in treatments. As before, the Edith Peak clearcut was stratified into burned and unburned areas which were sampled separately with 20 systematically located quadrats in each treatment.

During August, 1966, the remaining 10 clearcuts in the fir-larch zone were sampled to determine herbage production. After analyzing the results of the previous summer's sampling in the spruce-fir zone, it was determined that 20 quadrats were not sufficient to sample a clearcut and that clipping each plot was too time consuming. The number of quadrats used to sample the remaining 10 clearcuts was increased from 20 to 50 during this period. Ten quadrats were spaced at 20-step intervals along each of 5 transects. None of these clearcuts was stratified into treatments so that the transects were systematically located to equally cover each clearcut.
To avoid the time consuming necessity of clipping each quadrat, the first week in August, 1966, was spent gaining experience in the weight-estimate method as described by Pechanec and Pickford (1937). The weight of the important species was estimated separately and the minor species were estimated in groups. Following estimation the species and groups were clipped on each quadrat and compared with the estimated weights. This procedure was continued until the estimated weights were consistently within 10 per cent of the actual weights, at which time estimation became the principal method. However, approximately 10 out of each 50 quadrats were clipped to maintain a check on the estimated weights.

After sampling each clearcut to determine herbage production, approximately 200 grams of plant material from each important species and group of minor species was collected. This material was placed in separate paper bags and taken into the laboratory where it was air-dried at room temperature for 2 weeks and again weighed in grams. This information was later used during laboratory treatment of the field data to convert green weights into air-dry weights.

Of the 14 clearcuts studied, only Bear Creek, Blue Mountain, Ninemile and Gold Creek No. 6 showed evidence of being used by cattle. Cattle use was indicated by the actual presence of grazing animals or by indirect indications such as fecal groups.

A 1 by 5 foot plot was used when estimating the amount of utilization on each of these four clearcuts. The per cent utilization was recorded for each species that occurred on each quadrat. Twenty quadrats were spaced at 10-step intervals along a transect. The number of transects
used per clearcut varied from 10 on the Bear Creek clearcut to three on Gold Creek No. 6 and depended on the intensity of grazing. Those clearcuts that were grazed the heaviest received the most intensive sampling.

Additional information on utilization was obtained for selected species using step transects. On alternate steps, the species being sampled nearest the right toe was examined. Species selected in this way were recorded as grazed or ungrazed, and if grazed, the percent of the plant removed through grazing was estimated.

Appendix I is a chart showing the sampling regimen for each clearcut.

One soil pit was dug in each cutover area. The soil profile was described for later use in determining the type of soil upon which each clearcut occurred. A Munsell color chart was used to describe the dry and moist color of each horizon. A Hellige-Troug Soil Reaction Tester was used to determine the pH of each horizon. To supplement this information, a color photograph was taken of each profile.

At the same time, the physical characteristics of each clearcut were described. The degree of slope was determined with an Abney level, aspect with a Silva compass, and elevation with a Thommen altimeter.

**Laboratory Methods**

As the sampling was carried out the field sheets were placed in individual folders maintained for each clearcut. During the winter of 1967 this field data were compiled and tabulated on summary sheets. The information from these summary sheets was combined into histograms so that visual comparisons between clearcuts could be made.
The canopy-coverage values were tabulated by species for each clearcut. The quadrats making up each transect were first totaled; then the transects were totaled and averaged to give an average canopy-coverage for the species that occurred within the quadrats. A species list for each clearcut was compiled from these data.

The samples of plant material collected from each clearcut were immediately weighed in grams and after drying at room temperature for 2 weeks were again weighed in grams. This information was used to calculate the per cent dry matter of the important species and groups of minor species. This conversion factor was then multiplied by the corresponding field weights to convert them to air-dry weights.

After the field weights were converted to air-dry weights, the production in grams of each major species and group of minor species was totaled for each clearcut. On the four clearcuts sampled with 20-4.8 square foot quadrats these totals in grams were converted directly into production in pounds per acre. On the remaining 10 clearcuts sampled with 50 of these 4.8 square foot quadrats the totals were divided by 2.5 to convert them from grams to pounds per acre.

Frequency values, by clearcut, for each species were taken directly from the canopy-coverage and production field sheets. Frequency values were available for only the important species from the production data since the minor species were grouped into classes.

Species encountered on the clearcuts were either identified in the field or collected and pressed for later identification in the laboratory. A species list was compiled for each clearcut and another for all
clearcuts (Appendix II). The nomenclature follows that of Hitchcock and Chase (1950) for the Gramineae; Booth and Wright (1966) for the Dicotyledoneae; and Booth (1950) for the Monocotyledoneae. The Poly-podiaceae was determined from Davis (1952).
RESULTS

The vegetation occurring on several clearcuts in each of two forest zones was studied in terms of canopy-coverage and herbage production in pounds per acre. Canopy-coverage data were obtained for the understory vegetation on the adjacent timber stands. The canopy-coverage and herbage yield of the dominant species will be discussed separately. Several species of grasses, grasslike plants, forbs and shrubs which occurred infrequently and added little to the vegetative coverage or yield will be grouped into the appropriate categories. Frequency values, which were computed from the canopy-coverage and herbage yield field sheets, will be given to indicate the dispersion of the dominant species.

The amount and kind of vegetation that occurs on clearcuts within a particular forest zone is of fundamental importance in determining the grazing value of those clearcuts. The results of this study will be presented as an average for all clearcuts within each forest zone. The variation in dominant species between clearcuts in the same zone will then be discussed. Since burning is a common method of destroying slash accumulations on cutover areas and causes a certain amount of additional site disturbance the vegetation that occurs on burned areas will be discussed separately.

The clearcuts that were studied were selected to be as uniform in age as possible. The clearcuts in the fir-larch zone were logged 3 to 4 years prior to being sampled while those in the spruce-fir zone were 4 to 5 years old when sampled (Table 1). Generally these clearcuts
were burned the same year or the year following logging. As a result, the following data represent one stage in the plant succession on these areas.

The observations on utilization of herbage by species indicates the degree to which these clearcuts are currently being used and the preference of cattle for certain species that occur on these cutover areas. A brief survey of the extent of cattle use on the 14 clearcuts studied will be given. Cattle preference for certain species and groups of species will then be discussed. Such data will be of additional value in indicating the grazing potential of these cutover areas.

Species Composition of Understory Vegetation

In order to describe the forest zone in which each clearcut occurred, the forest understory surrounding the clearcuts was measured in terms of canopy-coverage. Frequency values were later computed from the field sheets. The forest understory associated with nine of the 10 clearcuts in the fir-larch zone was sampled. The tenth, surrounding Gold Creek No. 7, was burned by wildfire in 1961 and was not sampled. In the spruce-fir zone, only one stand of understory vegetation adjacent to the Lost Park clearcut was sampled. The forest understory associated with the three remaining clearcuts in this zone was not sampled due to lack of time. However, the species composition of the forest understory associated with these three clearcuts appeared to be similar to the one sampled. No measurements, other than noting the dominant species, were made of the forest overstories since it was felt that the understory vegetation should adequately characterize each zone.
The average canopy-coverage values of the major species and
groups of minor species in the fir-larch and spruce-fir zones are given
in Tables 2 and 3, respectively. The average values for each stand
sampled in the fir-larch zone is given in Appendix IV.

The overstory in the fir-larch zone was dominated by Pseudotsuga
menziesii and Larix occidentalis with minor amounts of Pinus ponderosa
and Pinus contorta scattered throughout the stand. The overstory of the
nine stands sampled in this zone is characteristically dense and shades

Table 2. The average frequency and canopy-coverage values for the
dominant species and groups of minor species in the forest
understory in the fir-larch zone.

<table>
<thead>
<tr>
<th></th>
<th>Frequency</th>
<th>Coverage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Grasses and Grasslike Plants</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Calamagrostis rubescens</td>
<td>47</td>
<td>2.20</td>
</tr>
<tr>
<td>Carex geyeri</td>
<td>17</td>
<td>1.00</td>
</tr>
<tr>
<td>Carex spp.</td>
<td>6</td>
<td>.30</td>
</tr>
<tr>
<td>Other Grasses</td>
<td></td>
<td>.19</td>
</tr>
<tr>
<td>Subtotal</td>
<td></td>
<td>2.69</td>
</tr>
<tr>
<td>Forbs</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Arnica cordifolia</td>
<td>37</td>
<td>4.10</td>
</tr>
<tr>
<td>Fragaria spp.</td>
<td>17</td>
<td>.50</td>
</tr>
<tr>
<td>Lupinus spp.</td>
<td>9</td>
<td>1.40</td>
</tr>
<tr>
<td>Xerophyllum tenax</td>
<td>15</td>
<td>5.20</td>
</tr>
<tr>
<td>Other Forbs</td>
<td></td>
<td>1.76</td>
</tr>
<tr>
<td>Subtotal</td>
<td></td>
<td>12.96</td>
</tr>
<tr>
<td>Shrubs</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Arctostaphylos uva-ursi</td>
<td>10</td>
<td>1.10</td>
</tr>
<tr>
<td>Chimaphila umbellata</td>
<td>19</td>
<td>1.20</td>
</tr>
<tr>
<td>Linnaea borealis</td>
<td>23</td>
<td>2.20</td>
</tr>
<tr>
<td>Mahonia repens</td>
<td>22</td>
<td>1.80</td>
</tr>
<tr>
<td>Spiraea betulifolia</td>
<td>12</td>
<td>.50</td>
</tr>
<tr>
<td>Vaccinium spp.1</td>
<td>20</td>
<td>1.70</td>
</tr>
<tr>
<td>Other Shrubs</td>
<td></td>
<td>1.11</td>
</tr>
<tr>
<td>Subtotal</td>
<td></td>
<td>8.61</td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td>25.26</td>
</tr>
</tbody>
</table>

1Vaccinium membranaceum and Vaccinium myrtillus
Table 3. The average frequency and canopy-coverage values for the dominant species and groups of minor species in the forest understory in the spruce-fir zone.

<table>
<thead>
<tr>
<th></th>
<th>Frequency</th>
<th>Coverage</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Forbs</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Arnica cordifolia</td>
<td>5</td>
<td>1.25</td>
</tr>
<tr>
<td>Clintonia uniflora</td>
<td>1</td>
<td>.03</td>
</tr>
<tr>
<td>Goodyera oblongiflora</td>
<td>2</td>
<td>.19</td>
</tr>
<tr>
<td>Lupinus spp.</td>
<td>1</td>
<td>.08</td>
</tr>
<tr>
<td>Pedicularis racemosa</td>
<td>2</td>
<td>.06</td>
</tr>
<tr>
<td>Viola spp.</td>
<td>8</td>
<td>.30</td>
</tr>
<tr>
<td>Xerophyllum tenax</td>
<td>58</td>
<td>20.24</td>
</tr>
<tr>
<td>Other Forbs</td>
<td>2</td>
<td>.26</td>
</tr>
<tr>
<td><strong>Subtotal</strong></td>
<td></td>
<td>22.41</td>
</tr>
</tbody>
</table>

|                |           |          |
| **Shrubs**     |           |          |
| Betula glandulosa | 1        | .80      |
| Chimaphila umbellata | 1       | .03      |
| Ledum glandulosm | 2         | .70      |
| Menziesia ferruginea | 27      | 14.28    |
| Vaccinium spp.  | 37        | 8.18     |
| Vaccinium scoparium | 22      | 2.52     |
| **Subtotal**    |           | 26.51    |
| **Total**       |           | 48.92    |

1Vaccinium membranaceum and Vaccinium myrtillus

most of the ground surface from direct sunlight. The dominant overstory species in the spruce-fir zone are *Picea engelmanni* and *Abies lasiocarpa*. These species, which have narrow crowns and grow close together, form dense stands that physically limit extensive grazing by cattle in this zone.

The total coverage of understory vegetation in the fir-larch zone averaged 25 per cent while that in the spruce-fir zone was much denser and averaged 49 per cent. Considerable variation in the per cent composition of grasses and grasslike plants, forbs and shrubs between the
two zones was noted. While grasses and grasslike plants made up 23 per cent of the vegetative cover in the fir-larch zone, they were not present in the understory of the spruce-fir zone. Similarly, the forbs, which were the dominant group in the fir-larch zone, were subdominant to the shrubs in the spruce-fir zone, even though they made up about the same per cent composition in both zones. The forbs made up 48 and 46 per cent and the shrubs 36 and 54 per cent of the vegetative coverage in the fir-larch and spruce-fir zones, respectively.

The grasses and grasslike plants occurring in the fir-larch zone were dominated by Calamagrostis rubescens and Carex geyeri. Several other species of grasses and Carex were present but made up a minor part of the total vegetative coverage.

Approximately 30 species of forbs occurred in the fir-larch zone while only seven occurred in the spruce-fir zone. Of these, Xerophyllum tenax dominated the forbs coverage in both zones. Another important forb species in both forest zones was Arnica cordifolia. Several species of Fragaria and Lupinus were common in the fir-larch zone but only Lupinus spp. occurred in minor amounts in the spruce-fir zone. The remaining forbs in the fir-larch zone occurred infrequently and were a minor part of the vegetative coverage. Similarly, Clintonia uniflora, Goodyera oblongiflora, Pedicularis racemosa, and Viola spp., the remaining forbs in the spruce-fir zone, were of minor importance.

Several important species of shrubs in the fir-larch zone were Mahonia repens, Vaccinium spp., Chimaphila umbellata, Arctostaphylos uva-ursi, and Spiraea betulifolia. Amelanchier alnifolia, Lonicera spp., Pachistima myrsinites, Physocarpus malvaceus, Rosa spp., Salix spp.,
Symphoricarpos albus, Vaccinium scoparium, and Ceanothus velutinus occurred in the understory in this zone but added little to the total vegetative coverage. The dominant shrub in the spruce-fir zone was Menziesia ferruginea. Other important shrubs in this zone were Vaccinium scoparium and Vaccinium spp. Several other species of shrubs such as Betula glandulosa, Ledum glandulosum and Chimaphila umbellata were present but were of minor importance.

Species Composition of Clearcuts in the Fir-Larch Zone

Canopy-coverage averaged 28 per cent and herbage yield was 1,114 pounds per acre for all clearcuts within the fir-larch zone. Considerable variation from these averages occurred for Gold Creek No. 3 and 7 which were burned by wildfire in 1961. Similarly, the canopy-coverage and herbage yield for the Ninemile and Bear Creek clearcuts, which were moderately to heavily grazed, were less than average. Table 4 gives the average canopy-coverage and herbage yield for the 10 clearcuts within this zone.

Table 4. Average canopy-coverage and herbage yield for the clearcuts in the fir-larch zone.

<table>
<thead>
<tr>
<th>Clearcut</th>
<th>Total Canopy-coverage</th>
<th>Total Production</th>
</tr>
</thead>
<tbody>
<tr>
<td>Blue Mountain</td>
<td>21.3</td>
<td>873.2</td>
</tr>
<tr>
<td>Ninemile</td>
<td>35.3</td>
<td>1,150.2</td>
</tr>
<tr>
<td>Gold Creek No. 1</td>
<td>33.0</td>
<td>1,298.4</td>
</tr>
<tr>
<td>Gold Creek No. 2</td>
<td>28.1</td>
<td>1,254.8</td>
</tr>
<tr>
<td>Gold Creek No. 3</td>
<td>15.9</td>
<td>722.8</td>
</tr>
<tr>
<td>Gold Creek No. 4</td>
<td>38.6</td>
<td>1,460.8</td>
</tr>
<tr>
<td>Gold Creek No. 5</td>
<td>27.2</td>
<td>1,238.4</td>
</tr>
<tr>
<td>Gold Creek No. 6</td>
<td>34.4</td>
<td>1,391.6</td>
</tr>
<tr>
<td>Gold Creek No. 7</td>
<td>20.5</td>
<td>768.4</td>
</tr>
<tr>
<td>Bear Creek</td>
<td>24.6</td>
<td>982.4</td>
</tr>
<tr>
<td>Average</td>
<td>27.9</td>
<td>1,114.3</td>
</tr>
</tbody>
</table>

1When sampled for canopy-coverage and herbage yield, no provision was made for reconstructing plant parts removed through grazing.
Approximately 90 species occurred on the clearcuts within the fir-larch zone. Table 5 shows the average frequency, canopy-coverage, and herbage yield for the dominant species and groups of minor species. The average values for each clearcut are given in Appendix III.

The canopy-coverage and herbage yield followed closely for all classes of vegetation in this zone. The forbs, which were the most abundant class of vegetation, made up 44.5 per cent of the vegetative coverage and 46 per cent of the herbage yield. The per cent composition of the canopy-coverage and herbage yield for the grasses and grasslike plants was 33 per cent and 35.5 per cent, respectively. The shrubs were less abundant than the other two classes but still made up 24 per cent of the vegetative coverage and 18 per cent of the herbage yield.

The data in Tables 2 and 5 show that the most significant differences in vegetation between the cutover areas and forest understory are changes in the total coverage of herbaceous and shrubby vegetation and changes in the proportion of grasses and grasslike plants, forbs and shrubs. The total coverage of herbaceous and shrubby vegetation on the cutover areas in the fir-larch zone is approximately 33 per cent greater than on the uncut areas. The grasses and grasslike plants are much more abundant (2.5 times) on the cutover areas than in the forest understory. The forb coverage is about the same in both areas while the shrub coverage is 25 per cent less on the cutover areas.

The grasses and grasslike plants occurred throughout the clearcuts in the fir-larch zone. *Calamagrostis rubescens*, the most important grass species, was the dominant species on these clearcuts. Another important species was *Carex geyeri*, which dominated the grasslike plants.
Table 5. The average frequency, canopy-coverage, and herbage yield for the dominant species and groups of minor species on the clearcuts in the fir-larch zone.

<table>
<thead>
<tr>
<th>Grasses and Grasslike Plants</th>
<th>Frequency</th>
<th>Canopy-Cover</th>
<th>Herbage yield</th>
<th>lbs/acre</th>
</tr>
</thead>
<tbody>
<tr>
<td>Calamagrostis rubescens</td>
<td>64.7</td>
<td>1.16</td>
<td>143.80</td>
<td></td>
</tr>
<tr>
<td>Carex geyeri</td>
<td>39.6</td>
<td>2.07</td>
<td>118.62</td>
<td></td>
</tr>
<tr>
<td>Carex spp.</td>
<td>33.9</td>
<td>1.95</td>
<td>85.00</td>
<td></td>
</tr>
<tr>
<td>Festuca occidentalis</td>
<td>19.8</td>
<td>5.55</td>
<td>48.70</td>
<td></td>
</tr>
<tr>
<td>Other Grasses</td>
<td>9.3</td>
<td>0.38</td>
<td>8.00</td>
<td></td>
</tr>
<tr>
<td>Other Grasslike plants</td>
<td>4.4</td>
<td>0.66</td>
<td>50.50</td>
<td></td>
</tr>
<tr>
<td>Subtotal</td>
<td>9.17</td>
<td></td>
<td>404.82</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Forbs</th>
<th>Frequency</th>
<th>Canopy-Cover</th>
<th>Herbage yield</th>
<th>lbs/acre</th>
</tr>
</thead>
<tbody>
<tr>
<td>Xerophyllum tenax</td>
<td>18.0</td>
<td>3.00</td>
<td>117.21</td>
<td></td>
</tr>
<tr>
<td>Fragaria spp.</td>
<td>37.5</td>
<td>2.02</td>
<td>57.30</td>
<td></td>
</tr>
<tr>
<td>Lupinus spp.</td>
<td>20.5</td>
<td>1.40</td>
<td>53.40</td>
<td></td>
</tr>
<tr>
<td>Arnica cordifolia</td>
<td>48.6</td>
<td>2.04</td>
<td>52.20</td>
<td></td>
</tr>
<tr>
<td>Cirsium spp.</td>
<td>9.0</td>
<td>0.46</td>
<td>42.30</td>
<td></td>
</tr>
<tr>
<td>Achillea millefolium</td>
<td>11.4</td>
<td>0.36</td>
<td>28.60</td>
<td></td>
</tr>
<tr>
<td>Epilobium angustifolium</td>
<td>8.6</td>
<td>0.32</td>
<td>8.40</td>
<td></td>
</tr>
<tr>
<td>Apocynum androsumifolium</td>
<td>2.2</td>
<td></td>
<td>0.06</td>
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</tr>
<tr>
<td>Other Forbs</td>
<td>89.3</td>
<td>2.66</td>
<td>133.50</td>
<td></td>
</tr>
<tr>
<td>Subtotal</td>
<td>12.26</td>
<td></td>
<td>492.97</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Shrubs</th>
<th>Frequency</th>
<th>Canopy-Cover</th>
<th>Herbage yield</th>
<th>lbs/acre</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mahonia repens</td>
<td>36.4</td>
<td>2.42</td>
<td>71.11</td>
<td></td>
</tr>
<tr>
<td>Spiraea betulifolia</td>
<td>32.1</td>
<td>0.67</td>
<td>25.60</td>
<td></td>
</tr>
<tr>
<td>Vaccinium spp.</td>
<td>17.4</td>
<td>5.00</td>
<td>23.70</td>
<td></td>
</tr>
<tr>
<td>Symphoricarpos albus</td>
<td>11.5</td>
<td>0.60</td>
<td>19.80</td>
<td></td>
</tr>
<tr>
<td>Amelanchier alnifolia</td>
<td>5.4</td>
<td>0.18</td>
<td>16.70</td>
<td></td>
</tr>
<tr>
<td>Arctostaphylos uva-ursi</td>
<td>3.5</td>
<td>0.26</td>
<td>15.40</td>
<td></td>
</tr>
<tr>
<td>Linnaea borealis</td>
<td>4.7</td>
<td>0.49</td>
<td>11.20</td>
<td></td>
</tr>
<tr>
<td>Ceanothus velutinus</td>
<td>2.4</td>
<td>1.14</td>
<td>8.30</td>
<td></td>
</tr>
<tr>
<td>Rosa spp.</td>
<td>10.8</td>
<td>0.23</td>
<td>7.80</td>
<td></td>
</tr>
<tr>
<td>Salix spp.</td>
<td>1.4</td>
<td>1.19</td>
<td>7.80</td>
<td></td>
</tr>
<tr>
<td>Ribes spp.</td>
<td>5.2</td>
<td>1.18</td>
<td>4.80</td>
<td></td>
</tr>
<tr>
<td>Pachistima myrsinates</td>
<td>7.8</td>
<td>0.14</td>
<td>2.40</td>
<td></td>
</tr>
<tr>
<td>Artemisia frigida</td>
<td>2.2</td>
<td></td>
<td>0.30</td>
<td></td>
</tr>
<tr>
<td>Chimaphila umbellata</td>
<td>4.4</td>
<td></td>
<td>0.20</td>
<td></td>
</tr>
<tr>
<td>Rubus parviflorus</td>
<td>2.2</td>
<td></td>
<td>0.08</td>
<td></td>
</tr>
<tr>
<td>Rubus idaeus</td>
<td>2.2</td>
<td></td>
<td>0.04</td>
<td></td>
</tr>
<tr>
<td>Acer glabrum</td>
<td>0.53</td>
<td></td>
<td>207.43</td>
<td></td>
</tr>
<tr>
<td>Subtotal</td>
<td>6.51</td>
<td></td>
<td>207.43</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>27.94</td>
<td></td>
<td>1,105.02</td>
<td></td>
</tr>
</tbody>
</table>
Festuca occidentalis and several species of Carex occurred in varying amounts on most of the clearcuts within this zone. Several species of grasses, Juncus, and Luzula parviflora, were present on these clearcuts but made up a small part of the vegetative coverage and herbage yield.

The forbs, the most abundant class of vegetation, were dominated by Xerophyllum tenax. Other important forbs were Arnica cordifolia, Fragaria spp. and Lupinus spp. Several species of Cirsium, Achillea millefolium and Epilobium angustifolium were present on most of the clearcuts in this zone. Many additional species of forbs occurred on these clearcuts but were of minor importance. As a group they covered 2.4 per cent of the area and produced 134 pounds per acre.

The shrubs were less abundant than the grasses and grasslike plants or the forbs. Mahonia repens dominated the shrub coverage in this zone. Three other shrubs that occurred throughout the clearcuts of this zone were Vaccinium spp., Symphoricarpos albus and Spiraea betulifolia. Several species of shrubs were of minor importance since they were not abundant and did not occur in all clearcuts within the fir-larch zone. These were Amelanchier alnifolia, Arctostaphylos uva-ursi, Linnaea borealis, Ceanothus velutinus, Rosa spp., Salix spp., Ribes spp., Fuchsia myrsinoides, Artemisia frigida, Chimaphila umbellata, Rubus parviflorus, and Rubus idaeus. The canopy-coverage and herbage yield for this group of species averaged 2.3 per cent and 71 pounds, respectively.

The average frequency values shown in Table 5 are included to indicate the dispersion of the dominant species. Generally the dominant species, with one exception, were well dispersed and occurred throughout the clearcuts of this zone. This does not follow for Xerophyllum tenax,
which occurred in only 18 per cent of the sample plots. The minor species of grasses and grasslike plants, forbs and shrubs occur infrequently throughout this zone.

The variations in terms of canopy-coverage of the dominant species between the clearcuts within the fir-larch zone is indicated in Figure 14. With few exceptions, these dominant species occurred in all 10 of the clearcuts studied. The remainder of the species encountered on these cutover areas occur on some but not all of the clearcuts studied.

The variations shown are not explainable in terms of differences in treatment received by each clearcut. Gold Creek No. 3 and 7, which were burned by wildfire in 1961, showed a marked decrease in canopy-coverage and herbage yield from the average for all clearcuts within this zone (Table 4). However, noticeable differences in the dominant species are not present. Similarly, Blue Mountain and Bear Creek, the two most heavily grazed clearcuts, do not show significant differences in species to be attributed to this factor.

With one exception, the variation in minor species between clearcuts is not important from a grazing standpoint. Ninemile, however, has a greater incidence of grass species than does any of the other clearcuts in this zone. Several of these species are considered to be introduced.

Most of the dominant species variation is probably due to chance occurrences of species and local variation in environmental factors between clearcuts. In addition, sampling error probably accounts for some of this variation.
Figure 14. The canopy-cover values by clearcut for the nine dominant species in the fir-larch zone.
Figure 14. The canopy-cover values by clearcut for the nine dominant species in the fir-larch zone. (continued)
Figure 14. The canopy-cover values by clearcut for the nine dominant species in the fir-larch zone. (continued)

Lupinus spp.

Spiraea betulifolia

Mahonia repens

Bar charts showing the percent canopy cover for different species across various sites.
Species Composition of Clearcuts in Spruce-Fir Zone

Approximately 50 species were encountered on the clearcuts in this zone; about half as many as occurred on the clearcuts in the fir-larch zone. However, canopy-coverage and herbage yield, which averaged 30.5 per cent and 1,243 pounds, respectively, were almost equal in both forest zones. Table 6 gives the average canopy-coverage and herbage yield for each clearcut in the spruce-fir zone.

Table 6. The average canopy-coverage and herbage yield for each clearcut in the spruce-fir zone.

<table>
<thead>
<tr>
<th>Clearcut</th>
<th>Canopy-coverage %</th>
<th>Herbage Prod. lbs/acre</th>
</tr>
</thead>
<tbody>
<tr>
<td>Edith Peak</td>
<td>40.1</td>
<td>1,268</td>
</tr>
<tr>
<td>Lost Park</td>
<td>24.6</td>
<td>1,166</td>
</tr>
<tr>
<td>Lee Creek</td>
<td>31.2</td>
<td>1,276</td>
</tr>
<tr>
<td>Granite Creek</td>
<td>24.2</td>
<td>1,262</td>
</tr>
<tr>
<td>Average</td>
<td>30.5</td>
<td>1,243</td>
</tr>
</tbody>
</table>

The average frequency, canopy-coverage, and herbage yield for the dominant species and groups of minor species in the spruce-fir zone are given in Table 7. The average values for each of the four clearcuts in this zone are given in Appendix IV.

The forbs were the most abundant class of vegetation on the clearcuts in the spruce-fir zone and made up 39.6 and 48.7 per cent of the canopy-coverage and herbage yield, respectively. The shrubs were of increased importance in this zone over the fir-larch zone and made up 31 per cent of the vegetative coverage and 28.4 per cent of the vegetation by weight. Similarly, the grasses and grasslike plants were of less
Table 7. The average frequency, canopy-coverage, and herbage yield for the dominant species and groups of minor species on the clearcuts in the spruce-fir zone.

<table>
<thead>
<tr>
<th></th>
<th>Frequency</th>
<th>Canopy-cover</th>
<th>Herbage Yield</th>
<th>lbs/acre</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Grasses and Grasslike Plants</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Carex geyeri</td>
<td>51</td>
<td>6.7</td>
<td>153.8</td>
<td></td>
</tr>
<tr>
<td>Carex spp.</td>
<td>17</td>
<td>1.0</td>
<td>88.0</td>
<td></td>
</tr>
<tr>
<td>Other Grasses</td>
<td>31</td>
<td>.9</td>
<td>39.0</td>
<td></td>
</tr>
<tr>
<td>Other Grasslike Plants</td>
<td>1</td>
<td>.2</td>
<td>4.2</td>
<td></td>
</tr>
<tr>
<td><strong>Subtotal</strong></td>
<td>8.8</td>
<td></td>
<td>285.0</td>
<td></td>
</tr>
<tr>
<td><strong>Forbs</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Anaphalis margaritacea</td>
<td>4</td>
<td>.5</td>
<td>16.0</td>
<td></td>
</tr>
<tr>
<td>Arnica cordifolia</td>
<td>8</td>
<td>3.9</td>
<td>7.8</td>
<td></td>
</tr>
<tr>
<td>Epilobium angustifolium</td>
<td>29</td>
<td>1.1</td>
<td>87.5</td>
<td></td>
</tr>
<tr>
<td>Senecio spp.</td>
<td>1</td>
<td>.8</td>
<td>11.5</td>
<td></td>
</tr>
<tr>
<td>Xerophyllum tenax</td>
<td>34</td>
<td>2.8</td>
<td>256.5</td>
<td></td>
</tr>
<tr>
<td>Other Forbs</td>
<td>76</td>
<td>2.8</td>
<td>217.5</td>
<td></td>
</tr>
<tr>
<td><strong>Subtotal</strong></td>
<td>11.9</td>
<td></td>
<td>596.8</td>
<td></td>
</tr>
<tr>
<td><strong>Shrubs</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Menziesia ferruginea</td>
<td>12</td>
<td>2.2</td>
<td>64.3</td>
<td></td>
</tr>
<tr>
<td>Rubus ideaus</td>
<td>5</td>
<td>.2</td>
<td>57.8</td>
<td></td>
</tr>
<tr>
<td>Rubus parviflorus</td>
<td>9</td>
<td>1.5</td>
<td>19.0</td>
<td></td>
</tr>
<tr>
<td>Sambucus spp.</td>
<td>4</td>
<td>.5</td>
<td>3.3</td>
<td></td>
</tr>
<tr>
<td>Vaccinium scoparium</td>
<td>25</td>
<td>.6</td>
<td>29.0</td>
<td></td>
</tr>
<tr>
<td>Vaccinium spp.</td>
<td>50</td>
<td>3.4</td>
<td>169.0</td>
<td></td>
</tr>
<tr>
<td>Other Shrubs</td>
<td>4</td>
<td>9.3</td>
<td>6.3</td>
<td></td>
</tr>
<tr>
<td><strong>Subtotal</strong></td>
<td>30.0</td>
<td></td>
<td>1,230.5</td>
<td></td>
</tr>
</tbody>
</table>

importance in this zone but still made up 29 per cent of the canopy-coverage and 23 per cent of the herbage yield.

The most significant differences in vegetation between the cut-over areas and uncut forests in this zone are changes in the total coverage of herbaceous and shrubby vegetation and changes in the proportion of grasses and grasslike plants, forbs and shrubs (Tables 3 and 7).
The total coverage of herbaceous and shrubby vegetation on clearcuts in the spruce-fir zone is approximately 40 per cent less than that in the forest understory. The greatest differences concern the grasses and grasslike plants which were not present in the forest understory in this zone but covered approximately 8 per cent of the cutover areas. Most of the forbs and shrubs, however, decreased on the cutover areas.

Several species of grasses occurred on these clearcuts but were of minor importance. The grasses, as a group, made up 3.1 per cent of the total cover and 3.2 per cent of the herbage yield while the grasslike plants composed 26 per cent of the vegetative cover and 19.7 per cent of the herbage yield. *Carex geyeri* dominated the grasses and grasslike plants on these clearcuts. *Calamagrostis rubescens*, the dominant grass species, made up 63 per cent of the total grass cover but was of minor importance. Several species of *Carex* were an important part of the grasslike vegetation on these clearcuts. Several species of *Juncus* and *Luzula parviflora* were present but made up a minor part of the vegetation in the spruce-fir zone.

The forbs, the most abundant class of vegetation, were dominated by *Xerophyllum tenax* while *Epilobium angustifolium* was of secondary importance. Other important species were *Anaphalis margaritacea*, * Arnica cordifolia* and *Senecio* spp. Several other species of forbs occurred on these clearcuts in the spruce-fir zone, but as individuals contributed little to the total canopy-coverage or herbage yield. As a group, however, they covered 2.8 percent of the area and produced 218 pounds per acre of herbage.

The shrubs, which were more abundant than the grasses and grasslike plants but not as abundant as the forbs, were dominated by *Vaccinium*
spp. and to a lesser degree by *Vaccinium scoparium*. Two other important species of shrubs were *Menziesia ferruginea* and *Rubus idaeus*. *Rubus parviflorus* and *Sambucus* spp. occurred on the clearcuts in the spruce-fir zone but were of minor importance. Several other species of shrubs occurred infrequently and covered .6 per cent of the total area and produced 6.3 pounds per acre.

The frequency values for the dominant species in this zone are given in Table 7. Generally, the dominant species are well dispersed while the species of minor importance occur infrequently. However, there are a few exceptions to this. *Xerophyllum tenax*, the dominant forb, occurred on approximately 34 per cent of the plots but made up 20 per cent of the total vegetation by weight. Similarly, *Menziesia ferruginea* and *Rubus idaeus*, two important species of shrub, occurred on 12 and 5 per cent of the plots, respectively. Although these species were not well dispersed, they occurred in dense patches or clumps and gave high values when sampled. Conversely, the grasses and one species of shrub, *Vaccinium scoparium*, contributed very little to the total herbage yield but occurred on 31 and 25 per cent of the plots, respectively. These were fairly widely dispersed but occurred in small amounts at any one place.

The variation in dominant species between the clearcuts in this zone was more pronounced than between the clearcuts in the fir-larch zone. Most of the variation between the Edith Peak, Granite Creek, and Lost Park clearcuts was not pronounced and cannot be explained by differences in treatments between these clearcuts. The dominant species on the Lee Creek clearcut, however, showed considerable variation from the above clearcuts and will be discussed separately. The dominant species variation between the clearcuts in the spruce-fir zone is shown in Figure 15.
Figure 15. The canopy-cover values for the dominant species in the spruce-fir zone.

species in the spruce-fir zone. The canopy-cover values by vegetation for the

Figure 15. The canopy-cover values by vegetation for the
dominant

—— % Canopy-cover

Edith Peak
Granite Creek
Lost Park
Lee Creek

Batisma gentilis

—— % Canopy-cover

Edith Peak
Granite Creek
Lost Park
Lee Creek

(Fr.)
The vegetation on the Edith Peak, Granite Creek, and Lost Park clearcuts was dominated by several species of *Carex*, *Xerophyllum tenax*, and *Vaccinium* spp. *Carex geyeri* was the dominant grasslike plant on the Edith Peak and Granite Creek clearcuts but was of minor importance on the Lost Park clearcut. Similarly, the species of *Carex*, which were of minor importance on Edith Peak and Granite Creek, were the dominant grasslike plants on Lost Park. The average canopy-coverage for *Xerophyllum tenax* was approximately seven times greater on Granite Creek than on Lost Park and twice as great as on Edith Peak. *Vaccinium* spp. covered about the same area on all three of these clearcuts. In addition, the minor forbs, as a group, were abundant on the Edith Peak and Lost Park clearcuts but made up a small part of the vegetative coverage on the Granite Creek clearcut. The above variations cannot be explained in terms of differences in treatment. In addition, the soils showed similar development on each of these areas. This variation is probably due to chance occurrences of species and local variations in environmental factors between these three clearcuts. Also, sampling error probably contributed to these differences.

Another difference between these three clearcuts was noted. *Menziesia ferruginea* made up a much greater part of the vegetative cover on the Lost Park clearcut than on either the Granite Creek or Edith Peak clearcuts. Differences in treatment might explain this variation. The slash was piled in rows on all three of these cutover areas but was not burned on the Lost Park clearcut. This piled slash might have protected *Menziesia ferruginea*, a dominant species in the forest understory, from scarification and other logging disturbances and allowed it to maintain
its dominance over these areas. This would account for its greater canopy-coverage on the Lost Park clearcut.

Several species showed considerable variation between Lee Creek and the other three clearcuts in this forest zone. *Rubus ideaus* and *Rubus parviflorus*, which were present in minor amounts on the other three clearcuts, made up a much larger part of the vegetative coverage on the Lee Creek clearcut. Similarly, several species of grasses were of minor importance on the Edith Peak, Granite Creek, and Lost Park clearcuts but made up a large part of the vegetation on this clearcut. *Carex geyeri* and several other species of *Carex* were of minor importance on the Lee Creek clearcut but dominated the other three cutover areas. This variation is probably due to environmental differences between the Lee Creek clearcut and the three clearcuts discussed above. The narrow band of the spruce-fir zone in which the Lee Creek clearcut is found, occurs in a creek bottom and can be considered a physiographic climax while the other three clearcuts occur in climatic climax areas of the spruce-fir zone (Daubenmire, 1952). In addition, the Lee Creek clearcut is lower in elevation than the other three clearcuts and appeared to be more zeric.

**Species Composition of Burned Areas**

Of the 14 clearcuts samples, three were stratified into burned and unburned areas before sampling for canopy-coverage. On these three clearcuts the slash was piled in rows and when burned caused hot fires that consumed the duff and exposed the blackened mineral soil. The information from this stratified sampling gives an indication of the
vegetation that occurs on severely burned areas. Two of the clearcuts, Edith Peak and Granite Creek, are in the spruce-fir zone. The third, Ninemile, is in the fir-larch zone.

**Fir-larch zone.** The total vegetative coverage on the burned areas (34 per cent) was similar to the total coverage on the unburned areas (35.3 per cent) on the Ninemile clearcut. On this clearcut burning apparently had no effect on total canopy-coverage; however, there was a significant difference in the proportion of grasses and grasslike plants, forbs and shrubs on the burned areas as compared to the unburned areas. The grasses and grasslike plants made up only 4.3 per cent of the total cover on the burned areas and 42 per cent of the total cover on the unburned areas. The forbs, which were disproportionately represented on the burned areas, made up 91.5 per cent of the cover on these areas as compared to 50 per cent of the cover on the unburned areas. The shrubs made up 3.7 per cent of the total cover on the burned areas and 7 per cent of the vegetative cover on the unburned areas. Table 8 compares the average canopy-coverage values for the dominant species and groups of minor species that occurred on the burned and unburned areas of this clearcut.

The grasses and grasslike plants were of minor importance and covered only 1.4 per cent of the burned areas. Only one species of Carex was present and made up most of the vegetative cover of this group. *Calamagrostis rubescens*, *Festuca idahoensis*, and *Festuca occidentalis* were the only three species of grasses found on the burned area and occurred in trace amounts. All of these species were more abundant on the unburned than on the burned areas.
Table 8. The average canopy-coverage values for the dominant species and groups of minor species found on the burned and unburned areas on the Ninemile clearcut in the fir-larch zone.

<table>
<thead>
<tr>
<th></th>
<th>Burned % Coverage</th>
<th>Unburned % Coverage</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Grasses and Grasslike Plants</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Calamagrostis rubescens</td>
<td>.1</td>
<td>2.0</td>
</tr>
<tr>
<td>Carex geyeri</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Carex spp.</td>
<td>1.3</td>
<td>9.2</td>
</tr>
<tr>
<td>Festuca occidentalis</td>
<td>.1</td>
<td>1.1</td>
</tr>
<tr>
<td>Other Grasses</td>
<td></td>
<td>2.0</td>
</tr>
<tr>
<td>Other Grasslike Plants</td>
<td></td>
<td>.6</td>
</tr>
<tr>
<td><strong>Subtotal</strong></td>
<td>1.5</td>
<td>14.9</td>
</tr>
<tr>
<td><strong>Forbs</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Xerophyllum tenax</td>
<td></td>
<td>.2</td>
</tr>
<tr>
<td>Fragaria spp.</td>
<td>.5</td>
<td>6.6</td>
</tr>
<tr>
<td>Lupinus spp.</td>
<td></td>
<td>.5</td>
</tr>
<tr>
<td>Arnica cordifolia</td>
<td>1.4</td>
<td>2.6</td>
</tr>
<tr>
<td>Cirsium spp.</td>
<td>22.6</td>
<td>1.7</td>
</tr>
<tr>
<td>Achillea millefolium</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Epilobium angustifolium</td>
<td>5.4</td>
<td>1.3</td>
</tr>
<tr>
<td>Astragalus spp.</td>
<td>.9</td>
<td>5.5</td>
</tr>
<tr>
<td>Other Forbs</td>
<td>.4</td>
<td>4.5</td>
</tr>
<tr>
<td><strong>Subtotal</strong></td>
<td>31.2</td>
<td>17.9</td>
</tr>
<tr>
<td><strong>Shrubs</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Acer glabrum</td>
<td>.2</td>
<td></td>
</tr>
<tr>
<td>Amelanchier alnifolium</td>
<td></td>
<td>.2</td>
</tr>
<tr>
<td>Artemisia frigida</td>
<td>.2</td>
<td></td>
</tr>
<tr>
<td>Linnaea borealis</td>
<td></td>
<td>.4</td>
</tr>
<tr>
<td>Mahonia repens</td>
<td></td>
<td>.2</td>
</tr>
<tr>
<td>Fachistima myrsinites</td>
<td></td>
<td>.2</td>
</tr>
<tr>
<td>Ribes spp.</td>
<td>.1</td>
<td>.4</td>
</tr>
<tr>
<td>Rosa spp.</td>
<td>.3</td>
<td>.4</td>
</tr>
<tr>
<td>Spiraea betulifolia</td>
<td></td>
<td>.2</td>
</tr>
<tr>
<td>Symphoricarpos albus</td>
<td>.6</td>
<td>.5</td>
</tr>
<tr>
<td>Vaccinium spp.</td>
<td></td>
<td>.1</td>
</tr>
<tr>
<td><strong>Subtotal</strong></td>
<td>1.4</td>
<td>2.6</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>34.1</td>
<td>35.4</td>
</tr>
</tbody>
</table>
The forbs were dominated by several species of *Cirsium* which covered 22.6 per cent of the burned areas. Other important species of forbs were *Epilobium angustifolium*, *Arnica cordifolia*, *Astragalus* spp. and *Fragaria* spp. Several other species of forbs were present on the burned areas, but as a group covered only .4 per cent of the area. Of these forbs, *Cirsium* spp., *Epilobium angustifolium* and *Astragalus* spp. were more abundant on the burned than on the unburned areas while *Arnica cordifolia* and *Fragaria* spp. were more abundant on the unburned areas.

The total shrub cover on the burned areas averaged 1.4 per cent. *Symphoricarpos albus* was the dominant shrub. *Amelanchier alnifolia*, *Artemisia frigida*, *Pachistima myrsinites*, *Ribes* spp., and *Rosa* spp. were present in minor amounts and as a group covered only .8 per cent of the burned areas. All of these species were more abundant on the unburned than on the burned areas.

**Spruce-fir zone.** Burning appeared to cause a decrease in total canopy-coverage on the Edith Peak and Granite Creek clearcuts. The total cover on the burned areas was 30 per cent less than the cover on the unburned areas. When broken down by clearcuts, the canopy-coverage on the burned areas averaged 25.9 and 14.3 per cent and on the unburned areas averaged 40.1 and 24 per cent for the Edith Peak and Granite Creek clearcuts, respectively. There was also a significant difference in the proportion of grasses and grasslike plants, forbs and shrubs on the burned areas as compared to the unburned areas. The grasses and grasslike plants, which made up 9 per cent of the vegetative cover on the burned areas, made up 38 per cent of the total coverage on the unburned areas. The forbs made up a much greater part of the cover on the burned areas (79 per cent)
than on the unburned areas (40 per cent) and the shrubs covered 12 per cent of the burned areas and 21 per cent of the unburned areas. Figures 16 and 17 are close-up views of a burned and unburned area on the Edith Peak clearcut. Table 9 compares the average canopy-coverage of the dominant species and groups of minor species which occurred on the burned and unburned areas in the spruce-fir zone.

**Table 9.** The average canopy-coverage for the dominant species and groups of minor species on the burned and unburned areas on the Edith Peak and Granite Creek clearcuts.

<table>
<thead>
<tr>
<th></th>
<th>Burned Coverage</th>
<th>Unburned Coverage</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Grasses and Grasslike Plants</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td><em>Carex geyeri</em></td>
<td>1.8</td>
<td>12.3</td>
</tr>
<tr>
<td>Other Grasses</td>
<td>2.0</td>
<td></td>
</tr>
<tr>
<td>Other Grasslike Plants</td>
<td>3.0</td>
<td></td>
</tr>
<tr>
<td>Subtotal</td>
<td>2.0</td>
<td>12.6</td>
</tr>
<tr>
<td><strong>Forbs</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td><em>Anaphalis margaritacea</em></td>
<td>1.4</td>
<td>1.1</td>
</tr>
<tr>
<td><em>Arnica cordifolia</em></td>
<td>4.9</td>
<td>2.9</td>
</tr>
<tr>
<td><em>Epilobium angustifolium</em></td>
<td>4.4</td>
<td>0.8</td>
</tr>
<tr>
<td><em>Hieracium spp.</em></td>
<td>4.5</td>
<td>0.5</td>
</tr>
<tr>
<td><em>Lupinus spp.</em></td>
<td>1.0</td>
<td>2.5</td>
</tr>
<tr>
<td><em>Senecio spp.</em></td>
<td>1.7</td>
<td>0.5</td>
</tr>
<tr>
<td><em>Asterophyllum tenax</em></td>
<td>0.6</td>
<td>5.3</td>
</tr>
<tr>
<td>Other Forbs</td>
<td>0.9</td>
<td></td>
</tr>
<tr>
<td>Subtotal</td>
<td>15.5</td>
<td>12.4</td>
</tr>
<tr>
<td><strong>Shrubs</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td><em>Vaccinium spp.</em></td>
<td>1.2</td>
<td>1.5</td>
</tr>
<tr>
<td><em>Andromedum scoparium</em></td>
<td>1.1</td>
<td>1.1</td>
</tr>
<tr>
<td><em>Menziesia ferruginea</em></td>
<td>0.1</td>
<td>1.6</td>
</tr>
<tr>
<td>Other shrubs</td>
<td>0.2</td>
<td>0.5</td>
</tr>
<tr>
<td>Subtotal</td>
<td>2.6</td>
<td>6.7</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>20.1</td>
<td>31.7</td>
</tr>
</tbody>
</table>
Figure 16. A close-up view of a burned row on the Edith Peak clear-cut.

Figure 17. A close-up view of an unburned area on the Edith Peak clear-cut.
The grasses and grasslike plants made up a smaller part of the total canopy-coverage than did either the forbs or shrubs. Carex geyeri was the most important species and covered most of the area. The other species of grasses and grasslike plants were present in only trace amounts. All of the grasses and grasslike plants which occurred on the burned areas were more abundant on the unburned areas.

The forbs were dominated by Arnica cordifolia and Epilobium argustifolium. These species occurred in approximately equal amounts on the burned areas. Other abundant forbs were Senecio spp., Anaphalis margaritacea and Lupinus spp. Two species of Hieracium, and Xerophyllum tenax occurred on the burned areas in lesser amounts. Several other species occurred on the burned areas but covered only .5 per cent of the area. Of these forbs, Anaphalis margaritacea, Arnica cordifolia, Epilobium argustifolium, Hieracium spp. and Lupinus spp. were more common on the burned than on the unburned areas, while Senecio spp. and Xerophyllum tenax were more common on the unburned areas.

Only four species of shrubs were found on the severely burned areas. Vaccinium spp. and Vaccinium scoparium dominated the shrub cover and were present in equal amounts. Menziesia ferruginea and Salix spp., the other two shrubs found on the burned areas, covered approximately .5 per cent of the area. All of these species of shrubs were more abundant on the unburned areas.

Utilization

The class of stock, both wildlife and livestock, which used the clearcuts in the spruce-fir and fir-larch zones was determined by
observation of grazing animals and examination of pellet groups found on the cutover areas; however, no pellet counts were taken. The clearcuts in the spruce-fir zone were used by elk (Cervus canadensis) and to some extent by mule deer (Odocoileus hemionus). but not by cattle. Elk were present on all four clearcuts studied in this zone and appeared to use them extensively. Mule deer were sighted infrequently on these areas. The clearcuts in the fir-larch zone were used by cattle, elk and white-tailed deer (Odocoileus virginianus). No mule deer were sighted on these clearcuts. White-tailed deer were abundant and were sighted frequently on most of the clearcuts within this zone. Elk appeared to make less use of these clearcuts than did the deer but evidence of some elk use was found on most of these clearcuts. Sheep were not present on any of the clearcuts studied in either the spruce-fir or larch-fir zones.

The current cattle use on the clearcuts within the study area was not very extensive. As was noted above, cattle were not present on the four clearcuts studied in the spruce-fir zone. Observation of other clearcuts within this zone indicated that cattle are not abundant on these cutover areas and use only the most accessible clearcuts in the creek bottoms. Of the 10 clearcuts studied in the fir-larch zone, four were not grazed and the remaining six were grazed in varying intensities from light to locally heavy. Gold Creek No. 1, 2, 3, and 7 were not grazed. The grazing intensity on Gold Creek No. 4 and 5 was very light and was only slightly greater on Gold Creek No. 6. Nine mile showed evidence of heavier grazing than did the previous clearcuts but was still only lightly grazed. Bear Creek and Blue Mountain were the most
heavily grazed clearcuts within this zone. On these two cutover areas, approximately 25 per cent of the forage produced by the preferred species was utilized.

The Bear Creek, Blue Mountain, Nine Mile and Gold Creek No. 6 clearcuts were sampled to determine the amount of cattle use on these areas. The remaining clearcuts were either not grazed or were grazed too lightly to be of importance. Since these clearcuts are grazed during the summer by cattle, elk, and deer, the results represent the combined use of all three classes of animals. Complete separation of use was impossible; however, some separation was achieved through selection of the clearcuts to be discussed. After sampling Gold Creek No. 6, it became apparent that this clearcut was grazed very lightly and that most of the use was made by deer. Similarly, Nine Mile, which was grazed lightly by cattle, showed evidence of considerable use by both elk and deer. Thus, the discussion of cattle preference for certain species and groups of species was limited to the results from the Bear Creek and Blue Mountain clearcuts, which were moderately grazed by cattle but showed little evidence of the presence of either elk or deer. The average percent utilization and frequency values for the important species are given in Table 10. These averages were compiled from the Blue Mountain and Bear Creek clearcuts. The averages for each clearcut that was sampled are given in Appendix V.

The results of the utilization study indicate that cattle prefer the grasses and grasslike plants to the forbs and shrubs. Of the grasses and grasslike plants, Calamagrostis mobes was the most preferred species. Approximately 22 per cent of the herbage produced by this
Table 10. The average frequency values and per cent utilization of the important species in the fir-larch zone.

<table>
<thead>
<tr>
<th>Grasses and Grasslike Plants</th>
<th>Frequency</th>
<th>Utilization</th>
</tr>
</thead>
<tbody>
<tr>
<td>Calamagrostis rubescens</td>
<td>44.6</td>
<td>22.3</td>
</tr>
<tr>
<td>Festuca occidentalis</td>
<td>18.2</td>
<td>9.1</td>
</tr>
<tr>
<td>Carex geyeri</td>
<td>26.7</td>
<td>14.4</td>
</tr>
<tr>
<td>Carex spp.</td>
<td>20.1</td>
<td>10.0</td>
</tr>
<tr>
<td><em>Achillea millefolium</em></td>
<td>9.9</td>
<td>4.9</td>
</tr>
<tr>
<td><em>Arnica cordifolia</em></td>
<td>4.4</td>
<td>2.2</td>
</tr>
<tr>
<td><em>Cirsium spp.</em></td>
<td>1.1</td>
<td>0.6</td>
</tr>
<tr>
<td><em>Fragaria spp.</em></td>
<td>23.4</td>
<td>11.7</td>
</tr>
<tr>
<td><em>Geum</em> spp.</td>
<td>15.8</td>
<td>7.9</td>
</tr>
<tr>
<td><em>Juncus</em></td>
<td></td>
<td></td>
</tr>
<tr>
<td><em>Malva parviflora</em></td>
<td>1.9</td>
<td>1.6</td>
</tr>
<tr>
<td><em>Rosa</em> spp.</td>
<td>33.6</td>
<td>16.7</td>
</tr>
<tr>
<td><em>Symphoricarpus albus</em></td>
<td>29.8</td>
<td>14.2</td>
</tr>
<tr>
<td><em>Taccodium</em> spp.</td>
<td>5.6</td>
<td>4.6</td>
</tr>
</tbody>
</table>

Long grazed.

species was removed through grazing. *Carex geyeri* and several other species of *Carex* were grazed less than *Calamagrostis rubescens* but made up an important part of cattle diet. The per cent utilization on *Carex geyeri* averaged 14 per cent while the other species of *Carex* were grazed approximately 10 per cent. *Festuca occidentalis* was less abundant than the above species but approximately 9 per cent of the forage produced by this species was utilized. The remaining species of grasses and
grasslike plants occurred too infrequently to be important forage species and an accurate estimate of the use on these species could not be made.

Of the dominant species of forbs that occurred on the cutover areas, *Epipírum* spp. appeared to be the most palatable. Utilization of this species averaged about 12 per cent. *Xerophyllum tenax* was the dominant forb on the cutover areas but only 8 per cent of the herbage produced by this species was utilized. To get a better estimate of the utilization on *Xerophyllum tenax*, an additional 2,200 plants were sampled on the Bear Creek clearcut. This sample indicated that use on *Xerophyllum tenax* averages about 14 per cent. These data are misleading, however, since only the young plants and seedstalks were heavily grazed while the older, coarser plants were virtually ungrazed. Two other important forbs on the cutover areas were *Arnica cordifolia* and *Fragaria* spp. Only 2 per cent of the herbage produced by *Arnica cordifolia* was removed while *Fragaria* spp. received very little grazing use. Utilization on *Achillea millefolium* averaged about 5 per cent and *Uscirium* spp., another common forb, was ungrazed. The remaining species of forbs were not abundant enough to be important forage species.

The shrubs contributed a minor part to the total cattle diet. *Mahoria repens* and *Salix incanum* spp. were the dominant shrubs but were grazed very lightly. *Symphoricarpos albus* and *Spiraea betulifolia* were common on the cutover areas and were grazed more heavily. The average utilization on *Symphoricarpos albus* and *Spiraea betulifolia* was 15 and 8 per cent, respectively. The remaining shrubs did not produce enough herbage to be important forage species; however, the utilization on
these species gives some indication of their palatability. *Acer glabrum*,
*Amelanchier alnifolia*, *Holodiscus discolor*, and *Rosa* spp. appeared to be
palatable. The other shrubs that occurred on the cutover areas in the
fir-larch zone were ungrazed.
DISCUSSION

This study has shown that the cutover areas within a particular forest zone are similar with respect to the dominant species that occur on each area. For example, *Calamagrostis rubescens* occurs in abundant amounts on all of the clearcuts in the fir-larch zone. However, the natural variations that would be expected in the abundance of the dominant species between cutover areas within a particular zone do occur. Similarly, the variations in minor species between cutover areas is more pronounced than that of the dominant species. Most of the variation in dominant species between cutover areas in a particular zone is probably due to chance occurrences of species and local environmental differences. The vegetation that occurs on the cutover areas in the fir-larch zone is significantly different from that which occurs on clearcuts in the spruce-fir zone. This variation between forest zones is probably due to differences in environmental factors.

The grazing value of a cutover area is dependent on the forage produced on that area. The results of the utilization study indicates that the grasses and grasslike plants are the preferred forage species on the cutover areas. Several species of forbs are somewhat palatable; however, most of the forbs, because of life form, abundance, or palatability, are not preferred forage species. None of the shrubs combined sufficient palatability and abundance to be important as forage. The results of the vegetation study on the cutover areas indicate that the clearcuts in the fir-larch and spruce-fir zones produced approximately
1 ton of air-dry herbage per acre. Of the total herbage yield, the grasses and grasslike plants, forbs and shrubs made up 35.5, 46, and 18.5 per cent, respectively, in the fir-larch zone. As a result, the cutover areas in the fir-larch and spruce-fir zones, although highly productive, do not produce large amounts of palatable forage.

Clear-cutting removes the forest overstory and exposes the site to the drying effects of the sun and wind. This effect of clear-cutting combined with the reduced competition from the forest overstory promotes changes in the understory vegetation that add to the grazing value of the cutover areas. Clear-cutting in the fir-larch zone causes an increase in the production of herbaceous vegetation over that found on the uncut areas. In addition, the palatable grasses and grasslike plants greatly increase on the cutover areas while the less palatable forbs and shrubs either decrease or remain the same. The production of herbaceous and shrubby vegetation on the cutover areas in the spruce-fir zone is less than that on the uncut areas. However, all of the loss in production is due to a decrease in unpalatable forbs and shrubs on the cutover areas and is more than offset by a large increase in grasses and grasslike plants on the cutover areas. Thus, the net effect of clear-cutting in both forest zones is an increase in the most palatable forage species while the less desirable forage species remain the same or decrease on the cutover areas. Clear-cutting may or may not be accompanied by an increase in total herbage production.

The results discussed above are not in total agreement with the findings of Garrison (1960) on the early vegetative recovery on cutover ponderosa pine forests in Eastern Washington. He found that the forbs
were abundant and disproportionately represented in comparison to their original status and that the grasses and shrubs took 7 years to reach their original abundance. These differences might be due to the differences in forest types in which the two studies were conducted.

The clearcuts in the fir-larch zone appear to be more important from a grazing standpoint than do those in the spruce-fir zone. The total herbage production and the proportion of grasses and grasslike plants, forbs, and shrubs are similar for the cutover areas in both forest zones. However, the most significant difference in vegetation that affects the grazing value of one zone as compared to the other concerns the grasses and grasslike plants. The grasses and grasslike plants occur in almost equal amounts in the fir-larch zone while the grasslike plants make up almost all of the herbage yield of this group in the spruce-fir zone. This difference is due to a decrease in the productivity of *Calamagrostis rubescens*, the most important forage species, on the cutover areas in the spruce-fir zone. In addition, several other factors are important in comparing the grazing value of the cutover areas in the fir-larch zone to those in the spruce-fir zone. The cutover areas in the fir-larch zone are usually at lower elevations than those in the spruce-fir zone. As a result, these cutover areas are usually more accessible to cattle. Similarly, since the cutover areas in the spruce-fir zone are at higher elevations, the grazing season is usually shorter than on the lower fir-larch clearcuts. The importance of these factors is not entirely known; however, as the intensity of use of cutover areas increases they will probably become more important.

Although not an objective of this study, some indication of successional patterns can be obtained from the results. Since all of the
cutover areas were examined at the same successional stage, no definite indications are available on the rate or the trends of succession on these areas. Generally, the burned areas or areas where the surface soil horizons were severely disturbed supported pioneer species while the less disturbed areas supported species that were originally present in the forest understory. Most of the vegetational differences between cutover and uncut areas are due to an increase or decrease in the abundance of the species present in the forest understory after clear-cutting. In addition, several species occurred on the cutover areas that were not originally present in the forest understory. However, with the exception of those on the burned and severely disturbed areas, these species did not make up an important part of the vegetative cover.

Additional observations were made on several cutover areas in the spruce-fir zone that were clear-cut approximately 10 years ago. On these areas, brush species and forest reproduction were beginning to dominate the site and form a closed canopy. The cover on these areas was still open enough to allow grazing by cattle; however, after 5 or 6 more years the successional cycle will probably be completed as far as cattle are concerned.

Burning is a common method of destroying slash accumulations on the cutover areas. This practice not only reduces the fire hazard on these areas but removes much of the physical obstacles which would otherwise limit cattle use on these areas. Piling and burning of slash seems to be more effective than does broadcast burning in destroying slash accumulations.

The physical effect of burning had an adverse effect on the grazing value of the cutover areas. Burning generally caused a decrease in
the total herbage production as well as a decrease in the palatable grasses and grasslike plants. Succession on these areas favored pioneer species, most of which did not occur in the forest understory before clear-cutting. The results of the vegetation study indicated that the palatable grasses and grasslike plants as well as the shrubs occurred on the burned areas in minor amounts. Most of those species were more abundant on the unburned areas and probably occurred accidentally on the burned areas. Invading species such as _Epilobium angustifolium_ and _Cirsium_ spp., which made up most of the cover on the burned areas, were less common on the unburned areas. Similar results were observed on other severely disturbed areas such as skid trails and landings. These adverse effects of burning on the forage value of the vegetation occurring on cutover areas are probably offset, however, by the increased availability of forage on areas cleared of slash accumulations.

Several species were observed that showed a physiological response to clear-cutting. _Calamagrostis rubescens_ produced abundant seedstalks on the cutover areas but was never observed to produce seedstalks when occurring in the forest understory. Conversely, _Arnica cordifolia_ grew taller and produced larger, broader leaves within the forest understory than on the cutover areas. This species reached similar proportions on the cutover areas in comparison to the uncut areas only when it occurred under logs or was well shaded by other species. These physiological differences might affect the palatability of these species and thus might explain some of the discrepancies between this and other studies. The results of the utilization study showed that _Arnica cordifolia_ was a poor forage species; however, Harris (1954), Pickford and Ried (1948),
and Morris (1947) found this species to be an important forage species in the forest understory. This is explained, however, by the findings of Pickford and Rein (1948) who reported that *Calamagrostis rubescens* and *Arnica cordifolia* were better forage plants in the denser timber than in the more open areas.

Limited observations on tree regeneration were made on the cut-over areas that were studied. Tree seedlings occurred infrequently on any of the samples and were not observed in abundant amounts on any of the cutover areas. Grazing on tree regeneration was not abundant; however, sufficient observations were not made to draw any conclusive conclusions.

The results of the utilization study indicated that cattle use of clearcuts in Western Montana is generally limited. The intensity of grazing on each of the clearcuts studied varied from ungrazed to moderate and can be attributed to several factors. Accessibility seems to be the primary factor affecting the use of cutover areas in the spruce-fir zone. These clearcuts usually occur at higher elevations than those in the fir-larch zone and thus are separated from the spring-fall ranges by relatively long distances through dense forests or along access roads. Relatively few cattle reach this zone and those that do graze only the most accessible clearcuts. In the fir-larch zone accessibility is less important; however, other factors are. In this zone the proximity of clearcuts to bluegrass bottoms seems to be an important factor in determining whether a clearcut is extensively grazed or not. All of the clearcuts that occurred in areas with these moist bottoms were either not grazed or only grazed lightly. The remaining clearcuts that were
not associated with bluegrass bottoms or mountain meadows were more heavily grazed. The cattle were probably attracted to the meadows and bottoms, which were dominated by palatable grasses, at the expense of the clearcuts, which support large amounts of forbs and shrubs.

Other factors seem to be important in promoting the use of cut-over areas by cattle and have important management implications. A saltground and spring were located on one of the most heavily grazed clearcuts. The salt and water probably served to attract and hold the cattle on this area. Water development would be of little importance in promoting cattle distribution on the cut-over areas since water occurred on or near most of the clearcuts studied. The proper use of salt, however, might be an effective way of attracting more cattle to the cut-over areas. The other most heavily grazed clearcut was also the most isolated in terms of distances along access routes. At the beginning of the grazing season, the cattle were probably trailed to this clearcut and faced with the alternative of grazing off through dense forest and large areas of poor forage, preferred to remain on the clear-cut throughout the summer. This indicates that if cattle were driven to the more isolated clearcuts they might remain on those clearcuts and thus use areas that would otherwise go unused. Another way of holding cattle on the clearcuts would be to place drift fences across the access roads just below each clearcut. This would be especially true in the spruce-fir zone where the forest cover surrounding the cutover areas is dense and would effectively prevent cattle movement off the cutover areas. Drift fences would be of little value on cutover areas in the more open forest types.
Although cattle currently make little use of the cutover areas in Western Montana they have important value from a grazing standpoint. Most of the cattle use on the transitory forest ranges is concentrated on dry parks, meadows, glades, open slopes and bare ridges (Morris, 1947). Since most of these areas are currently heavily grazed and cannot stand increased grazing pressures, clear-cutting and burning of the dense forested areas offer the only practical methods of increasing the grazing capacity of these ranges. This study has shown that the cutover areas are highly productive and capable of producing an abundant forage supply; however, the seeding to more palatable forage species and methods to promote better cattle distribution are needed to fully realize the grazing potential of these areas.

This study provides basic information on the vegetation that occurs on clearcuts in the spruce-fir and fir-larch forest zones in Western Montana, on the amount of cattle use on these areas, and their preference for certain species and groups of species. This information is needed for the proper management of cattle use on these cutover areas.

The results of this study could serve as the basis for other more comprehensive investigations. Further studies on ways to promote more intensive grazing use of cutover areas would be in order. A comprehensive study on the amount of cattle use on conifer reproduction is needed. And the practicality of reseeding these areas to more palatable forage species should be investigated.
SUMMARY AND CONCLUSIONS

Much of the forested areas in Western Montana are dominated by dense stands of spruce and subalpine fir or by Douglas-fir and western larch. By clear-cutting these forests, openings are created that are favorable for cattle grazing for a number of years prior to being closed in by tree regeneration. It has been the objective of this study to describe the vegetation that occurs on clearcuts within each forest zone, to determine the amount of use cattle make of these cutover areas and to determine the preference of cattle for certain species and groups of species that occur on the cutover areas.

Fourteen clearcuts occurring within a 50 mile radius of Missoula, Montana, were selected for study. Four of these clearcuts occurred in the spruce-fir zone and the remaining 10 clearcuts occurred in the fir-larch zone. The vegetation occurring on the clearcuts in the spruce-fir and fir-larch forest zones has been characterized in terms of frequency distribution, canopy-coverage and herbage yield in pounds per acre. The results indicate that the individual clearcuts in each forest zone are similar in terms of dominant species present; most of the variations in dominant species between the clearcuts of a particular zone are probably due to chance dissemination of species and local environmental variations. The variations in minor species within a zone were more pronounced, which was to be expected. The vegetative differences between forest zones were more apparent. Generally, the dominant species in one zone were present in the other with the major differences being in the
proportions in which they occurred in each forest zone. These differences in vegetation between the spruce-fir and larch-fir zones are probably due to environmental factors.

The total cover of herbaceous and shrubby vegetation on the cut-over areas in the fir-larch zone was approximately 23 per cent greater than on the uncut areas. In addition, changes occurred in the proportion of grasses and grasslike plants, forbs and shrubs between the cutover areas and the forest understory. The grasses and grasslike plants were much more abundant (2.5 times) on the cutover areas than in the forest understory. The forb cover was about the same in both areas while the shrub cover was less on the cutover areas. The clearcuts within this zone not only produce more herbage than the uncut areas but support a greater proportion of palatable forage species such as *Calamagrostis rubescens* and *Carex geyeri*.

The cover of herbaceous and shrubby vegetation on the clearcuts in the spruce-fir zone was approximately 40 per cent less than that in the forest understory. The forest understory in this zone was made up entirely of forbs and shrubs, most of which decreased in abundance on the cutover areas. However, the palatable grasses and grasslike plants greatly increased on the cutover areas. Thus, even though these clearcuts are less productive than the forest understory, they support a greater amount of palatable forage.

The results of the vegetation study indicate that the clearcuts in the fir-larch zone and spruce-fir zone are about equal in productivity. Similarly, the proportion of the grasses and grasslike plants and forbs are about the same in both zones. However, the shrub cover is approximately
25 per cent greater in the spruce-fir zone. The major differences in vegetation between the clearcuts in the fir-larch and spruce-fir zones is in the dominant species composition of the grasses and grasslike plants, forbs and shrubs. This dominant species variation is important in comparing the grazing value of the clearcuts in the spruce-fir zone to those in the fir-larch zone.

The most important difference in vegetation between the clearcuts in these two forest zones is in the dominant species composition of the grasses and grasslike plants. *Calamagrostis rubescens* was abundant in the fir-larch zone but occurred in trace amounts in the spruce-fir zone. Similarly, the cover of *Carex geyeri* and the other species of grasslike plants was much greater in the spruce-fir zone than in the fir-larch zone.

The variation in the dominant species of forbs and shrubs between the clearcuts in the spruce-fir and fir-larch zones is not as important from a grazing standpoint since most of the forbs and shrubs are poor forage species. Of the dominant forbs, *Xerophyllum tenax* and *Arnica cordifolia* were abundant in both forest zones. *Epilobium angustifolium*, *Anaphalis margaritacea* and *Senecio* spp. were abundant in the spruce-fir zone while *Fragaria* spp. and *Lupinus* spp. were abundant in the fir-larch zone. Except for *Vaccinium* spp., which was common on clearcuts in both forest zones, there was a significant difference between the dominant shrubs that occurred on the cutover areas in the spruce-fir and fir-larch zones. Generally, the dominant species in one zone were of minor importance or did not occur in the other.

Burning was a common method of destroying slash accumulations on the cutover areas. This practice not only reduced the fire hazard on
these areas but removed much of the physical obstacles which would otherwise limit cattle use on these areas. Piling and burning of slash seemed to be more effective in destroying slash accumulations than did broadcast burning.

The vegetation that occurred on these areas where the slash was piled in rows and burned was described in terms of canopy-coverage. All of these areas were severely burned by slash fires. The total coverage on the burned areas in the spruce-fir zone was 30 per cent less than the cover on the unburned areas. On one clearcut studied in the fir-larch zone the coverage on the burned rows was equal to the cover on the unburned areas. However, the vegetative cover on the two clearcuts in this zone that were burned by wildfire was 44 per cent less than the cover on the clearcuts that were not burned by wildfire.

The species composition of the burned areas was different than the species composition of the unburned areas. In addition, the number of different species found on the burned areas was considerably less than the number on the unburned areas. The burned areas in both forest zones were dominated almost exclusively by forbs. The grasses and grasslike plants and shrubs made up a minor part of the cover on these areas and probably occurred there accidentally. All of the grasses and grasslike plants and shrubs that occurred on the burned areas were more abundant on the unburned areas. Of the forbs that occurred on the burned areas in the fir-larch zone, Cirsium spp., Epilobium angustifolium and Astragalus spp. were more abundant on the burned areas than on the unburned. Arnica cordifolia and Fragaria spp. occurred on the burned areas but were more abundant on the unburned areas. Of the forbs
occurring on the burned areas in the spruce-fir zone *Anaphalis margari-

tacea, Arnica cordifolia, Epilobium angustifolium, Hieracium spp., and

Lupinus spp.* were more common on the burned areas than on the unburned

areas. *Senecio* spp. and *Xerophyllum tenax* were more abundant on the

unburned areas.

Generally, the burned areas produced less herbage than the unburned

areas and the species that commonly occurred on these areas were of little

value as forage. These undesirable effects of burning are offset, how­

ever, by the fact that burning destroys slash accumulations and by so

doing helps promote better cattle distribution on the cutover areas.

Also, the total area of a clearcut that was severely burned was usually

small.

The results of the utilization study indicated that cattle use of

clearcuts in Western Montana is generally limited. The intensity of

grazing on each of the clearcuts studied varied from ungrazed to moder­

ate and can be attributed to several factors. Accessibility seems to

be the primary factor affecting the use of cutover areas in the spruce­

fir zone. These clearcuts usually occur at higher elevations than those

in the fir-larch zone and thus are separated from the spring-fall ranges

by relatively long distances through dense forests or along access roads.

Relatively few cattle reached this zone and those that did grazed only

the most accessible clearcuts. In the fir-larch zone accessibility was

less important; however, other factors are. In this zone the proximity

of clearcuts to bluegrass bottoms seems to be an important factor in
determining whether a clearcut is extensively grazed or not. All of the

clearcuts that occurred in areas with these moist bottoms were either
not grazed or only lightly grazed. The remaining clearcuts that were not associated with bluegrass bottoms or mountain meadows were more heavily grazed. The cattle were probably attracted to the meadows and bottoms, which were dominated by palatable grasses, at the expense of the clearcuts which support large amounts of forbs and shrubs.

The grasses and grasslike plants made up most of the forage on the clearcuts in the fir-larch zone. Of these, *Calamagrostis rubescens* was the most abundant and was grazed the heaviest. *Carex geyeri* and several other species of *Carex* were grazed less than *Calamagrostis rubescens* but made up an important part of the cattle diet. Most of the remaining grasses and grasslike plants appeared to be palatable but were not abundant enough to be important forage species.

The forbs made up 40 to 50 per cent of the herbage yield but contributed little forage. Of the dominant species of forbs, *Lupinus* spp. seemed to be the most palatable. *Xerophyllum tenax* was the most abundant forb but only the young plants and seedstalks of the other plants were palatable. Many other species of forbs occurred on the cutover areas but because of palatability, abundance, or life form were of minor importance as forage species.

None of the shrubs combined sufficient abundance and palatability to be important as forage.

The following conclusions were drawn from the results of this study:

Clear-cutting in the fir-larch zone is accompanied by an increase in total vegetative cover over that found in the forest understory, while clear-cutting in the spruce-fir zone is accompanied by a decrease in
total cover on the cutover areas. The grasses and grasslike plants are more abundant on the cutover areas than in the forest understory. The cover of forbs and shrubs remains the same or decreases on the cutover areas in both forest zones.

Burning causes a decrease in total canopy-coverage and an increase in poor forage species; however, these undesirable effects are probably offset by the favorable effect of reduced slash on cattle distribution.

Cattle make little use of the cutover areas observed in Western Montana.

The grasses and grasslike plants are the most important forage species. Of these, *Calamagrostis rubescens* and *Carex geyeri* provide most of the forage on the cutover areas.
LITERATURE CITED


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APPENDIX
Appendix I. Summary of the sampling regimen on the 14 clearcuts studied.

<table>
<thead>
<tr>
<th></th>
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<th></th>
<th></th>
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<tbody>
<tr>
<td>Blue Mountain</td>
<td>200</td>
<td>50</td>
<td>80</td>
<td>*</td>
<td>140</td>
<td></td>
</tr>
<tr>
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<td>200</td>
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<td>100</td>
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<td>*</td>
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<td>120</td>
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<td>*</td>
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</tr>
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<td>*</td>
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<td>*</td>
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<td>50</td>
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<td>*</td>
<td>*</td>
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</tr>
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<td>*</td>
<td>*</td>
<td></td>
</tr>
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<td>50</td>
<td>*</td>
<td>*</td>
<td>*</td>
<td></td>
</tr>
<tr>
<td>Bear Creek</td>
<td>280</td>
<td>100</td>
<td>120</td>
<td>*</td>
<td>200</td>
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<tr>
<td>Edith Peak</td>
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<td>20</td>
<td>*</td>
<td>100</td>
<td>*</td>
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<tr>
<td>Lost Park</td>
<td>200</td>
<td>20</td>
<td>200</td>
<td>*</td>
<td>*</td>
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</tr>
<tr>
<td>Lee Creek</td>
<td>200</td>
<td>20</td>
<td>*</td>
<td>*</td>
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<tr>
<td>Granite Creek</td>
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<td>20</td>
<td>*</td>
<td>80</td>
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* Unsampled.
Appendix II. List of the plant species found on the clearcuts within the fir-larch and spruce-fir zones.

<table>
<thead>
<tr>
<th>SCIENTIFIC NAME</th>
<th>COMMON NAME</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Grasses and Grasslike Plants</strong></td>
<td></td>
</tr>
<tr>
<td><em>Agropyron spicatum</em> (Pursh, Scribn., and Smith)</td>
<td>Bluebunch Wheatgrass</td>
</tr>
<tr>
<td><em>Agrostis alba</em> L.</td>
<td>Redtop</td>
</tr>
<tr>
<td><em>Agrostis scabra</em> Willd.</td>
<td>Bentgrass</td>
</tr>
<tr>
<td><em>Bromus vulgaris</em> (Hook.) Shear</td>
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<tr>
<td><em>Calamagrostis canadensis</em> (Michx.) Beauv.</td>
<td>Bluejoint</td>
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<tr>
<td><em>Calamagrostis rubescens</em> Buckl.</td>
<td>Finegrass</td>
</tr>
<tr>
<td><em>Carex filifolia</em> Nutt.</td>
<td>Threadleaf Sedge</td>
</tr>
<tr>
<td><em>Carex geyeri</em> Boott.</td>
<td>Eel Sedge</td>
</tr>
<tr>
<td><em>Carex spp.</em></td>
<td>Sedge</td>
</tr>
<tr>
<td><em>Danthonia intermedia</em> Vasey</td>
<td>Timber Oatgrass</td>
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<tr>
<td><em>Deschampsia elongata</em> (Hook.) Munro</td>
<td>Slender Hairgrass</td>
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<tr>
<td><em>Elymus glaucus</em> Buckl.</td>
<td>Blue Wild-rye</td>
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<td><em>Elymus spp.</em></td>
<td>Wild-rye</td>
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<tr>
<td><em>Festuca idahoensis</em> Elmer</td>
<td>Idaho Fescue</td>
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<tr>
<td><em>Festuca occidentalis</em> Hook.</td>
<td>Western Fescue</td>
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<tr>
<td><em>Juncus spp.</em></td>
<td>Rush</td>
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<tr>
<td><em>Luzula parviflora</em> (Ehrh.) Desv.</td>
<td>Wood-rush</td>
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<tr>
<td><em>Melica subulata</em> (Griseb.; Scribn.)</td>
<td>Alaska Oniongrass</td>
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<tr>
<td><em>Phleum pratense</em> L.</td>
<td>Timothy</td>
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<tr>
<td><em>Poa pratensis</em> L.</td>
<td>Kentucky Bluegrass</td>
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<tr>
<td><em>Stipa richardsoni</em> Link</td>
<td>Richardson Needlegrass</td>
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<tr>
<td><em>Trisetum canescens</em> Buckl.</td>
<td>Tall Trisetum</td>
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<tr>
<td><em>Trisetum cernuum</em> Trin.</td>
<td>Nodding Trisetum</td>
</tr>
<tr>
<td><em>Triticum spp.</em></td>
<td>Wheat</td>
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| **Forbs** | |
| *Achillea millefolium* L. | Yarrow |
| *Agoseris glauca* (Pursh.; L. Dietr.) | Pale Agoseris |
| *Allium cernuum* Roth | Nodding Onion |
| *Anaphalis margaritacea* (L.) Benth. & Hook. | Pearly Everlasting |
| *Antennaria racemosa* Hook. | Raceme Pussytoes |
| *Apocynum androsaemifolium* L. | Spreading Dogbane |
| *Arenaria spp.* | Sandwort |
| *Arnica cordifolia* Hook. | Arnica |
| *Aster conspicuus* Lindl. | Showy Aster |
| *Aster spp.* | Aster |
| *Balsamorhiza sagittata* (Pursh. Nutt.) | Arrowleaf Balsamroot |
| *Boykinia major* Gray | Large Boykinia |
| *Campanula rotundifolia* L. | Roundleaf Harebell |
| *Carum carvi* L. | Caraway |
| *Castilleja spp.* | Indian Paintbrush |
Appendix II. List of the plant species found on the clearcuts within the fir-larch and spruce-fir zones. (continued)

<table>
<thead>
<tr>
<th>SCIENTIFIC NAME</th>
<th>COMMON NAME</th>
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<tbody>
<tr>
<td>Cerastium vulgatum L.</td>
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<tr>
<td>Cirsium arvense (L.) Scop.</td>
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<tr>
<td>Cirsium foliosum (Hook.) DC.</td>
<td>Elk Thistle</td>
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<td>Clintonia uniflora (Schult.) Kunth.</td>
<td>One-flowered Clintonia</td>
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<tr>
<td>Collinsia parviflora Lindl.</td>
<td>Small-flowered</td>
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<tr>
<td>Cirsium foliosum (Hook.) DC.</td>
<td>Blue-eyed Mary</td>
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<tr>
<td>Cirsium vulgare (Save) A-S.</td>
<td>Narrow Leaved Collomia</td>
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<td>Hawksbeard</td>
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<td>Cynoglossum officinale L.</td>
<td>Willow-herb</td>
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<td>Epilobium angustifolium L.</td>
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<td>Epilobium spp.</td>
<td>Woodland Strawberry</td>
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<tr>
<td>Filago arvensis L.</td>
<td>Virginian Strawberry</td>
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<td>Fragaria vesca L.</td>
<td>Northern Bedstraw</td>
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<tr>
<td>Fragaria virginiana Duch.</td>
<td>Sticky Geranium</td>
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<tr>
<td>Galium boreale L.</td>
<td>Rattlesnake Plantain</td>
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<tr>
<td>Geranium viscosissimum Fisch. &amp; May</td>
<td>Western Sweetvetch</td>
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<tr>
<td>Goodyera oblongiflora Raf.</td>
<td>Allumroot</td>
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<tr>
<td>Hedysarum occidentale Greene</td>
<td>White Hawkweed</td>
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<tr>
<td>Heuchera spp.</td>
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<td>Hieracium albiflorum Hook.</td>
<td>Lupine</td>
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<tr>
<td>Lupinus wyethii Wts.</td>
<td>Sickletop Pedicularis</td>
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<td>Lupinus spp.</td>
<td>Wilcox Penstemon</td>
</tr>
<tr>
<td>Pedicularis racemosa Dougl.</td>
<td>Penstemon</td>
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<tr>
<td>Penstemon wilcoxii Rydb.</td>
<td>Phlox</td>
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<td>Penstemon spp.</td>
<td>Knotweed, Smartweed</td>
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<td>Phlox spp.</td>
<td>Clinguernoil</td>
</tr>
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<td>Common Selfheal</td>
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<td>Potentilla spp.</td>
<td>Bracken</td>
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<td>Prunella vulgaris L.</td>
<td>Northern Buttercup</td>
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<td>Pteridium aquilinum (Bong.) Ferwald</td>
<td>Buttercup</td>
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<tr>
<td>Ranunculus pedatifidus J.,E.,Sm.</td>
<td>Dock, Sorrel</td>
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<td>Ranunculus spp.</td>
<td>Yellow Stonecrop</td>
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<td>Rumex spp.</td>
<td>Groundsel</td>
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<td>Sedum stenopetalum Pursh.</td>
<td>Starry False Solomon's Sedge</td>
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<td>Senecio spp.</td>
<td>Goldenrod</td>
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<td>Smilacina stellata (L.) Dest.</td>
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<td>Solidago spp.</td>
<td>Common Dandelion</td>
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<tr>
<td>Solidago spp.</td>
<td>Veiny Meadow Rue</td>
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<td>Sonchus oleraceus L.</td>
<td>Fanweed</td>
</tr>
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<td>Taraxacum officinale Weber</td>
<td>Common Salsify</td>
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<tr>
<td>Thalictrum venulosum Trel.</td>
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</table>
Appendix II. List of the plant species found on the clearcuts within the fir-larch and spruce fir zones. (continued)

<table>
<thead>
<tr>
<th>SCIENTIFIC NAME</th>
<th>COMMON NAME</th>
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<tbody>
<tr>
<td><strong>Forbs continued</strong></td>
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<tr>
<td>Trifolium repens L.</td>
<td>White Clover</td>
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<tr>
<td>Trillium ovatum Pursh.</td>
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<tr>
<td>Urtica dioica L.</td>
<td>Stinging Nettle</td>
</tr>
<tr>
<td>Verbascum thapsus L.</td>
<td>Flannel Mullein</td>
</tr>
<tr>
<td>Xerophyllum tenax (Pursh.) Nutt.</td>
<td>Beargrass</td>
</tr>
<tr>
<td><strong>Shrubs</strong></td>
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<tr>
<td>Acer glabrum Torr.</td>
<td>Rocky Mountain Maple</td>
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<tr>
<td>Alnus spp.</td>
<td>Alder</td>
</tr>
<tr>
<td>Amelanchier alnifolia Nutt.</td>
<td>Service Berry</td>
</tr>
<tr>
<td>Arctostaphylos uva-ursi (L.) Spreng.</td>
<td>Kinikinnick</td>
</tr>
<tr>
<td>Artemisia frigida Willd.</td>
<td>Fringed Sagewort</td>
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<tr>
<td>Betula glandulosa Michx.</td>
<td>Scrub Birch</td>
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<tr>
<td>Ceanothus velutinus Doug.</td>
<td>Snowbrush Ceanothus</td>
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<tr>
<td>Chimaphila umbellata (L.) Bart.</td>
<td>Common Pipsissewa</td>
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<tr>
<td>Ledum glandulosum Nutt.</td>
<td>Glandular Labrador Tea</td>
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<tr>
<td>Linnaea borealis L.</td>
<td>Twinflower</td>
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<tr>
<td>Lonicera spp.</td>
<td>Honeysuckle</td>
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<tr>
<td>Mahonia repens Lindl.</td>
<td>Oregon Grape</td>
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<tr>
<td>Menziesia ferruginea Smith</td>
<td>Smooth Menziesia</td>
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<td>Pachistima myrsinites (Pursh.) Raf.</td>
<td>Myrtle Pachistima</td>
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<td>Physocarpus malvaceus (Greene) Kurtze</td>
<td>Ninebark</td>
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<tr>
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<td>Gooseberries and Currants</td>
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<td>Rosa spp.</td>
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<tr>
<td>Rubus idaeus L.</td>
<td>Red Raspberry</td>
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<tr>
<td>Rubus parviflorus Nutt.</td>
<td>Thimbleberry</td>
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<tr>
<td>Sambucus melanocarpa A. Cray</td>
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<tr>
<td>Spiraea betulifolia Fall.</td>
<td>White Spiraea</td>
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<td>Symphoricarpus albus (L.) Blake</td>
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<tr>
<td>Vaccinium membranaceum Doug.</td>
<td>Finleafed Huckleberry</td>
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<td>Vaccinium myrtillus L.</td>
<td>Myrtle Huckleberry</td>
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<tr>
<td>Vaccinium scoparium Leiberg.</td>
<td>Low Red Huckleberry</td>
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Appendix III. Canopy-coverage and production values for the dominant species and groups of minor species on the clearcuts in the fir-larch zone.

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<th>Blue Mountain Prod</th>
<th>Ninemile Prod</th>
<th>Gold Cr. Prod</th>
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<tbody>
<tr>
<td></td>
<td>% Cover lbs/acre</td>
<td>% Cover</td>
<td>% Cover lbs/acre</td>
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</tr>
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<td>Calamagrostis rubescens</td>
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<td>62.5</td>
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</tr>
<tr>
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<td></td>
<td></td>
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<tr>
<td>Carex spp.</td>
<td>.6</td>
<td>26.4</td>
<td>9.2</td>
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<tr>
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<tr>
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Appendix III. Canopy-coverage and production values for the dominant species and groups of minor species on the clearcuts in the fir-larch zone. (continued)

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<td>Prod.</td>
<td>%</td>
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<td>Cover lbs/acre</td>
<td>Cover lbs/acre</td>
<td>Cover lbs/acre</td>
<td>Cover lbs/acre</td>
<td>Cover lbs/acre</td>
<td>Cover lbs/acre</td>
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<td><strong>Grasses and Grasslike Plants</strong></td>
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<td>53.6</td>
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<td>Other Grasslike Plants</td>
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<td>7.1</td>
<td>233.3</td>
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<td>617.6</td>
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Appendix III. Canopy-coverage and production values for the dominant species and groups of minor species on the clearcuts in the fir-larch zone. (continued)

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<td>lbs/acre</td>
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<td>Rubus ideaus</td>
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-96-
Appendix III. Canopy-coverage and production values for the dominant species and groups of minor species on the clearcuts in the fir-larch zone. (continued)

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Appendix IV. Canopy-coverage and production values for the dominant species and groups of minor species on the clearcuts in the spruce-fir zone.

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Grasses and Grasslike Plants

Forbs

Shrubs

TOTAL
Appendix V. Canopy-coverage values for the dominant species and groups of minor species in the forest understory adjacent to the clearcuts in the fir-larch zone.

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<td>% Cover</td>
<td>% Cover</td>
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Appendix V. Canopy-coverage values for the dominant species and groups of minor species in the forest understory adjacent to the clearcuts in the fir-larch zone. (continued)

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Appendix VI. The percent utilization and frequency values for the important species on the Bear Creek, Blue Mountain, Ninemile, and Gold Creek No. 6 clearcuts.

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<td>% \ Freq.</td>
<td>% \ Util.</td>
<td>% \ Freq.</td>
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<td><strong>Grasses and Grasslike Plants</strong></td>
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<td>Calamagrostis rubescens</td>
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1 Ungrazed.