

AN ABSTRACT OF THE THESIS OF

Clinton Karl Williams for the degree of Doctor of Philosophy  
in Rangeland Resources Program presented on May 18, 1978

Title: VEGETATION CLASSIFICATION FOR THE BADGER  
ALLOTMENT, MT. HOOD NATIONAL FOREST

Abstract approved: \_\_\_\_\_

A. H. Winward

More than 200 sites between 500 and 2000 meters elevation were examined utilizing a reconnaissance sampling technique for a portion of the eastern slopes of the northern Oregon Cascade Mountains. Twelve different forested plant communities were described with data on vegetation, soils and topography. A map of their distribution and a key for their identification were presented.

The communities were grouped into four different series based on climax tree species. The Pinus ponderosa-Quercus garryana series dominated elevations between 600 and 850 meters and included four community types. The Quercus garryana/Purshia tridentata/Agropyron spicatum type was an open Quercus garryana woodland found on upper southerly slopes with relatively shallow soils. The Pinus ponderosa-Quercus garryana/Purshia tridentata/Festuca idahoensis type was the most widespread member of the series and was found on gentle slopes with east to south aspects. The Pinus/ponderosa/Purshia tridentata/Lupinus leucophyllus type was found

on gentle east to south facing slopes on flat or convex microrelief.

The Pinus ponderosa/Purshia tridentata Lupinus caudata type was on gentle east to south facing slopes having concave microrelief.

The Abies grandis series dominated elevations between 850 and 1500 meters and included four community types. The Abies grandis/Carex geyeri type occupied the lowest elevations within the series and was found on all aspects and slope positions. The Abies grandis/Pyrola secunda type was found at the upper elevations on midslopes with northerly aspects between 1360 and 1415 meters.

The Thuja plicata series was found in stream bottoms and valleys between 1100 and 1325 meters elevation and included two community types. The Thuja plicata/Linnaea borealis var. longiflora type was found on flat to concave microrelief with soils that had a high ground water table. The Tsuga heterophylla/Linnaea borealis var. longiflora type was found on lower sheltered valleys and side slopes.

The Abies amabilis series dominated the upper elevations of the study area between 1500 and 1960 meters and included two community types. Tsuga mertensiana was a conspicuous associate with Abies amabilis. The understory vegetation was often depauperate and poorly developed. Low shrubs were usually the most dominant understory species. The Abies amabilis/Rubus lasiococcus type was found at the lower elevations within the series on a variety of slopes, aspects and topography. The Abies amabilis/Vaccinium scoparium

type occupied the highest elevations within the study area and sub-alpine meadows and openings were commonly interspersed with it. It occurred on north to east aspects on a variety of slopes and topography.

Non-forested areas within the study area were not classified but were briefly described. Some implications for management by community were also given.

Vegetation Classification for the Badger  
Allotment, Mt. Hood National Forest

by

Clinton Karl Williams

A THESIS

submitted to

Oregon State University

in partial fulfillment of  
the requirements for the  
degree of

Doctor of Philosophy

Completed May 18, 1978

Commencement June 1979

APPROVED:

---

Associate Professor of Rangeland Resources  
in charge of major

---

Leader, Rangeland Resources Program

---

Head, Department of Animal Science

---

Dean of Graduate School

Date thesis is presented \_\_\_\_\_

Typed by Opal Grossnicklaus for Clinton Karl Williams

## ACKNOWLEDGEMENTS

I would like to thank my major professor Dr. Alma H. Winward for the counsel, guidance, encouragement and long hours of extra work he provided from the conception of the study to completion of the thesis. He served in the dual roles as mentor and friend throughout all phases of the work. Without his guidance and inspiration I never would have embarked in a career in ecology.

I want to thank all the members of my committee, Dr. A. H. Winward, Dr. W. W. Chilcote, Dr. R. E. Frenkle, Dr. W. C. Krueger, and Dr. J. F. Bell for the knowledge and inspiration I gained from being a student in their classes and for their critical review of the thesis.

Appreciation is expressed to the U.S. Forest Service personnel of the Mt. Hood National Forest and the Barlow Ranger District for their support and cooperation throughout the study. Thanks are also extended to my work supervisors on the Okanogan National Forest for permitting me to work on the thesis when time was available from my other duties.

Lastly, but most importantly, I want to thank my wife Marva for the many hours she spent typing rough drafts and tables and for her support, patience and long-suffering even to the point of letting me take my defense on our tenth wedding anniversary. All of this in

addition to the full time job as the mother of our children. It is to her and our children that I dedicate this thesis.

## TABLE OF CONTENTS

I.	INTRODUCTION	1
II.	STUDY AREA	3
	Geography	3
	Climate	5
	Geology	7
	Vegetation	9
	History of Use	11
III.	LITERATURE REVIEW	14
	Ecological Concepts and Terminology	14
	Usefulness of Vegetation Classifications	15
	Reconnaissance Sampling for Plant Community Classification	17
IV.	METHODS	19
	Aerial Photographs	19
	Field Sampling	21
	Species Taxonomy	21
	Selection of Plots	21
	Data Recording Procedure	23
	Data Analysis	27
V.	RESULTS	30
	The <u>Pinus ponderosa-Quercus garryana</u> Series	33
	<u>Quercus garryana/Purshia tridentata/</u> <u>Agropyron spicatum</u> c. t.	36
	<u>Pinus ponderosa-Quercus garryana/Purshia</u> <u>tridentata/Festuca idahoensis</u> c. t.	39
	<u>Pinus ponderosa/Purshia tridentata/</u> <u>Lupinus leucophyllus</u> c. t.	43
	<u>Pinus ponderosa/Purshia tridentata/</u> <u>Lupinus caudatus</u> c. t.	46
	The <u>Abies grandis</u> Series	50
	<u>Abies grandis/Carex geyeri</u> c. t.	51
	<u>Abies grandis/Pachistima myrsinites</u> c. t.	55
	<u>Abies grandis/Pyrola secunda</u> c. t.	58
	<u>Abies procera</u> phase of the <u>Abies grandis/</u> <u>Pyrola secunda</u> c. t.	61

The <u>Thuja plicata</u> Series	65
<u>Thuja plicata</u> / <u>Linnaea borealis</u> var. <u>longiflora</u> c. t.	66
<u>Tsuga heterophylla</u> / <u>Linnaea borealis</u> var. <u>longiflora</u> c. t.	69
The <u>Abies amabilis</u> Series	72
<u>Abies amabilis</u> / <u>Rubus lasiococcus</u> c. t.	74
<u>Abies amabilis</u> / <u>Vaccinium scoparium</u> c. t.	76
The Nonforested Communities	80
Xeric Low Elevation Grasslands	80
Low Elevation Swales	81
Subalpine Meadows	81
Subalpine Shrub Communities	82
<u>Alnus sinuata</u> Dominated Communities	83
VI. DISCUSSION	84
Management Implications by Community Types	84
<u>Quercus garryana</u> / <u>Purshia tridentata</u> / <u>Agropyron spicatum</u> c. t.	84
<u>Pinus ponderosa</u> - <u>Quercus garryana</u> / <u>Purshia</u> <u>tridentata</u> / <u>Festuca idahoensis</u> c. t.	85
<u>Pinus ponderosa</u> / <u>Purshia tridentata</u> / <u>Lupinus</u> <u>leucophyllus</u> c. t.	86
<u>Pinus ponderosa</u> / <u>Purshia tridentata</u> / <u>Lupinus</u> <u>caudatus</u> c. t.	87
<u>Abies grandis</u> / <u>Carex geyeri</u> c. t.	87
<u>Abies grandis</u> / <u>Pachistima myrsinites</u> c. t.	88
<u>Abies grandis</u> / <u>Pyrola secunda</u> c. t.	89
<u>Abies procera</u> phase of the <u>Abies grandis</u> / <u>Pyrola secunda</u> c. t.	90
<u>Thuja plicata</u> / <u>Linnaea borealis</u> var. <u>longiflora</u> c. t.	91
<u>Tsuga heterophylla</u> / <u>Linnaea borealis</u> var. <u>longiflora</u> c. t.	91
<u>Abies amabilis</u> / <u>Rubus lasiococcus</u> c. t.	92
<u>Abies amabilis</u> / <u>Vaccinium scoparium</u> c. t.	93
Sampling Procedures	93
Aerial Photographs and Photomosaic	93
Reconnaissance Approach	94
Data Codes	94
Data Analysis	96
Factors Affecting Species and Vegetation Distribution	97
Taxonomic Considerations	97
Species Distributions	98

Distribution of Annuals	100
Topographic Influences	100
Role of Fire	101
LITERATURE CITED	104
APPENDICES	109
Appendix A. Table of average constancy values by community type for those species with 50 percent or greater constancy in any type	109
Appendix B. Table of average dominance/cover values by community type for those species with 50 percent or greater constancy in any type	112
Appendix C. Scientific name, common name and abbreviation of plants cited in text and tables	115
Appendix D. Key to forested community types	118
Appendix E. Vascular plants observed in the Badger Allotment	120

## LIST OF FIGURES

<u>Figure</u>	<u>Page</u>
1. Location map of study area.	4
2. The <u>Quercus garryana</u> / <u>Purshia tridentata</u> / <u>Agropyron spicatum</u> and <u>Pinus ponderosa</u> - <u>Quercus garryana</u> / <u>Purshia tridentata</u> / <u>Festuca idahoensis</u> community types.	39
3. The <u>Pinus ponderosa</u> - <u>Quercus garryana</u> / <u>Purshia tridentata</u> / <u>Festuca idahoensis</u> community type (Plot 5).	41
4. The <u>Pinus ponderosa</u> / <u>Purshia tridentata</u> / <u>Lupinus leucophyllus</u> community type (Plot 22).	44
5. The <u>Pinus ponderosa</u> / <u>Purshia tridentata</u> / <u>Lupinus caudatus</u> community type (Plot 35).	47
6. The <u>Abies grandis</u> / <u>Carex geyeri</u> community type (Plot 108).	54
7. Selective cut area within the <u>Abies grandis</u> / <u>Carex geyeri</u> community type (Plot 58).	54
8. The <u>Abies grandis</u> / <u>Pachistima myrsinites</u> community type (Plot 95).	57
9. The <u>Abies grandis</u> / <u>Pyrola secunda</u> community type (Plot 154).	59
10. The <u>Abies procera</u> phase of the <u>Abies grandis</u> / <u>Pyrola secunda</u> community type (Plot 119).	63
11. The <u>Thuja plicata</u> / <u>Linnaea borealis</u> var. <u>longiflora</u> community type (Plot 89).	67
12. The <u>Tsuga heterophylla</u> / <u>Linnaea borealis</u> var. <u>longiflora</u> community type (Plot 141).	71
13. The <u>Abies amabilis</u> / <u>Rubus lasiococcus</u> community type (Plot 159).	76

<u>Figure</u>		<u>Page</u>
14.	The <u>Abies amabilis</u> / <u>Vaccinium scoparium</u> community type (Plot 190).	78
15.	Map showing plot locations and distribution of community types.	-- map pouch on back cover

## LIST OF TABLES

<u>Table</u>		<u>Page</u>
1.	Monthly precipitation in millimeters at Dufur and Friend, Oregon	6
2.	Mean monthly temperatures in degrees C at Dufur, Oregon.	6
3.	Average dominance and cover code values for tree species in overstory and understory by community type.	31
4.	Range and mean overstory tree crown cover density and total basal area by community type.	32
5.	Range or most commonly occurring values for environmental and soils data by community type.	34

# VEGETATION CLASSIFICATION FOR THE BADGER ALLOTMENT, MT. HOOD NATIONAL FOREST

## INTRODUCTION

Management of natural resources on range and forested lands has become increasingly critical as a result of greater resource needs and increased public awareness. Nowhere is this more evident than in the management of public lands (Public Land Law Review Commission, 1970). Hall (1967) stated that management of non-arable lands (forest and rangelands) is primarily concerned with deriving products from the natural vegetation; and as resource management intensifies, knowledge about the vegetation must increase.

Facing increased resource demands on some of the lands under its administration; the Barlow Ranger District, Mt. Hood National Forest, recognized the need for more resource information upon which to base management decisions. Consequently, a study of the vegetation of a portion of the district was initiated.

The objectives of this study were to:

1. classify and describe the plant communities of the area.
2. map the distribution of the plant communities.

This thesis provides a classification and description of the forested plant communities of part of the Barlow Ranger District.

Data on vegetation composition, seral relationships of trees and some

selected shrubs, soils and certain environmental factors are presented with some management implications and recommendations and the plant community types are mapped. In addition, some of the non-forested communities are described.

## STUDY AREA

### Geography

Located about 26 kilometers south of and 16 kilometers west of the city The Dalles, Oregon; most of the study area was in Wasco County but part of the western end extended into Hood River County (Figure 1).

An administrative unit of the Barlow Ranger District, The Badger Grazing Allotment, covered much of the study area. Hereafter, the study area will be referred to as the Badger Allotment. For this study the Badger Allotment was bounded on the south and west by Badger Creek. The boundary line followed the north rim of Badger Creek Canyon. Private, state and national forest lands are interspersed in the eastern part of the area creating a mosaic of ownerships. This ownership pattern was ignored during the study; consequently, the eastern boundary followed the east property line of the Mt. Hood National Forest. The northern boundary was formed by the southern rim of Fifteenmile Creek Canyon from the eastern boundary west to old Camp Friend; then along Forest Road S-208 to the junction with Forest Road S-205 and S-21 to the north rim of Badger Creek Canyon which was the southern and western boundary.

The highest elevation is 1990 meters at Lookout Mountain in the extreme west end of the area. The elevation generally declines

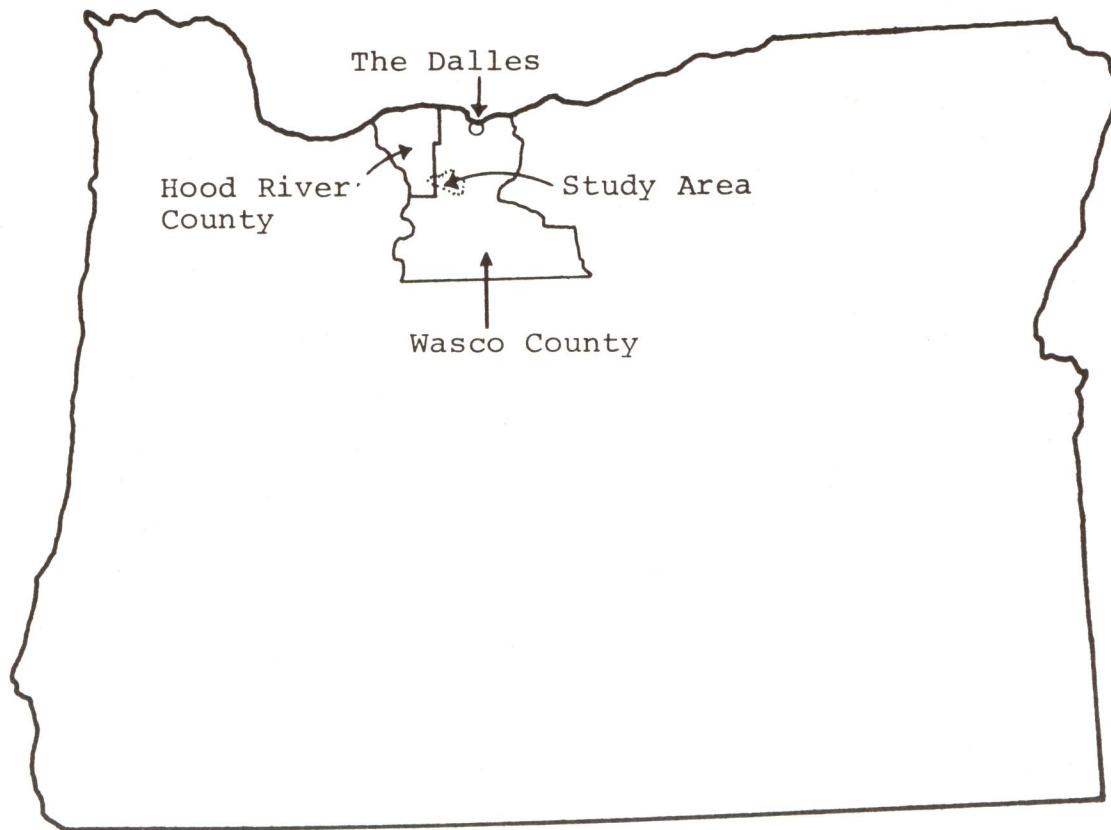


Figure 1. Location of the study area.

from west to east until an elevation of less than 600 meters is reached at the southeastern corner. Northerly to southerly slopes usually have a slight easterly aspect. Few slopes exhibit west aspects.

The Hood River Valley is immediately west of Lookout Mountain, and separates the Badger Allotment from the lower slopes of Mt. Hood. The summit of Mt. Hood, the highest point in Oregon, is about 13 kilometers west of the northwestern corner of the study area. The Columbia River Gorge, a major east-west low elevational break in the axis of the Cascade Mountains, lies approximately 32 kilometers to the north.

#### Climate

No long term climatic data were available for any location within the Badger Allotment. Long term precipitation measurements were available for the hamlet of Friend. This station is located 2.4 kilometers east of the Badger Allotment in the transition zone from forest to steppe vegetation. The small community of Dufur located 14.5 kilometers northeast of the study area is the nearest location where both precipitation and rainfall records were available. Mean monthly precipitation data for Friend and Dufur are presented in Table 1. Mean monthly temperature data for Dufur only are given in Table 2.

Table 1. Monthly precipitation in millimeters at Dufur and Friend, Oregon.<sup>a</sup>

	Jan.	Feb.	Mar.	Apr.	May	June	July
Dufur	49.8	34.0	26.7	16.8	19.3	22.9	4.6
Friend	71.6	52.3	34.8	19.8	25.4	26.9	4.8
	Aug.	Sept.	Oct.	Nov.	Dec.	Annual	
Dufur	4.1	11.7	25.4	43.2	46.0	305.0	
Friend	4.6	15.7	27.4	63.3	75.2	421.8	

<sup>a</sup>For 1931-1955 (U.S. Weather Bureau, 1960).

Table 2. Mean monthly temperatures in degrees C at Dufur, Oregon<sup>a</sup>

	Jan.	Feb.	Mar.	Apr.	May	June	July
	-.45	2.22	6.01	9.62	13.34	16.4	19.85
	Aug.	Sept.	Oct.	Nov.	Dec.	Annual	
	19.46	16.4	10.95	4.34	1.45	9.97	

<sup>a</sup>For 1931-1955 (U.S. Weather Bureau, 1960).

Climatic conditions within the Badger Allotment would be expected to vary greatly from the data in the tables because of differences in elevation and topography. Growing seasons are often very short at the higher elevations and snow may occasionally persist through September on parts of Lookout Mountain. Summers are usually quite dry with approximately 70 percent of the precipitation occurring from November through March, the bulk of which comes as snow.

### Geology

The Dalles Formation and Columbia River Basalts dominate the northeastern portion of the Badger Allotment. The rest of the area is underlain by basalt and andesite rock types with the exception of a small area in the southeast that has some Columbia River Basalts (Wells and Peck, 1961).

Conglomerate and tuffaceous sedimentary rocks make up the Dalles Formation which is generally believed to be of lower Pliocene Age (Baldwin, 1964). The Columbia River Basalt is widespread in eastern Oregon and is typically a fine grained dark gray dense basalt of Miocene age (Wells and Peck, 1961). The basalt and andesite rocks that extend through most of the study area are of Pliocene and Pleistocene Age. These rocks are gray open-textured olivene basalt and olivene-bearing andesite in flows and breccia forming lava domes and cones (Wells and Peck, 1961). Andesite is more common than

basalt in most of the area. Shields and Herman (1970) in examining the soils of an area immediately adjacent to the Badger Allotment, reported that mudflows and glacial till materials were widespread.

A mantle of fine geologically recent "volcanic ash" covered the entire area. It is not known for certain whether the "ash" is glacial flour or volcanic ash ejecta. Shields and Herman stated that the ash resembles both glacial flour and volcanic ash in physical properties. They found no evidence of pumic sized particles.

Shields and Herman working in the city of The Dalles watershed just north of the study area stated that the "volcanic ash" material was the most significant feature of the soils. Their observation appeared to fit the Badger Allotment since this material also blankets the study area. Because of its uniformity and lack of morphological development, it is assumed to be of very recent origin. They stated that there are no significant changes in the physical properties of the ash material within the soil profile with thickness as the primary difference. Depth of the deposits decrease from west to east. They described the properties of the ash material as fine sandy loams with weak to single-grained structures. Soils derived from it have a high rate of water infiltration and transmission, and tend to be droughty, especially on southerly slopes with moderate erosion potential except where water is concentrated. Problems include susceptibility to compaction when very wet and dustiness when dry.

## Vegetation

The vegetation of the Mill Creek Research Natural area, located approximately 14.5 km. north of the Badger Allotment, was briefly described by F. C. Hall in Franklin et al. (1972). Hall mentioned bunchgrass communities dominating steep to moderately steep southerly slopes and ridgetops. The communities were characterized by the grasses Agropyron spicatum,<sup>1</sup> Festuca idahoensis, Poa sandbergii, Bromus tectorum, and Stipa spp. with Balsamorhiza saggitata as the dominate forb. Hall also described two communities with Quercus garryana as the major tree species. The first had no Pinus ponderosa associated with it and was typified by small diameter (10 cm or less) Quercus garryana with abundant Symphoricarpos albus in the shrub layer. Elymus glaucus, Carex geyeri and various forbs dominated the ground vegetation. The second Quercus garryana community had larger diameter trees (15 cm or larger) with scattered Pinus ponderosa. Purshia tridentata and Amelanchier alnifolia were the major shrubs. Carex geyeri dominated the herbaceous vegetation in association with Agropyron spicatum, and Stipa spp.

In general, the Quercus garryana communities were located on southerly slopes. Swales and northerly slopes were dominated by

---

<sup>1</sup>All plant species in this paper will be referred to by their scientific name, except in parts of the history and literature review where the work of others is referred to. Common names and scientific name codes are provided in Appendix C.

mixtures of Pinus ponderosa and Pseudotsuga menziesii with occasional specimens of Abies grandis and Larix occidentalis. The major shrub was Symphoricarpos albus with some Holidiscus discolor. Carex geyeri was the principal herbaceous species. Arnica cordifolia, Hieracium spp., Fragaria spp. and other forbs also were found. The Mill Creek Research Natural Area varies in elevation from 790 to 1,040 meters. The descriptions of Hall provided an indication of the type of vegetation representative of those elevation ranges within the Badger Allotment. Hall's brief descriptions are the only vegetation studies in the Pacific Northwest that apply directly to the plant communities of the Badger Allotment. Franklin and Dyrness (1973) reviewed the vegetation and plant community studies pertinent to the states of Oregon and Washington. They discussed the vegetation of eastern Oregon and Washington in terms of broad zones. Their Pinus ponderosa and Abies grandis-Pseudotsuga menziesii zones appear to apply to the Badger Allotment.

Some elements usually considered typical of forests west of the Cascade Mountains are locally abundant in the study area; e.g., Abies amabilis, Tsuga heterophylla and Tsuga mertensiana. In addition, the study area is one of the few locations in Oregon where Quercus garryana extends east of the Cascades. Calocedrus decurrens approaches but does not reach the southern boundary of the Badger Allotment.

Detling (1958, 1966, and 1968) stated that the Columbia River Gorge is a major route of plant migration east and west of the Cascade Mountains. The close proximity of the Columbia River Gorge may account for the presence of species such as Quercus garryana within the study area.

#### History of Use

The Badger Grazing Allotment was not established until 1965. Prior to that the area was covered wholly or in part by the Wamic or Jordan cattle allotments. Information in old files at the Barlow Ranger District headquarters is fragmentary and incomplete but does shed some light on general trends in use of the study area.

Grazing occurred in the area covered by the Badger Allotment as early as 1893 when it was placed under control of the Federal Government. But no real regulation of grazing occurred until after 1906 when the area was placed under the administrative control of the Department of Agriculture. A 1949 allotment plan stated that prior to 1922 approximately 1720 cattle and 1200 sheep were grazed in the general area. The cattle numbers were reduced to about 1300 head and sheep were removed from the area in 1939.

Since the 1940's the trend in cattle numbers has been generally downward. In 1965 the Badger Allotment was formed from the Wamic Allotment and 109 head of cattle were run. Currently, 125 head of

cows with calves use the allotment. When the Badger Allotment was established livestock were removed from the higher elevations (over about 1500 meters).

Some interesting comments and observations concerning past conditions can be gleaned from some of the old reports in the file. A report dated 1922 observed that:

Mixed with the timber, most of the entire area supports a dense stand of reproduction and brush. Snow brush [ sic ], which has no forage value appears to be taking the range.

It may be of interest to note that the old stockmen, who used the range 20 years ago, say that the area was an open timbered, grass and weed range with scarcely any reproduction or brush at that time.

One undated paper that seems to have been written around 1936 recorded that formerly the range was open and park like and that one could ride and drive anywhere. But now it was becoming full of brush. The open park-like nature was attributed to: "...due to fern [ ? ] and surface burning each fall by stockmen." This same report goes on to elaborate:

Timber reproduction is encroaching heavily on this range and many areas formerly of good feed value, have grown up to stands of young pine, larch, and white fir. Likewise many of the old burns which had good stands of lupine, vetch and grasses, have been taken by snowbrush and manzanita.

The general pattern of grazing use appears to have been very heavy stocking early in the century with a series of reductions to where the present stocking is only a fraction of that of former levels.

The undated report also sheds some light on some of the early logging history with a comment under the heading of vegetation.

Approximately 65 to 70 percent of this range on the lower elevations, supports a stand of Ponderosa Pine, filled in by numerous areas of Douglas and White fire-timber [sic], which seems to be coming in as reproduction to a greater extent than the pine. Of the higher elevations or 35% of the area, supports a mixed stand of Douglas, White, Noble, and Amabilis, and Grand Fir, along with Ponderosa, White, and Lodgepole Pine, Spruce, Mountain Hemlock and Western Larch and Western Red Cedar, this latter type is now about all cut out.

A map with a 1916 date identifies a Fraleys mill within the study area at what later was a CCC camp during the 1930's. It is probable that this early sawmill produced mostly shakes from Thuja plicata. Some railroad logging was practiced in the eastern part of the unit from 1905 to 1936 (USDA Forest Service, Pacific Northwest Region, 1976). The majority of the activity was various types of selective cutting primarily in the eastern part of the study area. Up to the time of the study only a small proportion of the logging had been done in the western half or at elevations over 1200 meters. Some small clear-cuts were scattered over the area, the largest of which were on the south side of Jordan Creek. It was nearly always possible to find uncut stands at almost any elevation that were judged to be suitable for sampling.

## LITERATURE REVIEW

Ecological Concepts and Terminology

The term "community type" was used to describe those areas supporting or capable of supporting a given climax plant community. This is basically the same definition that Daubenmire and Daubenmire (1968) use for the term "habitat type." Habitat type was not used because it was felt that insufficient environmental data were collected in this study to fully apply the term in the same manner as Daubenmire and Daubenmire (1968). With the above exception, synecologic concepts and terminology closely follow Daubenmire (1968a) and Daubenmire and Daubenmire (1968). Tansley's (1935) definitions of various types of climax was adopted as outlined in Daubenmire (1968).

Classification of the plant communities for management purposes was one of the primary purposes of the study. Hence adoption of continuum philosophy and methodology, which emphasize variation and gradation, was deemed inappropriate. Daubenmire (1976) published an exhaustive review on the use of vegetation in assessing the productivity of forest lands in which he enumerated six basic principles for using vegetation types as indicators on forest lands:

- (1) Vegetation reflects the sum of all elements of the environment which are important to plants.
- (2) The species with the highest competitive powers are the best indicators.
- (3) Forests consist of superimposed groups ("unions" which occur in different combinations over the landscape.
- (4) Each

union is sensitive to certain special aspects of environment. (5) Many characters of vegetation have potential significance as ecologic indicators. (6) Types of environment ("habitat types") are the most basic ecologic units of landscapes.

#### Usefulness of Vegetation Classifications

The following is primarily a discussion of review papers concerning the uses of vegetatively based classifications in a variety of applications. This capsule review of more exhaustive papers on the subject indicates the value and growing use of vegetation classification in a variety of practical applications for wild land management.

Layser (1974) reviewed the uses of vegetation classification to forestry in the Northern Rocky Mountains. He cited the usefulness of plant community classifications in a diverse group of applications including: predicting forest site potential, disease susceptibility, frequency and extent of wildfire, soils type, forage production for domestic animals and wildlife, distribution of wildlife species; and potentials for recreation, aesthetic enjoyment, water production and for multiple use management. Daubenmire (1961) demonstrated that the growth of Pinus ponderosa varied according to habitat type and in a 1976 paper summarized the use of vegetation in assessing productivity of forest lands. Youngberg and Dahms (1970) found that plant communities gave a better indication of productivity of Pinus contorta on pumic soils than did soil characteristics alone. Maclean and Bolsinger

(1973) stated that timber yield productivity estimates based on plant communities were more realistic (gave a better approximation) than the standard yield tables and the regression equations they developed.

Wicker and Leaphart (1976) effectively discussed the relationships of fire and dwarf mistletoe (Arceuthobium spp.) in the Northern Rocky Mountains and related it to habitat type.

Arno and Pfister (1977) stated that the Montana habitat type classification (Pfister et al., 1974) has been used as a tool for communicating information about forest ecosystems between forest managers and scientists. They mentioned the use of habitat types for information concerning timber productivity, species selection for planting, genetic tree improvement programs, comparing regeneration success, selecting seed, and for evaluating cutting methods. Applications in range and wildlife, watershed, recreation, forest protection and natural area preservation were also discussed. Stress was placed on the value of habitat types as a common reference point of communication between and among scientists and laymen.

Dyrness et al. (1974) classified the plant communities of the central portion the Western Cascades in Oregon for the primary purpose of stratifying the area for intensive ecological study for the Coniferous Forest Biome of the International Biological Program.

Reconnaissance Sampling for Plant  
Community Classification

Franklin et al. (1970) described a reconnaissance method for forested plant community classification which was successfully applied in the Cascade Mountains of Oregon (Dyrness et al., 1974). Poulton et al. (1971) used a reconnaissance sampling technique for vegetation in their ecological inventory work in the steppe areas of Eastern Oregon. Reconnaissance sampling on a large scale was implemented for the forested lands of Montana (Pfister et al., 1974). The resulting classification in various states of completion has been used in a variety of drafts since 1972 by private timber companies as well as government agencies.

The primary advantage of a reconnaissance method is to greatly increase the number of plots that can be taken in a day. Franklin et al. (1970) stated that the loss of precision from reconnaissance procedures as compared to more detailed and deliberate methods is not as great as might be expected because the variation between stands in an association is often considerably greater than variation due to estimation of stand vegetation characteristics. The larger number of reconnaissance plots helps to compensate for the greater precision of slower more analytical sampling methods. They stated further that:

The pattern of classification that emerges from effective field reconnaissance is all the more valid because of the larger number of stands that have been included in the classification procedure. Variation within and between habitats can be more easily defined...

## METHODS

The study was initiated in late August of 1972. Three short visits were made to the study area before the end of the 1972 field season. These initial visits were made to become acquainted with roads, landforms, and gross vegetational features. Occasional weekend visits from March to June of 1973 were to observe plant phenology and to begin plant species collection.

Because of funding limitations, only two full summers for field work were available. In view of the limited amount of time for sampling, a technique was adopted based on reconnaissance plots in conjunction with the use of aerial photographs. The reconnaissance technique made it possible to sample a relatively large number of plots within the time limits. This permitted sampling a greater range of variability than would have been possible using a smaller number of intensively sampled plots. The larger number of reconnaissance plots substitute for the fewer number of intensive plots and their greater detail (Franklin et al., 1970).

### Aerial Photographs

Natural color aerial photographs at a scale of 1:15,840 were obtained the fall of 1972 and were used in the laboratory to become further acquainted with the area. The aerial photographs were

initially obtained to follow methods outlined by Poulton et al. (1971). However, because Poulton's plant community classification technique using aerial photographs was developed on non-forested lands, serious problems were soon encountered in trying to apply it to forested areas. The tree canopy in closed stands obscured the ground vegetation, making it impossible to make meaningful separations based on the trees and accompanying understory vegetation after the manner of other workers in forested areas in the Pacific Northwest (Daubenmire, 1952, 1953; Daubenmire and Daubenmire, 1968; Dyrness et al., 1974; Hall, 1967, 1973). Furthermore, it was necessary to study reproductive success of trees in order to evaluate successional relationships and project the eventual climax status of stands. Reproducing trees and understory species data were obtainable only by on the ground sampling. The foregoing difficulties did not obviate use of aerial photographs but necessitated a modification in their use from methods described by Poulton et al. (1971). The photographs were used primarily to stratify sample plot locations and to geographically identify plots that had been sampled. This was in addition to their use as a source of information on topography, gross vegetational features and spatial community relationships within the study area.

## Field Sampling

### Species Taxonomy

Most of the 1973 field season (from mid June to mid September) was devoted to collecting, identifying, and becoming acquainted with the vascular flora of the area and in developing a feeling for the major plant community patterns. Specimens of each species encountered were pressed and dried for the herbarium collections. Specimens were labeled as to (1) scientific and common name (2) date collected and (3) areas and/or habitats where found. Scientific names follow Hitchcock and Cronquist (1973), with the exception of the genus Artemisia which follows Beetle (1960). Common names follow Garrison et al. (1967) except where not listed; in which case names follow Hitchcock and Cronquist (1973). All vascular species encountered in the study are contained in Appendix E.

### Selection of Plots

A major objective was to sample a complete range of communities and environmental conditions within the study area. Plots were stratified prior to going into the field using aerial photographs to provide a "first cut" of homogeneous areas, i. e., areas that gave a uniform or distinctive photo image. The sample points on the aerial photographs also were systematically stratified in order to insure

sampling all aspects, slopes, and slope positions. Care was taken to include samples which were remote from roads and trails. These preliminary sampling areas were then marked on the aerial photographs with a wax pencil. The stereo model of the photos was taken into the field in order to locate the points on the ground.

Final selection of sampling locations was based on field observation. The criteria for a suitable sampling area was that the stand be relatively homogenous over a large enough area to include both the sample plot and a buffer zone around the plot. Generally, about 0.4 hectares was considered sufficient; however, most plots were in stands larger than this. Areas that were obvious ecotones between different communities were not sampled unless the ecotone was over 100 meters wide. Initial preference was for sampling undisturbed stands, but some lightly logged stands were sampled when unlogged ones were not available. Some plots were purposely placed in disturbed areas to aid in understanding successional relationships following disturbance. In all cases a representative portion of the stand was selected as the plot center. Plot size was the same as used by Franklin et al. (1970) which was a circle approximately 20 m diameter. A rod 1.25 meters tall, marked in one decimeter segments was used in each photograph as a size reference. The rod was placed at the plot center which was then photographed and the photo number noted on the data card. This "point" was then located on the aerial

photographs and a pin-prick made through the photo. This pin-prick was identified by recording the plot number on the back of the photo. The flight line and photo numbers of the aerial photograph were then entered on the data card for that plot. Field notes were recorded on many of the data cards giving a brief description of how to relocate the plot as well as miscellaneous notes about the plot. With this information and the combined use of the aerial and ground photographs it was possible to precisely relocate nearly every sample plot. In many cases it was possible to find the mark left in the ground by the rod even after a time span of up to six weeks.

#### Data Recording Procedure

All field data were recorded on forms printed on 5 x 8 inch Unisort Analysis Cards. Since a reconnaissance technique was being used, most data were gathered by ocular estimate; however, some were taken by measurement. The following site data were taken as modified from Poulton et al. (1971)

1. Elevation measure by a Thommen Altimeter to the nearest three meters.
2. Percent slope as measure by a Suunto Clinometer.
3. Slope position recorded on the basis of the following classes:
  - a. ridge top
  - b. upper 1/3 slope
  - c. midslope
  - d. lower 1/3 slope
  - e. bottom

4. Microrelief for the gross physiography recorded according to four classes:
  - a. steep and rough
  - b. rolling
  - c. undulating
  - d. flat

The classes were generalized for each area e. g. slopes generally steep, topography rough or area is mainly rolling hills and ridges.

5. Plot microrelief recorded as convex, flat, or concave.
6. Soils data on total depth, texture, structure, percent stones were taken by standard field techniques (U. S. Soil Conservation Service 1951). PH was measured with a Hellige-Truog soil pH test kit. Soils were judged to be hydrophobic when drops of water placed on a handful of soil were not readily absorbed.

Early in sampling it became apparent that inadequate field time made it impossible to dig a soil pit at each plot. Consequently, the vegetation was sampled and plots that were considered representative were marked for later revisiting for a soils description. In order to insure having adequate soil descriptions for all major community types, the plots were roughly stratified into groups based on presence or absence of major tree and shrub species over the range of elevations encountered. In this manner, 72 of 214 sample plots (34%) were accompanied by soils descriptions.

The major vegetation data collected were dominance, foliar coverage, and relative vigor of each species on the plot. These scales were adapted from Poulton et al. (1971). Tree overstory and understory by species were recorded separately, and subjective

judgement of age class was made based on relative size. Size-age classes in the tree understory included:

Young - trees one meter or less in height

Poles - trees one meter plus but below the general canopy

Mature - overstory trees reproducing in good vigor, growing actively and subdominant to dominant in the canopy

Decadent - large, old individuals in poor vigor, no longer growing actively (as evidenced by crown profiles).

These data were used to separate seral species from potential climax species and to aid in understanding successional relationships.

Foliar cover for each species of shrubs, forbs, graminoids, and trees in the overstory and understory was estimated using the following classes:

1 = 1% or less	5 = 31% to 50%
2 = 2% to 5%	6 = 51% to 70%
3 = 6% to 10%	7 = 71% to 90%
4 = 11% to 30%	8 = 91% to 100%

A Type C crown densiometer was used to measure tree canopy density (Lemmon, 1956). Line intercept transects occasionally were taken on understory species as a check on ocular estimates in situations where there was a question on coverage class for a particular species.

Dominance values were derived for each growth form, i. e.,

trees, shrubs and herbaceous species; with each species evaluated as to dominance within its own growth form. The dominance value was based on the relative impact each species was believed to have on the site. Abundance of individuals in the stand modified somewhat by the size of the species involved were the main criteria for estimating impact. In other words, a given number of large shrubs would have a greater dominance value than the same number of small shrubs. The following scale was used:

- 1 = Rare, essentially no impact on community.
- 2 = Uncommon, slight impact on community.
- 3 = Slightly abundant, small impact on community.
- 4 = Moderately abundant, some significant influence on community.
- 5 = Common, of average importance to the community.
- 6 = Subdominant, quite important to the community, importance exceeded by only a few species.
- 7 = Codominant or slightly subdominant, very important to the community. This value was given when two or more species were most dominant in the community.
- 8 = Dominant, clearly the most important and dominant species within its growth form in the community. This value was given to only one species in a particular growth form on each site.

Vigor of all species including trees in both overstory and understory was estimated and recorded by the following scale:

1 = poor vigor

3 = vigorous

2 = fair vigor

4 = very vigorous

Basal area for the stand was determined using a wedge prism (Dilworth and Bell, 1963).

### Data Analysis

Prior to the beginning of sampling a preliminary list of the major trees, shrubs, forbs and graminoides was made to coincide with the numbers along the margins of the unisort cards. At the end of each day in the field numbers of the cards representing those species that were within the plots were punched. A unisort procedure using a long needle was then used to separate cards representing rough vegetation groups based on presence and absence of species with major emphasis placed on trees. These rough groups were used as checks to stratify collection of soils information for each major type. This same unisort procedure was used to divide the 214 plots into groups that were of a manageable size for association table analysis. These groups generally were much broader than the ones used for collecting soils data and were based on the presence and absence of what were assumed to be the major climax tree dominants.

Association tables were prepared using data from all stands with

a tree overstory. Tables were not prepared for the non-forested communities because of the limited number of samples in these areas. Data used in the tables included the dominance and coverage codes written in the form of a fraction with the dominance code as the numerator and the coverage code as the denominator. In recording tree species, if a species was represented only in the understory, the fractional code was enclosed by a U-shaped line e. g.  $\overline{8/2}$ . If a tree species was found only in the overstory the fractional code was circled e. g.  $\textcircled{8/2}$ . Stands and species were "associated" in the table manually by cutting strips and rearranging them both vertically (by stands) and horizontally (by species). These first tables were very cumbersome because of the number of plots and the length of the species lists; therefore, species with a constancy of five percent or less were deleted from subjective comparison of the vegetation data using species with highest constancy, dominance and cover and the reproductive success of trees. These floristic groupings were then compared within groups to see if they reflected similar environmental conditions. They were then color coded upon an overlay on the photo mosaic to study their specific geographic locations. Minor adjustments in moving some stands to other types were made using the combined criteria of floristic, environmental and spatial data. These adjustments almost always involved stands that were disturbed in some way and consequently, represented seral

All changes were confirmed by field notes taken on the front of the data card where disturbance factors such as logging or evidence of recent fire or erosion were recorded.

Two summary tables of all community types were made. One was a table showing the constancy of species in various types (Appendix A). The other was a table based on average dominance-coverage values of species in the various community types (Appendix B). The species in the summary tables were arranged the same in both tables and represented species that had a constancy of 50 percent or more in any one type. Any species which met this criteria, therefore, had its value displayed in some types where its constancy value was less than 50 percent as long as it was included in the list by virtue of it occurring in 50 percent or more of the stands of any one community type. All plots that were obviously disturbed or were considered to be located on ecotones between community types were not used in deriving the values for the summary tables.

## RESULTS

Plant communities were grouped into 12 forested and four non-forested communities. The forested communities were named after what were judged to be the dominant climax species. Areas that were believed to have similar environmental potentials for plant communities have been referred to as community types (abbreviated as c. t.).

Table 3 gives average dominance and cover code values for tree species in both overstory and understory by c. t. Table 4 gives average total tree overstory crown cover and basal area by c. t. as measured with a crown densiometer and wedge prism respectively. Appendix A gives constancies and Appendix B gives dominance/coverage values for all species with 50 percent or more constancy in any one c. t.

Climax or potential climax tree species was the basis for grouping the community types into series following the method described by Daubenmire and Daubenmire (1968).

Non-forested communities were named by descriptive terms since insufficient successional data were available to assess potential climax vegetation.

Table 3. Average dominance and cover code values for tree species in overstory and understory by community type.

	<u>Quga/Putr/</u> <u>Agsp</u>		<u>Pipo-Quga/</u> <u>Putr Feid</u>		<u>Pipo/Putr/Lule</u>		<u>Pipo/Putr/Luca</u>		<u>Abgr/ Cage</u>		<u>Abgr/Pamy</u>		<u>Abgr/Pyse</u>		<u>Abpr phase of</u> <u>Abgr/Pyse</u>		<u>Thpl/Libol</u>		<u>Tshe/Libol</u>		<u>Abam/Rula</u>		<u>Abam/Vasc</u>	
	over	under	over	under	over	under	over	under	over	under	over	under	over	under	over	under	over	under	over	under	over	under	over	under
Abam													1/1	1/1	1/1	1/1			1/1	3/1	7/3	8/4	5/3	7/3
Abgr							1/1		3/2	5/2	7/4	8/3	8/4	8/3	6/3	7/3	4/2	7/2	3/1	4/2	1/1	1/1		
Abla													4/2	3/1	2/1	2/1					4/2	4/1	5/2	4/2
Abpr											1/1	1/1	1/1	8/4	8/4			3/1	1/1	3/1	1/1			1/1
Laoc										3/1	1/1	4/2		2/1	1/1	2/1				3/1			2/1	
Pien									1/1	1/1	3/1	1/1	3/1	1/1	3/1	1/1	7/4	6/1	5/2	1/1	4/2	1/1	3/2	1/1
Pico										2/1		4/2	1/1	3/1	1/1				1/1		1/1	1/1	2/1	1/1
Pimo										1/1		3/1	1/1	3/1	1/1	1/1	1/1	6/3	1/1	2/1	1/1			
Pipo	2/1	2/1	8/4	7/3	8/5	4/1	8/5	4/1	4/2	1/1	4/2	1/1	3/2		1/1		2/1							
Psme									8/5	6/2	6/3	1/1	5/2	2/1	6/3	1/1	4/1		4/2	1/1	1/1			
Quga	8/4	6/1	7/3	7/2	2/1	4/1		3/1	3/1	1/1														
Thpl																		8/5	8/3	5/2	7/3			
Tshe																	1/1	1/1	8/4	7/3				
Tsme												1/1	1/1	6/2	6/2				3/2	3/2	7/4	5/2	7/4	6/2

Table 4. Range and mean of overstory tree crown cover and total basal area by community type .

Community type	% Crown cover*		Basal area in m <sup>2</sup> /hectare**	
	Range	Mean	Range	Mean
<u>Quga/Putr/Agsp</u>	7-21	12.4	4-24	18.0
<u>Pipo-Quga/Putr/Feid</u>	18-52	35.2	4-32	20.7
<u>Pipo/Putr/Lule</u>	29-40	34.0	16-32	23.0
<u>Pipo/Putr/Luca</u>	34-43	39.7	20-32	25.7
<u>Abgr/Cage</u>	43-76	59.0	20-66	40.1
<u>Abgr/Pamy</u>	43-69	53.8	28-76	54.3
<u>Abgr/Pyse</u>	41-67	59.0	30-92	51.6
<u>Abpr/Phase</u>	44-67	54.5	46-66	55.6
<u>Thpl/Libol</u>	59-68	63.0	52-70	60.7
<u>Tshe/Libol</u>	66-70	67.7	76-84	80.0
<u>Abam/Rula</u>	48-67	56.7	38-106	60.4
<u>Abam/Vasc</u>	36-59	49.3	44-100	66.0

\*Crown cover measured by a type C crown densiometer (Lemmon, 1956).

\*\*Basal area measured by a wedge prism (Dilworth and Bell, 1963).

The *Pinus ponderosa*-*Quercus garryana* Series

This series has *Pinus ponderosa* as the major coniferous species present. *Quercus garryana* is the only other tree present in any quantity. *Juniperus occidentalis* is sparsely represented at lower elevations. Occasional rocky outcrops with shallow soils at elevations above 915 meters have a variation of the *Pinus-Quercus* series where *Quercus* is absent and *Juniperus occidentalis* becomes more prominent.

This series tends to be restricted to southerly slopes and upper slope positions (Table 5). Most of the area encompassed by the series has been heavily grazed. Present range condition is generally poor to fair with some areas in good condition. Generally speaking the amount of *Bromus tectorum* is an indication of current condition.

A significant characteristic of the series is the large amount of annual forbs and grasses. Presently, annuals are often the major herbaceous component of the communities both in terms of cover and number of species involved. Annuals in the other series are generally insignificant members of the community. Perennial grasses are also very important but are significant in only one community type in the other series (Appendices A and B).

*Quercus garryana* appears to tolerate drier and rockier sites,

Table 5. Range or most commonly occurring values for environmental and soils data by community type.

Type	Elevation m	% Slope	Position	Aspect	Macrorelief	microrelief	Total soil depth cm	% Stones	Texture	Structure	Hydrophobic	pH
<u>Quga/Putr/Agsp</u>	793-836	15-27	upper 1/3 slopes and ridgetops	south to southwest	steep	convex to flat	38-72	10-40	sandy loam to loam	weak to moderate subangular blocky	no	6.5-7.5
<u>Pipo-Quga/Putr/Feid</u>	600-800	2-15	ridgetop to midslope	east to southwest	rolling or undulating	convex to flat	43-102+	10-35	sandy loam to silt loam	weak to moderate subangular blocky	no	6.3-8.0
<u>Pipo/Putr/Lule</u>	610-732	6-11	ridgetops and upper 1/3 slopes	east to southwest	rolling	convex to flat	76-73+	0-20	fine sandy loam	weak subangular blocky	no	6.5-7.0
<u>Pipo/Putr/Luca</u>	610-640	5-11	ridgetops to lower 1/3 slopes	east to southwest	rolling	concave	no data	no data	no data	no data	no data	no data
<u>Abgr/Cage</u>	683-1043	5-60	all	all	rolling to steep	all	50-89+	0-50	fine sandy loam	weak to moderate subangular blocky	no	6.3-7.0
<u>Abgr/Pamy</u>	933-1425	35-50	all	all	rolling to steep	convex to flat	48-78+	20-60 increases with depth in profile	fine sandy loam to sandy clay loam	structureless to weak subangular blocky and occasional platy	occasional in duff and upper horizon	6.3-7.0
<u>Abgr/Pyse</u>	1275-1550	8-51	midslopes	northeast to south	steep to rolling	all	78+	5-50	fine sandy loam	weak subangular blocky	duff and upper horizons	5.5-7.0

Table 5. (Continued)

Type	Elevation m	% Slope	Position	Aspect	Macrorelief	microrelief	Total soil depth cm	% Stones	Texture	Structure	Hydrophobic	pH
<u>Abpr</u> phase of the <u>Abgt/Pyse</u> c. t.	1360-1415	11-24	midslope	north to northeast	steep to rolling	all	64-77	10-50	fine sandy loam	weak subangular blocky	duff and upper horizons	6.5-7.0
<u>Thpl/Libol</u>	1244-1311	6-9	lower slopes and bottoms	north to south	undulating to steep	flat to concave	38 to water table	0-50	fine sandy clay loam	weak subangular blocky	no	7.5
<u>Tshe/Libol</u>	1150-1220	17-25	lower slopes	north	steep	flat	70+	0-70	fine sandy loam	weak subangular blocky to platy	duff only	6.8-7.0
<u>Abam/Rula</u>	1264-1707	5-50	all	north to south	undulating to steep	all	64-78+	20-50	fine sandy loam	weak subangular blocky to platy	duff and upper horizons	5.5-7.0
<u>Abam/Vasc</u>	1692-1952	3-50	all	north to east	steep to rolling	convex to flat	68-824	0-55	fine sandy loam	weak to strong subangular blocky to platy	weakly to strongly in duff and upper horizons	4.8-7.5

heavier subsoils, and root zone flooding in the spring better than does Pinus ponderosa. It is important for wildlife both as food and shelter (U.S. D. A. Forest Service, 1976). The acorns and leaves provide food for large and small animals and the hollow trunks, common in many decadent and dead trees, provide shelter for small mammals and birds.

Observations show fire has been a major factor in the Pinus-Quercus series. Quercus appears less affected by fire than Pinus ponderosa, especially in the smaller age classes. It frequently resprouts from the stump when cut or burned. The sprouts generally appear heavily browsed by deer (Odocoileas hemionus).

Purshia tridentata, a palatable and important forage species, is sensitive to fire. Purshia is believed to be the climax shrub species in the series. Its absence from many stands is believed due to wildfires temporarily removing it from the area. Ceanothus integerrimus, another palatable forage species, is stimulated by fire and disturbance. In the Badger Allotment, Ceanothus integerrimus is judged to be even more desirable deer forage than is Purshia tridentata.

Quercus garryana/Purshia tridentata/Agropyron spicatum c.t.

The general appearance of the Quga/Ptr/Agsp community is that of a scrubby, open Quercus woodland rather than that of a closed

It is frequently adjacent to treeless areas. Total crown cover and basal areas are the lowest of all the community types (Table 4). It is not a commercial forest type but produces considerable forage for livestock as well as game animals.

The Quga/Putr/Agsp community is found on southerly ridge-tops and upper slopes at elevations below 915 meters. Slopes are moderate and microrelief is variable. Soils are shallow, stoney sandy loams or loams with weak to moderate subangular blocky structures (Table 5). Some profiles may have a horizon with clay to clay loam textures at approximately 35 cm.

Quercus garryana is the only tree species present in significant amounts (Table 3). Pinus ponderosa is stunted with only 40 percent constancy and low coverages.

Purshia tridentata is present in all stands examined and is the only shrub with 100 percent constancy. Amelanchier alnifolia and Symphoricarpos mollis var. hesperius have coverages exceeding five percent in some stands.

Balsamorhiza deltoidea and Lupinus caudatus are the only ubiquitous perennial forbs. These species are relatively large and conspicuous and have coverages averaging 20 percent. Agropyron spicatum, the only perennial grass with 100 percent constancy, coverage averages five percent. The alien annual Bromus tectorum, has the highest average cover (40 percent) of all herbaceous species. It

is believed that the ratio of Agropyron to Bromus is roughly indicative of the past grazing intensity. Plectris macrocera, Zigadenus venenosus, Achillea millefolium var. lanulosa, Frasera albicaulis var. columbiana, and Poa sandbergii have constancies exceeding 75 percent but are variable in coverage.

This community appears to resemble one briefly described by Hall in Franklin et al. (1972) with the exception that Hall mentioned Carex geyeri as being one of the dominant understory species. Carex geyeri was sparingly represented in only one of the five plots that typify the type. Hall labeled the Symphoricarpos species present in the Mill Creek Research Natural Area as S. albus. At the start of the Badger Allotment study the Symphoricarpos species present was keyed by the author to S. mollis var. hesperius and all Symphoricarpos plants encountered in sampling were labeled such. It is possible that S. albus was present in the study area and was not identified. In a like manner the Balsamorhiza species present was keyed to B. deltoidea instead of B. sagittata and in sampling was listed as such. The rest of Hall's description of the larger diameter Quercus stands in the Mill Creek Research Natural area is directly applicable to the Quga/Putr/Agsp community type. The difference in the amount of Carex geyeri may be due to the lack of grazing pressure in the Mill Creek area over the past six decades; while the Badger Allotment has been subject to livestock grazing. The

Quercus garryana forests described by Thilenius (1968) have only Quercus garryana and Amelanchier alnifolia in common with the communities of the Badger Allotment.

Pinus ponderosa-Quercus garryana/Purshia tridentata/  
Festuca idahoensis c. t.

The Pipo-Quga/Putr/Feid community has Quercus garryana codominant to subdominant to Pinus ponderosa. The appearance is that of a closed forest rather than that of the open woodland appearance of the Quga/Putr/Agsp community type. Figure 2 shows the contrasting appearance of the two types.



Figure 2. Examples of the Quga/Putr/Agsp c. t. in upper right center and the Pipo-Quga/Putr/Feid c. t. in the remainder of the photograph.

The Pipo-Quga/Putr/Feid community is found on gentle slopes in areas of rolling topography on midslopes to ridgetops with convex or flat microrelief. Aspects are from east to southwest and elevations are low (600-800 m) (Table 5). Soils are variable in depth with 10 to 40 percent stoniness in the profile on a variety of substrates. Textures are sandy loams to silt loams with weak to moderate sub-angular blocky structures (Table 5).

Pinus ponderosa is the only conifer present and is similar in stature to Quercus garryana but appears to be slightly more dominant. Quercus garryana apparently is able to maintain its role in the community partly because its ability to resprout following burning or cutting without having to grow from seed gives it a competitive advantage over Pinus ponderosa. Table 4 reveals that total crown cover and basal area are greater than in the Quga/Putr/Agsp c. t. indicating more favorable conditions for tree growth. In spite of this increase in productivity it is still a marginal commercial forest type. Tree growth, as judged by increment cores examined in the field, is slow and few trees attain large stature. Many areas within this c. t. are covered by dense stands of stunted Pinus mixed with Quercus as illustrated in Figure 3.

Purshia tridentata with 84 percent constancy is the only shrub normally found in the type; Purshia coverage averages five percent (Appendices A and B). Ceanothus integerrimus, a species favored

by fire and disturbance, occasionally is abundant in stands that are lacking Purshia. This tends to support the theory that Purshia is the potential climax shrub on these areas but is temporarily absent because of fire or other disturbing factors.



Figure 3. Photograph of plot number 5 showing a representative portion of the Pipo-Quga/P'utr/Feid c. t. Note the density of the stand and the stunted appearance of the trees.

Balsamorhiza deltoidea and Lupinus caudatus are robust forbs that average five percent coverage but in individual plots may exceed 25 percent. Lupinus was absent from one of the 13 plots that are included in this type, while Balsamorhiza was present in all. Achillea millefolium var. lanulosa is present in all plots but

averages one percent cover. Forbs with constancies exceeding 75 percent but low coverage values are: Habenaria unalascens, Hieracium albertinum, Lotus nevadensis, Plectris macrocera, and Collinsia sparsiflora. Festuca idahoensis, Koleria cristata and Bromus tectorum are ubiquitous grasses with coverages averaging 8, 5, and 20 percent respectively. Festuca idahoensis is judged to be the climax dominant even though Bromus tectorum coverage is almost always greater. Agropyron spicatum is much less abundant than in the Quga/Putr/Agsp community, averaging only one percent cover with a constancy of 76 percent. The change in dominance from Agropyron in the Quga/Putr/Agsp c.t. to Festuca in the Pipo-Quga/Putr/Feid c.t. seems to indicate a slightly more mesic environment associated with more gentle slopes and deeper soils (Table 5) in the Pipo-Quga/Putr community type. These are environmental factors that appear to favor greater moisture storage.

Hall's description of the Mill Creek Research Natural Area in Franklin et al. (1972) does not mention any communities that fit this type. Plant communities or "habitat types" (sensu Daubenmire and Daubenmire, 1968) with Pinus ponderosa, Purshia tridentata and Festuca idahoensis have been described from south central and south eastern British Columbia (Brayshaw, 1965; McLean, 1970; McLean and Holland, 1958) through eastern Washington (Daubenmire and Daubenmire, 1968; Franklin and Dyrness, 1973) in Montana (Pfister

et al., 1974) throughout eastern Oregon (Berry, 1963; Dealy, 1971; Dyrness and Youngberg, 1966; Hall, 1967; Hall, 1973; Volland, 1976; Weaver, 1957) and into northern California (Countryman and Cornelius, 1957). Quercus garryana is absent from all of the above descriptions with the sole exception of brief mention in Franklin and Dyrness (1973). It appears that the Pipo-Quga/Ptr/Feid c. t. described for the Badger Allotment is a local variant of a large, heterogeneous, widespread vegetation unit.

Pinus ponderosa/Purshia tridentata/Lupinus leucophyllus c. t.

Open park-like stands of large, widely spaced Pinus ponderosa are typical of the Pipo/Ptr/Lule community. Quercus garryana appears more as a tall shrub rather than as a tree and nowhere approaches the stature of Pinus ponderosa (Figure 4).

Lupinus leucophyllus, a large gray-wooly forb, gives a distinct appearance to the undergrowth and has excellent indicator value (Appendices A and B). This type is frequently associated with the Pipo/Ptr/Luca c. t. The similarities and differences are discussed in the description of the Pipo/Ptr/Luca c. t.

The Pipo/Ptr/Lule community is found only on convex or flat microrelief in areas of gentle topography (slopes less than 15%) on upper slopes and ridgetops. Aspects are from east to southwest and elevation varies from 610 to 732 meters. Soils are generally deeper

(80-90+ cm) and less stoney (0-10%) than in the Quga/Putr/Agsp and Pipo-Quga/Putr/Feid community types (Table 5). The soils appear to be formed largely of "ash" with uniform fine sandy loam textures and weak subangular blocky structures.



Figure 4. Photograph of plot number 22 showing a representative part of the Pipo/Putr/Lule c. t. Note the open nature of the stand and the subordinate stature of Quercus garryana. Other community types predominate the dense stands in the background.

Pinus ponderosa is the only coniferous species present (Table 3) with cover averaging 34 percent. Quercus garryana is occasionally absent (constancy 75%) and is more shrub-like than tree-like with cover values generally less than five percent. Total crown cover is

nearly the same as in the Pipo-Quga/Putr/Feid c. t. but basal area is somewhat larger reflecting the generally larger size of the trees (Table 4).

Shrub cover is low and in one of the four plots (plot 22) that typify the type, shrubs are absent. Ceanothus integerrimus is found in 75 percent of the plots with cover values of one to five per cent. Purshia tridentata has only 50 percent constancy and coverage averaged the same as Ceanothus. Since Ceanothus is considered a seral species, Purshia was used to name the type.

The herbaceous vegetation contains a variety of species but coverage values tend to be low giving a general appearance of sparseness to stands of the type. This sparseness of vegetation is interesting to note because this c. t. is generally in close proximity to the Pipo-Quga/Putr/Feid and the Pipo/Putr/Luca community types (descriptions follow) both of which have a more luxuriant appearance to the understory. Nine forbs have 100 percent constancy but only Lupinus leucophyllus and Lotus nevadensis average over one percent cover. Other ubiquitous forbs are Balsamorhiza deltoidea, Lomatium triternatum, Hieracium albertinum, Achillea millefolium var. lanulosa, Agoseris retrorsa, Calochortus macrocarpus, and Clarkia rhomboidea. Festuca microstachys and Bromus tectorum are the most abundant grass species, yet average only five percent cover. Koeleria cristata and Sitanion hystrix are present in all plots but

have lower coverages (Appendix B). It is difficult to judge from the limited number of stands representing this type which grass (if any) was the climax dominant. Festuca idahoensis is well represented in plot number 24 (8% cover) but absent from the others. This plot also had some of the highest coverages of several other herbaceous species which are common to the type.

Lupinus leucophyllus is present in one of the nine plots Daubenmire and Daubenmire (1968) used to typify their Pinus ponderosa/Festuca idahoensis association, and in one of the three plots representing their Pinus ponderosa/Stipa comata association. No other workers in the Pacific Northwest mentioned the presence of Lupinus leucophyllus in association with Pinus ponderosa.

Pinus ponderosa/Purshia tridentata/Lupinus caudatus c. t.

Stands of this type are often found in juxtaposition with stands representing the Pipo/Putr/Lule c. t. but occur on concave slopes while the latter are found on convex and flat slopes (Table 5). These stands also are often park-like in appearance; but the very different color and appearance of Lupinus caudatus from that of L. leucophyllus gives a much different appearance in the understory. The green color and relative abundance of L. caudatus gives an impression of lushness that contrasts sharply with the sparse appearance of adjacent areas supporting the Pipo/Putr/Lule community.

The type is found on slopes of five to 11 percent on rolling

topography in areas of concave microrelief. Elevations are between 610 and 640 meters (Table 5). No soils data were collected. Field notes taken on plot number 35 indicated more rocks on the soil surface than were apparent in adjacent areas supporting the Pipo/Putr/Lule community.



Figure 5. Photograph of plot number 35 showing a representative stand of the Pipo/Putr/Luca community. Note density of Lupinus caudatus and the clumped nature of the Pinus reproduction.

Pinus ponderosa reproduction appears to be episodic, as in the other Pinus types, occurring in what appears to be even-aged patches. Hence, the average figures for the type of Pinus ponderosa understory presented in Table 3 are somewhat misleading. If plot number 36 is

not included in the averages the understory value for Pinus ponderosa in Table 3 would be 6/2 instead of 4/1. Reproduction of Pinus ponderosa is apparently more abundant on this type than on the Pipo/Ptr/Lule community type. The limited number of stands examined that represent this type (three) make it difficult to reach definitive conclusions on the reproductive success of Pinus ponderosa. Quercus garryana is sparsely represented in the understory in all stands (Table 3), but does not appear in the overstory and is more of a tall shrub than a tree. Table 4 shows an increase in crown cover and basal area for Pinus.

Purshia tridentata is usually present (66 percent constancy) but in small coverages (Appendix B). No other shrubs are common (Appendix A).

Lupinus caudatus is overwhelmingly the most abundant forb present with coverages averaging 20 percent and sometimes reaching 40 percent. Other forbs present in all stands are Lomatium triternatum, Lotus nevadensis and Habenaria unalascens. Koeleria cristata is the only grass with 100 percent constancy but coverage is low and in general grasses are subordinant to forbs. Bromus tectorum is notably absent from the type. Plot number 33 had eight percent coverage of Festuca idahoensis. This plot also had the lowest coverage of Lupinus caudatus. This may indicate that Festuca is the climax dominant and the present abundance of Lupinus is related to past

grazing history; however insufficient data precludes all but tentative conclusions.

Lupinus caudatus in association with Pinus ponderosa was mentioned by Dealy (1971) as being important in some of the vegetation units he described. Lupinus caudatus had 75 percent frequency in Dealy's Pinus ponderosa/Purshia tridentata/Festuca idahoensis ecosystem with 100 and 83 percent frequency respectively in the Festuca idahoensis and Carex rossii phases (Dealy, 1971). Less than 60 percent of the species in Dealy's types were common to the Pipo/Putr/Luca community. Dyrness and Youngberg (1966) showed 100 percent constancy of L. caudatus in their Pinus ponderosa/Festuca idahoensis and Pinus ponderosa/Purshia tridentata-Arctostaphylos parryana var. pinetorum associations in the pumice region of Central Oregon. Carex rossii was abundant and common in both Dealy's and Dyrness and Youngberg's plant communities. Less than 50 percent of the species important in Dyrness and Youngberg's associations were common in the Pipo/Putr/Luca community. Volland (1976) mentioned Lupinus caudatus as part of four Pinus ponderosa communities he described for the Central Oregon pumic region. However, he gave no constancy or coverage data for his types so direct comparison was not possible. It may be that the Pipo-Quga/Putr/Feid, Pipo/Putr/Lule and Pipo/Putr/Luca communities are merely local expressions of a broadly defined widespread Pinus ponderosa/Purshia

tridentata/Festuca idahoensis plant community.

### The Abies grandis Series

This series is distinguished from the Pinus ponderosa-Quercus garryana series by the presence of conifers other than P. ponderosa in all types. Abies grandis is judged to be the potential climax dominant tree for the series despite being absent from some low elevation stands representing the Abies grandis/Carex geyeri c. t. and despite the subordinate role it plays in the Abies procera phase of the A. grandis/Pyrola secunda community type. Quercus garryana is present only in the Abgr/Cage c. t. which represents the lowest elevational type of the series.

The understory vegetation throughout most of the Abies grandis series is dominated by a variable mixture of shrubs and herbaceous vegetation resembling what has been described by Daubenmire (1953) as the Pachistima union. Only one type, Abies grandis/Pachistima myrsinites, is named after the union. Differences in associated conifers and in relative dominance and abundance of understory species necessitate different names for types within the series even though some species indicative of the Pachistima union are represented in the understory throughout the entire series. Pfister et al. (1974) used the forb Clintonia uniflora as an indicator of the Pachistima union in Montana. If Clintonia is used as the indicator

of the Pachistima union, only the Abies procera phase of the Abies grandis/Pyrola secunda c. t. has sufficient Clintonia to be considered diagnostic.

Annual forbs and grasses are common only in disturbed or open areas of the Abgr/Cage c. t. (Appendices A and B). This is also the only unit of the series where native grasses and grasslikes are important members of the natural community.

Abies grandis/Carex geyeri c. t.

The presence of Pseudotsuga menziesii and Abies grandis with Pinus ponderosa distinguish this type from members of the Pinus ponderosa-Quercus garryana series. Presence of Quercus garryana and absence of any other conifers except those above distinguish this c. t. from members of all other series. The Abgr/Cage c. t. is widespread in the Badger Allotment and appears to be the climatic climax community within its elevational range.

Representative stands of the Abgr/Cage community are found on all aspects, slope positions, and microreliefs on rolling to steep topography. Elevations range from 683 to 1043 meters (Table 5) with a variation of the type observed occasionally occurring on ridgetops and upper slopes with southerly exposures up to 1220 meters. Conversely, below about 850 meters it is usually found on steep northerly slopes. Soils are variable in depth and stoniness (Table 5).

Textures are fine sandy loams with weak to moderate subangular blocky structures.

Below approximately 850 meters, Abies grandis may be absent from some stands, presumably because of past fires eliminating it from local areas. A. grandis appears unable to become established in the absence of shade at these lower elevations. Abies grandis representation increases with elevation. Elevations over 850 meters appear to provide a less droughty environment because A. grandis is able to repopulate an area immediately following disturbance instead of waiting for an overstory to be established. Pseudotsuga menziesii dominates most stands, especially those below 850 meters. Because of this there is some justification to describe the lower elevation areas as Pseudotsuga climax similar to Daubenmire and Daubenmire (1968). However, some stands as low in elevation as 714 meters (plot 107) have Abies grandis dominating the tree regeneration. Hall (1967) reported Abies grandis communities adjacent to steppe vegetation or to Pinus ponderosa climax communities without an intervening belt of climax Pseudotsuga menziesii. In light of Hall's study, the evidence of fire in all 42 stands representative of the type, the presence of vigorous Abies grandis reproduction as low as 714 meters, and the limited acreages involved, no Pseudotsuga climax communities are recognized for the Badger Allotment. However, it is recognized that some stands show tree age class

distributions indicative of Pseudotsuga climax.

Basal area and percent crown cover are much greater than for members of the Pinus ponderosa-Quercus garryana series (Table 4) indicating greater productivity and more favorable environmental conditions for tree growth in this community type.

Symphoricarpos mollis var. hesperius has the highest constancy (90%) of all shrubs (Appendix A), and coverage varies from one to 20 percent. Several other shrubs are important in some stands but have constancies of 75 percent or less. The most important of these are: Amelanchier alnifolia, Holodiscus discolor, Rosa woodsii var. ultramontana, Spirea betulifolia var. lucida, and Berberis repens.

Osmorhiza chilensis and Hieracium albiflorum are the only forbs with constancies of 75 percent or more. Carex geyeri with 73 percent constancy and highly variable coverages (1-40%) is the most important herbaceous species (Appendix B).

This type appears to resemble the Abies grandis/Calamagrostis rubescens association of Hall (1967) for the Ochoco Mountains. Calamagrostis is poorly represented in the Badger Allotment, but Hall mentions Carex geyeri as an important part of his Abies grandis/Calamagrostis rubescens association. Franklin and Dyrness (1973) described a similar Abies grandis/Calamagrostis association for the Ochoco and Blue Mountains and for parts of the east slope of the Cascade Range. The Pseudotsuga menziesii/Calamagrostis rubescens



Figure 6. Photograph of plot number 108 representative of a relatively dense stand on the Agbr/Cage c.t. Abies grandis dominates all age classes. Note the lack of understory vegetation.



Figure 7. Photograph of plot number 58 a representative part of the Abgr/Cage c.t. which was selection cut a few years prior to being photographed. Contrast the understory development with that in Figure 6.

association of Daubenmire and Daubenmire (1968) does not appear comparable to the Abgr/Cage community type. Abies grandis was absent from stands representative of their association and all of their stands were over 1100 meters elevation; well above the normal range of the Abgr/Cage c. t. in the Badger Allotment.

Abies grandis/Pachistima myrsinites c. t.

Moving from low elevations upwards, this is the first type encountered that has conifers other than Pinus ponderosa, Pseudotsuga menziesii, and Abies grandis present. Absence of Quercus garryana helps in a separation from types representative of lower elevations and the absence of Abies lasiocarpa helps separate this c. t. from those types generally higher in elevation. Stands belonging to this community type are found from 900 to over 1400 meters elevation on all slope positions and aspects (Table 5). At upper elevations the type is generally on south and east facing slopes. Some stands are occasionally found in sheltered north slopes as low as 900 meters, well within the elevation zone generally occupied by the Abgr/Cage community type. Slopes vary from five to 55 percent on rolling to steep topography and flat to convex microrelief. Soils are stoney (20-60%) fine sandy loams to occasional clay loams and are 48 to 78 cm deep with structureless to weak subangular blocky or platy structures. The amount of stones increases with depth and the duff layer

and upper profile are often strongly hydrophobic (Table 5).

Abies grandis, Pseudotsuga menziesii, Pinus ponderosa and Larix occidentalis all have constancy values of 75 percent or more (Appendix A). Pinus contorta, P. monticola, Picea engelmannii, and Abies procera are occasionally present as scattered individuals. A. grandis dominates all age classes (Table 3) and is judged to be the climax tree species. Average crown cover is somewhat less than in the Abgr/Cage c. t. but average basal area is considerably greater (Table 4).

Rosa woodsii var. ultramontana is the only shrub with 100 percent constancy, but Symphoricarpos mollis var. hesperius and Chimaphila umbellata var. occidentalis both have 90 percent constancy (Appendix A). Coverage values within and among the shrubs varied considerably with little or no apparent pattern (Appendix B). For want of a more definitive name, Daubenmire's (1953) description of the Pachistima union was adopted to describe the assemblage of understory plants typical of the type, even though Pachistima myrsinites has only 52 percent constancy (Appendix A). Anemone oregana and Arenaria macrophylla are the only herbaceous species with more than 75 percent constancy (Appendix A).

The Abgr/Pamy community in the Badger Allotment does not appear to be the same as the Abies grandis/Pachistima myrsinites association of Daubenmire and Daubenmire (1968) or the Abies

grandis/Clintonia uniflora community of Pfister et al. (1974). The Abies grandis types described for the Rocky Mountains by the above authors, have more Clintonia uniflora, Vaccinium membranaceum and Linnaea borealis var. longiflora than do the stands representing the Abgr/Pamy community in the Badger Allotment. Hall's (1967) Abies grandis associations for the Ochocho Mountains also do not appear closely related.



Figure 8. Photograph of plot number 95 showing a representative part of the Abgr/Pamy c.t. Abies grandis is dominant in all age classes.

Abies grandis/Pyrola secunda c.t.

Polemonium pulcherrimum var. calycinum is found only in this type, the Abies procera phase of this type and the Abies amabilis series. It thus serves as a character species for separating the Abgr/Pyse c.t. from both the Abgr/Cage and Abgr/Pamy community types. Seral stands of the type are further distinguished from the preceding types by the near ubiquitous presence of Abies lasiocarpa (Appendix A). Abies procera dominates a phase of the type which is discussed separately.

The Abgr/Pyse community is found in midslope positions on northeast to south aspects from 1370 to 1555 meters elevation. Slopes are generally less than 30 percent but attain as much as 50 percent. Topography is rolling to steep with variable microrelief. Soils are fine sandy loams with depths 75 cm or greater with weak subangular blocky structures. Stoniness usually increases with depth and ranges from five to 50 percent (Table 5). The duff and upper five centimeters usually are strongly hydrophobic (Table 5). These hydrophobic tendencies were noted to extend as deep as 46 centimeters in some profiles.

Abies grandis usually dominates all age classes (Table 3) and is the only tree species with 100 percent constancy. Abies lasiocarpa and Larix occidentalis have 90 percent constancy for the type while

Pseudotsuga menziesii, Pinus contorta, P. ponderosa, P. monticola and Picea engelmannii each have 70 percent or greater constancies (Appendix A). Abies procera, A. amabilis and Tsuga mertensiana are found occasionally in some stands representative of the type. Total tree crown cover is greater than on the Abgr/Pamy c. t. but total basal area is slightly lower (Table 4).



Figure 9. Photograph of plot number 154 showing a representative part of the Abgr/Pyse c. t., Abies grandis, A. lasiocarpa, Pinus monticola and P. contorta are all present but A. grandis dominates the reproduction.

Symphoricarpos mollis var. hesperius and Chimaphila menziesii are ubiquitous shrubs. Rosa woodsii var. ultramontana and Pyrola

secunda var. secunda have 90 percent constancy. Coverage values usually are five percent or less. No other shrubs have constancy values greater than 20 percent (Appendix A). Pyrola secunda var. secunda was selected as a character understory species because of its high constancy in the type and low representation on the other Abies grandis community types. Its evergreen nature makes it a useful indicator all seasons of the year, a characteristic not shared by forbs. Cover on this species averaged one percent (Appendix B).

Arenaria macrophylla is the only forb with 100 percent constancy. However, Hieracium albiflorum, Campanula scouleri, Anemone oregona, Trillium ovatum, and Polemonium pulcherrimum var. calycinum each have 80 percent constancy (Appendix A). Polemonium is almost totally unrepresented in the Abgr/Cage and Abgr/Pamy community types and is best represented in the Badger Allotment in the Abgr/Pyse c. t. as well as the Abies procera phase of the community type (Appendix A). The above forbs usually do not exceed five percent cover (Appendix B).

Daubenmire and Daubenmire's (1968) Abies grandis/Pachistima myrsinites association for Eastern Washington and Northern Idaho appears similar to the Abgr/Pyse community type. Their association contained Symphoricarpos albus and Rosa gymocarpa instead of Symphoricarpos mollis var. hesperius and Rosa woodsii var. ultramontana. They also showed more Linnaea borealis var. longiflora,

Galium triflorum, and Smilacina stellata. In addition, they have significant amounts of Bromus vulgaris, Adenocaulon bicolor, Coptis occidentalis, Thallictrum occidentale and Viola orbiculata; species which are wholly absent or very poorly represented in the Abgr/Pyse community.

Hall's (1967) Abies grandis/Bromus vulgaris association also does not appear closely related. Hall mentioned a noticeable absence of shrubs and a large amount of Bromus vulgaris as being typical of the Abies grandis/Bromus vulgaris association of the Ochoco Mountains.

Abies procera Phase of the Abgr/Pyse c. t.

This phase is distinguished from the Abgr/Pyse c. t. primarily on the amount of Abies procera, the near total exclusion of Pinus ponderosa and the large increase of Tsuga mertensiana in the stands (Table 3). It is difficult in many stands to determine if Abies grandis or A. procera will be the climax tree species, hence it is considered to be a phase of the Abgr/Pyse c. t. which it is most similar to. Shrubs and forbs show much the same pattern as in the Abgr/Pyse c. t. except that Clintonia uniflora is much more abundant.

The Abies procera phase is typically found on moderately sloping north to northeast aspects on midslopes at 1360 to 1415 meters elevation on all microreliefs (Table 5). Soils are fine sandy loams

61 to 75 cm or greater in depth. Stoniness varies from 10 to 50 percent. Structures are weak subangular blocky and the duff and upper portions of the soil profile are strongly hydrophobic (Table 5).

Baker (1949) rated Abies procera as intolerant of shade in his five-class scale second to "very intolerant." Sudworth (1908) described it as "rather intolerant of shade." However, Merkle (1951) described two plant communities in the coast range of Oregon that had significant amounts of Abies procera. He indicated that A. procera dominated these communities above 1037 meters and apparently achieved climax status. Franklin (1964) indicated that the question of the shade tolerance of A. procera was still open to discussion. Within the A. procera phase of the Abgr/Pyse c.t., A. procera dominates both the overstory and understory (Table 3). Abies grandis is always present and is usually abundant but generally less so than A. procera, and it appears that neither species will ever fully replace the other. Pseudotsuga menziesii also has 100 percent constancy and is as abundant as Abies grandis in the overstory but is poorly represented in the understory. This indicates its inability to replace itself on the site in undisturbed conditions (Table 3). Tsuga mertensiana is present in all stands and averages five percent coverage on both overstory and understory. It appears that it will be a minor associate even in climax stands. Pinus contorta and Picea engelmannii both average 87 percent constancy but have variable coverages and show

little or no reproduction. Pinus monticola has the same average coverage values as P. contorta and Picea engelmannii (Table 3) but is present in only three-fourths of the plots (Appendix A). Abies lasiocarpa inexplicably shows 50 percent constancy and low average coverages; values that are considerably less than the Abgr/Pyse c.t. (Table 3). Pinus ponderosa is almost absent, apparently snowpack and low temperatures have exceeded the ecological limits of this species.



Figure 10. Photograph of plot number 119 showing a representative stand of the Abpr phase of the Abgr/Pyse c.t. A. procera dominates both overstory and understory.

Chimaphila menziesii shows 100 percent constancy in the phase as it does in the Abgr/Pyse c. t. Symphoricarpos mollis var. hesperius and Rosa woodsii var. ultramontana have constancies of 75 percent or greater (Appendix A). Coverages for shrubs are low, rarely exceeding five percent (Appendix B). Pyrola secunda var. secunda shows only 50 percent constancy; down from the 90 percent constancy value for the species in the Abgr/Pyse c. t. itself. This is the same pattern as exhibited by Abies lasiocarpa and the explanation for it is equally obscure. A. lasiocarpa was absent from plots 117, 119, 125, and 133 while Pyrola secunda var. secunda was lacking in plots 117, 118, 119, and 132 thus there appears to be little or no relationship in the presence or absence of one species to the other.

Anemone oregana is the only forb with 100 percent constancy although coverage is only about one percent. Hieracium albiflorum, Arenaria macrophylla, Clintonia uniflora and Trillium ovatum all had constancies of 87 percent and Achlys triphylla, Polemonium pulcherrimum var. calycinum and Arnica latifolia var. latifolia all had constancy values of 75 percent. Coverage values of forbs was variable, Clintonia uniflora and Achlys triphylla averaged five percent or more in at least two stands. Lupinus latifolius had only 50 percent constancy but had 20 percent cover in stand number 132.

The communities described by Merkle (1951) for Marys Peak in the Coast Range of Oregon were broadly defined and included areas

where Abies procera was definitely subordinate to Tsuga heterophylla and Pseudotsuga menziesii. His communities had only six species in common with the Abies procera phase as it appears in the Badger Allotment. Dyrness et al. (1974) described two seral plant communities dominated by Abies procera for a portion of the western slopes of the Cascade Mountains. Their communities were all seral to Abies amabilis. No evidence of eventual Abies amabilis dominance is apparent in the A. procera phase (Table 3). Vaccinium membranaceum was present in all of their plots but is present in only half of the plots for Abies procera phase. A number of forbs are common to both areas including Clintonia uniflora, and Achlys triphylla. However, Dyrness et al. (1974) indicated higher average forb coverage.

#### The Thuja plicata Series

This series is characterized by the presence of Thuja plicata in all stands. It is limited in distribution, being generally confined to relatively narrow bands along streams. Tsuga heterophylla dominates one community type but Thuja is always associated with it. The series occupies productive sites with a large variety of species in both the overstory and understory. Depth to the ground water table appears to be the principal environmental factor that separates the two community types within the series.

Thuja plicata/Linnaea borealis var. longiflora c.t.

Thuja plicata is the dominant tree species though Picea engelmannii and Abies grandis are always present (Table 3). The type is generally found near streams in areas with a high water table. Because of the rather limited areas it occupies within the Badger Allotment, only three plots were located representing this type.

The Thpl/Libol community is found on gentle slopes (6 to 9%) on lower slopes and valley bottoms with flat to concave microrelief. Aspects are variable and the surrounding topography is undulating to steep and rough (Table 5). Elevations are from 1244 to 1311 meters. Soils are 50 cm or more in depth and the water table was observed in mid-July to be at a depth of 38 cm in plot number 88. Textures are fine sandy clay loams with iron stains and weak sub-angular blocky structures (Table 5). Roots were abundant especially in the upper half of the profile.

Thuja plicata is the dominant tree in the overstory and understory while Picea engelmannii and Abies grandis are present in lesser amounts (Table 3). Picea appears less able to reproduce itself in closed stands than A. grandis (Table 3). The data seem to indicate a trend of a gradual decrease of Picea and a gradual increase of Abies grandis as time progresses. From the limited areas sampled, it appears that Thuja will be the major climax dominant

and Abies grandis and perhaps Picea engelmannii will be minor climax associates. Pseudotsuga menziesii, Larix occidentalis, and Populus trichocarpa all had coverage of five percent or more in at least one plot.



Figure 11. Photograph of plot number 89. Note the large size of the Thuja plicata trees and the depauperate understory evident in this heavily shaded stand within the Thpl/Libol c. t.

Total basal area and total crown cover are greater in the Thpl/Libol c. t. than in any part of the Pinus ponderosa-Quercus garryana or Abies grandis series (Table 4). This reflects what appears to be more favorable growing conditions or perhaps a greater age of the stands due to the relative infrequency of fire in the streamside

locations. Daubenmire and Daubenmire (1968) have reported that stands dominated by Thuja plicata showed a lower fire frequency than most other forested communities.

Linnaea borealis var. longiflora, Rosa woodsii var. ultramontana, and Chimaphila menziesii are ubiquitous shrubs whose coverages were generally less than five percent (Appendix B). Acer circinatum was present in two of the three plots with cover between five and ten percent.

Smilacina stellata, Anemone oregana, and Trillium ovatum were always present (Appendix A). Smilacina was the only herbaceous species that averaged five percent or more coverage. It was abundant in plot number 88 with a coverage value of ten percent.

Based on the limited samples available for the Badger Allotment, it appears that the Thpl/Libol community is not closely related floristically to the Thuja plicata/Athyrium felix-femina association described by Daubenmire and Daubenmire (1968). It appears to resemble the Thuja plicata/Clintonia uniflora association of Pfister et al. (1974) for Montana, and the Thuja plicata/Pachistima myrsinites association of Daubenmire and Daubenmire (1968). Both of these types found in the Rocky Mountains were on steeper slopes and included a number of species that are not found in the Badger Allotment.

Tsuga heterophylla/Linnaea borealis var. longiflora c. t.

Tsuga heterophylla dominates the overstory and the reproduction in two of the three plots representative of this type. The abundance of T. heterophylla in the stands separates this type from all other plant communities sampled on the Badger Allotment. Thuja plicata is always present but usually in lesser amounts than Tsuga heterophylla (Table 3). Ground water tables were not encountered in soil pits as in the Thpl/Libol community type. Slopes are steeper and soils more stoney than in adjacent areas supporting the Thpl/Libol community type (Table 5).

Stands belonging to the Tshe/Libol community are on northerly aspects with flat microrelief and on lower slopes within a small (1159 to 1220 meters) elevational range (Table 5). They were restricted to narrow zones along streams such as Jordan Creek that head at upper elevations (1525 meters) and serve as conduits for downslope cool air movement. Soils are 70 cm or greater in depth with weak fine subangular blocky structures. Textures are fine sandy loams with no stones near the top of the profile to 70 percent stoniness at the bottom. Only the litter layer shows any tendency to be hydrophobic (Table 5).

In two of the three plots that are representative of the type, Tsuga heterophylla dominates the reproduction. In the other,

Thuja plicata is the most abundant tree in the understory. In all plots Tsuga heterophylla dominates the overstory. Thuja is always present with lesser amounts of Abies grandis, Picea engelmannii, and Pinus monticola (Table 3). This is the only type where P. monticola is abundant. Pinus ponderosa is completely absent. Pseudotsuga menziesii and Tsuga mertensiana at times had coverages of up to 30 percent but are not present in all plots. Crown cover and especially total basal area are greater than on any other community type in the study area (Table 4).

Shrubs with 100 percent constancy are: Linnaea borealis var. longiflora, Pyrola secunda var. secunda, Rosa woodsii var. ultramontana, and Chimaphila umbellata var. occidentalis. Shrub coverages are low perhaps reflecting the high density of the tree crowns. Chimaphila menziesii is absent from all plots in the Tshe/Libol c. t. and is present in all plots in the Thpl/Libol c. t. This may be an artifact of sampling due to the difficulty experienced in identifying them when not in flower.

Forb coverages by individual species are low, but total cover is often high because of the number of species encountered (Appendix B). Smilacina stellata and Trillium ovatum are the only ubiquitous forbs (Appendix A).



Figure 12. Photograph of plot number 141 showing a representative part of the Tshe/Libol c. t. Specimens of Picea engelmannii and Abies lasiocarpa are visible in the right center, but both the overstory and understory are dominated by Tsuga heterophylla.

The Tsuga heterophylla/Clintonia uniflora association of Pfister et al. (1974) for Montana was poorly defined and successional relationships were not clear because their area was near the limit of the range of Tsuga heterophylla. Daubenmire and Daubenmire's (1968) Tsuga heterophylla/Pachistima myrsinites association also had Linnaea borealis var. longiflora, Smilacina stellata, Trillium ovatum and Pyrola secunda var. secunda but contained much greater amounts of Pachistima myrsinites and Clintonia uniflora as well as

many other species not present in the Badger Allotment.

### The *Abies amabilis* Series

*Abies amabilis* is felt to be the climax dominant for the series though *Tsuga mertensiana* dominates many of the stands. Examination of the data in Table 3 show that *A. amabilis* dominates the tree understory class while *T. mertensiana* tends to dominate the overstory. Study of field data cards for plots representative of the series show that most *T. mertensiana* reproduction are in the pole and sapling size with *A. amabilis* dominating the smaller (and presumably younger) sized reproduction. Franklin (1966) stated that *Abies amabilis* is the eventual climax species in the southern Washington Cascades in his *Tsuga mertensiana* zone. He stated that *A. amabilis* is the climax dominant even though *T. mertensiana* was a major or dominant component of most of the stands he examined. Franklin cited age-class distribution data to justify his conclusion. Franklin and Dyrness (1973) also stated that *A. amabilis* is the dominant climax species when it is found with *Tsuga mertensiana*.

*Pinus ponderosa* is entirely absent and *Pseudotsuga menziesii* nearly absent from plots representative of the *Abies amabilis* series (Table 3).

Within the elevation zone of the *Abies amabilis* series, wind-swept ridges and points are usually occupied by a discontinuous cover

of clumped Pinus albicaulis and Abies lasiocarpa. High ridges in the Badger Allotment frequently have shallow soils and severe wind-shear. Pinus albicaulis is the most common tree in these areas and is usually associated with Abies lasiocarpa. These areas resemble the Pinus albicaulis-Abies lasiocarpa habitat types described by Pfister et al. (1974) for Montana; and Daubenmire and Daubenmire (1968) for Eastern Washington and Northern Idaho. Hall (1973) described a similar plant community for the Blue Mountains of Oregon except that Carex geyeri was an important constituent of his type. Carex geyeri was not observed at high elevations in the Badger Allotment. The Pinus albicaulis-Abies lasiocarpa community was observed but not sampled due to its limited occurrence.

The Abies amabilis zone described by Franklin and Dyrness (1973) may include the Abies amabilis series found in the Badger Allotment but their Tsuga mertensiana zone (with A. amabilis as the climax dominant) appears to better describe the conditions in the Badger Allotment. They stated that the Tsuga mertensiana zone is wet and is the coolest forested zone in Western Washington and Oregon. They mentioned that a large proportion of the precipitation comes as snow and that snow-packs are deep and last six to eight months. Their observations seemed to be representative of the conditions observed in the Abies amabilis series in the Badger Allotment. For example, part of the previous winter's snow-pack

within the Abies amabilis series was still present in protected areas in September 1973.

Abies amabilis/Rubus lasiococcus c. t.

Abies grandis and Pseudotsuga menziesii are poorly represented or absent and either Tsuga mertensiana and/or Abies amabilis dominate stands representative of this type. Thuja plicata and Tsuga heterophylla are absent (Table 3). Many of the larger shrub species that are common in the Abies grandis series are absent or poorly represented (Appendix A). Instead, a few small shade tolerant species such as Rubus lasiococcus predominate.

The Abam/Rula c. t. is found on all slope positions and aspects on gentle to steep slopes at elevations from 1264 to 1707 meters (Table 5). Soils are fine sandy loams with weak subangular blocky (platy) structures. Rocks and stones make up 20-50 percent of the profile which is usually over 64 cm deep. The duff layer and upper horizons are usually strongly hydrophobic (Table 5). This tendency was observed to extend deeper in the profile in the oldest stand examined (plot number 159) than in what were judged to be younger stands.

Tsuga mertensiana is somewhat more abundant in the overstory than is Abies amabilis, but A. amabilis is much more dominant and abundant in the understory (Table 3). Abies lasiocarpa and Picea engelmannii are represented in 83 percent of the plots representing

the type and have coverages of five percent, Larix occidentalis shows 75 percent constancy but lower cover. No other trees are found in two-thirds or more of the stands. Basal areas are higher than any other types except for the Thuja plicata series (Table 4).

Rubus lasiococcus and Pyrola secunda var. secunda are the most common shrub species each with 91 percent constancy. Coverage of Rubus averages five percent but because of growth form Pyrola averages only one percent. Vaccinium membranaceum has only 66 percent constancy but when present often covers ten percent of the ground (Appendices A and B). Anemone oregana and Valeriana sitchensis are the only forbs with more than 50 percent constancy; averaging 83 and 58 percent respectively (Appendix A). Anemone coverage varies between one and 20 percent, but coverage of Valeriana averages only one percent (Appendix B). The Abam/Rula community appears to closely resemble the Abies amabilis-Tsuga mertensiana/Vaccinium membranaceum association of Franklin (1966) for the Southern Washington Cascades. However, in Franklin's association, Xerophyllum tenax was ubiquitous and abundant, but is completely absent from the Badger Allotment. Vaccinium membranaceum coverage and constancy in the Abam/Rula community is less than the values reported for Franklin's Abies amabilis-Tsuga mertensiana/Vaccinium membranaceum association.

north exposures which have gentle to moderate slopes (3-50%). Microrelief is either flat or convex and elevations range from 1692 to 1952 meters. Soils are 66 to 82 cm deep and are fine sandy loams in texture. Stoniness increases with depth in the profile up to 55 percent (Table 5). Structures are weak subangular blocky and the upper layers and duff are often hydrophobic (Table 5). Tsuga mertensiana, Abies amabilis and A. lasiocarpa are the only trees with 100 percent constancy (Appendix A). Tsuga mertensiana dominates the overstory and Abies amabilis the understory. A. lasiocarpa is subdominant in both layers (Table 3). Pinus contorta and Picea engelmannii both have constancies of 72 percent. Coverage for both species averages five percent in the overstory and one percent in the understory (Appendices A and B). No other tree species have constancies over 50 percent (Appendix A).

Total average crown cover is lower than any other types in the Badger Allotment except for members of the Pinus ponderosa-Quercus garryana series (Table 4). Total basal area averages higher than for any other type except the Tshe/Libol community type. The trees tend to be short as evidenced by the low crown cover and high basal area values (Table 4). In using the crown densiometer, tree trunks were registered in the mirror as part of the crown cover. Hence values tend to be higher with tall trees.



Figure 14. Photograph of plot number 190 showing a representative part of the Abam/Vasc community type. Tsuga mertensiana is the major overstory species but Abies amabilis dominates the understory.

Vaccinium scoparium usually dominates the understory but was absent from two of the 11 plots representative of the type, plots number 182 and 185. Four plots (numbers 182, 185, 184, and 199) were noted as having charred logs or other evidence of fire. Both of the plots lacking V. scoparium were in this category. Constancy of Vaccinium scoparium is 81 percent (Appendix A). Coverage averages five percent (Appendix B), although it exceeded 20 percent in two plots. Rubus lasiococcus is the only other shrub with more than 70 percent constancy (Appendix A).

Valeriana sitchensis was the only forb present in all plots and covered between one and five percent (Appendices A and B). Luzula hitchcockii and Lomatium martindale have constancy values of 81 percent. Aster foliaceus var. apricus was present in 72 percent of the plots representative of the Abam/Vasc c. t. These last two species are common in adjacent meadows and perhaps may best be considered as meadow species that extend into contiguous forested areas. All of the above except Valeriana sitchensis occur only in this c. t. or in adjacent unforested areas and thus are indicators of the Abam/Vasc c. t. when encountered in forested areas.

Franklin (1966) briefly described a similar community that he called Tsuga mertensiana/Vaccinium scoparium. He gave no quantitative data but indicated that Abies amabilis would be a climax component. Communities at high elevations with Vaccinium scoparium as the understory dominant have been reported by Daubenmire and Daubenmire (1968) for Eastern Washington and Northern Idaho, in Montana by Pfister et al. (1974) and for the Blue Mountains of Oregon and Washington by Hall (1973). Abies amabilis was not represented in the areas covered by the preceding workers but it appears that the Abies amabilis/Vaccinium scoparium c. t. of the Badger Allotment is analogous to a variety of forested communities with a Vaccinium scoparium understory found at high elevations throughout the Pacific Northwest.

### Nonforested Communities

Nonforested communities within the Badger Allotment fall into five main groups. Two occur at lower elevations and three are found at elevations above 1220 meters. Some quantitative data were taken but because of the small sample size; no analysis was made.

#### Xeric Low Elevation Grasslands

These grasslands are usually adjacent to areas supporting the Quga/Putr/Agsp c. t. and contain many of the same species with the exception of Quercus. Soils are generally very rocky and shallow and appear to have formed over basalt or over the The Dalles Formation (Wells and Peck, 1961) and most areas exhibit moderate to severe erosion. These grasslands are most common south slopes and were observed to initiate plant growth and development earlier in the spring than did nearby forested communities. Nearly all of the stands sampled were considered in poor range condition. In good range condition it appears that Festuca idahoensis dominates the few north slopes and Agropyron spicatum dominates the south slopes. Bromus tectorum and a variety of annual forbs and grasses are common. In early spring, elk (Cervus canadensis) use is heavy and imprints of their hooves chop up the soil surface.

### Low Elevation Swales

Within the Pinus ponderosa-Quercus garryana series, numerous swales with concave microrelief are wet early in the spring and dry out later in the summer. These areas have shallow stoney soils and serve as drainageways for early spring runoff. Hordeum geniculatum, Lotus denticulatus, Orthocarpus hispidus and Danthonia unispicata are representative of the swales. Many of the annual and perennial species common to the Pinus ponderosa-Quercus garryana series are conspicuous in these areas with Allium acuminatum and Brodiaea hyacinthina being especially abundant. Shrubs are almost entirely lacking. The swales were observed to remain green later into the growing season than the xeric low elevation grasslands.

### Subalpine Meadows

In openings within areas supporting the Abies amabilis series, many different subalpine meadows are found of which High Prairie is the most notable. There are tremendous differences in the plant communities found in these meadows. In High Prairie alone, seven distinctly different plant communities were sampled. However, because of the limited amount of subalpine meadows within the study area, no assessment of successional status could be made and the relationship of one community to another was not ascertained. Elk use is heavy in all of the meadows and hoofprints are often deeply

pressed into the soil. Soil profiles and soil moisture content appeared to differ among communities. They also appeared to vary in their susceptibility to tree invasion. There are areas where roads cut through the meadows are eroding and the road construction appears to have altered the water table and brought about a change in community structure.

#### Subalpine Shrub Communities

On the south face of Cold Point above the headwaters of Jordan Creek between 1525 and 1740 meters elevation, is an open slope dominated by a variety of shrubs and some scattered trees. The principal shrubs are: Artemisia tridentata subspecies vaseyana form spicaformis, Arctostaphylos nevadensis, Ceanothus velutinus var. velutinus, Pachistima myrsinites, and Prunus emarginata. Daubenmire (1970), Hall (1967), McLean (1970), and Franklin and Dyrness (1973) reported and briefly described similar communities in similar topographic positions. Daubenmire (1968) stated that grassy openings on such topography experienced soil drought (greater than trees could tolerate) thus maintaining openings in areas that normally would be forested. He stated further that wind removal of snow was an important factor in creating soil drought at elevations that received an abundance of precipitation. Presumably somewhat similar conditions exist in those subalpine openings dominated by

shrubs. A soil pit in part of the Abam/Vasc c.t. on the ridgetop above the subalpine shrub communities had a layer of soil superimposed on a typical soil profile for the type. It is speculated that this soil material was removed from the shrub covered slope below by wind and deposited at the top of the ridge where trees and the change in slope altered the flow of air. This southerly slope exhibits heavy use by deer.

#### Alnus sinuata Dominated Communities

Steep slopes (50%) above 1220 meters elevation with water tables near the surface are dominated by Alnus sinuata. Bedrock is often near the surface and running water is common. No data were taken because of the small extent of most stands. Daubenmire and Daubenmire (1968) described a similar community for Eastern Washington and Northern Idaho. Franklin and Dyrness (1963) mentioned recurrent snow avalanches and high water tables over impervious substrates as being involved in the maintenance of communities dominated by Alnus sinuata.

## DISCUSSION

During field work and data analysis some observations concerning management implications, sampling methods, and plant distribution were noted that merit discussion.

Management Implications by Community Type

Quercus garryana/Purshia tridentata/  
Agropyron spicatum c. t.

This is a non-commercial timber type since Quercus garryana is not generally a marketable timber species and is short and shrub-like in appearance. Purshia tridentata and Quercus provide considerable browse for big game. Fire can potentially decrease the amount of Purshia (as evidenced in the Rocky Fire area in 1973) but may stimulate additional sprouting of Quercus. Consequently, total browse production may not decline as much as would be anticipated if a fire were to kill the Purshia. Ceanothus integerrimus germination and sprouting is stimulated by fire (Cronemiller, 1959) but is not an abundant species in the type. Most areas were observed to exhibit considerable soil erosion apparently because of overgrazing by cattle, deer and elk. Trails, tracks and droppings of deer and elk were abundant, especially in the spring. The type appears to be an important winter and early spring range for big game. Potential for forage

production appears good. Because of the dry conditions where reseeding becomes necessary, xeromorphic grasses such as members of the genus Agropyron should be selected.

Pinus ponderosa-Quercus garryana/Purshia tridentata/Festuca idahoensis c. t.

Pinus ponderosa is the only commercial species suitable for the type but is of marginal commercial value here since its growth is slow and trees are often stagnated due to overcrowding. The gentle slopes permit tractor access but the relatively fine textured soils may be subject to compaction if operated on when wet (Shields and Herman, 1970). Browse production is similar to the Quga/Putr/Agsp c. t. One stand was observed where Purshia was absent and Ceanothus integerrimus was abundant (Plot #30). Data from field notes indicated a lot of charcoal in the surface soil layers; suggesting a history of fire in the type. Observations indicate that C. integerrimus is abundant in disturbed areas within the type. Big game use of Ceanothus appears to be as heavy or heavier than use of Purshia. Consequently, loss of browse due to management activities which reduce Purshia cover may be wholly or partly offset by an increase in Ceanothus.

Range condition in the stands sampled was usually considered poor to fair although total herbaceous cover is usually high (Appendix B). Lupinus caudatus is common and is rated as one of the most

poisonous members of the genera Lupinus (U.S. Dept. of Ag. 1968).

Deer, elk, and turkey (Meleagris gallopavo) make extensive use of the type in the winter and spring (U.S. D. A. Forest Service, 1976). The entire Pinus ponderosa-Quercus garryana series was rated as valuable winter range for big game as well as prime habitat for a variety of other animals and birds (U.S. D. A. Forest Service, 1976). Management should be geared towards maintaining adequate representation of Quercus because of its value as forage and shelter to a wide variety of wildlife (U.S. D. A. Forest Service, 1976).

Drought tolerant grasses should be seeded if revegetation is necessary.

Pinus ponderosa/Purshia tridentata/  
Lupinus leucophyllus c. t.

The open park-like stands with a sparse understory indicated relatively poor growing conditions for both trees and understory species. The soils appear droughty and seem to be the limiting factor for growth. Pinus ponderosa attains large size and is a commercial timber species in this type, however reestablishment appears difficult and natural regeneration should not be relied upon.

Production of browse and of herbaceous vegetation appears low and seems to offer little opportunity for improvement. The relatively limited acreages involved and their mosaic occurrence

also handicap management of the type.

Pinus ponderosa/Purshia tridentata/Lupinus caudatus c. t.

Pinus ponderosa is the only commercial tree species on this type. Natural reproduction is much more common than in adjacent areas of the Pipo/Putr/Lule c. t. (Table 3) but appeared episodic. It may not be reliable on a year to year basis so planting may sometimes be necessary.

Shrub cover is low (Appendix B) and variable and exhibits little potential for management. Herbaceous cover is high but the majority of the understory is made up of Lupinus caudatus (Appendix B). Forbs tend to dominate the grasses and it is not known if reducing forb competition would stimulate grass production. A conspicuous absence of Bromus tectorum was noted in this type.

Abies grandis/Carex geyeri c. t.

Abies grandis, Pseudotsuga menziesii, and Pinus ponderosa each can be grown successfully in the type. Current selective cutting practices are favoring the shade tolerant and fire sensitive Abies at the expense of Pseudotsuga and Pinus. Clearcutting and heavy shelterwood cuttings tend to favor the last two species. Clearcutting below 850 meters in elevation and on south slopes appears inadvisable because of droughty soils. No tree reproduction was evident on some

old landings, presumably because of soil compaction and soil drought. Pinus ponderosa is likely the best adapted species to plant especially at the lower elevations where soil drought may be common (Fowells, 1965).

Stands with well developed shrub and herbaceous vegetation appear to respond vigorously to logging (see Figure 6) and may require scarification for tree regeneration. Many stands have poorly developed understory vegetation because of the dense shade and may not exhibit the same vigorous response by the understory vegetation. If regeneration is not accomplished within a year or two following cutting, scarification may be required. Most of the shrub species were observed to be resprouting following burning, especially Symphoricarpos mollis var. hesperius and Rosa woodsii var. ultramontana. Quercus garryana appears to linger in an unhealthy condition under heavy shade for many years and then respond vigorously following logging or fire.

Bromus inermis and Dactylis glomerata were observed to be successful seeded species in the type. Phleum pratense did not appear to be as successful.

Abies grandis/Pachistima myrsinites c.t.

Abies grandis, Pseudotsuga menziesii, Pinus ponderosa are common and generally abundant species in nearly all stands. All

three can seed into openings without needing a nurse crop. Larix occidentalis and to a lesser extent Pinus contorta function as early successional species (Fowells, 1965). Larix occidentalis is usually infested with Arceuthobium campylopodum form laricis. Judging from increment cores taken in the field, Abies grandis grows faster than either Pseudotsuga menziesii or Pinus ponderosa. However, on southerly slopes especially at lower elevations Pinus ponderosa appears to be the best timber species to plant. Observations in clearcuts along Jordan Creek within this c. t. show a vigorous response of several Carex spp. Tree reproduction was sparse presumably because of a combination of herbaceous competition and hydrophobic soils. Dyrness (1976) demonstrated that slash burning increased the hydrophobic tendencies in the soils in the High Cascade mountains of Oregon.

Abies grandis/Pyrola secunda c. t.

The largest individuals of Abies grandis were observed in this type. Pinus ponderosa is more abundant on southerly aspects; north slopes may be too cool for it. Larix occidentalis and Pinus contorta are major early seral species that appear well suited to the type (Appendix A). Abies lasiocarpa also is a common species but tends to come into the stands after a tree cover has been established. On clearcuts, naturally seeded Larix occidentalis were observed growing

taller than Pinus ponderosa but had slightly smaller diameters. Plantings of Pseudotsuga menziesii should work well in the type. Competition from understory species does not appear a major problem if reforestation is prompt following logging.

Dactylis glomerata, Bromus inermis, Bromus carinatus and Phleum pratense all appear suitable for seeding. Hydrophobism of the soils is very common and often extends deep into the profile (Table 5).

Abies procera Phase of the Abgr/Pyse c. t.

Substantial amounts of Abies procera and Tsuga mertensiana indicate cool conditions with abundant precipitation, much coming as snow (Fowells, 1965). The absence of Pinus ponderosa is indicative of its poor adaptation to the type. Pseudotsuga menziesii appears suitable for planting in clearcuts but selective cutting favors Abies grandis, A. procera, Tsuga mertensiana and to a lesser extent A. lasiocarpa. Grass seeding recommendations are the same as for the Abgr/Pyse c. t.

The relatively gentle slopes common in the type should cause no problem for management activities. The hydrophobic duff and upper horizons may cause difficulties in reforestation.

Thuja plicata/Linnaea borealis var. longiflora c.t.

This type is limited in acreage but poses some significant management challenges in spite of the limited areas involved. When found in an upland situation it indicates the presence of a high water table posing problems for road construction. Clearcuts may become swampy quagmires due to the increase of available water on the site because of reduced transpiration. Picea engelmannii is well adapted to the type and tolerates the high water table better than other associated species with the exception of Thuja. Selective cutting favors the more shade tolerant Thuja at the expense of Picea. The understory vegetation often responds dramatically upon logging, and may hinder tree regeneration.

Tsuga heterophylla/Linnaea borealis var. longiflora c.t.

Based on the data in Table 4, this is the most productive timber type present in the Badger Allotment. The primary restriction is in its limited distribution within the area. Tsuga heterophylla, Abies grandis, Thuja plicata, Pseudotsuga menziesii, Pinus monticola and Tsuga mertensiana are all present in sufficient numbers to indicate that the type is capable of variety of management options. The understory does not appear to compete strongly with tree reproduction. The soils exhibit little tendency to hydrophobism. In all,

there are few restrictions on management. Selective cutting will favor Tsuga heterophylla because it is the most shade tolerant species found in the type.

Abies amabilis/Rubus lasiococcus c.t.

Cold air drainage appears to be a significant feature in the distribution of this type within the Badger Allotment. Frost pockets are to be expected in clearcuts in the type therefore, cold tolerant species should be selected for regeneration.

Moisture did not appear to be a limiting factor (Fowells, 1965). Pinus ponderosa, Abies grandis and Pseudotsuga menziesii are almost completely absent from the type (Table 3), consequently they do not appear suitable for use in reforestation. The relatively high basal areas (Table 4) give the impression of a productive type. Limited observations on increment cores taken in the field indicate relatively slow growth; Fowells (1965) indicated that both Abies amabilis and Tsuga mertensiana are relatively slow growing species.

Larix occidentalis forms nearly pure stands in areas of old burns indicating it is adapted to the type. Pinus contorta is poorly represented, apparently it is not as well suited to the type as is Larix. Picea engelmannii and Abies lasiocarpa are important seral species but are secondary to Tsuga mertensiana which is the major seral dominant (Appendices A and B).

Hydrophobic soils are common (Table 5) and duff layers are often very thick. The understory vegetation is sparse and does not exhibit any tendency to respond vigorously to removal of the overstory.

Abies amabilis/Vaccinium scoparium c. t.

This is the highest elevational closed forest type in the study area. It is a true subalpine forest with a short, cold growing season. The trees are generally short and with considerable body taper. Only cold tolerant trees are abundant (Table 3). Because of the short and cold growing season and slow growth the type is marginal at best for timber production. Serious problems with frost pockets, and frost heaving should be anticipated. Heavy snowpack was observed to cause damage in some stands, and pistol butting is common on steep slopes. Strongly hydrophobic soils are common and may cause difficulties in revegetation.

The cool temperatures and heavy snowpack levels common in the type make it an important watershed area and other values should be secondary to its value for water production.

Sampling Procedures

Aerial Photographs

The aerial photographs were extremely useful because they

provided an overview of the study area not easily obtained any other way. The scale, clarity, constancy of color, and generally high quality of the natural color photographs used were the major factors in their usefulness. For study of plant communities, natural color aerial photography was preferable to black and white photography because of the greater amount of information that was conveyed to the user. The photographs insured sampling a range of elevations, aspects, slopes and slope positions. They were invaluable in stratifying the area for sampling and in mapping the plant communities.

#### Reconnaissance Approach

The reconnaissance sampling technique permitted classification of a relatively large area with a limited amount of field time more rapidly than would have been possible using more traditional methods. The reconnaissance approach appeared well suited for familiarization and definition of the plant communities of an area and for stratifying the vegetation for subsequent resampling by more intensive methods.

#### Data Codes

It was easier to assign the cover value of a species to a coverage class using ocular estimates than to assign a single specific value. However, the coverage classes used were not always satisfactory. The cover classes over 70 percent (classes 7 and 8) were rarely used,

while the lower classes often seemed too broad. Two species in class 4 could have had a difference in actual cover of up to 19 percent. One species might have actual cover of 11 percent while the other species had 30 percent cover; yet both would receive the same cover class value. This difficulty did not seriously affect the classification because dominance ratings were also used in establishing the community types.

The dominance ratings were useful in plant community classification. Cover values and dominance ratings were often complementary. Using cover classes it often was important to have some method of differentiating between species which were in the same cover class, but had different cover values and/or assumed different impacts in the community. The dominance rating generally provided the necessary distinction.

Data from the vigor ratings were unsatisfactory and therefore not used in community analysis. The problem was not whether vigor was an important attribute to consider, but instead was in application of the vigor codes in the field. The way the vigor code classes were structured, created most of the difficulty. Without considerable experience it was difficult to properly assess the relative vigor of individual plants. Consequently, at the beginning of the field work nearly all species in a sample plot were rated as having average vigor. As familiarity and experience with the species grew, a more

meaningful assessment of the relative vigor of the various species in a plot could be made. Near the end of the sampling period it was possible to apply the vigor ratings with greater objectivity and judgment based on accumulated experience.

### Data Analysis

Data analysis was first attempted using a computer. Problems encountered in transferring data from the plot cards to computer cards were such that hand analysis of data was used as an alternative.

Use of association tables worked, but was slow because of the large numbers of sample plots and species. A needle sorting procedure was used to divide the 214 plots into preliminary groups based on the most shade tolerant tree species present. This resulted in very broad groupings; one of the first association tables had over 90 plots and 100 species. Subsequent experience in computer analysis of ecological data leads to the conclusion that hand analysis gives the worker a greater familiarity with the characteristics of each sample plot as a distinct entity than does computer analysis. However, the computer facilitates the study of large amounts of data in ways difficult to duplicate by hand analysis.

If a computer is needed for data handling it is important to insure that the type of data recorded is selected with the limitations of the computer in mind. Data recording forms should be designed

to minimize keypunch errors.

### Factors Affecting Species and Vegetation Distribution

#### Taxonomic Considerations

Four true fir species were found in the Badger Allotment:

Abies amabilis, A. grandis, A. lasiocarpa and A. procera. Some A. grandis trees exhibited a few of the characteristics of A. concolor in needle shape, size and arrangement on the twigs. This tendency was most evident in the elevation zone of 1220 to 1525 meters. Out of this elevation range A. grandis more closely resembled the botanical description of the species. In the 1220 to 1525 meter elevational range, all four of the above species could be found in the same stand or nearby. Thus, some of the variation observed may be due to crossing between two or more species resulting in hybrids which would be difficult to identify precisely using normal field techniques. Ecologically, the trees with A. concolor characteristics appeared to function similarly to A. grandis and because no uniform population existed they were considered to be variations of A. grandis and were labeled as such while sampling.

During sampling it was difficult to separate Chimaphila menziesii from C. umbellata var. occidentalis when they were not in flower. Separation was often done on relative size of the plants

although this was recognized as not being entirely accurate. In retrospect it was regrettable that a more definitive separation was not made while sampling in view of the marked differences in distribution of the two species in the Thpl/Libol and Tshe/Libol community types.

An unsuccessful attempt was made to identify a moss common in the Abies amabilis series which subsequently appeared to be an important understory species in some stands. Since it was not identified it was left out of the classification tables (Appendices A and B).

#### Species Distributions

The plant communities of the Badger Allotment are an interesting mixture of species and types. Many elements of forests west of the Cascade Crest are present, especially at the higher elevations. The study area is one of the few locations in Oregon where Quercus garryana extends east of the Cascade Crest. Detling (1966) mentioned Quercus garryana and Balsamorhiza deltoidea as part of a Rogue River flora that is represented sporadically west of the Cascades and is only found east of the crest in the vicinity of the Columbia River Gorge.

Two widely distributed forest species in the northwest, Xerophyllum tenax and Arctostaphylos uva-ursi, are notably absent from the study area. Franklin (1966) noted that Xerophyllum was absent

from areas near Mt. Adams with soils developed on gravel textured pumice. He speculated that Xerophyllum was not adapted to coarse pumice soils. The soils in the Badger Allotment are not formed on coarse pumic materials hence the reason for the lack of Xerophyllum in the study area remains moot. While Arctostaphylos uva-ursi is absent, Arctostaphylos nevadensis, a morphologically similar species, is common.

The Columbia River Gorge, a major physiographic break in the axis of the Cascade Mountains, is approximately 32 kilometers north of the Badger Allotment. The Gorge is notable for its physiography, climate (Lynott, 1966), and as a route of plant and animal migration (Detling, 1958; 1966; 1968). Maritime air masses carried by the prevailing westerly winds move through the Gorge with less modification than when forced up and over the mountains (Lynott, 1966). Mt. Hood is just 13 kilometers northwest of the study area and undoubtedly modifies the movement of air masses coming from the west towards the Badger Allotment. The location of these two major physiographic features in close proximity to the study area undoubtedly affect the vegetation of the Badger Allotment. Furthermore, the mantle of fine "ash" (Shields and Herman, 1970) that dominates the upper soil layers may also affect the distribution of plants within the study area. These factors singly or in concert may account for the apparent anomalies noted in plant species distribution.

### Distribution of Annuals

Annual forbs and grasses were often the dominant understory species in the community types of the Pinus ponderosa-Quercus garryana series. Annual species declined in coverage and dominance in the Abies grandis series. They were well represented only in the Abgr/Cage c. t. (Appendices A and B) in the Abies grandis series. They were essentially absent from the other series.

### Topographic Influences

Much of the vegetation within the Pinus ponderosa-Quercus garryana series was topographically controlled as evidenced by their presence on upper slope positions with southerly aspects (Table 5). Lower slope positions and northerly slopes were generally occupied by members of the Abies grandis series. Local air drainage, as controlled by topography, is important in the distribution of several types (Figure 15, map pouch, back cover). As mentioned, the presence of the Tshe/Libol c. t. in the study area appeared to be directly related to cool air drainage along sheltered stream channels. The importance of air drainage in the distribution of some community types was especially noticeable in the distribution of the Abam/Rula c. t. Several plots representative of the type were taken within the range of elevations, and on aspects that normally supported members of

the Abies grandis series. Most of these plots were located within the Fret Creek drainage basin where the top of some slopes exceed 1925 meters. The opening at the lower end, just upstream from where Fret Creek flows into Fifteen Mile Creek, is restricted by ridges on either side. Cool air is collected and concentrated in the basin and consequently excludes Abies grandis dominated communities from elevations where they would normally occur. A similar situation exists on the upper part of Fifteen Mile Creek and to a lesser extent on the upper part of Jordan Creek. These areas support the Abam/Rula c. t. at elevations and aspects well within the range of the Abies grandis series.

Topography also influences wind patterns in the Badger Allotment. The steep southerly slopes of Lookout Mountain and Cold Point are exposed to strong winds coming from the Badger Lake Basin to the south and west. Tree cover is sparse and most individuals exhibited flagging. Pinus albicaulis appeared to be the tree species best adapted to these windswept slopes. True krumholz individuals were not observed; although the bases of some Abies lasiocarpa were surrounded by a mat of layered branches.

### Role of Fire

In nearly all plots one or more types of evidence was found to indicate that fire had been a part of the stand history. Types of

evidence observed to a greater or lesser extent in individual stands were the presence of burned logs, snags, stumps or wood fragments, fire scarred trees and/or charcoal in the soil profiles.

On August 15, 1973, the "Rocky Fire" burned approximately 7,000 acres, 200 of which occurred in the Pipo-Quga/Putr/Feid c.t., In the first growing season following the fire an annual forb, Montia perfoliata, was exceptionally vigorous and conspicuous. Diameter of many individuals exceeded one decimeter. Observation of old slash burns indicated that Montia returned to a more typical stature in subsequent years. Presumably, the vigor and size of the plants the first growing season was due to the nutrients made available by the fire and or to the lack of competing vegetation.

In areas where the fire burned only in the understory, the herbaceous vegetation was apparently little damaged. However, on areas where a crown fire burned, the herbaceous species appeared to show less vigorous response the growing season after the fire. Presumably this was due to the high temperatures developed in the crown fires which usually occurred in areas with dense tree cover. However, the more dense tree canopies may have reduced the vigor of the herbaceous vegetation through shading and competition prior to the fire.

The impact on trees and shrubby vegetation varied with the species involved and with fire intensity. In areas covered with dense

stands of Pinus ponderosa and Quercus garryana, hot crown fires killed most or all Pinus. The aerial parts of Quercus were also killed but many individuals exhibited sprouting from root crowns by the summer of 1974. Sprouting of Quercus was observed even though some stems were burned to the ground. Fire appears to play an important role in maintaining Quercus garryana in areas of Abies grandis climax, and also seems to be an important factor in maintaining abundant Quercus in the Pinus ponderosa-Quercus garryana series.

Purshia tridentata appeared to be the most fire sensitive shrub species since no evidence of resprouting was observed. In contrast, Ceanothus integerrimus resprouted vigorously the first growing season even though the aerial portion of the shrub was reduced to blackened stubs.

## LITERATURE CITED

- Baker, F. S. 1949. A revised tolerance table. *J. For.* 47:179-181.
- Baldwin, E. M. 1964. *Geology of Oregon*. 2nd Ed. Univ. Oreg. Coop. Bookstore, Eugene. 165 p.
- Beetle, A. A. 1960. A study of sagebrush. Section Tridentatae of Artemisia. *Wyoming Agr. Exp. Sta. Bull.* 368. 83 p.
- Berry, D. W. 1963. An ecological study of a disjunct ponderosa pine forest in the northern Great Basin of Oregon. Unpublished Ph.D. thesis. Oreg. State Univ. 291 p.
- Brayshaw, T. C. 1965. The dry forest of Southern British Columbia. In *Ecology of western North America*. V. J. Krajina (ed.). Vol. 1, Univ. B.C. Dep. Bot. pp. 65-75.
- Countryman, C. M. and D. R. Cornelius. 1957. Some effects of fire on a perennial range type. *J. Range Manage.* 2:122-127.
- Cronemiller, F. P. 1959. The life history of deerbrush - a fire type. *J. Range Manage.* 12:21-25.
- Daubenmire, R. 1952. Forest vegetation of northern Idaho and adjacent Washington, and its bearing on concepts of vegetation classification. *Edolo. Mono.* 22:301-330.
- Daubenmire, R. 1953. Classification of the conifer forests of eastern Washington and northern Idaho. *Northwest Sci.* 27(1): 17-24.
- Daubenmire, R. 1961. Vegetative indicators of rate of height growth in ponderosa pine. *For. Sci.* 7:24-34.
- Daubenmire, R. 1968a. *Plant Communities*. Harper and Row, New York. 300 p.
- Daubenmire, R. 1968b. Soil moisture in relation to vegetation distribution in the mountains of northern Idaho. *Ecol.* 49:431-438.
- Daubenmire, R. and J. B. Daubenmire. 1968. Forest vegetation of eastern Washington and northern Idaho. *Wash. Agric. Exp. Stn. Tech. Bull.* 60. 104 p.

- Daubenmire, R. 1976. The use of vegetation in assessing the productivity of forest lands. *Bot. Review.* 42:115-143.
- Dealy, J. E. 1971. Habitat characteristics of the Silver Lake mule deer range. USDA For. Serv. Res. Pap. PNW-125. 99 p.
- Detling, L. E. 1958. Peculiarities of the Columbia River Gorge flora. *Madrono.* 14:160-172.
- Detling, L. E. 1966. The flora of the Columbia River Gorge. *Northwest Sci.* 40:133-137.
- Detling, L. E. 1968. Historical background of the flora of the Pacific Northwest. *Univ. Oreg. Mus. Nat. Hist. Bull.* 13. 57 p.
- Dilworth, J. R. and J. F. Bell. 1963. Variable plot cruising. 2nd Ed. O.S.U. Bookstores, Inc., Corvallis, Ore. 107 p.
- Dyrness, C. T. 1976. Effect of wildfire on soil wettability in the High Cascades of Oregon. U.S. Forest Serv. Pacific Northwest Forest and Range Exp. Sta. PNW-202. 18 p.
- Dyrness, C. T. and C. T. Youngberg. 1966. Soil-vegetation relationships within the ponderosa pine type in the central Oregon pumic region. *Ecology* 47:122-138.
- Dyrness, C. T., J. F. Franklin, and W. H. Moir. 1974. A preliminary classification of forest communities in the central portion of the Western Cascades in Oregon. U.S./International biological program, ecosystem analysis studies. *Bull.* 4. 123 p.
- Fowells, H. A. 1965. Silvics of forest trees of the United States. U.S.D.A. Handbook 271. 762 p.
- Franklin, J. F. 1964. Some notes on the distribution and ecology of noble fir. *Northwest Sci.* 38:1-13.
- Franklin, J. F. 1965. Tentative ecological provinces within the true fir-hemlock forest areas of the Pacific Northwest. U.S. Forest Serv. Pacific Northwest Forest and Range Exp. Sta. Res. Paper PNW-22. 31 p.
- Franklin, J. F. and C. T. Dyrness. 1973. Natural vegetation of Oregon and Washington. U.S. Forest Serv. Gen. Tech. Report PNW-8. 417 p.

- Franklin, J. F., C. T. Dyrness, and W. H. Moir. 1970. A reconnaissance method for forest site classification. *Shinrin Richi* XII:1-14.
- Franklin, J. F., F. C. Hall, C. T. Dyrness, and C. Maser. 1972. Federal research natural areas in Oregon and Washington: A guidebook for scientists and educators. U.S. Forest Serv. Pacific Northwest Forest and Range Exp. Sta. Portland, Oregon. 489 p.
- Franklin, J. F. 1966. Vegetation and soils in the subalpine forests of the southern Washington Cascade Range. Unpublished Ph. D. thesis. Wash. State Univ. Pullman. 132 p.
- Garrison, G. A., J. M. Skovlin, and Charles E. Poulton. 1967. Northwest range-plant symbols. U.S. Forest Serv. Pacific Northwest Forest and Range Exp. Sta. Res. Paper PNW-40. 121 p.
- Hall, F. C. 1970. An ecological classification proposal and its importance in land management. U.S. Forest Serv. Misc. Pub. 1147. p. 210-216.
- Hall, F. C. 1973. Plant communities of the Blue Mountains in eastern Oregon and southeastern Washington. U.S. Forest Serv. Pacific Northwest Region 6 area guide 3-1. 62 p.
- Hall, F. C. 1967. Vegetation-soil relations as a basis for resource management on the Ochoco National Forest of Central Oregon. Unpublished Ph. D. thesis. Oregon State Univ. Corvallis. 207 p.
- Hitchcock, C. L., and A. Cronquist. 1973. Flora of the Pacific Northwest. An illustrated manual. Univ. of Wash. Press. Seattle. 730 p.
- Layser, E. F. 1974. Vegetative classification: its application to forestry in the Northern Rocky Mountains. *J. Forest.* 72:354-357.
- Lemmon, P. E. 1956. A spherical densiometer for estimating forest overstory density. *Forest Sci.* 2:314-320.
- Lynott, R. E. 1966. Weather and climate of the Columbia River Gorge. *Northwest Sci.* 40(4):129-132.

- McLean, A. 1970. Plant communities of the Similkameen Valley, British Columbia and their relationships to soils. *Ecol. Monogr.* 40(4):403-424.
- McLean, A. and W. D. Holland. 1958. Vegetation zones and their relationship to the soils and climate of the upper Columbia valley. *Can. J. Plant Sci.* 38:328-345.
- MacLean, C. D. and C. L. Bolsinger. 1973. Estimating productivity on sites with a low stocking capacity. PNW-152, 18 p.
- Merkle, J. 1951. An analysis of the plant communities of Marys Peak, western Oregon. *Ecology* 32:618-640.
- Pfister, R. D. 1976. Land capability assessment by habitat types. In *America's renewable resource potential--1975: the turning point*, p. 312-325. Proc. 1975 Natl. Conv. Soc. Am. For. 503 p. Washington, D.C.
- Pfister, R. D., B. L. Kovalchik, S. F. Arno, R. C. Presby. 1974. Forest habitat types of Montana. U.S. Forest Serv. Intermountain Forest and Range Exp. Sta. and Region 1. 213 p.
- Poulton, C. E., D. P. Faulkner, and N. L. Martin. 1971. A procedural manual for resource analysis: application of ecology and remote sensing in the analysis of range watersheds. Final Report with Appendices. Range Manage. Program. Ore. State Univ. 93 p.
- Public Land Law Review Commission. 1970. One Third of the Nation's Land. U.S. Govt. Printing Office. 342 p.
- Shields, P. and L. D. Herman. 1970. Soil resource survey, city of The Dalles Watershed, Mt. Hood U.S. Forest Serv. Mt. Hood National Forest. 68 p.
- Sudworth, G. B. 1908. Forest trees of the Pacific slope. U.S. Forest Serv. 441 p.
- Swedberg, K. 1961. The coniferous ecotone of the east slope of the northern Oregon Cascades. Unpublished Ph.D. thesis. Ore. State Univ. Corvallis. 118 p.
- Swedberg, K. C. 1973. A transition coniferous forest in the Cascade Mountains of northern Oregon. *Am. Midl. Nat.* 89:1-25.

- Tansley, A. G. 1935. The use and abuse of vegetational concepts and terms. *Ecology* 16:284-307.
- Thilenius, J. F. 1968. The Quercus garryana forests of the Willamette Valley, Oregon. *Ecology* 49:1124-1133.
- U.S. Department of Agriculture. 1968. 22 plants poisonous to livestock in the Western States. U.S. Agricultural Info. Bul. No. 327. 64 p.
- U.S.D.A. Forest Service, Pacific Northwest Region. 1976. Draft environmental statement Badger-Jordan Planning Unit, Mt. Hood National Forest. 219 p.
- U.S. Soil Conservation Service, Soil Survey Staff. 1951. Soil survey manual. U.S.D.A. Handb. 18. 503 p.
- U.S. Weather Bureau. 1960. *Climates of the States, Oregon. Climatography of the United States.* pp. 841-860.
- Volland, L. A. 1976. Plant communities of the central Oregon pumice zone. USDA For. Serv. Pacific Northwest Region, R6 Area Guide 4-2. 110 p.
- Wells, F. G., and D. L. Peck. 1961. Geologic map of Oregon west of the 121st Meridian. U.S. Geol. Surv., Misc. Geol. Invest. Map I-325.
- West, N. E. 1964. An analysis of montane forest vegetation on the east flank of the central Oregon Cascades. Unpublished Ph.D. thesis. Oreg. State Univ. 272 p.
- Youngberg, C. T. and W. G. Dahms. 1970. Productivity indices for lodgepole pine on pumice soils. *J. of Forest.* 68:90-94.

APPENDICES

APPENDIX A. Table of average constancy values by community type for those species with 50 percent or greater constancy in any type.

No. of samples	<u>Quga/</u> <u>Putr/</u> <u>Agsp</u> c. t.	<u>Pipo-</u> <u>Quga/</u> <u>Putr/</u> <u>Feld</u> c. t.	<u>Pipo/</u> <u>Putr/</u> <u>Lule</u> c. t.	<u>Pipo/</u> <u>Putr/</u> <u>Luca</u> c. t.	<u>Abgr/</u> <u>Cage</u> c. t.	<u>Abgr/</u> <u>Pamy</u> c. t.	<u>Abgr/</u> <u>Pyse</u> c. t.	<u>Abpr</u> phase of the <u>Abgr/</u> <u>Pyse</u> c. t.	<u>Thpl/</u> <u>Libol</u> c. t.	<u>Tshe/</u> <u>Libol</u> c. t.	<u>Abam/</u> <u>Rula</u> c. t.	<u>Abam/</u> <u>Vasc</u> c. t.
	5	13	4	3	42	21	10	8	3	3	24	11
TREES												
<u>Quga</u>	100	100	75	100	87							
<u>Pipo</u>	40	100	100	100	78	85	70	12	33			
<u>Psme</u>					100	95	80	100	66	66	12	
<u>Abgr</u>				33	85	100	100	100	100	100	20	
<u>Laoc</u>						76	90	75	66		75	36
<u>Pico</u>						44	80	87		33	25	72
<u>Pimo</u>						23	70	75	33	100	62	
<u>Abpr</u>						19	30	100		66	50	9
<u>Pien</u>						28	70	87	100	100	83	72
<u>Abla</u>							90	50			83	100
<u>Abam</u>							30	37		66	100	100
<u>Tsme</u>							40	100		66	100	100
<u>Thpl</u>									100	100		
<u>Tshe</u>									33	100		
SHRUBS												
<u>Cein</u>	20	15	75									
<u>Putr</u>	100	84	50	66								
<u>Amal</u>	40				75							
<u>Bere</u>					73	19	10					
<u>Hodi</u>					56	14	10					
<u>Acci</u>					19	52	10		66			
<u>Rowou</u>					70	100	90	75	100	100		
<u>Spbel</u>					48	66	20	12		33		
<u>Bene</u>					12	19		12	33	66		
<u>Chumo</u>						19		12	33	100		
<u>Chme</u>						90	100	100	100		33	
<u>Pamy</u>						52	20	25	33	33	8	9
<u>Pyse</u>						28	90	50	33	100	91	45
<u>Pypi</u>						38	50	16	33	66	16	
<u>Rula</u>						4	10	50		66	91	72
<u>Libol</u>						38	10	62	100	100	8	
<u>Vame</u>								50		66	66	36
<u>Pymi</u>									66	33		
<u>Coca</u>									33	66		
<u>Vasc</u>											14	81
<u>Symoh</u>	20	7		33	90	90	100	87	33	66	12	

## APPENDIX A. (Continued)

	<u>Quga/Putr/Agsp</u> c. t.	<u>Pipo-Quga/Putr/Feld</u> c. t.	<u>Pipo/Putr/Lule</u> c. t.	<u>Pipo/Putr/Luca</u> c. t.	<u>Abgr/Cage</u> c. t.	<u>Abgr/Pamy</u> c. t.	<u>Abgr/Pyse</u> c. t.	<u>Abpr</u> phase of the <u>Abgr/Pyse</u> c. t.	<u>Thpl/Libol</u> c. t.	<u>Tshe/Libol</u> c. t.	<u>Abam/Rula</u> c. t.	<u>Abam/Vasc</u> c. t.
No. of samples	5	13	4	3	42	21	10	8	3	3	24	11
FORBS												
<u>Lapa</u>	60	7										
<u>Plte</u>	60	53										
<u>Plma</u>	80	84	25									
<u>Andi</u>	60	15	25									
<u>Trdu</u>	40	53	50									
<u>Hial 2</u>	60	76	100	33								
<u>Lotr</u>	60	100	100	100								
<u>Lone</u>	20	76	100	100								
<u>Luca</u>	100	92	25	100								
<u>Mamy</u>	20	53	75	33								
<u>Acmi</u>	80	100	100	33	10							
<u>Aghe</u>	40	53	25	33								
<u>Alac</u>	60	46	50	66								
<u>Bade</u>	100	100	100	66								
<u>Cami</u>	20	15	50	66								
<u>Cogr 2</u>	20	38	25	66								
<u>Fralc 2</u>	80	61	25	33								
<u>Cosp</u>	60	84		33								
<u>Lonu</u>	60	46		33								
<u>Agre</u>		7	100	66								
<u>Cama</u>		30	100	33								
<u>Clrh</u>		7	100	66								
<u>Liru</u>		15	25	66								
<u>Magr</u>		30	25	66								
<u>Lule</u>		38	100									
<u>Lule 2</u>			50									
<u>Mopc</u>	40	61	75	33	29							
<u>Viam</u>	60	30	25	33	12	7						
<u>Haun</u>		76	50	100	43							
<u>Hisc</u>		25	33		46							
<u>Apanp</u>		7			63							
<u>Arco</u>					46	38						
<u>Lula</u>						4	30	50				37
<u>Luna</u>							40	50				
<u>Hial</u>		15	75		75	52	80	87		66		12
<u>Arma 3</u>					41	76	100	87	33			
<u>Trla</u>					26	42			66	33		8



APPENDIX B. Table of average dominance/cover values by community type for those species with 50 percent or greater constancy in any type.

No. of samples	<u>Quga</u> / <u>Putr</u> / <u>Agsp</u> c. t.	<u>Pipo</u> - <u>Quga</u> / <u>Putr</u> / <u>Feid</u> c. t.	<u>Pipo</u> - <u>Putr</u> / <u>Lule</u> c. t.	<u>Pipo</u> / <u>Putr</u> / <u>Luca</u> c. t.	<u>Abgr</u> / <u>Cage</u> c. t.	<u>Abgr</u> / <u>Pamy</u> c. t.	<u>Abgr</u> / <u>Pyse</u> c. t.	<u>Abpr</u> phase of the <u>Abgr</u> / <u>Pyse</u> c. t.	<u>Thpl</u> / <u>Libol</u> c. t.	<u>Tshe</u> / <u>Libol</u> c. t.	<u>Abam</u> / <u>Rula</u> c. t.	<u>Abam</u> / <u>Vasc</u> c. t.
	5	13	4	3	42	21	10	8	3	3	24	11
TREES												
<u>Quga</u>	8/4	7/3	4/1	3/1	3/1							
<u>Pipo</u>	2/1	8/4	8/5	8/5	4/1	4/2	3/2	1/1	2/1			
<u>Psme</u>					8/5	6/3	5/2	6/2	4/1	4/2	1/1	
<u>Abgr</u>				1/1	4/2	7/4	8/4	6/4	6/2	3/1	1/1	
<u>Laoc</u>						3/1	3/2	2/1	2/1		3/2	2/1
<u>Pico</u>						2/1	4/2	3/2		1/1	1/1	4/2
<u>Pimo</u>						1/1	3/1	3/1	1/1	6/3	2/1	
<u>Abpr</u>						1/1	1/1	8/4		3/1	3/1	1/1
<u>Pien</u>						1/1	3/1	2/1	7/4	5/2	4/2	3/2
<u>Abla</u>							4/2	2/1			4/2	5/2
<u>Abam</u>							1/1	1/1			7/3	6/3
<u>Tsme</u>							1/1	6/2	2/1	4/2	7/4	7/4
<u>Thpl</u>										8/5	5/3	
<u>Tshe</u>									1/1	8/4		
SHRUBS												
<u>Cein</u>	1/1	1/1	4/1									
<u>Putr</u>	8/2	5/2	3/1	2/1								
<u>Amal</u>		1/1			3/1							
<u>Bere</u>					3/1	1/1						
<u>Hodi</u>					3/1	1/1	1/1					
<u>Acci</u>					1/1	2/1	1/1		5/2			
<u>Rowou</u>					3/1	4/1	2/1	3/1	5/1	5/1		
<u>Spbel</u>					2/1	3/1	1/1	1/1		1/1		
<u>Bene</u>					1/1	1/1	1/1	1/1	2/1	3/1		
<u>Chumo</u>						2/1		1/1	1/1	1/1		
<u>Chme</u>						3/1	4/1	2/1	3/1		2/1	
<u>Pamy</u>						1/1	1/1	1/1	1/1	1/1	1/1	1/1
<u>Pyse</u>						1/1	3/1	1/1	1/1	3/1	3/1	1/1
<u>Pypi</u>						1/1	2/1	1/1	1/1	3/1	1/1	
<u>Libol</u>						2/1	1/1	3/1	3/1	4/1	1/1	
<u>Rula</u>						1/1	1/1	2/1		2/1	6/2	4/1
<u>Vame</u>								3/1		1/1	4/1	1/1
<u>Pymi</u>									3/1	1/1		
<u>Coca</u>									2/1	2/1		
<u>Vasc</u>										1/1	2/1	6/2
<u>Symoh</u>	1/1		1/1		1/1	5/1	3/1	4/1	3/1	1/1	1/1	

## APPENDIX B. (Continued)

No. of samples	<u>Quga/Putr/Agsp</u> c. t.	<u>Pipo-Quga/Putr/Feid</u> c. t.	<u>Pipo-Putr/Lule</u> c. t.	<u>Pipo/Putr/Luca</u> c. t.	<u>Abgr/Cage</u> c. t.	<u>Abgr/Pamy</u> c. t.	<u>Abgr/Pyse</u> c. t.	Abpr phase of the <u>Abgr/Pyse</u> c. t.	<u>Thpl/Libol</u> c. t.	<u>Tshe/Libol</u> c. t.	<u>Abam/Rula</u> c. t.	<u>Abam/Vasc</u> c. t.
FORBS												
<u>Lapa</u>	3/1	1/1										
<u>Plte</u>	3/1	2/1										
<u>Plma</u>	4/1	4/1	1/1									
<u>Andi</u>	2/1	1/1	1/1									
<u>Trdu</u>	1/1	1/1	1/1									
<u>Hial 2</u>	2/1	4/1	5/1	4/1								
<u>Lotr</u>	2/1	4/1	5/1	4/1								
<u>Lone</u>		3/1	7/2	5/1								
<u>Luca</u>	6/2	5/2	1/1	8/4								
<u>Mami</u>		3/1	3/1	1/1								
<u>Acmi</u>	4/1	5/1	5/1	5/1	1/1							
<u>Aghe</u>	2/1	3/1	1/1	1/1								
<u>Alac</u>	5/1	2/1	2/1	2/1								
<u>Bade</u>	7/3	6/2	6/1	5/1								
<u>Cami</u>	1/1	1/1	2/1	3/1								
<u>Cogr 2</u>	1/1	1/1	1/1	1/1								
<u>Fralc 2</u>	3/1	2/1	1/1	2/1								
<u>Cosp</u>	2/1	3/1		1/1								
<u>Lonu</u>	2/1	2/1		2/1								
<u>Agre</u>		1/1	4/1	4/1								
<u>Cama</u>		1/1	2/1	1/1								
<u>Clrh</u>		1/1	5/1	2/1								
<u>Liru</u>		1/1	1/1	2/1								
<u>Magr</u>	1/1		1/1	2/1								
<u>Lule</u>		1/1	7/2									
<u>Lule 2</u>			2/1									
<u>Mope</u>	1/1	2/1	1/1	1/1	1/1							
<u>Viam</u>	3/1	2/1	1/1	1/1								
<u>Haun</u>		2/1	3/1	3/1	2/1							
<u>Hisc</u>					2/1							
<u>Apanp</u>		1/1			3/1							
<u>Arco</u>					1/1	1/1						
<u>Lula</u>						1/1	1/1	3/1			2/1	2/1
<u>Luna</u>							2/1	1/1				
<u>Hial</u>		1/1	3/1		4/1	1/1	3/1	3/1		1/1	1/1	
<u>Arma 3</u>					2/1	1/1	5/1	4/1		1/1		
<u>Trla</u>					2/1	2/1		1/1	3/1	1/1	1/1	
<u>Casc 2</u>						3/1	3/1	3/1	2/1			

## APPENDIX B. (Continued)

	<u>Quga/Putr/Agsp</u> c. t.	<u>Pipo-Quga/Putr/Feid</u> c. t.	<u>Pipo/Putr/Lule</u> c. t.	<u>Pipo/Putr/Luca</u> c. t.	<u>Abgr/Cage</u> c. t.	<u>Abgr/Pamy</u> c. t.	<u>Abgr/Pyse</u> c. t.	<u>Abpr phase of the Abgr/Pyse</u> c. t.	<u>Thp1/Libol</u> c. t.	<u>Tshe/Libol</u> c. t.	<u>Abam/Rula</u> c. t.	<u>Abam/Vasc</u> c. t.
No. of samples	5	13	4	3	42	21	10	8	3	3	24	11
FORBS (Continued)												
<u>Goob</u>						1/1	1/1	1/1	2/1	1/1	1/1	
<u>Clun</u>						1/1	1/1	4/1	2/1	3/1	2/1	
<u>Anor</u>						3/1	5/1	5/1	5/1	3/1	5/1	
<u>Actr</u>						1/1	1/1	3/1	2/1	1/1	1/1	
<u>Smst</u>						2/1	2/1	1/1	6/2	4/1	1/1	
<u>Trov</u>						1/1	2/1	2/1	4/1	2/1	1/1	
<u>Vasi</u>						1/1	1/1	1/1	1/1		2/1	4/1
<u>Popuc</u>						1/1	2/1	1/1			1/1	1/1
<u>Arla</u>							1/1	2/1			3/1	1/1
<u>Mipe</u>									2/1	3/1	1/1	1/1
<u>Atfi</u>									4/1	1/1		
<u>Vevi</u>											1/1	2/1
<u>Loma</u>												4/1
<u>Asfoa</u>												3/1
<u>Frveb</u>		1/1	2/1	1/1	3/1	1/1	2/1	1/1		1/1		1/1
<u>Osch</u>		1/1		1/1	4/1	1/1	1/1	2/1				
GRAMINOIDS												
<u>Agsp</u>	6/2	3/1										
<u>Brmo</u>	4/1	3/1	1/1									
<u>Brte</u>	7/5	8/4	5/2									
<u>Feid</u>	3/1	7/3	2/1	3/1								
<u>Kocr</u>	3/1	5/2	5/1	5/1								
<u>Posa</u>	4/1	4/1	3/1	1/1								
<u>Sihy</u>	2/1	3/1	6/1	4/1								
<u>Stoc</u>	2/1	1/1	4/1	4/1								
<u>Aica</u>		3/1	3/1	2/1								
<u>Femi</u>		3/1	6/2	4/1								
<u>Trca</u>					1/1							
<u>Mebu</u>					3/1							
<u>Feoc</u>					3/1	1/1	1/1	1/1				
<u>Cage</u>	1/1	1/1			4/2							
<u>Luhi</u>											1/1	3/1

## APPENDIX C. Scientific name, common name and abbreviation of plants cited in text and tables.

Abbr.	Scientific name	Common name
TREES		
<u>Abam</u>	<u>Abies amabilis</u>	silver fir
<u>Abgr</u>	<u>Abies grandis</u>	grand fir
<u>Abla</u>	<u>Abies lasiocarpa</u>	subalpine fir
<u>Abpr</u>	<u>Abies procera</u>	noble fir
<u>Juoc</u>	<u>Juniperus occidentalis</u>	western juniper
<u>Laoc</u>	<u>Larix occidentalis</u>	western larch
<u>Pien</u>	<u>Picea engelmannii</u>	Engelmann spruce
<u>Pico</u>	<u>Pinus contorta</u>	lodgepole pine
<u>Pimo</u>	<u>Pinus monticola</u>	western white pine
<u>Pipo</u>	<u>Pinus ponderosa</u>	ponderosa pine
<u>Potr 2</u>	<u>Populus trichocarpa</u>	black cottonwood
<u>Psme</u>	<u>Pseudotsuga menziesii</u>	Douglas-fir
<u>Quga</u>	<u>Quercus garryana</u>	Oregon oak
<u>Thpl</u>	<u>Thuja plicata</u>	western red cedar
<u>Tshe</u>	<u>Tsuga heterophylla</u>	western hemlock
<u>Tsme</u>	<u>Tsuga mertensiana</u>	mountain hemlock
SHRUBS		
<u>Acci</u>	<u>Acer circinatum</u>	vine maple
<u>Alsi</u>	<u>Alnus sinuata</u>	sitka alder
<u>Amal</u>	<u>Amelanchier alnifolia</u>	serviceberry
<u>Arne</u>	<u>Arctostaphylos nevadensis</u>	pinemat manzanita
<u>Artrs</u>	<u>Artemisia tridentata</u> ssp. <u>vaseyana</u> form <u>spicaformis</u>	subalpine big sagebrush
<u>Bene</u>	<u>Berberis nervosa</u>	Cascade Oregongrape
<u>Bere</u>	<u>Berberis repens</u>	low Oregongrape
<u>Cein</u>	<u>Ceanothus integerrimus</u>	deerbrush
<u>Ceve</u>	<u>Ceanothus velutinus</u> var. <u>velutinus</u>	snowbrush
<u>Chme</u>	<u>Chimaphila menziesii</u>	little pipsissewa
<u>Chumo</u>	<u>Chimaphila umbellata</u> var. <u>occidentalis</u>	western pipsissewa
<u>Hodi</u>	<u>Holodiscus discolor</u>	oceanspray
<u>Libol</u>	<u>Linnaea borealis</u> var. <u>longiflora</u>	twinflower
<u>Pamy</u>	<u>Pachistima myrsinites</u>	pachistima
<u>Prem</u>	<u>Prunus emarginata</u> var. <u>emarginata</u>	bitter cherry
<u>Putr</u>	<u>Purshia tridentata</u>	bitterbrush
<u>Pymi</u>	<u>Pyrola minor</u>	snowline pyrola
<u>Pypi</u>	<u>Pyrola picta</u>	whitevein pyrola
<u>Pyses</u>	<u>Pyrola secunda</u> var. <u>secunda</u>	sidebells pyrola
<u>Rowou</u>	<u>Rosa woodsii</u> var. <u>ultramontana</u>	rose
<u>Rula</u>	<u>Rubus lasiococcus</u>	dwarf bramble
<u>Spbel</u>	<u>Spirea betulifolia</u> var. <u>lucida</u>	shinelyleaf spirea
<u>Symoh</u>	<u>Symphoricarpos mollis</u> var. <u>hesperius</u>	creeping snowberry
<u>Vame</u>	<u>Vaccinium membranaceum</u>	big huckleberry
<u>Vasc</u>	<u>Vaccinium scoparium</u>	grouse huckleberry

## APPENDIX C. (Continued)

Abbr.	Scientific name	Common name
FORBS		
<u>Acmi</u>	<u>Achillea millefolium</u> ssp. <u>lanulosa</u>	yarrow
<u>Actr</u>	<u>Achlys triphylla</u>	vanilla leaf
<u>Aghe</u>	<u>Agoseris heterophylla</u>	annual agoseris
<u>Agre</u>	<u>Agoseris retrorsa</u>	spear-leaf agoseris
<u>Alac</u>	<u>Allium acuminatum</u>	tapertip onion
<u>Anor</u>	<u>Anemone oregana</u>	Oregon anemone
<u>Apanp</u>	<u>Apocynum androsaemifolium</u> var. <u>pumilum</u>	low dogbane
<u>Arma</u> 3	<u>Arenaria macrophylla</u>	bigleaf sandwort
<u>Arco</u>	<u>Arnica cordifolia</u>	heartleaved arnica
<u>Arla</u>	<u>Arnica latifolia</u>	broadleaf arnica
<u>Asfoa</u>	<u>Aster foliaceus</u> var. <u>apricus</u>	leafybract aster
<u>Afti</u>	<u>Athyrium filix-femina</u>	ladyfern
<u>Bade</u>	<u>Balsamorhiza deltoidea</u>	deltoid balsamroot
<u>Brhy</u>	<u>Brodiaea hyacinthina</u>	hyacinth brodiaea
<u>Cama</u>	<u>Calochortus macrocarpus</u>	sagebrush mariposa
<u>Casc</u> 2	<u>Campanula scouleri</u>	Scouler bellflower
<u>Cami</u>	<u>Castilleja miniata</u>	scarlet paintbrush
<u>Carh</u>	<u>Clarkia rhomboidea</u>	rhombic-petaled clarkia
<u>Clun</u>	<u>Clintonia uniflora</u>	queencup
<u>Cosp</u>	<u>Collinsia sparsiflora</u>	few flowered collinsia
<u>Cogr</u> 2	<u>Collomia grandiflora</u>	largeflower collomia
<u>Coca</u>	<u>Cornus canadensis</u>	bunchberry dogwood
<u>Frveb</u>	<u>Fragaria vesca</u> var. <u>bracteata</u>	woods strawberry
<u>Fr alc</u> 2	<u>Frasera albicaulis</u> var. <u>columbiana</u>	white stem frasera
<u>Goob</u>	<u>Goodyera oblongifolia</u>	western rattlesnake plantain
<u>Haun</u>	<u>Habenaria unalascens</u>	Alaska reinorchid
<u>Hial</u> 2	<u>Hieracium albertinum</u>	western hawkweed
<u>Hial</u>	<u>Hieracium albiflorum</u>	white hawkweed
<u>Hisc</u>	<u>Hieracium scouleri</u>	woolyweed
<u>Lapa</u>	<u>Lathyrus pauciflorus</u>	fewflowered peavine
<u>Ligr</u>	<u>Ligusticum grayi</u>	Gray's licoriceroot
<u>Lipa</u>	<u>Lithophragma parviflora</u>	small flower woodland star
<u>Liru</u>	<u>Lithospermum ruderale</u>	western gromwell
<u>Loma</u>	<u>Lomatium martindalei</u>	few-fruited lomatium
<u>Lonu</u>	<u>Lomatium nudicaule</u>	barestem lomatium
<u>Lotr</u>	<u>Lomatium triternatum</u>	nine-leaved lomatium
<u>Lode</u>	<u>Lotus denticulatus</u>	meadow lotus
<u>Lone</u>	<u>Lotus nevadensis</u>	Nevada deervetch
<u>Luna</u>	<u>Lunia nardosmia</u>	silvercrown lunia
<u>Luca</u>	<u>Lupinus caudatus</u>	tailcup lupine
<u>Lula</u>	<u>Lupinus latifolius</u>	broadleaved lupine
<u>Lule</u> 2	<u>Lupinus lepidus</u>	prairie lupine
<u>Lule</u>	<u>Lupinus leucophyllus</u>	velvet lupine
<u>Magr</u>	<u>Madia gracilis</u>	common tarweed
<u>Mami</u>	<u>Madia minima</u>	small head tarweed
<u>Mipe</u>	<u>Mitella pentandra</u>	fivestamen miterwort
<u>Mope</u>	<u>Montia perfoliata</u>	miner's lettuce

## APPENDIX C. (Continued)

Abbr.	Scientific name	Common name
FORBS (Continued)		
<u>Orhi</u>	<u>Orthocarpus hispidus</u>	hairy owlcover
<u>Osch</u>	<u>Osmorhiza chilensis</u>	mountain sweetroot
<u>Plte</u>	<u>Plagiobothrys tenellus</u>	slender popcornflower
<u>Plma</u>	<u>Plectris macrocera</u>	longhorn plectris
<u>Popuc</u>	<u>Polemonium pulcherrimum</u> var. <u>calycinum</u>	skunkleaf polemonium
<u>Smst</u>	<u>Smilicina stellata</u>	starry solomonplume
<u>Trdu</u>	<u>Tragopogon dubius</u>	yellow salsify
<u>Trla</u>	<u>Trientalis latifolia</u>	western starflower
<u>Trov</u>	<u>Trillium ovatum</u>	white trillium
<u>Vasi</u>	<u>Valeriana sitchensis</u>	sitka valerian
<u>Vevi</u>	<u>Veratrum viride</u>	American falsehellebore
<u>Viam</u>	<u>Vicia americana</u>	American vetch
<u>Zive</u>	<u>Zigadenus venosus</u>	meadow deathcamas
GRAMINOIDES		
<u>Agsp</u>	<u>Agropyron spicatum</u>	bluebunch wheatgrass
<u>Aica</u>	<u>Aira caryophylla</u>	silver hairgrass
<u>Brmo</u>	<u>Bromus mollis</u>	soft brome
<u>Brte</u>	<u>Bromus tectorum</u>	cheatgrass
<u>Daun</u>	<u>Danthonia unispicata</u>	onespike oatgrass
<u>Feid</u>	<u>Festuca idahoensis</u>	Idaho fescue
<u>Femi</u>	<u>Festuca microstachys</u>	small fescue
<u>Feoc</u>	<u>Festuca occidentalis</u>	western fescue
<u>Hoge</u>	<u>Hordeum geniculatum</u>	Mediterranean barley
<u>Kocr</u>	<u>Koeleria cristata</u>	prairie Junegrass
<u>Posa</u>	<u>Poa sandbergii</u>	Sandberg's bluegrass
<u>Sihy</u>	<u>Sitanion hystrix</u>	bottlebrush squirreltail
<u>Stoc</u>	<u>Stipa occidentalis</u>	western needlegrass
<u>Trca</u>	<u>Trisetum canescens</u>	tall trisetum
<u>Cage</u>	<u>Carex geyeri</u>	elk sedge
<u>Luhi</u>	<u>Luzula hitchcockii</u>	smooth woodrush

## APPENDIX D

## Key to Forested Community Types

1. a. Quercus garryana most dominant tree, Pinus ponderosa may be occasionally represented. The general appearance is that of an open woodland and not a closed forest. QUERCUS GARRYANA/PURSHIA TRIDENTATA/AGROPYRON SPICATUM c. t.
1. b. Conifers dominant or codominant with Quercus garryana; form a closed forest.
  2. a. Pinus ponderosa only conifer present or other conifer species represented only by one or two individuals.
    3. a. Quercus garryana equal or subequal to Pinus ponderosa. PINUS PONDEROSA-QUERCUS GARRYANA/PURSHIA TRIDENTATA/FESTUCA IDAHOENSIS c. t.
    3. b. Quercus garryana definitely subordinate to Pinus ponderosa.
      4. a. Lupinus leucophyllus conspicuous, L. caudatus and Pinus ponderosa regeneration sparse or lacking. PINUS PONDEROSA/PURSHIA TRIDENTATA/LUPINUS LEUCOPHYLLUS c. t.
      4. b. Lupinus leucophyllus absent or much less common than L. caudatus; Pinus ponderosa regeneration generally present. PINUS PONDEROSA/PURSHIA TRIDENTATA/LUPINUS CAUDATUS c. t.
  2. b. Other conifer species present, with or without Pinus ponderosa.
    5. a. Quercus garryana still present in stand although often dwarfed and shrubby. ABIES GRANDIS/CAREX GEYERI c. t.
    5. b. Quercus garryana absent from stand. Conifers common.
      6. a. Thuja plicata common.
        7. a. Reproduction dominated by Thuja plicata, soil often wet and marshy. THUJA PLICATA/LINNAEA BOREALIS c. t.
        7. b. Reproduction dominated by Tsuga heterophylla, soil surface not wet or marshy. TSUGA HETEROPHYLLA/LINNAEA BOREALIS c. t.
      6. b. Thuja plicata absent. Other conifers common.
        8. a. Tsuga mertensiana, Abies lasiocarpa and A. amabilis all absent. Abies grandis and/or Pseudotsuga menziesii and/or Pinus ponderosa common. ABIES GRANDIS/PACHISTIMA MYRSINITES c. t.

## APPENDIX D (Continued)

8. b. Tsuga mertensiana and/or Abies lasiocarpa and/or A. amabilis present.
9. a. Reproduction dominated by Abies grandis and/or A. procera.
10. a. A. grandis reproduction clearly most dominant. ABIES GRANDIS/PYROLA SECUNDA c. t.
10. b. A. grandis reproduction equaled or exceeded by A. procera reproduction. ABIES PROCERA PHASE OF THE ABIES GRANDIS/PYROLA SECUNDA c. t.
9. b. Reproduction dominated by A. amabilis and/or Tsuga mertensiana.
11. a. Vaccinium scoparium clearly dominates ground vegetation and/or elevation 1700 meters or higher. ABIES AMABILIS/VACCINIUM SCOPARIUM c. t.
11. b. Rubus lasiococcus dominant over Vaccinium scoparium or elevations less than 1700 meters. ABIES AMABILIS/RUBUS LASIOCOCCUS c. t.

## APPENDIX E

Name, authorship, family, and brief description of the ecology of all  
vascular plants observed in the Badger Allotment.

## TREES

Abies amabilis (Dougl.) Forbes

Pinaceae, Pacific silver fir; found at higher elevations.

Abies grandis (Dougl.) Forbes

Pinaceae, grand fir; common tree, often found as saplings in fairly deep shade from moderate to high elevations - trees in some areas may not show typical A. grandis features. A. grandis and A. concolor freely interbreed but north of Mt. Jefferson taxonomists refer to them as Abies grandis. Some individual trees may look more like Abies concolor.

Abies lasiocarpa (Hook.) Nutt.

Pinaceae, subalpine fir; common from middle elevations to subalpine areas, often in relatively moist areas.

Abies procera Rehder

Pinaceae, noble fir; not usually common in large numbers or in pure stands but individuals are scattered throughout higher elevations, and dominate some stands.

Juniperus occidentalis Hook.

Cupressaceae, western juniper; not common, small tree on dry sites.

Larix occidentalis Nutt.

Pinaceae, western larch; common seral species that often comes in after a fire.

Picea engelmannii Parry var. glabra Goodm.

Pinaceae, Engelmann spruce; middle to higher - subalpine elevations, frequently in swampy situations.

Pinus albicaulis Engelm.

Pinaceae, whitebark pine; at or near timberline especially on windswept ridges where often it grows deformed.

Pinus contorta Dougl. var. latifolia Engelm.

Pinaceae, lodgepole pine; often in disturbed areas usually at middle to high elevations.

Pinus monticola Dougl.

Pinaceae, western white pine; never in pure stands in this area but mixed with other conifers from middle to upper elevations.

Pinus ponderosa Dougl.

Pinaceae, ponderosa pine; common from low to fairly high elevations, often on south slopes at higher elevations.

Populus tremuloides Michx.

Salicaceae, quaking aspen; often a large shrub or small tree frequently near water or springs and seeps.

Populus trichocarpa T. & G.

Salicaceae, black cottonwood; found along streams, often in water, may reach 30 m+ in height.

Pseudotsuga menziesii (Mirbel) Franco var. menziesii

Pinaceae, coastal Douglas-fir; common, especially at middle elevations, generally a long-term successional species in this area.

Quercus garryana Dougl.

Fagaceae, Oregon white oak; common low elevation tree.

Thuja plicata Donn.

Cupressaceae, western redcedar; found in moist areas, usually along streams. When found in upland situation it indicates a perched water table. Usually found below 1311 m except on south slopes where it grows somewhat higher in elevation.

Tsuga heterophylla (Raf.) Sarg.

Pinaceae, western hemlock; not common - found in relatively moist, protected valleys.

Tsuga mertensiana (Bong.) Carr.

Pinaceae, mountain hemlock; common at middle to high elevations.

#### SHRUBS

Acer circinatum Pursh

Aceraceae, vine maple; shrub to small tree usually in moist areas.

Alnus incana (L.) Moench var. occidentalis (Dippel) Hitchc.

Betulaceae, mountain alder; moist to wet places often along streams.

Alnus sinuata (Rege1) Rydb.

Betulaceae, Sitka alder; forms shrub communities in moist places often on steep slopes where snowpack movement takes place.

Amelanchier alnifolia Nutt.

Rosaceae, Saskatoon serviceberry; fairly common, open woods and slopes low to high elevation.

Arctostaphylos nevadensis Gray

Ericaceae, pinemat manzanita; common, especially on dry middle to high elevation slopes.

Arctostaphylos patula Greene

Ericaceae, greenleaf manzanita; common in openings and along roadsides.

Artemisia tridentata Nutt. ssp. vaseyana form spiciformis (Osterhout) Beetle

Compositae, subalpine big sagebrush; along open high elevation ridges, along Cold Point.

Berberis aquifolium Pursh

Berberidaceae, tall Oregongrape; not usually very tall in this area, leaves are shiny and more numerous than B. repens but less than B. nervosa.

Berberis nervosa Pursh

Berberidaceae, Cascade Oregongrape; found at middle elevations and higher; often with grand fir.

Berberis repens Lindl.

Berberidaceae, low Oregongrape; lower to middle elevations, generally in openings or sparsely covered woodlands.

Castanopsis chrysophylla (Dougl. ) D. C.

Fagaceae, golden chinkapin; dry open sites to fairly thick woods; may even become a small tree.

Ceanothus integerrimus H. & A.

Rhamnaceae, deerbrush or wild lilac; common at middle to lower elevations in open disturbed areas.

Ceanothus prostratus Benth.

Rhamnaceae, squawcarpet or mahala mat; common at middle elevations.

Ceanothus sanguineus Pursh

Rhamnaceae, redstem ceanothus; often found in roadcuts near streams or in openings within the forest.

Ceanothus velutinus Dougl. var. velutinus

Rhamnaceae, snowbrush; frequently found on exposed ridges at higher elevations.

Chimaphila menziesii (R. Br. ) Spreng.

Ericaceae, little pipsissewa; usually found in shaded conifer forests; widespread but rarely abundant. Smaller than and not as common as C. umbellata var. occidentalis.

Chimaphila umbellata (L. ) Bart var. occidentalis (Rydb. ) Blake

Ericaceae, western pipsissewa; at middle to upper elevations often in deep shade.

Chrysothamnus nauseosus (Pall. ) Britt.

Compositae, gray rabbitbrush; found on dry rocky sites often with juniper.

Cornus nutallii Aud.

Cornaceae, Pacific dogwood; may become treelike - usually found near streams, springs or seeps.

Gaultheria ovatifolia Gray

Ericaceae, Oregon wintergreen; small trailing subshrub in moist to fairly dry woods, not common.

Haplopappus greenei Gray

Compositae, Greenes goldenweed; found at higher elevations often on exposed ridges.

Holodiscus discolor (Pursh) Maxim.

Rosaceae, oceanspray; common shrub often on south slopes at mid-elevations.

Juniperus communis L. var. montana Ait.

Cupressaceae, mountain juniper; a prostrate shrub often in exposed areas.

Linnaea borealis L. var. longiflora Torr.

Caprifoliaceae, twinflower; woods, middle to upper elevations.

Lonicera ciliosa (Pursh) D. C.

Caprifoliaceae, trumpet honeysuckle; a climbing vine often found growing up trees and tall shrubs along streams.

Lonicera dioica L. var. glaucescens (Rydb.) Butters

Caprifoliaceae, glaucous honeysuckle; a twining vine that often is tightly wound around pole-sized trees. The underleaf is bluish-white (glaucous) because of a fine waxy removable powder.

Lonicera involucrata (Rich.) Banks var. involucrata

Caprifoliaceae, bearberry honeysuckle; common on exposed high ridges.

Pachistima myrsinites (Pursh) Raf.

Celastraceae, Pachistima; common at most elevations except where very dry.

Philadelphus Lewisii Pursh

Hydrangeaceae, mockorange, often on rocky outcrops.

Phyllodoce emeptriformis (Sw.) D. Don

Ericaceae, red mountainheath; at higher elevations on Lookout Mountain.

Prunus emarginata (Dougl.) Walp. var. emarginata

Rosaceae, bitter cherry; common on slopes and ridges up to subalpine areas.

Prunus virginiana L. var. melanocarpa (Nels.) Sarg.

Rosaceae, common chokecherry; sometimes found near streams or in mesic habitats.

Purshia tridentata (Pursh) D C.

Rosaceae, bitterbrush; common at middle and lower elevations.

Pyrola aphylla Smith

Ericaceae, leafless pyrola; in dense forest; a saprophytic plant without green leaves.

Pyrola minor L.

Ericaceae, snowline pyrola; found in moist, cool woods.

Pyrola picta Smith

Ericaceae, whitevein pyrola; common at middle and higher elevations; if lower, in areas of moist woods, especially on north slopes.

Pyrola secunda L. var. secunda

Ericaceae, sidebells pyrola; found in moist woods, and very common at mid to upper elevations.

Pyrola uniflora L.

Ericaceae, woodnymph pyrola; open to dense woods where moist; found next to streams.

Rhododendron albiflorum Hook.

Ericaceae, Cascades azalae; moist areas and streambanks at higher elevations.

Ribes lacustre (Pers.) Poir.

Grossulariaceae, prickly currant; common at middle and higher elevations, especially near water.

Ribes sanguineum Pursh

Grossulariaceae, redflower currant; open to wooded, dry to moist valleys at lower elevations.

Rosa nutkana Presl. var. hispida Fern.

Rosaceae, bristly Nootka rose; species identification not definite. Found on Lookout Mountain in dense moist mountain hemlock forest.

Rosa woodsii Lindl. var. ultramontana (Wats.) Gepp.

Rosaceae, rose; common at middle elevations; often dwarfed under heavy shade.

Rubus lasiococcus Gray

Rosaceae, dwarf bramble; moist to dry woods at higher elevations, often in deep shade.

Rubus parviflorus Nutt.

Rosaceae, thimbleberry; not too common in area, usually found near streams.

Rubus ursinus Cham. and Schlect var. macropetalus (Dougl.) Brown

Rosaceae, trailing blackberry; common especially in openings in the forest.

Salix scouleriana Barratt

Salicaceae, Scouler willow; common, usually near moist streams or in moist woods.

Sambucus cerulea Raf. var. cerulea

Carprifoliaceae, blue elderberry; common along roads and near base of rock outcrops.

Sorbus scopulina Greene

Rosaceae, Greene's mountain-ash; may become a small tree, upper elevations.

Spiraea betulifolia Pall. var. lucida (Dougl.)

Rosaceae, shiny leaf spirea; common, especially with Douglas-fir and grand fir.

Symphoricarpos mollis Nutt. var. hesperius (G. N. Jones) Cronq.

Caprifoliaceae, creeping snowberry; woods and open slopes up to middle elevations, very common.

Symphoricarpos oreophilus Gray

Caprifoliaceae, mountain snowberry; found on exposed slopes at higher elevations.

Tetradymia canescens D C.

Compositae, gray horsebrush; scattered at lower elevations in relatively dry areas.

Vaccinium membranaceum Dougl.

Ericaceae, big huckleberry; common at higher elevations often under shade or in small openings.

Vaccinium ovalifolium Smith

Ericaceae, oval leaf huckleberry; moist areas along streams - not common.

Vaccinium scoparium Leiberg

Ericaceae, grouse huckleberry; occurs in patches in subalpine woods and on open slopes at high elevations.

## FORBS

Achillea millefolium L. ssp. lanulosa (Nutt.) Piper  
Compositae, yarrow; very common and widespread - probably two varieties depending on elevation.  
Var. lanulosa lowland to middle elevations. Var. alpicola at subalpine elevations.

Achlys triphylla (Smith) D. C.  
Berberidaceae, vanilla leaf; wooded areas often fairly high elevations in moderate to deep shade.

Actaea rubra (Ait.) Willd.  
Ranunculaceae, baneberry; moist woods, often near streams.

Adenocaulon bicolor Hook.  
Compositae, adenocaulon, pathfinder or trail-plant; found in moist shady woods.

Agastache urticifolia (Benth.) Kuntze var. urticifolia  
Labiatae, nettleleaf giant hyssop; wet to boggy areas.

Agoseris heterophylla (Nutt.) Greene var. heterophylla  
Compositae, annual agoseris; common in open, dry places at lower elevations.

Agoseris retrorsa (Benth.) Greene  
Compositae, spear-leaf agoseris; common in open dry woods such as the ponderosa pine-oak areas.

Allium acuminatum Hook.  
Liliaceae, tapertip onion; dry rocky outcrops and into dry forests; flowers may be either purple or white.

Allium validum Wats.  
Liliaceae, Pacific onion; very moist boggy areas.

Anaphalis margaritacea (L.) B. & H.  
Compositae, common pearl-everlasting; common, often along roads.

Anemone oregana Gray var. oregana  
Ranunculaceae, Oregon anemone; moist woods to open hillsides, often in deep shade.

Antennaria dimorpha (Nutt.) T. & G.  
Compositae, low pussytoes; lower elevations.

Antennaria luzuloides T. & G.  
Compositae, woodrush pussytoes; often along roads at middle elevations.

Antennaria racemosa Hook.  
Compositae, raceme pussytoes; common under Douglas-fir and grand fir.  
Leaves bright green above, fuzzy below. Most leaves basal.

Antennaria umbrinella Rydb.  
Compositae, umber pussytoes; common in and around high prairie.

Apocynum androsaemifolium L. var. pumilum Gray

Apocynaceae, low dogbane; common on south slopes and open to moderately shaded woods at mid elevations.

Aquilegia formosa Fisch.

Ranunculaceae, red columbine; woods, moist meadows and seeps on slopes.

Arenaria macrophylla Hook.

Caryophyllaceae, bigleaf sandwort; found in moist shaded areas.

Arenaria obtusiloba (Rydb. ) Fern.

Caryophyllaceae, arctic sandwort; rocky slopes and subalpine ridges.

Arnica cordifolia Hook. var. cordifolia

Compositae, heartleaved arnica; in woods often in deep shade up to middle elevations.

Arnica latifolia Bong. var. latifolia

Compositae, broadleaf arnica; moist woods, meadows, and moist open places at higher elevations than A. cordifolia var. cordifolia.

Arnica mollis Hook.

Compositae, hairy arnica; found in high prairie and in moist boggy meadows.

Aster alpigenus (T. & G. ) Gray.

Compositae, alpine aster; found at higher elevations, often in association with A. foliaceus var. apricus.

Aster foliaceus Lindl. var. apricus Gray

Compositae, leafybract aster; found in meadows, sometimes in association with A. alpigenus.

Astragalus howellii Gray

Leguminosae, Howell's milkvetch; common at lower elevations often on disturbed places such as skid roads.

Athyrium filix-femina (L. ) Roth.

Polypodiaceae, ladyfern; moist to boggy areas.

Balsamorhiza deltoidea Nutt.

Compositae, deltoid balsamroot; common especially in dry areas with thin soils.

Blepharipappus scaber Hook. var. scaber

Compositae, blepharipappus; open slopes at low elevations.

Brodiaea hyacinthina (Lindl. ) Baker

Liliaceae, hyacinth brodiaea; moist areas on open hillside from low to middle elevations, often growing under shrubs.

Calochortus macrocarpus Dougl.

Liliaceae, sagebrush mariposa; dry places often with ponderosa pine and bitterbrush.

Calochortus subalpinus Piper

Liliaceae, mountain mariposa; open slopes and forest openings at high elevations

Caltha leptosepala D C. var. leptosepala

Ranunculaceae, elk slip marsh marigold; moist boggy areas, High Prairie.

Campanula scouleri Hook.

Campanulaceae, Scouler bellflower; found in clearcuts along Jordan Creek and very common at middle elevations.

Cardamine cordifolia Gray var. lyallii (Wats.) Nels. and Macbr.

Cruciferae, large mountain bittercress; streambanks and subalpine meadows, i. e., High Prairie.

Castilleja miniata Dougl. var. miniata

Scrophulariaceae, scarlet paintbrush; common and widespread but rarely abundant.

Castilleja suksdorfii Gray

Scrophulariaceae, Suksdorf paintbrush; moist boggy areas at upper elevations.

Centaurea diffusa Lam.

Compositae, diffuse knapweed; a very noxious weed found along roads and disturbed areas such as clearcuts.

Cirsium vulgare (Savi.) Tenore

Compositae, bull thistle; common along roads and disturbed areas.

Clarkia pulchella Pursh

Onagraceae, elkhorn clarkia; generally found at middle elevations.

Clarkia quadrivulnera (Dougl.) Nels. and Macbr.

Onagraceae, small-flowered clarkia; common especially in lower elevations on dry slopes and woods. Often found in swales that dry early.

Clarkia rhomboidea Dougl.

Onagraceae, rhombic-petaled clarkia; common in the lower elevations often on fairly dry slopes.

Clintonia uniflora (Schult.) Kunth.

Liliaceae, queen cup; usually in fairly moist woods often under moderately deep shade.

Collinsia sparsiflora Fisch and Mey. var. bruciae (Jones) Newsom (C. b.)

Scrophulariaceae, few flowered collinsia; open slopes.

Collomia grandiflora Dougl.

Polemoniaceae, large flowered collomia; dry slopes.

Comandra umbellata (L.) Nutt.

Santalaceae, common comandra; root parasite, found on many species.

Convolvulus polymorphus Greene

Convolvulaceae, variable morning glory; found in dry valleys and on hillsides, not common.

Corallorhiza maculata Raf.

Orchidaceae, spotted coralroot; moist to fairly dry woods.

Cor allorhiza striata Lindl.

Orchidaceae, hooded coralroot; not common, found in deep woods.

Cordylanthus captiatus Nutt.

Scrophulariaceae, clustered birdbeak; found with sagebrush on exposed slopes.

Cornus canadensis L.

Cornaceae, bunchberry dogwood; found at mid to upper elevations often in fairly moist woods.

Crepis intermedia Gray

Compositae, gray hawkbeard; found in the ponderosa pine-oak areas.

Crocidium multicaule Hook.

Compositae, spring-gold; very early annual species in dry open places at low elevations.

Delphinium depauperatum Nutt.

Ranunculaceae, slim larkspur; common in open areas to subalpine slopes.

Dodecatheon alpinum (Gray) Greene

Primulaceae, alpine shootingstar; moist areas at high elevations.

Epibolium angustifolium L.

Onagraceae, fireweed; usually found in disturbed areas.

Epilobium paniculatum Nutt. var. paniculatum

Onagraceae, autumn willow-herb; common in disturbed areas often in ponderosa pine areas.

Epilobium glaberrimum Barbey var. fastigiatum (Nutt.) Trel.

Onagraceae, smooth willowweed; moist areas and streambanks.

Erigeron foliosus Nutt.

Compositae, leafy fleabane; found in dry areas often with E. linearis. They both appear the same except E. linearis has yellow ray flowers and E. foliosus has purple ray flowers.

Erigeron linearis (Hook.) Piper

Compositae, lineleaf fleabane; common at lower to middle elevations on drier slopes.

Erigeron peregrinus (Pursh) Green ssp. callianthemus, (Greene) Cronq. var. eucallianthemus Cronq.

Compositae, peregrine fleabane; found in meadows at higher elevations.

Eriogonum compositum Dougl. var. compositum

Polygonaceae, northern buckwheat; common on exposed slopes.

Eriogonum douglasii Benth var. tenue (Small) Hitchc.

Polygonaceae, Douglas buckwheat; usually found on dry slopes or on rocky, shallow soils.

Eriogonum heracleoides Nutt.

Polygonaceae, Wyeth buckwheat; found with ponderosa pine - not as common as several other buckwheats.

Eriogonum umbellatum Torr. var. umbellatum

Polygonaceae, sulphur buckwheat; common on drier slopes often in rocky areas.

Eriophyllum lanatum (Pursh) Forbes. var. integrifolium (Hook.) Smiley  
Compositae, wooly eriophyllum; common in dry areas middle to low elevations.

Erythronium grandiflorum Pursh var. grandiflorum  
Liliaceae, lambstongue fawnlily; fairly common - flowers early in spring.

Frageria vesca L var. bracteata (Heller) Davis  
Rosaceae, woods strawberry; common in meadows and along streambanks to light woods.

Frasera albicaulis Dougl. var. columbiana (St. John) Hitchc.  
Gentianaceae, white stem frasera; dry ridges at lower elevations.

Fritillaria pudica (Pursh) Spreng.  
Liliaceae, yellow fritillary; found in oak-pine areas - not common.

Gaillardia aristata Pursh  
Compositae, gaillardia; found with ponderosa pine.

Galium triflorum Michx.  
Rubiaceae, sweetscented bedstraw; common in moist woods, i. e., with Douglas-fir or grand fir.

Geum triflorum Pursh  
Rosaceae, prairiesmoke avens; in moister places of dry slopes, such as on a north facing open slopes.

Gilia aggregata (Pursh) Spreng. var. aggregata  
Polemoniaceae, kyrocket gilia; common on dry open slopes.

Goodyera oblongifolia Raf.  
Orchidaceae, western rattlesnakeplantain; found in moist woods, i. e., Douglas-fir or grand fir at mid to upper elevations.

Habenaria dilatata (Pursh) Hook. var. leucostachys (Lindl.) Ames  
Orchidaceae, boreal bogorchid; found in boggy meadows, i.e., meadows along Fret Creek.

Habenaria saccata Greene  
Orchidaceae, slender bogorchid; moist and boggy places.

Habenaria unalascensis (Spreng.) Wats.  
Orchidaceae, Alaska reinorchid; common especially in lower elevations under trees.

Habenaria viridis (L.) R. Br. var. bracteata (Muhl.) Gray  
Orchidaceae, frog orchid; not common, found in moist woods.

Hackelia floribunda (Lehm.) Johnst.  
Boraginaceae, showy stickweed, in dry disturbed openings at low elevations.

Helianthella uniflora (Nutt.) T. & G. var. douglasii (T. & G.) Weber  
Compositae, oneflower helianthella; on south slopes at elevations over 1500 m.

Hesperochiron pumilus (Griseb.) Porter  
Hydrophyllaceae, dwarf hesperochiron; moist swales at low elevations.

Hieracium albertinum Farr.

Compositae, western hawkweed; the most hairy of the common hawkweeds. Often found with H. scouleri; on fairly dry slopes.

Hieracium albiflorum Hook.

Compositae, white hawkweed; the only hawkweed in the area with white flowers, moist slopes and open woods.

Hieracium gracile Hook.

Compositae, slender hawkweed; found in moist areas at higher elevations, i. e., High Prairie.

Hieracium scouleri Hook.

Compositae, woollyweed; fairly common often on moderately dry slopes.

Horkelia fusca Lindl. var. fusca

Rosaceae, tawny horkelia; rocky hill tops.

Hydrophyllum capitatum Dougl. var. capitatum

Hydrophyllaceae, ballhead waterleaf; widespread - flowers in early spring, dry slopes at lower elevations.

Hypopitys monotropa Crantz.

Ericaceae, pinesap; a saprophyte with no green leaves, found under conifers, often in very moist stands, i. e., with western red cedar.

Kelloggia galioides Torr.

Rubiaceae, kelloggia; found with sagebrush at high elevations.

Lathyrus pauciflorus Fern. ssp. pauciflorus var. utahensis (Jones) Peck.

Rosaceae, fewflowered peavine; often with ponderosa pine.

Lewisia rediviva Pursh

Portulacaceae, bitterroot lewisia; found on shallow gravelly soils.

Ligusticum grayi Coult. and Rose

Umbelliferae, Gray's licoriceroot; common in and around High Prairie.

Lilium washingtonianum Kell.

Liliaceae, Washington lily; not common; usually found in thickets at higher elevations. Often used as an ornamental but does not transplant well.

Linathus bakeri Mason

Polemoniaceae, Baker's linathus; found in dry open places at lower elevations.

Lithopragma parviflora (Hook. ) Nutt.

Saxifragaceae, smallflower woodlandstar; common early spring annual especially in grasslands and forest openings.

Lithospermum ruderae Dougl.

Boraginaceae, western gromwell; often found with ponderosa pine; frequently growing near rocks.

Lomatium martindalei Coult. and Rose var. martindalei.

Umbelliferae, few-fruited lomatium; rocky ridges and drier meadows and better drained wet meadow margins at higher elevations.

Lomatium nudicaule (Pursh) Coult. and Rose

Umbelliferae, barestem lomatium; common especially in dry rocky areas at lower elevations.

Lomatium triternatum (Pursh) Coult. and Rose subspecies triternatum var. triternatum

Umbelliferae, nine-leafed lomatium; common at low and middle elevations usually in more moist sites than L. nudicaule.

Lotus corniculatus L.

Leguminosae, birdsfoot trefoil; fairly common, not native, probably planted as part of a seeding mix.

Lotus crassifolius (Benth.) Greene var. crassifolius

Leguminosae, big deervetch; common with ponderosa pine and Douglas-fir.

Lotus denticulatus (Drew) Greene

Leguminosae, meadow lotus; common in swales, sometimes along roads at lower elevations.

Lotus nevadensis (Wats.) Greene var. douglasii (Greene) Ottley (L. d.)

Leguminosae, Nevada deervetch; dry slopes on sandy or rocky soil.

Luetkea pectinata (Pursh) Kuntze.

Rosaceae, luetkea; at higher elevations to subalpine areas, often forming a mat mostly where snow lies late in the spring.

Luina nardosmia (Gray) Cronq. var. glabrata (Piper) Cronq.

Compositae, silvercrown luina; fairly common at middle elevations often in fairly deep shade but also in open forests and clearings.

Luina stricta (Greene) Rob.

Compositae, tongue-leafed luina; meadows and open slopes to open forest.

Lupinus caudatus Kell.

Leguminosae, tailcup lupine; very common at lower elevations often with ponderosa pine.

Lupinus latifolius Agardh. var. latifolius

Leguminosae, broadleafed lupine; widespread at middle to higher elevations.

Lupinus lepidus Dougl. var. lepidus (Dougl.) Jeps.

Leguminosae, prairie lupine; not very common - usually found in association with ponderosa pine.

Lupinus leucophyllus Dougl.

Leguminosae, velvet lupine; common in lower and drier elevations on some sites.

Lupinus wyethii Wats.

Leguminosae, Wyeth lupine; dry slopes at upper elevations.

Madia citriodora Greene

Compositae, lemon-scented tarweed; found on dry hillsides; has a lemon scent.

Madia gracilis (J. E. Smith) Keck

Compositae, common tarweed; found in dry open places often along roads.

Madia minima (Gray) Keck

Compositae, small head tarweed; found in dry disturbed areas.

Microseris alpestris (Gray) Q. Jones

Compositae, alpine microseris; higher elevation meadows and openings.

Microseris laciniata (Hook.) Schultz. Bip.

Compositae, cutleaved microseris; common in drier sites often with ponderosa pine and oak.

Microseris nutans (Geyer) Schultz. Bip.

Compositae, nodding microseris; often with Douglas-fir. Found in more moist areas than

M. laciniata.

Microsteris gracilis (Hook.) Greene

Polemoniaceae, pink microsteris; very common at lower elevations, especially on dry slopes.

Mimulus lewisii Pursh

Scrophulariaceae, Lewis monkeyflower; moist areas at middle and higher elevations.

Mimulus moschatus Dougl. var. moschatus

Scrophulariaceae, muskplant monkeyflower; moist areas at higher elevations.

Mimulus tilingii Regel. var. tilingii

Scrophulariaceae, clustered monkeyflower; boggy, moist places at higher elevations, approx. 1200 m and higher.

Mitella pentandra Hook.

Saxifragaceae, fivestamen miterwort; moist boggy areas and streambanks at middle to high elevations.

Montia perfoliata (Donn) Howell

Portulacaceae, minerslettuce, very common at lower elevations especially in the spring season.

Montia sibirica (L.) Howell

Portulacaceae, Siberian montia; found at mid elevations; not as common as minerslettuce.

Navarretia intertexta (Benth.) Hook var. propinqua (Suksd.) Brand

Polemoniaceae, needleleaf navarretia; found in dry areas and along roads.

Nothochelone nemorosa (Dougl.) Straw

Scrophulariaceae, woodland beard-tongue; woods and moist, open, rocky slopes.

Orobanche fasciculata Nutt.

Orobanchaceae, clustered broomrape; parasitic on other plants' roots, i. e., on buckwheats; no green leaves; not common.

Orthocarpus hispidus Benth.

Scrophulariaceae, hairy owlclover; common in swales or areas that are moist in the spring. Small annual with white flowers.

Osmorhiza chilensis H. & A.

Umbelliferae, mountain sweetroot; common at middle elevations, i. e., with Douglas-fir and grand fir.

Osmorhiza purpurea (Coul. & Rose) Suksd.

Umbelliferae, purple sweetroot; in relatively moist areas at higher elevations.

Parnassia fimbriata Konig. var. fimbriata

Saxifragaceae, fringed grass-of-parnassus; in moist boggy areas.

Pedicularis groenlandica Retz.

Scrophulariaceae, elephanthead pedicularis; found in moist boggy meadows, i. e., along Fret Creek. When in flower the purple flowers look like an elephant's head.

Pedicularis racemosa Dougl. var. alba

Scrophulariaceae, sickletop pedicularis; subalpine to montane.

Penstemon cinicola Keck

Scrophulariaceae, smallflower penstemon; on ash outcrops.

Penstemon euglaucus English

Scrophulariaceae, glaucous penstemon; open forests and openings.

Penstemon fruticosus (Pursh) Greene var. fruticosus

Scrophulariaceae, shrubby or bush penstemon; rocky areas.

Penstemon procerus Dougl. var. brachyanthus (Pennell) Cronq.

Scrophulariaceae, tinybloomed penstemon; in High Prairie.

Phacelia heterophylla Pursh

Hydrophyllaceae, varileaf phacelia; quite common at most elevations, on open exposed slopes.

Phacelia linearis (Pursh) Holz.

Hydrophyllaceae, threadleaf phacelia; found in dry open places such as treeless ridgetops at middle to lower elevations.

Phlox diffusa Benth var. longistylis (Wherry) Peck

Polemoniaceae, spreading phlox; found at middle to higher elevations, often in dry rocky areas.

Plagiobothrys tenellus (Nutt.) Gray

Boraginaceae, slender popcornflower; very common in relatively dry areas and disturbed sites.

Plectritis macrocera T. & G.

Valerianaceae, longhorn plectris; common early spring annual especially in open disturbed areas.

Polemonium pulcherrimum Hook. var. calycinum (Eastw.) Brand

Polemoniaceae, skunkleaf polemonium; common at upper elevations.

Polygonum bistortoides Pursh

Polygonaceae, American bistort, streambanks and wet meadows often at higher elevations; common in High Prairie.

Polygonum newberryi Small var. newberryi

Polygonaceae, Newberry fleecflower; found on cinder soils, on Lookout Mountain often the only plant present.

Polystichum lonchitis (L.) Roth

Polypodiaceae, mountain hollyfern; found on rock outcrops at middle elevations and occasionally in shaded forests.

Polystichum munitum (Kaulf.) Presl.

Polypodiaceae, swordfern; moist woods; not common.

Potentilla drummondii Lehm.

Rosaceae, drummond cinquefoil; found in High Prairie - especially with Carex scrophulorum; larger than P. flabellifolia.

Potentilla flabellifolia Hook.

Rosaceae, fanleaf cinquefoil; common in High Prairie.

Potentilla glandulosa Lindl. var. reflexa Greene

Rosaceae, gland cinquefoil; common at middle elevations.

Potentilla pensylvanica L.

Rosaceae, prairie cinquefoil; on open ridges often at high elevations.

Prunella vulgaris L. var. lanceolata (Barton) Fern.

Labiatae, common selfheal; found in Jordon Creek clearcuts.

Pteridium aquilinum (L.) Kuhn. var. pubescens Underw.

Polypodiaceae, brackenfern; common at middle elevations.

Pterospora andromedea Nutt.

Ericaceae, woodland pinedrops; common, usually under ponderosa pine.

Ranunculus alismaefolius Geyer

Ranunculaceae, plantainleaved buttercup; high elevation meadows, i. e., High Prairie.

Rumex acetosella L.

Polygonaceae, sheep sorrel; common in waste and disturbed areas.

Satureja douglasii (Benth.) Briq.

Labiatae, yerba buena; occasionally found in fairly moist woods along streams or relatively open slopes at mid elevations. Has a strong medicinal odor when crushed.

Saussurea americana Eat.

Compositae, sassurea; moist rocky areas at middle to upper elevations.

Saxifraga arguta D. Don.

Saxifragaceae, brook saxifrage; moist places such as streambanks.

Saxifraga ferruginea Grah. var. macounii Engl. and Irmsch.

Saxifragaceae, rusty saxifrage; moist areas at middle and higher elevations.

Saxifraga oregana Howell var. montanensis (Small) Hitch.

Saxifragaceae, saxifrage; moist meadows and boggy situations.

Sedum oregonense (Wats.) Peck

Crassulaceae, creamy sedum; dry rocky outcrops, mid to high elevations.

Sedum stenopetalum Pursh

Crassulaceae, spatula-leaf stonecrop; dry rocky outcrops often at high elevations, sometimes scattered in open woods.

Senecio cymbalarioides Buek

Compositae, cleftleaf groundsel; found in wet meadows at higher elevations.

Senecio integerrimus Nutt.

Compositae, western groundsel; widespread at most elevations.

Senecio triangularis Hook. var. triangularis

Compositae, arrowleaf groundsel; streambanks and wet areas at middle to upper elevations.

Silene douglasii Hook. var. douglasii

Caryophyllaceae, Douglas silene; often found on open ridges.

Sisyrinchium douglasii A. Dietr.

Iridaceae, Douglas blue-eyed grass; from low to high elevations; flowers very early in spring.

Smilacina racemosa (L.) Desf.

Liliaceae, feather solomonplume; found at middle elevations.

Smilacina stellata (L.) Desf.

Liliaceae, starry solomonplume; common at middle to higher elevations.

Solidago canadensis L. var. salebrosa (Piper) Jones

Compositae, Canada goldenrod; moist meadows.

Spraguea umbellata Torr. var. caudicifera Gray

Portulacaceae, Mt. Hood pussypaws; pinewoods to subalpine ridges.

Stellaria umbellata Turcz.

Caryophyllaceae, umbellate starwort; found in the High Prairie area.

Thelypodium integrifolium (Nutt.) Endl.

Cruciferae, entireleaf thelypody; found at middle elevations.

Tiarella trifoliata L. var. unifoliata (Hook.) Kurtz

Saxifragaceae, trefoil foam flower; moist woods, often near streams.

Tragopogon dubius Scop.

Compositae, yellow salsify; found in disturbed areas at lower elevations.

Trautvetteria caroliniensis (Walt.) Vail var. occidentalis (Gray) Hitchc.

Ranunculaceae, false bugbane; moist woods and streambanks.

Trientalis latifolia Hook.

Primulaceae, western star flower; woods at middle elevations.

Trifolium longipes Nutt. var. longipes

Leguminosae, longstem clover; High Prairie and meadows.

Trifolium macrocephalum (Pursh) Poiret

Leguminosae, bighead clover; common in rocky places at lower elevations.

Trillium ovatum Pursh

Liliaceae, white trillium; common at mid to upper elevations.

Valeriana sitchensis Bong.

Valerianaceae, Sitka valerian; moist woods, mid to upper elevations and also along streams and in wet meadows.

Veratrum viride Ait.

Liliaceae, American falsehellebore; moist meadows and woodlands to subalpine areas, i. e., High Prairie.

Verbascum thapsus L.

Scrophulariaceae, flannel mullein; common weed especially along roads.

Veronica americana Schwein

Scrophulariaceae, American speedwell; wet to boggy areas.

Veronica cusickii Gray

Scrophylariaceae, Cusick speedwell; higher elevations.

Vicia americana Muhl.

Leguminosae, American vetch; widespread; quite a lot of variation in leaf shape and number of flowers.

Viola glabella Nutt.

Violaceae, pioneer violet; moist woods and stream edges.

Viola palustris L.

Violaceae, marsh violet; moist meadows and stream banks.

Zigadenus venenosus Wats. var. venenosus

Liliaceae, meadow deathcamas; poisonous; flowers early on open slopes and in meadows.

## GRASSES

Agropyron spicatum (Pursh) Scribn. and Smith

Gramineae, bluebunch wheatgrass; common at lower, drier elevations.

Agrostis humilis Vasey

Gramineae, alpine bentgrass; found in High Prairie.

Agrostis interrupta L.

Gramineae, interrupted apera; common in dry, disturbed areas at lower elevations.

Aira caryophyllea L.

Gramineae, silver hairgrass; small annual grass; widespread, especially at lower elevations, but easily overlooked.

Bromus carinatus H. and A. var. carinatus

Gramineae, California brome; quite common at middle and higher elevations, may be dominant grass in dry meadows.

Bromus inermis Leys

Gramineae, smooth brome; common along mid to high elevation roads where it has been seeded.

Bromus mollis L.

Gramineae, soft brome; common in disturbed areas and along roads; introduced.

Bromus suksdorfii Vasey

Gramineae, Suksdorf brome; looks very similar to Bromus vulgaris but differs in having an erect instead of drooping head and is usually found at 1200 m in elevation or higher.

Bromus tectorum L.

Gramineae, cheatgrass; very common grass up to mid elevations especially in waste and overgrazed areas; introduced species.

Bromus vulgaris (Hook) Shear var. vulgaris

Gramineae, Columbia brome; common, especially in moist woods, i. e., Douglas-fir areas.

Calamagrostis koelerioides Vasey

Gramineae, fire reedgrass; dry ridges to mountain meadows.

Calamagrostis rubescens Buckl.

Gramineae, pinegrass; open slopes to moist forest, often without a head in shade; shade tolerant.

Dactylis glomerata L.

Gramineae, orchardgrass; common seeded species along roads and disturbed areas at mid to higher elevations.

Danthonia unispicata (Thurb.) Munro

Gramineae, onespike oatgrass; found in seasonally moist areas that dry out later in year.

Deschampsia caespitosa (L.) Beauv.

Gramineae, tufted hairgrass; in moist meadows such as High Prairie.

Deschampsia danthonioides (Trin.) Munro

Gramineae, annual hairgrass; found in swales that are moist early in spring but dry out later in season.

Deschampsia elongata (Hook.) Munro

Gramineae, slender hairgrass; found in Jordan Creek clearcuts.

Elymus caput-medusae L.

Gramineae, medusahead wildrye; a very noxious annual grass, not yet common in study area; introduced from Asia and adapted to dry areas with heavy soils.

Elymus glaucus Buckl. var. glaucus

Gramineae, blue wildrye; often found in open woods.

Festuca idahoensis Elmer

Gramineae, Idaho fescue; common bunchgrass with thin rolled leaves. Found in drier areas than F. occidentalis. Idaho fescue is found where Douglas-fir and grand fir generally can't grow.

Festuca microstachys Nutt.

Gramineae, small fescue; common especially in dry areas - very often mixed with cheatgrass.

Festuca ovina L.

Gramineae, sheep fescue; often found along roads in ponderosa pine where it has been seeded.

Festuca occidentalis Hook.

Gramineae, western fescue; found in Jordan Creek clearcuts and in higher elevations than F. idahoensis. Common in moist woods. Easily confused with F. idahoensis but found in moister stands, i. e. , with Douglas-fir and grand fir.

Hordeum geniculatum All.

Gramineae, Mediterranean barley; found in swales at low elevations.

Koeleria cristata Pers.

Gramineae, prairie Junegrass; common at lower to middle elevations on open slopes and open forests.

Melica bulbosa Geyer var. bulbosa

Gramineae, oniongrass; openings at middle to upper elevations and open forests.

Muhlenbergia filiformis (Thurb.) Rydb.

Gramineae, pullup muhly; small grass found in High Prairie.

Phleum pratense L.

Gramineae, timothy; common seeded species along roads and in disturbed areas at middle elevations.

Poa bulbosa L.

Gramineae, bulbous bluegrass; lower elevations often in disturbed areas; introduced species.

Poa fendleriana (Steud.) Vasey

Gramineae, muttongrass; found at middle elevations often on exposed slopes.

Poa juncifolia Scribn. (Poa ampla)

Gramineae, alkali bluegrass; often on open slopes and rocky areas to moist woods.

Poa nevadensis Vasey

Gramineae, Nevada bluegrass; found on north slopes at low elevations.

Poa pattersonii Vasey

Gramineae, Patterson's bluegrass; found near road in High Prairie.

Poa sandbergii Vasey

Gramineae, Sandberg's bluegrass; very common, especially in dry, rocky areas.

Scribneria bolanderi (Thurb.) Hackel.

Gramineae, Scribner-grass; a small annual grass at lower elevations; very uncommon, found in dry open areas that hold moisture very early in spring.

Sitanion hystrix (Nutt.) Smith

Gramineae, bottlebrush squirreltail; common, especially in openings.

Stipa lemmonii (Vasey) Scribn. var. lemmonii

Gramineae, Lemmon needlegrass; often with ponderosa pine but also found on areas that have soils too shallow for ponderosa pine.

Stipa occidentalis Thurb.

Gramineae, western needlegrass; widespread grass but not usually very abundant.

Trisetum canescens Buckl.

Gramineae, tall trisetum; often with ponderosa pine and Douglas-fir.

## GRASSLIKES

Carex deweyana Schw.

Cyperaceae, Dewey sedge; common in meadows, i. e., High Prairie.

Carex dioica L. var. gynocrates (Wormsk.) Ostenf.

Cyperaceae, yellow bog sedge; found in wet boggy areas, i. e., bogs and meadows along Fret Creek.

Carex douglasii Boott.

Cyperaceae, Douglas sedge; a tall plant which is not common but quite conspicuous where it occurs, usually in small patches.

Carex geeyeri Boott.

Cyperaceae, elk sedge; common, woodlands to open slopes.

Carex hoodii Boott.

Cyperaceae, Hood sedge; found at middle elevations where tree stand has been opened up; very common in Jordan Creek clearcuts.

Carex rossii Boott.

Cyperaceae, Ross sedge; found in Jordan Creek clearcuts, also common up to fairly high elevations.

Carex scrophulorum Holm

Cyperaceae, Holm's sedge; common in High Prairie.

Eriophorum gracile Koch

Cyperaceae, slender cottonsedge; found in wet meadows, i. e., those along Fret Creek.

Juncus effusus L.

Juncaceae, common rush; High Prairie.

Juncus ensifolius Wikst. var. ensifolius

Juncaceae, swordleaf rush; common in High Prairie.

Juncus mertensianus Bong.

Juncaceae, Merten's rush; found along streams from mid to high elevations (at high elevations it is not restricted to stream margins).

Luzula campestris (L.) D C. var. frigida Buch.

Juncaceae, field woodrush; found in shaded to moist areas at mid elevations - leaves may be reddish-purple.

Luzula hitchcockii Hamet-Ahti

Juncaceae, smooth woodrush; found at high elevations.