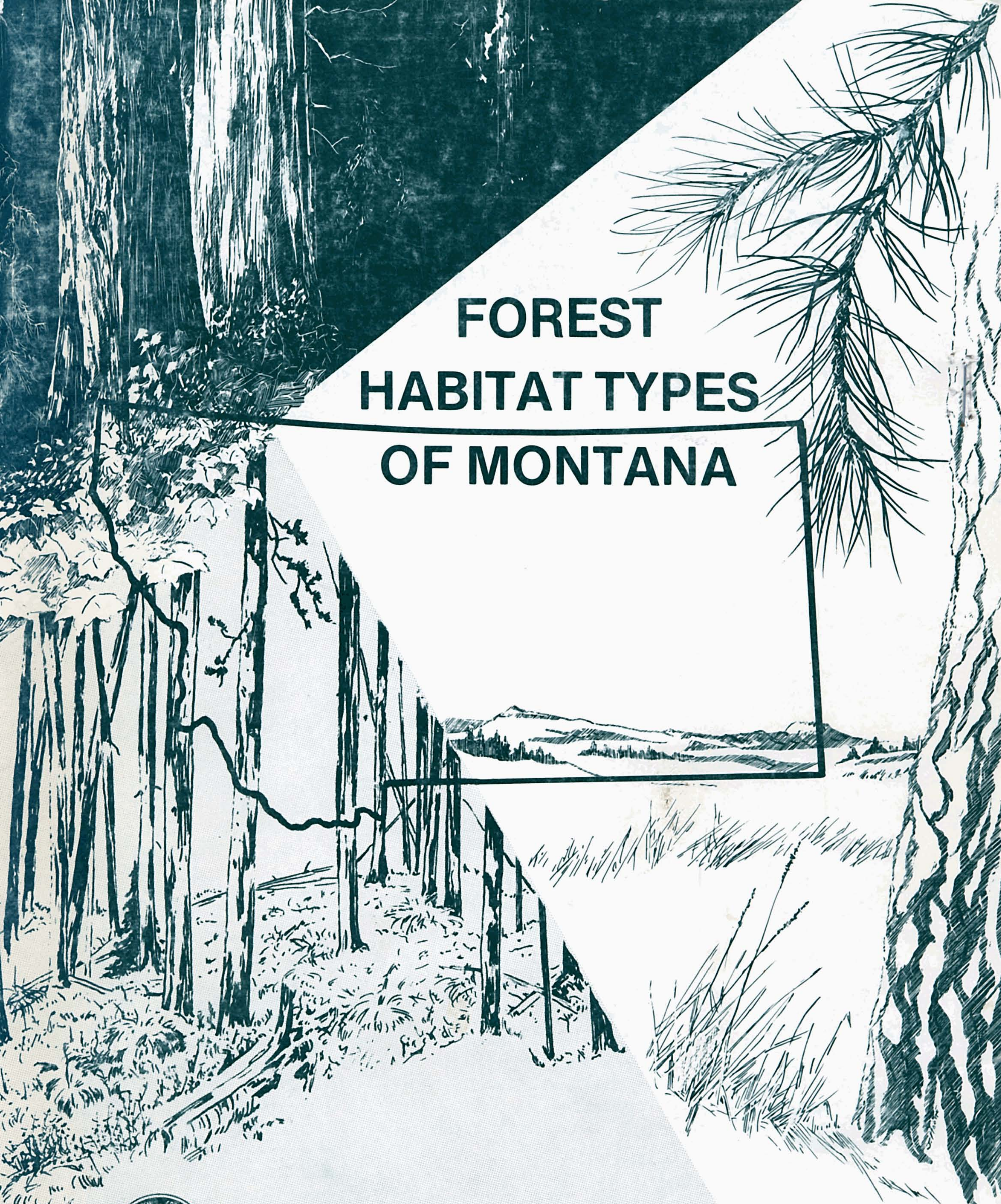
FOREST HABITAT TYPES OF MONTANA



USDA Forest Service General Technical Report INT-34
INTERMOUNTAIN FOREST AND RANGE EXPERIMENT STATION
FOREST SERVICE, U.S. DEPARTMENT OF AGRICULTURE

UNITED STATES DEPARTMENT OF AGRICULTURE
FOREST SERVICE
FSL - Missoula - INT

REPLY TO: 4100 Timber Management Research

June 6, 1977

SUBJECT: Publication: Forest Habitat Types of Montana - 1977

TO: Users of the 1974 Review Draft

The new publication "Forest Habitat Types of Montana" completely replaces the 1974 review draft (as well as the 1972 and 1973 preliminary classifications). Although the manuscript has been extensively rewritten, there are only a few basic changes in the classification, per se. The purpose of this memorandum is to explain the changes needed to convert from the 1974 to the 1977 classification system.

Nomenclature & Coding

We now use the standard scientific abbreviations--the first two letters of the genus and species names--with all trees, indicator species, and habitat types. For example, PSME/CAGE h.t. The three digit codes for data processing are essentially unchanged, except where type designations were changed.

Habitat Types

The changes shown in table 1 have been made in structure of the basic classification to more clearly reflect site differences and relationships to other units. In most instances, a direct conversion of existing codes can be used for data collected in previous years. Conversions of data collected according to the 1972 and 1973 preliminary classifications can be made according to Fig. 57 (p. 137-138 in the 1977 publ.).

Key

The key (Fig. 7, p. 19-22) has been changed to accommodate the changes shown in table 1. In addition, the key now goes directly to the phase level.

New Information

Additional information has been incorporated into written descriptions. The timber productivity section was completely re-analyzed by improved techniques. The new data on surface soil characteristics is presented in Appendix D-1 and a paragraph on soils has been added to each habitat type description. A glossary (Appendix G) has also been added.

Colored illustrations and the species presence table (Appendix C-2) have been included in the back pocket for convenient use. Extra copies of the key and field form are also included for your convenience in making copies for field use.

Errata

On page 51, third line, the word "seed-tree" should be substituted for the work "shelterwood". The third sentence then will read: "Clearcutting and seed-tree systems will favor seral species, . . ."

Additional copies of the publication can be ordered from:

Intermountain Forest and Range Experiment Station
507 25th Street
Ogden, Utah 84401

A semi-popular article explaining this classification is available in the June 1977 issue of W. Wildlands, publ. by University of Montana Forestry School.

Robert D. Pfister

ROBERT D. PFISTER, Project Leader
Forest Ecosystems Research Work Unit

Table 1. Substantive changes in the 1977 list of A.D.P. code numbers and habitat types, from the 1974 review draft.

1974 Review Draft		1977 Publication	
---	PP/Andr (minor type)	110	PIPO/AND h.t.
270	DF/Xete h.t. (part of)	280	PSME/VAGL h.t.
272	" , Aruv phase	282	PSME/VAGL h.t., ARUV phase
271	" , Vagl phase	283	PSME/VAGL h.t., XETE phase
270	DF/Xete & 280 DF/Vagl (parts of)	293	PSME/LIBO h.t., VAGL phase
323	DF/Caru h.t., Caru phase (part of)	324	PSME/CARU h.t., PIPO phase
---	DF/Syor (incidental type)	380	PSME/SYOR h.t.
521	GF/Clun h.t., Clun phase (part of)	523	ABGR/CLUN h.t., XETE phase
	" " "	590	ABGR/LIBO h.t.
	" " " + new stnd	591	ABGR/LIBO h.t., LIBO phase
510	GF/Xete (part of) + new stands	592	ABGR/LIBO h.t., XETE phase
631	AF/Gatr h.t., Gatr phase	630	ABLA/GATR h.t.
641	AF/Vaca h.t., Vaca phase	640	ABLA/VACA h.t.
650	AF/Caca h.t.	651	ABLA/CACA h.t., CACA phase
632	AF/Gatr h.t., Caca phase	653	ABLA/CACA h.t., GATR phase
642	AF/Vaca h.t., Caca phase	654	ABLA/CACA h.t., VACA phase
---	AF/Alsi c.t.	740	ABLA/ALSI h.t.
---	(see below)	790	ABLA/CAGE h.t.
---	AF/Cage (minor type)	791	ABLA/CAGE h.t., CAGE phase
750	AF/Caru h.t., (part of)	792	ABLA/CAGE h.t., PSME phase
---	AF/Rimo (minor type)	810	ABLA/RIMO h.t.
---	MH/Luhi (minor type)	840	TSME/LUHI h.t.
		841	TSME/LUHI, VASC phase
		842	TSME/LUHI, MEFE phase
---	Timberline h.t.s.	890	Timberline h.t.s.

Table 2. Minor name changes.

700	Temperate h.t.s. (AF series)	700	Lower subalpine h.t.s
800	Subalpine h.t.s.	800	Upper subalpine h.t.s
820	AF(WBP)/Vasc h.t.	820	ABLA-PIAL/VASC h.t.
850	WBP-AF h.t.	850	PIAL-ABLA h.t.s (made plural)
860	AL-AF h.t.	860	LALY-ABLA h.t.s (made plural)
870	WBP h.t.	870	PIAL h.t.s (made plural)

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THE AUTHORS

ROBERT D. PFISTER, Principal Plant Ecologist and Leader of the Forest Ecosystems research work unit at Missoula, initiated and directed this classification project. He joined the Intermountain Station staff in 1961 as a Research Forester in western white pine silviculture in northern Idaho. He holds B.S. and M.S. degrees in forest management from Iowa State University and Oregon State University, respectively, and a Ph.D. in botany from Washington State University.

BERNARD L. KOVALCHIK, now Timber Management Planner on the Helena National Forest, did much of the habitat type field sampling, and was primary analyst and author of the Pinus flexilis, Pinus ponderosa, Pseudotsuga, Picea, and Pinus contorta series. He earned a B.S. in forestry and an M.S. in silviculture and forest ecology from the University of Montana.

STEPHEN F. ARNO, Associate Plant Ecologist on the Forest Ecosystems research work unit at Missoula, did much of the habitat type sampling, and was the primary analyst and author of the Abies grandis, Thuja, Tsuga, and Abies lasiocarpa series, as well as introductory sections of the manuscript. He earned a B.S. in forestry at Washington State University and M.F. and Ph.D. degrees in forestry and plant science at the University of Montana.

RICHARD C. PRESBY, now Forest Biotic Planning Specialist on the Idaho Panhandle National Forests, St. Maries, Idaho, shared responsibility for developing the preliminary Montana forest habitat type classifications during the first half of the project, and participated in the field sampling. He holds a B.S. and an M.S. in forestry (major in wildlife management) from the University of Idaho. He began his Forest Service career in 1965 on the Coeur d'Alene National Forest.

ACKNOWLEDGMENTS

Major support for this study was provided by the Northern Region of the Forest Service, U.S. Department of Agriculture, through a cooperative agreement with the Intermountain Forest and Range Experiment Station. Many foresters, both public and private, assisted in field sampling and provided feedback during development of the classification.

Dr. James R. Habeck (University of Montana) generously provided data from over 200 of his sample stands in western Montana as well as data from a current study in the Selway River drainage in Idaho. Peter F. Stickney (Intermountain Station, Missoula) helped train project personnel in plant identification and provided taxonomic verification of voucher specimens. Robert Steele (Intermountain Station, Boise) reviewed the Montana classification in relation to his concurrent work on a forest habitat type classification for central Idaho. Ronald C. ("Mac") McConnell (USDA Forest Service - Retired) volunteered his services in describing and interpreting soil samples. Sigrid Asher-Moore and Cynthia Heliker (University of Montana) identified rock and pebble parent material specimens. Robert R. Alexander (Rocky Mountain Station, Ft. Collins) provided spruce yield data needed for productivity estimates.

David Ondov handled most of the computer programing in addition to serving as a field and lab technician. Other University of Montana students, Gerald Moore, Jeffrey Hart, and Marla Kapperud, served as valuable research assistants.

The University of Montana Forestry School extended cooperative administrative and financial support during the final year of the project.

CONTENTS

FIGURES: Page

TABLES:

RESEARCH SUMMARY

A land-classification system based upon potential natural vegetation is presented for the forests of Montana. It is based on an intensive 4-year study and reconnaissance sampling of about 1,500 stands. A hierarchical classification of forest sites was developed using the habitat type concept. A total of 9 climax series, 64 habitat types, and 37 additional phases of habitat types are defined. A diagnostic key is provided for field identification of the types based on indicator species used in development of the classification.

In addition to site classification, descriptions of mature forest communities are provided with tables to portray the ecological distribution of all species. Potential productivity for timber, climatic characteristics, and surface soil characteristics are also described for each type. Preliminary implications for natural resource management are provided, based on field observations and current information.

INTRODUCTION

Natural resource managers and researchers in Montana have found that existing forest cover-type classifications and site classifications have not been adequate for their needs. Forest cover-type classifications are based only on the current (often early successional) tree species. Thus, they often encompass a wide range of environmental conditions; for example, one cover type might include saplings on clearcut sites in one environment and 400-year-old climax forests in a totally different environment. Moreover, the cover type on a given site is always changing with advancing succession or sudden disturbance (such as fire, logging, insect damage, or windthrow).

Existing site classifications are usually of limited value because they are intended for use in a certain resource specialty. Also, they often have little relation to forest vegetation, even though the vegetation represents a detailed expression of the overall environment and is itself a primary object of management.

We need a better classification system for forest communities and the sites on which they develop for three reasons:

1. Communication.--Land managers and research specialists dealing with several disciplines need a common system for describing forest communities and sites.

2. Management interpretations.--Land managers must be able to make intelligent prescriptions for manipulating vegetation based on knowledge of the ecological potential of the land.

3. Research application.--Researchers can improve sampling design and layout of experiments by use of an ecological classification.

The habitat type approach to classification of forest sites was developed more than 20 years ago by Daubenmire (1952) for forests of northern Idaho and eastern Washington. His original classification, and a subsequent revision (R. and J. Daubenmire 1968), have proven useful in forest management and research (Layser 1974; Pfister 1976). Thus, after examining various approaches to forest ecosystem classification, the Intermountain Forest and Range Experiment Station and the Northern Region of the USDA Forest Service began a cooperative study in 1971 to develop this forest habitat type classification for Montana.

Objectives and Scope

The objectives of this study were:

1. To develop a habitat type classification for the forested lands of Montana based on the potential vegetation.

2. To describe the general geographic, physiographic, climatic, and edaphic (see the Glossary, appendix G, for definitions) features of each type.

3. To describe the mature forest communities (late seral) as well as the potential climax communities (associations) characteristic of each type.

4. To present information on successional development, timber productivity potential, and other biological observations of importance to forest land managers.

5. To develop and test a reconnaissance-plot method of data gathering that would permit accurate habitat type classification in a minimum period of time.

The area of Montana studied includes 10 National Forests and adjacent public and private forest lands (fig. 1). Not included were aspen grovelands of north-central Montana, coniferous forests of the Bearpaw Mountains and the Little Rockies, the ponderosa pine woodlands of the Missouri River breaks, bottomland hardwood forests of major floodplains, and minor areas of Rocky Mountain juniper woodlands scattered throughout the State. (Researchers from the University of Montana School of Forestry, are currently conducting a study of forest habitat types in north-central Montana which is scheduled for completion in December 1978.)

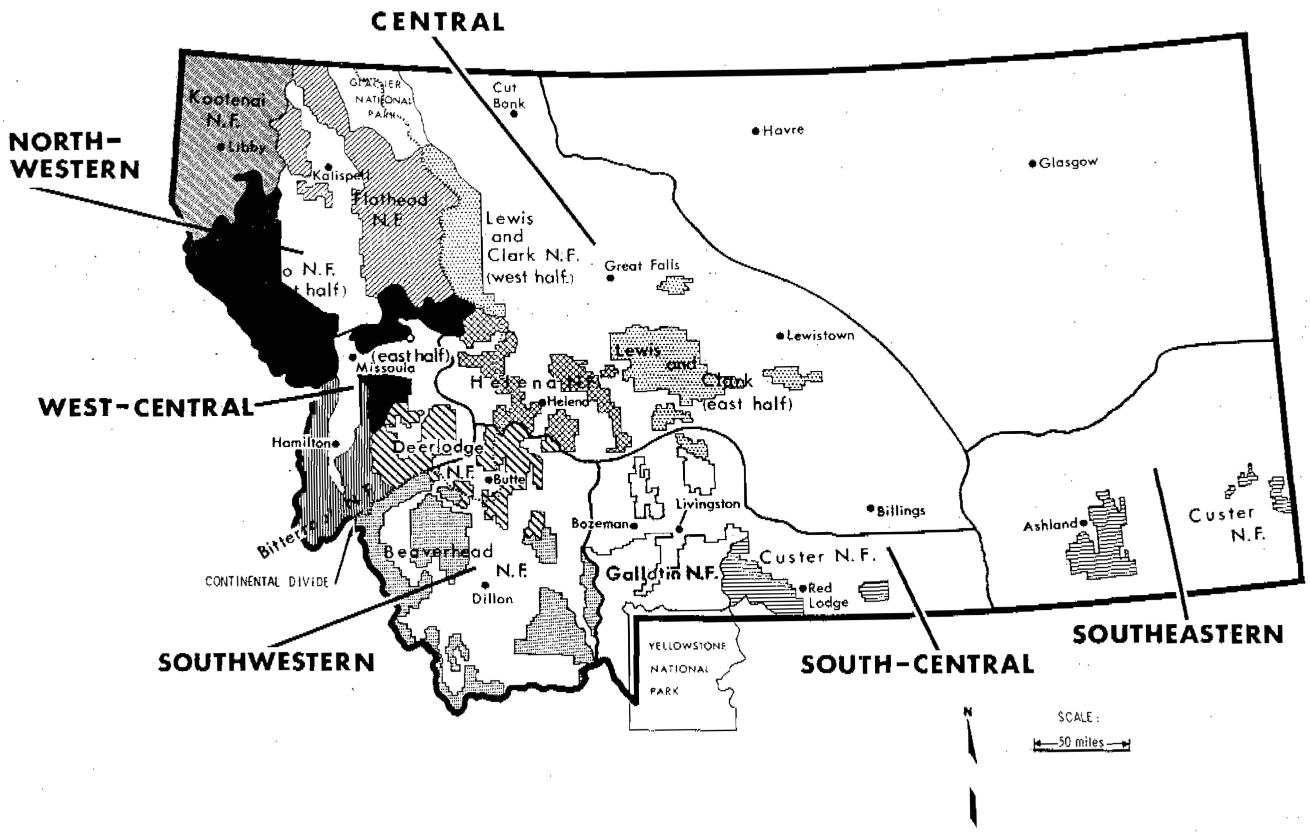


Figure 1.--Geographic subdivisions and National Forests of Montana.

METHODS

Plot Sampling

Mature stands were sampled along elevational transects at selected locations throughout forested areas of western, central, and southeastern Montana in an attempt to represent the full range of environmental conditions and later successional stages (fig. 2). Sampling was conducted on temporary 375-m^2 (about one-tenth acre) circular plots, referenced so that relocation would be possible. Transects were dispersed with the goal of essentially blanketing the Montana Rockies to the extent possible in three summers of field sampling by two to three sampling teams.

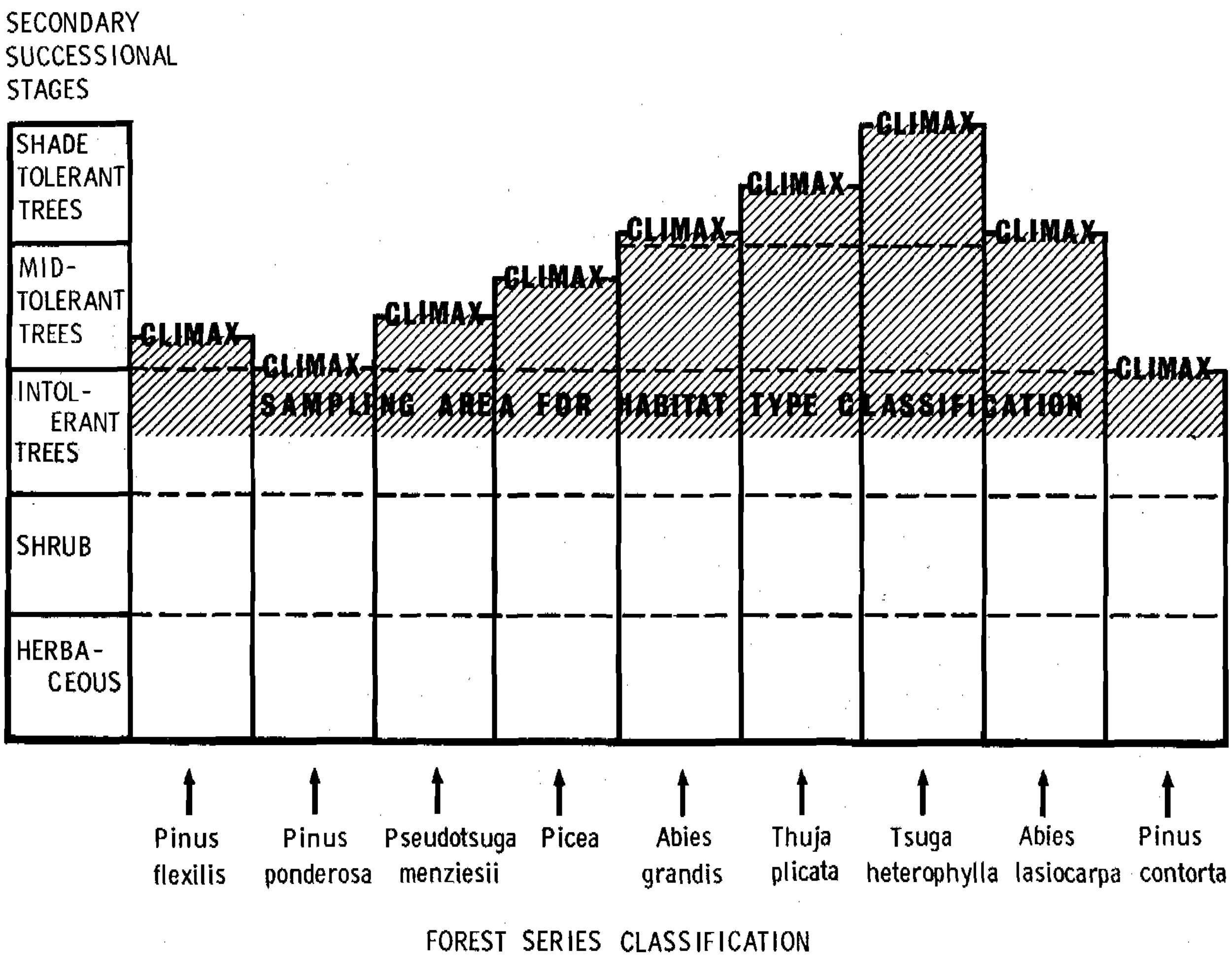


Figure 2.--Generalized successional stages of each forest series, showing the types of stands sampled as the basis for our habitat type classification.

The usual procedure of stand selection was for the team leader to travel the transect routes by vehicle, keeping a mileage log and taking notes on the patterns of forest communities. While brief stops were made to inspect undergrowth, changes in overstory and general undergrowth patterns could be observed from a moving vehicle. The extent of apparently homogeneous communities of trees and undergrowth, transitions into other communities, and topographic and edaphic features were noted. At the end of each transect, the mileage log and notes were inspected and a plan was formulated to sample representative, relatively mature forest communities on the trip back. The number of sample plots depended upon the availability of mature stands and the apparent diversity of forest communities.

Sample plots were located in representative portions of the selected stands, with special attempts made to avoid edge effects, obvious ecotones, openings, unusually dense clumps, recent disturbances, and microsites (rock outcrops, seep areas, or swales). The emphasis was on sampling stands without any preconceived idea of a classification system. Independent sampling by the three teams helped minimize the influence of possible individual biases. The transect (with stand selection) approach also had the advantage of emphasizing observations of forest community patterns on the landscape that were helpful in constructing the classification.

Random and systematic systems of stand selection were rejected because they would be very inefficient. They would oversample abundant communities and undersample scarcer ones. Also, many plots would fall on ecotones, in disturbed areas, or in heterogeneous places within a stand, providing samples of little use for developing a habitat type classification.

In each 375-m^2 plot, tree species were tallied by 2-inch d.b.h. classes. Saplings between 0.5 and 4.5 feet in height were recorded in a 50-m^2 plot. Canopy coverage of each vascular plant species was estimated by assigning one of the following seven coverage classes: + = present in stand but not in plot, T = 0 to 1 percent coverage, 1 = 1 to 5 percent, 2 = 5 to 25 percent, 3 = 25 to 50 percent, 4 = 50 to 75 percent, 5 = 75 to 95 percent, 6 = 95 to 100 percent. These classes were modified from Daubenmire (1959). Coverage class for each undergrowth species was estimated for the entire 375-m^2 plot rather than for a series of small quadrats, as is the usual procedure (R. and J. Daubenmire 1968). This approach seemed efficient for providing data on species presence and percent coverage. With a little practice and teamwork (including practice layouts of areas within the plot representing 1, 5, and 25 percent), the samplers were able to visualize and estimate coverage of grasses, forbs, shrubs, and trees using this one method. Although accuracy may be somewhat lower than that obtained by estimating coverage classes in small quadrats, the number of plots can be increased two- to fourfold, allowing for much better coverage of the forest communities. Also, the coverage-class values obtained can be used directly in association tables or ordinations.

A relatively free-growing tree of each tree species, if available, was measured for height, age, and d.b.h. to estimate site potential by species. (Suitable site trees were generally not available in the denser old-growth stands.) Maximum heights of old-growth trees were also measured.

Thicknesses of the litter, fermentation, and humus layers were measured at three locations in the plot. Samples of the upper 20 cm of mineral soil were collected for laboratory analysis along with samples of the parent material.

Observations were made on fire history, insect and disease occurrence, animal use, and environmental positions of the stand in relation to adjoining stands.

During the summer of 1971 a total of 429 stands were sampled by three teams throughout northwestern and west-central Montana (fig. 1). Data from previous studies were used whenever possible, including those collected by James R. Habeck (University of Montana) and his students, 12 of R. and J. Daubenmires' (1968) Montana plots, and 85 stands previously sampled by Pfister (unpublished reports) and Arno (1970). Although different sampling methods were used in these studies, the data could be adapted to our reconnaissance system. The combined data formed the basis for the preliminary habitat type classification of northwestern and west-central Montana in 1972, which covered the Kootenai, Flathead, Lolo, and Bitterroot National Forests and adjacent areas (fig. 1).

The following summer (1972), a total of 591 stands were sampled by three teams in central, southwestern, south-central, and southeastern Montana. These were the basis for the second preliminary classification in 1973, which covered the Deerlodge, Beaverhead, Helena, Lewis and Clark, Gallatin, and Custer National Forests and intervening areas (fig. 1).

During the field season of 1973 an additional 249 stands were sampled in areas where previous data were scant. About 50 additional stands were sampled during 1974 and 1975. The current classification of forest habitat types throughout Montana was based on a compilation of all these data.

Office Procedures

The chronological development of our classification is outlined as follows:

1. We made a subjective first grouping of possible types at the end of the 1971 and 1972 field seasons.

2. We constructed several index-of-similarity ordinations (Bray and Curtis 1957) to array the stands graphically on the basis of their species composition and coverage data. Because of the large number of stands, we grouped them by climax series (fig. 2) prior to ordination. We also gained insight to potential groupings of similar stands and the use of various species as indicators through analyzing the distributions of individual species on the ordinations.

3. We developed a classification of types and phases by comparing the first grouping with the ordination. At this time, as well as at each successive revision, we used association tables to test each stand against habitat type and phase parameters.

4. We inspected geographic location, elevation, topographic position, soils, etc., to insure that specific environmental patterns could be related to each habitat type and phase.

5. We corrected terminology for the types to express the inter-relationships of our types as clearly as possible and to correlate them with R. and J. Daubenmire (1968) whenever appropriate.

6. We used the phase as a classification unit to subdivide habitat types where appropriate. In some cases a phase represents a broad transition between two adjacent habitat types, and it may occupy major areas of the forest landscape--for example, *ABLA/CLUN* h.t., *MEFE* phase. (Because of frequent reference to habitat type names, abbreviations are used for convenience throughout this report; these are shown in table 1.) In other cases a phase represents a difference of vegetation dominance in a third layer, whereas the habitat type is defined by dominants or indicator species in two layers (e.g., *PIPO/PUTR* h.t. *AGSP* and *FEID* phases).

7. We presented the preliminary classifications, with brief descriptions of each type, at training sessions in 1972 and in 1973. These were immediately put into use on the National Forests. We solicited evaluations from users of the preliminary classification, and attempted to rectify problems, often by conducting more field sampling of problem stands.

Table 1.--*Montana forest habitat types*

ADP code[1]	Abbreviation	Habitat types and phases: Scientific names	Habitat types and phases: Common names
010	SCREE		
000		PINUS FLEXILIS CLIMAX SERIES	
040	PIFL/AGSP h.t.	Pinus flexilis/Agropyron spicatum h.t.	limber pine/bluebunch wheatgrass
050	PIFL/FEID h.t.	Pinus flexilis/Festuca idahoensis h.t.	limber pine/Idaho fescue
051	-FEID phase	-Festuca idahoensis phase	-Idaho fescue phase
052	-FESC phase	-Festuca scabrella phase	-rough fescue phase
070	PIFL/JUCO h.t.	Pinus flexilis/Juniperus communis h.t.	limber pine/common juniper
100		PINUS PONDEROSA CLIMAX SERIES	
110	PIPO/AND h.t.[2]	Pinus ponderosa/Andropogon spp. h.t.	ponderosa pine/bluestem
130	PIPO/AGSP h.t.	Pinus ponderosa/Agropyron spicatum h.t.	ponderosa pine/bluebunch wheatgrass
140	PIPO/FEID h.t.	Pinus ponderosa/Festuca idahoensis h.t.	ponderosa pine/Idaho fescue
141	-FEID phase	-Festuca idahoensis phase	-Idaho fescue phase
142	-FESC phase	-Festuca scabrella phase	-rough fescue phase
160	PIPO/PUTR h.t.	Pinus ponderosa/Purshia tridentata h.t.	ponderosa pine/bitterbrush
161	-AGSP phase	-Agropyron spicatum phase	-bluebunch wheatgrass phase
162	-FEID phase	-Festuca idahoensis phase	-Idaho fescue phase
170	PIPO/SYAL h.t.	Pinus ponderosa/Symphoricarpos albus h.t.	ponderosa pine/snowberry
171	-SYAL phase	-Symphoricarpos albus phase	-snowberry phase
172	-BERE phase	-Berberis repens phase	-creeping oregon grape phase
180	PIPO/PRVI h.t.	Pinus ponderosa/Prunus virginiana h.t.	ponderosa pine/chokecherry
181	-PRVI phase	-Prunus virginiana phase	-chokecherry phase
182	-SHCA phase	-Shepherdia canadensis phase	-buffaloberry phase
200		PSEUDOTSUGA MENZIESII CLIMAX SERIES	
210	PSME/AGSP h.t.	Pseudotsuga menziesii/Agropyron spicatum h.t.	Douglas-fir/bluebunch wheatgrass
220	PSME/FEID h.t.	Pseudotsuga menziesii/Festuca idahoensis h.t.	Douglas-fir/Idaho fescue
230	PSME/FESC h.t.	Pseudotsuga menziesii/Festuca scabrella h.t.	Douglas-fir/rough fescue
250	PSME/VACA h.t.	Pseudotsuga menziesii/Vaccinium caespitosum h.t.	Douglas-fir/dwarf huckleberry
260	PSME/PHMA h.t.	Pseudotsuga menziesii/Physocarpus malvaceus h.t.	Douglas-fir/ninebark
261	-PHMA phase	-Physocarpus malvaceus phase	-ninebark phase
262	-CARU phase	-Calamagrostis rubescens phase	-pinegrass phase
280	PSME/VAGL h.t.	Pseudotsuga menziesii/Vaccinium globulare h.t.	Douglas-fir/blue huckleberry
281	-VAGL phase	-Vaccinium globulare phase	-blue huckleberry phase
282	-ARUV phase	-Arctostaphylos uva-ursi phase	-kinnikinnick phase
283	-XETE phase	-Xerophyllum tenax phase	-beargrass phase
290	PSME/LIBO h.t.	Pseudotsuga menziesii/Linnaea borealis h.t.	Douglas-fir/twinflower
291	-SYAL phase	-Symphoricarpos albus phase	-snowberry phase
292	-CARU phase	-Calamagrostis rubescens phase	-pinegrass phase
293	-VAGL phase	-Vaccinium globulare phase	-blue huckleberry phase
310	PSME/SYAL h.t.	Pseudotsuga menziesii/Symphoricarpos albus h.t.	Douglas-fir/snowberry
311	-AGSP phase	-Agropyron spicatum phase	-bluebunch wheatgrass phase
312	-CARU phase	-Calamagrostis rubescens phase	-pinegrass phase
313	-SYAL phase	-Symphoricarpos albus phase	-snowberry phase
320	PSME/CARU h.t.	Pseudotsuga menziesii/Calamagrostis rubescens h.t.	Douglas-fir/pinegrass
321	-AGSP phase	-Agropyron spicatum phase	-bluebunch wheatgrass phase
322	-ARUV phase	-Arctostaphylos uva-ursi phase	-kinnikinnick phase
323	-CARU phase	-Calamagrostis rubescens phase	-pinegrass phase
324	-PIPO phase	-Pinus ponderosa phase	-ponderosa pine phase
330	PSME/CAGE h.t.	Pseudotsuga menziesii/Carex geyeri h.t.	Douglas-fir/elk sedge
340	PSME/SPBE h.t.	Pseudotsuga menziesii/Spiraea betulifolia h.t.	Douglas-fir/white spiraea
350	PSME/ARUV h.t.	Pseudotsuga menziesii/Arctostaphylos uva-ursi h.t.	Douglas-fir/kinnikinnick
360	PSME/JUCO h.t.	Pseudotsuga menziesii/Juniperus communis h.t.	Douglas-fir/common juniper
370	PSME/ARCO h.t.	Pseudotsuga menziesii/Arnica cordifolia h.t.	Douglas-fir/heartleaf arnica
380	PSME/SYOR h.t.[2]	Pseudotsuga menziesii/Symphoricarpos oreophilus h.t.	Douglas-fir/mountain snowberry
400		PICEA CLIMAX SERIES	
410	PICEA/EQAR h.t.	Picea/Equisetum arvense h.t.	spruce/common horsetail
420	PICEA/CLUN h.t.	Picea/Clintonia uniflora h.t.	spruce/queencup beadlily
421	-VACA phase	-Vaccinium caespitosum phase	-dwarf huckleberry phase
422	-CLUN phase	-Clintonia uniflora phase	-queencup beadlily phase
430	PICEA/PHMA h.t.	Picea/Physocarpus malvaceus h.t.	spruce/ninebark
440	PICEA/GATR h.t.	Picea/Galium triflorum h.t.	spruce/sweetscented bedstraw
450	PICEA/VACA h.t.	Picea/Vaccinium caespitosum h.t.	spruce/dwarf huckleberry
460	PICEA/SEST h.t.	Picea/Senecio streptanthifolius h.t.	spruce/cleft-leaf groundsel
461	-PSME phase	-Pseudotsuga menziesii phase	-Douglas-fir phase
462	-PICEA phase	-Picea phase	-spruce phase
470	PICEA/LIBO h.t.	Picea/Linnaea borealis h.t.	spruce/twinflower
480	PICEA/SMST h.t.	Picea/Smilacina stellata h.t.	spruce/starry Solomon's seal
500		ABIES GRANDIS CLIMAX SERIES	
510	ABGR/XETE h.t.	Abies grandis/Xerophyllum tenax h.t.	grand fir/beargrass
520	ABGR/CLUN h.t.	Abies grandis/Clintonia uniflora h.t.	grand fir/queencup beadlily
521	-CLUN phase	-Clintonia uniflora phase	-queencup beadlily phase
522	-ARNU phase	Aralia nudicaulis phase	-wild sarsaparilla phase
523	-XETE phase	-Xerophyllum tenax phase	-beargrass phase
590	ABGR/LIBO h.t.	Abies grandis/Linnaea borealis h.t.	grand fir/twinflower
591	-LIBO phase	-Linnaea borealis phase	-twinflower phase
592	-XETE phase	-Xerophyllum tenax phase	-beargrass phase

(con.)

Table 1.--(con.)

ADP code[1]	Abbreviation	Habitat types and phases	
		Scientific names	Common names
501		THUJA PLICATA CLIMAX SERIES	
530	THPL/CLUN h.t.	Thuja plicata/Clintonia uniflora h.t.	western redcedar/queencup beadlily
531	-CLUN phase	-Clintonia uniflora phase	-queencup beadlily phase
532	-ARNU phase	-Aralia nudicaulis phase	-wild sarsaparilla phase
533	-MEFE phase	-Menziesia ferruginea phase	-menziesia phase
550	THPL/OPHO h.t.	Thuja plicata/Oplopanax horridum h.t.	western redcedar/devil's club
502		TSUGA HETEROPHYLLA CLIMAX SERIES	
570	TSHE/CLUN h.t.	Tsuga heterophylla/Clintonia uniflora h.t.	western hemlock/queencup beadlily
571	-CLUN phase	-Clintonia uniflora phase	-queencup beadlily phase
572	-ARNU phase	-Aralia nudicaulis phase	-wild sarsaparilla phase
600		ABIES LASIOCARPA CLIMAX SERIES	
700		Lower subalpine h.t.s	
610	ABLA/OPHO h.t.	Abies lasiocarpa/Oplopanax horridum h.t.	subalpine fir/devil's club
620	ABLA/CLUN h.t.	Abies lasiocarpa/Clintonia uniflora h.t.	subalpine fir/queencup beadlily
621	-CLUN phase	-Clintonia uniflora phase	-queencup beadlily phase
622	-ARNU phase	-Aralia nudicaulis phase	-wild sarsaparilla phase
623	-VACA phase	-Vaccinium caespitosum phase	-dwarf huckleberry phase
624	-XETE phase	-Xerophyllum tenax phase	-beargrass phase
625	-MEFE phase	-Menziesia ferruginea phase	-menziesia phase
630	ABLA/GATR h.t.	Abies lasiocarpa/Galium triflorum h.t.	subalpine fir/sweetscented bedstraw
640	ABLA/VACA h.t.	Abies lasiocarpa/Vaccinium caespitosum h.t.	subalpine fir/dwarf huckleberry
650	ABLA/CACA h.t.	Abies lasiocarpa/Calamagrostis canadensis h.t.	subalpine fir/bluejoint
651	-CACA phase	-Calamagrostis canadensis phase	-bluejoint phase
653	-GATR phase	-Galium triflorum phase	-sweetscented bedstraw phase
654	-VACA phase	-Vaccinium caespitosum phase	-dwarf huckleberry phase
660	ABLA/LIBO h.t.	Abies lasiocarpa/Linnaea borealis h.t.	subalpine fir/twinflower
661	-LIBO phase	-Linnaea borealis phase	-twinflower phase
662	-XETE phase	-Xerophyllum tenax phase	-beargrass phase
663	-VASC phase	-Vaccinium scoparium phase	-grouse whortleberry phase
670	ABLA/MEFE h.t.	Abies lasiocarpa/Menziesia ferruginea h.t.	subalpine fir/menziesia
680	TSME/MEFE h.t.	Tsuga mertensiana/Menziesia ferruginea h.t.	mountain hemlock/menziesia
690	ABLA/XETE h.t.	Abies lasiocarpa/Xerophyllum tenax h.t.	subalpine fir/beargrass
691	-VAGL phase	-Vaccinium globulare phase	-blue huckleberry phase
692	-VASC phase	-Vaccinium scoparium phase	-grouse whortleberry phase
710	TSME/XETE h.t.	Tsuga mertensiana/Xerophyllum tenax h.t.	mountain hemlock/beargrass
720	ABLA/VAGL h.t.	Abies lasiocarpa/Vaccinium globulare h.t.	subalpine fir/blue huckleberry
730	ABLA/VASC h.t.	Abies lasiocarpa/Vaccinium scoparium h.t.	subalpine fir/grouse whortleberry
731	-CARU phase	-Calamagrostis rubescens phase	-pinegrass phase
732	-VASC phase	-Vaccinium scoparium phase	-grouse whortleberry phase
733	-THOC phase	-Thalictrum occidentale phase	-western meadowrue phase
740	ABLA/ALSI h.t.	Abies lasiocarpa/Alnus sinuata h.t.	subalpine fir/Sitka alder
750	ABLA/CARU h.t.	Abies lasiocarpa/Calamagrostis rubescens h.t.	subalpine fir/pinegrass
770	ABLA/CLPS h.t.	Abies lasiocarpa/Clematis pseudoalpina h.t.	subalpine fir/virgin's bower
780	ABLA/ARCO h.t.	Abies lasiocarpa/Arnica cordifolia h.t.	subalpine fir/heartleaf arnica
790	ABLA/CAGE h.t.[2]	Abies lasiocarpa/Carex geyeri h.t.	subalpine fir/elk sedge
791	-CAGE phase	-Carex geyeri phase	-elk sedge phase
792	-PSME phase	-Pseudotsuga menziesii phase	-Douglas-fir phase
800		Upper subalpine h.t.s	
810	ABLA/RIMO h.t.[2]	Abies lasiocarpa/Ribes montigenum h.t.	subalpine fir/mountain gooseberry
820	ABLA-PIAL/VASC h.t.	Abies lasiocarpa-Pinus albicaulis/Vaccinium scoparium h.t.	subalpine fir-whitebark pine/ grouse whortleberry
830	ABLA/LUHI	Abies lasiocarpa/Luzula hitchcockii h.t.	subalpine fir/smooth wood-rush
831	-VASC phase	-Vaccinium scoparium phase	-grouse whortleberry phase
832	-MEFE phase	-Menziesia ferruginea phase	-menziesia phase
840	TSME/LUHI h.t.[2]	Tsuga mertensiana/Luzula hitchcockii h.t.	mountain hemlock/smooth wood-rush
841	-VASC phase	-Vaccinium scoparium phase	-grouse whortleberry phase
842	-MEFE phase	-Menziesia ferruginea phase	-menziesia phase
890		Timberline h.t.s	
850	PIAL-ABLA h.t.s	Pinus albicaulis-Abies lasiocarpa h.t.s	whitebark pine-subalpine fir
860	LALY-ABLA h.t.s	Larix lyallii-Abies lasiocarpa h.t.s	alpine larch-subalpine fir
870	PIAL h.t.s	Pinus albicaulis h.t.s	whitebark pine
900		PINUS CONTORTA CLIMAX SERIES	
910	PICO/PUTR h.t.	Pinus contorta/Purshia tridentata h.t.	lodgepole pine/bitterbrush
920	PICO/VACA c.t.	Pinus contorta/Vaccinium caespitosum c.t.	lodgepole pine/dwarf huckleberry
930	PICO/LIBO c.t.	Pinus contorta/Linnaea borealis c.t.	lodgepole pine/twinflower
940	PICO/VASC c.t.	Pinus contorta/Vaccinium scoparium c.t.	lodgepole pine/grouse whortleberry
950	PICO/CARU c.t.	Pinus contorta/Calamagrostis rubescens c.t.	lodgepole pine/pinegrass

Total Number of Habitat Types = 64

Total Number of Habitat Types, Phase, and Pinus contorta Community Type Categories = 105

[1] Automatic data processing codes for National Forest System use.
[2] Minor type in Montana; described in other study areas.

8. We developed the final classification (table 1) after 3 years of field testing and revising preliminary classifications, and incorporating new data. This included redefining types, rewriting the keys, checking all stands against the classification, and mutually agreeing on the types and phases. Approximately 3 percent of the sample stands did not fit the resulting classification. Many of these were ecotones or vegetational mosaics, unusual seral communities, very dense stands with little undergrowth, or minor or local associations. Some of the latter may represent potential habitat types that our data were too scant to identify.

9. We prepared a description for each habitat type, including a generalized discussion of geographic distribution, physical environmental features, key vegetational features, descriptions of phases, and the basis for their separation.

10. Where environmental characteristics and vegetative features provide a basis for predicting response to management practices, we have pointed out some of the more obvious interrelations. This classification should serve as a foundation for further development of "site-specific" management implications pertaining to several disciplines.

Taxonomic Considerations

Voucher collections of several thousand plants were made in the course of stand sampling. About 1,000 specimens of the better collections have been deposited in the herbarium of the Forestry Sciences Laboratory, Missoula. Most of the plants were identified to species, but some nonflowering specimens could not be identified to or beyond the genus level. Peter F. Stickney of the Missoula herbarium verified many of the field identifications. Specimens of some of the more difficult groups were sent to the USDA Forest Service herbarium in Fort Collins, Colorado, where Dr. F. J. Hermann made determinations for *Carex* and Dr. Charles Feddema identified the remaining groups. Determinations for *Penstemon* were made by Dr. David V. Clark, Colorado Mountain College, Glenwood Springs; Dr. Rupert C. Barneby, Greenport, Long Island, made the identifications for *Astragalus* and *Oxytropis*. The presence table (appendix C-2) provides a complete list of species found in at least five of the nearly 1,500 stands sampled. Nomenclature generally follows Hitchcock and Cronquist (1973).

The nature of the survey method often required that field identification be made on material in vegetative, sterile, or other than optimal condition for taxonomic separation. This prevented positive identification of some closely related species; in such cases, specimens were grouped under the most prevalent species for the region.

A few species presented special taxonomic problems. Although *Vaccinium membranaceum* is reported for Montana (Hitchcock and others 1955-69), essentially all of our *Vaccinium globulare-V. membranaceum* collections appeared to be *V. globulare*.

Vaccinium myrtillus often intergrades extensively with *V. scoparium* and perhaps also with *V. globulare* in Montana. Our tabular data represent *V. myrtillus* as identified by the strictest taxonomic criteria.

Clematis pseudoalpina and *C. tenuiloba* are evidently restricted to similar environments and they intergrade to such a confusing extent that we lumped them under *C. pseudoalpina*.

Special attention needs to be given to the distinction between *Pinus albicaulis* and *P. flexilis* in Montana. *Pinus albicaulis* grows at high elevations all across the Montana Rockies, whereas *P. flexilis* is common below the forest zone along or east of the Continental Divide extending up to midelevations on droughty sites. Cones of *Pinus albicaulis* are purple and *disintegrate on the tree* (leaving only broken scales on the ground), whereas those of *P. flexilis* turn from green to brown and *remain intact on the* *ground* for a few years. *Pinus albicaulis* is a common forest component whose reproduction, usually as stagnant saplings, may extend down to midelevations. *Pinus flexilis* is rarely a component of dense forests, and seldom reproduces in stands dominated by other species.

Most *Picea* populations in Montana are the result of *P. engelmannii* X *P. glauca* hybridization (Daubenmire 1974; Habeck and Weaver 1969). However, our observations and cone scale measurements indicate recognizable differences in the degree of hybridization. The cone scales of *Picea glauca* are broadest near the tip, which is rounded and smooth. The cone scales of *P. engelmannii* are broadest near the base, narrowing at the tip, and having a wavy, crinkled, papery margin. *P. engelmannii* twigs are usually finely pubescent, whereas those of *P. glauca* are normally without hairs. Recognition of these and other taxonomic differences (Daubenmire 1974) is important for silvicultural practices and future research efforts involving *Picea*.

Synecological Perspective and Terminology

Definition and Explanation of Habitat Type

All land areas potentially capable of producing similar plant communities at climax may be classified as the same habitat type (Daubenmire 1968b). The climax plant community, because it is the end result of plant succession, reflects the most meaningful integration of the environmental factors affecting vegetation. Thus, each habitat type represents a relatively narrow segment of environmental variation and delineates a certain potential for vegetative development. One habitat type may support a variety of disturbance-induced, or seral, plant communities, but the vegetative succession will ultimately produce similar plant communities at climax throughout the type.

The climax community type, or association, provides a logical name for the habitat type--for example, *Pseudotsuga menziesii/Calamagrostis rubescens*. The first part of this name is based on the climax tree species, which is usually the most shade-tolerant tree adapted to the site. We call this level of classification the series and it encompasses all habitat types having the same dominant tree at climax. The second part of the habitat type name is based on the dominant or characteristic undergrowth species in the climax community type.

Use of climax community types to name habitat types does not imply that we have an abundance of climax vegetation in the present landscape. Actually, most vegetation in the landscape reflects some form of disturbance and various stages of succession towards climax. Nor do climax community type names imply that management is for climax vegetation; in fact, seral species are frequently preferred for timber and wildlife browse production. Furthermore, this method does not require the presence of a climax stand to identify the habitat type. It can be identified during most intermediate stages of succession by comparing the relative reproductive success of the tree species present with known successional trends and by observing the existing undergrowth vegetation. Successional trends toward climax usually appear to progress more rapidly in the undergrowth than in the tree layer. In very early stages of secondary succession, the habitat type can be identified by comparing the site with similar adjacent ones having mature stands.

Not all units of land will fit neatly into the habitat type system. As in most biological classifications, intergrades, or transitional areas will be encountered. However, these situations occupy a small percentage of land and need not greatly detract from the utility of a habitat type classification.

The main advantage of habitat types in forest management is that they provide a permanent and ecologically-based system of land stratification. Each habitat type encompasses a certain amount of environmental variation, but the variation within a habitat type should be less than that between types. In addition, habitat types provide a classification of climax plant communities. Plant succession should be generally predictable for each habitat type, and similar responses to management treatments can be expected on units of land within the same type.

Habitat Types Versus Continuum Philosophy

A vigorous debate has been carried on for many years by ecologists who study plant communities--i.e., phytosociologists. Although several philosophies have been developed to interpret plant-community organization, two of them are often the center of debate: (1) the advocates of typal communities argue that distinct vegetation types develop at climax and are repeated over the landscape where environmental conditions are similar; (2) continuum advocates argue that even at climax, vegetation, like environmental conditions, varies continuously over the landscape (Daubenmire 1966; Cottam and McIntosh 1966; Vogl 1966). Some of those who accept the typal communities philosophy may view habitat type classification much the same as they view the taxonomic classification of the plant kingdom. Continuum advocates may regard habitat type classifications as an attempt to make categories by drawing fine lines at intervals along a complex vegetational continuum. Collier and others (1973) presented these contrasting philosophies and advocated an intermediate viewpoint.

While this debate may be of interest academically, it need not preoccupy natural resource managers and field biologists who need a logical, ecologically-based classification with which to work. We have proceeded under the philosophy that if a "continuum" does exist, then we would subdivide it into classes. Our primary objective has remained to develop a logical classification that reflects the natural patterns found on the landscape. Local conditions that deviate from this classification can still be described in terms of how they differ from the nearest typal description.

Some Synecological Relationships

R. and J. Daubenmire (1968) presented a detailed discussion of many synecological concepts that apply here also. Like the Daubenmires, we found that overstory and undergrowth unions generally do not have identical range limits. Some of the undergrowth unions that the Daubenmires defined in combination with only one climax overstory union were found more broadly distributed in Montana forests. Thus, we have *Xerophyllum tenax* as an undergrowth type with *Pseudotsuga menziesii* and *Abies grandis* as well as *A. lasiocarpa* and *Tsuga mertensiana*. In these situations, distinguishing habitat types primarily on the basis of climax tree species leads to recognizing a larger number of habitat types. Other aspects of undergrowth-overstory relationships are discussed in the series and habitat type descriptions.

Our stand tables and observations also support R. and J. Daubenmire's (1968) contention that the "principle of competitive exclusion" is rarely achieved in natural stands because it requires several centuries without disturbance. However, there is a *trend* toward dominance by the most shade-tolerant tree species. This trend is most evident on mesic sites, where the seral and climax species show the greatest differences in shade tolerance. It becomes less evident as climax species such as *Tsuga*, *Thuja*, and *Abies grandis* reach their geographic range limits eastward across the Montana Rockies. In such peripheral stands, these species do not always maintain their characteristic ability to exclude other species at climax (R. and J. Daubenmire 1968). The trend toward monospecific dominance is also less evident where forests do not develop a closed canopy. Stand analysis indicates that certain conifers persist in a minor climax or even coclimax status along with the dominant climax species in several habitat types. These relationships are portrayed in appendix B. In the interest of simplicity the habitat type name usually reflects only one major climax species. Exceptions are *ABLA-PIAL/VASC*, *PIAL-ABLA*, and *LALY-ABLA* habitat types (table 1).

Although transitional areas or ecotones between habitat types can be interpreted as being broad or narrow, our approach was to interpret them as narrowly as possible. In this way, more of the land surface is definable to habitat type and less is in ecotonal categories that may be impractical for use in resource management.

In discussing the relationship of a habitat type to certain environmental features, we have followed the polyclimax concept of Tansley (1935). Thus, a *climatic climax* develops on deep loamy soils of gently undulating relief; an *edaphic climax* differs from the climatic climax due to extreme soil conditions such as coarse texture or poor drainage; and a *topographic climax* reflects compensating effects of topography on microclimate. The *topoedaphic climax* is a convenient way to designate deviation from a climatic climax due to combined effects of edaphic and topographic features. Some habitat types reflect only one type of climax, but the majority of them occur in two or more of the above categories in response to interaction of environmental factors.

THE PHYSICAL SETTING

Topography and Geology

The western one-third of Montana--roughly, the area west of a line running from Red Lodge to East Glacier Park--is prominently mountainous with intervening valleys. However, isolated mountain ranges occur as far as 150 to 200 miles east of that line (fig. 3) in the Montana Great Plains. In northwestern and west-central Montana (fig. 1), valley base elevations generally range between 2,000 and 4,000 feet; these valleys are either forested or grassland. The major mountain ranges rise to elevations of 7,000 to 9,000 feet. These mountains support extensive forests up to subalpine levels, and there is a small amount of area above the alpine timberline.

In central Montana the broad, grassy intermountain valleys are generally 4,000 to 5,000 feet in elevation; the major mountain ranges, which are often less rugged than ranges to the west, rise to between 7,000 to 9,000 feet.

In the southwestern and south-central portions of the State the grassy intermountain valleys are high, generally 4,500 to 6,500 feet, and major mountain ranges usually rise to 10,000 feet or higher. The Absaroka and Beartooth Ranges have rather extensive plateau-like areas above timberline.

The surface geologic formation throughout most of northwestern Montana is the Precambrian Belt Series, consisting primarily of quartzites and argillites. The Idaho and Boulder Batholiths comprise the Bitterroot Range west of the Bitterroot Valley and much of the southern Sapphire and Anaconda-Pintlar Ranges as well as the Continental Divide from Butte to Helena. Composition is predominantly granitic with inclusions of gneiss and schist. Volcanic and sedimentary rocks (both limestone and nonlimestone) constitute most of the remainder of the Montana Rockies. Many of the mountain areas near or east of the Continental Divide are geologically complex in contrast to areas farther west (Perry 1962).

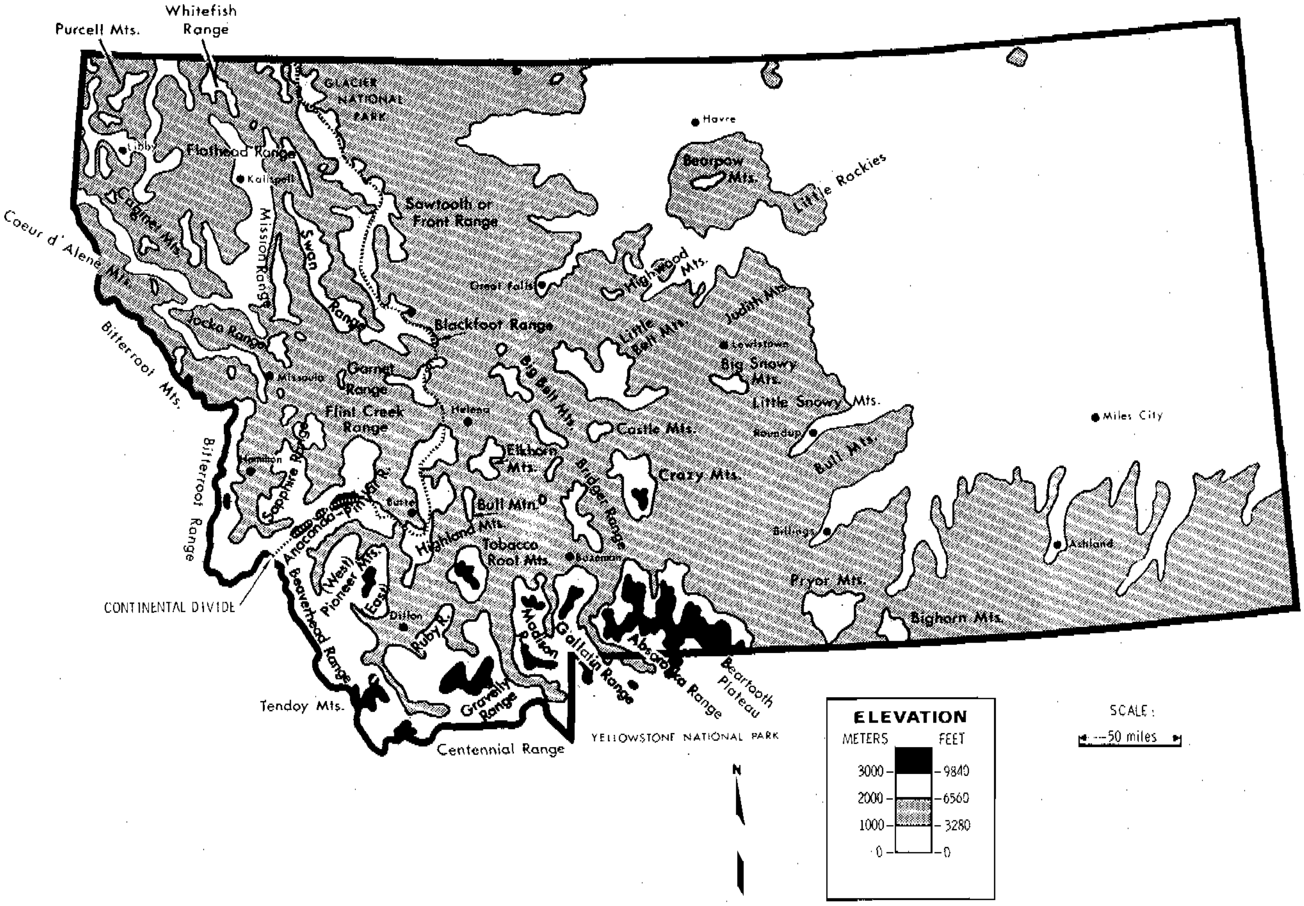


Figure 3.--Distribution of mountain ranges in Montana

Most of the prominent valleys in the Montana Rockies contain a layer of alluvium deposited by streams and glacial action. The majority of these areas support grassland, riparian, or cultivated vegetation, although substantial areas in northwestern Montana valleys support forests.

Contrasting plant communities develop where limestone and noncalcareous substrates meet in many areas east of the Continental Divide in Montana. Bamberg and Major (1968), Despain (1973), Patten (1963), and others have described vegetational patterns related to limestone substrates in and adjacent to Montana. Herbert Holdorf--soil scientist on the Lewis and Clark National Forest at Great Falls, Montana--has also noted the relationships of various geological substrates to soil and forest development. Goldin (1976) has enumerated Holdorf's observations in addition to documenting the relationship of forest habitat types to three substrates (limestone, granite, and quartzite) in the Garnet Range east of Missoula. Several correlations of forest vegetation to limestone and other calcareous rocks became apparent during the current study and are discussed in later sections

Soils

In general, Montana forest soils are quite rocky, reflecting their mountainous setting. Because steep topography and rocky soils are so prevalent, sites capable of supporting a climatic climax are scarce over much of the forested landscape.

In northern Idaho, R. and J. Daubenmire (1968) observed that soil mantles on leeward slopes were better developed than those on windward slopes because of wind-deposited loess and volcanic ash from the west. This correlation applies also in Montana west of the Continental Divide although it is usually much less pronounced.

Nimlos (1963) described the prominent great soil groups found in Montana west of the Continental Divide. Brown Podzolic soils occupy the moister forest sites--"areas of more than 25 inches of mean annual precipitation on fine textured calcareous materials and on areas of more than 17 inches on coarse textured, acid materials." He further stated that a Bir horizon 4 to 18 inches thick is the most diagnostic feature of these soils. Brown Podzolic soils are apparently also associated with moist forest types east of the Divide in Montana (Western Land Grant Univ. 1964). Such soils are evidently associated with the *Tsuga*, *Thuja*, *Abies grandis*, and *A. lasiocarpa* climax series we well as wetter habitat types in the *Picea*, *Pinus contorta*, and *Pseudotsuga* series.

Gray Wooded soils (Nimlos 1963; Western Land Grant Univ. 1964) are associated with the drier forest types in Montana. The average annual precipitation of these sites, which support the *Pinus ponderosa* and drier part of the *Pseudotsuga* series, is about 15 to 20 inches.

Chernozems are also likely to be found in the open forests where steppe understory vegetation has a dominant soil forming effect.

According to the maps, descriptions, and nomenclature of the new *Soil Taxonomy* (USDA Soil Conservation Service 1975) the major subgroups of soils in Montana forests are:

1. Cryoborolls--on lower elevation slopes with grass-dominated undergrowth.
2. Cryoboralfs--on midelevation slopes in central and southern Montana.
3. Cryandepts--on midelevation slopes in areas of western Montana with volcanic ash deposits.
4. Cryochrepts--on higher elevation and steep slopes throughout mountains of Montana.
5. Torriorthents--shallow soils on the steep mountain slopes, badlands, and rolling plains in central and southeastern Montana.

Climate and Microclimate

The Continental Divide exerts a marked influence on Montana's climate (U.S. Dep. Commerce 1971), resulting in marked vegetation differences across the State. The area west of the Divide has an inland climate strongly modified by moisture-laden air masses from the North Pacific Ocean. Mild, cloudy weather prevails in all seasons except midsummer. Precipitation is rather evenly distributed throughout the year, except for a dry period in July and August. In the northwest portion of the State, where the maritime influence is strongest, some of the lower elevations have a sufficiently moist (average annual precipitation greater than 30 inches) and mild climate to support vegetation similar to that of the Pacific Coast mountains (*Tsuga* and *Thuja* series). Eastward, Pacific Coast species drop out of the flora as oceanic moisture diminishes with each crossing of a mountain range.

East of the Divide the climate is decidedly continental. It is characterized by warm summers with a high proportion of the precipitation falling between May and September and winter conditions that have invasions of subzero Arctic air followed by warm dry Chinook winds.

Elevation also has a major effect on climate and thus on vegetation patterns. Except in extreme northwestern Montana, lowlands are semiarid and support either grassland or very dry forest types. Mountains are much cooler and often receive two to three times as much annual precipitation, most of it coming in the form of snow. Above 8,000 feet in northern Montana and 9,500 feet in southern Montana, forests give way to alpine tundra. About 25 mountain ranges in the State support some tundra, which develops on sites having mean July temperatures of less than 50 degrees F. (Arno 1970). Thus, the lower elevational limits of coniferous forests are controlled primarily by moisture, while the upper elevational limits are controlled primarily by temperature.

Topographic features also have a strong influence on microclimate, as R. and J. Daubenmire (1968) pointed out. North and south exposures have strongly contrasting environments because of differences in insolation, snow accumulation, and soil development. Cold air drains down into mountain valleys at night and forms "frost pockets" behind topographic constrictions. These sites are occupied by distinctive vegetation, some of it characteristic of higher elevations.

SUCCESSIONAL STATUS OF MONTANA FORESTS

Fire History

Recognition of the important role played by lightning-caused fires in Montana forests has been growing, especially in the last few decades (Wellner 1970). During our sampling, we observed and recorded evidence of past fires on about 1,000 plots. Such evidence consists of partially-healed fire scars at the base of old trees or stumps, charred material on or in the ground, and presence of new stands or age-classes of seral species.

Some of the most abundant species in Montana forests are fire-adapted seral trees (Starker 1934; Wellner 1970). Mature *Larix occidentalis*, *Pinus ponderosa*, and *Pseudotsuga menziesii* have thick basal bark which makes them very resistant to fire. *Pinus contorta* and *Thuja* show moderate resistance to death from ground fire. Most other species (e.g., *Abies*, *Tsuga*, *Picea*) are likely to be killed by most fires, because of thin bark and susceptibility to rot entering fire-caused wounds.

The vast majority of all sample stands showed evidence of wildfire within the past two centuries, despite deliberate selection of the oldest and least-disturbed stands. The few stands that showed no evidence of fire in the past 200 years were usually at high elevations or on very moist sites.

In general, the *Pinus flexilis*, *Pinus ponderosa* and drier *Pseudotsuga* habitat types showed evidence of light ground fires at intervals averaging less than 30 years. Moister *Pseudotsuga* habitat types and *Abies lasiocarpa* habitat types showed much longer fire-free intervals, and the fires often resulted in formation of new stands, or at least in the addition of a new age class in surviving stands.

Arno (1976) cross-sectioned fire scars on old growth *Pinus ponderosa*, *Pseudotsuga menziesii*, *Pinus contorta*, *Larix occidentalis*, and *Pinus albicaulis* in several habitat types in three areas of the Bitterroot National Forest. He found that prior to 1900 average fire frequencies had been about 10 years in *Pinus ponderosa*/ and *Pseudotsuga*/ bunchgrass habitat types, 16-19 years in most other *Pseudotsuga* habitat types, 27 years in lower subalpine *Abies lasiocarpa* habitat types, and 30-33 years in upper subalpine and timberline habitat types. Many individual trees and stumps in *Pseudotsuga* habitat types at various locations in west-central Montana have scars from 10 or more fires in a period of 200 or 250 years; however, few fires occurred in the last 50 years.

Gabriel (1976) studied the fire history of *Pinus contorta*-dominated forests in an area of the Bob Marshall Wilderness, Flathead National Forest. He found evidence that fire had been rather frequent and that it burned at various intensities. Other fire frequency studies have been made by Houston (1973) in northern Yellowstone National Park and by Loope and Gruell (1973) in the Jackson Hole area of northwestern Wyoming. East of the Continental Divide, in the vast forests dominated by *Pinus contorta*, we commonly found stands where many of the trees had scars indicating they had survived one to three ground fires. If *Pinus contorta* stands survive more than about 100 years, they often become susceptible to attack and mortality from mountain pine beetle (*Dendroctonus ponderosae*); the resulting large buildup of dry fuels invites an intense conflagration (Roe and Amman 1970). *Pinus contorta* stands showing no evidence of having survived a fire were in most cases even-aged and evidently had become established after an intense forest fire.

Relative coverages and species composition in the tree layer and undergrowth often change dramatically after an intense fire. West of the Continental Divide, double or triple burns have sometimes removed the conifer seed source. Thus, a shrub-field stage of succession (composed of such species as *Amelanchier alnifolia*, *Salix scouleriana*, *Acer glabrum*, *Ceanothus velutinus*, *Prunus* spp., and *Physocarpus malvaceus*) may dominate the site for half a century or longer.

Grazing History

In general, domestic grazing has not had a pronounced impact upon the forest vegetation in Montana. In northwestern and west-central portions of the State, however, some of the most open, low-elevation forests (i.e., *Pinus ponderosa* series and drier habitat types in the *Pseudotsuga* series) and streamside areas have been moderately to heavily grazed by cattle, horses, or sheep. Hillsides too steep for cattle have not been grazed heavily, due to the decline in sheep raising in the past 20-30 years. Grazing has been extended into moister forest types in some localities, such as the Montana-Idaho Divide west of Superior, where sheep were historically grazed. Also, clearcuts and other heavily logged areas are often used by cattle. Still, a large proportion of the west-side forest has apparently never been grazed by domestic stock.

East of the Continental Divide, there is a higher proportion of dry, open forest having bunchgrasses and other palatable forage. Also, the forest is broken by extensive mountain grasslands suitable for summer range. Grazing is often extended up the major forested valleys where streamside vegetation and luxuriant meadows are common. Although lower east-side forests are often moderately to heavily grazed, the denser, high-elevation forests receive little use except as bedding areas where they border subalpine grasslands. Sheep grazing of alpine tundra on the Montana side of the Beartooth Plateau was halted in the 1950's, and plant recovery has been noticeable. Large flocks of sheep continue to graze the Wyoming portion of this alpine area.

Logging History

About half of the forest land in Montana had not been logged as of 1973. This generalization applies to both sides of the Continental Divide. However, in some historical mining localities such as Butte and Helena, extensive forests were cut between about 1870 and 1920. In the Highland Mountains south of Butte, for example, the forests were logged nearly to the alpine timberline.

Early settlement west of the Continental Divide brought extensive clearing of forests in the major valleys for farming and ranching. Heavy cutting was also associated with early mining and railroading activities. Commercial lumbering has long been practiced west of the Divide, and it has expanded considerably with the establishment of a diversified forest products industry in the past two decades. A great deal of virgin forest land both east and west of the Divide has been roaded and logged since 1950, but several wilderness and primitive areas have also been established and many of the remaining roadless areas are being studied for possible inclusion in the National Wilderness System.

THE HABITAT TYPE CLASSIFICATION

We defined a total of 64 forest habitat types for Montana. Although this may seem like an unusually large number, the environmental diversity across the State warrants recognition of many types.

Figure 4 shows a generalized elevational distribution of the various climax series encountered in the Montana Rockies, except for the *Pinus contorta* series. These are

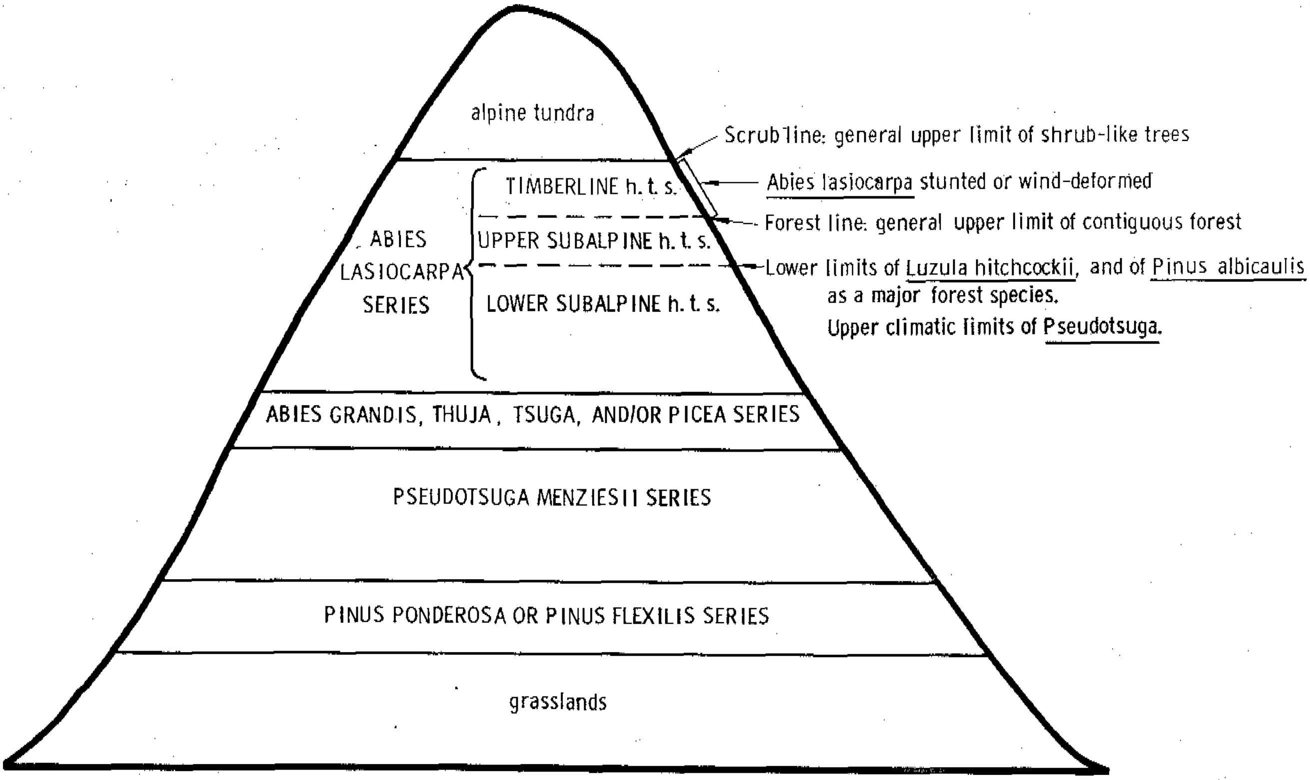


Figure 4.--Generalized climax zonation of the coniferous forest series in Montana.

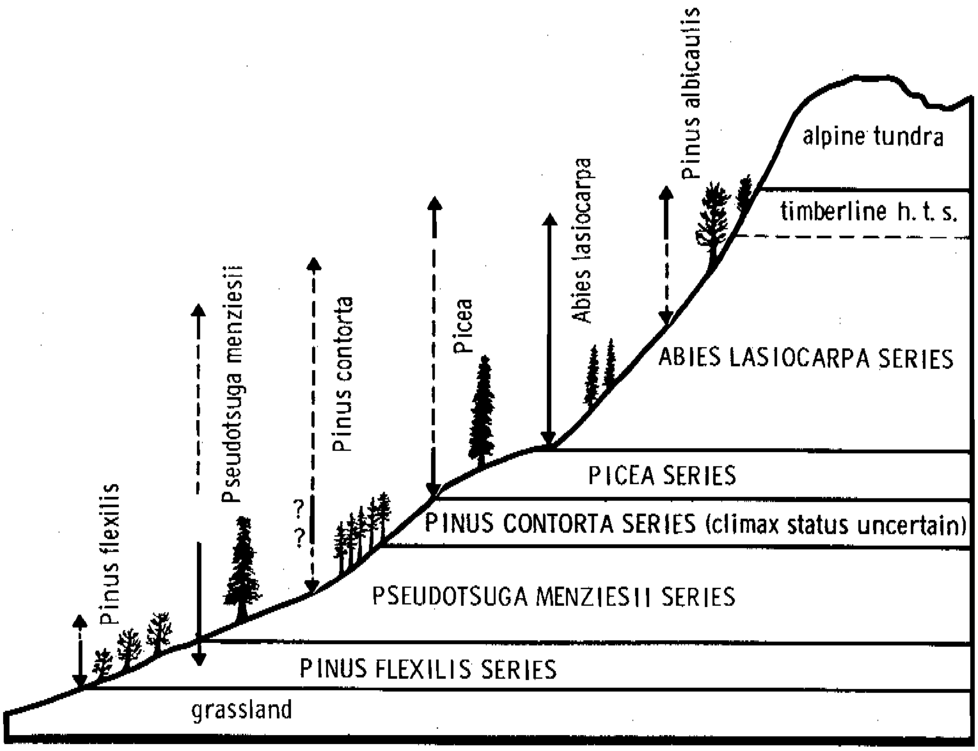


Figure 5.--Generalized distribution of forest trees in southwestern and south-central Montana. Arrows show the relative elevational range of each species; solid portion of the arrow indicates where a species is the potential climax and dashed portion shows where it is seral.

discussed in approximately the order shown here, going from dry, warm (lower elevation) sites to increasingly colder and more moist conditions.

These series do not all occur in all parts of the Montana Rockies. For instance, in much of southwestern and south-central Montana, the *Pinus ponderosa*, *Abies grandis*, *Thuja plicata*, and *Tsuga heterophylla* series are absent. The distribution of individual tree species and the climax series relationships for that area are shown in figure 5.

The greatest number of climax series is found in certain parts of northwestern Montana. Figure 6 shows a composite distribution of the most diverse zonation found in that area.

The total classification is listed in table 1 for convenient reference. Scientific names, abbreviated names, and common names are listed in the habitat type writeups, table 1, and the checklist, appendix F. Common names are not used in the text because they vary from place to place and could lead to confusion. With the need for frequent references to habitat type names in the text, some form of abbreviation seemed desirable. We have used a four-letter abbreviation consisting of the first two letters of the genus name and the first two letters of the species name. Although these abbreviations may be unfamiliar initially, we have found them to be readily accepted by professional foresters and biologists as a substitute for common names.

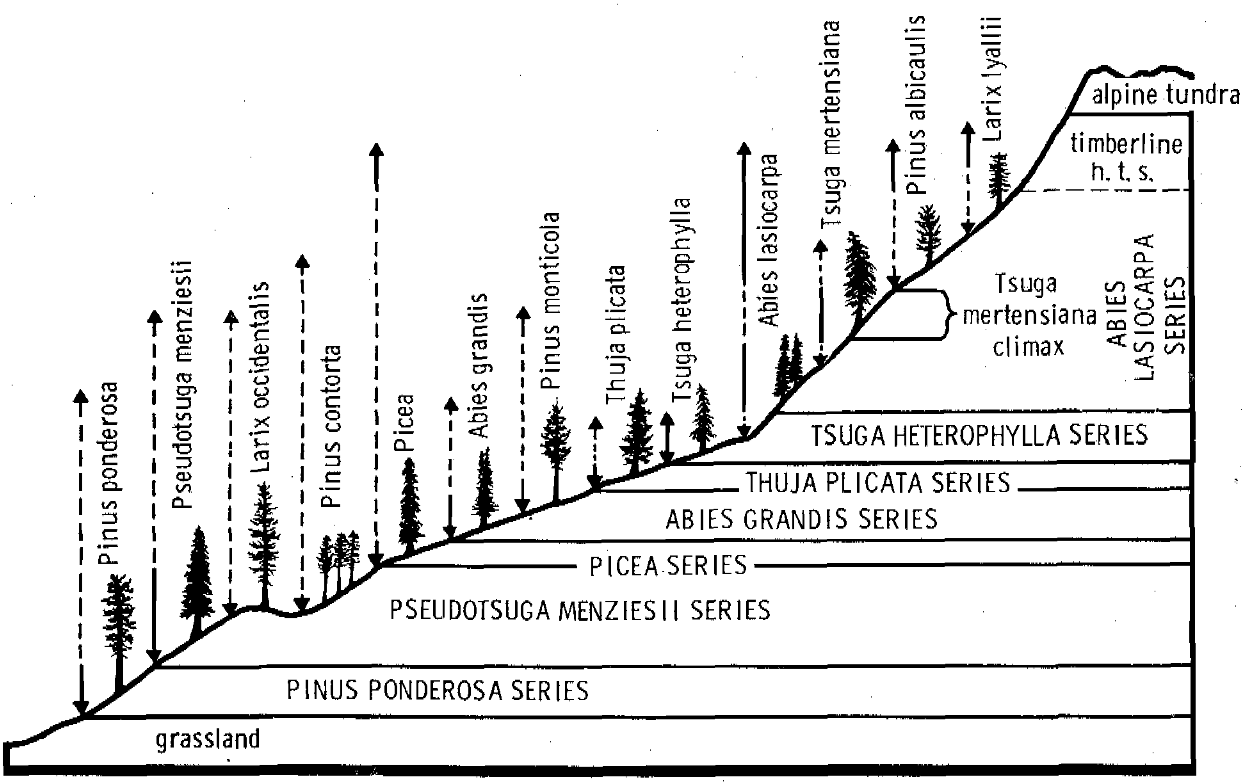


Figure 6.--Distribution of forest trees in an area of northwestern Montana. Arrows show the relative elevational range of each species; solid portion of the arrow indicates where a species is the potential climax and dashed portion shows where it is seral.

The classification is presented in the following order:

1. *Key to the habitat types (fig. 7).*--The first step in correct identification of the habitat type is becoming familiar with the instructions for use of the key. Next comes identification of the potential climax series, followed by identification of the habitat type and then the phase.

2. *Series description.*--Many habitat type characteristics are summarized at the series level, rather than repeating general similarities in vegetation and habitat characteristics in the habitat type descriptions.

3. *Habitat type description.*--This information summarizes geographic range, vegetation, phases, and general management implications.

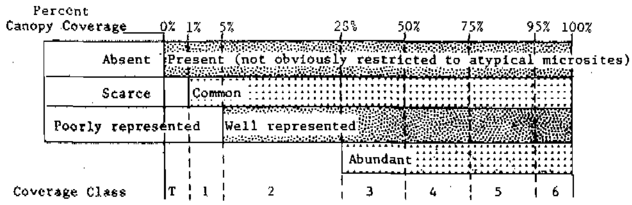
Pinus flexilis Series

Distribution.--In Montana *Pinus flexilis* distribution is related to the continental climatic regime; thus the species seldom occurs very far west of the Continental Divide. The *Pinus flexilis* series is found on some of the driest sites capable of supporting trees.

Figure 7. — Key to climax series, habitat types, and phases.

READ THESE INSTRUCTIONS FIRST!

1. Use this key for stands with a mature tree canopy that are not severely disturbed by grazing, logging, forest fire, etc. (If the stand is severely disturbed or in an early successional stage, the habitat type can best be determined by extrapolating from the nearest mature stand occupying a similar site.)
2. Accurately identify and record canopy coverages for all indicator species (appendix F).
3. Check plot data in the field to verify that the plot is representative of the stand as a whole. If not, take another plot.
4. Identify the correct potential climax tree species in the SERIES key. (Generally, a tree species is considered reproducing successfully if 10 or more individuals per acre occupy or will occupy the site.)
5. Within the appropriate series, key to HABITAT TYPE by following the key literally. Determine PHASE by matching the stand conditions with the phase descriptions for the type. (The first phase description that fits the stand is the correct one.)
6. Use the definitions diagramed below for canopy coverage terms in the key. If you have difficulty deciding between types, refer to constancy and coverage data (appendix C-1) and the habitat type descriptions.
7. In stands where undergrowth is obviously depauperate (unusually sparse) because of dense shading or duff accumulations, adjust the above definitions to the next lower coverage class (e.g., well represented >1%, common >0%).
8. Remember, the key is NOT the classification! Validate the determination made using the key by checking the written description.



KEY TO CLIMAX SERIES

(DO NOT PROCEED UNTIL YOU HAVE READ THE INSTRUCTIONS!)

1. Habitats on steep slopes (30°)composed primarily of unstable fine rock; undergrowth sparse, poorly developed and quite variable. . . . SCREE (p. 121)
1. Habitats on sites with some soil development and stability; undergrowth rather well developed and somewhat uniform. 2
   2. Tsuga heterophylla present and reproducing successfully . . . . TSUGA HETEROPHYLLA SERIES (item G)
   2. Tsuga heterophylla not the indicated climax 3
3. Thuja plicata present and reproducing successfully. . . . . THUJA PLICATA SERIES (item F)
3. Thuja plicata not the indicated climax. 4
   4. Abies grandis present and reproducing more successfully than Abies lasiocarpa. . . . . ABIES GRANDIS SERIES (item E)
   4. Abies grandis not the indicated climax. 5
5. Abies lasiocarpa, Tsuga mertensiana, or Larix lyallii present and reproducing successfully, or Pinus albicaulis the dominant tree . . . . . ABIES LASIOCARPA SERIES (item I)
5. Not as above. 6
   6. Picea present and reproducing successfully. . . . . PICEA SERIES (item D)
   6. Picea not the indicated climax. 7
7. Pinus flexilis a successfully reproducing dominant; often sharing that status with Pseudotsuga . . . . PINUS FLEXILIS SERIES (item A)
7. Pinus flexilis absent or clearly seral. 8
   8. Pseudotsuga menziesii present and reproducing successfully. . . . . . PSEUDOTSUGA MENZIESII SERIES (item C)
   8. Pseudotsuga menziesii not the indicated climax. 9
9. Pure Pinus contorta stands, with little evidence as to potential climax. . . . . PINUS CONTORTA SERIES (item H)
9. Pinus contorta absent; Pinus ponderosa the indicated climax . . . . PINUS PONDEROSA SERIES (item B)

A. Key to Pinus flexilis Habitat Types

1. Festuca idahoensis well represented or F. scabrella common. . . . . PINUS FLEXILIS/FESTUCA IDAHOENSIS h.t. (p. 25)
   a. Festuca scabrella common. . . . . FESTUCA SCABRELLA phase
   b. F. scabrella scarce . . . . FESTUCA IDAHOENSIS phase
1. F. idahoensis poorly represented and F. scabrella scarce. 2
   2. Agropyron spicatum well represented . . . . PINUS FLEXILIS/AGROPYRON SPICATUM h.t. (p. 24)
   2. A. spicatum poorly represented; Juniperus communis (or J. horizontalis) well represented . . . . PINUS FLEXILIS/JUNIPERUS COMMUNIS h.t.(p. 26)

B. Key to *Pinus ponderosa* Habitat Types

1. *Prunus virginiana* well represented; only in southeastern Montana	PINUS PONDEROSA/PRUNUS VIRGINIANA h.t. (p. 34)
a. *Shepherdia canadensis* well represented	SHEPHERDIA CANADENSIS phase
b. *Shepherdia* poorly represented	PRUNUS VIRGINIANA phase
1. *P. virginiana* poorly represented	2
2. *Symphoricarpos albus* well represented	PINUS PONDEROSA/SYMPHORICARPOS ALBUS h.t. (p. 33)
a. *Berberis repens* common	BERBERIS REPENS phase
b. *Berberis* scarce	SYMPHORICARPOS ALBUS phase
2. *S. albus* poorly represented	3
3. *Purshia tridentata* well represented	PINUS PONDEROSA/PURSHIA TRIDENTATA h.t. (p. 32)
a. *Festuca idahoensis* well represented or *F. scabrella* common	FESTUCA IDAHOENSIS phase
b. *F. idahoensis* poorly represented and *F. scabrella* scarce	AGROPYRON SPICATUM phase
3. *Purshia* poorly represented	4
4. *Festuca idahoensis* well represented or *F. scabrella* common	PINUS PONDEROSA/FESTUCA IDAHOENSIS h.t. (p. 31)
a. *Festuca scabrella* common	FESTUCA SCABRELLA phase
b. *F. scabrella* scarce	FESTUCA IDAHOENSIS phase
4. *F. idahoensis* poorly represented and *F. scabrella* scarce	5
5. *Agropyron spicatum* well represented	PINUS PONDEROSA/AGROPYRON SPICATUM h.t. (p. 30)
5. *A. spicatum* poorly represented; *Andropogon* spp. well represented	PINUS PONDEROSA/ANDROPOGON h.t. (p. 30)

C. Key to *Pseudotsuga menziesii* Habitat Types

1. *Vaccinium caespitosum* present	PSEUDOTSUGA MENZIESII/VACCINIUM CAESPITOSUM h.t. (p. 39)
1. *V. caespitosum* absent	2
2. *Physocarpus malvaceus* or *Holodiscus discolor* well represented	PSEUDOTSUGA MENZIESII/PHYSOCARPUS MALVACEUS h.t. (p. 41)
a. *Calamagrostis rubescens* and/or *Carex geyeri* are the dominant undergrowth	CALAMAGROSTIS RUBESCENS phase
b. *Physocarpus* and/or *Holodiscus* dominate the undergrowth	PHYSOCARPUS MALVACEUS phase
2. *Physocarpus* and *Holodiscus* poorly represented	3
3. *Linnaea borealis* common	PSEUDOTSUGA MENZIESII/LINNAEA BOREALIS h.t. (p. 44)
a. *Symphoricarpos albus* well represented	SYMPHORICARPOS ALBUS phase
b. *Vaccinium globulare* well represented	VACCINIUM GLOBULARE phase
c. Not as above	CALAMAGROSTIS RUBESCENS phase
3. *Linnaea* scarce	4
4. *Vaccinium globulare* or *Xerophyllum tenax* well represented	PSEUDOTSUGA MENZIESII/VACCINIUM GLOBULARE h.t. (p. 43)
a. *Arctostaphylos uva-ursi* and *Pinus ponderosa* common	ARCTOSTAPHYLOS UVA-URSI phase
b. *Xerophyllum* common	XEROPHYLLUM TENAX phase
c. Not as above	VACCINIUM GLOBULARE phase
4. *Vaccinium globulare* and *Xerophyllum tenax* poorly represented	5
5. *Symphoricarpos albus* well represented	PSEUDOTSUGA MENZIESII/SYMPHORICARPOS ALBUS h.t. (p. 45)
a. Bunchgrasses well represented in old-growth stands	AGROPYRON SPICATUM phase
b. *Calamagrostis rubescens* well represented	CALAMAGROSTIS RUBESCENS phase
c. Not as above	SYMPHORICARPOS ALBUS phase
5. *S. albus* poorly represented	6
6. *Calamagrostis rubescens* well represented	PSEUDOTSUGA MENZIESII/CALAMAGROSTIS RUBESCENS h.t. (p. 47)
a. Bunchgrasses well represented in old-growth stands	AGROPYRON SPICATUM phase
b. *Arctostaphylos uva-ursi* common; sites capable of supporting *Pinus ponderosa* and not too dry for *Pinus contorta* (or *Larix occidentalis*)	ARCTOSTAPHYLOS UVA-URSI phase
c. *Pinus ponderosa* common	PINUS PONDEROSA phase
d. Not as above	CALAMAGROSTIS RUBESCENS phase
6. *C. rubescens* poorly represented	7
7. *Carex geyeri* well represented	PSEUDOTSUGA MENZIESII/CAREX GEYERI h.t. (p. 51)
7. *C. geyeri* poorly represented	8
8. *Arctostaphylos uva-ursi* well represented and *Pinus ponderosa* present	PSEUDOTSUGA MENZIESII/ARCTOSTAPHYLOS UVA-URSI h.t. (p. 52)
8. *Arctostaphylos* poorly represented or stands above elevational limits of *Pinus ponderosa*	9
9. *Juniperus communis* (or *J. horizontalis*) dominates the undergrowth	PSEUDOTSUGA MENZIESII/JUNIPERUS COMMUNIS h.t. (p. 53)
9. *J. communis* not the dominant undergrowth plant	10
10. *Spiraea betulifolia* well represented	PSEUDOTSUGA MENZIESII/SPIRAEA BETULIFOLIA h.t. (p. 52)
10. *S. betulifolia* poorly represented	11
11. *Arnica cordifolia* or *Antennaria racemosa* the dominant undergrowth	PSEUDOTSUGA MENZIESII/ARNICA CORDIFOLIA h.t. (p. 54)
11. *A. cordifolia* and *A. racemosa* not the dominant undergrowth	12
12. *Festuca scabrella* common	PSEUDOTSUGA MENZIESII/FESTUCA SCABRELLA h.t. (p. 38)
12. *F. scabrella* scarce	13
13. *Symphoricarpos oreophilus* well represented and *Festuca idahoensis* scarce	PSEUDOTSUGA MENZIESII/SYMPHORICARPOS OREOPHILUS h.t. (p. 55)
13. Not as above	14
14. *Festuca idahoensis* common; *Pinus ponderosa* scarce	PSEUDOTSUGA MENZIESII/FESTUCA IDAHOENSIS h.t. (p. 38)
14. *F. idahoensis* usually scarce; *Agropyron spicatum* well represented; *Pinus ponderosa* usually common	PSEUDOTSUGA MENZIESII/AGROPYRON SPICATUM h.t. (p. 37)

D. Key to *Picea* Habitat Types

1. Equisetum spp. abundant . . . . PICEA/EQUISETUM ARVENSE h.t.(p. 58)
1. Equisetum spp. not abundant 2
   2. Clintonia uniflora, Cornus canadensis, or Aralia nudicaulis present (sites in northwestern Montana). . . . . . . PICEA/CLINTONIA UNIFLORA h.t.(p. 59)
      a. Vaccinium caespitosum present . . . . VACCINIUM CAESPITOSUM phase
      b. V. caespitosum absent . . . . CLINTONIA UNIFLORA phase
   2. Not as above 3
3. Physocarpus malvaceus well represented . . . . PICEA/PHYSOCARPUS MALVACEUS h.t.(p. 61)
3. Physocarpus poorly represented 4
   4. Two of these moist-site forbs present: Galium triflorum, Streptopus amplexifolius, Actaea rubra . . . . PICEA/GALIUM TRIFLORUM h.t.(p. 62)
   4. Not as above 5
5. Vaccinium caespitosum present . . . . PICEA/VACCINIUM CAESPITOSUM h.t.(p. 62)
5. V. caespitosum absent 6
   6. Linnaea borealis common . . . . PICEA/LINNAEA BOREALIS h.t.(p. 64)
   6. Linnaea scarce 7
7. Smilacina stellata or Thalictrum occidentale present . . . . PICEA/SMILACINA STELLATA h.t.(p. 65)
7. Not as above; Senecio streptanthifolius present; undergrowth depauperate . . . . PICEA/SENECIO STREPTANTHIFOLIUS h.t.(p. 63)
   a. Pseudotsuga menziesii common . . . . PSEUDOTSUGA MENZIESII phase
   b. Pseudotsuga scarce (stands above its elevational limits) . . . . PICEA phase

E. Key to *Abies grandis* Habitat Types

1. Clintonia uniflora present . . . . ABIES GRANDIS/CLINTONIA UNIFLORA h.t.(p. 67)
   a. Aralia nudicaulis, Gymnocarpium dryopteris, or Athyrium filix-femina common . . . . ARALIA NUDICAULIS phase
   b. Xerophyllum tenax well represented . . . . XEROPHYLLUM TENAX phase
   c. Not as above . . . . CLINTONIA UNIFLORA phase
1. Clintonia absent 2
   2. Linnaea borealis common . . . . ABIES GRANDIS/LINNAEA BOREALIS h.t.(p. 69)
      a. Xerophyllum tenax well represented . . . . XEROPHYLLUM TENAX phase
      b. Xerophyllum poorly represented . . . . LINNAEA BOREALIS phase
   2. Linnaea scarce; Xerophyllum common . . . . ABIES GRANDIS/XEROPHYLLUM TENAX h.t.(p. 69)

F. & G. Key to *Thuja* and *Tsuga heterophylla* Habitat Types

1. Oplopanax horridum well represented . . . . THUJA PLICATA/OPLOPANAX HORRIDUM h.t.(p. 73)
1. Oplopanax poorly represented 2
   2. Tsuga heterophylla present and reproducing successfully . . . . TSUGA HETEROPHYLLA/CLINTONIA UNIFLORA h.t.(p. 74)
      a. Aralia nudicaulis, Gymnocarpium dryopteris, or Athyrium filix-femina common . . . . ARALIA NUDICAULIS phase
      b. Not as above . . . . CLINTONIA UNIFLORA phase
   2. Tsuga heterophylla absent or not reproducing successfully . . . . THUJA PLICATA/CLINTONIA UNIFLORA h.t.(p. 71)
      a. Aralia nudicaulis, Gymnocarpium dryopteris, or Athyrium filix-femina common . . . . ARALIA NUDICAULIS phase
      b. Menziesia ferruginea common . . . . MENZIESIA FERRUGINEA phase
      c. Not as above . . . . CLINTONIA UNIFLORA phase

H. Key for *Pinus contorta* Communities

1. Clintonia uniflora present . . . . ABIES LASIOCARPA/CLINTONIA UNIFLORA h.t.(p. 82)
1. Clintonia absent 2
   2. Two of these moist-site forbs present: Galium triflorum, Actaea rubra, Streptopus amplexifolius . . . . ABIES LASIOCARPA/GALIUM TRIFLORUM h.t.(p. 86)
   2. Not as above 3
3. Calamagrostis canadensis well represented . . . . ABIES LASIOCARPA/CALAMAGROSTIS CANADENSIS h.t.(p. 88)
3. C. canadensis poorly represented 4
   4. Vaccinium caespitosum present . . . . PINUS CONTORTA/VACCINIUM CAESPITOSUM comm. type(p. 118)
   4. V. caespitosum absent 5
5. Linnaea borealis common . . . . PINUS CONTORTA/LINNAEA BOREALIS comm. type(p. 119)
5. Linnaea scarce 6
   6. Xerophyllum tenax common . . . . ABIES LASIOCARPA/XEROPHYLLUM TENAX h.t.(p. 94)
   6. Xerophyllum scarce 7
7. Vaccinium globulare well represented . . . . ABIES LASIOCARPA/VACCINIUM GLOBULARE h.t.(p. 97)
7. V. globulare poorly represented 8
   8. Vaccinium scoparium well represented . . . . PINUS CONTORTA/VACCINIUM SCOPARIUM comm. type(p. 119)
   8. V. scoparium poorly represented 9
9. Calamagrostis rubescens well represented . . . . PINUS CONTORTA/CALAMAGROSTIS RUBESCENS comm. type(p. 120)
9. C. rubescens poorly represented 10
   10. Carex geyeri well represented . . . . ABIES LASIOCARPA/CAREX GEYERI h.t.(p. 105)
   10. C. geyeri poorly represented 11
11. Juniperus communis (or J. horizontalis) the major undergrowth . . PSEUDOTSUGA MENZIESII/JUNIPERUS COMMUNIS h.t.(p. 53)
11. Not as above; Purshia tridentata present . . . . PINUS CONTORTA/PURSHIA TRIDENTATA h.t.(p. 117)

I. Key to Abies lasiocarpa Habitat Types

A. Sites at or above the cold limits of Pseudotsuga and also meeting one of the following criteria:
  (a) Pinus albicaulis well represented;
  (b) Luzula hitchcockii present;
  (c) Ribes montigenum present;
  (d) Stands at upper timberline
  UPPER SUBALPINE AND TIMBERLINE h.t.s. 17

A. Not as above
  LOWER SUBALPINE h.t.s. 1

1. Oplopanax horridum well represented. . . . . ABIES LASIOCARPA/OPLOPANAX HORRIDUM h.t. (p. 81)
1. Oplopanax poorly represented 2

2. Clintonia uniflora present . . . . ABIES LASIOCARPA/CLINTONIA UNIFLORA h.t. (p. 82)
  a. Aralia nudicaulis, Gymnocarpium dryopteris, or Athyrium filix-femina common . . . . ARALIA NUDICAULIS phase
  b. Menziesia ferruginea well represented . . . . . . MENZIESIA FERRUGINEA phase
  c. Vaccinium caespitosum or Arctostaphylos uva-ursi common . . . . VACCINIUM CAESPITOSUM phase
  d. Xerophyllum tenax well represented . . . . XEROPHYLLUM TENAX phase
  e. Not as above. . . . . CLINTONIA UNIFLORA phase
2. Clintonia absent 3

3. Menziesia ferruginea well represented. 4
3. Menziesia poorly represented 5

4. Tsuga mertensiana well represented . . . . TSUGA MERTENSIANA/MENZIESIA FERRUGINEA h.t. (p. 94)
4. Tsuga mertensiana poorly represented . . . . ABIES LASIOCARPA/MENZIESIA FERRUGINEA h.t. (p. 92)

5. Calamagrostis canadensis, Senecio triangularis, or Ledum glandulosum well represented . . . . ABIES LASIOCARPA/CALAMAGROSTIS CANADENSIS h.t. (p. 88)
  a. Galium triflorum or Actaea rubra present. . . . . GALIUM TRIFLORUM phase
  b. Vaccinium caespitosum present . . . . VACCINIUM CAESPITOSUM phase
  c. Not as above. . . . . CALAMAGROSTIS CANADENSIS phase
5. C. canadensis, S. triangularis, and Ledum poorly represented 6

6. Two of these moist-site forbs present: Galium triflorum, Actaea rubra, Streptopus amplexifolius . . . . ABIES LASIOCARPA/GALIUM TRIFLORUM h.t. (p. 86)
6. Not as above 7

7. Vaccinium caespitosum present. . . . . ABIES LASIOCARPA/VACCINIUM CAESPITOSUM h.t. (p. 87)
7. V. caespitosum absent. 8

8. Linnaea borealis common . . . . ABIES LASIOCARPA/LINNAEA BOREALIS h.t. (p. 90)
  a. Xerophyllum tenax well represented. . . . . XEROPHYLLUM TENAX phase
  b. Vaccinium scoparium well represented. . . . . VACCINIUM SCOPARIUM phase
  c. Not as above. . . . . LINNAEA BOREALIS phase
8. Linnaea scarce 9

9. Alnus sinuata well represented . . . . ABIES LASIOCARPA/ALNUS SINUATA h.t. (p. 100)
9. A. sinuata poorly represented 10

10. Xerophyllum tenax common 11
10. Xerophyllum scarce 12

11. Tsuga mertensiana well represented . . . . TSUGA MERTENSIANA/XEROPHYLLUM TENAX h.t. (p. 97)
11. Tsuga mertensiana poorly represented . . . . ABIES LASIOCARPA/XEROPHYLLUM TENAX h.t. (p. 94)
  a. Vaccinium globulare poorly represented and V. scoparium abundant . . . . VACCINIUM SCOPARIUM phase
  b. Not as above. . . . . VACCINIUM GLOBULARE phase

12. Vaccinium globulare well represented . . . . ABIES LASIOCARPA/VACCINIUM GLOBULARE h.t. (p. 97)
12. V. globulare poorly represented. 13

13. Vaccinium scoparium (including V. myrtillus) well represented . . . . ABIES LASIOCARPA/VACCINIUM SCOPARIUM h.t. (p. 98)
  a. Calamagrostis rubescens common and Arctostaphylos uva-ursi or Berberis repens present . . . . CALAMAGROSTIS RUBESCENS phase
  b. Thalictrum occidentale common or Viola orbiculata or Valeriana sitchensis present . . . . THALICTRUM OCCIDENTALE phase
  c. Not as above. . . . . VACCINIUM SCOPARIUM phase
13. V. scoparium poorly represented. 14

14. Clematis pseudoalpina (including C. tenuiloba) present or Pinus flexilis common. (Sites usually on calcareous substrates.) . . . . ABIES LASIOCARPA/CLEMATIS PSEUDOALPINA h.t. (p. 102)
14. C. pseudoalpina absent and Pinus flexilis scarce 15

15. Calamagrostis rubescens well represented . . . . ABIES LASIOCARPA/CALAMAGROSTIS RUBESCENS h.t. (p. 101)
15. C. rubescens poorly represented. 16

16. Carex geyeri well represented under well-developed forest canopies . . . . ABIES LASIOCARPA/CAREX GEYERI h.t. (p. 105)
  a. Pseudotsuga well represented; Carex geyeri sharing dominance in the undergrowth with forbs such as Thalictrum. . . . . PSEUDOTSUGA MENZIESII phase
  b. Pseudotsuga poorly represented; undergrowth dominated by C. geyeri alone. . . . . CAREX GEYERI phase
16. C. geyeri poorly represented . . . . ABIES LASIOCARPA/ARNICA CORDIFOLIA h.t. (p. 103)

17. Abies lasiocarpa and Picea engelmannii scarce and Pinus albicaulis the indicated climax. . . . . PINUS ALBICAULIS h.t.s. (p. 114)
17. Not as above 18

18. Timberline habitats; Abies lasiocarpa stunted; Pinus contorta and Menziesia ferruginea absent 19
18. Forest habitats; Abies lasiocarpa tall (generally 50 feet or more at maturity) 20

19. Larix lyallii present. . . . . LARIX LYALLII-ABIES LASIOCARPA h.t.s. (p. 112)
19. Larix lyallii absent . . . . PINUS ALBICAULIS-ABIES LASIOCARPA h.t.s (p. 111)

20. Calamagrostis canadensis, Senecio triangularis, or Ledum glandulosum well represented . . . . ABIES LASIOCARPA/CALAMAGROSTIS CANADENSIS h.t. (p. 88)
20. C. canadensis, S. triangularis, and Ledum poorly represented 21

21. Luzula hitchcockii present or Menziesia ferruginea well represented 22
21. L. hitchcockii absent and Menziesia poorly represented . . . 23

22. Tsuga mertensiana well represented . . . . TSUGA MERTENSIANA/LUZULA HITCHCOCKII h.t. (p. 110)
  a. Menziesia ferruginea well presented . . . . MENZIESIA FERRUGINEA phase
  b. Menziesia poorly represented . . . . VACCINIUM SCOPARIUM phase
22. Tsuga mertensiana poorly represented . . . . ABIES LASIOCARPA/LUZULA HITCHCOCKII h.t. (p. 108)
  a. Menziesia ferruginea well represented . . . . MENZIESIA FERRUGINEA phase
  b. Menziesia poorly represented. . . . . VACCINIUM SCOPARIUM phase

23. Vaccinium scoparium (including V. myrtillus) Carex geyeri well represented . . . . ABIES LASIOCARPA-PINUS ALBICAULIS/VACCINIUM SCOPARIUM h.t. (p. 107)
23. Not as above; Ribes montigenum present . . . . ABIES LASIOCARPA/RIBES MONTIGENUM h.t. (p. 106)

Figure 8.--Pinus flexilis/Festuca idahoensis *h.t. (*F. scabrella *phase) at the western edge of the Great Plains, northwest of Choteau in central Montana (5,900 feet elev.). Trees are a mixture of* Pinus flexilis *and stunted* Pseudotsuga.

Pinus flexilis dominates stands that extend eastward from the foothills into the adjacent Great Plains (fig. 8). Low tree height (about 20 feet) and the topographic position of such stands below the forest proper is suggestive of the "coniferous woodland" or pinyon-juniper zone of the southwestern United States.

Pinus flexilis stands are also found on steep, dry, rocky mountain slopes at lower to midelevations (fig. 9). Adjacent drier sites are grassland, while cooler, more moist exposures often support the *Pseudotsuga* series. In this situation the *Pinus flexilis* series generally represents a topographic or edaphic climax.

Vegetation.--*Pinus flexilis* is either the only tree species present or it is codominant with *Pseudotsuga* and reproducing successfully with no indication of being replaced at climax. *Agropyron spicatum* dominates the undergrowth in stands at lower elevations on dry, rocky sites. With increasing moisture, *Pseudotsuga* becomes codominant with *Pinus flexilis*, and undergrowth is dominated by *Festuca idahoensis* or *F. scabrella*. At the highest elevations occupied by this series, bunchgrasses give way to undergrowth dominated by *Juniperus communis, J. horizontalis*, and dry-site forbs.

Soil/Climate.--Sites are generally rocky with intermittent shallow duff accumulation (appendix D-1). Surface soils are shallow gravelly loams to gravelly silts, nearly neutral, and generally derived from limestone or other calcareous parent materials. Surface horizons are typically dark-colored, reflecting the strong influence of grasses and forbs on soil development.

Figure 9.--Pinus flexilis/Juniperus communis *h.t. high on a southwest exposure (7,650 feet elev. near Red Lodge in south-central Montana.* Pseudotsuga *is subordinate to* Pinus flexilis; *the substrate is calcareous.*

Weather stations at Townsend and Black Leaf apparently have a climate typical of the *Pinus flexilis* series. Some climatic parameters for these stations are shown in appendix D-2.

Productivity/Management.--Timber productivity is very low (appendix E-4) in the severe environments of this series. Site indexes of both *Pinus flexilis* and *Pseudotsuga menziesii* are very low, and stockability limitations are reflected by low basal areas in natural stands (appendix E-1). Old growth trees rarely reach 50 feet height (appendix E-2)

The forage value of the undergrowth for domestic stock or wildlife varies among the habitat types. The overstory may provide important escape cover for wildlife, especially on sites adjacent to grasslands.

Pinus flexilis seeds are large, and constitute an important food source for certain bird and rodent species.

Other studies.--Other *Pinus flexilis* habitats have been described southward in the Rocky Mountains: in Utah by Ellison (1954), Pfister (1972a), and Ream (1964); in Wyoming by Reed (1969), Despain (1973), and Wirsing (1973); and in central Idaho by Robert Steele and others (1975 preliminary draft, USDA Forest Service, Intermountain Station).

Pinus flexilis/Agropyron spicatum h.t.
(PIFL/AGSP; limber pine/bluebunch wheatgrass)

Distribution.--The *PIFL/AGSP* h.t. is widely distributed east of the Continental Divide on dry, rocky sites adjacent to or within the grassland zone. Elevations of our sample stands ranged from 4,400 feet on the Helena to 6,600 feet on the Beaverhead National Forest (appendix A).

Vegetation.--*Pinus flexilis* is the dominant climax tree, often with *Juniperus scopulorum* as a major climax associate. *Pseudotsuga* is occasionally present in minor amounts. In a few areas, *Pinus ponderosa* is a climax associate.

Dry-site forbs and graminoids (grasses, *Carex*, *Juncus*, and other grasslike plants) of the contiguous grasslands accompany *Agropyron spicatum* in the undergrowth. These include *Hesperochloa kingii, Oryzopsis hymenoides, Koeleria cristata, Bouteloua gracilis, Yucca glauca,* and species of *Opuntia, Phlox, Draba, Hymenoxys, Hymenopappus,* and *Liatris*.

Soil.--We found this type only on sedimentary parent materials, primarily limestone and sandstone (appendix D-1). The average pH was high (7.1), reflecting the calcareous parent materials. Ground surfaces had averages of 18 percent exposed rock and 25 percent bare soil. Duff accumulation averaged only 1 cm on the remaining area.

Fire history.--Wildfires are apparently of low intensity because of sparse vegetation and rocky, broken terrain.

Productivity/Management.--Although these sites are often adjacent to heavily-grazed grasslands, domestic livestock do not use the *PIFL/AGSP* h.t. heavily. Low forage production and steep slopes limit potential for domestic grazing.

Elk sign was not observed on any of our plots. Mule deer use was light.

Timber productivity is very low (appendix E-4). Maximum heights of old-growth *Pinus flexilis* are only 30 to 35 feet. Basal areas are also very low (appendix E).

Other studies.--*PIFL/AGSP* stands in south-central and southeastern Montana on the Beaverhead and Custer National Forests often contain *Hesperochloa kingii*. These stands appear to be related to part of the *Pinus flexilis/Hesperochloa kingii* h.t. described for the Medicine Bow Mountains of Wyoming (Wirsing 1973).

Pinus flexilis/Festuca idahoensis h.t.
(*PIFL/FEID*; limber pine/Idaho fescue)

Distribution.--The *PIFL/FEID* h.t. is found east of the Continental Divide on dry, wind-exposed slopes; in some localities it covers substantial acreages. Elevations of sample plots ranged from 4,800 feet at the base of the Front Range west of Choteau to 8,200 feet on the Beaverhead National Forest.

Vegetation.--*Pinus flexilis* is a successfully reproducing dominant in old-growth stands, often sharing climax status with *Pseudotsuga*. *Juniperus scopulorum* is a minor component of some stands.

The undergrowth is dominated by bunchgrasses, primarily *Festuca idahoensis*, *F. scabrella*, and *Agropyron spicatum*. Associated species include *Geum triflorum*, *Allium cernuum*, *Artemisia frigida*, *Achillea millefolium*, *Lithospermum ruderale*, *Koeleria cristata*, and *Balsamorhiza sagittata*. Forb and bunchgrass coverages are much higher here than in the *PIFL/AGSP* h.t. (appendix C-1). Occasionally *Juniperus communis* is well represented in stands on sites transitional toward the *PIFL/JUCO* h.t.

Festuca idahoensis (FEID) phase.--This widely distributed phase denotes the portion of the h.t. where *Festuca scabrella* is scarce.

Festuca scabrella (FESC) phase.--This phase is found exclusively in central Montana (fig. 1). Locally it is extensive, especially on the east slope of the Rockies in the vicinity of Choteau and in the foothills on the east side of the Big Belt Mountains north of White Sulphur Springs. *Festuca scabrella* is common, and codominates with *F. idahoensis*. Average canopy coverage for bunchgrasses is notably higher (47 percent) than in the *FEID* phase (30 percent). Where the two phases occur together, the *Festuca scabrella* phase is on the cooler, less rocky sites.

Soil.--More than one half the sample stands were on calcareous parent materials (appendix D-1). Surface soils were slightly basic on the calcareous substrates and neutral to acidic on other substrates. Textures were gravelly, ranging from sandy loams to silts. Moderate amounts of surface rock (12 percent) and bare soil (8 percent) were exposed in the *FEID* phase. Duff was shallow (1 cm) in both phases.

Fire history.--Evidence of wildfire was more conspicuous here than in the *PIFL/AGSP* h.t. However, fires did not appear to markedly modify plant composition.

Productivity/Management.--*PIFL/FEID* h.t. seems to be capable of supporting considerable use by domestic stock. However, use was light in the areas we sampled. Immediately north of the Montana border, Moss and Campbell (1947) found that heavy grazing of *Festuca scabrella*-dominated grasslands resulted in greatly decreasing the coverage of that species while increasing the coverage of *Festuca idahoensis*.

Pellets and shed antlers from both deer and elk indicate moderate to heavy use as winter range. Deer also appear to use this type as summer range. Overstory density is adequate to provide cover and escape for big game without shading out desirable forage and browse species. Where use by domestic stock and big game conflicts, management priorities need to be determined.

Pseudotsuga is often a major dominant on these sites, but timber productivity is very low (appendix E-4). Average maximum heights for *Pseudotsuga* and *Pinus flexilis* are only 40 to 45 feet (appendix E-2).

Other Studies.--Robert Steele and others (1975 preliminary draft, USDA Forest Service, Intermountain Station) have described the *FEID* phase of *PIFL/FEID* h.t. in east-central Idaho, and Cooper (1975) found a minor representation of similar communities in northwestern Wyoming.

Pinus flexilis/Juniperus communis h.t.
(*PIFL/JUCO*; limber pine/common juniper)

Distribution.--The *PIFL/JUCO* h.t. is widespread in dry mountain areas east of the Continental Divide. It is common in the Pryor Mountains and on the east slopes of the Beartooth Mountains near Red Lodge. It is primarily restricted to limestone or other calcareous parent materials on severe south to southwest exposures and ridges. Occasionally it is found on north aspects adjacent to *Festuca idahoensis* grasslands. Elevations of sample stands were 4,600 to 6,000 feet in central Montana, increasing to 7,600 to 8,300 feet in the south-central portion of the State.

Vegetation.--*Pinus flexilis* is a successfully reproducing dominant in old-growth stands, often sharing climax status with *Pseudotsuga*. Rarely, *Pinus albicaulis* is a minor climax associate.

This undergrowth is composed primarily of dry-site shrubs and forbs. *Juniperus communis* or *J. horizontalis* are well represented and bunchgrasses are scarce. Forbs commonly found are *Clematis pseudoalpina, Arnica cordifolia, Aster conspicuus, Campanula rotundifolia, Galium boreale, Astragalus miser, Anemone multifida,* and *Frasera speciosa*.

Soil.--Soils had high pH values (average 7.1), reflecting the predominance of calcareous parent materials (appendix D-1). Bare soil (1 percent) and rock exposure (6 percent) were less than, and duff accumulations (3 cm) were greater than in other habitat types in this series. Textures were gravelly loams to gravelly clay loams.

Fire history.--Old-growth stands sampled showed little evidence of fire, suggesting a low frequency of wildfires in this habitat type. Overstories are all-aged, with continual replacement of dead old growth.

Productivity.--Timber productivity is low to very low (appendix E). Cattle use appears to be moderate. Our observations also indicate that mule deer make substantial use of the type from spring through fall.

Other studies.--The *PIFL/JUCO* h.t. appears to be similar to part of Wirsing's (1973) *Pinus flexilis/Hesperochloa kingii* h.t. described for the Medicine Bow Mountains of Wyoming.

Pinus ponderosa Series

Distribution.--In many areas of the Montana Rockies, the first forest zone above the grassland is *Pinus ponderosa* climax. This species endures dry environments more successfully than other native conifers--except *Pinus flexilis* and *Juniperus scopulorum*, which form zones of climax vegetation only in certain local areas of Montana. Usually, a belt of climax *Pinus ponderosa* forest separates grassland from climax *Pseudotsuga* forests. When *Pinus ponderosa* is found above this belt, it usually is either a topographic climax on steep southerly slopes or a seral component of stands in other climax series (this relationship is shown in fig. 6). In the southwestern part of the State (fig. 1), *Pinus ponderosa* does not occur and the grasslands give way directly to *Pseudotsuga* forests. The valley base level in these mountain areas usually exceeds 5,500 feet elevation, and apparently the climate is too cold for *Pinus ponderosa*.

Vegetation.--*Pinus ponderosa* and *Juniperus scopulorum* are the only successfully reproducing trees in this series. Although *Pseudotsuga* is found scattered on rocky microsites, there is no indication that it can regenerate effectively or that it will become more abundant at climax.

Pinus ponderosa savannas (grasslands with scattered trees) are found in the eastern part of Montana and to a limited extent in the mountainous western portions. However, our classification includes only sites potentially capable of supporting at least 25 percent coverage by tree canopies. This appears to be an acceptable breakpoint between "savanna" and "open forest" (Penfound 1967).

R. and J. Daubenmire (1968) discussed two groups of *Pinus ponderosa* habitat types; (1) a shrubby group on deep, heavy-textured fertile soils; and (2) a grassy group on stony, coarse-textured, or shallow soils (this includes the *Pinus-Purshia* habitat type in which *Purshia tridentata* is superimposed over the same bunchgrasses). In the mountains of Montana, the grassy group of *Pinus ponderosa* habitats predominates (fig. 10). Stands are fairly open and regeneration is sparse, but rather well distributed. In the eastern part of central Montana and in southeastern Montana, both grassy and shrubby groups are abundant (fig. 11 and 12); tree reproduction in the shrubby group tends to occur in dense patches.

In contrast, in northern Idaho and adjacent Washington, R. and J. Daubenmire (1968) described dense patches of reproduction in the grassy group, and sparse, scattered reproduction in the shrubby group. Interestingly, most of the Daubenmires' grassy stands were on gentle terrain, while the shrubby stands were on steeper slopes. Our west-side Montana stands (grassy) were on steep terrain, and our east-side shrubby stands were on gentler terrain. The few grassy stands we observed on level ground

Figure 10.--Pinus ponderosa/ Agropyron spicatum *h.t. on a steep southwest exposure (2,750 feet elev.) near Ravalli in northwestern Montana.*

Figure 11.--Pinus ponderosa/ Festuca idahoensis *h.t. (*F. idahoensis *phase) on gentle terrain (4,300 feet elev.) east of Ashland in southeastern Montana.*

Figure 12.--Pinus ponderosa/ Prunus virginiana *h.t. (*P. virginiana *phase) on a moderate north slope (4,000 feet elev.) east of Ashland in southeastern Montana. The* Prunus *has been browsed back by deer.*

in western Montana had dense, patchy reproduction. Thus it appears that topography may influence natural seedbed preparation and hence regeneration.

The shrubby group is poorly developed in the Montana Rockies. If a dense shrubby layer occurs beneath an overstory of *Pinus ponderosa, Pseudotsuga* is usually regenerating and is the indicated climax.

Substantial genetic differences appear to exist between west- and east-side populations of *Pinus ponderosa*. A manifestation of this is the high frequency of trees having mostly two needles per fascicle in the eastern part of central Montana and in southeastern Montana. A much smaller proportion of trees bearing two-needle fascicles occurred in sample plots near Helena, and few if any were found in *Pinus ponderosa* west of the Divide. Height growth differential also suggests east-west genetic differences in this species; trees in eastern Montana may grow as rapidly as their west-side counterparts, but they reach their maximum height at an earlier age (appendix E-2).

East of the Continental Divide *Rhus trilobata* is commonly encountered throughout the *Pinus ponderosa* series. In central and southeastern Montana, the grassy group of *Pinus ponderosa* habitat types includes several additional species. *Yucca glauca*, and *Opuntia* spp., *Carex pensylvanica, Bouteloua* spp., and *Andropogon* spp. are found on some of the driest sites.

Soil.--Soils are variable throughout this series. The surface horizons are gravelly in all types except the *Berberis repens* phase of the *PIPO/SYAL* h.t. Less surface rock and bare soil are exposed in the shrubby group of habitat types, but this may be attributable to heavier duff accumulation and more undergrowth rather than inherent site characteristics.

Fire history.--Before the advent of modern fire suppression, ground fires were frequent in most *Pinus ponderosa* habitat types, but had little effect upon vegetative composition. Of the major undergrowth species, only *Purshia tridentata* is likely to be killed by fire, and it reinvades burned areas quickly (R. and J. Daubenmire 1968). In the tree layer, only saplings and smaller poles are normally killed by most fires in these habitat types.

Productivity/Management.--Timber productivity ranges from very low to moderate within the series (appendix E). The grassy habitat types (including *PIPO/PUTR*) support open forests with stockability limitations and slow growth rates. The bunchgrass-dominated undergrowth has above-average forage potential for livestock or big-game winter range, depending on location within a particular landscape.

The shrubby habitat types support closed-canopy forests with a higher productivity potential (appendix E). Forage production for domestic livestock is lower under the closed canopies, although browse species may provide good forage for big game.

Wellner and Ryker (1973) suggest that a full range of silvicultural systems are available for timber harvesting and regeneration in this series. Under any system, natural regeneration will be slow because good seed crops are infrequent and soil moisture is often inadequate for seedling establishment. Mechanical site preparation will aid establishment by reducing competition for moisture.

Foiles and Curtis (1973), in applying cutting methods to R. and J. Daubenmires' (1968) *Pinus ponderosa* habitat types, emphasize clearcutting and mechanical site preparation where dwarf mistletoe is present or where timber production is the primary goal. We advocate caution in clearcutting in this series in Montana for several reasons:

1. Dwarf mistletoe is rarely found on *Pinus ponderosa* in Montana.

2. Many natural stands, especially in the grassy group, are unevenaged.

3. Timber production often will not be the primary goal because other multiple-use values are often higher.

Based on these considerations, we suggest selection or shelterwood systems coupled with a long natural regeneration period as a general guideline for this series. In practice, stand prescriptions should be based on individual stand conditions, local experience, and management objectives. For instance, even-aged stands in the *PIPO/SYAL* and *PIPO/PRVI* h.t.s. may be suited to seed-tree or clearcut systems.

Pinus ponderosa/Andropogon spp. h.t.
(*PIPO/AND*; ponderosa pine/bluestem)

Distribution.--This is a minor habitat type in southeastern Montana, where it apparently represents the driest conditions within the *Pinus ponderosa* series. It occurs rarely in the vicinity of Ashland (where our one stand was sampled), but is reportedly more common eastward in the Long Pine Mountains near the South Dakota border. Stands are found on south-facing slopes at elevations near 4,000 feet. This habitat type replaces *PIPO/FEID* and *PIPO/AGSP* as one goes eastward toward the Black Hills, where Thilenius (1972) described a similar "habitat unit" (No. 11--*Pinus ponderosa/Andropogon scoparius*).

Vegetation.--Very open stands of *Pinus ponderosa* are typical. Undergrowth is dominated by rather low-growing forms of either *Andropogon gerardii* or *A. scoparius* and dry-site forbs. *Agropyron spicatum* and *Festuca idahoensis* are poorly represented.

Management.--Management implications are similar to those for the *PIPO/AGSP* h.t.

Pinus ponderosa/Agropyron spicatum h.t.
(*PIPO/AGSP*; ponderosa pine/bluebunch wheatgrass)

Distribution.--The *PIPO/AGSP* h.t. is widespread in Montana below 4,800 feet elevation on the driest forested sites, especially on south-facing slopes.

Vegetation.--*Pinus ponderosa*, and occasionally *Juniperus scopulorum*, are the only successful coniferous trees. Grassland forbs and minor amounts of shrubs accompany *Agropyron spicatum* in the undergrowth: these include *Balsamorhiza sagittata*, *Lithospermum ruderale*, and *Prunus virginiana*. Stands in western Montana have undergrowth composition similar to that of R. and J. Daubenmires' (1968) *Pinus-Agropyron* h.t. However, species composition is somewhat different on some sites east of the Continental Divide (as discussed in the series description), and this may warrant future phase recognition.

Soil/Climate.--Our stands were on a variety of sedimentary parent materials, the majority of which were calcareous (appendix D-1). Surface soils were gravelly loams to gravelly silts and ranged from acidic to slightly basic, depending on the parent material. Ground surfaces had moderate bare soil (7 percent) and little rock exposed (3 percent); duff depth averaged less than 4 cm. Most of the soils had an A1 horizon.

Weather data for Roundup (appendix D-2) reflect the climate of this habitat type in central Montana.

Productivity/Management.--Although forage production is low, winter use by mule deer was evident on most sites. Occasional evidence of elk use was also observed.

This habitat type may have moderate potential for livestock forage production where slopes are not too steep.

Timber productivity is low to very low, with low site indexes and stockability limitations (appendix E). Clearcutting will generally result in conversion to a grassland community with very slow reinvasion of *Pinus ponderosa*. Intensive site preparation and planting may succeed, but the expense is difficult to justify with such low growth potential. Light selection or sanitation-salvage cutting can provide some timber while maintaining site protection. Natural regeneration may take 20 to 40 years, but this should be acceptable under a selection system of management.

Other studies.--A *PIPO/AGSP* h.t. has been described by R. and J. Daubenmire (1968), by McLean (1970) in British Columbia, by Hoffman and Alexander (1976) in Wyoming, and by Robert Steele and others (1975 preliminary draft, USDA Forest Service, Intermountain Station) in central Idaho. This type is more variable in Montana than in other areas.

Pinus ponderosa/Festuca idahoensis h.t. (*PIPO/FEID*; ponderosa pine/Idaho fescue)

Distribution.--The *PIPO/FEID* h.t. occurs throughout Montana wherever the *Pinus ponderosa* climax forest zone exists. It occurs primarily on south- and west-facing slopes with better soil development or in areas less droughty than the *PIPO/AGSP* h.t. Occasionally it is found on benchlands and gentle north slopes near lower timberline adjacent either to *Festuca idahoensis* grasslands or to the *PIPO/AGSP* h.t. on drier exposures. Elevations are less than 5,000 feet.

Vegetation.--*Festuca idahoensis* and/or *Festuca scabrella* are common in the undergrowth. *Agropyron spicatum* is usually present. Associated species are similar to those of the *PIPO/AGSP* h.t., except for greater frequency of *Antennaria rosea* on the *PIPO/FEID* h.t. and of *Danthonia unispicata* on the *PIPO/FEID* h.t., *FEID* phase in the Custer National Forest.

Festuca idahoensis (FEID) phase.--This phase is common in west-central and southeastern Montana. *Festuca idahoensis* is well represented and *Festuca scabrella* is scarce.

Festuca scabrella (FESC) phase.--This phase is frequently found in west-central and central Montana. *Festuca scabrella* is common, reflecting sites that are cooler, less droughty, or having better soil development within the *PIPO/FEID* h.t. Canopy coverage for bunchgrasses averages substantially higher than for the *Festuca idahoensis* phase. Because *Festuca scabrella* decreases markedly in coverage after several years of heavy grazing (Moss and Campbell 1947), its mere presence under such conditions is sufficient evidence for classification in this phase.

Soil.--Our stands were on a variety of parent materials (appendix D-1). Surface soils were gravelly loams to gravelly silts. Most of the soils were acidic, although a few that developed from calcareous parent materials were slightly basic. Ground surfaces had little bare soil and moderate amounts of exposed rock; duff depth averaged 4 cm. Most of the soils have darkened A1 surface horizons, reflecting the forb and grass influence on soil development.

Productivity/Management.--On gentle terrain *PIPO/FEID* is one of the better forest habitat types for production of forage for domestic stock. Forage production is considerably greater than in the *PIPO/AGSP* h.t., especially in the *Festuca scabrella* phase (appendix C-1) Mule deer apparently use these sites as both winter and summer range. Elk winter use appears greater than in the *PIPO/AGSP* h.t., perhaps due to better cover and forage. Forage allocation between big game and domestic stock should be a major management consideration in many areas of this habitat type.

Timber productivity is low, due to both low site index and stockability limitations (appendix E). Silvicultural considerations are similar to those described for the *PIPO/AGSP* h.t.

Other studies.--The *FEID* phase is nearly equivalent to the *Pinus ponderosa/Festuca idahoensis* h.t. described by McLean (1970), Hoffman and Alexander (1976), Steele and others (1975 preliminary draft of forest habitat types of central Idaho, USDA Forest Service, Intermountain Station), and R. and J. Daubenmire (1968). However, *Agropyron spicatum* is apparently more prevalent in Montana than in northern Idaho. The *FESC* phase has not been described elsewhere.

Pinus ponderosa/Purshia tridentata h.t.
(*PIPO/PUTR*; ponderosa pine/bitterbrush)

Distribution.--This habitat type occurs primarily on dry benches and rocky slopes at low elevations. It is locally common in the Kootenai River canyon as well as in the vicinities of Plains, Darby, and Helena.

Vegetation.--In general the undergrowth composition is similar to that of the *PIPO/AGSP* or *PIPO/FEID* h.t. with the addition of *Purshia tridentata*.

Sometimes *Prunus virginiana*, and in the Helena vicinity *Rhus trilobata*, share dominance with *Purshia*. *Cercocarpus ledifolius* is an associate of *Purshia* in stands near Darby, but it is restricted to rock outcrops.

Agropyron spicatum (*AGSP*) phase.--*Agropyron* is the dominant grass, and the site appears drier than in the *Festuca idahoensis* phase. Bare soil is more obvious, bunchgrass canopy coverage averages only 16 percent, and litter is sparse.

Festuca idahoensis (*FEID*) phase.--*Festuca idahoensis*, *F. scabrella*, and *Agropyron spicatum* are the dominant grasses, and the undergrowth is better developed than in the *Agropyron spicatum* phase. Bare soil is less conspicuous, slopes are gentle, and bunchgrasses have a combined average canopy coverage of 50 percent. This phase is more important for both livestock and big game due to the high coverage of bunchgrasses.

Soil/Climate.--About half of the sample stands were on calcareous parent materials (appendix D-1). Surface soils were gravelly, but not more so than other h.t.s in this series. Reactions were acidic to slightly basic, depending on parent material. Ground surfaces had moderate (averages of 4 and 5 percent) exposed rock. The *AGSP* phase had considerable bare soil (17 percent) and less than 1 cm of duff, whereas the *FEID* phase had 6 percent bare soil with duff depth averaging 2.4 cm. All of the soils had darkened A1 surface horizons.

Weather data from Canyon Ferry (appendix D-2) provide an example of the climate on a *PIPO/PUTR* site.

Productivity/Management.--Forage production for domestic stock, deer, and elk is substantial. Deer and elk winter use is heavy because of mild temperatures, lack of snow cover, and the presence of *Purshia tridentata*, one of the more desirable big-game browse species. *Purshia tridentata* is killed by ground fire but apparently reinvades quickly following surface fires (R. and J. Daubenmire 1968).

Timber productivity is very low, because of slow growth and stockability limitations (appendix E). Silvicultural considerations are similar to those described for the *PIPO/AGSP* h.t.

Other studies.--R. and J. Daubenmire (1968) described situations in this habitat type in which *Stipa comata* or *Aristida longiseta* dominated the forb layer. *Stipa* was an important component along with *Agropyron spicatum* near Rexford, Montana, but this situation was not found elsewhere in the State. R. and J. Daubenmire (1968) have cited several examples of this habitat type in the northwestern United States and adjacent British Columbia.

Pinus ponderosa/Symphoricarpos albus h.t.
(*PIPO/SYAL*; ponderosa pine/snowberry)

Distribution.--This habitat type is common on benchlands and north-facing slopes in central and southeastern Montana. It is occasionally found in western Montana on benchlands in the lower-elevation valleys. Sometimes the dry extreme of *PIPO/SYAL* develops on south-facing slopes, but the bunchgrass-dominated *Pinus ponderosa* habitat types are generally more prevalent on such exposures. West of the Continental Divide *PIPO/SYAL* is often absent, since the grassy *Pinus ponderosa* habitat types usually are bordered by the *Pseudotsuga* series, often the *PSME/SYAL* h.t. Elevations of sample plots ranged from 2,600 feet at Plains to 5,400 feet near Lewistown.

Vegetation.--Some stands appear even-aged, exhibiting a relatively uniform, closed canopy. Other stands have several age classes, reflecting the influence of ground fires. Because of fairly dense shade and heavy duff accumulation, disturbance appears necessary to establish regeneration. Undergrowth is dominated by *Symphoricarpos albus* and other shrubs, accompanied by a rich assortment of perennial forbs and grasses.

Symphoricarpos albus (SYAL) phase/Soil.--This is the most widespread phase. Bunchgrasses are often codominant with *Symphoricarpos;* such stands either are seral, or are transitional to the grassy *Pinus ponderosa* habitat types.

Parent materials in this phase were variable with only one stand found on calcareous parent material (appendix D-1). Surface soils were slightly acidic and gravelly with a full range of textures from loamy sands to silty clay loams. Ground surfaces were rock-free with little bare mineral soil exposed in natural stands; duff depth averaged 4.5 cm. Although most soils had darkened A1 horizons, a few displayed surface A2 or B horizons.

Soil moisture depletion during the growing season has been documented for this phase in two different studies (Daubenmire 1968a, McMinn 1952). Soil dries to the wilting point in the surface horizons during late June to July. By mid- to late August the wilting point depth reaches at least 20 inches.

Berberis repens (BERE) phase/Soil.--This minor phase was found only in central Montana in the vicinity of Lewistown and Roundup where it occupies gentle slopes and benches more moist than those occupied by the *SYAL* phase. *Berberis repens* is common in the luxuriant undergrowth, and bunchgrasses are poorly represented. *Juniperus communis* and *Spiraea betulifolia* are common in the shrub layer. *Schizachne purpurascens* is often present, indicating some similarity to the *PIPO/PRVI* h.t.

Parent materials in this phase were exclusively limestone (appendix D-1). Soils were virtually gravel-free in the surface 20 cm and ranged from slightly acidic to slightly basic. Textures ranged from silt loam to silty clay loam. Ground surfaces were rock-free and no bare soil was exposed in natural stands. Average duff accumulation was greater than 5 cm. All soils had well-developed A1 surface horizons.

Climate.--Weather data for Lewistown represent the climate of the *PIPO/SYAL* h.t. in central Montana (appendix D-2).

Productivity/Management.--Timber productivity is low, although it is one of the more productive habitat types in the *Pinus ponderosa* series (appendix E). In western Montana, site index for *Pinus ponderosa* is similar to that for the grassy habitat types, but basal areas in *PIPO/SYAL* are substantially greater, indicating higher stockability and volume potentials. Eastward, both site indexes and basal areas are generally higher than for the grassy habitat types in this series. *PIPO/SYAL* stands should regenerate faster than the grassy habitat types, if site preparation is adequate. However, clearcuts may be difficult to regenerate due to droughtiness and competition from seral bunchgrasses.

Forage production is somewhat variable. Bunchgrasses are well represented in the *Symphoricarpos albus* phase (appendix C-1), indicating a good potential for domestic livestock. This potential declines in later successional stages. Both phases have a fair complement of palatable big-game browse species.

Other studies.--The *SYAL* phase is comparable to the *Pinus ponderosa/Symphoricarpos albus* h.t. described by R. & J. Daubenmire (1968) and Robert Steele and others (1975, preliminary draft of forest habitat types of central Idaho, USDA Forest Service, Intermountain Station). Hoffman and Alexander (1976) describe a *Pinus ponderosa/Spiraea betulifolia* h.t. in Wyoming that is similar to our *BERE* phase.

Pinus ponderosa/Prunus virginiana h.t.
(*PIPO/PRVI*; ponderosa pine/chokecherry)

Distribution.--This habitat type was found only in southeastern Montana where it is restricted to moist, north-facing slopes and draws mostly between 3,900 and 4,400 feet in elevation.

Vegetation.--Stand structure is variable. Some stands appear to be all-aged, with scattered regeneration and rather uniform representation of size classes. Other stands show two or even three distinct size classes.

Undergrowth differs from other *Pinus ponderosa* habitat types. *Prunus virginiana, Amelanchier alnifolia,* and *Symphoricarpos albus* form a shrubby layer. Green ash, *Fraxinus pennsylvanica,* occurs on semiriparian sites. *Berberis repens, Arnica cordifolia, Cystopteris fragilis, Rhus radicans, Galium boreale, Schizachne purpurascens* and *Agrostis scabra* are characteristic of this habitat type.

Prunus virginiana (PRVI) phase.--This is the common phase of the habitat type.

Shepherdia canadensis (SHCA) phase.--This minor phase was found only on the northern Cheyenne Indian Reservation west of Ashland. It is distinguished by a shrub layer dominated by *Shepherdia canadensis.* In addition, *Arctostaphylos uva-ursi, Pyrola* spp., *Spiraea betulifolia* and occasionally *Linnaea borealis* help to differentiate this phase from the rest of the *PIPO/PRVI* h.t.

Soil/Climate.--This habitat type was found only on noncalcareous sandstone, siltstone, and shale parent materials (appendix D-1). Surface soils were acidic to slightly acidic gravelly silt loams with well-developed A1 horizons. Ground surfaces were virtually rock-free and no mineral soil was exposed in natural stands. Duff depths averaged 5.8 cm in the *PRVI* phase and 3.5 cm in the *SHCA* phase.

Although annual precipitation is low in this region (about 11 inches at Ashland), much of it falls during the growing season. It is doubtful if severe periods of summer drought occur on these sites.

Productivity/Management.--Timber productivity is low to moderate (appendix E). Average site index and maximum stand heights are higher than other eastside *Pinus ponderosa* habitat types.

A rich assortment of palatable shrubs and forbs makes this a preferred wildlife habitat type. Mule deer browse heavily on *Prunus virginiana, Amelanchier alnifolia,* and other shrubs, often severely restricting development of the shrubs.

Cattle make little use of this habitat type, preferring adjacent open forests with bunchgrass undergrowth.

Other studies.--Thilenius (1972) described three habitat units in the Black Hills that appear similar to the *PRVI* phase: *Pinus ponderosa-Quercus macrocarpa/*

Prunus virginiana/Symphoricarpos albus/Berberis repens (HU-6), *Pinus ponderosa-Quercus macrocarpa/Prunus virginiana/Symphoricarpos albus/Schizachne purpurascens-Carex foena* (HU-7), and part of *Pinus ponderosa/Prunus virginiana/Amelanchier alnifolia/Galium biflorum* (HU-8). The *SHCA* phase appears to be related to two of Thilenius' (1972) habitat units: *Pinus ponderosa/Shepherdia canadensis/Symphoricarpos albus/Arctostaphylos uva-ursi* (HU-2) and part of *Pinus ponderosa/Prunus virginiana/Amelanchier alnifolia/Galium biflorum* (HU-8).

Pseudotsuga menziesii Series

Distribution.--*Pseudotsuga* is the indicated climax in a broad forest belt at moderate elevations in the Montana Rockies. Unlike the drier *Pinus ponderosa* and *Pinus flexilis* series, the *Pseudotsuga* series does not extend appreciably out onto the Great Plains. It is associated with well-drained mountain slopes and valleys and extends from the lower elevations of forest growth up to about 5,500 feet on southern exposures in northwestern Montana, and from lower timberline up to about 7,500 feet on warm aspects in southern Montana.

This climax series is broader and more diverse in the Montana Rockies than in northern Idaho. In fact, the *Pseudotsuga* and *Abies lasiocarpa* series form the bulk of the coniferous forest in the Montana Rockies.

The *Pseudotsuga* series is bordered on warmer, drier sites by the *Pinus ponderosa* or *P. flexilis* series or by grassland. In many areas it is bounded on more moist sites by the *Picea* series, and in northwestern Montana often by the *Abies grandis* series. At higher elevations it gives way to the *Abies lasiocarpa* series.

Vegetation.-- *Pseudotsuga menziesii* is more shade-tolerant than its principal associates, which are *Pinus ponderosa* on warm-dry sites within the series, and *Pinus contorta* and (west of the Continental Divide) *Larix occidentalis* under cool-moist conditions. Historically, wildfire has helped maintain these seral species in much of the *Pseudotsuga* series. All four of these species are adapted to fire, and they regenerate well following disturbance. *Pinus ponderosa* and *Larix occidentalis* commonly survive 300 to 400 years, while *Pinus contorta* survives only about half as long. In the absence of disturbance *Pseudotsuga* is the only species that continues to regenerate in any abundance; thus it gradually becomes dominant in undisturbed stands.

Undergrowth is variable among the 15 habitat types in this series. Bunchgrasses dominate three of the driest habitat types: *Pseudotsuga/Agropyron spicatum*, *Pseudotsuga/Festuca idahoensis*, and *Pseudotsuga/Festuca scabrella*. These often appear similar to the corresponding *Pinus ponderosa*/bunchgrass habitat types (fig. 13). In some of the other *Pseudotsuga* habitat types (for example, *PSME/CARU*), bunchgrasses often occur under seral conditions and may persist in openings. Several of the cooler *Pseudotsuga* habitat types (e.g., *PSME/VACA*, *PSME/LIBO*, *PSME/VAGL*) have undergrowth roughly comparable to some types in the *Abies lasiocarpa* series (fig. 14).

Soil/Climate.--Soils are variable throughout the series. In general, habitat types were not strongly related to specific parent materials, although many were found only on noncalcareous substrates. Surface soils are consistently gravelly and acidic, except on calcareous substrates. Surface rock and bare soil are conspicuous in the *Pseudotsuga*/bunchgrass h.t.s and average duff depth is less than 3 cm. Average duff depth in the other *Pseudotsuga* habitat types is from 3 to 6 cm.

Some climatic parameters for the *Pseudotsuga* series are shown in appendix D-2.

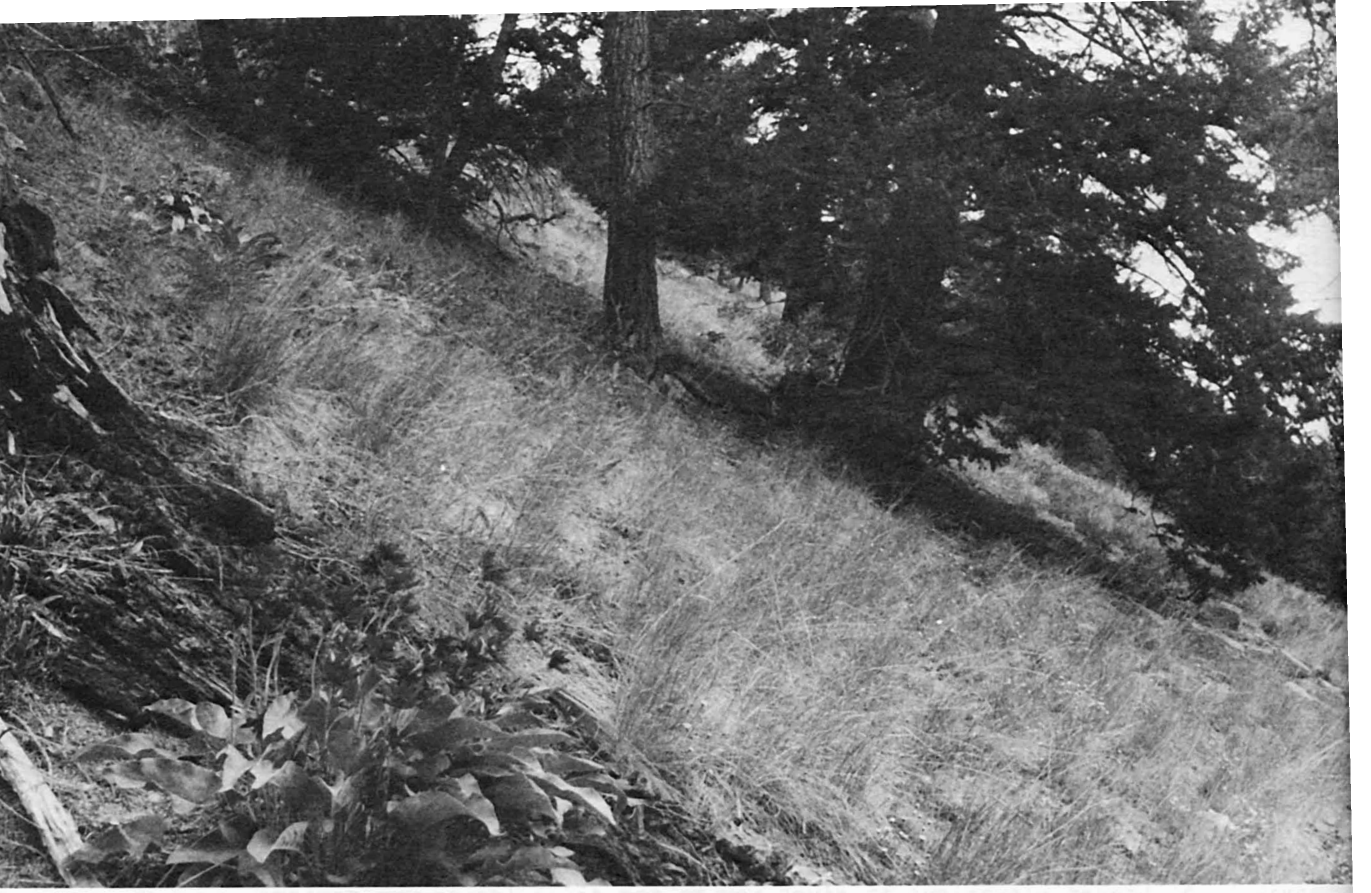


Figure 13.--Pseudotsuga menziesii/Agropyron spicatum *h.t. on a steep south slope (5,650 feet elev.) east of Philipsburg in west-central Montana. Soil is loose and sandy; much of the ground surface is exposed, partially because of grazing.*

Figure 14.--Pseudotsuga menziesii/Vaccinium globulare *h.t. (*Arctostaphylos uva-ursi *phase) on a south exposure (4,700 feet elev.) in a relatively moist area west of Missoula in west-central Montana. Seral* Pinus ponderosa *dominates in the overstory;* Vaccinium *and* Xerophyllum *can be seen in the undergrowth.*

Fire history.--Wildfire appears to have occurred more frequently in this series than in cooler or more moist series. However, fires have generally been less destructive to mature stands in this series than in the cooler or more moist series (Wellner 1970; Arno 1976). Natural fire frequency in many stands has been between 10 and 30 years.

Productivity/Management.--Timber productivity ranges primarily from low to moderate in this series (appendix E). Production of forage for domestic stock and big game varies considerably between habitat types. Lower elevations and southerly exposures are often important for deer and elk winter range.

Pseudotsuga menziesii/Agropyron spicatum h.t.
(*PSME/AGSP*; Douglas-fir/bluebunch wheatgrass)

Distribution.--The *PSME/AGSP* h.t. represents the warm-dry extreme of the *Pseudotsuga* climax series. It occurs mostly on steep southern or western exposures, and is most common in central and west-central Montana. Elevation of sample plots ranged from 5,000 to 6,500 feet. It has a cooler environment and shorter growing season than the *PIPO/AGSP* h.t.

Vegetation.--Trees are widely spaced and stand structure is similar to that of the grassy group of habitat types in the *Pinus ponderosa* series. *Pinus ponderosa* is often a major seral or climax associate. On limestone-derived soils, *Pinus flexilis* is commonly present as a minor seral component.

Undergrowth is dominated by *Agropyron spicatum* and *Balsamorhiza sagittata*. Scattered shrubs may be present with low coverages (appendix C). Undergrowth composition is quite similar to the *PIPO/AGSP* h.t.; however, the *PSME/AGSP* h.t. has no appreciable representation of Great Plains grassland species. *Festuca idahoensis* was common in a few *PSME/AGSP* stands west of the Continental Divide, but *Pinus ponderosa* was a major seral species and site features fit the *PSME/AGSP* description.

Soil.--Our stands were on a variety of calcareous and noncalcareous parent materials (appendix D-1). Surface soils were gravelly (42 percent), acidic to slightly basic (on limestone), and ranged in texture from loamy sand to silt. Ground surfaces averaged 11 percent rock, 13 percent bare soil, and only 2.5 cm duff depth. All of the soils had an A1 surface horizon.

Productivity/Management.--Forage production for livestock is moderate, but steep slopes limit grazing. Mule deer and elk use was quite evident, apparently as part of their winter range. Browse production is low, but warm exposures encourage frequent use.

Timber productivity is low to very low, as indicated by both low site indexes and stockability limitations (appendix E). Clearcutting in this type will generally result in conversion to grassland with very slow reinvasion of trees. Light selection or sanitation-salvage cutting will permit timber harvest and protect the site. Natural regeneration may take 20 to 40 years, but this should be acceptable under a selection system of management. Intensive cultural work is difficult to justify with such low productivity potential.

Other studies.--McLean (1970) described a very similar *Pseudotsuga/Agropyron* h.t. in British Columbia. Robert Steele and others (1975 preliminary draft, USDA Forest Service, Intermountain Station) also describe a comparable situation in central Idaho.

Pseudotsuga menziesii/Festuca idahoensis h.t. (*PSME/FEID*; Douglas-fir/Idaho fescue)

Distribution.--The *PSME/FEID* h.t. is found on dry sites that are generally cooler than those of the *PSME/AGSP* h.t. It occurs on a variety of aspects usually between 5,600 and 7,350 feet elevation. *PSME/FEID* is common in west-central Montana on the Deerlodge National Forest and in southwestern Montana, but is rare elsewhere. In southwestern Montana it often occurs as a topographic climax at the lower edge of the forest on north slopes. It also forms a topographic climax on southerly exposures at higher elevations. There stands are more open and undergrowth is better developed.

Vegetation.--*PSME/FEID* differs from the other *Pseudotsuga*/bunchgrass habitat types in that *Pinus ponderosa* is essentially absent. *PSME/FEID* occurs in areas where even the valley base elevations are near the upper elevational or cold limits of *P. ponderosa*. Small amounts of *Pinus flexilis* may occur in stands on limestone-derived soils.

As with *PSME/AGSP*, undergrowth coverage is sparse. Common associates of *Festuca idahoensis* include *Ribes cereum*, *Artemisia tridentata*, and *Agropyron spicatum*.

Soil.--Our stands were on a variety of calcareous and noncalcareous parent materials (appendix D-1). Surface soils were acidic, averaged 31 percent gravel content, and ranged in texture from sandy loam to silt. Ground surfaces averaged 9 percent rock, 9 percent bare soil, and 2.4 cm duff depth. Almost all of the soils had an A1 horizon.

Productivity/Management.--Forage potential for livestock is moderate in cleared or open stands. Slopes are often gentle enough to allow domestic livestock grazing. Mule deer and elk use was quite evident, apparently for winter cover and forage.

Timber productivity is low, as reflected by low site-index values and apparent stockability limitations (appendix E). Dense stands on north or east aspects often become stagnated. *Pseudotsuga* is the only commercial tree species in this habitat type. Timber management considerations are similar to those described for the *PSME/AGSP* h.t., except that small clearcuts may be appropriate for stagnated stands on north slopes.

Other studies.--This habitat type has been described for central Idaho (Robert Steele and others 1975 preliminary draft, USDA Forest Service, Intermountain Station). McLean (1970) described a *PSME/FEID* h.t. in British Columbia; however, his description corresponds to our *PSME/CARU* h.t., *AGSP* phase in Montana.

Pseudotsuga menziesii/Festuca scabrella h.t. (*PSME/FESC*; Douglas-fir/rough fescue)

Distribution.--The *PSME/FESC* h.t. was found only in northwestern, west-central, and central Montana. Most sample stands were on south- or west-facing slopes between 2,700 and 5,700 feet in elevation, but they ranged as high as 7,400 feet in central Montana.

Vegetation.--*Pinus ponderosa* is often a major seral or climax associate with *Pseudotsuga*. Only occasionally are sites found at elevations above the cold limits of *Pinus ponderosa*. *Pinus flexilis* is a minor component of some stands on calcareous soils.

Undergrowth appears similar to that of adjacent *Festuca scabrella* grasslands. Small amounts of *Amelanchier alnifolia*, *Prunus virginiana*, and *Rosa woodsii* are often found. *Purshia tridentata* was abundant in two sample stands; in this situation wildlife management implications might parallel those for the *PIPO/PUTR* h.t. Major grasses and forbs associated with *Festuca scabrella* include *Agropyron spicatum*, *Festuca idahoensis*, *Koeleria cristata*, *Balsamorhiza sagittata*, and *Lithospermum ruderale*.

The *Festuca scabrella* union was given habitat type status in the *Pseudotsuga* series for two reasons: (1) There is a geographical segregation of *PSME/FEID* and *PSME/FESC* h.t.s, the latter occurring to the north; (2) *Pinus ponderosa* is often a major climax associate in the *PSME/FESC* h.t., but is absent in *PSME/FEID*. *Festuca scabrella* and *F. idahoensis* unions have less-contrasting habitats in the *Pinus flexilis* and *P. ponderosa* series, thus they are classified as phases.

Soil.--Our stands were on a variety of calcareous and noncalcareous parent materials (appendix D-1). Surface soils were acidic, averaged 37 percent gravel content and ranged in texture from loam to silt. Ground surfaces averaged 5 percent rock, 7 percent bare soil, and 2.5 cm duff depth. Many of the soils had an A1 horizon.

Productivity/Management.--On gentle terrain, the *PSME/FESC* h.t. is one of the better forest habitat types for production of forage for domestic stock. Canopy coverage of bunchgrasses is much greater than for other *Pseudotsuga* habitat types (appendix C-1). Mule deer and elk use was quite evident, apparently as winter range.

Timber productivity is low to very low, due to both low site index values and stockability limitations (appendix E). Timber management considerations are similar to those described for the *PSME/AGSP* h.t.

Other studies.--The *PSME/FESC* h.t. has not been described elsewhere.

(*Pseudotsuga menziesii/Vaccinium caespitosum* h.t.
(*PSME/VACA*; Douglas-fir/dwarf huckleberry)

Distribution.--The *PSME/VACA* h.t. is found on relatively warm and moist, but well-drained benches and gentle slopes. It is common in northwestern, west-central, and central Montana. Elevations are mostly 2,500 to 3,800 feet in northwestern Montana, 2,900 to 4,500 feet in west-central Montana, and 5,200 to 6,400 feet east of the Continental Divide. Afternoon temperatures may be high in summer, but in many of these sites cold air accumulation creates a "frost pocket."

Vegetation.--Most stands in northwestern Montana are dominated either by *Pinus ponderosa* or *Larix occidentalis* (fig. 15). East of the Continental Divide and on colder sites in northwestern Montana, *Pinus contorta* is the dominant seral tree species.

Undergrowth is a low, dense layer of *Calamagrostis rubescens*, *Carex geyeri*, *Vaccinium caespitosum*, and *Arctostaphylos uva-ursi*. *Linnaea borealis* is well represented in about a third of the stands sampled, apparently on the more moist sites. *Symphoricarpos albus* is sometimes well represented, but usually has less coverage than *Calamagrostis* and its low-growing associates. *Xerophyllum tenax* is occasionally present on sites in cool mountain canyons.

The open, park-like conditions and large fire-scarred seral trees found in undisturbed stands of *PSME/VACA* suggest a history of frequent ground fires. In many cases *Pseudotsuga* has only recently begun to regenerate, because of past fires or perhaps due to moisture depletion in the surface soil caused by heavy stocking of old-growth *Pinus ponderosa* and *Larix occidentalis* and the dense mat of undergrowth.

Soil/Climate.--Our stands were on a variety of noncalcareous parent materials (appendix D-1). Surface soils were acidic, gravelly (26 percent) sandy loams to loams. Very little rock and bare soil were exposed; duff depth averaged 4.3 cm.

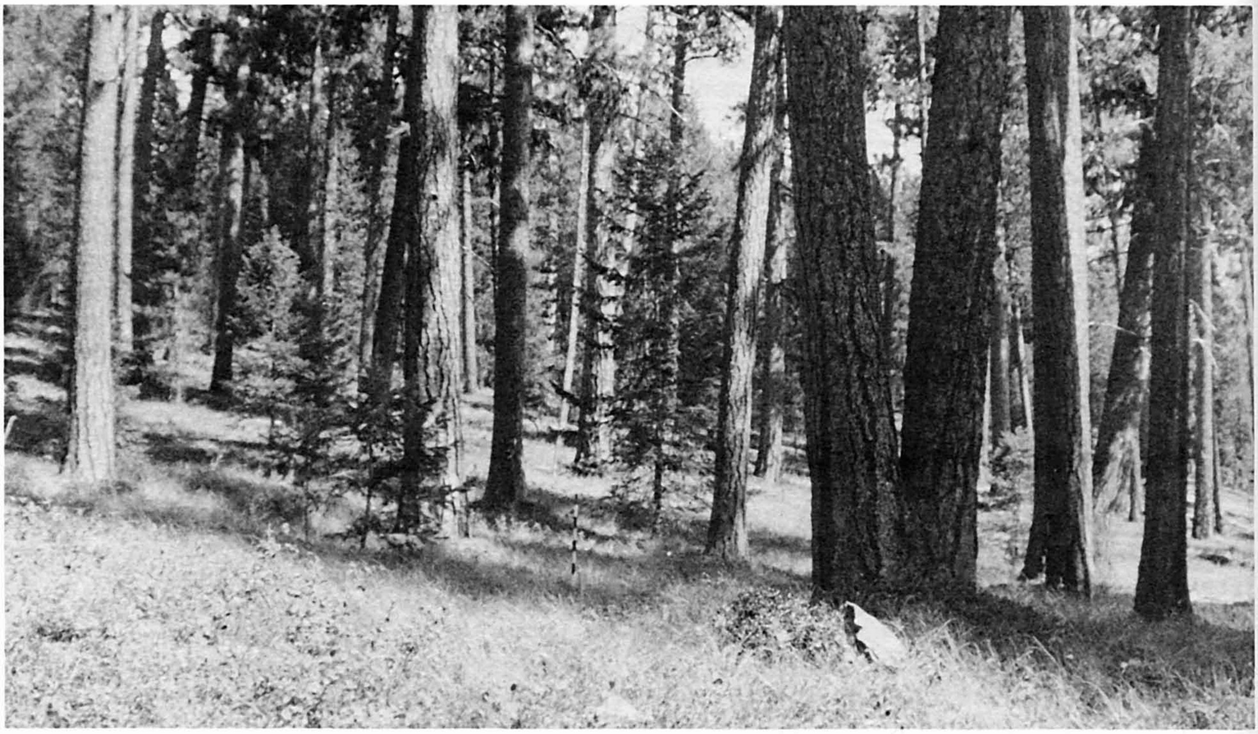


Figure 15.--Pseudotsuga menziesii/Vaccinium caespitosum *h.t. on gentle terrain (4,500 feet elev.) northeast of Missoula.* Pinus ponderosa *and* Larix occidentalis *dominate the overstory, but the regeneration is* Pseudotsuga.

Weather data from Greenough and Pleasant Valley (appendix D-2) represent the climate of the *PSME/VACA* h.t. west of the Continental Divide.

Productivity/Management.--West of the Continental Divide this habitat type affords good growth for a mixture of commercially valuable tree species; growth of *Pinus ponderosa* is excellent. Productivity ranges from moderate to high in western Montana (appendix E). Eastward, the habitat type is less productive, *Pinus contorta* is the dominant seral species, and *Pinus ponderosa* and *Larix occidentalis* are absent.

Either even-aged management or selective removal of *Pseudotsuga* will favor perpetuation of seral tree species in this habitat type. Overstory removal will lead to increasing dominance by *Pseudotsuga*. The sod formed by *Calamagrostis rubescens* and its associates may need breaking for successful regeneration of conifers. Wide latitude can be taken in managing these productive and accessible sites.

Domestic stock use was observed only locally. The forage potential for livestock is low in natural stands. However, deer, elk, and occasionally moose use them heavily in winter, if snow depths are not too great.

This habitat type is frequently used for recreation sites, including campgrounds and summer home developments.

Other studies.--Steele and others (1976 preliminary draft, USDA Forest Service, Intermountain Station) has recorded this habitat type in north-central Idaho. In Alberta, that part of Ogilvie's (1962) *Pseudotsuga/Calamagrostis* h.t. which includes *Vaccinium caespitosum* appears to be similar.

Pseudotsuga menziesii/Physocarpus malvaceus h.t. (*PSME/PHMA*; Douglas-fir/ninebark)

Distribution.--In most of Montana, the *PSME/PHMA* h.t. occurs predominantly on cool and moist north- or east-facing slopes. However, the *Calamagrostis rubescens* phase is usually associated with southerly exposures, and in moist areas of northwestern Montana the *Physocarpus* phase occurs on south-facing slopes. In northwestern and west-central Montana the habitat type was found at elevations of 2,000 to 5,700 feet, in central Montana at 4,800 to 5,800 feet, and in south-central Montana at 5,100 to 6,700 feet.

Vegetation.--The overstory is normally dominated by *Pseudotsuga*. West of the Continental Divide, *Pinus ponderosa, Larix occidentalis,* and *Pinus contorta* are minor seral components of many stands; however, *Pseudotsuga* is usually the dominant tree species in all stages of succession. East of the Continental Divide, *Pseudotsuga* is the only tree species present in appreciable amounts. An exception was found on limestone substrates in south-central Montana, where *Pinus flexilis* was a major associate of *Pseudotsuga* under seral conditions.

Physocarpus malvaceus (PHMA) phase.--*Physocarpus malvaceus* or *Holodiscus discolor* form a dense shrubby layer that dominates the undergrowth (fig. 16). *Symphoricarpos albus, Spiraea betulifolia, Calamagrostis rubescens, Arnica cordifolia,* and *Carex geyeri* are often well represented. *Disporum trachycarpum, Smilacina* spp., *Thalictrum occidentale,* and other moist-site forbs are common. Stands are normally on north or east aspects.

Calamagrostis rubescens (CARU) phase.--This warm-exposure variation of the *PSME/PHMA* h.t. is common in west-central Montana. In mature stands *Calamagrostis rubescens* and *Carex geyeri* are dominant beneath a scattered *Physocarpus* shrub layer. *Agropyron spicatum* and *Balsamorhiza sagittata* are common in half of the sample stands (fig. 17) and they may dominate stands in early seral condition. *Pinus ponderosa* is a major seral dominant on these sites, and *Pinus contorta* and *Larix occidentalis* are absent because of droughty conditions. This phase evidently represents a transition from *PSME/PHMA* to the *PSME/CARU* or *PSME/AGSP* h.t.s.

Soil.--Our stands were on a variety of noncalcareous parent materials west of the Continental Divide; near and east of the Continental Divide stands were also found on limestone (appendix D-1). Surface soils were acidic (slightly basic on limestone), gravelly (average 42 percent), and ranged in texture from sandy loam to silt. Little exposed rock was evident in the *PHMA* phase with about 5 percent in the *CARU* phase. No bare soil was exposed in either phase and duff depth averaged about 4 cm in both.

Productivity/Management.--Timber productivity is moderate to high in western Montana, but only low to moderate eastward (appendix E). The highest productivities are found in western Montana in the *PHMA* phase. East of the Continental Divide, silvicultural prescriptions consider only *Pseudotsuga* since *Pinus ponderosa* and *P. contorta* are rarely present. West of the Divide, *P. ponderosa, P. contorta,* and *Larix occidentalis* may be perpetuated where they occur naturally through even-aged management. Partial cutting favors *Pseudotsuga*, but timber production may be severely reduced in dwarf-mistletoe (*Arceuthobium*) infected stands.

Livestock usually graze only small areas of gentle topography in this type. Heavy grazing can establish a *Poa* disclimax similar to that described by R. and J. Daubenmire (1968).

Big game use of *PSME/PHMA* h.t. is variable, ranging from transitory or bedding activity to heavy winter use by elk and deer. Intensity of use may depend on

Figure 16.--Physocarpus *phase* (PSME/PHMA *h.t.*) *on a steep east exposure* (*5,000 feet elev.*) *south of Drummond in west-central Montana. The overstory is almost purely* Pseudotsuga *about 170 years of age.*

Figure 17.--Calamagrostis *phase* (PSME/PHMA *h.t.*) *on a steep southwest exposure* (*4,500 feet elev.*) *southeast of Missoula.* Pinus ponderosa *is a long-lived seral dominant.*

snowpack depth, successional stage, and the availability of favored browse species. The *Calamagrostis rubescens* phase, which occurs on warmer slopes, may have the greatest importance as winter range.

Other studies.--R. and J. Daubenmire (1968) and Hoffman and Alexander (1976) defined *Pseudotsuga/Physocarpus* h.t.s that are similar to our *PSME/PHMA* h.t., *PHMA* phase. Steele and others (1975 preliminary draft, USDA Forest Service, Intermountain Station) reported finding both phases of the habitat type in central Idaho.

Pseudotsuga menziesii/Vaccinium globulare h.t.
(*PSME/VAGL*; Douglas-fir/blue huckleberry)

Distribution.--*PSME/VAGL* is found on relatively cold sites within the *Pseudotsuga* series, and generally is bordered upslope by the *Abies lasiocarpa* series (*ABLA/XETE* h.t., *VAGL* phase or *ABLA/VAGL* h.t.). It is a major habitat type in vicinities of the Lolo and Bitterroot National Forests and is also prominent in central Montana. It occurs on well-drained slopes at elevations between 4,300 and 6,800 feet.

Vegetation.--*Pseudotsuga* is the indicated climax as well as a vigorous member of most seral communities. *Pinus contorta, Larix occidentalis,* and *Pinus ponderosa* are seral components whose abundance varies considerably by phase. *Vaccinium globulare* is well represented in undergrowth throughout the habitat type. Most stands have a mat of *Calamagrostis rubescens* and *Carex geyeri*. *Spiraea betulifolia* is usually common, as is *Xerophyllum* in two of the phases.

Arctostaphylos uva-ursi (ARUV) phase.--This phase occurs on relatively warm sites, on moderate southerly slopes mostly between 4,300 and 5,600 feet. It occurs rather extensively near and west of Missoula, as well as along the west side of the Bitterroot Valley. Unlike other phases, *Pinus ponderosa* is a dominant in seral communities, and *Pinus contorta* and *Larix occidentalis* have only minor representation in most stands. *Arctostaphylos uva-ursi* is common in the undergrowth, and *Carex geyeri* and *Xerophyllum* are usually common also. Vegetative composition of stands in this phase is related to that of the *PSME/CARU* h.t., *ARUV* phase, except for the *Vaccinium globulare* and *Xerophyllum*, which are indicative of colder climatic conditions.

Xerophyllum tenax (XETE) phase.--Although this phase is found in the same geographic area as the *ARUV* phase, it occupies cooler sites. It is also found on southern exposures, but at somewhat higher elevations (4,800 to 6,500 feet). *Pinus contorta* and *Larix occidentalis* are major dominants in seral stands, and *Pinus ponderosa* is absent or only a minor component. *Vaccinium globulare* is usually well represented, and *Xerophyllum* is common. Most stands in this phase were classified as *Pseudotsuga/Xerophyllum* h.t. in our preliminary publications (1972 and 1974).

Vaccinium globulare (VAGL) phase.--In contrast to the other phases, this one is commonly associated with the continental mountain climate found near and east of the Continental Divide in Montana. It was sampled in central Montana and also locally in an area immediately southeast of Missoula. Unlike the other phases, it is restricted to cool exposures (northwest, north, and east), where it occupies moderately steep slopes. Elevations of sample stands ranged from 6,200 to 6,800 feet in central Montana and from 5,000 to 5,600 feet near Missoula. *Pinus contorta* is a major component of seral stands; additionally, *Larix occidentalis* and *Pinus ponderosa* are minor components of the stands near Missoula. *Arctostaphylos* and *Xerophyllum* are scarce in the undergrowth, although *Vaccinium globulare* is well represented. *Arnica latifolia,* indicative of colder climatic conditions, is common in some stands.

Soil.--Our stands were on a variety of noncalcareous parent materials (appendix D-1). Surface soils were very gravelly sandy loams to silts in the *XETE* phase; gravelly silty clay loams in the *ARUV* phase, and gravelly loams to silts in the *VAGL* phase. Soils were acidic in all phases. Ground surfaces had little rock or bare soil exposed; duff depths averaged about 3 cm.

Productivity/Management.--Timber productivity is low to moderate (appendix E). Silvicultural prescriptions and choice of species will vary depending on the phase. This habitat type receives little use by domestic stock. Deer and elk use is light to moderate.

This is an important habitat type for production of *Vaccinium globulare*, whose berries are utilized by bears, grouse, other wildlife, and humans, and whose shoots are browsed by big game. Miller (1977) studied the response of *Vaccinium globulare* to prescribed fires in spring and fall on a site in the *Arctostaphylos* phase in west-central Montana. Her findings should be useful for predicting response of *Vaccinium globulare* to management activities.

This *PSME/VAGL* h.t. includes a combination of stands formerly classified as *Pseudotsuga/Vaccinium globulare* h.t. and *Pseudotsuga/Xerophyllum tenax* h.t. (fig. 57, page 137) in our preliminary classifications. In final analysis it seemed most realistic to treat these situations as three phases of one habitat type.

Other studies.--Steele and others (1975 preliminary draft, USDA Forest Service, Intermountain Station) have identified a few stands as this habitat type in central Idaho; it has evidently not been noted or recognized elsewhere.

Pseudotsuga menziesii/Linnaea borealis h.t. (*PSME/LIBO*; Douglas-fir/twinflower)

Distribution.--*PSME/LIBO* is a major habitat type in northwestern, west-central, and central Montana, where it occurs on relatively moist sites for the *Pseudotsuga* series. It often forms a transition between this series and the *Picea, Abies grandis,* or *Abies lasiocarpa* series. This type is usually found on moderate slopes and all but the driest (southeast to west) aspects. Elevations vary by phase, but are mostly 2,600 to 4,000 feet in northwestern, 4,000 to 6,000 feet in west-central, and 5,000 to 6,500 feet in central Montana.

Vegetation.--*Pseudotsuga* forms the climax and is also a vigorous member of seral communities. *Pinus contorta* is a major component of young stands throughout the *VAGL* and *CARU* phases--collectively the cooler sites within this habitat type. *Larix occidentalis* and *Pinus ponderosa* are often components of seral stands in northwestern and west-central Montana, but are absent eastward.

Undergrowth in all three phases is characterized by a mat of *Calamagrostis rubescens* in which *Linnaea borealis* is common. Also, *Arctostaphylos uva-ursi, Spiraea betulifolia,* and *Arnica cordifolia* or *A. latifolia* are typically found. Other characteristics of the undergrowth vary by phase.

Calamagrostis rubescens (CARU) phase.--This phase occupies relatively cold, dry sites within the habitat type. It occurs mostly in west-central and central Montana at 4,800 to 6,000 feet on cool exposures, but is found as high as 7,250 feet in the Big Hole River drainage of southwestern Montana. *Pinus contorta* is a major component of seral stands. Undergrowth is distinguished by scarcity of *Vaccinium globulare* and *Symphoricarpos albus.* *Vaccinium scoparium* is often well represented, showing this phase's resemblance to the neighboring (colder) *ABLA/LIBO* h.t., *VASC* phase. The undergrowth in representation of *Arnica latifolia* and moist-site forbs *Osmorhiza chilensis, Smilacina stellata,* and *Thalictrum occidentale* is intermediate between that of the *SYAL* and *VAGL* phases.

Symphoricarpos albus (SYAL) phase.--The *SYAL* phase occurs on benches and cool exposures having moist and mild-temperature environments. It was sampled at 2,600 to 3,800 feet in northwestern, 4,000 to 5,000 feet in west-central, and near 6,000 feet in central Montana. In contrast to other phases, *Pinus contorta* is seldom a component of seral stands. *Symphoricarpos albus* is well represented in the undergrowth, while *Vaccinium globulare, V. scoparium,* and *Xerophyllum* are poorly represented. *Arnica cordifolia* is common and *A. latifolia* rare, reflecting warmer environmental conditions. Also, moist-site forbs *Osmorhiza chilensis, Smilicina stellata,* and *Thalictrum occidentale* are conspicuous in this phase.

Vaccinium globulare (VAGL) phase.--This phase occupies the coolest, most moist sites within the habitat type; it was found mostly in west-central Montana between 4,250 and 6,000 feet elevation on cool exposures. *Pinus contorta* is a major component of seral stands, and *Vaccinium globulare* is well represented in the undergrowth. The coolness of these sites is indicated by the presence of *Xerophyllum* in about half of the sample stands and by *Arnica latifolia* being as abundant as *Arnica cordifolia;* the phase thus shows an affinity with the *Abies lasiocarpa* series.

Soil.--Our stands were on a variety of primarily noncalcareous parent materials (appendix D-1). Surface soils were acidic, gravelly sandy loams to silty clay loams. Little rock or bare soil were exposed. Duff depths averaged 4.6 cm in the *SYAL* phase, 6.1 cm in the *CARU* phase, and 3.5 cm in the *VAGL* phase.

Productivity/Management.--Timber productivity is moderate in western Montana, and low to moderate eastward (appendix E). The highest productivities were in the *CARU* phase. The prevalence of *Calamagrostis rubescens* in all phases should be considered in site preparation plans. However, competition for moisture should be less severe than in the *PSME/CARU* and *PSME/SYAL* h.t.s. Light to moderate use by deer and often by elk was evident in most sample stands.

Other studies.--Two sample stands from R. and J. Daubenmire's (1968) *Pseudotsuga/Calamagrostis* h.t. contained *Linnaea borealis* and appear similar to our *PSME/LIBO* h.t. Ogilvie's (1962) *Pseudotsuga/Arctostaphylos* h.t. contained *Linnaea* and is also similar.

Pseudotsuga menziesii/Symphoricarpos albus h.t.
(*PSME/SYAL*; Douglas-fir/snowberry)

Distribution.--*PSME/SYAL* is one of the more common habitat types and is found throughout Montana on moderately warm slopes and benches. Occasionally it occurs on northerly aspects near the lower distribution of *Pseudotsuga* in the foothills of drier mountain ranges.

Vegetation.--Seral stands at lower elevations are frequently dominated by *Pinus ponderosa.* At higher elevations *Pseudotsuga* dominates most stages of succession. Occasionally *Pinus contorta* is a minor seral species. The dominant undergrowth species is usually *Symphoricarpus albus*; variations in undergrowth composition are described for three phases.

Agropyron spicatum (AGSP) phase.--This phase occupies sites on the droughty extreme of the habitat type; stands are somewhat open and often appear similar to those of the three *Pseudotsuga*/bunchgrass h.t.s, reflecting a transitional environment. The phase is generally restricted to west-central Montana, where it occurs on warm, dry southerly exposures. *Agropyron spicatum, Festuca idahoensis*, and/or *Balsamorhiza sagittata* are well represented in undisturbed old-growth stands. *Pinus ponderosa* is a major seral dominant, and *Pinus contorta* and *Larix occidentalis* are absent.

Calamagrostis rubescens (CARU) phase.--Over half of the sample stands in this habitat type had *Calamagrostis rubescens* and *Carex geyeri* as major components of the undergrowth (fig. 18). In northwestern and west-central Montana elevations were mostly between 2,700 and 5,500 feet. Eastward, elevations of sample stands were higher (5,300 to 7,000 feet). *Pinus ponderosa* is a seral dominant in northwestern and west-central Montana. *Pinus contorta* is a minor seral component, increasing in abundance to the east. *Larix occidentalis* is generally absent. In many stands *Pseudotsuga* dominates most stages of succession.

No consistent environmental differences were found to distinguish this phase from the *SYAL* phase. However, the abundance of rhizomatous graminoids seems important to recognize.

Symphoricarpos albus (SYAL) phase.--Bunchgrasses, *Calamagrostis rubescens*, and *Carex geyeri* are poorly represented in old-growth stands. Elevations of sample stands ranged from 3,600 to 6,400 feet west of the Continental Divide and from 4,800 to 7,200 feet eastward. *Pinus ponderosa* is a major seral component on sites within its range, while *Pinus contorta* and *Larix occidentalis* are essentially absent. In many stands *Pseudotsuga* dominates most stages of succession.

Figure 18.--Pseudotsuga menziesii/Symphoricarpos albus *h.t.* (Calamagrostis *phase) on a broad ridge (6,000 feet elev.) in the Big Belt Mountains east of Townsend in central Montana. Seral* Pinus contorta *dominates the overstory along with some* Pseudotsuga; Symphoricarpos *and* Calamagrostis *dominate the undergrowth.*

Soil.--The *PSME/SYAL* h.t. was sampled on a variety of calcareous and noncalcareous parent materials (appendix D-1). Surface soils were gravelly (33 percent) sandy loams to silts with acidic reactions (slightly basic on some of the calcareous parent materials). Little surface rock was evident in the *CARU* and *SYAL* phases, although an average of 7 percent was noted in the *AGSP* phase. Only small amounts of bare soil were exposed; duff depth averages 2.6 cm in the *AGSP* phase, 3.6 cm in the *CARU* phase, and 4.1 cm in the *SYAL* phase.

Productivity/Management.--Timber productivity of this type ranges from low to high in western Montana and from low to moderate eastward (appendix E). Basal area stocking is good in the *CARU* and *SYAL* phases, but the *AGSP* phase may have stockability limitations and also has the lowest site index values. Regeneration may be difficult in the droughty *AGSP* phase. The prevalence of rhizomatous graminoids in the *CARU* phase should be considered in site preparation plans.

Moderate use by deer and occasionally by elk and moose was evident in most stands in the *CARU* and *SYAL* phases.

Other studies.--Our *SYAL* phase is similar to most of R. and J. Daubenmire's (1968) *Pseudotsuga/Symphoricarpos* h.t.; two of their stands are similar to our *CARU* phase. Ogilvie's (1962) *Pseudotsuga/Symphoricarpos* h.t. and the part of his *Pseudotsuga/Calamagrostis* h.t. having *Symphoricarpos* "well represented" are comparable to our *CARU* phase. Most of Steele and others (1975 preliminary draft, USDA Forest Service, Intermountain Station) *PSME/SYAL* h.t. in central Idaho is also comparable to our *CARU* phase.

Pseudotsuga menziesii/Calamagrostis rubescens h.t.
(*PSME/CARU*; Douglas-fir/pinegrass)

Distribution.--*PSME/CARU* is the most ubiquitous habitat type in the *Pseudotsuga* series in Montana. It occurs on moderately dry mountainsides and upper slopes. At the lower elevations it often occupies northerly aspects or benches, shifting to southerly positions at high elevations. It often represents the highest extension of the *Pseudotsuga* series.

Vegetation.--Seral tree species include *Pinus ponderosa, Pinus contorta, Larix occidentalis,* and occasionally *Pinus albicaulis*. As shown in figure 19, tree composition varies considerably by phase; *Pseudotsuga*, however, succeeds quite well and dominates most stands. Old-growth stands often have a park-like appearance.

Undergrowth composition also varies by phase; however, some features are characteristic of the habitat type in general. As R. and J. Daubenmire (1968) have noted, the undergrowth is a brilliant green grassy layer with uniformity enhanced by the lack of inflorescences. *Carex geyeri* is often well represented and may even dominate *Calamagrostis*. *Arctostaphylos uva-ursi* is occasionally well represented. The most abundant forb in the 97 sample stands was *Arnica cordifolia*; other characteristic forbs include *Antennaria racemosa, Aster conspicuus,* and *Fragaria virginiana*. *Spiraea betulifolia* is occasionally well represented, but such stands were similar in other respects to stands having little or no *Spiraea*. Therefore, we gave *Spiraea* less weight as an indicator than *Calamagrostis rubescens*, unlike R. and J. Daubenmire (1968) and Robert Steele and others (1975 preliminary draft of forest habitat types of central Idaho, USDA Forest Service, Intermountain Station).

Figure 19 shows some of the major vegetational differences among the four phases of this habitat type. The elevation distributions of these phases are shown in table 2.

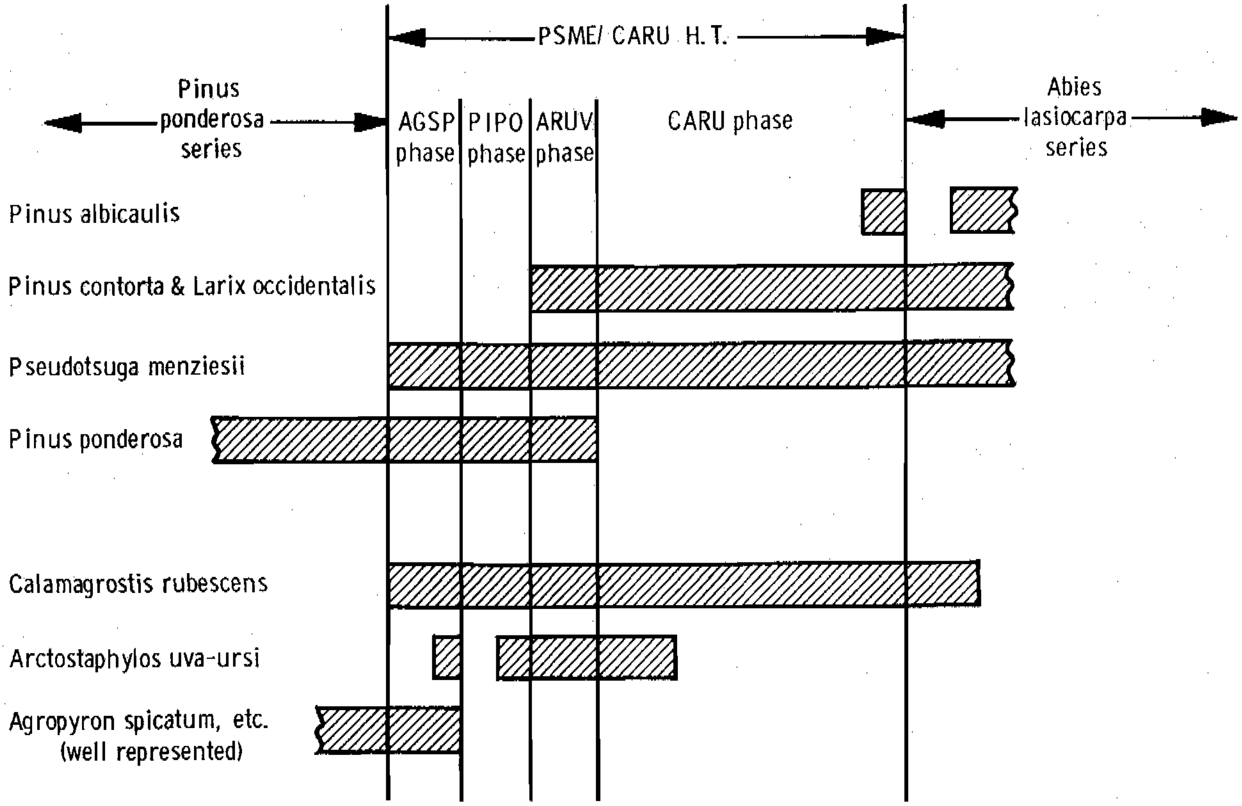


Figure 19.--Generalized distribution of key indicator species within phases of the Pseudotsuga/Calamagrostis *habitat type.*

Table 2.--*Elevational range (in feet) of* Pseudotsuga/Calamagrostis *h.t. sample stands by phase in geographic subdivisions of Montana (as shown in fig. 1)*

Phase of the habitat type	Geographic subdivision of Montana		
	Northwestern	West-central and central	Southwestern and south-central
AGSP	2,700 to 3,500	4,400 to 5,300	none
PIPO	3,500 to 4,800	4,800 to 6,000	none
ARUV	3,000 to 4,000	4,000 to 5,400	none
CARU	4,700 to 5,300	5,300 to 7,000	6,500 to 7,800

Agropyron spicatum (AGSP) phase.--This phase is most common in west-central Montana where it occupies the droughty extremes of the *PSME/CARU* h.t. Bunchgrasses *Agropyron spicatum, Festuca idahoensis,* or *F. scabrella,* are well represented and not obviously seral in mature stands. Also in contrast to other phases, *Balsamorhiza sagittata* is usually well represented on these sites. *Pinus ponderosa* is the major seral component of the overstory, and *Pinus contorta* and *Larix occidentalis* are absent on these dry sites. *Pseudotsuga* increases its coverage slowly beneath pine-dominated stands. This phase represents a transitional environment between the *PSME/CARU* and the various *PIPO/* or *PSME*/bunchgrass h.t.s.

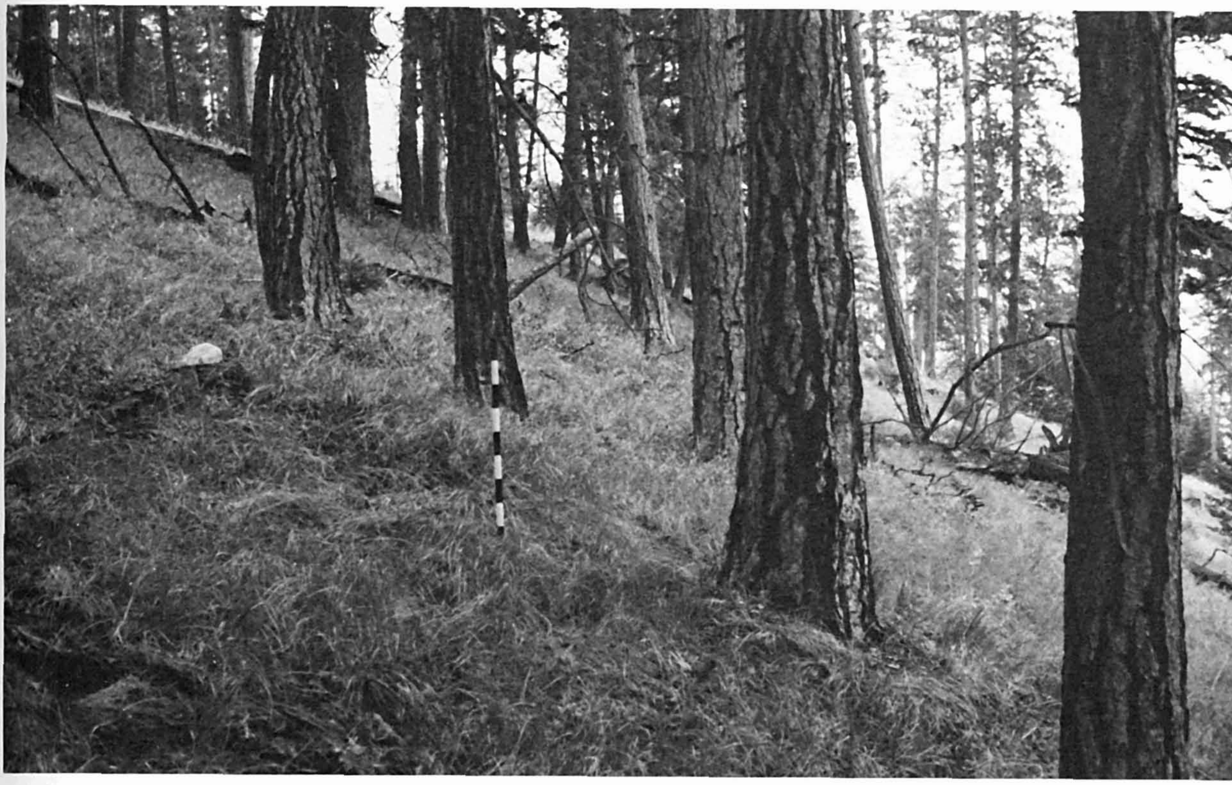


Figure 20.--Pinus ponderosa *phase (*PSME/CARU *h.t.) on a steep south-facing slope (4,550 feet elev.) southwest of Eureka in northwestern Montana.* Pinus ponderosa *is the long-lived seral dominant.*

In contrast to other phases in the *PSME/CARU* h.t., *Calamagrostis rubescens* decreases following overstory removal. Sites apparently become too dry and warm for *Calamagrostis* and it will become well represented again only as the overstory closes, creating a cooler microclimate.

Pinus ponderosa (PIPO) phase.--This warm phase is found mostly between 4,500 and 6,000 feet elevation on south-facing slopes (fig. 20). It is common in west-central and northwestern Montana, and occurs locally in central Montana. It is similar to the *AGSP* phase in that it does not support *Pinus contorta* or *Larix occidentalis* (fig. 19), but is less droughty. *Pinus ponderosa* is common ($\geq$ 10 trees/acre) and typically codominant with *Pseudotsuga* under seral conditions.

Indicators for the *Agropyron spicatum* phase are poorly represented in mature stands. *Calamagrostis rubescens* may or may not maintain high coverage after logging or fire. In contrast to the usual situation for the habitat type, *Calamagrostis rubescens* flowers profusely in some of the relatively open but undisturbed stands. This phase is bordered upslope by the cooler *CARU* phase.

Arctostaphylos uva-ursi (ARUV) phase.--This phase occurs on warm, well-drained benches and gentle slopes. Topographically and climatically these sites are similar to but slightly drier than those of the *PSME/VACA* h.t. This minor phase is common in west-central Montana and is found occasionally in northwestern Montana, as well as on the Helena National Forest in the central part of the State.

These stands are typically dominated by seral *Pinus ponderosa*; however, small amounts of *P. contorta* or *Larix occidentalis* are also present, reflecting more moisture than the other warm phases (*AGSP* and *PIPO*) of the habitat type.

Arctostaphylos uva-ursi, Calamagrostis rubescens, and *Carex geyeri* form the dominant undergrowth. In a few seral stands *Calamagrostis* is not well represented, but nevertheless is common.

This phase should not be confused with the *PSME/ARUV* h.t., which is found on distinctly drier sites in central Montana.

Calamagrostis rubescens (CARU) phase.--This phase makes up the bulk of the *PSME/CARU* h.t. (62 out of the 97 sample stands) (fig. 21). *Calamagrostis rubescens* is well represented, and bunchgrasses are poorly represented in mature stands, although they may increase with disturbance. As shown in table 2, elevations are higher than for the other phases, and the sites are too cold for any appreciable representation of *Pinus ponderosa*. Drought is evidently less severe than in the *AGSP* and *PIPO* phases, allowing *Pinus contorta* to become a seral component of many stands. *Larix occidentalis* is found in some stands in northwestern Montana. East of the Continental Divide, *Pinus albicaulis* may be well represented at the upper limits of this phase.

Soil.--Our stands were on a variety of primarily noncalcareous parent materials (appendix D-1). Surface soils were acidic, ranging in texture from gravelly sandy loams to gravelly silts. Surface rock exposure averaged 5 to 6 percent in the *AGSP* and *ARUV* phases and 2 to 3 percent in the *CARU* and *PIPO* phases. Bare soil exposure was minimal and duff depth averaged about 4 cm in all phases.

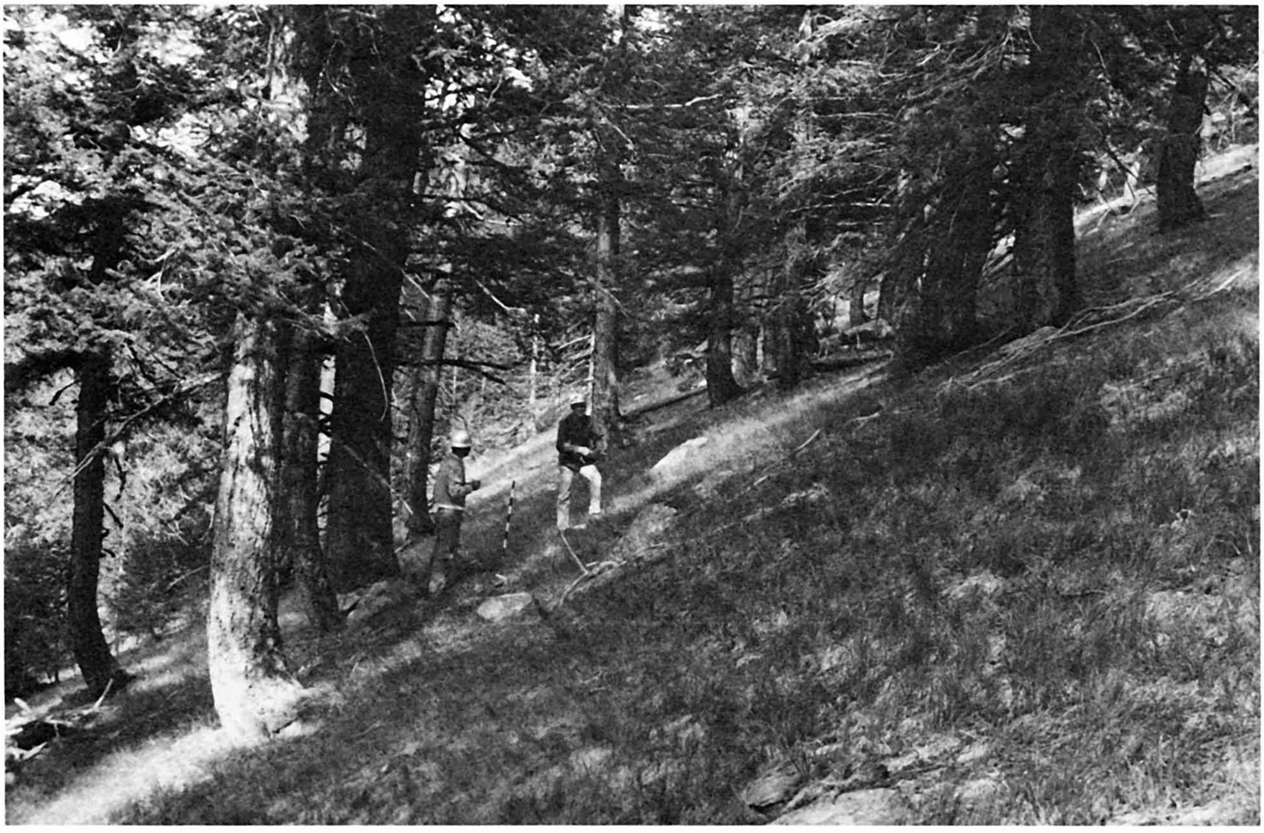


*Figure 21.--*Calamagrostis *phase (*PSME/CARU *h.t.) on a steep southwest exposure (6,900 feet elev.) southwest of Missoula. This site is above the cold limits of* Pinus ponderosa

Productivity/Management.--Timber productivity is low to moderate in the *PSME/CARU* h.t. (appendix E). The *ARUV* phase averaged highest in productivity; the *CARU* phase was lowest. Clearcutting and shelterwood systems will favor seral species, while partial cutting will lead to eventual dominance by *Pseudotsuga* in most cases. Extensive scarification may be needed to reduce grass competition for successful regeneration.

Although forage production is low, cattle and horse use is evident on many gentle slopes. Moderate winter use by deer and elk is apparent in the *AGSP* and *ARUV* phases. The *PIPO* and *CARU* phases show light to moderate use, evidently in spring and fall.

Other studies.--Similar habitat types have been described from Wyoming (Cooper 1975) and central Idaho (Robert Steele and others, 1975 preliminary draft, USDA Forest Service, Intermountain Station) to Alberta (Ogilvie 1962), British Columbia (Brayshaw 1965; McLean 1970), northern Idaho, Washington (R. and J. Daubenmire 1968), and eastern Oregon (Hall 1973).

Pseudotsuga menziesii/Carex geyeri h.t. (*PSME/CAGE*; Douglas-fir/elk sedge)

Distribution.--The *PSME/CAGE* h.t. is similar to but apparently somewhat drier than the *PSME/CARU* h.t. East of the Continental Divide *PSME/CAGE* is locally abundant, but is much less common than *PSME/CARU*. Limited areas of it are found in west-central Montana. Stands are generally between 6,100 and 7,600 feet in elevation on mid- and upper slopes having southern exposure. *PSME/CAGE* may be an ecological replacement for *PSME/CARU* beyond the limits of *Calamagrostis rubescens*, especially in south-central Montana. Elsewhere *PSME/CAGE* often occurs on south exposures, adjacent to north-facing *PSME/CARU* sites.

Vegetation.--*Pseudotsuga* is normally the only coniferous tree in seral stands. Many sites are above the elevational limits of *Pinus ponderosa* and are too dry for *Pinus contorta*. *Pinus flexilis* was present in one stand with limestone parent material, and *Pinus albicaulis* was codominant with *Pseudotsuga* in another high-altitude stand approaching subalpine conditions.

Carex geyeri is usually abundant and *Arnica cordifolia* well represented. Small quantities of *Juniperus communis* and *Spiraea betulifolia* often occur, along with many species of forbs including *Osmorhiza chilensis*, *Thalictrum occidentale*, and *Smilacina racemosa*. *Calamagrostis rubescens* is poorly represented on these dry sites.

Soil.--Our stands were on calcareous and noncalcareous parent materials of sedimentary and metamorphic origin (appendix D-1). Surface soils were acidic to slightly basic, gravelly (42 percent) sandy loams to silts. Little surface rock or bare soil were exposed; duff depth averaged 4.7 cm.

Productivity/Management.--Management implications are similar to those for the *PSME/CARU* h.t., *CARU* phase, although timber productivity is somewhat less (appendix E-4). Regeneration may also be more difficult on these drier sites and overstory species manipulations are essentially restricted to *Pseudotsuga*. Evidence from sample plots suggests that this habitat type receives moderate use by mule deer.

Other studies.--A *PSME/CAGE* h.t. was not recognized by R. and J. Daubenmire (1968), *Carex geyeri* being considered an ecological equivalent of *Calamagrostis*. Robert Steele and others (1975 preliminary draft, USDA Forest Service, Intermountain Station) report extensive occurrence of the *PSME/CAGE* h.t. in central Idaho.

Pseudotsuga menziesii/Spiraea betulifolia h.t.
(*PSME/SPBE*; Douglas-fir/white spiraea)

Distribution.--This minor habitat type is found on relatively warm, dry slopes at lower elevations--generally 3,500 to 4,200 feet in west-central Montana and 5,300 to 5,800 feet east of the Continental Divide. Aspect is mostly south and west, but may be north at lowest elevations or on limestone substrates.

Vegetation.--*Pinus ponderosa* is usually a major seral dominant, except in areas such as north of Rogers Pass (southwest of Great Falls) where severe winter winds and widely fluctuating temperatures cause "red belt" mortality. Undergrowth associates of *Spiraea* include *Arnica cordifolia, Aster conspicuus, Fragaria virginiana, Allium cernuum,* and *Berberis repens.* Sites are apparently too dry for appreciable amounts of *Calamagrostis rubescens, Carex geyeri,* or *Symphoricarpos albus* to develop.

Soil.--Our stands were on calcareous and noncalcareous sedimentary and metamorphic parent materials (appendix D-1). Surface soils were acidic to slightly basic gravelly (40 percent) sandy loams to silts. A moderate amount of surface rock (5 percent) was evident, but little bare soil was exposed. Duff depth averaged 2.5 cm.

Productivity/Management.--Timber productivity of the *PSME/SPBE* h.t. is moderate in western Montana but low eastward (appendix E.) Most sample stands had evidence of moderate use by mule deer.

Other studies.--Robert Steele and others (1975 preliminary draft, USDA Forest Service, Intermountain Station) defined a broader *PSME/SPBE* h.t. for central Idaho which may contain considerable amounts of *Calamagrostis.* R. and J. Daubenmire (1968) treated *Spiraea betulifolia* as an ecological equivalent of *Symphoricarpos albus.*

Pseudotsuga menziesii/Arctostaphylos uva-ursi h.t.
(*PSME/ARUV*; Douglas-fir/kinnikinnick)

Distribution.--*PSME/ARUV* is one of the warmest and driest habitat types in the *Pseudotsuga* climax series. It is found mostly in central Montana between elevations of 4,600 and 5,600 feet on the Helena National Forest, and between 4,700 and 6,500 feet on the east Lewis and Clark National Forest. Aspect is generally south, and stands often occur on calcareous substrates.

Vegetation.--*Pinus ponderosa* is a major seral associate of *Pseudotsuga.* Scattered individuals of *Pinus flexilis* may occur on sites having limestone parent material. Sites are apparently too dry for *Pinus contorta.*

Arctostaphylos uva-ursi and *Juniperus communis* are dominants in the undergrowth. *Spiraea betulifolia* is often well represented, and dry-site species including *Agropyron spicatum, Festuca idahoensis, F. scabrella, Apocynum androsaemifolium, Balsamorhiza sagittata,* and *Lithospermum ruderale* are common.

Soil.--Our stands were on calcareous and noncalcareous sedimentary and metamorphic parent materials (appendix D-1). Surface soils were acidic to slightly basic gravelly (36 percent) loams to silt loams. Little rock and moderate (5 percent) bare soil were exposed; average duff depth was 6.0 cm.

Productivity/Management.--Timber productivity is low (appendix E). High soil-surface temperatures coupled with low soil moisture may hamper regeneration of logged stands. Stands might be managed for *Pinus ponderosa* using partial cuttings. *Pseudotsuga* appears to be a poor choice for timber production on these sites based on site index comparison (appendix E-1).

Sites are relatively warm and free of snow through much of the winter, and several important big-game forage species are found in this habitat type (appendix C-1). Sample stands showed evidence of moderate to heavy use by mule deer.

Other studies.--This habitat type has not been described elsewhere.

Pseudotsuga menziesii/Juniperus communis h.t. (*PSME/JUCO*; Douglas-fir/common juniper)

Distribution.--The *PSME/JUCO* h.t. is locally abundant in central and southwestern Montana, mostly at 6,400 to 7,100 feet on the Deerlodge, 5,300 to 6,800 feet on the Lewis and Clark (fig. 22), and 7,500 to 7,800 feet on the Beaverhead National Forest. It is found on gentle, north-facing slopes on decomposed granite substrates on the Deerlodge National Forest. On the Lewis and Clark National Forest, moderately steep south exposures with limestone substrates are typical sites. The general environment is cool and dry or excessively well-drained.

Vegetation.--*PSME/JUCO* is apparently one of the driest habitat types in the *Pseudotsuga* series that still supports *Pinus contorta*. On granitic substrates *Pinus contorta* is a persistent seral species and succession to *Pseudotsuga* is very slow. In contrast, on calcareous parent materials *Pinus contorta* and *Pinus flexilis* are only minor seral components, with *Pseudotsuga* dominating even in young stands.

*Figure 22.--*Pseudotsuga menziesii/Juniperus communis *h.t. on a gentle southwest exposure (6,800 feet elev.) in the Little Belt Mountains northeast of White Sulphur Springs in central Montana. The overstory is pure, old-growth* Pseudotsuga, *and undergrowth is dominated by* Juniperus *and* Arnica cordifolia.

Juniperus communis (occasionally accompanied by *J. horizontalis*) is the dominant undergrowth species. *Arctostaphylos uva-ursi* is often present, but is usually poorly represented. This may indicate some relationship to the *PSME/ARUV* h.t. However, *PSME/JUCO* occupies a cooler environment which supports *Pinus contorta*, while *PSME/ARUV* is characterized by warmer, *Pinus ponderosa*-supporting sites. Small quantities of *Spiraea betulifolia* are often present along with the forbs *Arnica cordifolia, Aster conspicuus, Astragalus miser,* and *Fragaria virginiana*. Grasses are relatively inconspicuous except in young seral stands.

Soil.--Our stands were on a variety of sedimentary and igneous parent materials (appendix D-1). Surface soils were acidic to slighltly basic, gravelly (27 percent), sandy loams to silts. Little surface rock or bare soil were exposed; duff depth averaged 4.2 cm.

Productivity/Management.--Timber productivity is low to moderate (appendix E). Overstories are strongly even-aged; however, sites appear droughty and regeneration might be difficult to obtain following clearcutting. *Pinus contorta* should be the major species for timber management on granitic substrates, while *Pseudotsuga* should be the primary species on calcareous substrates. *PSME/JUCO* sample stands had been used heavily by mule deer and occasionally by elk. *Juniperus communis* and *J. horizontalis* may be important browse species.

Other studies.--A *PSME/JUCO* h.t. has also been recognized in central Idaho by Robert Steele and others (1975 preliminary draft, USDA Forest Service, Intermountain Station).

Pseudotsuga menziesii/Arnica cordifolia h.t. (*PSME/ARCO*; Douglas-fir/heartleaf arnica)

Distribution.--*PSME/ARCO* is a cool, dry habitat type occurring on relatively gentle slopes on all aspects from 5,900 to 7,000 feet elevation in central Montana and from 6,700 to 8,000 feet in southwestern Montana (fig. 23). Stands generally appear similar to *PSME/CARU* h.t., *CARU* phase, but they are too dry to support *Calamagrostis* and *Carex geyeri*. Thus, only a dry forb undergrowth remains.

Pseudotsuga is generally the only tree in *PSME/ARCO* stands. Undergrowth is variously dominated by *Arnica cordifolia, Antennaria racemosa,* and *Astragalus miser*. In many old-growth or dense younger stands undergrowth is very sparse, and the above species may be poorly represented yet still dominant. *Juniperus communis* and *Fragaria* spp. are also components of the undergrowth. Occasionally *Juniperus* forms large, scattered patches, but it is clearly subordinant to forbs in total coverage. Bunchgrasses *Agropyron spicatum, Festuca idahoensis,* and *F. scabrella,* as well as *Poa nervosa* are often weakly represented in old-growth stands and may become abundant following overstory removal.

Soil.--Our stands were on a variety of primarily noncalcareous parent materials (appendix D-1). Surface soils were gravelly (30 percent) sandy loams to silts with reactions ranging from acidic to slightly basic (on limestone). A moderate amount of surface rock (4 percent) was exposed with no bare soil evident; duff depth averaged 4.3 cm.

Productivity/Management.--Timber productivity is low (appendix E). The *PSME/ARCO* h.t. frequently occurs adjacent to montane grasslands, suggesting that severe cutting or burning might result in converting the stand to prairie for a long period. Group selection cutting would probably duplicate the natural regeneration patterns observed in sample stands.

Figure 23.--Pseudotsuga menziesii/Arnica cordifolia *h.t. on a gentle northwest exposure (7,050 feet elev.) in a dry mountain range north of Whitehall in southwestern Montana. The overstory is purely old-growth* Pseudotsuga *and undergrowth is principally* Arnica cordifolia.

Young seral stands should provide considerable forage for cattle and big game. Mature stands have a poor representation of forage species but are often used for bedding and cover by both mule deer and domestic stock.

Other studies.--The *PSME/ARCO* h.t. has also been described by Robert Steele and others (1975 preliminary draft, USDA Forest Service, Intermountain Station) in central Idaho.

Pseudotsuga menziesii/Symphoricarpos oreophilus h.t.
(*PSME/SYOR*; Douglas-fir/mountain snowberry)

Distribution.--Minor amounts of *PSME/SYOR* were found at two locations in southwestern Montana. These represent eastward extensions of the *PSME/SYOR* h.t., *SYOR* phase that is fairly common in east-central Idaho, according to Robert Steele and others (1975 preliminary draft, USDA Forest Service, Intermountain Station).

One stand was sampled west of Wisdom in the Bighole River drainage; the other was observed at Cliff Lake on the Madison River. Both sites are on steep south-facing slopes near 6,500 feet. In each case *PMSE/CARU* h.t., *CARU* phase occupies adjacent, less arid sites.

Vegetation.--In both stands the overstory is nearly pure *Pseudotsuga*, and the trees are heavily limbed and rather short. Undergrowth is dominated by *Symphoricarpos oreophilus* along with lesser amounts of *Agropyron spicatum* and *Artemisia tridentata* ssp. *vaseyana;* other species have only minor coverages.

Soil.--Soils observed were shallow, coarse-textured, rocky, and excessively well drained. Parent material was not calcareous.

Productivity/Management.--Timber productivity and management implications are probably similar to those expressed for *PSME/AGSP* h.t. as it occurs in southwestern Montana where *Pinus ponderosa* is absent.

Other studies.--Robert Steele and others (1975 preliminary draft, USDA Forest Service, Intermountain Station) have provided a more detailed description of this habitat type in central Idaho. Reed (1969, 1976) also described a *Pseudotsuga/Symphoricarpos oreophilus* h.t. in Wyoming which represents a much broader concept.

Picea Series

Distribution.--The *Picea* series is found on moderately moist and cool sites between the *Pseudotsuga* series (drier and warmer sites) and the *Abies lasiocarpa* series (more moist and cooler sites) (fig. 4). It covers a significant percentage of the landscape in the Flathead Valley and in central and south-central Montana. By contrast, elsewhere in the State it is limited to where *Picea* extends down cool ravines slightly below the lower limits of *Abies lasiocarpa.*

In northwestern Montana, as in northern Idaho (R. and J. Daubenmire 1968), *Picea* is often a major component of stands in the *Abies grandis, Thuja,* and *Tsuga* series (appendix B). Going eastward beyond the range of these maritime conifers, *Picea* may replace them.

The occurrence of *Picea* below the limits of *Abies lasiocarpa* may also be related to hybridization of *Picea glauca* and *P. engelmannii* (Daubenmire 1974; Habeck and Weaver 1969). *Picea glauca* is a tree of northern Canada and Alaska whose genetic influence extends south in the Rockies through Montana. In contrast, *Picea engelmannii* is a subalpine Rocky Mountain species whose genetic influence extends northward into southern Canada. Samples of ovuliferous cone scales indicate a range of hybridization in Montana from *P. glauca* X *P. engelmannii* hybrids to pure *P. engelmannii* (table 3). Our limited sample of cone material did not indicate a strong relationship between hybridization and habitat type or geographical area. Therefore, we did not attempt to distinguish species of *Picea* in Montana. We agree with the findings of Daubenmire (1974) that *P. glauca* influence is generally strongest at lower elevations and that of *P. engelmannii* is generally predominant at high elevations.

Vegetation.--Climax stands are dominated by *Picea* but composition of seral stands is variable depending upon geographic area and habitat type. In well-drained *Picea* habitat types in northwestern Montana, *Pseudotsuga, Larix occidentalis,* and *Pinus contorta* are major seral components. East of the Continental Divide, *Pseudotsuga* and *Pinus contorta* are major seral components on similar sites.

Undergrowth composition varies widely among the different *Picea* habitat types. It is often similar to that in comparable *Abies lasiocarpa* or *Pseudotsuga* habitat types.

Soil.--Soils are quite variable in the *Picea* series (appendix D-1). *PICEA/SEST* and *PICEA/PHMA* h.t.s occur primarily on calcareous substrates while *PICEA/CLUN* and *PICEA/VACA* h.t.s were found only on noncalcareous parent materials. Surface rock and bare soil exposure are minimal throughout the series. Duff depths are considerable (average greater than 6 cm) in all types except the *PICEA/VACA* h.t. and the *VACA* phase of *PICEA/CLUN* h.t. Gravel content of surface soils is generally lower and texture finer than in the *Pseudotsuga* series.

Productivity/Management.--The *Picea* series contains some of the better timber-producing lands in Montana. Productivity is moderate to high (appendix E-4) and the sites support several coniferous species. Sites are at moderate elevations, on gentle topography, and are usually accessible. Disadvantages to timber utilization may be that *Picea* series stands are often adjacent to visual corridors, and they provide streamside stability for many watersheds. They are often important habitat for deer, elk, and moose.

Table 3.--*Distribution of* Picea *phenotypes by habitat type and National Forest. Numbers of sample stands dominated by each phenotype are shown below. The hybrid categories are based on percentage free cone-scale length as interpreted from Daubenmire 1974*

Category	P. glauca	P. glauca X P. engelmannii hybrid	P. engelmannii X P. glauca hybrid	P. engelmannii
Percent free cone scale:	<16	16-23	23-30	>30
Habitat type:				
PICEA/EQAR	--	3	3	1
PICEA/CLUN	--	6	4	4
PICEA/PHMA	--	--	1	1
PICEA/GATR	--	2	2	2
PICEA/VACA	1	--	1	1
PICEA/SEST	--	1	7	--
PICEA/LIBO	--	2	5	1
PICEA/SMST	--	--	2	3
Total	1	14	25	13
ABLA/OPHO	--	--	1	1
ABLA/CLUN	--	1	8	7
ABLA/GATR	--	3	10	8
ABLA/VACA	--	2	1	--
ABLA/CACA	--	--	1	3
ABLA/LIBO	--	1	6	2
ABLA/MEFE	--	--	4	13
ABLA/XETE	--	--	1	3
ABLA/VAGL	--	--	2	3
ABLA/VASC	--	--	4	3
ABLA/CARU	--	--	--	2
ABLA/CLPS	--	2	4	2
ABLA/ARCO	--	--	4	1
ABLA/RIMO	--	--	3	1
ABLA-PIAL/VASC	--	--	5	4
ABLA/LUHI	--	--	1	7
PIAL-ABLA	--	--	3	--
Total	0	9	58	60
National Forest:				
Kootenai	--	2	1	14
Flathead	1	6	10	6
Lolo	--	--	3	10
Bitterroot	--	--	3	5
Deerlodge	--	--	1	9
Beaverhead	--	--	2	2
Helena	--	--	1	7
Lewis & Clark (east)	--	6	20	7
Lewis & Clark (west)	--	1	6	10
Gallatin	--	3	24	6
Custer	--	3	9	3
Yellowstone N.P.	--	1	4	1
Glacier N.P.	--	1	6	7
Total	1	23	90	87

Other studies.--Ogilvie (1962) defined several *Picea* habitat types for the Rocky Mountains of Alberta. Thilenius (1972) mentioned forests of *Picea glauca* in the Black Hills and presumably these are *Picea* climax. Small areas of *Picea* habitat types were described by Cooper (1975) and Hoffman and Alexander (1976) in Wyoming and by Robert Steele and others (1975 preliminary draft, USDA Forest Service, Intermountain Station) in east-central Idaho.

Picea/Equisetum arvense h.t.
(*PICEA/EQAR*; spruce/common horsetail)

Distribution.--*PICEA/EQAR* is a localized wet-soil habitat type that characteristically develops on flat sites with poor drainage such as broad alluvial valley bottoms (fig. 24). It is similar topographically and edaphically to the *THPL/OPHO* h.t. of northwestern Montana and northern Idaho. Overall the habitat type is rare, but it is locally common in a few areas such as along Sheep Creek north of White Sulphur Springs and in the Flathead Valley. It is found mostly at elevations of 2,900 to 3,600 feet in northwestern Montana and 5,300 to 6,800 feet east of the Continental Divide. Adjacent habitat types are normally other members of the *Picea* or *Pseudotsuga* series on upland sites, or swamps, marshes, or bogs dominated by *Salix*, *Carex*, or *Typha* on wetter sites.

Vegetation.--*Picea* is usually the only successful coniferous tree species; however, *Pinus contorta* is occasionally well represented on sites having alluvium substrates. High water tables restrict other conifers to drier hummocks. *Populus trichocarpa* or *Betula papyrifera* may be abundant in seral stands.

Undergrowth normally is dominated by *Equisetum* spp. and wet-site forbs and graminoids. *Equisetum arvense* was abundant in seven out of nine sample stands, while *E. scirpoides* dominated another. Other frequent species include *Cornus stolonifera*, *Carex* spp., *Galium triflorum*, *Geranium richardsonii*, *Senecio triangularis*, *Geum macrophyllum*, and *Streptopus amplexifolius*. *Athyrium filix-femina*, *Rubus pubescens*, *Cornus canadensis*, and *Viola canadensis* were often found in stands in northwestern Montana.

Lysichitum americanum is abundant in some stands near Flathead Lake. It is a coastal (maritime) indicator that becomes scarce and then absent as one travels eastward into the Rockies. *PICEA/EQAR* stands having *Lysichitum* are indicative of milder climatic conditions than those characterizing the rest of the habitat type.

Soil.--Soils are wet throughout the year, often with standing water. Some sites have a thick layer of organic "muck." Other sites have a substrate composed of coarse-textured alluvium. Mineral soil samples were collected in only three stands (appendix D-1). Surface soil reactions were acidic to slightly basic, depending on parent material. Gravel content and texture were variable. Surface rock and mineral soil exposure were minimal; duff depth averaged 7.3 cm.

Productivity/Management.--Timber productivity is moderate (appendix E-4), but conifers other than *Picea* are usually of minor importance. Overstory manipulation requires special constraints because of the wet soils and potential windthrow of residual trees. Road construction and site development present extreme problems related to high water tables, poor drainage, streamside locations, and organic soils.

Use by big game and domestic stock is variable. In general it appears they avoid this habitat during periods of peak soil saturation but may make some use as soils dry out in late summer. Some stands show moderate winter use by deer, elk, and moose.

Other studies.--Ogilvie (1962) described two similar *Picea* habitat types for the Rocky Mountains in Alberta. His *Picea glauca/Equisetum* h.t. appears similar to our variation occurring on alluvial silts. His *Picea glauca/Sphagnum-Ledum groenlandicum* h.t. occurring on acid peat accumulations appears much like our stands growing on deep

Figure 24.--Picea/Equisetum arvense *h.t. in a stream bottom (5,600 feet elev.) west of Augusta in central Montana. Nearly all the tree growth is* Picea, *and* Equisetum arvense *is the major undergrowth plant.*

organic soils, except that our stands have few shrubs. Bell (1965) used *Lysichitum* to name a wet-site association within the *Tsuga heterophylla* zone in southeastern British Columbia.

Picea/Clintonia uniflora h.t.
(*PICEA/CLUN*; spruce/queencup beadlily)

Distribution.--*PICEA/CLUN* is a moist habitat type found on benches and gentle north slopes in northwestern Montana. It is quite common in the Flathead Valley and is occasionally found to the west in the Kootenai National Forest (fig. 25). Elevations of sample stands ranged from 3,000 to 4,100 feet.

Vegetation.--*Pseudotsuga menziesii, Pinus contorta,* or *Larix occidentalis* often dominate seral stands. Relatively warm and dry sites within this habitat type near Kalispell contain seral *Pinus ponderosa* and have little if any *Pinus contorta.*

Undergrowth is typified by *Clintonia uniflora, Aralia nudicaulis,* or *Cornus canadensis,* and has much in common with *ABGR/, THPL/, TSHE/,* and *ABLA/CLUN* h.t.s of northwestern Montana. Other characteristic species include *Cornus stolonifera, Rubus pubescens, Linnaea borealis, Oryzopsis asperifolia, Adenocaulon bicolor,* and *Galium triflorum.*

The warmest, driest sites in this habitat type lack *Clintonia* but have *Cornus canadensis* and *Galium triflorum.* These sites were included because of the minor area

Figure 25.--Picea/Clintonia uniflora *h.t.* (Clintonia *phase) in a stream bottom (3,000 feet elev.) southeast of Eureka in northwestern Montana. Seral* Pseudotsuga *and* Larix occidentalis *codominate with* Picea. Aralia nudicaulis *is the most abundant undergrowth.*

they cover as well as their general similarity to the sites supporting *Clintonia*. *Aralia* is usually associated with more moist lowland sites; *Clintonia* occurs on all but the warm, dry margins of the habitat type; and *Cornus canadensis* is found essentially throughout the habitat type.

Clintonia uniflora (CLUN) phase.--This is the typical phase of the habitat type, identified by the absence of *Vaccinium caespitosum*.

Vaccinium caespitosum (VACA) phase.--This phase occurs on gravelly benches and may also be subject to more frequent frosts than the *Clintonia* phase. *Pinus contorta* is a major seral species in natural stands, while *Pseudotsuga* and *Larix* are less important. Basal area stocking is less than in the *CLUN* phase. In general, the *VACA* phase can be considered as transitional to the *PICEA/VACA* h.t.

Soil.--Our stands were on various noncalcareous sedimentary and metamorphic parent materials (appendix D-1), occurring as alluvial or glacial deposits. Surface soils were acidic loams and silt loams with variable gravel content (average 15 percent). Ground surfaces had virtually no rock or bare soil exposed. Duff depth averaged 6.3 cm in the *CLUN* phase, but only 2.6 cm in the *VACA* phase.

Productivity/Management.--Timber productivity is moderate to high (appendix E-3). Productivity was generally highest in the *CLUN* phase. Partial cutting tends to convert overstories to *Pseudotsuga* and eventually *Picea*. Clearcutting and seed-tree cutting will favor *Pinus contorta, Larix, Pseudotsuga,* or *Pinus ponderosa.* The vigorous growth, apparent ease of regeneration, and accessibility of the *PICEA/CLUN* h.t. offer opportunities for intensive timber management. However, much of the area of the habitat type has been cleared for grazing or farming.

PICEA/CLUN often provides winter range for deer, and occasionally elk and moose. Use by domestic stock appears limited in natural stands.

Picea/Physocarpus malvaceus h.t.
(*PICEA/PHMA*; spruce/ninebark)

Distribution.--The *PICEA/PHMA* h.t. covers sizable areas on moist, north-facing slopes in south-central Montana on the Gallatin National Forest (fig. 26). Elevations of sample plots were 5,900 to 7,000 feet.

Vegetation.--*Pseudotsuga menziesii* is the typical overstory dominant in seral stands, with *Pinus contorta* occasionally well represented. In these stands *Picea* is normally represented by scattered but vigorous seedlings, saplings, and poles. *Abies lasiocarpa* is occasionally present at higher elevations in the habitat type; however, both representation and vigor of *Abies* are weak compared with *Picea.*

Symphoricarpos albus and *Spiraea betulifolia* are common associates of *Physocarpus* in the shrub layer. *Actaea rubra* occurs in about half the stands and *Galium triflorum* is usually present; thus, stands would often key to *PICEA/GATR* h.t. except for the shrubby layer of *Physocarpus* that dominates even under mature forest canopies.

Figure 26.--Picea/Physocarpus malvaceus *h.t. on a moderate east-facing slope (6,600 feet elev.) south of Big Timber in south-central Montana.* Pseudotsuga *dominates the stand, but* Picea *is present in all size classes.*

Soil.--Our stands were primarily on calcareous parent material (appendix D-1). Surface soils were acidic to neutral, gravelly (average 17 percent) loams to silts. Ground surfaces had virtually no rock or bare soil exposed; duff depth averaged 6.5 cm.

Productivity/Management.--This is one of the better habitat types east of the Continental Divide (appendix E-1) for growth of *Pseudotsuga*. Timber productivity is moderate (appendix E-4). Potential for cattle grazing appears poor; however, sample stands showed evidence of considerable use by deer, elk, and moose, often with browsing of *Acer* and *Prunus*.

Other studies.--The *PICEA/PHMA* h.t. has not been described elsewhere in the Rocky Mountains.

Picea/Galium triflorum h.t.
(*PICEA/GATR*; spruce/sweetscented bedstraw)

Distribution.--*PICEA/GATR* is found on cool, moist sites, usually bordering streams, or occasionally on moist toe-slopes. It is abundant only in south-central Montana in the vicinity of the Gallatin National Forest, mostly between 6,000 and 7,000 feet. It is found infrequently elsewhere.

Vegetation.--Seral stands may contain *Pseudotsuga* or *Pinus contorta* in the overstory, but *Picea* reestablishes quickly on disturbed sites and soon dominates. *Abies lasiocarpa* is frequently present in small numbers, but exhibits low vigor.

Undergrowth is composed of various wet-site forbs such as *Galium triflorum*, *Actaea rubra*, and *Streptopus amplexifolius*. Other characteristic species include *Rubus parviflorus*, *Ribes lacustre*, *Symphoricarpos albus*, *Linnaea borealis*, *Heracleum lanatum*, *Smilacina stellata*, and *Geranium richardsonii*. The common occurrence of *Equisetum arvense* testifies to the moist nature of the sites. In general, the undergrowth might be considered as a geographic replacement for the "*Pachistima* union" of northern Idaho (R. and J. Daubenmire 1968) and those habitat types containing *Clintonia* in northwestern and west-central Montana.

Soil.--*PICEA/GATR* was sampled on a variety of primarily noncalcareous parent materials (appendix D-1). Surface soils were loams to silts with reactions ranging from neutral to acidic. Ground surfaces had little rock or bare soil exposed; duff depth averaged 6.8 cm.

Productivity/Management.--Timber productivity is moderate to high (appendix E-4); this is one of the most productive habitat types for *Picea* and *Pinus contorta* east of Divide in Montana. Silvicultural prescriptions leading to all-aged management of *Picea* should be considered as a possible management alternative.

Pellet groups, trails and tracks, and browsing indicate that the habitat type is used by elk and deer as winter range. Some of the broad, flat mountain valleys associated with this type appear to be prime year-round moose habitat. Grazing by domestic stock was light in the sampled stands.

Other studies.--This habitat type has not been described elsewhere in the Northern Rockies.

Picea/Vaccinium caespitosum h.t.
(*PICEA/VACA*; spruce/dwarf huckleberry)

Distribution.--The *PICEA/VACA* h.t. is common in northwestern Montana, especially in the Flathead Valley where sample stands range in elevation from 3,100 to 4,200 feet.

One stand was also sampled near the Sun River Game Range west of Augusta at 5,300 feet. Stands are typically located on gravelly terraces, but sometimes they occupy gentle slopes. Although summer daytime temperatures are probably high on these sites, frost is common. *PICEA/VACA* is probably cooler and perhaps more moist than the *PSME/VACA* h.t., but drier than the *PICEA/CLUN* h.t., *VACA* phase. Eastward in Montana *Vaccinium caespitosum* is usually restricted to benchlands at somewhat higher elevations, where cooler and more moist conditions permit *Abies lasiocarpa* to form the climax (thus, *ABLA/VACA* h.t.).

Vegetation.--*Pseudotsuga menziesii*, *Larix occidentalis*, and *Pinus contorta* are major seral dominants in this habitat type, and stands seldom reach a near-climax condition. Periodic wildfires seem to recycle stands in which mature *Pinus contorta* has begun to die. In most instances these sites are too cold for *Pinus ponderosa*.

Undergrowth is similar to that of the *PSME/VACA* h.t. A mat of *Calamagrostis rubescens* dominates, and *Vaccinium caespitosum* and *Linnaea borealis* are usually major components of the undergrowth. *Spiraea betulifolia* and *Symphoricarpos albus* may be well represented.

Soil.--Our stands were on noncalcareous parent materials (appendix D-1). Surface soils were slightly acidic, gravelly (30 percent) loams and silt loams. Ground surfaces had virtually no rock or bare soil exposed; average duff depth was only 2.6 cm.

Productivity/Management.--Timber productivity ranges from moderate to high (appendix E-3) with a good mixture of commercially valuable tree species (appendix B). Well-drained soils and gentle topography offer opportunities for intensive timber management. The forage potential for domestic livestock is limited. However, *PICEA/VACA* is evidently used as winter range by elk and mule deer and may provide year-round habitat for moose and white-tail deer.

Other studies.--In Alberta a portion of Ogilvie's (1962) *Picea glauca/Calamagrostis rubescens* h.t. appears similar to our *PICEA/VACA* h.t.

Picea/Senecio streptanthifolius h.t.
(*PICEA/SEST*; spruce/cleft-leaf groundsel)

PICEA/SEST is a minor but distinctive habitat type found in a few limestone mountainous areas of central and southwestern Montana. Sample plots were taken in the Beaverhead Range at 8,300 to 8,600 feet and in the southeastern portion of the Little Belt Mountains at 7,200 to 8,200 feet (fig. 27). One stand was sampled in the Front Range in the Lewis and Clark National Forest at 6,900 feet, and small amounts of it have also been found in the Helena National Forest. Aspects are generally north to east on mid- to upper-slopes or ridgetops. Adjacent sites with deeper soils often support *ABLA/ARCO* h.t., while *PIFL/JUCO* and *PSME/JUCO* occur on warmer exposures.

Vegetation.--Near-climax stands are dominated by *Picea* in all age classes. *Abies lasiocarpa* may be present in minor amounts at higher elevations, but appears incapable of gaining dominance. At lower elevations, *Pseudotsuga* is a major seral dominant. *Pinus flexilis* and *P. albicaulis* are minor seral components.

Undergrowth is primarily composed of small amounts of *Senecio streptanthifolius*, *Pyrola secunda*, *Arnica cordifolia*, *Osmorhiza chilensis*, *Clematis pseudoalpina*, *Festuca idahoensis*, *Trisetum spicatum*, *Poa nervosa*, *Poa fendleriana*, and *Juniperus communis*.

Pseudotsuga menziesii (PSME) phase.-- The *PSME* phase is found in central and southwestern Montana. In the Little Belt Mountains it occurs between 7,000 and 7,500 feet. *Pseudotsuga* is a major seral dominant. *Shepherdia canadensis* is also an indicator of this phase.

Figure 27.--Picea/Senecio streptanthifolius *h.t.* (Pseudotsuga *phase) on a broad limestone ridge (7,200 feet elev.) northwest of Harlowton in central Montana.* Picea, Pseudotsuga, *and* Pinus flexilis *make up the overstory.* Juniperus communis *is the dominant undergrowth.*

Picea (PICEA) phase.--This phase was found only on the Little Belt Mountains, between 7,500 and 8,200 feet. *Pseudotsuga* is absent because sites are above its elevational limits. *Shepherdia canadensis* is also absent.

Soil.--The *PICEA/SEST* h.t. was found exclusively on calcareous parent materials. Soil samples were not obtained, but field observations indicated soils were shallow and droughty.

Productivity/Management.--Timber productivity is low, making this habitat type the least productive in the *Picea* series (appendix E-4). The sparse undergrowth provides little forage for domestic stock or big game. Some stands show evidence of light use by deer and elk.

Other studies.--This habitat type has not been described elsewhere in the northern Rocky Mountains.

Picea/Linnaea borealis h.t.
(*PICEA/LIBO*; spruce/twinflower)

Distribution.--The *PICEA/LIBO* h.t. is found on cool, well-drained benches and gentle northeast slopes, mostly east of the Continental Divide in Montana. Location and elevation of sample stands are shown in table 4.

Vegetation.--Nearly all of the 21 sample stands apparently became established after wildfires. *Pinus contorta, Pseudotsuga,* and *Picea* dominate stands in that order as succession progresses.

Table 4.--*Distribution of* Picea/Linnaea borealis *h.t. sample stands in Montana*

National Forest vicinity	No. plots	Elevational range
		Feet
Lolo	1	4,200
Deerlodge	2	6,400 to 6,700
Beaverhead	2	6,600 to 7,200
Lewis and Clark (east)	5	5,200 to 6,000
Gallatin	8	5,700 to 7,800
Yellowstone Park	3	6,800 to 7,200

Vaccinium globulare, Vaccinium scoparium, Alnus sinuata, Calamagrostis rubescens, or *Symphoricarpos albus* frequently dominate the undergrowth. *Shepherdia canadensis* often dominates seral stands.

Soil/Climate.--The *PICEA/LIBO* h.t. was sampled on a variety of primarily noncalcareous parent materials (appendix D-1). Surface soils were gravelly (24 percent) sandy loams to silts with reactions ranging from very acidic to slightly basic (mean pH 6.1). Ground surfaces had little rock or bare soil exposed; duff depth averaged 6.4 cm. Weather data from the northeast entrance to Yellowstone Park (appendix D-2) represent this habitat type.

Productivity/Management.--Timber productivity is moderate (appendix E-4). Also, the gentle topography associated with this type offers better opportunity for intensive timber management than many other east-side habitat types.

Elk and deer use was conspicuous in most stands; several stands were also frequented by moose. Use by domestic stock was not observed in any of the sample stands.

Other studies.--This habitat type has not been described elsewhere.

Picea/Smilacina stellata h.t.
(*PICEA/SMST*; spruce/starry Solomon's seal)

Distribution.--*PICEA/SMST* occurs on warm, moist benches and lower slopes. It was sampled only near or east of the Continental Divide at elevations ranging from 4,400 feet on the Helena National Forest to 7,400 feet in Yellowstone Park, but mostly between 5,000 and 7,000 feet.

Vegetation.--*Pseudotsuga* or occasionally *Pinus contorta* dominates in seral stands, giving way to *Picea* as succession advances. Undergrowth is dominated by a luxuriant growth of forbs. *Smilacina stellata, Thalictrum occidentale, Smilacina racemosa, Disporum trachycarpum,* and *Geranium richardsonii* are characteristically present. Sites are evidently too warm for *Linnaea borealis*; but *Calamagrostis rubescens* and *Symphoricarpos albus* commonly dominate the undergrowth as in the *PICEA/LIBO* h.t.

Our observations and those of Herbert Holdorf (Soil Scientist, Lewis and Clark National Forest) indicate that some stands on limestone substrates in central Montana have lower productivity and may even support scattered *Pinus flexilis*, suggestive of *PICEA/SEST* h.t. However, they have luxuriant undergrowth, occur at moderate elevations, and are most logically attributable to the dry margin of the *PICEA/SMST* h.t.

Soil.--Our stands were on a variety of calcareous and noncalcareous parent materials (appendix D-1). Surface soils were mostly gravelly loams to silts. Reactions ranged from neutral to acidic (mean pH 5.9). Ground surfaces had virtually no rock or bare soil exposed; duff depth averaged 6.0 cm.

Productivity/Management.--Timber productivity is moderate (appendix E-4). Several stands showed light use by cattle, and moderate to heavy winter use by deer and elk.

Other studies.--This habitat type has not been described elsewhere.

Abies grandis Series

Distribution.--*Abies grandis* is the indicated climax on many low- to midelevation sites in northwestern and west-central Montana. Its geographic distribution is correlated with the maritime-influence climate, which extends eastward in Montana to Glacier National Park and to the Swan (fig. 28), Clearwater, lower Blackfoot, and Bitterroot river valleys.

This series is bounded on drier sites by the *Pseudotsuga* series and on cooler sites by the *Abies lasiocarpa* series. The overlap of *A. grandis* and *A. lasiocarpa* distributions creates some problems in separating the two series in the field. The distinction is based on competitive potential, rather than presence or absence. Stands with *A. grandis* reproducing more successfully than *A. lasiocarpa* are placed in the *A. grandis* series, and vice versa. Thus, each species may occur in the other series as a seral or minor climax component (appendix B).

Moving westward toward stronger maritime influence, the moist sites are occupied by the *Thuja plicata* series and the *Tsuga heterophylla* series, which reach maximum development in northern Idaho (R. and J. Daubenmire 1968). In frost pockets or on drier sites in the valleys of northwestern Montana, the *Abies grandis* series is occasionally bordered by the *Picea* series.

We recognize three *Abies grandis* habitat types in Montana, which indicates greater environmental diversity near the eastern limits of the series than in northern Idaho, where only one *A. grandis* habitat type has been defined (R. and J. Daubenmire 1968). This increased diversity is even more pronounced near the southern limits of the series in the Nezperce National Forest where six *A. grandis* habitat types have been recognized by Robert Steele and others (1976, preliminary draft, USDA Forest Service, Intermountain Station).

Vegetation.--*Pseudotsuga menziesii* is usually a major component of seral stands. *Larix occidentalis*, *Pinus contorta*, *Picea*, *Pinus ponderosa*, *Pinus monticola* (roughly in order of decreasing importance) may also occur as seral dominants or components of mixed stands.

The undergrowth is typified by numerous moist-site forbs and a diverse mixture of shrub species which may gain temporary dominance during early successional stages.

Soil/Climate.--Most soils were derived from noncalcareous parent materials (appendix D-1). Intermittent shallow A_2 horizons overlying a dominant B horizon suggest that loess and volcanic ash represent a major contribution to soil development. Surface soils are generally gravelly loams and silt loams with acidic reactions. Ground surfaces have virtually no rock or bare soil exposed; duff depths are moderate (3 to 6 cm).

Some climatic parameters for the *Abies grandis* series are shown in appendix D-2.

Productivity/Management.--Timber productivity in the series ranges from moderate to very high (appendix E-3). Browse production for elk and deer is high during early

*Figure 28.--*Abies grandis/Clintonia uniflora *h.t. (*Aralia *phase) in the Swan River Valley of northwestern Montana (3,100 feet elev.).* Abies grandis *and a lesser amount of* Picea *are the only tree species remaining in this near-climax stand.*

successional stages. Some lower elevation sites in the series are utilized as winter range. Forage potential and use for domestic livestock is generally limited to valley bottoms that have been cleared for farming and pastures.

Abies grandis/Clintonia uniflora h.t.
(*ABGR/CLUN*; grand fir/queencup beadlily)

Distribution.--The *ABGR/CLUN* h.t. is found on relatively moist sites from 2,400 to 5,000 feet elevation in northwestern and west-central Montana. It occurs on valley bottoms, benches, and on all aspects.

Vegetation.--*Abies grandis* appears capable of gaining dominance over all other conifers as succession proceeds toward climax. However, in some areas, *Abies lasiocarpa* persists as a minor climax component. Following major disturbance such as fire or logging, *Pseudotsuga, Larix occidentalis,* and *Picea* (as well as *Pinus contorta, Pinus monticola,* and *Pinus ponderosa* on some sites) invade along with *Abies grandis.* By the time a pole-sized stand has developed, *Abies grandis* is generally the only species that continues to reproduce beneath the forest canopy.

Undergrowth is characterized by moist-site herbs including *Clintonia, Adenocaulon bicolor, Disporum hookeri, Galium triflorum,* and *Bromus vulgaris* as well as the subshrub *Linnaea borealis.* Several shrubs share dominance in younger stands; these include *Acer glabrum, Rosa gymnocarpa, Rubus parviflorus, Amelanchier alnifolia, Spiraea betulifolia,* and *Symphoricarpos albus* (appendix C). A number of these species are part of the "*Pachistima* union" described by R. and J. Daubenmire (1968) for northern Idaho. However, the "*Pachistima* union" nomenclature was not used in this classification because individual members of the union have different range limits eastward from Idaho. *Clintonia uniflora* is a reliable indicator species for moist sites within the *Abies grandis* series, and also has high fidelity in the *Abies grandis/Pachistima myrsinites* h.t. of northern Idaho; thus, the latter is similar to our *ABGR/CLUN* h.t.

Clintonia uniflora (CLUN) phase.--This is the typical and most extensive phase, generally occurring at elevations below 4,500 feet. In the wettest mountain ranges it occurs on dry exposures, with adjacent moist sites being occupied by the *THPL/CLUN* or *TSHE/CLUN* h.t.s. In drier areas it typically occurs on moist exposures, with adjacent drier sites being occupied by the *PSME/PHMA* or *ABGR/LIBO* h.t.s. Cooler sites usually support the *XETE* phase of *ABGR/CLUN* h.t. or the *ABLA/CLUN* h.t.

Aralia nudicaulis (ARNU) phase.--This phase was sampled on low elevation (near 3,000 feet) bottomlands and moist benches in northwestern Montana. *Picea* and *Betula papyrifera* are more common here than in other phases, while *Pinus contorta* and *Abies lasiocarpa* are usually absent. Undergrowth is more luxuriant than in other phases, with *Aralia* and *Disporum hookeri* usually well represented. This phase was also found in similarly wet sites (at 4,000 to 4,500 feet in the Bitterroot Range south of Missoula, where it was indicated by *Athyrium filix-femina* being common.

Xerophyllum tenax (XETE) phase.--This phase was encountered at somewhat higher elevations (3,600 to 5,000 feet), where it occupies relatively cold and well-drained sites within the habitat type. It appears to be environmentally intermediate between the warmer *CLUN* phase and the colder *Abies lasiocarpa* series. *A. lasiocarpa* is more common in this phase, while *Pinus ponderosa* is usually absent. *Xerophyllum* and *Vaccinium* globulare are well represented.

Although it occupies a limited area in Montana, the XETE phase is common in the Selway River drainage of Idaho (Habeck 1973, 1976; Robert Steele and others 1976 preliminary draft, USDA Forest Service, Intermountain Station).

Soil/Climate.--The *ABGR/CLUN* h.t. was sampled on a variety of noncalcareous substrates (appendix D-1). Surface soils were gravelly sandy loams to silts in the *CLUN* phase, gravelly loams in the *XETE* phase, and usually, nongravelly silt loams and silts in the *ARNU* phase. Reactions ranged from acidic to slightly acidic in all phases. Little surface rock or bare soil were exposed; duff depths were moderate (3 to 6 cm).

Weather data from Trout Creek, Montana, (appendix D-2) represent the climate of a warm site at low elevation in this habitat type.

Productivity/Management.--*ABGR/CLUN* has high to very high timber productivity (appendix E-3). Partial cutting practices will lead to dominance by *Abies grandis*, which is often greatly reduced in value by Indian paint fungus *(Echinodontium tinctorum)*. Obtaining regeneration of the seral species is usually the best approach for timber management.

Abundant forage for deer and elk is produced during earlier successional stages. Although many stands showed evidence of browsing, the low-elevation and south-exposure sites are usually the only portions of the habitat type offering winter-range potential. Domestic forage production is minimal in natural stands.

Other studies.--The *CLUN* phase is comparable to most of the stands in R. and J. Daubenmire's (1968) *Abies grandis/Pachistima* h.t. in northern Idaho.

Abies grandis/Linnaea borealis h.t.
(*ABGR/LIBO*; grand fir/twinflower)

Distribution.--*ABGR/LIBO* is a minor habitat type in Montana that occurs between about 3,700 and 5,500 feet on northerly to southeasterly aspects. It is locally common in the mountains near Perma and Hot Springs, as well as at various locations in the Bitterroot Range south of Missoula. It often occupies better-drained slopes or benches adjacent to the *ABGR/CLUN* h.t. on moist sites, such as ravines. As one moves east or south, out of the maritime-influence climatic zone, this habitat type replaces *ABGR/CLUN*.

Vegetation.--Most sample stands are dominated by *Pseudotsuga, Larix occidentalis,* or *Pinus ponderosa,* with *Abies grandis* gaining dominance in the understory. In contrast to other habitat types in the series, *Abies lasiocarpa* and *Picea* were absent from almost all stands.

Undergrowth is similar to that of the *ABGR/CLUN* h.t. except for the lack of certain "*Pachistima* union" members (such as *Clintonia, Adenocaulon bicolor,* and *Disporum hookeri*) and the scarcity of others (such as *Galium triflorum*). *Linnaea* often forms a rather extensive mat on the forest floor.

Linnaea borealis (LIBO) phase.--This appears to be the most common phase, ranging from 3,700 to above 4,600 feet on northerly aspects. *Pinus ponderosa* is often a major seral dominant.

Xerophyllum tenax (XETE) phase.--Stands observed in this phase occur between 4,700 and 5,500 feet on easterly to southeasterly exposures. It appears to be transitional between the *LIBO* phase and the *ABLA/LIBO* h.t., *XETE* phase or the *ABGR/XETE* h.t.

Soil.--Our two stands having soils data were on noncalcareous parent materials (appendix D-1). Surface soils were acidic, gravelly loams to silts. Ground surfaces had no rock or bare soil exposed; duff depths were 3 and 4 cm.

Management Implications.--Timber productivity is high (appendix E-3) affording good opportunities for timber management. Productivity was highest in the *LIBO* phase. Forage production for deer and elk is moderately good in early successional stages, although sites are often not accessible for winter range. Forage production for domestic livestock offers little potential.

Other studies.--This habitat type has been described by Robert Steele and others (1975 preliminary draft, USDA Forest Service, Intermountain Station) in central Idaho as well as by Robert Steele and others (1976 preliminary draft, USDA Forest Service, Intermountain Station) for the Nezperce National Forest.

Abies grandis/Xerophyllum tenax h.t.
(*ABGR/XETE*; grand fir/beargrass)

Distribution.--*ABGR/XETE* is a minor habitat type locally common on well-drained slopes between 4,700 and 5,300 feet in western portions of the Lolo and Bitterroot National Forests. It is apparently the driest of the *Abies grandis* habitat types in Montana, being bordered on more moist sites by the *ABGR/CLUN* or *ABGR/LIBO* h.t.s and on colder sites by *ABLA/XETE*.

Vegetation.--Most sample stands were rather young (50 to 100 years) and were dominated by *Pseudotsuga, Larix,* and *Pinus contorta*. Regeneration of *Abies grandis* was abundant in some stands, but was scattered in other stands apparently because of difficulties in establishment (dry site conditions). We interpret *Abies grandis* as a significant site indicator and predict that it will be a major component, if not dominant, in climax stands.

Undergrowth is rather sparse, with only *Xerophyllum*, *Vaccinium globulare*, *Calamagrostis rubescens*, and sometimes *Pachistima* or *Arnica latifolia* being well represented. Moist site species such as *Clintonia*, *Linnaea*, *Adenocaulon*, and *Galium triflorum* are absent.

Soil.--Field observations indicated that soils were similar to those in the *ABGR/CLUN* h.t. Ground surfaces had little bare soil and surface rock exposed; duff depth ranged from 1 to 3 cm.

Productivity/Management.--Timber productivity is moderate to high (appendix E-3). Numerous valuable seral species and ease of regeneration are favorable for intensive timber management; however, the type only covers a small area. Forage production for deer and elk is good, although primarily for spring through fall use. According to Richard Ringleb (Lolo National Forest, Missoula) young stands originating after the 1910 burn in the St. Regis River Valley are used heavily by deer and elk, with major browsing on *Vaccinium globulare* and *Pachistima*. *ABGR/XETE* provides no potential for domestic livestock use.

Other studies.--Habeck (1973, 1976) and Robert Steele and others (1976 preliminary draft, USDA Forest Service, Intermountain Station) have identified an *ABGR/XETE* h.t. as representing sites at the cold, dry limits of the *Abies grandis* series in the Selway River drainage in Idaho. Robert Steele and others (1975 preliminary draft, USDA Forest Service, Intermountain Station) have described an *Abies grandis/Vaccinium globulare* h.t. in central Idaho, that may represent an extension of *ABGR/XETE* beyond the geographic range of *Xerophyllum tenax*.

Thuja plicata Series and *Tsuga heterophylla* Series

Distribution.--Associations dominated by *Thuja plicata* and *Tsuga heterophylla* occupy moist areas within the maritime-influenced climatic zone of the northern Rocky Mountains. They occur extensively in northern Idaho (R. and J. Daubenmire 1968), but diminish eastward in northwestern Montana. In Montana these habitats are generally confined to bottomland or northerly exposures between about 2,000 and 5,000 feet elevation on sites where average annual precipitation is 32 inches or more. They are bordered on drier sites by the *Abies grandis* series and on colder sites (at higher elevations and in frost pockets) by the *Abies lasiocarpa* series (*ABLA/CLUN* h.t.).

Both the *Thuja* and *Tsuga* series are most common in the extreme northwestern portion of Montana but extend eastward sporadically almost to the Continental Divide in Glacier National Park. Isolated stands of the *Tsuga* series also occur locally in the Swan Valley, but generally *Tsuga* is confined to the vicinities of Libby and Thompson Falls and westward to Idaho. The *Thuja* series occurs more extensively in the Swan Valley and Mission Range; it extends eastward locally to Missoula, and forms small riparian stringers along major streams in the Bitterroot Range west of Hamilton.

Vegetation.--*Thuja* and *Tsuga* are shade-tolerant climax conifers that grow in similar environments. However, *Thuja* extends locally onto slightly drier sites than *Tsuga*, in addition to spreading farther south and east in Montana. *Tsuga heterophylla* is usually capable of attaining dominance over *Thuja* and other species at climax because it is better able to reproduce under a dense forest canopy. However, *Thuja* is capable of maintaining itself indefinitely as a minor climax species in the *Tsuga* series because of its shade tolerance, longevity (often 600 to 1,000 years), and apparent ability to regenerate vegetatively (Habeck 1968).

There are two exceptions to the climax dominance of *Tsuga*. One is the high water table *Thuja/Oplopanax* h.t. where *Thuja* and *Tsuga* are considered as major coclimax dominants in Montana (appendix B). The other exception occurs sometimes near the range limits of *Tsuga* in Montana, where only scattered individuals of *Tsuga* are present (often exhibiting frost-killed tops) in stands having *Abies lasiocarpa* clearly indicated as the potential climax dominant.

Pseudotsuga, Larix occidentalis, and to a lesser extent *Picea* are often dominants in seral stands in these series (appendix B). *Pinus contorta, Pinus monticola,* and *Betula papyrifera* are minor components of seral stands. *Abies grandis* and *A. lasiocarpa* are either minor seral or minor climax components of most of the habitat types. *Thuja* and *Tsuga* usually regenerate on disturbed sites along with and beneath the seral tree species, but it takes them several hundred years to assume dominance in the overstory because of the longevity of the large seral trees. Stands commonly have a mixture of four to six tree species; occasionally as many as 10 tree species can be found in the same stand.

Undergrowth is composed of many moist-site forbs and shrubs (appendix C-1 and C-2); coverages vary considerably depending upon successional status. In the most dense forest stands, *Clintonia uniflora* persists as a useful indicator of the "*Pachistima union*" described by R. and J. Daubenmire (1968).

Early successional stages may be dominated by a dense invasion of *Epilobium angustifolium* and other forbs, or shrubfields composed of *Salix scouleriana, Rubus parviflorus, Amelanchier alnifolia, Acer glabrum, Vaccinium globulare, Ceanothus velutinus,* and (near the Idaho-Montana border) *Ceanothus sanguineus.*

Soil/Climate.--Parent materials within both series are exclusively noncalcareous and nonigneous--predominantly sedimentary rock and argillite (appendix D-1). Presumably, volcanic ash and loess deposits have also had a major influence on soil development with resultant fertility and moisture-holding characteristics beneficial to *Thuja, Tsuga,* and associated undergrowth. Surface soils are primarily acidic, gravelly loams to silts. Ground surfaces rarely have exposed rock or bare soil; mean litter depth exceeds 5 cm for all habitat types and phases in the series.

Weather records from Heron, Montana, near the Idaho border (appendix D-2), illustrate the moist, mild-temperature conditions associated with these series. R. and J. Daubenmire (1968) presented additional climatic data for sites in northern Idaho.

Productivity/Management.--The *Thuja* and *Tsuga* series have the highest timber productivity (appendix E-3). Maximum production is usually found in stands dominated by seral species. Shade-tolerant conifers are often susceptible to fungal decay (e.g., *Echinodontium tinctorum* in *Abies grandis* and *Tsuga*) that may be accelerated by partial cutting. Maximum productivity will likely be realized by even-aged management of seral species. Natural regeneration occurs readily when an adequate seed source is available and site preparation has been thorough enough to retard development of brushfields.

Forage potential (primarily palatable shrubs) for deer and elk is very high in early successional stages, but may be almost nonexistent in dense, near-climax stands. In some areas, these series occur at low enough elevations to provide winter range. *Thuja plicata* may be utilized heavily on big-game winter range. Forage potential for domestic livestock is very low.

Other studies.--Our habitat types within the *Thuja* and *Tsuga* series are essentially equivalent to those defined for northern Idaho by R. and J. Daubenmire (1968). However, we used the typal epithet of--/*Clintonia uniflora* instead of--/*Pachistima myrsinites* to maintain consistency with related habitat types in the *Picea, Abies grandis,* and *Abies lasiocarpa* series

Thuja plicata/Clintonia uniflora h.t.
(*THPL/CLUN*; western redcedar/queencup beadlily)

Distribution.--*THPL/CLUN* is relatively common in northwestern Montana, extending east to Glacier National Park, the Swan River Valley, and south to the Bitterroot

Range near Hamilton. It is typically associated with bottomlands, benches, and northerly exposures from about 2,000 to 5,000 feet in elevation. Within the geographic range of *Tsuga heterophylla* (and therefore the *TSHE/CLUN* h.t.), *THPL/CLUN* is restricted to relatively warmer and drier sites. Beyond the range of *Tsuga*, *THPL/CLUN* occupies the bottoms and extends in fingers up cool and moist ravines bordered by the *ABGR/CLUN* h.t.

Vegetation.--*Thuja* is the indicated climax as well as being the major dominant in most sample stands. Major components of seral stands throughout the habitat type are *Abies grandis*, *Pseudotsuga*, *Larix*, *Picea*, and *Abies lasiocarpa*. *Abies grandis* is usually a persistent seral component, as was found by R. and J. Daubenmire (1968), but occasionally appears to achieve coclimax status with *Thuja*, especially near *Thuja's* range limits in Montana. This situation was found to be common in Idaho's upper Selway River drainage (Habeck 1976).

Clintonia is almost always present in the undergrowth. Other species generally found throughout this habitat type in Montana include shrubs *Rubus parviflorus*, *Vaccinium globulare*, and *Linnaea borealis*, and forbs *Goodyera oblongifolia*, *Pyrola secunda*, and *Viola orbiculata* (appendix C). *Cornus canadensis*, *Adenocaulon bicolor*, *Galium triflorum*, and *Tiarella trifoliata* occur less frequently, but are generally indicative of this habitat type.

Clintonia uniflora (CLUN) phase.--This is the most common phase of the type, and it occurs widely on well-drained bottoms, moist benches, and north slopes. *Menziesia ferruginea*, *Aralia nudicaulis*, and fern indicators of the other phases are notably scarce.

Aralia nudicaulis (ARNU) phase.--Undergrowth is distinguished by having *Aralia*, or ferns *Athyrium filix-femina* or *Gymnocarpium dryopteris* common in addition to the usual *Clintonia* associates. This phase also has a more luxuriant assemblage of moist-site forbs, including higher coverages of *Adenocaulon*, *Tiarella*, and *Galium triflorum*. This phase occupies more moist bottoms and slopes than the *CLUN* phase, generally at elevations below 4,000 feet.

Menziesia ferruginea (MEFE) phase.--This phase occurs near the upper elevational (cold) limits of the habitat type on north-facing slopes or in ravines. It was sampled between 4,300 and 5,300 feet in northwestern Montana. It is identified by *Menziesia* being common in the undergrowth. *Xerophyllum*, *Taxus*, and *Arnica latifolia* are usually conspicuous also, in contrast to the other phases of the habitat type. *Abies lasiocarpa* is almost as abundant as *Thuja* in most stands, and probably plays a minor climax role, although *Thuja* regenerates more effectively. *Larix*, *Pseudotsuga*, and *Picea engelmannii* are the other major constituents of seral stands. *Pinus contorta* is a more frequent seral component in this phase than in other phases of the type, while *Abies grandis* occurs only rarely. This phase is bordered above by *ABLA/CLUN* h.t., *MEFE* phase, or by *ABLA/MEFE* h.t.

Soil.--The *THPL/CLUN* h.t. was commonly found on argillite or noncalcareous sedimentary parent materials (appendix D-1). Surface soils were acidic, gravelly loams to silts. Ground surfaces had little rock or bare soil exposed; and duff depths averaged greater than 5 cm.

Productivity/Management.--Timber productivity is high to very high (appendix E-3). However, it is difficult to find free-growing individuals for determining site index in the dense mature stands on this habitat type. Limited data from the *CLUN* phase suggest that productivity is uniformly high for *Pseudotsuga*, *Abies lasiocarpa*, *A. grandis*, *Picea*, and *Larix*. In the *MEFE* phase, productivity is somewhat lower and *A. grandis* is absent. The *ARNU* phase has the highest productivity, especially for *Pseudotsuga* and *Abies grandis*. Although potential productivity is high, realization of it may require intensive management--selecting the best species, controlling the stocking, and minimizing disease and insect losses.

Basal areas are high in stands throughout this habitat type, natural fire frequency is low, although fires that do occur are often intense. Fires early in this century destroyed essentially all *Thuja* in some narrow canyon habitats observed west of Superior, Montana, and *Thuja* has not become reestablished in the new stands. Grazing of *Thuja* by cattle and big game appears to retard natural reinvasion.

Forage production for elk and deer is generally high during early successional stages. Some lower elevation sites provide winter range, with resultant heavy browsing of *Thuja*. Forage potential for domestic livestock is low in natural stands.

Isolated, ancient *Thuja* groves have special appeal for recreation and for botanical studies.

Construction and maintenance of campgrounds, roads, and trails may be difficult and may damage sites in the *ARNU* phase, which has high water tables for at least part of the growing season.

Other studies.--*THPL/CLUN* is very similar to the *Thuja/Pachistima* h.t. described in northern Idaho by R. and J. Daubenmire (1968). Our *CLUN* phase is comparable to most of their habitat type except for four of their stands (numbers 23, 49, 117, and 170), which appear to be similar to our *ARNU* phase. Additionally, our *THPL/CLUN* h.t. in Montana includes a *MEFE* phase which is not comparable to any of R. and J. Daubenmire's northern Idaho stands. Bell (1965) denoted *Aralia* and *Gymnocarpium* as indicators of a major association in the *Tsuga* and *Thuja* forests of interior British Columbia.

Thuja plicata/Oplopanax horridum h.t.
(*THPL/OPHO*; western redcedar/devil's club)

Distribution.--This minor, topo-edaphic habitat type was found only in wet bottoms and toe-slope seepage areas in northwestern Montana. It is usually confined to such sites below about 4,200 feet; at higher elevations the *ABLA/OPHO* h.t. occupies similar sites. Adjacent upland sites support the *TSHE/CLUN* h.t.

Vegetation.--*THPL/OPHO* usually supports ancient stands of large trees with diverse and luxuriant undergrowth. *Thuja* and/or *Tsuga heterophylla* are the climax dominants (fig. 29). Although *Tsuga* was slightly more dominant in most of the 11 Montana sample stands, *Thuja* is also clearly a major climax component in most stands. Since coclimax rather than monospecific dominance is apparently the case, we decided to adopt R. and J. Daubenmire's (1968) "*Thuja/Oplopanax*" terminology for the Montana version of this habitat type. Four of their sample stands from Montana were included in our analyses. See pages 35 and 36 in R. and J. Daubenmire (1968) for a detailed discussion of this habitat type.

Small amounts of *Pseudotsuga*, *Picea*, and *Abies lasiocarpa* are found in most stands. The latter functions as a minor climax species near the cold limits of the habitat type. Fire seldom destroys these wet-site stands; thus, the trees often attain large size and great age.

Undergrowth is dominated by *Oplopanax*, *Athyrium*, and *Gymnocarpium dryopteris* superimposed upon the luxuriant forb growth associated with *Clintonia uniflora*. Most prominant of these forbs are *Tiarella trifoliata*, *Smilacina stellata*, *Galium triflorum*, and *Adenocaulon bicolor*. *Taxus brevifolia*, a major dominant in the *ABLA/OPHO* h.t., is only a minor constitutent of *THPL/OPHO* stands.

Soil.--Soils data were very limited for this habitat type since most of the sample stands were obtained from other studies. In the two stands we sampled, surface soils were acidic, nongravelly loams (appendix D-1). Ground surfaces had no bare soil or rock exposed. R. and J. Daubenmire (1968) indicated that pH was within the range of the *Tsuga/Pachistima* h.t. (*TSHE/CLUN* h.t. equivalent for Montana).

Figure 29.--Thuja plicata/Oplopanax horridum *h.t. on a seep-covered north slope south of Libby in northwestern Montana. This site, at 4,300 feet in elev. has no* Thuja, *and is dominated by* Tsuga heterophylla *with small amount of* Abies lasiocarpa.

Productivity/Management.--Limited site-index data and ecological comparison with the *ABLA/OPHO* h.t. suggest that productivity potential would be high. However, intensive timber management is usually not practiced in this habitat type for several reasons. The habitat type covers a very small area, and existing stands are frequently ancient groves with high recreational, esthetic, and botanical value. Vegetation manipulation would require special constraints in typical streamside locations. High water tables during most of the season and the possibility of compaction preclude use of heavy equipment. Road construction and intensive site development would be expensive, and could cause irreparable damage.

Forage production for deer and elk is low to moderate in typical old-growth stands. Some stands may be valuable for winter range. Forage potential for domestic livestock is very low.

Other studies.--In addition to the similar habitat type described by R. and J. Daubenmire (1968), Bell (1965) recognized comparable associations in the *Tsuga-Thuja* forest of interior British Columbia.

Tsuga heterophylla/Clintonia uniflora h.t.
(*TSHE/CLUN*; western hemlock/queencup beadlily)

Distribution.--*TSHE/CLUN* is restricted to the extreme northwestern portion of Montana (The Libby-Thompson Falls area), with minor extensions east to Glacier National Park. It occupies areas having a very moist, ocean-influenced climate, ranging from the lowest elevations in the State (1,822 feet along the Kootenai River) up to about

Figure 30.--Tsuga heterophylla/Clintonia uniflora *h.t. (*Clintonia *phase) on a gentle east exposure south of Libby in northwestern Montana. The stand contains the following trees (in decreasing order of abundance):* Thuja, Tsuga heterophylla, Pinus monticola, Abies grandis, Larix occidentalis, Pseudotsuga, Picea, *and* Pinus contorta.

4,000 feet. Sites are mostly in valley bottoms, on benches, or on cool exposures. The eastern outlier of this type in Glacier National Park is apparently dependent upon the moderating climatic influence of Lake McDonald.

Vegetation.--Old-growth stands are usually dominated jointly by *Tsuga* and *Thuja*. Younger stands typically have a diverse mixture of six to nine coniferous species, varying by phase of the habitat type (fig. 30).

Undergrowth throughout the habitat type is characterized by forbs *Clintonia, Pyrola secunda, Tiarella trifoliata,* and *Viola orbiculata,* and shrubs *Linnaea borealis, Pachistima myrsinites, Taxus brevifolia,* and *Vaccinium globulare.*

Density of undergrowth in the *TSHE/CLUN* h.t. is markedly influenced by the development of the overstory canopy. Following destruction of the overstory (e.g., through clearcutting or fire), early successional stages may be brushfields. As a canopy of seral trees develops, the undergrowth density will gradually be reduced. When succession progresses to the point where shade-tolerant trees become dominant in the canopy, shading can eliminate many species and reduce coverage of even the most persistent forbs to just a trace.

Clintonia uniflora (CLUN) phase.--This is the prevalent phase of the habitat type in Montana; it is found on better drained sites. *Larix occidentalis, Pseudotsuga, Pinus monticola,* and *Pinus contorta* have greater representation in this phase than in the others; even *Pinus ponderosa* is occasionally found. Undergrowth has much more *Vaccinium globulare* and *Linnaea borealis* than in the *ARNU* phase.

A few old-growth stands in the *CLUN* phase, mostly on southerly aspects, had *Xerophyllum tenax* well represented in the undergrowth. But the limited extent of these stands and the minor site differences did not seem to warrant recognition of an additional phase.

Aralia nudicaulis (ARNU) phase.--This phase is associated with wetter sites, generally bottoms; *Aralia, Athyrium filix-femina,* or *Gymnocarpium dryopteris* are common and are indicative. *Rubus parviflorus, Adenocaulon bicolor,* and *Tiarella trifoliata* are more abundant than in the *Clintonia* phase.

Soil/Climate.--The *TSHE/CLUN* h.t. occurred almost exclusively on noncalcareous sedimentary and metamorphic parent materials (appendix D-1). Surface soils were acidic gravelly loams to silts. Ground surfaces had virtually no rock or bare soil exposed; duff depth ranged from 4 to 7 cm. Weather data from Heron, Montana, (appendix D-2) represent a relatively warm site within this habitat type.

Productivity/Management.--Timber productivity is high to very high, although it was difficult to find free-growing, vigorous trees of seral species in the old-growth stands sampled. Site-indexes for *Larix* and *Picea* are some of the highest attained for these species (appendix E). Because of moderate terrain, accessibility, and high productivity, *TSHE/CLUN* sites are excellent candidates for intensive timber management. Realizing this high productivity potential will require selecting the best species, controlling stocking, and minimizing disease and insect losses. Obtaining natural regeneration on burned or scarified clearcuts of moderate size is usually no problem, except when brushfields temporarily dominate early succession. Planting and direct seeding have a high probability of success; these measures are sometimes necessary to control species composition or to compensate for lack of a natural seed source.

Forage production for elk and deer is very high during early successional stages, and almost nonexistent, except for *Thuja* saplings, in dense, near-climax stands. Lower elevation sites often provide winter range for big game, with resultant heavy browsing of *Thuja.* Forage potential for domestic livestock is very low.

Isolated ancient groves of *Tsuga* and *Thuja* have high recreational and botanical value.

Intensive development may be difficult and may damage the site in the *Aralia* phase, which has a high water table for at least part of the growing season.

Other studies.--It is evident from the species composition that *TSHE/CLUN* is essentially equivalent to the *Tsuga/Pachistima* h.t. described for northern Idaho by R. and J. Daubenmire (1968). Concerning our *ARNU* phase, Bell (1965) also used *Aralia* and *Gymnocarpium* to designate an association within the *Tsuga* and *Thuja* forests of interior British Columbia.

Abies lasiocarpa Series

Distribution.--The *Abies lasiocarpa* series includes all forests potentially dominated at climax by *Abies lasiocarpa, Tsuga mertensiana, Pinus albicaulis,* or *Larix lyallii.* As indicated in figure 4, this is the predominant series at higher elevations in the Montana Rockies. At lower elevations in northwestern Montana and in northern Idaho, it often borders moist forests where shade-tolerant *Abies grandis, Thuja plicata,* or *Tsuga heterophylla* are the indicated climax (fig. 6). Elsewhere in Montana its lower limits are generally reached where slopes are not moist or cool enough to support *Abies lasiocarpa,* and it gives way to the *Picea* or *Pseudotsuga* series. The *Abies lasiocarpa* series is much more extensive and diverse eastward in Montana than it is in northern Idaho because of more abundant high-elevation terrain as well as a climate unfavorable to its potential competitors--*Abies grandis, Thuja,* and *Tsuga heterophylla.*

Near its upper limits this series forms the timberline, which is bordered above by alpine tundra. On especially dry, warm, windy exposures east of the Continental Divide, this series sometimes gives way to subalpine grassland.

The *Abies lasiocarpa* series is subdivided into three elevational categories (fig. 4), reflecting increasingly severe climatic conditions: (1) lower subalpine habitat types; (2) upper subalpine habitat types; and (3) timberline habitat types. This terminology essentially follows that of Weaver and Clements (1938) for western North America as shown graphically by Löve (1970).

Soil/Climate.--Soils in the Abies lasiocarpa series are derived from a variety of parent materials (appendix D-1). Relationships of habitat types to parent materials are not evident except that the *ABLA/CLPS* h.t. is generally restricted to calcareous substrates. Surface soils are usually acidic to very acidic, and range from gravelly sandy loams to silts. Ground surfaces have little rock or bare soil exposed, except in the upper subalpine and timberline habitat types. Duff depth varies; although litter production is relatively low, natural decomposition is slow and reduction of duff by natural fire occurs infrequently.

The progressively colder, shorter growing season at increasing elevations within the *Abies lasiocarpa* series is illustrated in table 5, which gives estimated climatic parameters for the three subdivisions of the series. Data for specific sites are found in appendix D-2.

Fire history.--Lightning-caused wildfires have allowed *Pseudotsuga, Larix occidentalis,* and *Pinus contorta* to dominate most stands in the lower subalpine category of the *Abies lasiocarpa* series. Fire is apparently more frequent and less intense in the dry habitat types like *ABLA/VASC* and *ABLA/XETE,* and less frequent and more intense in the moist ones like *ABLA/MEFE, ABLA/GATR,* and *ABLA/CLUN.* Although more lightning strikes may occur in the upper subalpine forests, cool, moist conditions and broken, rocky terrain limit the spread of fires. Fires at timberline tend to be even more localized, although they may prevent reestablishment of trees for several decades (Arno 1970).

Table 5.--*Estimated climatic parameters for the three subdivisions of the* Abies lasiocarpa *series in Montana*

Subdivision	July mean temperature	Impact of summer frost	Mean annual precipitation
	Degrees F		*Inches*
Lower subalpine forest	60 to 64	Light to moderate	20 to 50
Upper subalpine forest	55 to 59	Severe	25 to 60
Timberline	50 to 54	Severe	28 to 60
Alpine tundra	≤49		

LOWER SUBALPINE HABITAT TYPES

Distribution.--Lower subalpine habitat types are those generally warm enough to support *Pseudotsuga, Larix occidentalis,* or *Pinus monticola.* This category of habitat types covers about 2,000 feet of elevation on most of the higher mountains in the State. They are even more extensive in the Flathead River drainage of northwestern Montana, where they occupy all but the warmest exposures for about 3,000 feet vertically before giving way to upper subalpine forest at 6,200 to 6,500 feet. On the driest mountains east of the Continental Divide (for example, south of Dillon, Bull Mountain near Whitehall, and the Pryor Mountains), lower subalpine habitat types are largely restricted to a narrow belt on cool exposures.

The majority of sites within the *Abies lasiocarpa* series fall within this lower elevation category, which has 15 habitat types and numerous phases. The *ABLA/CLUN* and *ABLA/MEFE* h.t.s, highly productive for timber and water yields, are extensive in northwestern Montana. The *ABLA/GATR, ABLA/LIBO* and *ABLA/CACA* h.t.s might be considered as their nearest counterparts in productivity south and eastward in Montana, but they are more restricted physiographically to especially moist sites. *ABLA/XETE* is most common on drier uplands west of the Continental Divide, giving way to *ABLA/VASC* and *ABLA/VAGL* on similar upland sites east from the Divide. Dry sites on the east side--especially those on limestone substrates--support *ABLA/ARCO* and *ABLA/CARU,* or *ABLA/CLPS* under extremely droughty conditions.

Vegetation.--*Pseudotsuga* and *Pinus contorta* are major components of seral stands in the lower subalpine category. *Picea* is a major component of the moist habitat types. Our stand table data support the conclusion drawn by R. and J. Daubenmire (1968) that *Picea engelmannii* is generally a long-lived seral species rather than a coclimax in *Abies lasiocarpa* stands. *Larix occidentalis* and locally *Pinus monticola* are major components of stands in northwestern Montana.

Although *Pseudotsuga* is a common seral dominant in the lower subalpine forests, some habitat types or phases in this group contain only accidentals of this species: the *ABLA/CACA* h.t. occurs on sites apparently too wet for *Pseudotsuga* that are commonly bordered, or surrounded, by drier sites where the species is present. The *ABLA/VASC* h.t., *VASC* phase and *THOC* phase have only accidental, stunted individuals of *Pseudotsuga,* but such trees are frequent enough to indicate that these habitats are not clearly beyond the species' cold limits. A few sites in the *ABLA/MEFE* or *TSME/MEFE* h.t.s may not support *Pseudotsuga, Larix occidentalis,* or *Pinus monticola*; but in these cases *Luzula hitchcockii* (and thus *ABLA/LUHI* h.t., *MEFE* phase) serves as an additional indicator of upper subalpine conditions, making it unnecessary to rely solely upon the absence of *Pseudotsuga.*

Productivity/Management.--Timber productivity ranges from low to very high (appendix E). With relatively high precipitation and snowfall (appendix D-2) the lower subalpine sites are also important for water production. Mule deer, elk, and bear use these habitat types for summer range. Domestic stock use is rare west of the Divide, except locally in valley bottom sites. East of the Divide, some of the more moist plateaus and areas of gentle terrain provide moderate grazing opportunities, especially in early successional stages.

UPPER SUBALPINE HABITAT TYPES

Distribution.--This high-elevation forest belt is found all across the Montana Rockies; it covers approximately 700 feet of elevation, and it is bounded above by the timberline habitats. As a rough average this belt extends from 6,500 to 7,200 feet in northwestern Montana, 7,300 to 8,000 feet in west-central Montana, and 8,100 to 8,800 feet in southern Montana.

Vegetation.--Upper subalpine forest habitat types include those above the climatic limits of *Pseudotsuga, Larix occidentalis,* and *Pinus monticola.* Stands from the Continental Divide west characteristically have *Luzula hitchcockii* present in the undergrowth. In addition, except for some northerly exposures in northwestern Montana, stands throughout the State have whitebark pine well represented (canopy coverage greater than 5 percent).

Abies lasiocarpa is the indicated climax, but its growth in these habitats is quite slow, often requiring 200 years to reach dominant stand height (60 to 70 feet). Moreover, since its wood is weak and brittle, susceptible to wind and snow breakage, and to decay, these trees seldom live much more than 250 years.

Pinus albicaulis is often a persistent dominant seral species on all but the moist sites. It is hardier, longer lived (often surviving 500 to 700 years), and more drought-tolerant than *Abies*; it appears to be intermediate in shade tolerance, rather than very intolerant as suggested by Baker (1949). Most of the larger individuals of *Pinus albicaulis* over vast areas of the Northern Rockies were killed between 1909 and 1940 by mountain pine beetle (*Dendroctonus ponderosae*) epidemics (Arno 1970; personal communication with Arthur Roe, Forest Service retiree, Missoula, Montana); nevertheless *Abies* has not been able to substantially replace *Pinus albicaulis* in these habitat types.

Picea is longer-lived than *Abies*, and functions as an important, persistent seral component of stands on moist sites, but only as a minor seral component on dry sites. *Pinus contorta* is a major seral species in the lower portion of the upper subalpine belt.

Productivity/Management.--The upper subalpine forest is highly productive for water yield and constitutes a sizable proportion of the land in Wilderness and back-country recreation areas. It is also important as summer range for mule deer, elk, bears, and other big game species. Domestic forage production is low in these stands. Timber productivity is generally low (appendix E) and management is frequently hampered by problems in road construction, harvesting, regeneration, and site protection.

TIMBERLINE HABITAT TYPES

Distribution.--Timberline habitat types form the transition between contiguous forest and alpine tundra. These habitat types are relatively common in the higher mountain ranges of the State, occurring primarily on rugged topography west of the Continental Divide, but often on relatively broad, gentle slopes east of the Divide. Climatic timberline habitats generally average about 7,200 to 8,000 feet elevation in northwestern, 8,000 to 8,800 feet in west-central, and 8,800 to 9,600 feet in southern Montana. They usually occur somewhat higher on southerly exposures than on north-facing slopes, because of warmer summer temperatures. However, where the extremely cold-tolerant *Larix lyallii* (*LALY/ABLA* h.t.s) occupies north slopes, it may reach elevations comparable to the limits of other species on nearby southern aspects.

Timberline extends upward from the limit of contiguous forest ("forest line") to the general upper limits of krummholz or shrub-like trees ("scrub line") (Arno 1966). In some areas this forest line is hard to determine; a useful alternate indication is that forest line occurs where *Abies lasiocarpa* becomes generally stunted, and is usually not capable of developing as a tall tree (50 feet high) except when growing up through the crown of a *Picea, Pinus albicaulis,* or *Larix lyallii.* Widely scattered krummholz known as "alpine scrub" may occur above timberline in the lower fringes of the alpine tundra (Arno 1966).

Vegetation.--Only four tree species typically inhabit Montana timberlines. These are *Larix lyallii, Pinus albicaulis, Picea engelmannii,* and *Abies lasiocarpa,* listed in order of decreasing vigor or cold tolerance of timberline. *Abies* is noticeably stunted, sometimes shrub-like, or often with shrubby skirts, and it relies to a considerable extent upon vegetative means (i.e., layering of lower branches) for successfull regeneration. Competition related to tolerance is less evident than in lower habitat types, and "climax" relationships are frequently unclear.

At timberline, trees take on several life forms and often grow in groups or clusters with open areas in between. Vegetational communities often form an intricate mosaic. Because of the especially complex and unusual ecological relationships at timberline, the three habitat types in this group were named only for their tree components; this approach was used also by R. and J. Daubenmire (1968).

We recognize that definite combinations of trees and undergrowth species are recognizable at timberline. These have been delineated in detailed studies of timberline environments, as in Arno (1970) and Weaver and Dale (1974). However, in the broader perspective of the entire Montana classification, it seems unwarranted at this time to propose a detailed treatment of the extraordinarily complex differences in tree/undergrowth vegetation in timberline habitats.

Climate.--In general, cold summer temperature appears to be the most critical factor responsible for timberline formation in Montana (table 5); although some limits of the ecologically diverse *PIAL* h.t.s are evidently controlled by other factors. Alpine and Arctic timberlines throughout the Northern Hemisphere have been found to approximately coincide with the 50°F isotherm for the warmest month of the year (usually July) (Arno 1966, 1970). Habitats having a mean July temperature significantly less than 50°F support only tundra.

Such temperature-controlled or "Climatic" timberlines are the ones under general consideration here. Locally, excessive accumulations of snow (especially in northwestern Montana) or extreme rockiness and exposure to desiccating winds may cause an apparent timberline formation at unusually low elevations. However, such plant communities are composed largely of species characteristic of middle or lower elevation forests; thus, these areas are more accurately treated as forest-meadow or forest-grassland ecotones, or snowdrift, wind-funnel, or rock-outcrop sites. In Montana, climatic timberline sites are generally above the cold limits of *Pinus contorta*, *P. flexilis*, *Pseudotsuga*, *Tsuga mertensiana*, *Menziesia ferruginea*, and *Calamagrostis rubescens*.

Blizzard conditions occur commonly in timberline types in all months except July and August. Even during the brief growing season, winds of gale and hurricane velocity are rather common. In the more moist ranges, snow accumulations may be so great in the *PIAL/ABLA* and *LALY/ABLA* h.t.s that most of the steeper slopes are subject to snowslides or avalanche. Snowdrifts may persist so late into summer during some years that they retard plant growth. Sites with exceptional wind exposure are swept free of snow almost all winter; here, deep soil frost, winter and summer desiccation, extensive temperature fluctuations, and the mechanical damage caused by winds combine to inhibit tree growth.

Productivity/Management.--Timberline habitats have high water yields and provide summer range for various species of big game and other wildlife. Because of their high esthetic value, they are also of considerable interest to outdoor recreationists. Forb and grass growth may be luxuriant in certain timberline areas, particularly those east of the Continental Divide on better soils, notably those derived from limestone. Grazing pressure in these types must be carefully dispersed and otherwise controlled, however, because loss of vegetative cover makes them vulnerable to severe erosion in many cases. Vegetative recovery following disturbance is very slow. Heavy grazing by sheep has caused long-term range deterioration in several timberline and alpine areas in the Northern Rockies, although timberline meadows in Montana generally appear to be in better shape than those in the other Rocky Mountain States.

Similarly, the vegetation can support little concentrated use by sightseers or campers. Roads, ski facilities, and other developments are usually damaging to timberline ecosystems unless designed, constructed, and maintained with utmost care. The scenic beauty of these environments is easily degraded also. Vegetative healing of scarred areas may require several decades, and in some cases the degradation may be permanent (Habeck 1972; Willard and Marr 1971; Klock 1973).

Tree growth and regeneration are extremely slow in these habitat types, which can clearly be considered as "noncommercial" forest land (appendix E).

LOWER SUBALPINE HABITAT TYPES

Abies lasiocarpa/Oplopanax horridum h.t. (*ABLA/OPHO*; subalpine fir/devil's club)

Distribution.--*ABLA/OPHO* is a rare but very distinctive habitat type found in the Flathead and Kootenai River Drainages of northwestern Montana. It is restricted to ravine bottoms and sites near streams, springs, or seepage areas where the water table remains near the surface all year (fig. 31) Often it develops only as narrow stringers covering no appreciable acreage. Elevations of observed *ABLA/OPHO* sites range from 3,900 to almost 5,000 feet. Sites are similar to those of the *THPL/OPHO* h.t. except that they occur in colder areas.

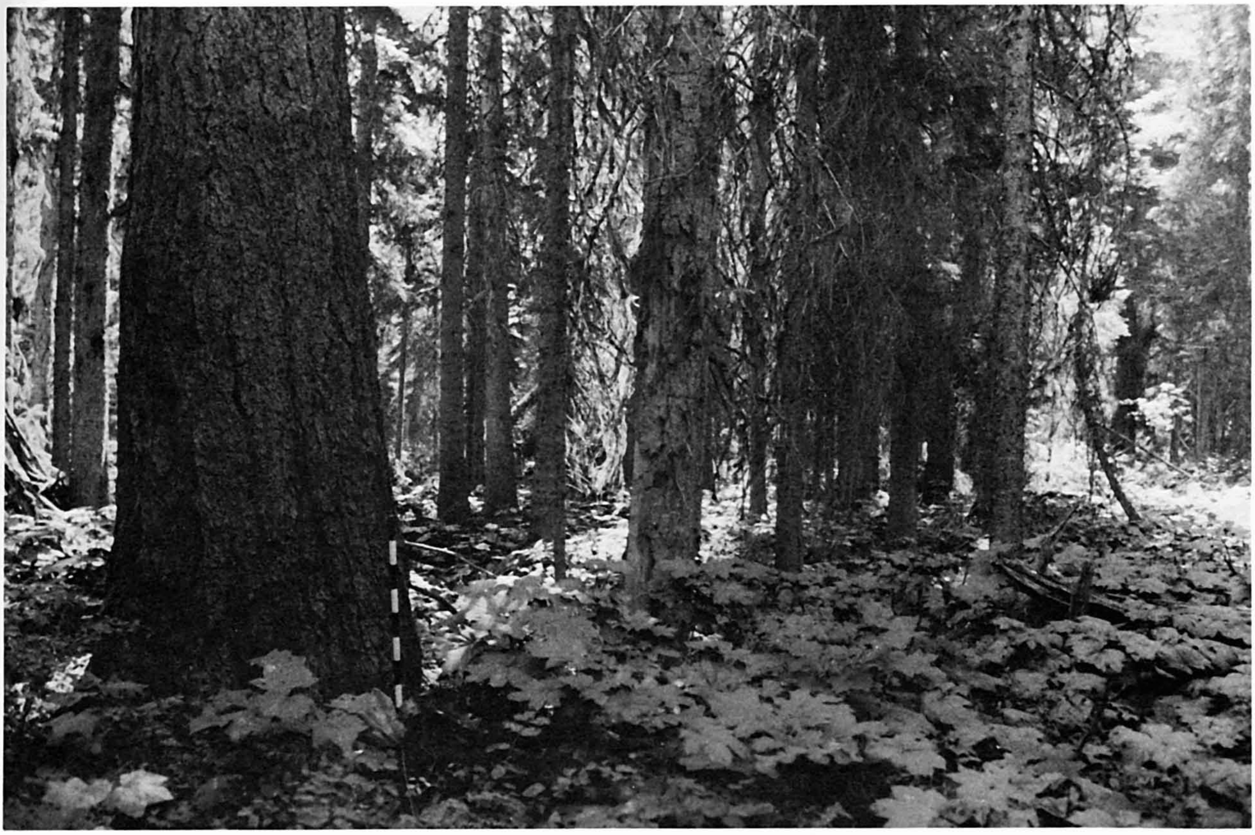


Figure 31.--Abies lasiocarpa/Oplopanax horridum *h.t. on a valley bottom site on the west side of Glacier National Park at 3,900 feet elev.* Abies, Picea, *and a few large* Larix occidentalis *make up the overstory.*

Vegetation.--Old-growth stands are codominated by *Abies lasiocarpa* and *Picea*; the latter will evidently maintain itself as a minor climax component. Small amounts of *Pseudotsuga, Larix occidentalis,* and *Pinus monticola* are found, while *Thuja* and *Tsuga heterophylla* sometimes occur sporadically as accidentals. Fire often skips these wet-site stands; thus they may support groves of old and very large trees (sample stands had trees taller than 150 feet).

Undergrowth is dominated by a shrub layer of *Oplopanax* and *Taxus brevifolia*. Beneath this, forbs *Clintonia uniflora* and *Tiarella trifoliata* and ferns *Athyrium filix-femina* and *Gymnocarpium dryopteris* are usually well represented.

Soil.--Our stands were on a variety of noncalcareous parent materials (appendix D-1). Surface soils were very acidic, nongravelly loams. Ground surfaces were rock free and no bare mineral soil was exposed. Duff depths were among the greatest recorded in any habitat type (7 to 10 cm).

Productivity/Management.--Productivity potential for timber is moderate to high (appendix E), but sites are generally not suitable for intensive timber production. As in the *THPL/OPHO* h.t., this habitat type occupies very small areas, often has high recreational and esthetic values, and has high water tables that preclude use of heavy equipment. Road construction, trails, and site development problems can be minimized by avoiding these sites. Domestic grazing potential is very low and little deer or elk use was observed.

Other studies.--A similar plant association was described by Illingworth and Arlidge (1960) for eastern British Columbia, and by Ogilvie (1962) for southwestern Alberta.

Abies lasiocarpa/Clintonia uniflora h.t.
(*ABLA/CLUN* h.t.; subalpine fir/queencup beadlily)

Distribution.--*ABLA/CLUN* is a relatively moist and warm habitat type for the *Abies lasiocarpa* series (fig. 32). It is extensive in the northwestern portion of the State, especially in the Flathead River drainage. There, it occurs (in five phases) from the lower mountain valleys at about 3,200 feet elevation up to 5,500 feet, and it can be found on all but the driest south-facing slopes. Its abundance and diversity is attested to by the large number (103) of *ABLA/CLUN* h.t. stands sampled in the course of this study.

It is extensive on both slopes of the Continental Divide in Glacier National Park and also immediately south of the Park. Westward, on comparable mountain slopes in the Kootenai River drainage (and in northern Idaho), Pacific maritime conifers (*Tsuga, Thuja,* and *Abies grandis* become increasingly common, and the *ABLA/CLUN* h.t. is more restricted in its distribution. *Clintonia* (necessary for this habitat type) is uncommon south or east of Missoula, and where it does occur it is largely restricted to swales or along streams.

Abies lasiocarpa is the indicated climax throughout the habitat type. Its major associates in seral stands are *Picea engelmannii* (or hybrids with *P. glauca*), *Pseudotsuga*, *Larix occidentalis*, *Pinus contorta*, and *P. monticola*. Additionally, all other tree species native to northwestern Montana with the exception of *Juniperus scopulorum* and *Larix lyallii* are sometimes found as minor stand components.

Diversity of the undergrowth among the five phases of *ABLA/CLUN* is even more marked than that of the tree layer; however, a sizable number of species are found throughout all five phases. *Clintonia uniflora* is indicative of this habitat type. *Adenocaulon bicolor, Coptis occidentalis, Cornus canadensis, Disporum hookeri, Galium*

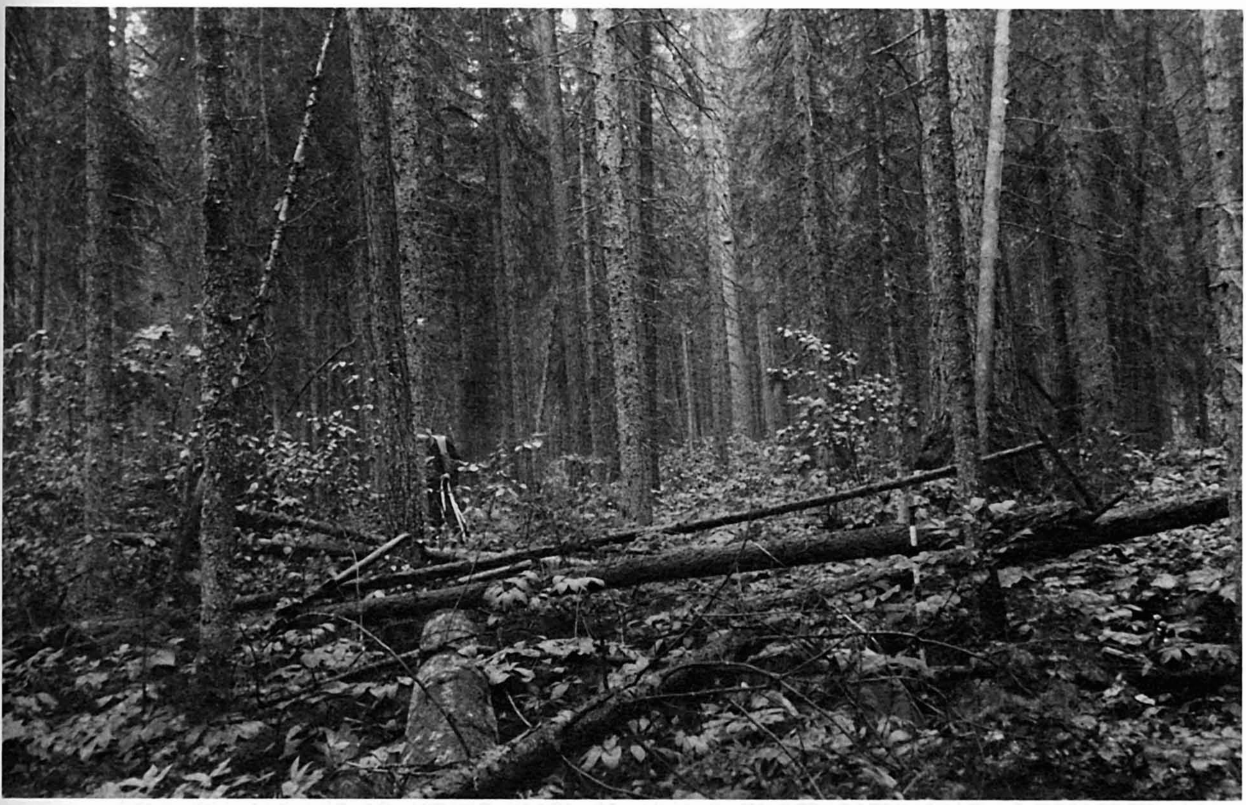


Figure 32.--Abies lasiocarpa/Clintonia uniflora *h.t. (*Aralia *phase) on a moist bench (3,900 feet elev.) south of Hungry Horse Reservoir in northwestern Montana. Old-growth* Larix occidentalis *and many-aged* Picea *dominate, with younger* Abies Lasiocarpa *increasing in abundance.* Aralia *is the dominant forb.*

triflorum, and *Tiarella trifoliata* are forbs largely restricted to the *Clintonia* undergrowth types in northwestern Montana. Shrubs *Linnaea borealis, Lonicera utahensis, Pachistima myrsinites,* and *Rubus parviflorus* are characteristically found throughout *ABLA/CLUN* h.t., and *Vaccinium globulare* is usually well represented. Forbs that are rather widespread in other types as well as being present throughout *ABLA/CLUN* include *Arnica latifolia* (usually well represented), *Chimaphila umbellata, Goodyera oblongifolia, Osmorhiza chilensis, Pyrola secunda, Thalictrum occidentale, Viola orbiculata,* and *Xerophyllum tenax.*

Clintonia uniflora (CLUN) phase.--This is the most common phase, representing the "middle ground" or average environmental conditions in the habitat type. It occurs throughout northwestern Montana and is most common between 4,400 and 5,600 feet, extending somewhat lower on frost-pocket sites.

In the more moist areas of northwestern Montana, this phase can be found on all but the driest exposures. In the drier areas and in west-central Montana it is usually confined to especially moist sites, such as canyon bottoms.

Major components of sample stands are *Abies lasiocarpa, Picea, Pseudotsuga, Larix occidentalis,* and *Pinus contorta,* in order of decreasing abundance; other tree species are relatively scarce. Undergrowth is dominated by species described previously for the habitat type.

Aralia nudicaulis (ARNU) phase.--This is the moist and relatively warm phase of the habitat type characteristic of bottomland sites at the lowest elevations. It is found in bottoms and occasionally toe-slope seepage areas between 3,200 and 4,200 feet elevation in the Flathead River drainage, and at 4,500 to 5,000 feet in west-central Montana as well as on the east side of Glacier National Park.

The major overstory species in the 18 sample stands were *Abies lasiocarpa, Picea, Larix occidentalis, Pseudotsuga,* and *Pinus monticola,* in order of decreasing abundance. *Betula papyrifera,* seldom found elsewhere in conifer forest types, was present in almost half of the sample stands. The phase is identified by *Aralia nudicaulis, Gymnocarpium dryopteris,* or *Athyrium filix-femina* being common. Other undergrowth species prevalent in this phase are: *Cornus stolonifera, Taxus brevifolia, Melica subulata, Oryzopsis asperifolia, Adenocaulon bicolor, Cornus canadensis, Lycopodium annotinum,* and *L. complanatum.*

Vaccinium caespitosum (VACA) phase.--This phase includes *ABLA/CLUN* habitats found on relatively dry, low-elevation benchlands. It is a minor but distinctive phase found on well-drained, gravelly benches between about 3,100 and 4,100 feet, mostly in the upper Flathead Valley. These sites may also be frost pockets.

Tree composition of the 100- to 300-year-old stands sampled is quite distinctive, especially for the *ABLA/CLUN* h.t. *Abies lasiocarpa* is obviously subordinate in coverage to both *Pseudotsuga* and *Pinus contorta. Abies* is clearly the potential climax dominant, but succession is relatively slow. Apparent *Picea glauca* X *P. engelmannii* hybrids and *Larix occidentalis* are common minor stand components, and *Pinus ponderosa* is present in almost half of the stands.

Undergrowth also contrasts with that of other phases of the habitat type. *Vaccinium caespitosum* and *Arctostaphylos uva-ursi* are usually well represented. *Linnaea borealis* is a dominant, and is often accompanied by *Xerophyllum tenax. Calamagrostis rubescens* is usually well represented and *Shepherdia canadensis* is present in most stands. *Galium boreale, Campanula rotundifolia,* and *Cornus canadensis* are often present, while *Thalictrum occidentale* and *Tiarella trifoliata* are usually absent (the latter are usually present in other phases of the *ABLA/CLUN* h.t.). There is some question whether most of the vegetational features described here will persist in "climax" stands. Coverage of *Vaccinium caespitosum* and some other species is reduced in undisturbed old-growth stands, but the question of true climax composition in this case seems academic because of the slow rate of succession.

Xerophyllum tenax (XETE) phase.--This phase occupies most of the dry, cold portion of the habitat type. It is found mostly on well-drained sites between 4,200 and 5,600 feet, commonly on south- or west-facing slopes. It occurs frequently on the Flathead and Lolo National Forests.

Abies lasiocarpa and *Pseudotsuga* were major components of the 21 sample stands, followed in order of decreasing abundance by *Picea engelmannii, Larix occidentalis,* and *Pinus contorta.* Other conifers were of minor importance. Undergrowth was dominated by *Xerophyllum* in addition to the species described previously for the habitat type as a whole.

Menziesia ferruginea (MEFE) phase.--This is the relatively cold and moist phase of the *ABLA/CLUN* h.t., and is transitional above to the *ABLA/MEFE* h.t. It is found throughout northwestern Montana between 4,500 and 5,700 feet, mostly on cool exposures. Also, about half of R. and J. Daubenmire's (1968) *Abies lasiocarpa/Pachistima* h.t. stands in northern Idaho seem equivalent to this phase.

Abies lasiocarpa, Picea engelmannii, and *Pseudotsuga* were the major components of sample stands. *Larix occidentalis* and *Pinus contorta* were often minor components. *Menziesia ferruginea* and *Arnica latifolia* were usually abundant in the undergrowth.

Soil/Climate.--Soils in the *ABLA/CLUN* h.t. were derived from a variety of noncalcareous sedimentary and metamorphic parent materials (appendix D-1). Surface soils were moderately gravelly throughout, with the lowest gravel contents in the *ARNU* phase and the highest in the *XETE* phase. Reactions varied from acidic to very acidic. Ground surfaces had virtually no rock or bare soil exposure and duff accumulation varied from moderate to deep. The *VACA* phase had the least duff (mean = 3.7 cm), while the *MEFE* and *ARNU* phases averaged 6.2 and 7.1 cm, respectively.

Weather data from three stations (appendix D-2) reflect the climate of some of the phases of this habitat type.

Productivity/Management.--Timber productivity potential ranges from moderate to very high in western Montana (appendix E-3). Productivity is highest in the *ARNU* phase and lowest in the *VACA* and *XETE* phases. In the few stands slightly east of the Continental Divide in Glacier National Park and the Lewis and Clark National Forest, productivity is low to moderate (appendix E-4). Five important seral species *(Pseudotsuga, Larix occidentalis, Pinus contorta, Picea,* and *Pinus monticola)* provide flexibility for intensive timber management and opportunities for developing mixed species stands. Preferred species vary by phase, as shown in appendix B; silvicultural prescriptions must be tempered by on-site evaluation of existing stands. Except for sites in the *VACA* phase where it occurs naturally, *Pinus ponderosa* is near its cold limits and grows poorly in this habitat type. Partial cutting of mature stands will increase dominance of *Abies lasiocarpa*. Even-aged management offers greater promise for production of seral species.

The *VACA* phase, with flat ground and well-drained soils, can tolerate heavy equipment, recreational use, and site development. The *ARNU* phase also has gentle topography, but soft ground and high water tables during part of the growing season limit certain activities and developments. The *XETE* and *MEFE* phases (and part of the *CLUN* phase) are typically on steeper ground at somewhat higher elevations, but are still relatively accessible with conventional logging techniques.

Site preparation needs will probably be greatest in the *XETE* and *MEFE* phases, but for different reasons. The *XETE* phase is the droughtiest, and site preparation may be needed for prompt seedling establishment. The *MEFE* phase has ample moisture, but brushfield development could be a problem, although in some areas *Menziesia ferruginea* apparently does not reinvade rapidly following disturbance. Additional observations and data are needed to define early successional development in all phases.

All phases can produce large quantities of browse for elk and deer in early successional stages. However, because of snow depths only a few of the lowest elevation sites (generally *VACA* and *ARNU* phases) provide opportunity for winter range.

Watershed management values in this habitat type are high--as they are throughout most of the *Abies lasiocarpa* series--because of high precipitation and snowpack accumulation.

Other studies.--*ABLA/CLUN* is similar to R. and J. Daubenmire's (1968) *Abies lasiocarpa/Pachistima myrsinites* h.t. Most of their stands are assignable to three of the Montana phases: *MEFE, XETE,* and *CLUN*. We did not extend their "*Pachistima* union" nomenclature to our classification because the undergrowth species making up that union reach their range limits independently going eastward into Montana. Also, these species occupy somewhat different sites in Montana; whereas in northern Idaho they apparently have similar environmental tolerances. Robert Steele and others (1975 preliminary draft, USDA Forest Service, Intermountain Station) report that *ABLA/CLUN* h.t. extends southward in west-central Idaho to the vicinity of McCall. *Clintonia uniflora* and many of its Montana associates are also components of major forest communities in western Washington and Oregon (Franklin and Dyrness 1973), suggesting that similar associations occur there.

Abies lasiocarpa/Galium triflorum h.t.
(*ABLA/GATR*; subalpine fir/sweetscented bedstraw)

Distribution.--*ABLA/GATR* is the warmest of the moist *Abies lasiocarpa* habitat types in most of the Montana Rockies. It is similar to the *ABLA/CLUN* h.t., but lacks some of the *ABLA/CLUN* moist-site indicators that do not extend eastward into the areas having a more continental climate.

ABLA/GATR occurs on moist bottomlands, benches, northern exposures, and occasionally in seepage areas on southern exposures. Stands are generally between 5,000 and 6,800 feet elevation, except in the vicinity of the Gallatin National Forest where the type is abundant between about 6,300 to 7,700 feet. In relatively dry mountain ranges, the habitat type is restricted to narrow stringers along stream bottoms. Sites with high water tables (surface water during the first part of the growing season) are often transitional to the *ABLA/CACA* h.t., and are classified as the *GATR* phase of the *ABLA/CACA* h.t., giving major emphasis to the dominant edaphic factors.

Vegetation.--*Picea* is usually dominant over *Abies* in all but the oldest stands. In some *Picea*-dominated old-growth stands on lower slopes south of Bozeman, *Abies* reproduction is less abundant than that of *Picea*. These stands are transitional to the *PICEA/GATR* h.t. found at lower elevations, but are nevertheless classified as *ABLA/GATR* h.t. However, in the vast majority of *ABLA/GATR* sites sampled in Montana, stand-structure data indicate that *Abies* is potentially the climax dominant. *Pseudotsuga* and *Pinus contorta* are usually represented in seral communities.

Dominant undergrowth is variable, especially in seral stands; however, certain moist-site species are characteristic. The habitat type is indicated by the presence of *Galium triflorum, Actaea rubra* and *Streptopus amplexifolius*. Since small quantities of *Galium* sometimes occur on adjacent drier slopes or on disturbed sites, *Galium* alone is not an adequate indicator. Other species generally restricted to this or other moist types (i.e., *ABLA/CLUN, ABLA/CACA*) include *Cornus stolonifera, Angelica arguta, Pyrola uniflora, Saxifraga arguta,* and *Senecio triangularis*.

Soil.--Soils in the *ABLA/GATR* h.t. were derived from almost all available parent materials (appendix D-1). Surface soils were generally acidic nongravelly loams to silts. Ground surfaces had virtually no bare soil or rock exposed, and duff depth averaged 5.9 cm.

Productivity/Management.--Timber productivity ranges from moderate to high west of the Continental Divide, and is moderate eastward (appendix E). Moderate to heavy use (including browsing and bedding) by deer and elk is apparent in most stands. Moose activity is also common especially on valley-bottom sites. In many areas this habitat type provides the best big-game cover available. Browse production is moderate to good, especially in the earlier successional stages. These sites are often used by cattle, primarily for resting or bedding after feeding on nearby meadows or grasslands. This type has high water yield potential, and management activities must be constrained to protect streams.

Other studies.--In a sense *ABLA/GATR* and *ABLA/CLUN* are similar, and would represent R. and J. Daubenmire's (1968) *Abies lasiocarpa/Pachistima* h.t.; however, *ABLA/CLUN* occurs extensively on uplands in the maritime-influence climatic zone, whereas its eastern counterpart *ABLA/GATR* is generally restricted to sites having especially moist soil. Cooper (1975) described a similar association in northwestern Wyoming. Robert Steele and others (1975 preliminary draft, USDA Forest Service, Intermountain Station) described an *Abies lasiocarpa/Streptopus amplexifolius* h.t. in central Idaho that is apparently related to our *ABLA/GATR* h.t. and *ABLA/CACA* h.t., *GATR* phase.

Abies lasiocarpa/Vaccinium caespitosum h.t.
(*ABLA/VACA*; subalpine fir/dwarf huckleberry)

Distribution.--*ABLA/VACA* is confined largely to well-drained sites on benchlands and in frosty basins where cold air accumulates. These sites are at moderate elevations for the *Abies lasiocarpa* series--mostly between 6,000 and 7,200 feet in basins near the Continental Divide and in the Little Belt Mountains (fig. 33). It was also found locally at 5,000 feet in a basin west of Kalispell.

Vegetation.--*Pinus contorta* was the sole dominant conifer in nearly all stands sampled, and it was often reproducing better than other conifers. *Abies lasiocarpa* and *Picea* were common in the understory. Most stands were less than 150 years old, however, so actual climax relationships could not be clearly established. *Pinus contorta* could at least be considered the persistent seral dominant of this habitat type.

Undergrowth is a rather dense mat of *Vaccinium caespitosum, Vaccinium scoparium*, and *Calamagrostis rubescens*, often with *Linnaea borealis*.

The retarded tree succession in this habitat type might be due to frequent summer frosts coupled with warm daily maximum temperatures; this combination would damage new growth of most conifers, but not *Pinus contorta* Often, however, *Picea* and *Abies* are able to grow satisfactorily once they become well established; establishment difficulties may include competition from the undergrowth and lack of seed source, as well as

Figure 33.--Abies lasiocarpa/Vaccinium caespitosum *h.t. on benchland (6,400 feet elev.) in the Little Belt Mountains of central Montana.* Pinus contorta *dominates the overstory; regeneration is* P. contorta, Abies lasiocarpa, *and* Pseudotsuga. Calamagrostis rubescens *and* Vaccinium caespitosum *are the principal undergrowth species.*

frost damage. The scarcity of the frost-susceptible *Vaccinium globulare* in this habitat type seems significant also. *ABLA/VASC*, *ABLA/XETE*, or *ABLA/VAGL* is usually found on adjacent upland slopes, and the *ABLA/CACA* h.t., *VACA* phase occurs on adjacent sites with high water tables.

Soil.--Our stands were on a variety of noncalcareous parent materials (appendix D-1). Surface soils were gravelly and nongravelly sandy loams to silts with acidic to very acidic reactions (mean pH 5.0). Ground surfaces had virtually no bare soil or rock exposed; duff depth averaged 4.8 cm.

Productivity/Management.--Timber productivity is moderate (appendix E-4), and *Pinus contorta* appears to be the only species well suited for management. *Pinus contorta* has mostly nonserotinous cones in this habitat type, and natural seedling establishment seems to occur periodically even without disturbance. Gentle terrain and stable soil conditions are favorable for timber management. Some mechanical scarification is desirable to prevent a mat of *Calamagrostis rubescens* from retarding reproduction.

Intensive recreational sites, such as campgrounds and picnic areas, are often located in this habitat type. Observations made in campgrounds indicate that *Vaccinium caespitosum* usually increases its coverage under moderate disturbance, while its associate *V. scoparium* dies out. However, heavy foot traffic, not directed or regulated by paths and barriers, will soon destroy most of the *V. caespitosum* also.

Light to moderate use by moose, elk, and deer is evident. Cattle use also occurs in some areas, although forage potentials for grazing are generally low.

Other studies.--In frosty basins of central Idaho, Robert Steele and others (1975 preliminary draft, USDA Forest Service, Intermountain Station) described an *ABLA/VACA* h.t. dominated by "stable communities of *Pinus contorta*." In most stands they found only scattered and often stunted *Picea* and *Abies* beneath the *Pinus contorta*, along with numerous seedlings of the latter. This situation is more extreme than that found in Montana stands. *ABLA/VACA* has evidently not been described in other areas, although Ogilvie's (1962) *Picea-Abies/Calamagrostis* type appears similar.

Abies lasiocarpa/Calamagrostis canadensis h.t.
(*ABLA/CACA*; subalpine fir/bluejoint)

Distribution.--*ABLA/CACA* is the major forest habitat type on wet sites at relatively high elevations (mostly 6,000 to 7,500 feet in west-central Montana and 7,000 to 8,500 feet east of the Continental Divide) in Montana, except in the northwestern part of the State. It is widely distributed in high mountains near and east of the Continental Divide, but is often confined to small areas because it is restricted to poorly drained sites that have surface water during late spring and early summer (fig. 34). These sites often border streams, adjoin wet meadows (dominated by *Carex* and *Juncus*) supporting only occasional trees, or occur as swales at the drainage headwaters. Adjacent better drained sites often support the *ABLA/VASC* and *ABLA/MEFE* h.t.s. Sometimes *ABLA/CACA* occurs on mountainslope seep areas. Herbert Holdorf (soil scientist, Lewis and Clark National Forest, Great Falls, Montana) has found it to be locally extensive on sites underlain by a clay pan.

Vegetation.--Because of the cool, wet conditions the tree flora is relatively simple. *Picea engelmannii* is usually the dominant species in old-growth stands, and it may persist as a minor climax or coclimax with *Abies lasiocarpa*. *Pinus contorta* is a major seral dominant in many younger stands. The upper limits of the habitat type occasionally extend into the upper subalpine zone in protected basins. *Pinus albicaulis* may be well represented in these situations, but it is most commonly found on hummocks or drier sites within the stand.

*Figure 34.--*Abies lasiocarpa/Calamagrostis canadensis *h.t. (*Calamagrostis *phase at 8,100 feet elev. on a seep-covered slope in the Beaverhead Range of southwestern Montana. The overstory is dominated by large* Picea *and smaller* Abies lasiocarpa. *The luxuriant undergrowth has* Veratrum viride, Senecio triangularis, Calamagrostis canadensis, *and* Ledum.

Wet-site graminoids and forbs and *Ledum glandulosum* characteristically dominate the undergrowth. *Calamagrostis canadensis* and *Senecio triangularis* are usually well-represented in the undergrowth. *Vaccinium scoparium* is abundant on drier hummocks, such as around the bases of large trees; *Vaccinium caespitosum* is prominent in one phase of the habitat type. Dwarf shrubs *Kalmia polifolia* and *Gaultheria humifusa* are sometimes present. *Dodecatheon jeffreyi, Ligusticum tenuifolium, L. canbyi, Streptopus amplexifolius, Veratrum viride,* and *Trollius laxus* are also characteristic of the *ABLA/CACA* h.t.

Calamagrostis canadensis (CACA) phase.--This is the commonest phase, representing the high-elevation conditions described above for the habitat type in general.

Galium triflorum (GATR) phase.--This phase occurs near the lower elevational limits of the habitat type, where it is transitional to warmer habitat types below, such as *ABLA/GATR* or *PICEA/EQAR*. Sample stands ranged from 5,800 feet in the Bitter-root Valley to 7,400 feet in south-central Montana. *Picea, Abies lasiocarpa,* and occasionally *Pinus contorta* constituted the tree flora of sample stands. *Calamagrostis canadensis* was accompanied in the undergrowth by *Galium triflorum* and *Ribes lacustre*, sometimes along with *Actaea rubra* and *Linnaea borealis*, indicating a milder climate.

Vaccinium caespitosum (VACA) phase.--This phase is also associated with the lower elevations of the habitat type, where it is often transitional to the *ABLA/VACA* h.t. on drier ground. A mosaic of *Carex* wet meadows, *ABLA/CACA* h.t., *VACA* phase, and

ABLA/VACA h.t. sometimes develops in flat basins where water-table depth is variable. This condition results from varying depth to an impermeable layer. Elevations of sample stands were about 5,000 feet in the Flathead Valley northwest of Kalispell and 7,000 to 7,400 feet in southwestern and central Montana. This phase contrasted with the others in having *Pinus contorta* as the dominant component of sample stands, while *Picea* and *Abies* are only minor components. Undergrowth is distinguished by *Vaccinium caespitosum* being associated with *Calamagrostis canadensis*. *Ledum* and *Linnaea borealis* were present in more than half of the sample stands.

Soil/Climate.--Soils in the *ABLA/CACA* h.t. were derived from a variety of noncalcareous parent materials (appendix D-1). Moist surface soils were acidic to very acidic sandy loams to silts. Most were nongravelly. Ground surfaces had little bare soil or rock exposed. Duff accumulations were extremely variable, ranging from almost none (in stream bottom sites subject to flooding) to depths of 10 to 15 cm in seepage or depression areas.

Climatic conditions for the *ABLA/CACA* h.t. are probably similar to those for *ABLA/VASC* (appendix D-2), except that the former probably has higher relative humidities and slightly cooler temperatures.

Fire history.--*ABLA/CACA* sites are apparently skipped by some of the lightning fires that burn the adjacent upland forest; but the abundance of *Pinus contorta* in sample stands suggests that occasional hot fires occur, probably during late-summer droughts.

Productivity/Management.--Timber productivity is moderate (appendix E). The *CACA* phase appears to have lower productivity than the other phases. *Picea* (attaining maximum heights of 90 to 120 feet in most stands) and *Pinus contorta* offer greatest potential for timber management. However, choice of cutting methods is largely restricted to clearcutting because of severe windthrow hazards associated with partial cutting on high-water-table sites. In narrow stringers along watercourses, light selection cutting (removing less than 30 percent of the basal area) can sometimes be done with little damage to the site or stand. Heavy equipment should not be used in the spring and early summer when water tables are highest.

Moderate summer use by deer and often by elk was evident in most sample stands in the *CACA* and *VACA* phases. Relatively heavy use by moose was noted in each of the *GATR* phase stands sampled. Domestic grazing values may be relatively high in early successional stages. However, cattle may churn the wet soils by trampling and severely limit conifer seedling establishment. Sites are poorly suited for roads, trails, or other developments. Protection of water resources is a major consideration in any management activity in this habitat type.

Other studies.--The 1974 review draft of our Montana classification treated the current *GATR* and *VACA* phases as *CACA* phases of the *ABLA/GATR* and *ABLA/VACA* h.t.s; the change places primary importance on *Calamagrostis canadensis* and its associates as indicators of seasonally water-saturated sites.

Robert Steele and others (1975 preliminary draft, USDA Forest Service, Intermountain Station) have used a more restrictive definition for *ABLA/CACA* in central Idaho, where it is accompanied by several other high-elevation wet types covering extensive areas. Cooper (1975) also described an *ABLA/CACA* h.t. in northwestern Wyoming.

Abies lasiocarpa/Linnaea borealis h.t.
(*ABLA/LIBO*; subalpine fir/twinflower)

Distribution.--*ABLA/LIBO* is associated with relatively moist, north-facing slopes and benches mostly at elevations of 5,000 to 7,000 feet, which are moderate for the *Abies lasiocarpa* series. It occurs rather commonly throughout the Montana Rockies.

Vegetation.--Seral stands are usually dominated by *Pseudotsuga*, *Pinus contorta*, and/or *Picea*. Undergrowth varies considerably by phase of the habitat type. Nevertheless, shrubs *Linnaea borealis*, *Lonicera utahensis*, *Vaccinium globulare*, and herbs *Calamagrostis rubescens*, *Arnica latifolia*, and *Pyrola secunda* occur throughout the type.

Linnaea borealis (LIBO) phase.--This phase was sampled in the vicinities of the Lolo, Bitterroot, Lewis and Clark, and Gallatin National Forests. It was largely restricted to north-facing slopes between 5,000 and 6,500 feet elevation, except on the Gallatin where it was found near 7,500 feet. *Pseudotsuga*, *Pinus contorta*, and *Picea*, (in order of decreasing abundance) were the major dominants in sample stands, along with *Abies lasiocarpa*. *Pinus ponderosa* and *Larix occidentalis* were major components of some seral stands in the Lolo and Bitterroot National Forests. Undergrowth is as described for the type with the frequent addition of *Amelanchier alnifolia* and *Rubus parviflorus*. Widely scattered individuals of either *Galium triflorum* or *Actaea rubra* are sometimes found, but this does not qualify the stand for inclusion in the more moist *ABLA/GATR* h.t.

Xerophyllum tenax (XETE) phase.--This phase was found only in the vicinities of the Flathead, Lolo, and Bitterroot National Forests, where it was occasional on all aspects between 4,500 and 6,000 feet. It gives way to the *ABLA/XETE* h.t., *VAGL* phase on drier sites, and to *ABLA/GATR* or *ABLA/CLUN* on more moist ones. Major associates of *Abies* in seral stands are (in order of decreasing abundance) *Pseudotsuga*, *Pinus contorta*, *Larix occidentalis*, and *Picea*. *Xerophyllum* and *Vaccinium globulare* form the dominant undergrowth in this phase, and are often accompanied by *Amelanchier alnifolia*, *Pachistima myrsinites*, *Rubus parviflorus*, and *Vaccinium scoparium* in addition to the characteristic typal species.

Vaccinium scoparium (VASC) phase.--This phase was found commonly on the Deerlodge and Beaverhead National Forests and in the Little Belt Mountains, where it was associated with gentle north slopes and benches between 6,300 and 7,300 feet. Like the *ABLA/VASC* and *ABLA/VAGL* h.t.s. that it adjoins on drier sites, it is usually dominated by seral stands of *Pinus contorta*. *Picea* and *Pseudotsuga* are minor components of most stands. A layer of *Vaccinium scoparium*, which has *Linnaea* and *Calamagrostis rubescens* growing with it, dominates the undergrowth. *Vaccinium globulare* may be present, but is seldom a major component of the undergrowth. Tom Lawrence, Kootenai National Forest, has also found this phase to be common between 4,600 and 5,300 feet on gentle slopes in the relatively dry mountains south and west of Eureka in northwestern Montana. Seral stands there are dominated mostly by *Larix occidentalis* and *Pinus contorta* with lesser amounts of *Picea* and *Pseudotsuga*.

Soil.--Our stands were on a variety of parent materials (appendix D-1). These were noncalcareous except for several stands in the *LIBO* phase. Surface soils in the *LIBO* phase were gravelly loams to silts with neutral to acidic reaction. Surface soils in the *VASC* phase were similar except for finer textures and greater acidity. Surface soils in the *XETE* phase were gravelly to very gravelly sandy loams to silts with acidic reactions. Ground surfaces generally had very little bare soil or rock exposed and moderate duff depths.

Productivity/Management.--Timber productivity ranges from low to high (appendix E). The *LIBO* and *XETE* phases appear to have the highest productivity; the *VASC* phase the lowest. Since *ABLA/LIBO* sites are generally located on well-drained uplands, they provide good opportunities for timber management. Our observations suggest that *Pseudotsuga* may often be frost-damaged when planted in the *VASC* phase. Value for domestic grazing is low. Light or sometimes moderate spring to fall use by deer and elk was evident in the sample stands; browse is limited, but stands provide good cover for big game. Water yield is moderately high.

Other studies.--Robert Steele and others (1975 preliminary draft, USDA Forest Service, Intermountain Station) described a comparable *ABLA/LIBO* h.t. in central Idaho, and Cooper (1975) reported the type in the northwestern portion of Yellowstone National

Park, but nowhere else in northwestern Wyoming. In northern Idaho, R. and J. Daubenmire (1968) found *Linnaea* to be almost constantly associated with their "*Pachistima* union." In Montana various members of that union reach their eastern range limits: *Clintonia* drops out in northwestern Montana, and farther east the depauperate "*Pachistima* union" is represented by the *ABLA/GATR* h.t. (on very moist sites) and by the *ABLA/LIBO* h.t. (on moist, but better drained sites).

Abies lasiocarpa/Menziesia ferrugina h.t.
(*ABLA/MEFE*; subalpine fir/menziesia)

Distribution.--*ABLA/MEFE* is an abundant habitat type in the moist, higher elevation forests of western Montana (fig. 35). It extends eastward slightly beyond the Continental Divide, and includes an isolated population near Hebgen Lake in the Madison Range. *Menziesia's* distribution in the northern Rockies generally coincides with the area having a maritime climatic influence.

In northwestern Montana *ABLA/MEFE* generally occurs on all cool exposures between about 5,300 and 6,500 feet. It is restricted to the coolest, most sheltered slopes on the Bitterroot National Forest, but it is common there between 5,500 and 7,200 feet. In southwestern Montana, including the isolated occurrence near Hebgen Lake, it is restricted to cool, sheltered slopes between 6,700 and 7,500 feet. In northwestern Montana *ABLA/MEFE* is usually bordered below by *ABLA/CLUN* h.t., *MEFE* phase. Elsewhere it typically gives way below to *ABLA/LIBO* h.t. Usually at higher elevations it adjoins

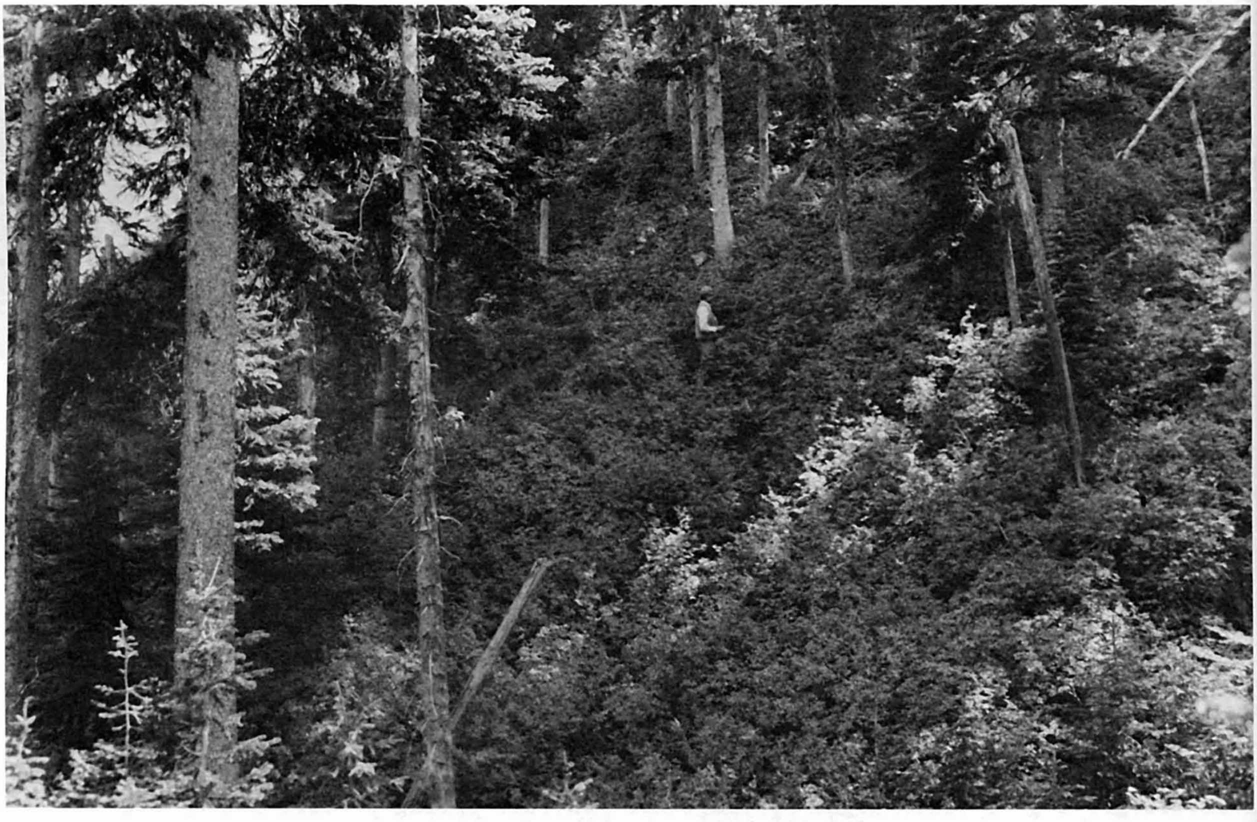


*Figure 35.--*Abies lasiocarpa/Menziesia ferruginea *h.t. on a steep north-facing slope (6,300 feet elev.) north of Hungry Horse Reservoir in northwestern Montana. The overstory is dominated by* Abies lasiocarpa *and* Picea; Menziesia *dominates the undergrowth.*

ABLA/LUHI h.t., *MEFE* phase. Approaching drier exposures it usually merges with *ABLA/XETE* h.t.; occasionally the transition forms a conspicuous zone having scattered *Menziesia* shrubs. At the edge of very wet sites *ABLA/MEFE* usually gives way to marsh or bog vegetation or to *ABLA/CACA* h.t.

Vegetation.--*Abies lasiocarpa* is usually the most abundant conifer in old-growth stands; however, large individuals of *Picea engelmannii* are often more conspicuous. *Pinus contorta* and frequently *Pseudotsuga* are the other common stand components. *Larix occidentalis* is often a seral component of stands in northwestern Montana.

Menziesia forms a patchy or dense layer usually 4 to 6 feet tall, often accompanied by *Alnus sinuata*. Beneath these shrubs, *Vaccinium globulare, V. scoparium, Xerophyllum tenax,* and *Arnica latifolia* are usually well represented. *Pyrola secunda, Viola orbiculata*, and a few other scattered forest herbs are also characteristically present.

In southwestern Montana, *Menziesia* is often only 3 to 4 feet tall, with obvious frost damage to the tallest shoots, presumably because of inadequate snowpack protection during subzero winter temperatures.

Soil/Climate.--Soils in the *ABLA/MEFE* h.t. were derived from a variety of noncalcareous parent materials (appendix D-1). Surface soils were gravelly (28 percent) loams to silts with very acidic to acidic reactions (mean pH 4.9). Ground surfaces had almost no bare soil or rock exposed; duff depth averaged 4.7 cm.

Weather data from Burke, Idaho (appendix D-2) should approximate climatic conditions in *ABLA/MEFE* h.t.s in northwestern Montana.

Productivity/Management.--Timber productivity is moderate to high (appendix E). with several commercial species well adapted to these sites (appendix B). However, intensive management for timber production presents some major problems. Partial cutting leads to an increase in the shade-tolerant *Abies lasiocarpa* or to a lack of regeneration under the dense *Menziesia ferruginea* and *Alnus sinuata* undergrowth. Clearcutting is recommmended to establish vigorous second-growth stands of seral species. Site preparation is essential and can be accomplished by dozer scarification on gentler slopes. However, on steep slopes prescribed burning is the only feasible method. Unfortunately, fuels on these slopes remain moist, leaving only a brief period in certain years when successful burning can be accomplished. The silvicultural recommendations of Roe and DeJarnette (1965) and Boyd and Deitschman (1969) are probably applicable to this habitat type as well as *TSME/MEFE*.

Watershed value is high; maintaining or improving water yields by regulating flows should be considered in any management actions. Elk often make extensive use of this habitat type for both cover and forage during the summer and fall. There is no potential for domestic grazing. Recreational use is severely limited by dense undergrowth and steep slopes.

Other studies.--R. and J. Daubenmire (1968) described an *Abies lasiocarpa/Menziesia ferruginea* h.t. in northern Idaho and eastern Washington that predominates on cool aspects at higher elevations. Three of their stands (numbers 134, 137, and 159) appear comparable to our *ABLA/MEFE* h.t. The remainder of their stands are evidently similar to our *ABLA/LUHI* h.t., *MEFE* phase. Robert Steele and others (1975 preliminary draft, USDA Forest Service, Intermountain Station) have found *ABLA/MEFE* h.t. extending southward into west-central Idaho. Ogilvie (1962) described a similar habitat type occurring between about 5,000 and 5,800 feet in southwestern Alberta; he found the soils to be highly podzolized, strongly leached, and very acidic. Franklin and Dyrness (1973) discuss an *Abies amabilis/Menziesia* association found on high, cool exposures in the Cascade Mountains of Oregon and Washington.

Tsuga mertensiana/Menziesia ferruginea h.t.
(*TSME/MEFE*; mountain hemlock/menziesia)

Distribution.--This habitat type is distinguished from *ABLA/MEFE* by the presence of successfully reproducing *Tsuga mertensiana*. *TSME/MEFE* is associated with mountain climates having an especially strong oceanic influence; it is restricted to the border region of northwestern Montana between Lolo Pass and Libby, where it is found at between 5,400 and 6,400 feet. Many of our *Tsuga mertensiana* sample stands came from Habeck (1967). Along the Montana-Idaho Divide west of St. Regis, this habitat type gives way to *TSME/LUHI* h.t., *MEFE* phase above about 6,000 feet, whereas on the next mountain range east (presumably not having such an extremely heavy snowfall) it extends higher. It is bordered on dry exposures by the *TSME/XETE* or *ABLA/XETE* h.t.s, and at lower elevations by the *ABLA/CLUN* h.t., *MEFE* phase.

Vegetation.--*Tsuga* may be either the climax dominant or a coclimax with *Abies lasiocarpa*. Sample stands were dominated by *Tsuga* and *Abies* with only small amounts of *Picea engelmannii*, *Larix occidentalis*, *Pinus monticola*, and *Pseudotsuga menziesii* (in order of decreasing abundance). Undergrowth is similar to that of the *ABLA/MEFE* h.t.

Soil.--Soils appear similar to those of the *ABLA/MEFE* h.t. (appendix D-1).

Productivity/Management.--This is similar to that for *ABLA/MEFE* except that seral conifers are often only minor components of natural stands.

Other studies.--This habitat type has been described in northern Idaho by R. and J. Daubenmire (1968), where it is apparently more extensive. Three of their sample stands (numbers 12, 63, and 132) appear comparable to our *TSME/MEFE* h.t. in Montana. The remainder of their stands are evidently similar to our *TSME/LUHI* h.t., *MEFE* phase.

Abies lasiocarpa/Xerophyllum tenax h.t.
(*ABLA/XETE*; subalpine fir/beargrass)

Distribution.--*ABLA/XETE* makes up a major portion of the *Abies lasiocarpa* series west of the Continental Divide in Montana, where it is usually associated with steep, dry exposures between 5,200 and 7,000 feet elevation. The eastern limits of *Xerophyllum tenax* are generally correlated with fringes of the maritime climatic influence. An isolated occurrence of *Xerophyllum* (and *ABLA/XETE* h.t.) far beyond its normal limits was noted in the vicinity of Elephanthead Peak, southeast of Livingston.

Vegetation.--*Abies lasiocarpa* is the indicated climax species and *Picea* is a minor component of most stands. *Pinus contorta* is a seral dominant throughout the type, but *Pseudotsuga's* role varies by phase. *Pinus albicaulis* is a minor component in many stands.

In addition to *Xerophyllum tenax*, undergrowth species occurring through the habitat type include *Vaccinium scoparium*, *Calamagrostis rubescens*, *Carex geyeri*, *Arnica latifolia*, and *Pyrola secunda*.

Vaccinum globulare (VAGL) phase.--This phase is abundant on relatively dry slopes and ridges between 5,000 and 6,300 feet in northwestern and west-central Montana. Elevations are somewhat higher near the southern and eastern limits (fig. 36). It typically merges with *ABLA/MEFE* on moist exposures; with *ABLA/LUHI* h.t., *VASC* phase at higher elevations; and with *PSME/VAGL* h.t., *XETE* phase on drier and warmer sites.

Pseudotsuga and *Pinus contorta* typically dominate seral stands, with *Larix occidentalis* and *Pinus monticola* present in lesser amounts. *Picea engelmannii* is

Figure 36.--Vaccinium globulare *phase (*ABLA/XETE *h.t.) on a south-facing slope (at an unusually high elevation of 8,100 feet) in the Beaverhead Range of southwestern Montana. Older* Picea *and all-aged* Abies lasiocarpa *make up the overstory of this 250-year-old stand.* Xerophyllum *and* Vaccinium globulare *are the principal undergrowth species.*

common as a minor component in all but the driest, south-facing slopes, where *Viola orbiculata* is also conspicuously absent.

Undergrowth is dominated by *Xerophyllum* and *Vaccinium globulare,* with minor coverages of *Pachistima myrsinites, Thalictrum occidentale,* and other species listed previously for the type. This phase is similar to the *ABLA/XETE* h.t., *VAGL* phase defined for central Idaho by Robert Steele and others (1975 preliminary draft, USDA Forest Service, Intermountain Station). It is also similar to R. and J. Daubenmire's (1968) *Abies lasiocarpa/Xerophyllum tenax* h.t. in northern Idaho, (except for stands 57 and 127, which are comparable to our *ABLA/LUHI* h.t., *VASC* phase).

Vaccinium scoparium (VASC) phase.--This phase represents the habitat type near its eastern limits, in the broad zone where it is transitional to the *ABLA/VASC* h.t. It was found extensively between 6,000 and 7,500 feet in west-central Montana near the Continental Divide. This phase is typically found on gentle slopes, cool, well-drained benches, or on cooler aspects than the *VAGL* phase. *Pinus contorta* is the dominant seral species (fig. 37). *Pseudotsuga* is widely scattered and apparently is frost-stunted. This phase is generally beyond the range limits of *Larix occidentalis.* Other conifers occur as described previously for the type. Undergrowth contrasts with that of the *VAGL* phase in that *Vaccinium globulare* is scattered or absent, *Xerophyllum* coverage is reduced, and *Vaccinium scoparium* is dominant. Nearly all sample stands were dominated by seral *Pinus contorta,* suggesting that extensive lightning fires occur periodically.

Figure 37.--Vaccinium scoparium *phase (*ABLA/XETE *h.t.) atop a level ridge (7,500 feet elev.) northeast of Wisdom in southwestern Montana. Seral* Pinus contorta *dominates the overstory along with scattered* Picea; Abies lasiocarpa *forms the bulk of the regeneration.* Vaccinium scoparium *dominates in the undergrowth;* Xerophyllum *is scattered about.*

Weather data for Summit (Marias Pass) in appendix D-2 shows this to be a cold, snowy, forest environment, with a winter climate more severe than that of the *VAGL* phase.

This phase has much in common with the *ABLA/VASC* h.t., which becomes extensive eastward in more continental and generally drier climates. Several of Robert Steele and others' (1975 preliminary draft, USDA Forest Service, Intermountain Station) sample stands (in their *ABLA/XETE* h.t., *XETE* phase) in central Idaho would evidently fit our *VASC* phase.

Soil.--Soils in the *ABLA/XETE* h.t. were derived from a variety of noncalcareous parent materials (appendix D-1). Surface soils were gravelly sandy loams to silts. Reactions were primarily acidic in the *VAGL* phase (mean pH 5.1) and very acidic in the *VASC* phase (mean pH 4.6). Ground surfaces had little bare soil and rock exposed; duff depth averaged about 3.5 cm.

Productivity/Management.--Timber productivity ranges from low to high (appendix E); highest values are generally in the *VAGL* phase. The *VAGL* phase offers opportunities for mixed species management, but prompt establishment of regeneration may require both site preparation and shade. *Pseudotsuga* and *Pinus contorta* appear to offer the greatest potential for timber management. In the *VASC* phase, timber management is generally limited to *Pinus contorta*. However, regeneration may be easier to obtain on these cooler aspects, and the gentler terrain is better suited for intensive timber management.

Browse production for deer and elk is moderate in the *VAGL* phase and low in the *VASC* phase. Evidence of light to moderate summer and fall use by deer and elk is present in most stands. Occasional use by moose is evident in the *VASC* phase.

Domestic grazing potential is generally low. Watershed management should recognize the moderately high precipitation coupled with high evapotranspiration and runoff rates on southerly exposures. Snowpack in this habitat type (especially in the *VAGL* phase) may melt periodically during winter and disappear in the spring several weeks earlier than in adjacent types.

Tsuga mertensiana/Xerophyllum tenax h.t.
(*TSME/XETE*; mountain hemlock/beargrass)

Distribution.--*TSME/XETE* occurs only sparingly in Montana. It is found mostly at 5,500 to 6,500 feet elevation on upper slopes and ridges in the extreme northwestern part of the State, between Lolo Pass and Libby. In northern Idaho it commonly occupies the warm exposures, but eastward from the Idaho-Montana Divide comparable exposures often lack *Tsuga* and are characterized by the *ABLA/XETE* h.t., *VAGL* phase.

Vegetation.--Vegetation of the *TSME/XETE* h.t. appears generally similar to that described for the *ABLA/XETE* h.t., *VAGL* phase, except that *TSME/XETE* is associated with a moist, more strongly maritime climate. Seral stands in the *TSME/XETE* h.t. are less likely to have *Pseudotsuga* than those of the *ABLA/XETE* h.t., *VAGL* phase, but they are more likely to have *Pinus monticola.*

Soil.--Soils were similar to those described for the *ABLA/XETE* h.t., *VAGL* phase (appendix D-1).

Productivity/Management.--This is similar to that described for the *ABLA/XETE* h.t., *VAGL* phase.

Other studies.--Three of R. and J. Daubenmire's (1968) *Tsuga mertensiana/Xerophyllum* h.t. stands in northern Idaho (numbers 47, 98, and 157) are comparable; the remainder of their stands are similar to our *TSME/LUHI* h.t., *VASC* phase.

Abies lasiocarpa/Vaccinium globulare h.t.
(*ABLA/VAGL*; subalpine fir/blue huckleberry)

Distribution.--*ABLA/VAGL* is a moderately moist upland type occurring mostly on north- or east-facing slopes or occasionally on cool benches, usually between 6,800 and 7,800 feet elevation. It is largely restricted to areas near or east of the Continental Divide, and is common in the vicinity of the Gallatin National Forest. *ABLA/VAGL* often alternates in a mosaic with the *ABLA/VASC* h.t. (especially the latter's *CARU* phase), the former apparently occupying more moist or more sheltered microsites.

Vegetation.--*Abies lasiocarpa* is the apparent climax, with seral stands usually dominated by *Pinus contorta* or *Pseudotsuga*. *Picea engelmannii* (or *P. engelmannii* X *glauca)* is a common though minor component of most stands, and *Pinus albicaulis* is a rather prominent minor species in some stands. These latter stands were not classified *ABLA-PIAL/VASC* h.t. because *Pseudotsuga* was present.

Undergrowth is luxuriant for east-side *Abies lasiocarpa* types. *Vaccinium globulare* forms a patchy layer a foot high. *Vaccinium scoparium* is also usually well represented, but other shrubs occur only in minor amounts. *Carex geyeri, Calamagrostis rubescens,* and *Arnica cordifolia* are common in more than half of the stands; small coverages of *Osmorhiza chilensis, Pyrola secunda,* and *Thalictrum occidentale* are also characteristic.

Soil.--Soils in the *ABLA/VAGL* h.t. were derived from a wide variety of parent materials (appendix D-1). Surface soils were acidic gravelly loams to silty clay loams. Ground surfaces had little bare mineral soil or rock exposed; duff was moderately deep (average 5.3 cm).

Productivity/Management.--Timber productivity is low to moderate (appendix E-4). *Pinus contorta* should be easier to regenerate than other species. Sample stands showed light to moderate use by deer and elk with occasional use by moose and bears. Domestic grazing use is quite limited, but watershed values are relatively high. Most of the denser stands of *Vaccinium globulare* east of the Continental Divide are limited to this habitat type, so management to enhance berry production may be an important consideration. However, silvicultural prescriptions to increase amounts of *Vaccinium globulare* and berry production are not known at this time, and it would be unwise to extrapolate from other habitat types or from areas where different species of *Vaccinium* have been studied. Responses of *Vaccinium globulare* to various types of vegetative manipulation need to be studied.

Other studies.--In central Idaho, Robert Steele and others (1975 preliminary draft, USDA Forest Service, Intermountain Station) have described a generally similar *ABLA/VAGL* h.t. that also occurs largely beyond the range limits of *Xerophyllum*. Cooper (1975) described this habitat type as reaching its maximum development in northeastern Idaho and northwestern Wyoming.

Abies lasiocarpa/Vaccinium scoparium h.t. (*ABLA/VASC*; subalpine fir/grouse whortleberry)

Distribution.--This is one of the most abundant forest habitat types near and east of the Continental Divide in Montana. It occurs mostly on well-drained soils on broad ridges, gentle slopes, and benches between about 7,000 and 8,500 feet. It is typically bounded at higher elevations by the *ABLA-PIAL/VASC* h.t., on drier sites by *ABLA/CARU* or *PSME/CARU* h.t.s, and on more moist sites by several of the moist *Abies lasiocarpa* h.t.s. (*ABLA/VASC* is also locally common at 5,000 to 5,700 feet in the relatively dry mountains south and west of Eureka in northwestern Montana.)

Vegetation.--*Abies lasiocarpa* is the indicated climax and *Pinus contorta* is the dominant seral species throughout the habitat type. *Picea engelmannii* is a major component in only the *THOC* phase. *Pseudotsuga* is a major seral component in the *CARU* phase, but becomes scarce and often frost stunted as it reaches its upper limits in the other two phases. (*Larix occidentalis* shares dominance with *Pinus contorta* in seral stands near Eureka, based on recent inventory data provided by Tom Lawrence, Kootenai National Forest.)

Undergrowth is dominated by a low-shrub layer of the *Vaccinium scoparium*, or occasionally by *V. myrtillus*. Where *V. myrtillus* is associated with more moist or milder environmental conditions that *V. scoparium*, indicators of other habitat types are usually present. Thus, *V. myrtillus* can be used as an alternate indicator of the *ABLA/VASC* h.t. without implying ecological equivalence of the two species. We also favored this approach because of the difficulty in taxonomically separating the two species. Other species in the undergrowth are inconspicuous, except for modest coverages of *Arnica latifolia* or *A. cordifolia*, *Carex geyeri*, and *Calamagrostis rubescens*.

Calamagrostis rubescens (CARU) phase.--This occurs in a warmer environment than other phases of the habitat type. It is found mostly between elevations of 5,200 and 7,100 feet, averaging almost 1,000 feet lower than the other phases. Although it is widespread east of the Continental Divide, it is less extensive than the *VASC* phase. This phase is usually bounded on cooler sites by other phases of the *ABLA/VASC* h.t., on drier sites by the *PSME/CARU* h.t., and on more moist sites by the *ABLA/VAGL* h.t. Although *Abies lasiocarpa* is the indicated climax, sites are often near the species' lower altitudinal (drought) limits and this tree is not particularly vigorous. Most sample stands are dominated by seral *Pinus contorta* and *Pseudotsuga*. *Picea* is only a minor component of stands in this phase. The undergrowth is dominated by *Vaccinium scoparium*, but several species characteristic of milder environments are conspicuous in this phase. *Calamagrostis rubescens* is common and either *Arctostaphylos uva-ursi* or *Berberis repens* are present. Additional species present may include *Juniperus communis, Spiraea betulifolia,* and *Vaccinium globulare.*

Vaccinium scoparium (VASC) phase.--Stands not meeting the criteria for the *CARU* or *THOC* phases are classified here. This is the most abundant phase of the habitat type in Montana. It occupies cold, relatively dry sites, usually on flat areas or gentle slopes between 7,000 and 8,000 feet elevation. It is common in southwestern and south-central Montana as well as in the Little Belt Mountains, and occasionally is found west of the Continental Divide.

Pinus contorta is the major dominant conifer on most sites and succession to climax dominance by *Abies lasiocarpa* is often very slow either because of lack of seed source or apparent low vigor in this phase. *Pseudotsuga,* if present, is often frost-stunted. *Picea* is usually scarce. Undergrowth is as described previously for the type.

The abundance of this phase in central and southwestern Montana and central Idaho (Robert Steele and others 1975 preliminary draft, USDA Forest Service, Intermountain Station) seems to be related to the scant summer precipitation in combination with well-drained upland soils.

Thalictrum occidentale (THOC) phase.--This phase occupies the moist, cool environments within the habitat type. Sample stands ranged from 7,300 to 8,600 feet in elevation and were common only in the Beaverhead and Gallatin National Forests. This is the only phase having *Picea* as a major component, sharing dominance about equally with *Abies lasiocarpa* and *Pinus contorta.* Stands in this phase have *Thalictrum occidentale* common or *Valeriana sitchensis* or *Viola orbiculata* present; also they do not meet the criteria for the *CARU* phase. In addition, *Osmorhiza chilensis* and *Pyrola secunda,* not found in the drier *VASC* phase, are usually present here.

Soil/Climate.--Soils in the *ABLA/VASC* h.t. were derived from a wide variety of parent materials with some differences by phase as shown in appendix D-1. Surface soils in the *VASC* phase were gravelly sandy loams to silts; those in the *CARU* and *THOC* phases had less gravel and were finer in texture. Soils in all phases were acidic to very acidic. Ground surfaces had small amounts of rock and very little bare mineral soil exposed. Duff was moderate in the *VASC* phase (average 3.5 cm) to moderately deep in the *THOC* phase (average 5.6 cm).

Weather data from Kings Hill (appendix D-2) reflect the climate of a relatively moist and cold site in this habitat type.

Fire history.--The preponderance of mature, even-aged stands of *Pinus contorta* in this habitat type is generally attributable to intense wildfires, which often follow severe outbreaks of mountain pine beetle (*Dendroctonus ponderosae* Hopk.). This fire history may also have contributed to lack of seed source of climax species. However, fire scars on old-growth (150 to 250 years) *Pinus contorta* trees in several sample stands indicate that one to three noncatastrophic ground fires occurred after initial stand establishment. No doubt this strongly influenced current stand structure.

Productivity/Management.--Timber productivity is low to moderate (appendix E), with highest productivities in the *CARU* and *THOC* phases. Extensive areas of gentle terrain are suitable for timber management. Existing stands of *Pinus contorta* could be managed for small sawtimber, pulpwood, posts, and poles. This species should do best under even-aged management systems. *Pseudotsuga* is generally available for timber production in the *CARU* phase; but regeneration may require scarification because of grass sod. In the *THOC* phase, *Picea* is also available; stands with overstories of

Pinus contorta and vigorous understories dominated by *Picea* offer opportunities for partial cutting. According to Roe and Amman (1970), the risk of *Pinus contorta* loss to mountain pine beetle epidemics is less in this habitat type than in lower elevation habitat types, and smaller trees are less susceptible than large ones.

Forage potential for big game or domestic stock is extremely low in forest stands. Clearcuts may produce 800 to 1,000 pounds of forage per acre per year, but palatability ratings are only fair for the native early-successional plants (Basile and Jensen 1971).

Water yield is relatively high, and management constraints may be needed to protect water resources.

Other studies.--*Abies lasiocarpa* and *Picea engelmannii/Vaccinium scoparium* habitat types have been described elsewhere in the Rockies by R. and J. Daubenmire (1968), McLean (1970), Pfister (1972a), Reed (1969, 1976); Wirsing (1973), Hoffman and Alexander (1976), and Cooper (1975). The abundance of *Picea* and the presence of moist indicator forbs suggest that most of their stands are similar to our *THOC* phase. However, the *CARU* phase has also been described in south-central British Columbia (McLean 1970), central Idaho (Robert Steele and others 1975 preliminary draft, USDA Forest Service, Intermountain Station), and northwestern Wyoming (Cooper 1975). In addition, Robert Steele and others (1975) reported the *VASC* phase from central Idaho.

Abies lasiocarpa/Alnus sinuata h.t.
(*ABLA/ALSI*; subalpine fir/Sitka alder)

Distribution.--*ABLA/ALSI* is a relatively cool and moist upland habitat type within the lower subalpine forest. Most stands are located on north-facing slopes between 6,500 and 7,500 feet elevation, except in northwestern Montana, where they occur at 5,000 to 5,800 feet. The type is rather widely distributed in the higher mountains of the State; however, stands are usually scattered and not extensive.

In west-central Montana *ABLA/ALSI* sometimes forms a transitional zone between the *ABLA/MEFE* h.t. and the *ABLA/XETE* h.t., *VASC* phase. Eastward *ABLA/ALSI* might be considered to be an extension of sites similar to *ABLA/MEFE*, but beyond the geographic limits of *Menziesia*.

ABLA/ALSI is often bordered below--on warmer, but similarly moist sites--by *ABLA/LIBO* stands in which *Alnus sinuata* is well represented. East of the Continental Divide the adjacent drier habitat types are *ABLA/VASC* or *ABLA/VAGL*.

Stands are dominated to varying degrees by *Pinus contorta*, *Picea engelmannii*, *Abies lasiocarpa*, and occasionally by *Pseudotsuga*. *Larix occidentalis* is often a major component west of the Continental Divide. Undergrowth is a relatively dense or a patchy layer of *Alnus*, sometimes with *Vaccinium globulare*, *V. scoparium*, or *Xerophyllum* also well represented. Scattered *Pyrola secunda*, *Arnica latifolia*, and similar forbs are also typical.

Since all stands observed were 200 years old or less, retention of *Alnus* at the theoretical climax is uncertain. Nevertheless, the vegetation and environment are distinctive enough to warrant designation as a habitat type.

Soil.--Our stands were on a variety of noncalcareous parent materials (appendix D-1). Surface soils were loams to silts with very acidic to acidic reactions. Gravel content averaged 18 percent. Ground surfaces generally had no bare soil or rock exposed; duff depth averaged 6.0 cm.

Productivity/Management.--Timber productivity is moderate (appendix E); *Pinus contorta* and *Picea* are prominent seral components. Big-game use appears to be light, although stands may be important for cover. Water yield should be relatively high. The presence of *Alnus sinuata* suggests that water tables may be high during part of the year; this would create problems for certain management activities. Conifers should reestablish readily following major overstory removal or wildfire; however, tree growth may sometimes be retarded initially by the development of an *Alnus*-dominated brushfield.

Other studies.--Although *Alnus sinuata* also forms a dominant undergrowth in seep areas and under seral conditions in many moist habitat types (R. and J. Daubenmire 1968), these situations are *not* included in our definition of the *ABLA/ALSI* h.t. Robert Steele and others (1975 preliminary draft, USDA Forest Service, Intermountain Station) mentioned finding a similar *ABLA/ALSI* habitat type in east-central Idaho.

Abies lasiocarpa/Calamagrostis rubescens h.t. (*ABLA/CARU*; subalpine fir/pinegrass)

Distribution.--*ABLA/CARU* was found only east of the Continental Divide in Montana, where it occurs on moderate slopes and all aspects near the warm, dry limits of the *Abies lasiocarpa* series. It is most extensive on the Gallatin National Forest and in the Centennial Mountains between 6,500 and 7,700 feet. It is also common in the Front Range west of Great Falls on limestone substrates between 5,800 and 6,300 feet.

Vegetation.--*ABLA/CARU* is apparently an extension of the *PSME/CARU* h.t. on slopes moist and cool enough for *Abies lasiocarpa*. *Pseudotsuga* and *Pinus contorta* dominate most stands, with *Abies* and *Picea* being minor stand components. Wildfire evidently sweeps through most stands often enough to set back invasion of *Abies* and *Picea* without destroying large *Pseudotsugas*, which may attain diameters of 3 feet and heights of 90 feet.

Undergrowth is dominated by *Calamagrostis rubescens* and resembles that of the *PSME/CARU* h.t, except in having greater coverages of forbs like *Thalictrum occidentale*, *Osmorhiza chilensis*, and *Pyrola secunda*. The mat of *Calamagrostis rubescens* and *Carex geyeri* is especially luxuriant in young or open stands. However, near the upper limits of the *ABLA/CARU* h.t. these rhizomatous graminoids have less vigor and give way to undergrowth dominated by forbs of the *ABLA/ARCO* h.t. or to *Vaccinium scoparium* or *V. globulare*. In some areas (e.g., the Centennial Mountains) there seems to be a broad transition between *ABLA/CARU* at its upper limits, and *ABLA/ARCO*.

Soil.--Our stands were primarily on sedimentary parent materials (appendix D-1). Surface soils were acidic sandy loams to silts with average gravel content of 21 percent. Ground surfaces had little or no bare soil or rock exposed. Duff averaged 4.3 cm deep.

Productivity/Management.--Timber productivity ranges from low to high (appendix E-4). *Pseudotsuga* and *Pinus contorta* are major components of seral stands. Some mechanical scarification may be necessary to obtain conifer regeneration following harvest cuttings. However, many stands have advance regeneration of *Picea*, *Abies*, and even *Pseudotsuga* that could be managed following careful removal of the overstory. Light to moderate deer and elk use is evident in most stands. Cattle also make light use of stands on gentle topography. The potential for domestic forage production may be fairly good in early successional stages of this type--better than in other habitat types in the *Abies lasiocarpa* series. However, we do not know of any studies on forage production or grazing potential in this habitat type.

Other studies.--A similar *ABLA/CARU* h.t. has been described by Robert Steele and others (1975 preliminary draft, USDA Forest Service, Intermountain Station) as being abundant in central Idaho. However, in western Wyoming, Cooper (1975) sampled only two stands (numbers 227 and 229) that seem comparable to this habitat type. Ogilvie (1962) described a *Picea-Abies/Calamagrostis* h.t. in Alberta, but the limited stand data show it to be comparable to our *ABLA/VACA* h.t.

Abies lasiocarpa/Clematis pseudoalpina h.t.
(*ABLA/CLPS;* subalpine fir/virgin's bower)

Distribution.--*ABLA/CLPS* represents the lower (warm, dry) limits of the *Abies lasiocarpa* series on calcareous substrates east of the Continental Divide in Montana (fig 38). It is an edaphically controlled forest environment in that all 15 sample stands (and all other stands observed) were on limestone or on other substrates containing layers of lime-rich material. The type is locally abundant in many of the high mountains east of the Divide where lime-rich rocks are prevalent (e.g., Little Belt Mountains at 7,000 to 7,500 feet, Big Snowies at 6,000 to 6,800 feet, and Pryor Mountains near 8,000 feet). It was found on all exposures, but was most common on steep south- or west-facing slopes.

Adjacent cooler or more moist sites on calcareous substrates often support the *ABLA/ARCO* h.t.; warmer sites often support habitat types in the *Pseudotsuga* or *Pinus flexilis* series,or grassland. On adjacent sites having noncalcareous rock substrates, the habitat type is likely to be *ABLA/VASC, ABLA/VAGL,* or *ABLA/CARU,* with seral stands dominated by *Pinus contorta.*

Figure 38.--Abies lasiocarpa/Clematis pseudoalpina *h.t. on a gentle south-facing slope (7,500 feet elev.) on limestone substrate near Red Lodge in south-central Montana. Seral* Pseudotsuga *and* Pinus flexilis *dominate the overstory while* Abies lasiocarpa *and* Picea *are dominant in the regeneration layer.* Arnica cordifolia *and* Clematis pseudoalpina *are the dominant undergrowth species in view here.*

Vegetation.--Although *Abies lasiocarpa* is present at more than 10 trees per acre, and for purposes of this classification is the "indicated climax," it often is not a vigorous competitor, probably because of droughty site conditions. Montana limestones often weather into soils that are excessively well drained or otherwise make water less available to conifers than substrates derived from noncalcareous rocks. An example of this is Herbert Holdorf's (soil scientist, Lewis and Clark National Forest, Great Falls, Montana) observation that *Pinus contorta* occupies certain limestone formations in the Little Belts only where average annual precipitation is at least 30 inches. By contrast *Pinus contorta* grows in the same area on acidic rock substrates (granite, quartzite, etc.) where annual precipitation averages as little as 16 inches.

Stands are usually dominated by *Pseudotsuga* and often by apparently drought-resistant *Picea engelmannii* X *glauca* hybrids. *Pinus contorta* occurs sporadically and then only as a minor stand component. *Pinus flexilis* is a rather long-lived seral member of most *ABLA/CLPS* stands; it is diagnostic, since it is seldom found in other *Abies lasiocarpa* h.t.s. Sometimes *Pinus albicaulis* is also present, but it is common in much of the *Abies lasiocarpa* series (appendix B). (Differentiation of *Pinus flexilis* and *P. albicaulis* is discussed under Taxonomic Considerations in the Introduction.

Clematis pseudoalpina and *C. tenuiloba* (which intergrade) are usually present and are apparently confined to calcareous substrates. Like *Pinus flexilis*, they reach their upper elevational limits barely within the *Abies lasiocarpa* series, and are associated with the *Pseudotsuga* series below. *Spiraea betulifolia*, *Juniperus communis* and *Berberis repens* are the only frequently found shrubs. *Arnica cordifolia* and *Galium boreale* were present in all sample stands, and were accompanied by such dry-site forbs as *Aster conspicuus*, *Astragalus miser*, *Fragaria virginiana*, *Frasera speciosa*, *Valeriana dioica*, and *Zigadenus elegans*.

Soil.--All of our stands in the *ABLA/CLPS* h.t. were on calcareous parent materials (appendix D-1). Surface soils were silts to silty clay loams, ranging from slightly acidic to slightly basic. Gravel content was variable. Ground surfaces had little exposed rock or bare soil; duff depth averaged 4.2 cm.

Productivity/Management.--Forage values for both big game and domestic livestock appear to be low, although stands are often used as bedding areas by deer and elk. Domestic stock also bed and graze in this habitat type occasionally.

Timber productivity is low (appendix E-4). Site indexes for all species and maximum stand heights are consistently low (appendix E-1 and E-2). The steep, exposed slopes with shallow, fine-textured soils warrant special precautions to prevent erosion.

Other studies.--This habitat type has not been described elsewhere.

Abies lasiocarpa/Arnica cordifolia h.t.
(*ABLA/ARCO*; subalpine fir/heartleaf arnica)

Distribution.--*ABLA/ARCO* is a relatively cool, moist habitat type found in semi-arid mountains east of the Continental Divide, often on limestone substrates (Fig. 39). It is associated with benchlike uplands and north-facing slopes, and is found extensively in the southern portion of the Beaverhead National Forest (at 7,600 to 8,400 feet) as well as in the Little Belt Mountains (at 6,900 to 7,600 feet), where it is usually on limestone. *ABLA/ARCO* is seldom found elsewhere.

Warmer sites often support *ABLA/CARU*, *ABLA/CLPS* (on limestone), or *Festuca idahoensis*-dominated mountain parks. When this type occurs on limestone, the adjacent, topographically similar but noncalcareous sites usually support the *ABLA/VASC* h.t.

Figure 39.--Abies lasiocarpa/Arnica cordifolia *h.t. on a gentle north-facing slope (7,650 feet elev.) in the Centennial Mountains of southwestern Montana.* Pseudotsuga, Pinus contorta, *and* Picea *dominate the overstory of this 150- to 200-year-old stand; regeneration is mostly* Abies lasiocarpa. Arnica, Thalictrum, *and shrubby skirts of* Abies lasiocarpa *form the undergrowth.*

Vegetation.--Although *Abies lasiocarpa* is the apparent climax dominant, all but the oldest stands are dominated by *Pseudotsuga* or *Pinus contorta*. *Pinus contorta* is scarce in this habitat type in the Little Belts, where the stands are mostly on limestone. Conversely, *Picea* is a prominent seral component of most stands on limestone, but is less common elsewhere.

The forest canopy is dense and undergrowth is correspondingly rather sparse, consisting mostly of *Arnica cordifolia, Thalictrum occidentale, Osmorhiza chilensis, Pyrola secunda,* and small amounts of several other forb species. *Vaccinium scoparium* and *V. globulare* do poorly on calcareous substrates such as those characterizing the *ABLA/ARCO* h.t. in the Little Belts; but this does not explain their absence in the *ABLA/ARCO* h.t. in the Beaverhead National Forest on noncalcareous parent materials.

Soil.--Soils in the *ABLA/ARCO* h.t. were derived from a broad variety of parent materials (appendix D-1). Surface soils were acidic, mostly nongravelly loams to silty clay loams. Ground surfaces had little bare soil and rock exposed; duff depth averaged 3.9 cm.

Productivity/Management.--Timber productivity is moderate (appendix E-4). Old-growth individuals of *Pseudotsuga* may attain maximum diameters of 3 feet and heights of 90 to 95 feet. Sod-forming grasses are usually scarce and tree regeneration after logging is not retarded by a flush of undergrowth vegetation in most cases. Watershed values are relatively high. Forest stands received light use by deer, elk, and cattle, but forage production for big game and domestic livestock is very low.

Other studies.--*ABLA/ARCO* h.t. has also been described by Hoffman and Alexander (1976) in Wyoming and by Robert Steele and others (1975 preliminary draft, USDA Forest Service, Intermountain Station) in east-central Idaho. Several stands apparently similar to this habitat type were sampled by Cooper (1975) in northwestern Wyoming (in his *Abies lasiocarpa/Thalictrum* h.t., *Arnica cordifolia* phase).

Abies lasiocarpa/Carex geyeri h.t.
(*ABLA/CAGE*; subalpine fir/elk sedge)

Distribution.--*ABLA/CAGE* is a minor habitat type in Montana that encompasses some of the driest sites in the *Abies lasiocarpa* series. It is apparently transitional to *PSME/CAGE* on still drier sites and to *ABLA/CARU* on slightly more moist sites. Sample stands were on southerly aspects between 6,600 and 7,700 feet elevation in the Gallatin National Forest (fig. 40) and from 6,700 to 7,100 feet in the Little Belt and Big Belt Mountains of central Montana.

Vegetation.--*Abies lasiocarpa* is the indicated climax. *Pseudotsuga* is the major, persistent seral dominant in the *PSME* phase, while *Pinus contorta* is usually the dominant seral tree in the *CAGE* phase. *Picea* is absent or at most widely scattered throughout the habitat type.

Undergrowth is dominated by *Carex geyeri; Calamagrostis rubescens* is poorly represented. Other characteristics of the undergrowth vary by phase of the habitat type.

Figure 40.--Abies lasiocarpa/Carex geyeri *h.t.* (Pseudotsuga *phase) on a moderate northeastern exposure (7,250 feet elev.) south of Big Timber in south-central Montana.* Pseudotsuga *dominates the overstory, but* Abies lasiocarpa *makes up most of the regeneration.* Carex geyeri *and* Thalictrum *dominate the luxuriant undergrowth.*

Carex geyeri (CAGE) phase.--This phase represents the coldest conditions within the habitat type. Only three stands were sampled, two of them occupying limestone substrates atop broad ridges near 7,000 feet in the Castle and Little Belt Mountains. The other stand was found at 8,500 feet on noncalcareous rock in the Madison Range. *Abies lasiocarpa* and *Pinus contorta* were the only major tree components. Undergrowth was an almost pure *Carex geyeri* with low coverages of scattered forbs. *ABLA/VASC* was found on adjacent, more moist sites, and the *PSME* phase or the *ABLA/CARU* h.t. on warmer (lower-elevation) slopes.

Pseudotsuga menziesii (PSME) phase.--This is the warmer (lower elevation) phase of the type and it appears to be more common than the *CAGE* phase. It is transitional to the *ABLA/CARU* h.t. on more moist sites. Stands are dominated by *Pseudotsuga* as in *ABLA/CARU* but *Pinus contorta* and *Picea* are largely absent, reflecting the drier conditions. As in *ABLA/CARU*, the undergrowth is rich in forbs such as *Thalictrum occidentale*, *Osmorhiza chilensis*, *Smilacina racemosa*, and *Arnica cordifolia* or *A. latifolia*; however, *Calamagrostis rubescens* is poorly represented.

Soil.--Our stands were on a variety of parent materials (appendix D-1). Surface soils were primarily nongravelly loams to silts with reactions ranging from very acidic to slightly basic (on limestone). Ground surfaces had little rock or bare soil exposed; duff depth averaged greater than 5 cm.

Productivity/Management.--Timber productivity is low to moderate (appendix E-4). Choice of species is limited and varies by phase (appendix B); regeneration may be difficult to obtain because of the cold, dry conditions and perhaps the competition from *Carex geyeri* and associated species. Moderate summer use by deer and elk was evident in sample stands. Cattle use appeared to be limited to bedding in stands adjacent to meadows. Maintaining vegetative cover to prevent erosion may be especially important on these sites.

Other studies.--It appears that four of Cooper's (1975) stands in his *Abies lasiocarpa/Thalictrum* h.t., *Thalictrum* phase (from northwestern Wyoming) are comparable to our *PSME* phase. Some of Robert Steele and others (1975 preliminary draft, USDA Forest Service, Intermountain Station) *ABLA/CAGE* h.t. stands (from central Idaho) are also similar to this phase. Robert Steele and others (1975) have described a *ABLA/CAGE* h.t., *CAGE* phase similar to ours in central Idaho. Also, our *CAGE* phase is similar in most respects to Cooper's (1975) *ABLA/CAGE* in the northwestern Wyoming vicinity. Wirsing (1973) also described *Abies lasiocarpa/Carex geyeri* h.t. in southern Wyoming.

UPPER SUBALPINE HABITAT TYPES

Abies lasiocarpa/Ribes montigenum h.t.
(*ABLA/RIMO*; subalpine fir/mountain gooseberry)

Distribution.--*ABLA/RIMO* is a minor habitat type found in upper subalpine areas near the southern boundary of Montana. The six stands sampled were found at 8,300 to 8,500 feet in the Pryor Mountains, at 8,300 to 9,000 feet in the Centennial Mountains, and at 8,900 feet in the southern Gravelly Range. All stands were on plateau-like sites or cool exposures above the limits of *Pseudotsuga* and apparently unfavorable for *Pinus contorta* (which was absent).

Vegetation.--Stands in the Pryor Mountains are jointly dominated by *Abies lasiocarpa* and apparent *Picea engelmannii* X *glauca* hybrids. *ABLA/RIMO* groves alternate with *Festuca idahoensis* grasslands which occupy more exposed sites where less snow accumulates. Stands in the Centennial and Gravelly Ranges were dominated by *Abies* and *Pinus albicaulis*, with lesser amounts of *Picea engelmannii*. They were bordered by the *ABLA/ARCO* h.t. at lower elevations and by *Festuca idahoensis*-dominated grasslands on drier exposures. Undergrowth was sparse in all stands, consisting of small, scattered clumps of *Ribes montigenum* and a few forbs such as *Arnica* spp.

Soil.--Soils were derived from a variety of parent materials (appendix D-1). Surface soils were very acidic nongravelly silts. Ground surfaces had little rock or bare soil exposed, and had deep duff (average 7.5 cm).

Productivity/Management.--Timber productivity is apparently low, based on limited data (appendix E-4). Forage production is very low, but deer, elk, and domestic livestock evidently use sites adjacent to mountain parks for resting and bedding.

Other studies.--Robert Steele and others (1975 preliminary draft, USDA Forest Service, Intermountain Station) described this habitat type in central and southern Idaho, where it is dominated by *Pinus albicaulis* and *Abies lasiocarpa*. Pfister (1972a) described a similar habitat type in Utah beyond the range limits of *Pinus albicaulis* that is dominated by *Picea engelmannii* and *Abies lasiocarpa*.

Abies lasiocarpa-Pinus albicaulis/Vaccinium scoparium h.t.
(*ABLA-PIAL/VASC*; subalpine fir-whitebark pine/grouse whortleberry)

Distribution.--This very extensive habitat type constitutes most of the highest elevation forest belt in Montana east of the Continental Divide in all but the driest mountain ranges. It can generally be considered to be the east-side replacement for the *ABLA/LUHI* h.t. It is found on all exposures at elevations ranging from about 7,200 to 8,100 feet in central Montana, 8,000 to 8,800 feet in southwestern Montana, and 8,100 to 9,000 feet in south-central Montana (fig. 41).

Figure 41.--Abies lasiocarpa-Pinus albicaulis/Vaccinium scoparium *h.t. on a northeast exposure (8,400 feet elev.) near Red Lodge in south-central Montana.* Pinus albicaulis *(up to 500 years of age) and* Picea engelmannii *dominate the overstory.* Abies lasiocarpa *regeneration is extensive, but this species does not grow as tall as* Pinus *or* Picea. *Undergrowth is almost entirely* Vaccinium scoparium.

ABLA-PIAL/VASC is usually bordered below by *ABLA/VASC,* but sometimes by *ABLA/XETE* or *ABLA/VAGL.* Drier sites may support subalpine grasslands or the *PIAL* h.t.s. Wetter sites support meadows or the *ABLA/CACA* h.t. It is bounded above by the *PIAL-ABLA* h.t.s.

Vegetation.--*Abies lasiocarpa* is the indicated climax dominant, but stands are also characterized by *Pinus albicaulis,* which is a long-lived, seral dominant approaching a "persistent" status on disturbed dry sites. *Picea engelmannii* is often a dominant, long-lived member of stands on moist sites. *Pinus contorta* is a major seral species at lower elevations.

Undergrowth in most stands is dominated by *Vaccinium scoparium,* although on drier sites or limestone substrates it sometimes gives way to *Carex geyeri. Xerophyllum* is often a codominant in moist stands near the Continental Divide. In some areas *Hieracium gracile* is largely restricted to this and higher habitat types. In such areas it may be useful as an indicator plant, but it does extend to somewhat lower elevations as an invader on roadsides, skid trails, etc. *Arnica latifolia* is the only other relatively consistent component of the undergrowth. *Phyllodoce* and *Ledum* often occur on moist sites. Like other upper subalpine types, *ABLA-PIAL/VASC* is characterized by a scarcity of the species that are so widely distributed in the forests below--e.g., *Spiraea betulifolia, Arctostaphylos uva-ursi, Calamagrostis rubescens, Berberis repens,* and *Pseudotsuga menziesii.*

Soil/Climate.--Soils in the *ABLA-PIAL/VASC* h.t. were derived from a wide variety of parent materials (appendix D-1). Surface soils were mainly gravelly loams to silts with acidic to very acidic reactions. Ground surfaces had moderate amounts of bare soil and rock exposed; duff depths averaged 4.4 cm.

This habitat type has a climate similar to that of *ABLA/LUHI,* except it is somewhat drier. Mean annual precipitation ranges from 25 to about 45 inches.

Productivity/Management.--Timber productivity is low (appendix E). Regenerating drier sites and those at higher elevations within the type will probably be difficult. Succession on disturbed sites will be slow and vegetation will be dominated by the same species found in old-growth stands. Managers should recognize the relatively high water yields and the importance of minimizing site disturbance because of slow vegetational recovery.

This type and adjacent meadows provide much of the summer range for elk, moose, mule deer, grizzly bears, and black bears in central and southern Montana.

Other studies.--Cooper (1975) described similar stands in his *ABLA/VASC* h.t., *Pinus albicaulis* phase. Robert Steele and others (1975 preliminary draft, USDA Forest Service, Intermountain Station) also had some similar stands in the upper part of their *ABLA/VASC* h.t. in central Idaho.

Abies lasiocarpa/Luzula hitchcockii h.t. (*ABLA/LUHI*; subalpine fir/wood-rush)

Distribution.--*ABLA/LUHI* is the major upper subalpine forest habitat type from the Continental Divide westward in Montana. It forms a zone extending over about 700 feet in elevation between the *ABLA/XETE* or *ABLA/MEFE* h.t.s below, and the *PIAL-ABLA* or *LALY-ABLA* h.t.s above (table 6).

At its eastern limits, *ABLA/LUHI* covers high-elevation terrain contiguous with the Continental Divide from Glacier National Park south to Lewis and Clark Pass (northeast of Lincoln); it continues southward in the Flint Creek and Anaconda-Pintlar Ranges and in the Beaverhead Range almost to Lemhi Pass, west of Dillon. Farther east its counterpart *ABLA-PIAL/VASC* occupies a similar elevational zone, sometimes occurring adjacent to *ABLA/LUHI* on dry sites in west-central Montana.

Table 6.--*Distribution of* ABLA/LUHI *h.t. and* TSME/LUHI *h.t. sample stands by phase*

Geographic vicinity	VASC phase: Elevation range	VASC phase: Exposure	MEFE phase: Elevation range	MEFE phase: Exposure
	Feet		*Feet*	
Northern Idaho[1]	6,000-6,500	S-SE	5,750-6,500	W, N, E
Northwestern Montana	6,000-7,000	S-W	6,000-6,800	N-E
West-central Montana (and Sun River drainage)	7,100-8,400	All	6,800-7,600	N-E
Southwestern Montana	8,000-8,900	All	None	None

[1] From data in R. and J. Daubenmire (1968); ABLA/ or TSME/LUHI h.t., VASC phase stands--57 (Alberta), 127, 97, 128, and 61. ABLA/ or TSME/LUHI h.t., MEFE phase stands--58 (Alberta), 131, 135, 133, 46, 99, and 158.

Vegetation.--*Abies lasiocarpa* is the indicated climax. *Pinus albicaulis, Picea engelmannii,* and *Pinus contorta* are the principal seral species, although their relative importance varies by phase. Sites are above the limits of *Pseudotsuga, Larix occidentalis,* and *Pinus monticola.*

Luzula hitchcockii is present and usually well distributed throughout the stand; it is not confined to unusual microsites or disturbed areas. Some stands particularly near the eastern limits of the habitat type, have no *Luzula.* Nevertheless, they are assigned to the *MEFE* phase of this habitat type through use of the key (fig. 7) because *Pinus albicaulis* is well represented. Other major undergrowth species are *Vaccinium scoparium, Xerophyllum,* and *Arnica latifolia.*

Vaccinium scoparium (VASC) phase.--This phase is largely restricted to dry exposures (table 6) in northwestern Montana and northern Idaho. In west-central Montana and central Idaho (Robert Steele and others, 1975 preliminary draft, USDA Forest Service, Intermountain Station), however, it becomes more common, often occupying moist exposures.

Pinus albicaulis, a long-lived seral species, was present in all sample stands. *Picea engelmannii* is normally present, but is abundant only on especially moist sites. In west-central Montana *Pinus contorta* is a major component of seral stands near the lower limits of the phase.

Undergrowth is dominated by *Vaccinium scoparium, Xerophyllum tenax,* and *Arnica latifolia,* sometimes along with *Vaccinium globulare* or *Carex geyeri* on warm exposures. *Phyllodoce empetriformis* is often well represented on moist sites, and occasionally it forms the dominant undergrowth over broad areas on northerly exposures.

Menziesia ferruginea (MEFE) phase.--This phase is generally restricted to northerly exposures, and is most abundant in northwestern Montana (table 6). *Abies lasiocarpa* is a major component of most stands. *Picea engelmannii* is a long-lived, seral component in most stands, but is a major component only on the more moist sites--those having small coverages of species typically associated with the *ABLA/CACA* h.t., such as *Calamagrostis canadensis, Ledum glandulosum, Senecio triangularis, Dodecatheon jeffreyi, Veratrum viride,* or *Ligusticum canbyi.* Generally *Pinus albicaulis* is a minor stand component, while *Pinus contorta* is scarce. On sites having some soil development, *Larix lyallii* occasionally extends downward as a minor seral species; however, on sites consisting of coarse talus surrounded by this phase, *Larix lyallii* often forms pure groves, representing an edaphic climax. This situation has not been recognized as a separate habitat type because of the limited area involved.

Menziesia ferruginea, and occasionally *Rhododendron albiflorum*, dominate an undergrowth similar in other respects to that of the *VASC* phase.

Soil/Climate.--Soils in the *ABLA/LUHI* h.t. were derived from a variety of noncalcareous parent materials (appendix D-1). Surface soils were very acidic, gravelly loams to silts. Ground surfaces had little rock or bare soil exposed; duff depths averaged about 4.5 cm.

The climate is characterized by short, cool summers (mean July temperatures 55° to 59° F) with only a 2- to 3-month growing season. Snowfall and snow accumulations surpass those of most other habitat types in the northern Rockies. Snow covers the ground continuously from November 1 through June 15 in most years. Mean annual precipitation is 35 to 60 inches in Montana stands. Summer drought is less common here than in many other habitat types, but severe windstorms and blizzards limit height growth and damage trees on all but the most sheltered sites.

Productivity/Management.--Timber productivity is generally low, although a few moist sites in the *MEFE* phase show moderate productivity (appendix E-3). Stands of large *Picea* sometimes develop in basins and on sheltered slopes. Because the more productive sites are often associated with wet soils, logging road construction may present problems. Clearcutting may make regeneration of *Picea* difficult in these severe environments (Pfister 1972b), and create excessive ground water. Partial cuttings are likely to incur heavy blowdown losses, as in high-elevation *Picea* stands in Colorado (Alexander 1973). The generally low productivity and problems associated with management for timber production suggest minimal development on these sites, at least until successful methods are developed and proven.

Light summer use by mule deer, elk, and bear was observed. Domestic stock use and potential use is very low. This habitat type is a major source for summer streamflow in much of western Montana. Watershed protection and enhancement, as well as maintenance of esthetic values for "high-county" recreational pursuits are of primary management importance.

Other studies.--Although R. and J. Daubenmire (1968) did not recognize this habitat type, their data indicate that 12 of their highest elevation *ABLA/XETE* and *ABLA/MEFE* stands would fit in *ABLA/LUHI* or *TSME/LUHI* h.t.s (table 6). These data and other observations suggest that *ABLA/LUHI* is probably well developed in parts of northern Idaho. Also, it has been described in central Idaho and in the Nezperce National Forest by Robert Steele and others (1975 and 1976 preliminary drafts, USDA Forest Service, Intermountain Station). In south-central British Columbia, McLean (1970) described an *Abies lasiocarpa/Vaccinium scoparium* h.t., *Phyllodoce empetriformis* phase that contains *Luzula* and is apparently similar to our *ABLA/LUHI* h.t., *VASC* phase.

Tsuga mertensiana/Luzula hitchcockii h.t.
(*TSME/LUHI*; mountain hemlock/wood-rush)

Distribution.--This habitat type is found along and adjacent to the Montana-Idaho Divide from Lolo Pass to the Cabinet Gorge between about 6,000 and 6,500 feet in elevation. Although it covers only a small area in Montana, it is evidently much more extensive immediately to the west in northern Idaho. More than half of R. and J. Daubenmire's stands that have *Luzula* spp. (apparently *Luzula hitchcockii*) have *Tsuga mertensiana* as a climax dominant; thus, these stands are comparable to our *TSME/LUHI* h.t.

Vegetation.--This habitat type has vegetation similar to the *ABLA/LUHI* h.t. except for the addition of *Tsuga mertensiana* as a major climax component. *Tsuga* is apparently the sole climax dominant in some stands, but forms a coclimax with *Abies lasiocarpa* in others. Most of R. and J. Daubenmire's apparent *TSME/LUHI* sample stands had only minor amounts of tree species other than *Tsuga* and *Abies*.

Vaccinium scoparium (VASC) phase.--This phase is associated with exposed ridgetops and southerly exposures. Undergrowth is dominated by *Xerophyllum tenax* and *Vaccinium scoparium.* It is generally comparable to the *ABLA/LUHI* h.t., *VASC* phase (table 6).

Menziesia ferruginea (MEFE) phase.--This phase is associated with sheltered slopes and cool aspects. It is generally comparable to the *ABLA/LUHI* h.t., *MEFE* phase (table 6).

Soil/Climate.--Soils appear similar to those described for the *ABLA/LUHI* h.t. (appendix D-1).

The type occupies the most maritime of the high subalpine environments in the Northern Rockies. Annual precipitation, snowfall, and cloudiness tend to be greater than in the *ABLA/LUHI* h.t.

Productivity/Management.--This is similar to the *ABLA/LUHI* h.t., based on limited data.

Other studies.--*TSME/LUHI* h.t. has not been described in other studies. Comparable stands from northern Idaho were classified under the *TSME/XETE* and *TSME/MEFE* h.t.s by R. and J. Daubenmire (1968).

TIMBERLINE HABITAT TYPES

A general discussion of characteristics and management implications common to all of the timberline habitat types is presented on pages 79-81.

Pinus albicaulis-Abies lasiocarpa h.t.s
(*PIAL-ABLA*; whitebark pine-subalpine fir)

Distribution.--*PIAL-ABLA* h.t.s. include most timberline sites in Montana and the Northern Rockies. Our *PIAL-ABLA* h.t.s. category and the other timberline habitat types encompass more variation in vegetational composition and tree life-forms than the forest habitat types found at lower elevations. However, there seems to be little need at this time to subdivide the complex undergrowth.

Vegetation.--*Pinus albicaulis, Abies lasiocarpa,* and *Picea engelmannii* occur in varying amounts. *Abies lasiocarpa* is generally not vigorous in these types; it is often stunted, wind-deformed, and shrublike (fig. 42). Saplings grow slowly, and on many sites this species reproduces largely through layering of lower branches. The superior hardiness of *Pinus albicaulis* and *Picea* allows them to coexist with the more shade-tolerant *Abies* at timberline. Often *Abies* is capable of achieving tree size only in the lee of the protective canopy of a large *Pinus* or *Picea*.

Undergrowth is quite variable, but *Vaccinium scoparium, Arnica latifolia,* and *Hieracium gracile* are present in most stands. *Luzula hitchcockii* and *Xerophyllum* are also prevalent in stands west of the Continental Divide. Mountain heath--*Phyllodoce empetriformis, P. glanduliflora,* and *Cassiope mertensiana*--is common in these habitat types on moist sites, especially west of the Continental Divide. On dry sites, especially east of the Continental Divide, the undergrowth is often dominated by *Juncus parryi, Carex rossii, Festuca idahoensis (F. ovina),* or *Arenaria congesta*.

Soil.--Soils in our sample stands were derived primarily from sandstone and argillite parent materials (appendix D-1). Surface soils were acidic to very acidic, gravelly loams to silts. Ground surfaces averaged 13 percent rock and 6 percent bare soil exposed; duff depth averaged only 2.8 cm.

Figure 42.--A Pinus albicaulis-Abies lasiocarpa *h.t. on an east exposure (8,000 feet elev.) on limestone substrate west of Augusta in central Montana.* Pinus albicaulis *and scattered* Picea *form the overstory; layered saplings of* Abies lasiocarpa *dominate the regeneration layer, but maximum height attained by this species is only 20 feet. Undergrowth is primarily* Vaccinium scoparium.

Other studies.--A *Pinus albicaulis-Abies lasiocarpa* association in eastern Washington and northern Idaho was described briefly by R. and J. Daubenmire (1968) as being confined to small areas atop the highest ridges and peaks, where it forms a belt of severely stunted "wind timber." By contrast, the *PIAL-ABLA* h.t.s are much better developed in Montana, and at least 25 mountain ranges support alpine tundra above timberline. Robert Steele and others (1975 preliminary draft, USDA Forest Service, Intermountain Station) have described *PIAL-ABLA* h.t.s similar to ours in central Idaho, except that *Picea* is generally absent.

Larix lyallii-Abies lasiocarpa h.t.s
(*LALY-ABLA*; alpine larch-subalpine fir)

Distribution.--*LALY-ABLA* h.t.s are prevalent on cool exposures in many timberline areas west of the Continental Divide in Montana. (*PIAL-ABLA* h.t.s usually occupy the adjacent warmer exposures.) *LALY-ABLA* h.t.s are best developed on granitic and quartzite substrates where there has been little if any soil development; they occur only on limited areas of finer sedimentary rock (i.e., argillites of the Belt Series), and apparently do not occur on limestone (Arno 1970). They are most extensive at the highest elevations of the Bitterroot, Anaconda-Pintlar, and Cabinet Ranges, but are also found atop the Whitefish, Swan, south Mission, Sapphire, and Flint Creek Ranges, as well as in scattered areas of Glacier National Park and the headwaters of the Teton and Sun Rivers (Arno and Habeck 1972).

Vegetation.--*Larix lyallii* is a long-lived dominant on these sites; it is accompanied by variable amounts of *Pinus albicaulis*, *Abies lasiocarpa*, and *Picea engelmannii*. At the highest elevations of the type, *Larix lyallii* often forms pure groves of erect trees on sites that are above the "tree limits" of the evergreen conifers (fig. 43). Undergrowth is usually dominated by combinations of *Phyllodoce empetriformis*, *Luzula hitchcockii*, *Vaccinium scoparium*, and severely stunted or shrublike *Abies lasiocarpa* (Arno and Habeck 1972).

Soil.--Soils were derived primarily from granite and quartzite parent materials, but occasionally from noncalcareous shale and argillite (Arno 1970). Surface soils were very gravelly loams usually ranging from 3.9 to 5.7 in pH. Ground surfaces had large amounts of rock but relatively little mineral soil exposed.

Other studies.--According to Arno and Habeck (1972) *Larix lyallii* is closely restricted to the outer fringe of the maritime mountain environments throughout its distribution in the northern United States and southern Canadian Rockies and along the eastern slope of the northern Cascades. Moreover, *Larix lyallii* has a nearly constant association with cool aspects and heavily glaciated acidic rocky sites at or near climatic timberline. A more detailed description of these sites is available in Arno and Habeck (1972).

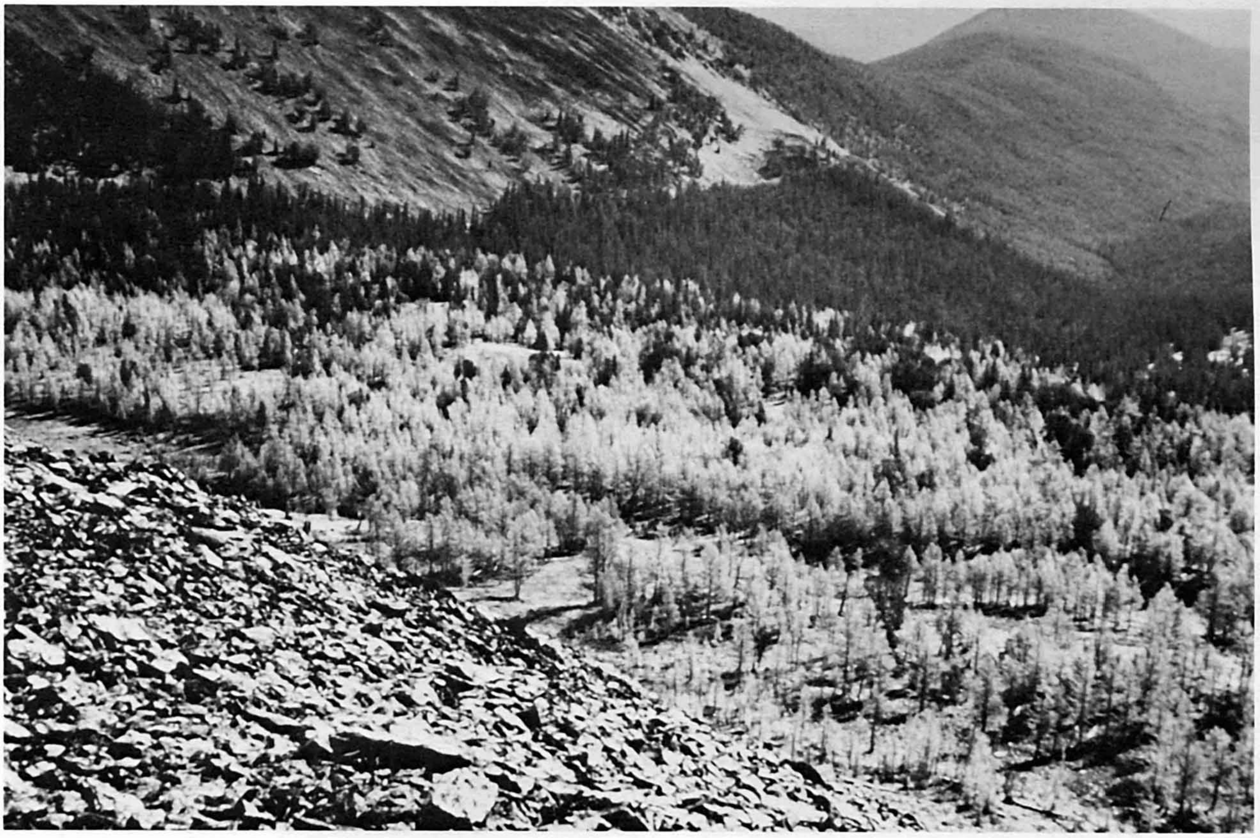


Figure 43.--A Larix lyallii-Abies lasiocarpa *h.t. at the head of a drainage (8,700 to 9,000 feet elev.) in the Anaconda-Pintlar Range north of Wisdom.* Larix lyallii *(turning color) and scattered* Pinus albicaulis *dominate, with stunted* Abies lasiocarpa *beneath them.* Vaccinium scoparium *and* Luzula hitchcockii *are the principal undergrowth plants.*

Pinus albicaulis h.t.s
(*PIAL*; whitebark pine)

Distribution.--*PIAL* h.t.s are rather common atop the drier mountain ranges east of the Continental Divide on sites apparently too dry for *Abies lasiocarpa* and near or above the cold limits of *Pseudotsuga* and *Pinus flexilis*. These types occur from the climatic timberline downward on exposed ridges and south slopes. Thus, they do not always represent cold timberline conditions, but sometimes occur where tree growth is limited by drought within the upper subalpine zone. Below that point, *Pseudotsuga* becomes the indicated climax (*Pseudotsuga* series), although *Pinus albicaulis* may remain well represented as a persistent seral species.

Vegetation.--*Pinus albicaulis* is the only tree species found in appreciable quantity in the *PIAL* h.t.s (fig. 44). Other timberline conifers apparently require more moisture.

Undergrowth is variable, ranging from essentially pure *Vaccinium scoparium* on the highest, least-droughty sites, to *Carex geyeri* (or occasionally *Juncus parryi*) on drier sites, and ultimately to *Festuca idahoensis* (*F. ovina*) and dry-site forbs on the most arid sites capable of supporting trees. Adjacent drier sites are occupied by subalpine grasslands, while more moist sites (e.g., northerly exposures or less windy exposures) usually support the *PIAL-ABLA* or *ABLA-PIAL/VASC* h.t.s.

Figure 44.--A Pinus albicaulis *h.t. on a steep southwest exposure (7,900 feet elev.) on limestone substrate in the Little Belt Mountains of central Montana. The stand is composed of many-aged* Pinus albicaulis *with widely scattered, stunted saplings of* Pseudotsuga *and* Abies lasiocarpa. *Undergrowth is an extensive mixture of dry-meadow forbs and grasses.*

Soil.--Our stands were on a variety of parent materials (appendix D-1). Surface soils were gravelly silt loams and silts ranging from slightly basic (on calcareous substrates) to slightly acidic. Ground surfaces had little rock or bare soil exposed; duff depths averaged only 2.7 cm.

Other studies.--Weaver and Dale (1974) described a *Pinus albicaulis/Vaccinium scoparium* association in central Montana which is similar to the coldest and least droughty of our *PIAL* h.t.s. In northwestern Wyoming, Cooper (1975) also described a *Pinus albicaulis/Vaccinium scoparium* h.t. in addition to a *Pinus albicaulis/Carex geyeri* h.t., *Pinus albicaulis* phase; both of these can be considered subdivisions of our *PIAL* h.t.s. However, none of these are similar to the *Festuca* and dry-forb dominated undergrowth situations we found in Montana. Reed (1976) designated a *Pinus albicaulis/ Vaccinium scoparium* h.t. in the Wind River Mountains of Wyoming. However, some of his stands did not contain *V. scoparium.* We have followed the method of Robert Steele and others (1975 preliminary draft, USDA Forest Service, Intermountain Station); they recognized *PIAL* h.t.s. in central Idaho and used the plural to denote their diversity, but did not formally subdivide the category.

Pinus contorta Series

Distribution.--This series consists of essentially pure stands of *Pinus contorta* in which there is insufficient evidence to indicate that other species constitute the potential climax. These stands occur on extensive areas in Montana, primarily at elevations of 5,000 to 7,500 feet east of the Continental Divide. They are typically located on well-drained upland sites with gentle topography. This series is similar environmentally to the colder part of the *Pseudotsuga* series, the drier part of the *Picea* series, and the warm, dry part of the *Abies lasiocarpa* series.

Vegetation.--The almost exclusive dominance of *Pinus contorta* may be due to these factors:

1. Historic, repeated wildfires over large areas may eliminate seed sources of potential shade-tolerant competitors.

2. Light ground fires may remove invading shade-tolerant competitors from the understory.

3. Dense stands may prevent regeneration of all conifers for up to 200 years in the absence of disturbance or stand deterioration.

4. Sites may be unfavorable for the establishment of other conifers. (In Montana, the best example of this situation is the *PICO/PUTR* h.t.)

Initially we selected 82 stands in which *Pinus contorta* was the nearly exclusive dominant. About half of these stands had enough other conifers *(Pseudotsuga, Picea,* and *Abies lasiocarpa)* to suggest eventual replacement of *Pinus contorta*; thus, they were also analyzed within that indicated series. After analyzing the 82 stands, we recognized 12 groups of communities. One group had definite evidence of climax potential for *Pinus contorta,* unique undergrowth, and unique environmental features; it was designated as the *PICO/PUTR* h.t. (fig. 45). Seven groups appeared to represent seral communities of other habitat types; these stands were removed from the *Pinus contorta* series and placed in their appropriate habitat types. The remaining four groups had undergrowth similar to that of habitat types in other series, but were defined as community types (c.t.) in the *Pinus contorta* series to indicate that *Pinus contorta* could possibly be the potential climax dominant (fig. 46). Another reason for recognizing these four groups as distinct community types was to facilitate field identification. Also, from a practical standpoint, it appears most reasonable to manage them as if *Pinus contorta* were the potential climax dominant.

Figure 45.--Pinus contorta/Purshia tridentata *h.t. on flat ground (6,600 feet elev.) at West Yellowstone, Montana.* Pinus contorta *is the only tree species and is regenerating successfully in undisturbed stands.* Purshia *is the dominant undergrowth plant.*

Figure 46.--Pinus contorta/Vaccinium scoparium *community type on a gentle southwest-facing slope (7,000 feet elev.) southwest of Helena.* Pinus contorta *is virtually the only tree species and is regenerating successfully; however, there is also widely scattered regeneration of* Abies lasiocarpa *and* Picea. Vaccinium scoparium *forms the principal undergrowth.*

In field identification it is important to remember that all *Pinus contorta*-dominated stands do not belong in this series. Stands with good representations of shade-tolerant competitors are clearly early successional stages and should be classified as habitat types in other series. Dense, stagnated, young stands may not allow regeneration of any species. By observing nearby seed sources and comparing these sites with similar sites supporting less dense stands, one can determine whether the stand represents a seral stage within another series or a possible *Pinus contorta* climax.

Soil/Climate.--Soils throughout the *Pinus contorta* series are derived from a wide variety of noncalcareous parent materials (appendix D-1). Surface soils range from acidic to very acidic, and are generally gravelly with a broad range of textures from coarse loamy sands to silts. Ground surfaces have small amounts of rock or bare soil exposed, and moderate duff accumulations. The only known weather station within the *Pinus contorta* series in Montana is West Yellowstone (appendix D-2).

Productivity/Management.--Timber productivity is low to moderate (appendix E). Based upon present evidence, *Pinus contorta* is the only tree species that can be managed successfully. Monoculture seems inevitable, but flexibility is available in silvicultural practices due to lack of competing conifers. Stands show evidence of light use (primarily spring to fall) by mule deer, elk, and occasionally moose. Water yield should be moderately high and subject to management by manipulation of vegetation. The gentle topography is well suited to many management activities; however, the esthetic appeal of these forests may be limited somewhat by their monotonous character.

Other studies.--Pfister and Daubenmire (1975) listed the current references to plant communities in the northwestern United States which refer to *Pinus contorta* as climax. The *Pinus contorta/Purshia tridentata* communities described by Youngberg and Dahms (1970) in Oregon appear similar to the *PICO/PUTR* h.t. of southern Montana. Additionally, the *Pinus contorta/Vaccinium uliginosum* community listed by Franklin and Dyrness (1973)--in which *Vaccinium caespitosum* is a characteristic species--may be related to our *Pinus contorta/Vaccinium caespitosum* community type. Moir (1969) also described a zone in Colorado where *Pinus contorta* is either climax or in a prolonged seral stage. Robert Steele and others (1975 preliminary draft, USDA Forest Service, Intermountain Station) described one *Pinus contorta* habitat type and several community types in central Idaho. Cooper (1975) described a *Pinus contorta* habitat type, as well as almost pure *Pinus contorta* stands within two other habitat types, in the northwest Wyoming vicinity. Hoffman and Alexander (1976) and Reed (1976) described a total of three *Pinus contorta* h.t.s in Wyoming.

Pinus contorta/Purshia tridentata h.t.
(*PICO/PUTR;* lodgepole pine/bitterbrush)

Distribution.--This habitat type has been observed only on obsidian-sand benchland of alluvial origin in the vicinity of West Yellowstone, Montana. It covers an area of perhaps 100 square miles at an elevation of approximately 6,600 feet.

At one point a rhyolite monolith (Horse Butte) rises about 300 feet in elevation from within this area; it supports an *ABLA/CARU* h.t. on northerly exposures, grassland on south exposures, and distinctive *Populus tremuloides-Picea* groves on the small area of flat terrain. Growth rates of *Abies lasiocarpa, Picea*, and *Pseudotsuga menziesii* are excellent on Horse Butte, but these species do not invade the adjacent obsidian-sand benchland. Because summer frosts are frequent at West Yellowstone (appendix D-2), these benchland sites are probably too frosty for *Pseudotsuga* and too dry (excessively well drained) for *Abies* and *Picea*.

Vegetation.--Stands are moderately open with numerous age classes (apparently all aged) of self-replacing *Pinus contorta*.

The undergrowth is sparse, with *Purshia tridentata* the most prominent plant. Scattered patches of *Arctostaphylos uva-ursi* are usually found; forbs include *Phlox multiflora, Antennaria microphylla, Lupinus* spp., and *Crepis acuminata;* graminoids include *Carex rossii, Sitanion hystrix, Danthonia intermedia, Poa nervosa,* and *Agropyron spicatum. Purshia* is locally scarce on recently burned land, but its seedlings usually reinvade within a few years.

Soil.--Soils in the *PICO/PUTR* h.t. were derived from obsidian-sand alluvial outwash. Surface soils are coarse sandy loams with acidic reactions. Ground surfaces had no bare soil or surface rock exposed; litter depth ranged from 2 to 5 cm. Cooper (1975) observed that the obsidian-sand outwash is often underlain by lake silts; he provides a more detailed description of soil characterisitcs for the same sampling area.

Productivity/Management.--Timber productivity is low (appendix E-4) because of low site indexes and stockability limitations. Cone serotiny (closed cones) averaged 40 percent in our three sample stands. In an earlier study, Lotan (1967) found 38 percent serotiny in the same area, compared with 58 percent serotiny in an adjacent upland stand on a different habitat type. The open cone habit aids development of all-aged stands, while cone serotiny insures stand replacement following an intense wildfire.

Stermitz and others (1974) studied the relationship of soil characteristics to *Pinus contorta* regeneration in the West Yellowstone area *(PICO/PUTR* h.t.). They found a strong positive correlation between seedling survival and amount of fine material (silt plus clay) in the soil.

In addition to being hampered by coarse (droughty) soils, regeneration may be retarded by frost damage, since natural regeneration was observed to be more successful in shaded than in cleared areas.

Mule deer and moose appear to use the type heavily, at least during summer.

Other studies.--Cooper (1975) sampled seven stands (compared with our three) in the West Yellowstone area, and provided a detailed description of this habitat type. Youngberg and Dahms (1970) described a very similar climax community type on well-drained pumice soils in frost pockets in central Oregon.

Pinus contorta/Vaccinium caespitosum community type
(PICO/VACA c.t.; lodgepole pine/dwarf huckleberry)

Distribution.--The *PICO/VACA* c.t. occurs mostly east of the Continental Divide on benches and gentle slopes. Stands were most commonly found on the Beaverhead and Lewis and Clark National Forests, between 6,200 and 7,200 feet in elevation. A few stands were sampled west of the Divide near Kalispell, Lincoln, and Philipsburg at 4,800 to 6,500 feet.

Vegetation.--Most stands showed evidence of possible succession to the *ABLA/VACA* h.t., which is also normally dominated by *Pinus contorta.* A few stands found on drier sites may be on a *PSME/VACA* h.t., and one stand located on coarse granitic sand in the Wise River drainage (Beaverhead National Forest) appeared to be *Pinus contorta* climax. The latter stand was apparently too frosty for *Pseudotsuga* and too dry for *Abies lasiocarpa* and *Picea.* (Note that seral stands dominated by *Pinus contorta*, but having an understory in which shade-tolerant conifers are well represented, are referred to as a successional stage of another habitat type.)

Vaccinium caespitosum is normally well represented and codominant with *Calamagrostis rubescens* in the undergrowth. *Vaccinium scoparium* and *Arctostaphylos uva-ursi* are often well represented and *Linnaea borealis* is often present on moist sites.

Soil.--Our stands were on a variety of noncalcareous parent materials (appendix D-1). Surface soils ranged from gravelly to nongravelly, from sandy loams to silts, and from very acidic to acidic. Ground surfaces had virtually no rock or mineral soil exposed; duff depths averaged 4.8 cm.

Productivity/Management.--Timber productivity is moderate (appendix E-4). *Pinus contorta* is the only species that can be managed with assurance of success. Planting of other conifers should be conducted only on an experimental basis. Other management implications are similar to those for the *ABLA/VACA* h.t. or the *PSME/VACA* h.t.s east of the Continental Divide.

Other studies.--Robert Steele and others (1975 preliminary draft, USDA Forest Service, Intermountain Station) also recognized this community type in central Idaho.

Pinus contorta/Linnaea borealis community type
(PICO/LIBO c.t.; lodgepole pine/twinflower)

Distribution.--*PICO/LIBO* c.t. is common near and east of the Continental Divide, mostly between elevations of 5,600 and 7,200 feet; it is infrequently found farther west. Sites are on benchlands or north-facing midslopes.

Vegetation.--Seven of our sample stands were possibly successional stages of the *ABLA/LIBO* h.t., *VASC* phase. Three stands might have been attributed to the *PICEA/LIBO* h.t. and one to the *PSME/LIBO* h.t. Six stands had no indication of climax other than *Pinus contorta.* (Note that seral stands dominated by *Pinus contorta*, but having an understory in which shade-tolerant conifers are well represented, are referred to as a successional stage of another habitat type.)

Undergrowth in the *PICO/LIBO* c.t. is dominated by various combinations of *Vaccinium globulare, V. scoparium,* and *Calamagrostis rubescens*, apparently reflecting the adjacent habitat types; however, *Linnaea borealis* is common throughout.

Soil.--Soils were derived from a variety of noncalcareous parent materials. Surface soils were acidic to very acidic sandy loams to silts. Gravel content averaged 21 percent. Ground surfaces had little surface rock and no bare soil exposed; duff depth averaged greater than 6 cm.

Productivity/Management.--Timber productivity is moderate (appendix E). *Pinus contorta* is the only species that can be managed with assurance of success. Planting of other conifers should be conducted only on an experimental basis. Deer, elk, and moose evidently use these areas lightly from spring to fall.

Other studies.--In central Idaho, Robert Steele and others (1975) found some *Pinus contorta*-dominated communities with *Linnaea* in the undergrowth, but they attributed these to their *ABLA/LIBO* h.t.

Pinus contorta/Vaccinium scoparium community type
(PICO/VASC c.t.; lodgepole pine/grouse whortleberry)

Distribution.--*PICO/VASC* c.t. occurs on relatively cold, dry sites on all exposures, mostly near and east of the Continental Divide. Most sample stands are found on gentle middle and upper slopes or broad ridgetops at 6,000 to 7,700 feet.

Vegetation.--Stands are typically even-aged and dominated almost exclusively by *Pinus contorta.* Some of the more open stands have *Pinus contorta* regeneration with widely scattered shade-tolerant conifers. Eight stands at higher elevations (mostly over 7,000 feet) were similar to the *ABLA/VASC* h.t., *VASC* phase, except for scarcity of *Abies lasiocarpa.* In the remaining 12 stands, at 5,800 to 7,100 feet, *Calamagrostis* *rubescens* and *Arctostaphylos* were common. Four of these were suggestive of *ABLA/VASC* h.t., *CARU* phase; four were indicative of a *Pseudotsuga* climax; and four were essentially pure *Pinus contorta*. The presence of limited amounts of *Pseudotsuga* does not preclude the possibility that the stands could also support *Picea* or *Abies* at climax. (Note that seral stands dominated by *Pinus contorta*, but having an understory in which shade-tolerant conifers are well represented, are referred to as a successional stage of another habitat type.)

Vaccinium scoparium is well represented and usually dominates the undergrowth. *Calamagrostis rubescens* and *Arctostaphylos uva-ursi* are common associates at lower elevations. *Carex geyeri* and *Arnica cordifolia* are often conspicuous.

Soil.--Soils were derived from a broad variety of noncalcareous parent materials (appendix D-1). Surface soils were gravelly sandy loams to silts with very acidic to acidic reactions. Ground surfaces had an average of 5 percent rock but little bare soil exposed; duff depth averaged 4.7 cm.

Productivity/Management.--Timber productivity is low to moderate (appendix E-4). *Pinus contorta* is the only species that can be managed with assurance of success. Planting of other conifers should be done only on an experimental basis. Mule deer, elk, and occasionally moose use the areas lightly during the summer. Other management implications should be comparable to those for the *VASC* and *CARU* phases of the *ABLA/VASC* h.t.

Other studies.--Robert Steele and others (1975 preliminary draft, USDA Forest Service, Intermountain Station) also recognized a *PICO/VASC* community type in central Idaho. However, Hoffman and Alexander (1976) designated a similar situation as a habitat type in Wyoming's Bighorn Mountains.

Pinus contorta/Calamagrostis rubescens community type (*PICO/CARU* c.t.; lodgepole pine/pinegrass)

Distribution.--*PICO/CARU* c.t. is found near and east of the Continental Divide at 5,900 to 6,800 feet on cool exposures and benches, and between 6,600 and 7,500 feet on south-facing slopes.

Vegetation.--An overstory of nearly pure *Pinus contorta* is combined with a grassy undergrowth of *Calamagrostis rubescens* and associates, often including *Carex geyeri* as well as *Arnica cordifolia* or various other forbs. The three sample stands at lowest elevation (5,900 to 6,500 feet) had *Arctostaphylos uva-ursi* or *Spiraea betulifolia* associated with *Calamagrostis*, and were suggestive of the *PSME/CARU* h.t., *CARU* phase. Stands at higher elevations (6,700 to 7,500 feet) had little evidence of the potential climax. (Note that seral stands dominated by *Pinus contorta*, but having an understory in which shade-tolerant conifers are well represented, are referred to as a successional stage of another habitat type.)

Soil.--Soils were derived primarily from igneous parent materials (appendix D-1). Surface soils were acidic sandy loams to silts with average gravel content of 22 percent. Ground surfaces had little rock or bare soil exposed; duff depths averaged 2.6 cm.

Productivity/Management.--Timber productivity is low to moderate (appendix E-4). *Pinus contorta* is the only species that can be managed with assurance of success. Planting of other conifers should be conducted only on an experimental basis. Other management implications should be similar to those for the *PSME/CARU* h.t., *CARU* phase, or the *ABLA/CARU* h.t.

Other studies.--Robert Steele and others (1975 preliminary draft, USDA Forest Service, Intermountain Station) described a similar community type for central Idaho.

Cooper (1975, p. 35) described pure *Pinus contorta* communities in the Ashton-Henry's Lake area of Idaho, which he attributed to the *PSME/CARU* h.t. We would have left the question of climax on those sites open by assigning them to a *PICO/CARU* c.t.

Other Vegetation Types

The current classification does not define habitat types for all tree-covered areas in the State. North-central and northeastern Montana were not sampled. (Dr. Lee Eddleman of the University of Montana Forestry School is directing a cooperative study of forest habitat types in north-central Montana to be completed in 1978). Also not sampled were a few forest-grassland transitions, and some sites where succession toward climax is frequently disrupted by flooding. These areas do represent unique sites for plant community development and habitat type classifications could be developed for them in future studies. For sites where physical disturbance is part of the natural environment, classification can be based on the types of relatively stable plant communities that occur. The following communities are recognizable, based upon limited sampling (i.e., SCREE), observations, and cited reports:

FORESTED SCREE COMMUNITIES (SCREE)

Slopes covered with rock fragments are variously referred to in the literature as talus, scree, or rock debris. We have chosen to use the broad sense of the term "scree"--that is, any slope covered with loose rock fragments (Fairbridge 1968). The term is derived from the Old Norse word "skritha" which literally means "landslide, or the rock that slides away under the foot" (Gary and others 1972). Many of these sites are treeless, but those with finer rock often support an open forest cover. Ecologically, such stands can be considered as topo-edaphic climaxes, where the vegetation reaches a quasi-equilibrium with the constantly shifting substrate.

Forest vegetation on scree appears as a scattered, open stand of trees with a sparse undergrowth (fig. 47). Differences in size of rock fragments and rates of movement cause heterogeneity in vegetation development on a given site, and normal succession is constantly interrupted. Thus, the species composition is extremely variable, with some of the common indicator species of other habitat types appearing unpredictably. Vegetation data from 16 sample stands are listed in appendix C.

Our preliminary western Montana classification (1972) identified a *Pinus ponderosa* or *Pseudotsuga*/"SCREE" h.t. Further observations statewide showed *Pinus flexilis* and *Abies lasiocarpa* also to be associated with scree. It would be possible to reflect the general climate by identifying forested scree sites as habitat types within a series. However, because of the dominant topo-edaphic influence and the variability involved, we prefer to group all these sites under the general heading of Forested Scree (abbreviation "SCREE"). In the key, SCREE is separated out first at the series level to prevent users of the classification from trying to force a habitat type name on these sites.

SCREE is most often found on steep (greater than 30 degrees), dry, south- to west-facing slopes; it occurs over a broad elevational range--5,000 to 6,700 feet in our few samples taken east of the Continental Divide, and 3,100 to 7,150 feet west of the Divide. It is most abundant along the canyons of major streams. SCREE sometimes occurs on northerly aspects and occasionally as high as the upper subalpine forest zone.

SCREE is characterized by steep, unstable slopes, lack of soil development, stockability limitations, low site productivity, and regeneration difficulty. Uses of these sites should be restricted to those which occur naturally, such as use by wildlife. Hazards are too high and opportunities too low to attempt intensive management.

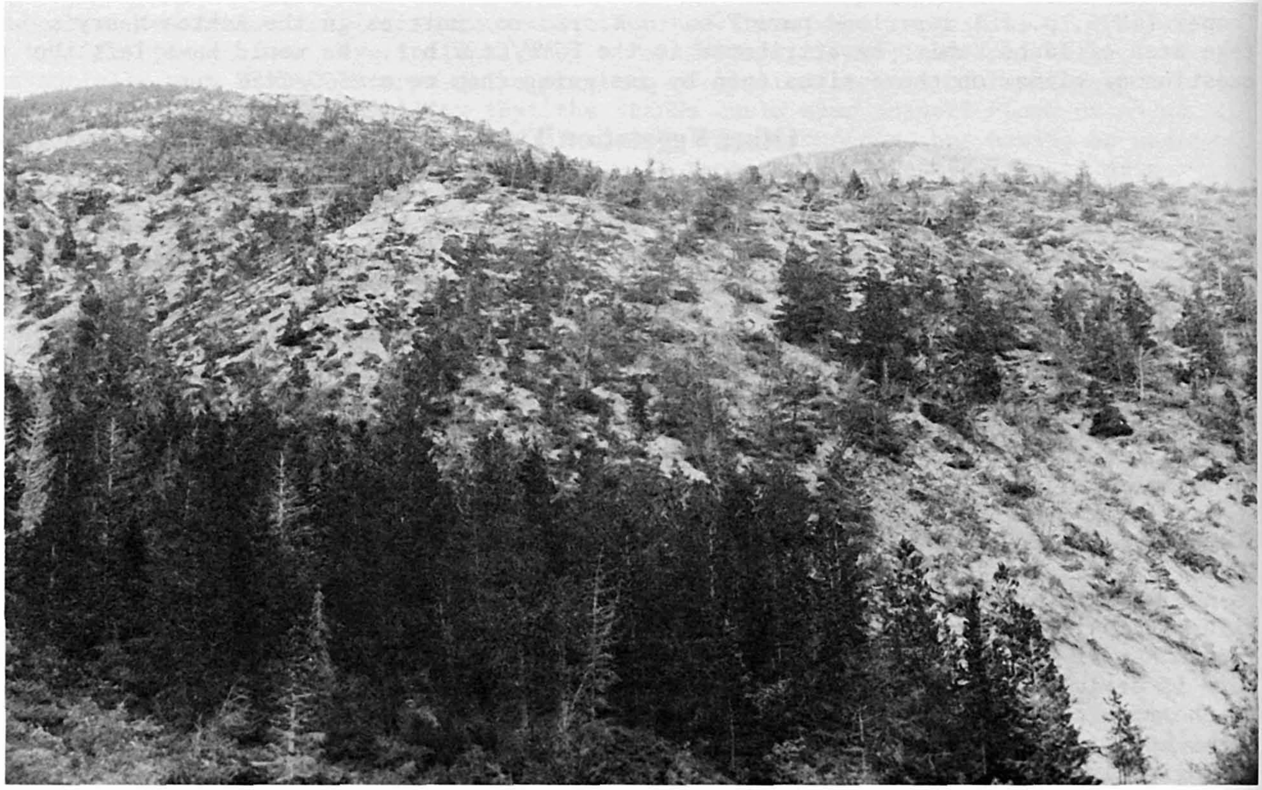


Figure 47.--Forested scree on a steep southwest exposure (5,800 feet elev.) southwest of Augusta in central Montana. Pinus flexilis *and* Pseudotsuga *are the principal tree species.* Arctostaphylos uva-ursi, Juniperus communis, Potentilla fruticosa, Prunus virginiana, Shepherdia canadensis, *and* Acer glabrum *are the common undergrowth plants.*

At high elevations, sites composed of large boulders are often treeless except for islands of stable vegetation attributable to specific habitat types--such as ABLA/*LUHI*, *ABLA/MEFE*, and *ABLA-PIAL/VASC*. Islands of a given habitat type thus may occur within a nonforested scree situation. The *LALY-ABLA* h.t.s occupy boulder-covered sites that are relatively stable.

BOTTOMLAND HARDWOOD FORESTS

These riparian forests are dominated by species of *Populus*, *Salix*, *Betula*, and *Alnus*, and by arborescent shrubs including *Cornus stolonifera*, *Sambucus coerulea*, *Sorbus scopulina*, *Acer glabrum*, *Crataegus* spp., and *Prunus* spp. They extend along rivers from the mountain forests far out into semiarid grasslands. Because of periodic destructive flooding, along with changes in stream channels and sedimentation, climax is rarely approached, even though conifers may be present with the hardwoods. Despite frequent disturbance, relatively stable plant communities develop and are identifiable. Analysis is complicated because these riparian forests are heavily grazed and otherwise disturbed by man's activities. Only a few undisturbed stands remain, usually on islands in the major rivers.

The following community types seem to exist, although stands were not sampled:

Populus trichocarpa-Pinus ponderosa Communities.--These are prevalent along the major alluvial valleys below about 4,000 feet elevation west of the Continental Divide, especially in west-central Montana. Foote (1965) sampled and described some of these stands.

Populus trichocarpa-Betula papyrifera Communities.--These occur at lower elevations (below about 3,500 feet) in relatively wet areas of northwestern Montana, such as the upper Flathead Valley. They often contain *Picea glauca X engelmannii,* and sometimes appear to be successional to *Picea* habitat types in the absence of severe flooding.

Populus trichocarpa Communities.--These are widespread at lower-to-middle elevations (below 6,000 feet), especially east of the Continental Divide in broad valleys isolated from the conifer forests or locally out of the range of *Pinus ponderosa*. The Jefferson, Gallatin, and Yellowstone River valleys support particularly extensive stands. In eastern Montana, comparable communities are dominated by the closely related *Populus deltoides*.

Salix-Betula occidentalis Communities.-- These occur in the high valleys near or east of the Continental Divide, mostly between 5,500 and 7,000 feet elevation. They are composed of small shrubby trees (10 to 20 feet tall) and are apparently associated with sites too cold for *Populus trichocarpa.* Examples include the Flint Creek and other headwater valleys of the Clark Fork River west of the Divide, and the Bighole, upper Madison, and other high valleys of southwestern Montana.

POPULUS TREMULOIDES STANDS

Populus tremuloides Climax Communities.--Pure stands of *Populus tremuloides* are found in the prairies immediately east of Glacier National Park. These self-perpetuating aspen stands are apparently the southward extension of the broad Canadian groveland found at the foot of the Rockies in Alberta and extending east across Alberta and Saskatchewan into southwestern Manitoba and adjacent Minnesota (Lynch 1955). Climax aspen stands apparently related to this groveland were noted in the current study as far south as Augusta (west of Great Falls). It is evident that the aspen groves have more soil moisture than the adjacent grassland (Lynch 1955). Conifers are at best marginally present in these situations and their reproduction may be prevented by abundant *Populus* and luxuriant undergrowth (Pfister 1972a). Small patches of climax aspen groveland may also occur to a limited extent farther south in Montana, near or east of the Continental Divide. Reed (1971), Wirsing (1973), and Hoffman and Alexander (1976) described three *Populus tremuloides* habitat types in Wyoming.

Populus tremuloides-Conifer Communities.--Most aspen groves in the Montana Rockies are quite small, and occur within or adjacent to conifer forest; they have apparently been perpetuated by periodic wildfires (Habeck 1970; Cooper 1975). With the current suppression of such fires, and especially where elk and other animals feed heavily on aspen, succession favoring *Abies lasiocarpa, Picea,* or *Pseudotsuga* is evident (Krebill 1972). Conifer regeneration is also apparent in many aspen stands, including those at the foot of the mountains on the eastern side of Glacier National Park (Habeck 1970). Presumably, stands with good representations of conifers should key to conifer habitat types. Cooper (1975) has also described *Populus tremuloides* stands in northwestern Wyoming where they are more extensive.

JUNIPERUS WOODLANDS

Stands of essentially pure *Juniperus scopulorum* cover small areas on rocky, dry sites in the higher valleys near the Continental Divide. We noted such stands in the vicinities of Drummond, Butte, Whitehall, and in the northern part of the Madison Range, but did not sample them. These coniferous woodlands, found well below the forest proper, are apparently a northern extension of the Great Basin "Pinyon/juniper" zone.

More commonly, *Juniperus scopulorum* is a minor associate with other conifers on low-elevation sites within the *Pinus flexilis, Pseudotsuga,* and *Pinus ponderosa* series.

SAVANNAS

Coniferous forest and mountain grassland are by far the two most extensive vegetational formations in the Montana Rockies. The boundary between them is usually well-defined. Mueggler and Handl (1974 preliminary draft, USDA Forest Service, Intermountain Station) have made a classification of grassland and shrubland habitat types in the Montana Rockies.

Our forest classification includes all stands having a potential of at least 25 percent forest canopy. Areas having 5 to 25 percent crown canopy coverage potential are termed savannas--grassland with scattered trees (Penfound 1967). Such areas are not extensive, but if encountered, they should be checked against both the grassland and forest classifications. (Neither study specifically sampled savannas.)

GREAT PLAINS FORESTS

Non-Rocky Mountain forests in eastern Montana were only marginally covered in this classification. Sampling was restricted to *Pinus ponderosa* forests in the Ashland and Roundup vicinities. Stands in the Missouri River Breaks northeast of Lewistown were not sampled, although Mackie (1970) described them. Isolated areas of mountain forests not sampled include the Bearpaw and Little Rocky Mountains, and the Sweetgrass Hills in north-central Montana, and the northern end of the Bighorn Range near the Wyoming line. Hoffman and Alexander (1976) should be useful in the latter area.

CHARACTERIZATON AND DISTRIBUTION OF HABITAT TYPES

Climate

Appendix D-2 shows key characteristics of the climate at stations representing various habitat types and phases. Most of the data are from U.S. Weather Service stations having 30-year normals or long-term records. The habitat type and phase shown for each of these stations is estimated to be the appropriate climatic climax. Often a reconnaissance plot was taken nearby.

Other climatic data representing specific forest habitat types in Montana may be available from Weather Service records or special studies made by various researchers. Even data taken at fire lookout sites may be useful if collected consistently and carefully for several summer seasons *and* if maximum and minimum thermometers or continuously recording hygrothermograph traces were used. Careful evaluation of the site is necessary to determine the appropriate climatic climax. For instance, climatic data from a site supporting an edaphic climax should be interpreted in relation to the nearest expression of a climatic climax, rather than the immediate edaphic climax.

Soils

Characteristics of the upper 10 cm of soil are summarized in appendix D-1 and as a paragraph in each habitat type description. Soil samples were first examined in the laboratory by an experienced soil scientist (Ronald McConnell, USDA Forest Service, retired) to determine structure, character of horizons, and textural class. Air-dry samples were then weighed, sieved (2 mm) to separate the gravel, and reweighed to determine percent gravel content. The soil separate was analyzed for wet color, dry color and pH, using the water-paste method with a 12-hour delay before reading with a glass electrode pH meter. The soil paste was then used to confirm the textural class designation. The gravel and larger coarse fragments were examined by geologists (Sigrid Asher-Moore and Cynthia Heliker, University of Montana, Missoula) to determine major parent materials.

Soil sampling and analyses were designed to obtain a simple characterization of surface soils for each habitat type, rather than detailed soil-vegetation relationships. Even our limited data make it evident that some habitat types are strongly controlled by edaphic or topo-edaphic factors and have a narrow range of soil characteristics; other habitat types occur on a broad range of soils.

One of the strongest influences of soil on vegetation in Montana is the presence of calcareous parent materials. The *PIPO/SYAL* h.t., *BERE* phase as well as the *PICEA/PHMA*, *PICEA/SEST*, *ABLA/CLPS*, and most of the *Pinus flexilis* h.t.s have a strong affinity for calcareous substrates. Dark-colored surface horizons were generally found in habitat types having either a grass-dominated undergrowth or calcareous substrates, although they were occasionally found in other habitat types as well.

Exposure of mineral soil and rock was greatest on the warm, dry habitat types of the *Pinus flexilis*, *Pinus ponderosa*, and *Pseudotsuga* series. Litter accumulation was lowest in these habitat types.

Several habitat types are associated with water tables close to the surface during part of the year (e.g., the *PICEA/EQAR*, *THPL/OPHO*, *ABLA/OPHO*, and *ABLA/CACA* h.t.s). Our samples indicate that these habitat types have less gravel, finer textures, lower pH, and deeper litter accumulation than adjacent upland sites; however, more complete soil descriptions would be necessary to adequately document these relationships.

A few research studies have documented soil characteristics by habitat type in the Northern Rockies. McMinn (1952) and Daubenmire (1968a) showed that soil moisture depletion rates differ substantially among habitat types, and this helped explain the differences in vegetation. Work is currently being conducted by the Soil Conservation Service (Harold Hunter, Bozeman) and the Bitterroot National Forest (B. John Losensky, Hamilton) to measure relationships between habitat types and soil temperatures.

It is often theorized that vegetation or habitat types can be predicted from soil characteristics. But R. and J. Daubenmire (1968) have emphasized that the correlation between habitat types and soil types (classified on the basis of standard soil profile characteristics) is too weak to allow prediction of habitat types from soil types, or vice versa. We subscribe to this viewpoint as a general rule for several reasons. First, the development of a soil profile reflects a long-term integration of soil forming factors, whereas vegetation development is much more sensitive to current climatic conditions. Second, soil classification systems are not designed to primarily reflect influences on vegetational development; therefore, predictive capabilities should not necessarily be expected. Third, vegetational development depends on many factors, of which soil characteristics is only one. According to the principle of factor interaction, species are able to grow on a wide range of substrates when other factors provide compensatory effects.

In summary, land managers should be cautious about attempting to "shortcut" inventories of either vegetative potentials or soils through the process of "assumed correlations." Some useful correlations undoubtedly exist; but they must be developed objectively, tested adequately, and extrapolated with caution.

Vegetation

OCCURRENCE OF SPECIES

Appendix B is an interpretation of tree species occurrence in habitat types and phases. This provides the basic information for selecting and managing tree species based on their environmental adaptation and successional role in specific habitats.

Appendix C-1 provides constancy and average coverage data for 93 "important" species (those with major occurrence or indicator significance) for each of the habitat types and phases. This table can be used (1) for gaining more insight into the structure of the classification than the key or the written type descriptions provide; (2) as a summary of composition in the relatively mature (70 years and older) sample stands; and (3) for evaluating the ecological amplitude and abundance of any species for the later successional stages of the entire classification.

Appendix C-2 provides a detailed presence list by habitat type. This includes all species that occurred in five or more of the approximately 1,500 sample stands.

How to use species occurrence data.--The following examples show how to use appendixes B, C-1, and C-2 to determine the distribution and relative importance of plants by habitat type. Keep in mind, however, that the potential application of these appendixes is much broader than shown in these introductory examples.

Question 1.--Is *Artemisia tridentata* found in the *Pseudotsuga menziesii/Festuca idahoensis* h.t., and if so, how abundant is it?

Data (from appendix C-1): *PSME/FEID* h.t.

19 stands

constancy ⟶ 6 (5) ⟵ average percent coverage

Answer: Constancy is about 60 percent (see code at bottom of appendix C-1). This means that 11 or 12 of the 19 sample stands had some *Artemisia tridentata*. The coverage value shows that *Artemisia* had an average canopy coverage of 5 percent in the stands where it occurred.

Question 2.--Is *Artemisia tridentata* a major undergrowth species in Montana forest stands?

Data: Appendix C-1 shows that *Artemisia tridentata* was found in 11 of the 100 habitat types and phases listed. However, only in 3 types and phases did it have a constancy of 50 percent or more:

PIFL/AGSP h.t.	*PIFL/FEID* h.t.	*PSME/FEID* h.t.
6 stands	7 stands	19 stands
5 (1)	6 (1)	6 (5)

Average canopy coverage by *Artemisia* is only 1 percent (even in those stands where it does occur) except in the *Pseudotsuga/Festuca idahoensis* h.t.

Answer: Evidently *Artemisia tridentata* is not a major undergrowth species in mature forest stands, with the limited exception of the *Pseudotsuga/Festuca idahoensis* h.t.

Question 3.--If you were given seedlings of *Acer glabrum* to plant for big game habitat purposes, which of the following habitat types would you choose for planting them in?

PIPO/FEID h.t., *FEID* phase
PSME/FESC h.t.
ABLA/VACA h.t.
PSME/PHMA h.t., *PHMA* phase
PSME/CAGE h.t.
THPL/CLUN h.t., *CLUN* phase

Data: This species is not shown in appendix C-1 (Constancy and Average Coverage); therefore, appendix C-2 (Presence List) will have to serve as the source of data. According to appendix C-2, *Acer glabrum* was absent in three of the habitat types--*PIPO/FEID, PSME/FESC,* and *ABLA/VACA*--and was present in only 1 out of the 10 stands in *PSME/CAGE* h.t. By contrast, it occurred in 18 of 45 stands in the *PSME/PHMA* h.t., *PHMA* phase, and in 10 of 15 stands in *THPL/CLUN* h.t., *CLUN* phase.

Answer: Thus, only *PSME/PHMA* and *THPL/CLUN* are logical choices.

Question 4.--Which tree species occur in the *PSME/CARU* h.t., *CARU* phase? What are their successional roles and how abundant are they?

Answer (provided by data from appendixes B and C-1):

PSME/CARU h.t., *CARU* phase

Species	*(Appendix B) Role*	*(Appendix C-1) Constancy (average coverage percent)*
Pinus ponderosa	a = accidental	2 (1)
Pseudotsuga menziesii	C = major climax	10 (60)
Pinus contorta	(S) = major seral in part of the phase	6 (20)
Larix occidentalis	(s) = minor seral in part of the phase	1 (11)
Abies lasiocarpa	a = accidental	1 (1)
Pinus albicaulis	a = accidental	1 (3)

TIMBER PRODUCTIVITY

Timber productivity is one of the key management implications for which data were collected during this study. Site trees were selected to determine the potential height growth of relatively free-growing trees. One site tree of each species was selected for each stand wherever possible. Site trees showing marked diameter-growth suppression for a period of 10 or more years were rejected during analysis of the increment cores. Old-growth and stagnated trees were not used for productivity estimation. Even though only a single site tree per species per stand was used, the data are reasonably consistent. Comparisons appear to be valid, and the sample size (794 stands) permits comparison of productivity among habitat types as well as within each habitat type.

Determination of site index from height-age data requires specific procedures for each tree species. The number of years to reach breast height (4.5 feet) must be measured or estimated for species having height-total age site curves. If a site curve is not available, a curve from another species must be selected as a substitute. Criteria used to determine total age, as well as sources of site index curves and yield capability data for this analysis, are summarized in table 7.

Table 7.--*Criteria and sources for determining site index and for estimating yield capability*

Species	Estimated years to obtain breast height	Source of site curve[1]	Yield capability (all trees - fig. 8)
PIPO	10	Lynch 1958	Brickell 1970
PSME	10	----------------Used PIPO curves----------------	
PICO	10 5-West side	Alexander 1966	Used LAOC curve[2]
LAOC	5	Schmidt and others 1976	Schmidt and others 1976[2]
PICEA	([3])	Alexander 1967	Alexander[4]
ABGR	([3])	Stage 1959	
ABLA	([3])	----------------Used PICEA curves----------------	
PIMO	5	Haig 1932	Brickell 1970
TSHE	10	Deitschman and Green 1965[5]	Used PIMO curve
THPL	([3])	----------------Used PICEA curves----------------	
TSME	([3])	----------------Used PICEA curves----------------	
LALY	([3])	----------------Used PICEA curves----------------	
PIAL	([3])	----------------Used PICEA curves----------------	
PIFL	([3])	----------------Used PICEA curves----------------	

[1] All site curves with a 100-year index age were converted to a 50-year index age.

[2] Brickell's (1970) curves for PICO and LAOC (trees larger than 5.0 inches) were nearly identical. A new curve (based on all trees) was developed for LAOC from yield data in Schmidt and others (1976). The LAOC curve for all trees appears to be as accurate as any available for estimating PICO yield capability for all trees.

[3] Curves based on age at breast height were used.

[4] Data used in a recent yield study (Alexander and others 1975) were provided by Alexander. Site index and mean annual increment from 21 fully-stocked natural stands were used to develop the curve shown in figure 8. (Yield capability = -26.0 + 1.84 Site Index (50); $R^2 = 0.66$).

[5] TSHE height and age were used to estimate PIMO site index.

We used *Pinus ponderosa* curves for determining *Pseudotsuga* site index rather than Brickell's (1968) *Pseudotsuga* curves, because the curve shapes for *Pinus ponderosa* are more realistic for our data (giving closer estimates for different aged site trees in the same stand). Furthermore, since *Pinus ponderosa* yield tables are currently used to estimate *Pseudotsuga* yields in the Northern Rocky Mountains, it is more logical to use *Pinus ponderosa* site index for estimating *Pseudotsuga* yields.

We used Alexander's (1967) *Picea engelmannii* curves for *Picea* rather than Brickell's (1966) because: (1) Alexander's are based on breast-height age (data available) rather than total age (estimate required); (2) the curve shapes are more realistic for our data (giving closer estimates for different aged site trees in the same stand); and (3) yield data related to the curves are available (Alexander and others 1975). We also used Alexander's (1967) *Picea engelmannii* curves for several other species that lack site-index curves; because they do not require breast-height age estimates. Thus a possible source of estimation error is eliminated.

The site-index data (base age 50 years) have been summarized by species within habitat types (appendix E-1). Because of regional differences in habitat-type occurrence as well as apparent regional differences in productivity for some habitat types, all timber productivity data were summarized separately for west-side and east-side forests. The mean site index was calculated whenever three or more values were available. With five or more values, a 95-percent confidence interval for estimation of the true population mean was calculated. (The confidence interval narrows with both decreased variability and increased sample size.) The same procedure was used for summarizing basal areas of sample stands.

The maximum heights observed in old-growth stands (>200 years) are presented in appendix E-2. These data can be used for simple comparisons and for identifying sites where height is severely limited.

Although site productivity can be compared by using site index alone, a more useful assessment can be made by using the estimated net yield capability of the site (cubic-foot production). Until managed-stand yield tables are completed, the best approach is to use natural-stand yield tables for assessing yield capability. As stated by Brickell (1970), "Yield capability, as used by Forest Survey, is defined as mean annual increment of growing stock attainable in fully stocked natural stands at the age of culmination of mean annual increment." (In other words, yield capability = maximum mean annual increment attainable in fully stocked natural stands. For additional explanation see Glossary, appendix G.)

The curves used to estimate yield capability from site index are presented in figure 48.

Yield capability values are based on cubic feet of all trees (>0.5 inch d.b.h.). The *Larix occidentalis* curve was derived from Schmidt and others (1976). (Brickell's 1970 curve for this species was only for trees greater than 5.0 inches in diameter.) The *Larix* curve was also used for *Pinus contorta* because Brickell's (1970) curves (trees >5.0 inches) are almost identical for the two species, and because natural stand yield data have not been published for *Pinus contorta*.

The *Picea* curve was derived from original data used in developing managed-stand yield tables (Alexander and others 1975). We calculated mean annual increment for all trees for 21 of Alexander's fully stocked natural stands near the age of culmination of mean annual increment (ages from 97 to 165 years). A linear regression of yield capability on Alexander's (1967) site index was conducted, converted to site index at base-age 50, and plotted in figure 48. [Yield Capability = -26.0 + (1.84 X 50-year site index.) $R^2 = 0.66$]. The other curves were developed by Brickell (1970) from natural-stand yield tables.

The spread in these curves indicates that natural-stand yield capability for a given site index is considerably higher in *Abies grandis*- and *Pinus monticola*-dominated stands than for other species. This illustrates the importance of using species-specific curves for estimating productivity.

Our best current estimates of yield capability (in cubic feet/acre/year) for each habitat type are shown in appendix E-3 (west-side) and E-4 (east-side). Procedures used to develop these estimates were:

1. Yield capability was estimated for each site tree from appropriate species curves according to the criteria in table 7. These values were plotted by species within habitat types and phases for a visual display of distribution.

2. Mean yield capability for all site trees in each habitat type was calculated and cutoff points were established to approximate 90 percent of the range of our data.

3. For habitat types where stockability appears to limit productivity, a stockability factor was developed. Basal area data for plots in these types were compared with Meyer's (1938) basal area data for fully stocked "normal" stands, following the approach of MacLean and Bolsinger (1973). From these calculations and additional observations, an average mean stockability factor was determined for several habitat types. This factor was multiplied by yield capability for a given site index to determine the adjusted yield capability. A factor of ±0.10 was used to expand the estimated range of productivity.

These current best estimates (appendixes E-3 and E-4) portray both relative productivity of habitat types and the range of productivity within a habitat type. From these, it is possible to assign a ranking or qualitative rating of potential timber productivity of natural stands for use in planning.

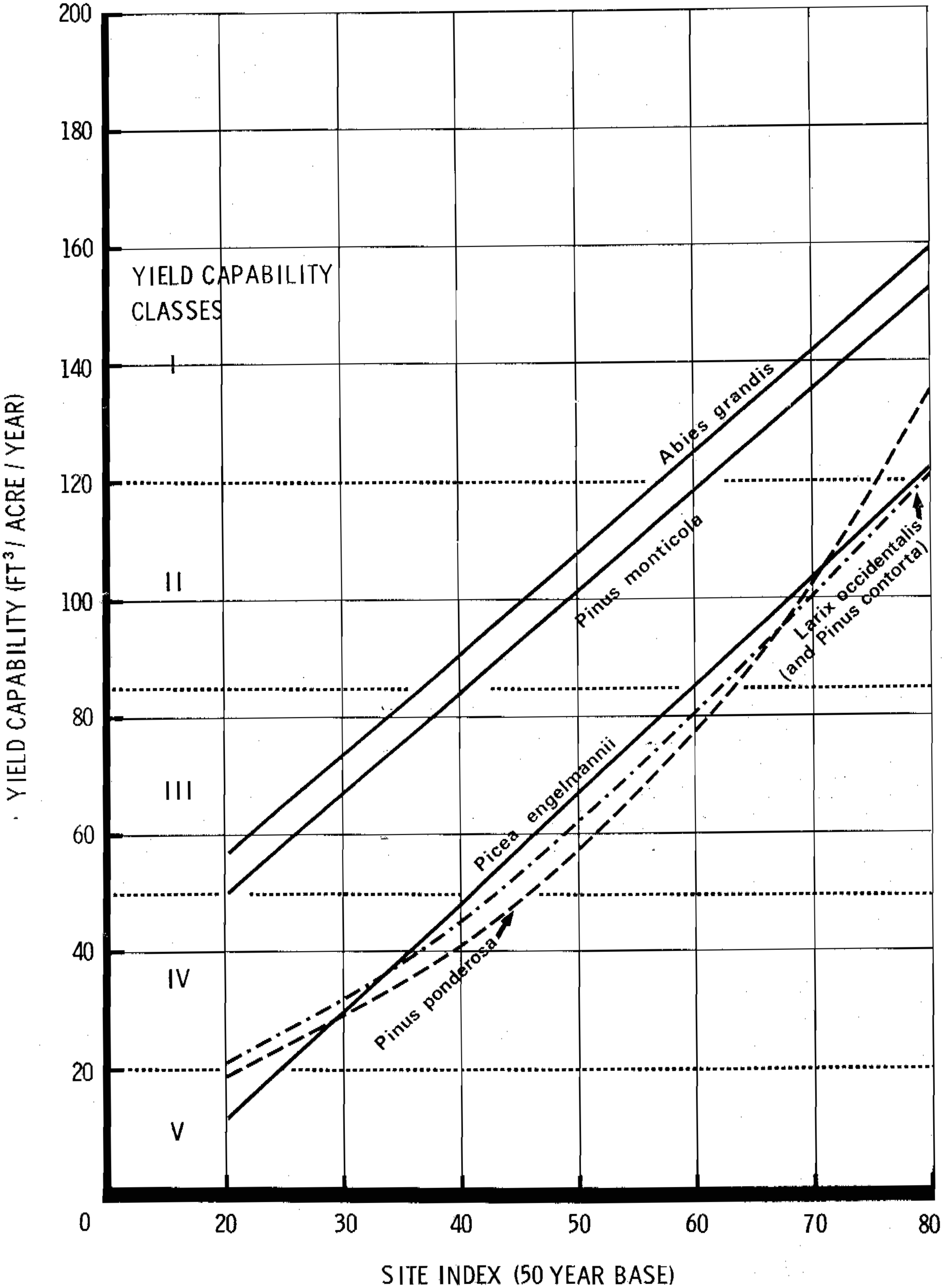


Figure 48.--Yield capability of fully stocked natural stands in relation to site index.

As Daubenmire (1976) emphasized, natural vegetation serves as a convenient indicator of productivity over large areas of land. However, productivity within habitat types (appendix E) often shows substantial variability. The following points help explain this variability, and give suggestions for reducing it.

1. Site-index curves were used to obtain productivity data from yield tables. Different height-growth patterns undoubtedly occur on different sites, but data to account for this variation are not available.

2. Yield tables and site curves have not been developed for all species, making extrapolation necessary.

3. Yields of mixed species stands can be estimated by several individual species' yield tables. We found that a range of 30 to 40 cubic feet/acre/year in yield capability was common in individual stands, depending upon the species used for estimation.

4. Some variability in productivity within a habitat type is logical in a natural classification system. The habitat type classification is based on abilities of species to reproduce and mature under competition, not on their rates of growth. The correlation between this and productivity is imperfect. (For instance, in some stands tree roots draw on underground water tables and achieve excellent growth rates, while surface drought limits development of tree seedlings and undergrowth.)

5. Where a more accurate estimate of productivity is needed for local areas, we recommend taking additional site-index samples.

6. It has been suggested that productivity estimates for habitat types could be improved by incorporating classifications of soils, topography, or climate. We have demonstrated a major regional difference in productivity by separating west-side and east-side data (appendix E). Differences in productivity within a habitat type due to topography or soils are also apparent in some local areas. However, because of the limitations of existing site index curves and yield tables, further refinement of productivity data for large areas should be based on more precise methods of measuring productivity.

7. Natural-stand yield capability by habitat type could be estimated more precisely by direct measurements of volume growth, rather than by using site index to enter a yield table based on averages. This would require analysis of existing timber inventory plots representing maximum growth potential or new field measurements.

8. Recent stand growth models (Stage 1973, 1975) utilize growth coefficients based on habitat types. These add a new dimension to yield prediction, provide the basis for developing managed-stand yield tables, and should improve our knowledge of productivity within and between habitat types.

Geographic Distributions of Habitat Types

As discussed in their individual descriptions, most habitat types are restricted to certain areas within the Montana Rockies. Many of them--including the entire *Abies grandis*, *Thuja*, and *Tsuga* series--are confined to northwestern and west-central parts of the State. Others, including the entire *Pinus flexilis* series, are found only near or east of the Continental Divide. Only a few--e.g., *PSME/CARU*, *PSME/SYAL*, *PIAL-ABLA*--are relatively common throughout the Montana Rockies.

The geographical distribution of each habitat type is reflected in appendix A, which shows the number of sample plots in each habitat type and phase taken in each of 12 portions of the State. Absence of sample plots in a given area does not necessarily indicate that the habitat type is not present, but it does suggest that it is at most of minor occurrence.

Figures 49 through 56 are schematic diagrams of the pattern of forest habitat types and phases found in seven areas of Montana. *These diagrams are not literally accurate,* but they do attempt to portray the arrangement of all major habitat types likely to be found in a given vicinity. On a specific mountainside or in a small drainage, as few as half of the types depicted for that general vicinity may be present. These diagrams also illustrate the criteria used in defining the classification units.

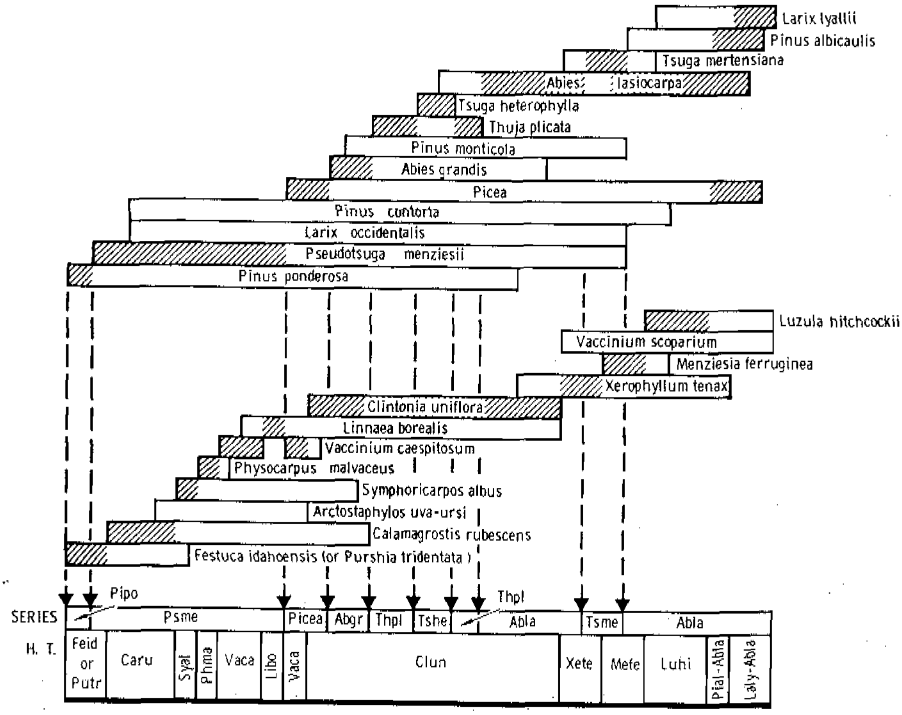


Figure 49.--Schematic distribution of tree and key undergrowth species usually encountered with increasing elevation (from left to right) in mature forest stands near Libby. The horizontal bars designate lower and upper limits of the species. That portion of the tree species' range where it is considered climax is indicated by shading. That portion of the undergrowth species' range where it is used to define a habitat type is indicated by shading.

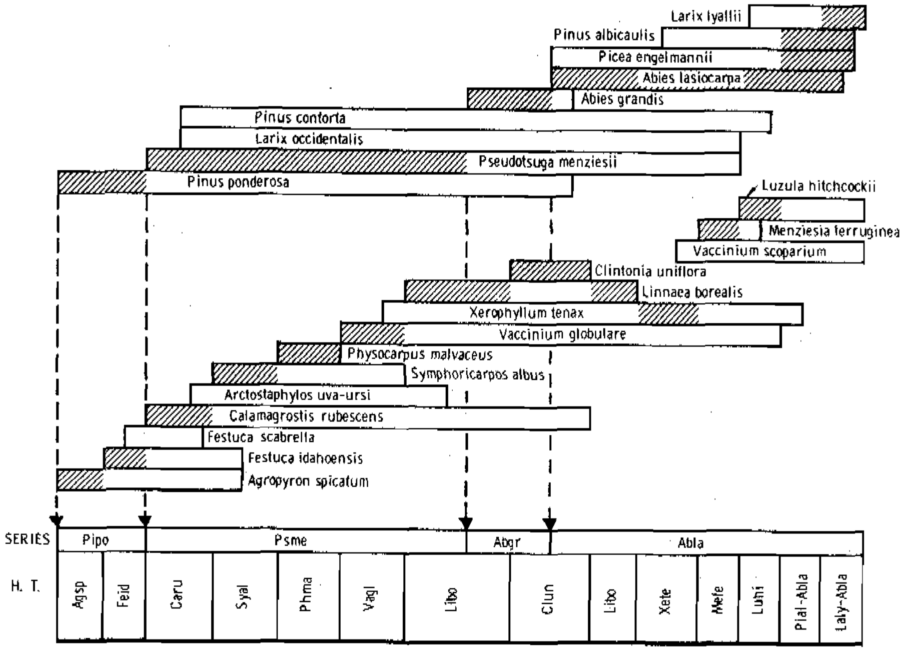


Figure 50.--Schematic distribution of tree and key undergrowth species usually encountered with increasing elevation (from left to right) in mature forest stands near Missoula. The horizontal bars designate lower and upper limits of the species. That portion of the tree species' range where it is considered climax is indicated by shading. That portion of the undergrowth species' range where it is used to define a habitat type is indicated by shading.

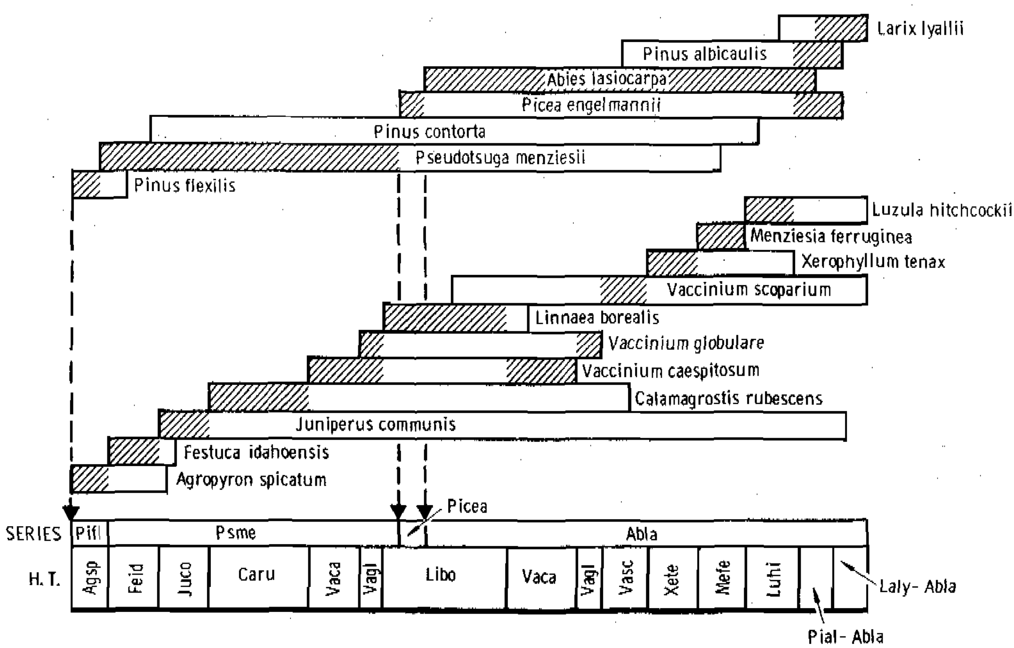


Figure 51.--Schematic distribution of tree and key undergrowth species usually encountered with increasing elevation (from left to right) in mature forest stands in the vicinity of Butte and Philipsburg. The horizontal bars designate lower and upper limits of the species. That portion of the tree species' range where it is considered climax is indicated by shading. That portion of the undergrowth species' range where it is used to define a habitat type is indicated by shading.

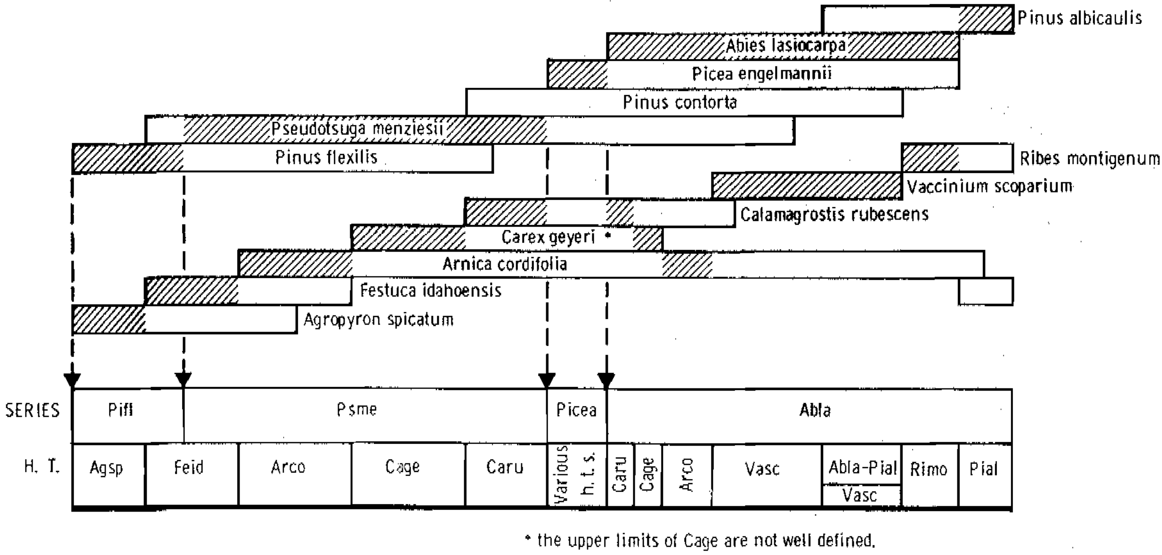


Figure 52.--Schematic distribution of tree and key undergrowth species usually encountered with increasing elevation (from left to right) in mature forest stands in the vicinity of Dillon and Lima. The horizontal bars designate lower and upper limits of the species. That portion of the tree species' range where it is considered climax is indicated by shading. That portion of the undergrowth species' range where it is used to define a habitat type is indicated by shading.

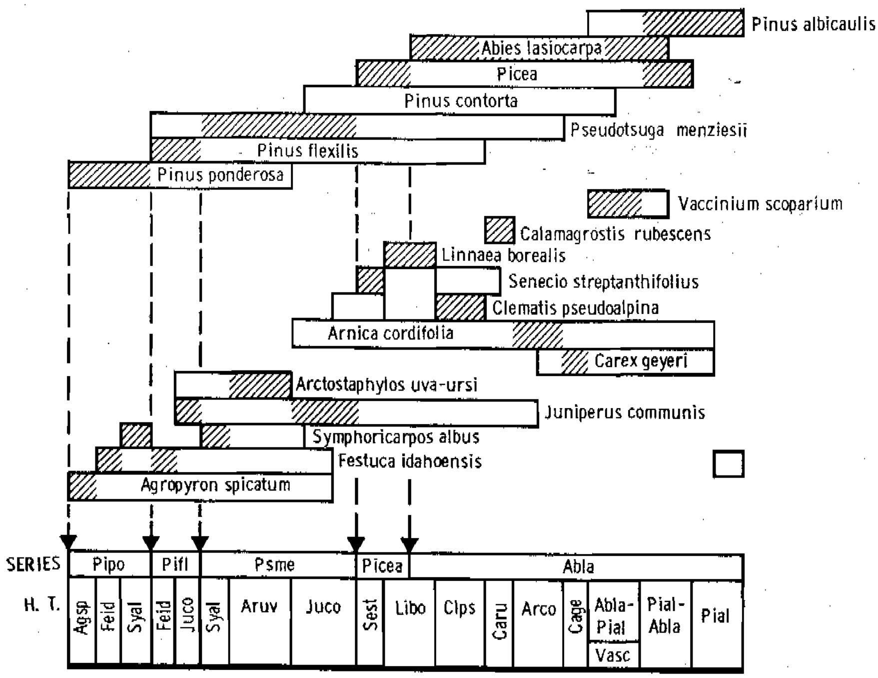


Figure 53.--Schematic distribution of tree and key undergrowth species usually encountered with increasing elevation (from left to right) in mature forest stands on limestone *substrates in the Little Belt Mountains. The horizontal bars designate lower and upper limits of the species. That portion of the tree species' range where it is considered climax is indicated by shading. That portion of the undergrowth species' range where it is used to define a habitat type is indicated by shading.*

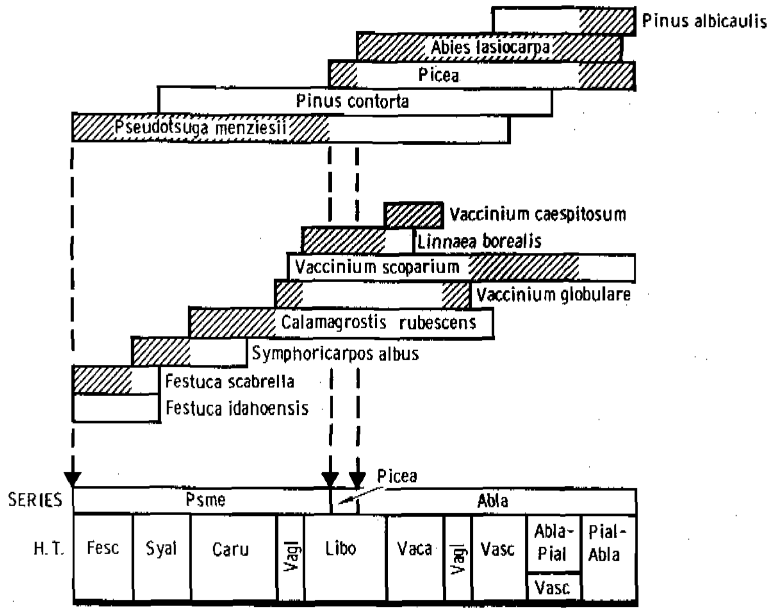


Figure 54.--Schematic distribution of tree and key undergrowth species usually encountered with increasing elevation (from left to right) in mature forest stands on nonlimestone *substrates in the Little Belt Mountains. The horizontal bars designate lower and upper limits of the species. That portion of the tree species' range where it is considered climax is indicated by shading. That portion of the undergrowth species' range where it is used to define a habitat type is indicated by shading.*

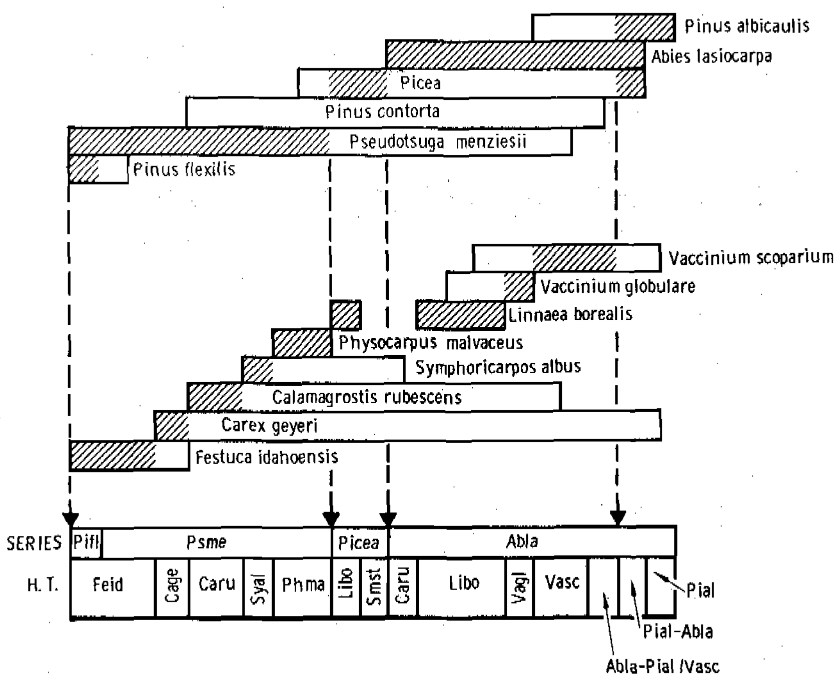


Figure 55.--Schematic distribution of tree and key undergrowth species usually encountered with increasing elevation (from left to right) in mature forest stands in the Gallatin and Absaroka Ranges. The horizontal bars designate lower and upper limits of the species. That portion of the tree species' range where it is considered climax is indicated by shading. That portion of the undergrowth species' range where it is used to define a habitat type is indicated by shading.

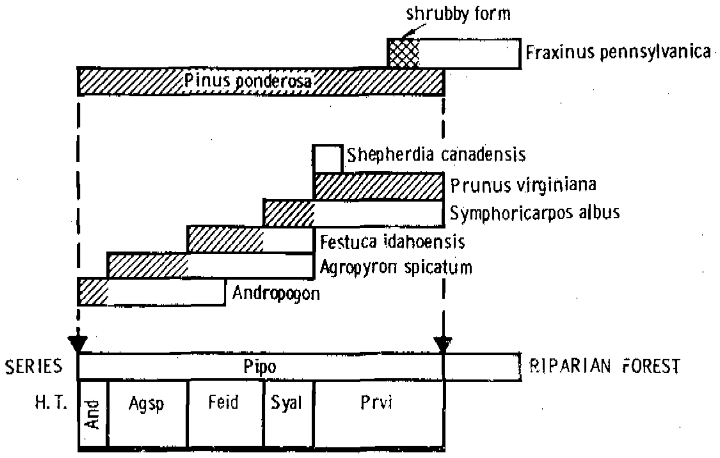


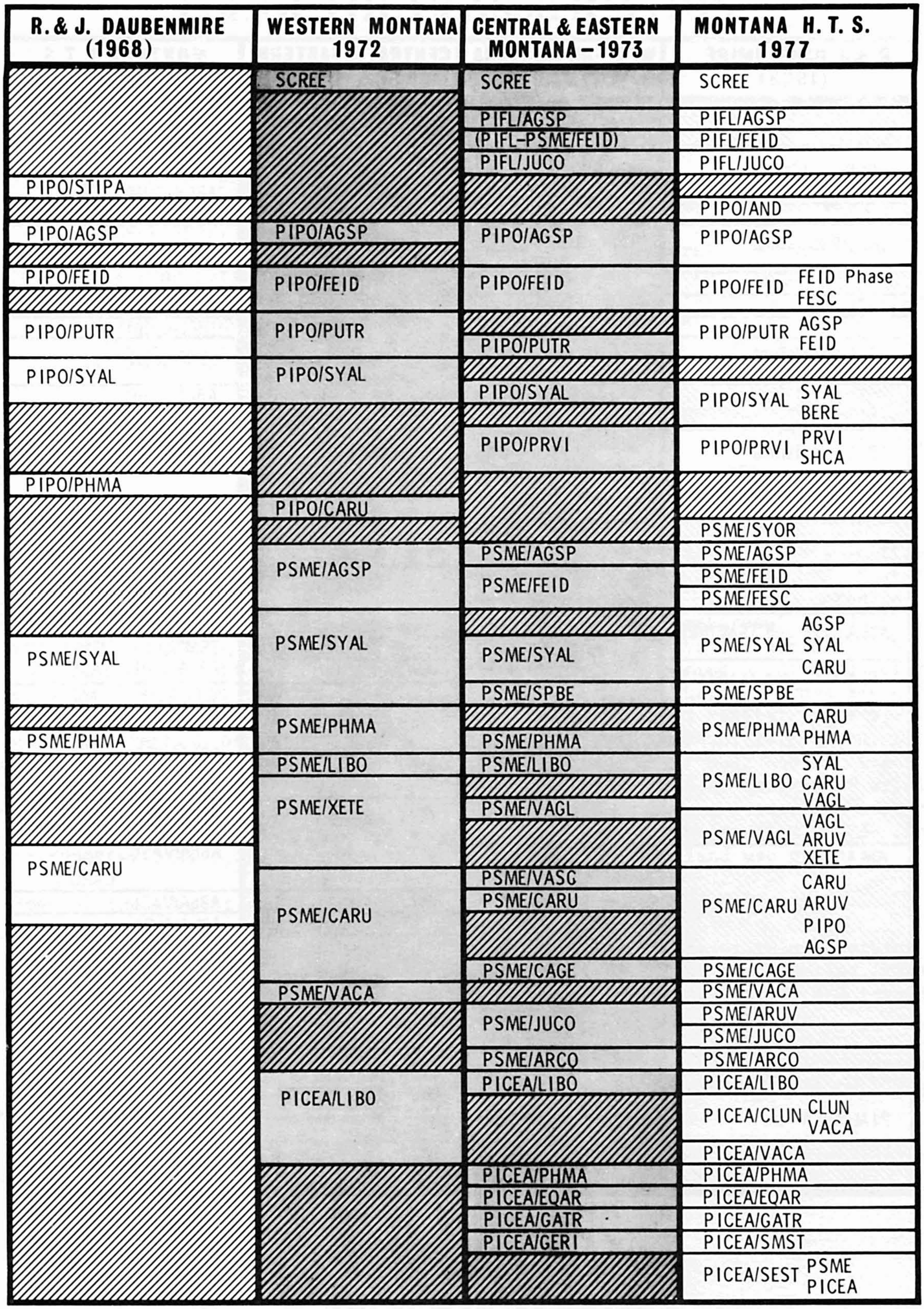
Figure 56.--Schematic distribution of tree and key undergrowth species usually encountered with increasing soil moisture (from left to right) in mature forest stands near Ashland. The horizontal bars designate lower and upper limits of the species. That portion of the tree species' range where it is considered climax is indicated by shading. That portion of the undergrowth species' range where it is used to define a habitat type is indicated by shading.

Relationship to Other Habitat Type Classifications

The Montana classification was developed through successive steps of data analysis and field testing; two preliminary classifications (1972, 1973) and a review draft (1974) were made available for field testing. The relationships of our classification to R. and J. Daubenmire's (1968) classification (which had been extrapolated to Montana prior to this study) as well as development from the preliminary classifications are illustrated in figure 57. This figure provides a means of translating fieldwork done with a preliminary classification to the current habitat type designations, and of comparing information from habitat types in northern Idaho.

The Montana forest classification is also closely related to concurrent studies in central Idaho and the Nezperce National Forest (Robert Steele and others 1975, 1976, preliminary drafts, USDA Forest Service, Intermountain Station) as well as northwestern Wyoming and adjacent portions of Idaho (Cooper 1975). As discussed in the habitat type writeups, many of the individual types are related to types or communities described in a number of other studies from areas outside of the Northern Rockies (McLean 1970; Ogilvie 1963; Reed 1969; Pfister 1972a; Thilenius 1972; Hall 1973; Hoffman and Alexander 1976). Forest habitat type classifications now being conducted in other areas will be compared with ours at a later date.

Figure 57.--The relationship of the final Montana classification to preliminary reports and to R. and J. Daubenmire's (1968) stand data.



R. & J. DAUBENMIRE (1968)	WESTERN MONTANA 1972	CENTRAL & EASTERN MONTANA–1973	MONTANA H.T.S. 1977
	ABGR/XETE		ABGR/XETE
ABGR/Pachistima	ABGR/CLUN		ABGR/LIBO: XETE Phase, LIBO
			ABGR/CLUN: CLUN, XETE, ARNU
THPL/Pachistima	THPL/CLUN		THPL/CLUN: CLUN, ARNU, MEFE
THPL/Athyrium			
THPL/OPHO	TSHE/OPHO		THPL/OPHO
TSHE/Pachistima	TSHE/CLUN		TSHE/CLUN: CLUN, ARNU
	ABLA/OPHO		ABLA/OPHO
ABLA/Pachistima	ABLA/CLUN	ABLA/CLUN	ABLA/CLUN: VACA, XETE, CLUN, MEFE, ARNU
		ABLA/GATR	ABLA/GATR
		ABLA/CACA	ABLA/CACA: GATR, CACA, VACA
		ABLA/VACA	ABLA/VACA
ABLA/MEFE and TSME/MEFE	ABLA/MEFE, TSME/MEFE	ABLA/MEFE	ABLA/MEFE and TSME/MEFE
ABLA/XETE and TSME/XETE	ABLA/LUHI	ABLA/LUHI	TSME/LUHI, ABLA/LUHI: MEFE, VASC
	ABLA/XETE · TSME/XETE	ABLA/XETE	ABLA/XETE, TSME/XETE: VAGL
		ABLA/LIBO	ABLA/LIBO: XETE, LIBO, VASC
	ABLA/VASC	ABLA/VASC	ABLA/XETE: VASC
ABLA/VASC			ABLA/VASC: VASC, THOC, CARU
		ABLA/VAGL	ABLA/VAGL
		ABLA/ALSI communities	ABLA/ALSI
		ABLA/CARU	ABLA/CARU
		ABLA/CAGE	ABLA/CAGE: PSME, CAGE
		unclassified communities	ABLA/ARCO
		ABLA/CLPS	ABLA/ CLPS
		ABLA/RIMO	ABLA/RIMO
		ABLA-PIAL/VASC	ABLA-PIAL/VASC
PIAL-ABLA	PIAL-ABLA	PIAL-ABLA	PIAL-ABLA H. T. S.
	LALY-ABLA	LALY-ABLA	LALY-ABLA H. T. S.
		PIAL	PIAL H. T. S.
		PICO/PUTR	PICO/PUTR

USE OF THE CLASSIFICATION

Validation

Our objective has been similar to that of R. and J. Daubenmire (1968)--that is, to develop an ecological classification of forest land in which not only vegetation but also climate, geography, and disturbance factors are taken into account. Vegetation characters are convenient to use for this purpose, and the natural vegetation that develops over a long period of time without disturbance is felt to reflect the overall environment. It acts like a complex environmental monitoring system. R. and J. Daubenmire (1968) stated the goal of such ecological classifications as follows: "That system . . . closest to a natural one that allows the most predictions about a unit from a mere knowledge of its position in the system."

The current Montana classification culminates 4 years of intensive research. Although its preliminary drafts have had the benefit of 3 years of testing by land managers, further refinement is always possible.

Use of Habitat Types

Layser (1974) and Pfister (1976) have outlined potential values of habitat types in resource management. Perhaps the most important overall use is as a land stratification system--designating land areas with similar environments or biotic potential--thereby providing a tool for cataloging and communicating research results, administrative study results, accumulated field observations, and intuitive evaluations. The habitat type classification is presented as a foundation for basing predictions of response to land and vegetation management activities. However, habitat types are *not* a panacea for decisionmaking or research interpretations. Rather, habitat types will complement information on current (seral) vegetation, soils, outdoor recreation, socioeconomic conditions, hydrology, and wildlife. For instance, although habitat types do not include a description of young seral communities which would be useful for wildlife, range, silviculture, etc., this classification of sites and mature forest communities does provide the foundation upon which successional stages can be studied and defined. Habitat types will also aid more intensive land management and land use planning.

Some of the current and potential uses of habitat types include:

1. Timber management--developing seed source and seed transfer rules, serving as a stratification for tree improvement programs, selecting species for planting (Pfister 1972b), comparing natural regeneration (Shearer 1976), evaluating cutting and regeneration methods, and assessing relative timber productivity.

2. Range and wildlife management--assessing relative forage production, comparing potential values for domestic grazing, and evaluating summer and winter use by big game (Lyon 1975; Marcum 1975).

3. Watershed management--estimating relative precipitation, evapotranspiration, and moisture-holding characteristics.

4. Recreation--assessing suitability for various types of recreational use, evaluating impacts of use on plant communities and sites (Helgath 1975; Dale 1973), and predicting recovery rates following disturbance.

5. Forest protection--categorizing fuel buildup, implementing fuel management, and evaluating the natural role of fire including frequency and intensity of burns (Aldrich 1973; Arno 1976); and assessing susceptibility to various insects and diseases.

6. Natural area preservation--helping to insure that the environmental spectrum is adequately represented in research natural areas (Schmidt and Dufour 1975).

Some management implications are discussed in the descriptions of the habitat types in this report. Additional implications can be developed from the appendix data. Valuable information regarding the response of each habitat type to specific treatments can be obtained by carefully documenting and analyzing field observations. Also, field research studies in many functions can use the habitat types as a stratification for designing studies. Study results can then be reported in a form suitable for application on appropriate habitat types.

Mapping

Habitat type maps have become an important management tool in the Northern Region of the USDA Forest Service (Deitschman 1973; Stage and Alley 1973; Daubenmire 1973). They provide a permanent record of habitat type distribution on the landscape and a basis for acreage estimates for land-use planning.

Maps may be made at various scales and degrees of accuracy, depending upon objectives. For research studies, project planning, etc., maps should be accurate and detailed; each phase of a habitat type should be delineated, especially for research studies. The map scale should range from 4 to 8 inches per mile. At a broader level of planning (multiple use planning unit, National Forests, etc.) map accuracy and detail may decrease and mapping efforts may be extensive. Habitat types are often the finest subdivisions shown, and map scale can range from 1 to 2 inches per mile.

Still broader levels of mapping may be required for regional needs (selection of powerline corridors, State or regional planning); these may employ scales of 1/4 to 1/2 inch per mile, and may depict only habitat type groups or series. These should be synthesized from large-scale habitat type maps whenever the latter are available.

Selecting a mapping approach and appropriate scale to produce an acceptable map must be based on the following: (1) anticipated use of the map, (2) accuracy level required, (3) availability of adequately trained personnel, and (4) amount of time and financial support available to achieve the specified accuracy level.

At scales of 4 to 8 inches per mile, the habitat types or phases are useful as the mapping units, accepting inclusions (up to 15 percent) of other types too small to map separately. In complex topography and at smaller map scales, special mapping units must be developed, which may be called complexes or mosaics. Such mapping-unit complexes must be defined for each area being mapped, rather than on a preconceived grouping. The amount and relative positions of habitat types and phases within a complex must be specified because the management interpretations of a mapping unit are tied to the taxonomic units--series, habitat type, and phase.

Regardless of the mapping scale used, the field reconnaissance should identify stands to the phase level. The amount and location of field reconnaissance should also be specified on the map or in a report for users of the map. Finally, the map accuracy should be estimated and checked to maintain quality control in application of the habitat type classification.

Grouping

Since this classification system for potential vegetation is hierarchical, it can be used at various levels of differentiation for various purposes. Field data (vegetational inventories) for determining habitat type and phase should be collected accurately and recorded for future reference--for instance, using a checklist (appendix F). This approach is only slightly more time-consuming than taking cruder field data. It enhances the value of the data and the comprehension of the investigator; moreover, it helps provide a basis of professional credibility for the work. Above all, it provides flexibility in the ultimate use of the data. In contrast, if habitat-type groups are assigned in the field, reevaluation or more detailed analysis is not possible. Without field data, the probability of an unsatisfactory product is high.

Relatively few habitat types and phases occur in a given forested area. Moreover, some of these will be so minor in extent that once their presence is documented they need not enter into most broad-scale forest management considerations. This leaves a relatively small number of habitat types to be identified (and mapped) in a given area. After the distributional patterns of all the habitat types have been identified, the types can be grouped in logical categories to facilitate resource planning and public presentations.

Where implications for management are similar, it may be desirable to consider an entire series (e.g., *Pinus flexilis* series, or *Abies grandis* series) as one group. Conversely, where management considerations contrast strongly even at the phase level (e.g., the phases of *PSME/CARU* h.t.), it may be desirable to split a habitat type in the grouping process.

Below is one example of a grouping made on the basis of overall ecological similarities including geographical distributions:

Pinus flexilis series
PIPO/AND; PIPO/AGSP; PIPO/FEID; PIPO/PUTR h.t.s
PIPO/SYAL; PIPO/PRVI h.t.s
PSME/AGSP; PSME/FEID; PSME/FESC; PSME/SYOR h.t.s
PSME/VACA; PSME/CARU h.t., *ARUV* phase
PSME/PHMA; PSME/SYAL h.t., *SYAL* and *CARU* phases
PSME/VAGL; PSME/LIBO h.t.s
PSME/CARU h.t., *AGSP* and *PIPO* phases; *PSME/SYAL* h.t., *AGSP* phase
PSME/CARU h.t., *CARU* phase; *PSME/CAGE* h.t.
PSME/SPBE; PSME/ARUV h.t.s
PSME/JUCO; PSME/ARCO h.t.s
PICEA/CLUN; PICEA/VACA h.t.s
PICEA/PHMA; PICEA/GATR; PICEA/LIBO; PICEA/SMST h.t.s
Abies grandis series
THPL/CLUN; TSHE/CLUN h.t.s
THPL/OPHO; ABLA/OPHO; PICEA/EQAR h.t.s
ABLA/CLUN; ABLA/GATR; ABLA/LIBO h.t.s
ABLA/VACA h.t.
ABLA/CACA h.t.
ABLA/MEFE; TSME/MEFE; ABLA/ALSI h.t.s
ABLA/XETE h.t., *VAGL* phase; *TSME/XETE; ABLA/VAGL* h.t.s
ABLA/XETE h.t., *VASC* phase; *ABLA/VASC* h.t., *ABLA/CAGE* h.t., *CAGE* phase
ABLA/CARU; ABLA/ARCO; ABLA/CAGE h.t., *PSME* phase
PICEA/SEST; ABLA/CLPS h.t.s
ABLA/LUHI; TSME/LUHI; ABLA-PIAL/VASC; ABLA/RIMO h.t.s
PIAL-ABLA; LALY-ABLA; PIAL h.t.s
Pinus contorta series

Other bases for groupings may be useful for various specialists in resource management. It is important to remember that such groupings (if used at all) should be made *after* a thorough inventory has been completed at the habitat type or phase level. Furthermore, every group should include a record of the relative amounts of each habitat type (and phase) within it; this will serve as a basis for general statements about the group.

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APPENDIXES

APPENDIX A

Number of sample plots by habitat type, phase, and National Forest in Montana. (c.t. = community type)

K = Kootenai National Forest
F = Flathead National Forest & west-side Glacier N.P.
WL = west Lolo National Forest (west of Missoula)
EL = east Lolo National Forest
B = Bitterroot National Forest
D = Deerlodge National Forest
BHD = Beaverhead National Forest
H = Helena National Forest
WLC = west Lewis and Clark National Forest and east-side Glacier N.P.
ELC = east Lewis and Clark National Forest (east of Choteau)
G = Gallatin National Forest and northern Yellowstone N.P.
C = Custer National Forest

HABITAT TYPE/PHASE	NATIONAL FOREST VICINITY												
	K	F	WL	EL	B	D	BHD	H	WLC	ELC	G	C	TOTAL
SCREE	.	.	2	4	3	.	.	4	2	1	.	.	16
PINUS FLEXILIS SERIES													
PIFL/AGSP	.	.	.	.	.	1	1	2	1	.	.	1	6
PIFL/FEID, FEID	.	.	.	.	.	.	2	2	1	.	1	1	7
/FEID, FESC	.	.	.	.	.	.	.	2	1	1	.	.	4
PIFL/JUCO	.	.	.	.	.	.	1	.	1	1	.	4	7
													24
PINUS PONDEROSA SERIES													
PIPO/AND	.	.	.	.	.	.	.	.	.	.	.	1	1
PIPO/AGSP	.	.	5	4	2	.	.	1	.	1	.	8	21
PIPO/FEID, FEID	.	.	1	2	6	.	.	1	.	.	.	4	14
/FEID, FESC	1	1	4	3	2	.	.	5	.	.	.	.	16
PIPO/PUTR, AGSP	.	.	.	1	2	.	.	1	.	.	.	.	4
/PUTR, FEID	2	.	1	1	1	.	.	2	.	.	.	.	7
PIPO/SYAL, SYAL	.	.	1	.	3	.	.	.	.	2	.	2	8
/SYAL, BERE	.	.	.	.	.	.	.	.	.	2	.	1	3
PIPO/PRVI, PRVI	.	.	.	.	.	.	.	.	.	.	.	6	6
/PRVI, SHCA	.	.	.	.	.	.	.	.	.	.	.	2	2
													82
PSEUDOTSUGA MENZIESII SERIES													
PSME/AGSP	.	1	.	.	1	4	.	3	.	2	1	1	13
PSME/FEID	1	.	.	.	.	3	12	.	.	.	2	1	19
PSME/FESC	2	3	.	2	.	.	.	6	.	.	.	.	13
PSME/VACA	8	2	5	5	2	1	.	2	1	1	.	.	27
PSME/PHMA, PHMA	2	4	9	10	7	3	1	3	.	.	2	4	45
/PHMA, CARU	.	.	2	2	4	.	.	.	.	.	.	.	8
PSME/VAGL, VAGL	.	1	1	4	.	.	1	3	.	2	1	.	13
/VAGL, ARUV	.	.	4	2	3	.	.	.	.	.	.	.	9
/VAGL, XETE	1	1	5	3	7	.	.	1	.	.	.	.	18
PSME/LIBO, SYAL	2	1	.	4	.	.	.	1	.	1	.	.	9
/LIBO, CARU	1	.	1	2	1	2	1	2	.	2	.	.	12
/LIBO, VAGL	.	.	3	2	2	1	.	.	.	1	.	.	9
PSME/SYAL, AGSP	.	1	1	1	4	.	.	2	.	.	.	.	9
/SYAL, CARU	2	6	1	6	10	1	3	4	.	1	6	.	40
/SYAL, SYAL	.	1	.	2	2	.	2	3	3	2	3	.	18
PSME/CARU, AGSP	2	1	2	2	3	.	.	.	.	.	.	.	10
/CARU, ARUV	2	.	.	2	5	.	.	2	.	.	.	.	11
/CARU, CARU	2	1	.	11	5	11	9	12	1	3	7	.	62
/CARU, PIPO	1	.	2	1	7	.	.	2	.	1	.	.	14
PSME/CAGE	.	.	.	3	.	.	1	2	.	2	1	1	10
PSME/SPBE	.	1	1	2	.	.	.	2	4	1	.	.	11
PSME/ARUV	.	.	.	.	.	.	.	3	.	4	.	1	8
PSME/JUCO	.	.	.	.	.	5	2	.	1	6	.	.	14
PSME/ARCO	.	.	.	.	.	2	5	4	.	2	.	.	13
PSME/SYOR	.	.	.	.	.	.	1	.	.	.	.	.	1
													416
PICEA SERIES													
PICEA/EQAR	.	3	.	.	.	.	1	1	2	1	1	.	9
PICEA/CLUN, VACA	1	7	.	.	.	.	.	.	.	.	.	.	8
/CLUN, CLUN	5	11	.	.	.	.	.	.	.	.	.	.	16
PICEA/PHMA	.	.	.	.	.	.	.	.	.	.	6	.	6
PICEA/GATR	.	.	.	1	1	1	1	1	.	1	9	.	15
PICEA/VACA	.	4	.	.	.	.	.	.	1	.	.	.	5
PICEA/SEST,PSME	.	.	.	.	.	.	2	.	1	2	.	.	5
PICEA/SEST,PICEA	.	.	.	.	.	.	.	.	.	5	.	.	5
PICEA/LIBO	.	.	.	1	.	2	2	.	.	5	11	.	21
PICEA/SMST	.	.	.	.	.	.	1	3	.	2	3	1	10
													100

(con.)

HABITAT TYPE/PHASE	NATIONAL FOREST VICINITY												
	K	F	WL	EL	B	D	BHD	H	WLC	ELC	G	C	TOTAL
ABIES GRANDIS SERIES													
ABGR/XETE	.	.	5	.	1	.	.	.	.	.	.	.	6
ABGR/CLUN, CLUN	1	1	2	.	2	.	.	.	.	.	.	.	6
/CLUN, ARNU	1	4	-	.	1	.	.	.	.	.	.	.	6
/CLUN, XETE	1	2	1	.	.	.	.	.	.	.	.	.	4
ABGR/LIBO, LIBO	.	1	2	.	2	.	.	.	.	.	.	.	5
/LIBO, XETE	.	.	3	.	.	.	.	.	.	.	.	.	3
													30
THUJA PLICATA SERIES													
THPL/CLUN, CLUN	3	6	5	1	.	.	.	.	.	.	.	.	15
/CLUN, ARNU	.	4	4	1	.	.	.	.	.	.	.	.	9
/CLUN, MEFE	1	2	3	1	.	.	.	.	.	.	.	.	7
THPL/OPHO	3	8	.	.	.	.	.	.	.	.	.	.	11
													42
TSUGA HETEROPHYLLA SERIES													
TSHE/CLUN, CLUN	8	19	.	.	.	.	.	.	.	.	.	.	27
/CLUN, ARNU	1	8	2	.	.	.	.	.	.	.	.	.	11
													38
ABIES LASIOCARPA SERIES													
Lower subalpine h.t.s													
ABLA/OPHO	1	3	.	.	.	.	.	.	.	.	.	.	4
ABLA/CLUN, CLUN	5	10	4	6	4	.	.	.	3	.	.	.	32
/CLUN, ARNU	.	12	.	2	2	.	.	.	2	.	.	.	18
/CLUN, VACA	.	8	.	1	1	.	.	.	.	.	.	.	10
/CLUN, XETE	1	8	7	4	.	.	.	.	1	.	.	.	21
/CLUN, MEFE	1	6	6	5	2	.	.	.	2	.	.	.	22
ABLA/GATR	.	.	2	1	4	2	.	4	4	2	15	.	34
ABLA/VACA	.	.	.	1	.	2	4	.	.	3	.	.	10
ABLA/CACA, CACA	.	.	.	.	6	2	8	.	.	1	5	1	23
/CACA, GATR	.	.	.	.	1	2	.	.	.	.	1	1	5
/CACA, VACA	.	3	.	.	.	2	1	.	.	1	.	.	7
ABLA/LIBO, LIBO	.	1	2	3	5	.	1	.	4	2	2	.	20
/LIBO, XETE	.	4	2	4	3	.	.	.	.	.	.	.	13
/LIBO, VASC	1	1	.	.	1	3	4	1	1	3	2	.	17
ABLA/MEFE	2	5	15	14	14	4	2	2	5	.	1	.	64
TSME/MEFE	1	.	8	1	.	.	.	.	.	.	.	.	10
ABLA/XETE, VAGL	4	6	11	4	11	.	1	.	3	.	.	.	40
/XETE, VASC	1	1	1	4	4	4	1	2	3	.	.	.	21
TSME/XETE	2	.	7	.	.	.	.	.	.	.	.	.	9
ABLA/VAGL	.	.	.	.	1	1	3	4	.	1	9	2	21
ABLA/VASC, CARU	.	.	.	.	.	1	2	1	.	1	4	1	10
/VASC, VASC	.	1	.	.	3	1	4	.	.	3	4	1	17
/VASC, THOC	.	.	.	.	.	2	3	.	.	1	4	.	10
ABLA/ALSI	.	.	.	.	1	1	1	.	1	.	2	.	6
ABLA/CARU	.	.	.	.	.	.	2	1	1	.	4	.	8
ABLA/CLPS	.	.	.	.	.	.	1	1	1	6	.	6	15
ABLA/ARCO	.	.	.	.	.	.	15	.	1	8	.	.	24
ABLA/CAGE, CAGE	.	.	.	.	.	.	.	.	.	2	1	.	3
/CAGE, PSME	.	.	.	.	.	.	1	.	.	2	3	.	6
Upper subalpine h.t.s													
ABLA/RIMO	.	.	.	.	.	.	3	.	.	.	.	3	6
ABLA-PIAL/VASC	.	.	.	.	3	4	12	2	3	7	10	3	44
ABLA/LUHI, VASC	1	3	1	3	11	3	2	1	4	.	.	.	29
/LUHI, MEFE	9	5	.	4	3	2	.	.	1	.	.	.	24
TSME/LUHI, VASC	.	.	2	.	.	.	.	.	.	.	.	.	2
/LUHI, MEFE	1	.	1	.	.	.	.	.	.	.	.	.	2
Timberline h.t.s													
PIAL-ABLA h.t.s	2	1	1	5	.	1	6	3	3	1	6	1	30
LALY-ABLA h.t.s	2	3	.	.	25	3	2	1	.	.	.	.	36
PIAL h.t.s	.	.	.	.	.	.	4	2	.	2	1	.	9
													682
PINUS CONTORTA SERIES													
PICO/PUTR h.t.	.	.	.	.	.	.	.	.	.	.	3	.	3
PICO/VACA c.t.	.	.	.	.	.	3	5	1	1	2	.	.	12
PICO/LIBO c.t.	.	1	.	.	2	6	2	.	.	2	4	.	17
PICO/VASC c.t.	.	1	.	.	3	5	4	3	.	2	1	1	20
PICO/CARU c.t.	.	.	.	.	.	1	3	.	.	1	1	.	6
													58*
UNCLASSIFIED STANDS (ecotonal, depauperate, or unusual communities)	3	3	6	1	6	1	2	6	3	6	4	2	43
Total Number of Plots*	91	189	154	149	200	87	138	116	66	109	137	60	1,496

* Thirty-five of the *Pinus contorta* community type plots were also listed under the corresponding *Pseudotsuga, Picea,* or *Abies lasiocarpa* h.t.s. These 35 were not counted twice in the "total number of plots" columns.

APPENDIX B

Distribution of tree species in Montana habitat types showing their dynamic status as interpreted from sample stand data

C = major climax species
S = major seral
a = accidentals
c = minor climax species
s = minor seral
( ) = in certain areas of the type

HABITAT TYPE/PHASE	JUSC	PIFL	PIPO	PSME	PICO	LAOC	PICEA	ABGR	PIMO	THPL	TSHE	ABLA	TSME	PIAL	LALY	BEPA
SCREE	.	(C)	(C)	C	a	.	(c)	.	.	.	.	(c)	.	(c)	.	.
PIFL/AGSP	(C)	C	(c)	a	.	.	.	.	.	.	.	.	.	.	.	.
PIFL/FEID, FEID	(c)	C	a	C	a	.	.	.	.	.	.	.	.	.	.	.
/FEID, FESC	.	C	a	C	a	.	.	.	.	.	.	.	.	.	.	.
PIFL/JUCO	a	C	a	c	a	.	a	.	.	.	.	a	.	(c)	.	.
PIPO/AND	c	.	C	.	.	.	.	.	.	.	.	.	.	.	.	.
PIPO/AGSP	(c)	a	C	a	.	.	.	.	.	.	.	.	.	.	.	.
PIPO/FEID, FEID	a	a	C	a	.	.	.	.	.	.	.	.	.	.	.	.
/FEID, FESC	a	a	C	a	.	.	.	.	.	.	.	.	.	.	.	.
PIPO/PUTR, AGSP	a	.	C	a	.	.	.	.	.	.	.	.	.	.	.	.
/PUTR, FEID	(c)	.	C	a	.	.	.	.	.	.	.	.	.	.	.	.
PIPO/SYAL, SYAL	a	a	C	a	.	.	.	.	.	.	.	.	.	.	.	.
/SYAL, BERE	a	a	C	a	.	.	.	.	.	.	.	.	.	.	.	.
PIPO/PRVI, PRVI	.	.	C	.	.	.	.	.	.	.	.	.	.	.	.	.
/PRVI, SHCA	a	.	C	.	.	.	.	.	.	.	.	.	.	.	.	.
PSME/AGSP	(c)	(c)	C	C	.	.	.	.	.	.	.	.	.	.	.	.
PSME/FEID	a	a	a	C	.	.	.	.	.	.	.	.	.	.	.	.
PSME/FESC	a	(c)	C	C	.	.	.	.	.	.	.	.	.	.	.	.
PSME/VACA	.	.	(S)	C	S	(S)	a	.	.	.	.	a	.	.	.	.
PSME/PHMA, PHMA	.	a	(s)	C	(s)	(s)	.	a	.	.	.	.	.	.	.	.
/PHMA, CARU	.	.	S	C	a	a	.	.	.	.	.	.	.	.	.	.
PSME/VAGL, VAGL	.	.	(s)	C	S	(s)	a	.	.	.	.	a	.	a	.	.
/VAGL, ARUV	.	.	S	C	(s)	(s)	.	a	.	.	.	.	.	.	.	.
/VAGL, XETE	.	.	(s)	C	S	(S)	.	a	.	.	.	a	.	a	.	.
PSME/LIBO, SYAL	.	.	(s)	C	(s)	(S)	.	.	.	.	.	.	.	.	.	.
/LIBO, CARU	.	.	(s)	C	(S)	(S)	.	.	.	.	.	a	.	.	.	.
/LIBO, VAGL	.	.	(s)	C	S	(s)	a	a	.	.	.	a	.	.	.	.
PSME/SYAL, AGSP	.	a	S	C	.	.	.	.	.	.	.	.	.	.	.	.
/SYAL, CARU	.	.	(S)	C	(s)	a	a	.	.	.	.	.	.	.	.	.
/SYAL, SYAL	.	a	(S)	C	(s)	.	.	.	.	.	.	.	.	a	.	.
PSME/CARU, AGSP	.	.	S	C	.	.	.	.	.	.	.	.	.	.	.	.
/CARU, ARUV	.	.	S	C	s	(s)	.	.	.	.	.	.	.	.	.	.
/CARU, CARU	.	.	a	C	(S)	(s)	.	.	.	.	.	a	.	a	.	.
/CARU, PIPO	.	.	S	C	.	.	.	.	.	.	.	.	.	.	.	.
PSME/CAGE	.	a	(s)	C	a	.	.	.	.	.	.	a	.	(c)	.	.
PSME/SPBE	.	a	(S)	C	a	a	.	.	.	.	.	.	.	.	.	.
PSME/ARUV	.	s	S	C	a	.	.	.	.	.	.	.	.	.	.	.
PSME/JUCO	.	(s)	a	C	S	.	a	.	.	.	.	a	.	a	.	.
PSME/ARCO	.	(s)	a	C	a	.	.	.	.	.	.	.	.	.	.	.
PSME/SYOR	(c)	(c)	.	C	.	.	.	.	.	.	.	.	.	.	.	.
PICEA/EQAR	.	.	.	a	a	.	C	.	.	.	.	a	.	.	.	(s)
PICEA/CLUN, VACA	.	.	(s)	S	S	S	C	.	a	.	.	a	.	.	.	.
/CLUN, CLUN	.	.	(s)	S	(S)	S	C	.	a	.	.	a	.	.	.	(S)
PICEA/PHMA	.	.	.	S	(S)	.	C	.	.	.	.	(c)	.	a	.	.
PICEA/GATR	.	.	(s)	S	S	.	C	.	.	.	.	a	.	a	.	.
PICEA/VACA	.	.	(s)	S	S	S	C	.	.	.	.	a	.	.	.	.
PICEA/SEST, PSME	.	s	.	S	.	.	C	.	.	.	.	a	.	a	.	.
/SEST, PICEA	.	.	.	a	.	.	C	.	.	.	.	a	.	a	.	.
PICEA/LIBO	.	.	a	S	S	.	C	.	.	.	.	a	.	a	.	.
PICEA/SMST	.	.	(s)	S	S	.	C	.	.	.	.	a	.	a	.	.
ABGR/XETE	.	.	s	S	S	S	a	C	a	a	.	a	.	.	.	.
ABGR/CLUN, CLUN	.	.	(s)	S	(s)	(s)	(s)	C	(s)	a	.	(c)	.	.	.	.
/CLUN, ARNU	.	.	a	S	a	S	S	C	(s)	a	a	a	.	.	.	s
/CLUN, XETE	.	.	a	S	s	S	(S)	C	s	a	a	c	.	.	.	a
ABGR/LIBO, LIBO	.	.	(S)	S	s	S	a	C	.	.	.	a	.	.	.	a
/LIBO, XETE	.	.	(s)	S	s	s	a	C	.	.	.	.	.	.	.	.
THPL/CLUN, CLUN	.	.	a	S	(s)	S	S	(c)	(s)	C	a	(c)	.	.	.	(s)
/CLUN, ARNU	.	.	.	S	a	S	(S)	(c)	(s)	C	(c)	(s)	.	.	.	(s)
/CLUN, MEFE	.	.	.	S	S	S	S	a	(s)	C	.	c	.	.	.	.
THPL/OPHO	.	.	.	s	.	a	s	(s)	a	(C)	(C)	(c)	.	.	.	(s)
TSHE/CLUN, CLUN	.	.	a	S	(s)	S	s	(s)	S	c	C	(c)	.	.	.	(s)
/CLUN, ARNU	.	.	a	(s)	a	S	(S)	(c)	.	c	C	(c)	.	.	.	(s)
ABLA/OPHO	.	.	.	s	.	s	S	.	s	.	a	C	.	.	.	.
ABLA/CLUN, CLUN	.	.	(s)	S	(S)	S	S	(s)	(s)	a	a	C	.	a	.	a
/CLUN, ARNU	.	.	a	s	(s)	S	S	(s)	(S)	.	a	C	.	.	.	(S)
/CLUN, VACA	.	.	(s)	S	S	s	s	a	a	.	.	C	.	a	.	.
/CLUN, XETE	.	.	.	S	S	S	S	a	(s)	.	a	C	(c)	a	.	.
/CLUN, MEFE	.	.	.	S	s	s	S	(C)	(s)	a	a	C	(c)	a	.	.
ABLA/GATR	.	.	a	S	S	(s)	S	.	.	.	.	C	.	.	.	.
ABLA/VACA	.	.	.	(s)	S	a	(c)	.	.	.	.	c	.	a	.	.
ABLA/CACA, CACA	.	.	.	.	S	.	S	.	.	.	.	C	.	(s)	.	.
/CACA, GATR	.	.	.	.	s	.	S	.	.	.	.	C	.	.	.	.
/CACA, VACA	.	.	.	a	S	.	s	.	.	.	.	C	.	a	.	.
ABLA/LIBO, LIBO	.	a	(s)	S	S	(S)	S	a	.	.	.	C	.	a	.	.
/LIBO, XETE	.	.	a	S	S	S	s	a	(s)	.	.	C	.	.	.	.
/LIBO, VASC	.	a	.	s	S	a	s	.	.	.	.	C	.	a	.	.
ABLA/MEFE	.	.	.	(S)	S	(s)	S	a	a	.	.	C	a	(s)	.	.
TSME/MEFE	.	.	.	(s)	s	s	s	.	(s)	.	.	C	C	(s)	.	.
ABLA/XETE, VAGL	.	.	(s)	S	S	(s)	s	a	(s)	.	.	C	a	(s)	.	.
/XETE, VASC	.	.	.	(s)	S	.	s	.	.	.	.	C	a	(s)	.	.
TSME/XETE	.	.	.	(s)	S	(s)	s	a	(s)	.	.	C	C	(s)	.	.
ABLA/VAGL	.	a	.	S	S	.	S	.	.	.	.	C	.	(s)	.	.
ABLA/VASC, CARU	.	.	.	S	S	.	s	.	.	.	.	C	.	a	.	.
/VASC, VASC	.	.	.	a	S	.	(s)	.	.	.	.	C	.	s	.	.
/VASC, THOC	.	.	.	a	S	.	S	.	.	.	.	C	.	a	.	.
ABLA/ALSI	.	.	.	(S)	S	.	S	.	.	.	.	C	.	(s)	.	.
ABLA/CARU	.	.	.	S	S	.	s	.	.	.	.	C	.	a	.	.
ABLA/CLPS	.	S	.	S	(s)	.	S	.	.	.	.	C	.	(S)	.	.
ABLA/ARCO	.	.	.	S	S	.	S	.	.	.	.	C	.	(s)	.	.
ABLA/CAGE, CAGE	.	a	.	a	(S)	.	a	.	.	.	.	C	.	(s)	.	.
/CAGE, PSME	.	.	.	S	a	.	a	.	.	.	.	C	.	.	.	.
ABLA/RIMO	.	.	.	.	.	.	(S)	.	.	.	.	C	.	(S)	.	.
ABLA-PIAL/VASC	.	.	.	.	(S)	.	S	.	.	.	.	C	.	S	.	.
ABLA/LUHI, VASC	.	.	.	.	(s)	.	S	.	.	.	.	C	a	S	.	.
/LUHI, MEFE	.	.	.	.	a	.	S	.	.	.	.	C	.	s	(C)	.
TSME/LUHI, VASC	.	.	.	.	(s)	.	s	.	.	.	.	C	C	s	.	.
/LUHI, MEFE	.	.	.	.	a	.	s	.	.	.	.	(C)	C	a	.	.
PIAL-ABLA h.t.s	.	.	.	.	.	.	(C)	.	.	.	.	(C)	.	(C)	.	.
LALY-ABLA h.t.s	.	.	.	.	.	.	(c)	.	.	.	.	(C)	.	(C)	(C)	.
PIAL h.t.s	.	a	.	a	.	.	a	.	.	.	.	a	.	C	.	.

APPENDIX C-1

(See instructions for use on page 126)

Constancy* and average canopy coverage percent (the latter in parentheses) of important plants in Montana forest habitat types and phases

	"SCREE"	PINUS FLEXILIS SERIES				PINUS PONDEROSA SERIES							
		AGSP h.t.	FEID h.t.		JUCO h.t.	AGSP h.t.	FEID h.t.		PUTR h.t.		SYAL h.t.		PRVI h.t.
			FEID phase	FESC phase			FEID phase	FESC phase	AGSP phase	FEID phase	SYAL phase	BERE phase	PRVI phase
No. of Stands	16	6	7	4	7	21	14	16	4	7	8	3	6
TREES													
Juniperus scopulorum	4(8)	5(30)	4(14)	-(0)	3(2)	3(4)	4(3)	4(1)	3(3)	4(14)	3(1)	3(1)	-(0)
Pinus flexilis	3(29)	10(38)	10(35)	10(44)	10(45)	+(0)	1(1)	1(1)	-(0)	-(0)	1(3)	3(1)	-(0)
Pinus ponderosa	6(21)	2(37)	1(3)	3(3)	1(3)	10(51)	10(59)	10(59)	10(38)	9(46)	10(56)	10(54)	10(70)
Fraxinus pennsylvanica	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	7(4)
Pseudotsuga menziesii	10(20)	3(2)	10(17)	10(23)	9(18)	3(0)	3(0)	4(1)	3(0)	-(0)	5(0)	3(1)	-(0)
Pinus contorta	1(19)	-(0)	1(0)	3(0)	1(1)	+(0)	-(0)	-(0)	-(0)	-(0)	1(0)	-(0)	-(0)
Larix occidentalis	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)
Pinus monticola	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)
Picea glauca	1(1)	-(0)	-(0)	-(0)	1(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)
Picea engelmannii	1(1)	-(0)	-(0)	-(0)	1(1)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)
Betula papyrifera	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)
Abies grandis	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)
Thuja plicata	-(0)	-(0)	-(0)	-(0)	-(0)	+(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)
Tsuga heterophylla	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)
Abies lasiocarpa	2(1)	-(0)	-(0)	-(0)	1(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)
Tsuga mertensiana	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)
Pinus albicaulis	1(15)	-(0)	-(0)	-(0)	1(15)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)
Larix lyallii	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)
SHRUBS AND SUBSHRUBS													
Alnus sinuata	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)
Amelanchier alnifolia	6(8)	2(1)	4(1)	3(1)	1(1)	5(1)	7(1)	6(2)	8(5)	4(1)	6(4)	7(1)	10(16)
Artemisia tridentata	-(0)	5(1)	6(1)	-(0)	1(1)	+(3)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)
Holodiscus discolor	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)
Juniperus communis	4(14)	2(1)	6(5)	8(11)	9(28)	+(1)	1(1)	1(1)	-(0)	-(0)	1(3)	10(5)	-(0)
Juniperus horizontalis	1(3)	2(1)	1(37)	5(20)	3(26)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)
Ledum glandulosum	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)
Menziesia ferruginea	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)
Oplopanax horridum	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)
Pachistima myrsinites	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)
Phyllodoce empetriformis	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)
Physocarpus malvaceus	2(10)	-(0)	1(1)	-(0)	1(3)	-(0)	1(0)	1(15)	3(3)	-(0)	-(0)	-(0)	-(0)
Prunus virginiana	4(2)	3(0)	-(0)	-(0)	-(0)	3(3)	5(1)	3(2)	5(1)	3(26)	6(1)	10(1)	10(34)
Purshia tridentata	-(0)	-(0)	1(3)	-(0)	-(0)	-(0)	1(1)	3(1)	10(26)	10(28)	1(1)	-(0)	-(0)
Ribes lacustre	-(0)	2(1)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)
Ribes montigenum	-(0)	-(0)	-(0)	-(0)	1(1)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)
Rubus parviflorus	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)
Shepherdia canadensis	3(2)	-(0)	1(1)	8(1)	6(2)	1(1)	-(0)	1(3)	-(0)	-(0)	1(1)	3(3)	-(0)
Spiraea betulifolia	5(4)	-(0)	1(1)	5(2)	3(9)	+(15)	1(1)	1(2)	-(0)	1(3)	1(3)	7(15)	-(0)
Symphoricarpos albus	4(5)	2(1)	4(1)	-(0)	3(8)	3(1)	4(1)	4(4)	5(2)	-(0)	10(47)	10(18)	10(13)
Taxus brevifolia	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)
Vaccinium caespitosum	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)
Vaccinium globulare	1(3)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)
Vaccinium myrtillus	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)
Vaccinium scoparium	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)
Arctostaphylos uva-ursi	4(9)	-(0)	3(2)	8(14)	4(18)	+(15)	-(0)	1(2)	-(0)	1(1)	-(0)	3(1)	2(0)
Berberis repens	1(0)	-(0)	3(1)	-(0)	4(1)	+(1)	2(6)	-(0)	3(1)	-(0)	4(1)	10(7)	10(20)
Linnaea borealis	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)
FERNS AND FERN ALLIES													
Athyrium filix-femina	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)
Equisetum arvense	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)
Gymnocarpium dryopteris	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)
GRAMINOIDS													
Agrostis scabra	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	10(6)
Agropyron spicatum	8(7)	10(20)	9(8)	8(6)	3(2)	10(28)	7(8)	9(20)	10(15)	7(28)	8(12)	3(3)	2(1)
Calamagrostis canadensis	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)
Calamagrostis rubescens	1(2)	-(0)	-(0)	-(0)	-(0)	-(0)	1(1)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)
Carex geyeri	5(3)	-(0)	1(1)	-(0)	-(0)	1(1)	2(1)	1(1)	-(0)	-(0)	1(15)	-(0)	-(0)
Festuca idahoensis	4(1)	5(1)	10(25)	10(23)	4(0)	4(2)	10(21)	9(12)	8(1)	7(23)	6(18)	7(1)	7(1)
Festuca scabrella	3(1)	2(1)	3(1)	10(21)	-(0)	1(1)	1(1)	10(18)	-(0)	9(16)	3(1)	-(0)	-(0)
Hesperochloa kingii	1(1)	3(15)	1(3)	-(0)	4(1)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)
Luzula hitchcockii	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)
Oryzopsis asperifolia	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)
Schizachne purpurascens	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	7(0)	8(4)
FORBS													
Actaea rubra	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)
Adenocaulon bicolor	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)
Aralia nudicaulis	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)
Arnica cordifolia	1(1)	-(0)	1(1)	-(0)	6(2)	-(0)	-(0)	-(0)	-(0)	-(0)	1(3)	-(0)	10(12)
Arnica latifolia	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)
Balsamorhiza sagittata	5(2)	2(3)	4(5)	5(26)	1(0)	7(7)	8(19)	9(8)	10(1)	7(11)	8(8)	10(1)	5(0)
Clematis pseudoalpina	1(1)	-(0)	-(0)	-(0)	6(1)	-(0)	-(0)	1(1)	-(0)	-(0)	1(0)	7(2)	-(0)
Clematis tenuiloba	-(0)	-(0)	-(0)	-(0)	3(1)	+(1)	-(0)	-(0)	-(0)	-(0)	1(0)	3(1)	-(0)
Clintonia uniflora	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)
Coptis occidentalis	-(0)	2(1)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)
Cornus canadensis	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)
Disporum trachycarpum	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	1(1)	3(1)	10(1)
Galium boreale	2(1)	2(1)	3(1)	10(1)	9(2)	1(1)	-(0)	1(2)	-(0)	-(0)	4(1)	10(1)	10(1)
Galium triflorum	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	1(1)	-(0)	-(0)	-(0)	-(0)	-(0)
Geranium richardsonii	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)
Hieracium gracile	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)
Osmorhiza chilensis	1(1)	-(0)	-(0)	-(0)	1(1)	-(0)	-(0)	-(0)	-(0)	-(0)	1(1)	7(2)	2(1)
Pyrola asarifolia	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)
Pyrola secunda	-(0)	-(0)	-(0)	3(1)	1(1)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)
Pyrola uniflora	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)
Senecio streptanthifolius	-(0)	-(0)	-(0)	-(0)	3(1)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)
Senecio triangularis	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)
Smilacina racemosa	2(1)	-(0)	-(0)	-(0)	-(0)	+(1)	1(1)	-(0)	2(1)	-(0)	-(0)	3(1)	3(1)
Smilacina stellata	1(1)	-(0)	-(0)	-(0)	3(1)	+(1)	-(0)	-(0)	-(0)	-(0)	1(1)	7(1)	3(1)
Streptopus amplexifolius	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)
Thalictrum occidentale	1(1)	-(0)	-(0)	-(0)	3(1)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	3(1)
Tiarella trifoliata	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)
Trollius laxus	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)
Valeriana sitchensis	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)
Veratrum viride	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)
Viola canadensis	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	2(1)
Viola orbiculata	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)
Xerophyllum tenax	1(1)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)

*Code to constancy values: + = 0-5%, 1 = 5-15%, 2 = 15-25%, 3 = 25-35%, 4 = 35-45%, 5 = 45-55%, 6 = 55-65%, 7 = 65-75%, 8 = 75-85%, 9 = 85-95%, 10 = 95-100%

(con.)

(See instructions for use on page 126)

Constancy* and average canopy coverage percent (the latter in parentheses) of important plants in Montana forest habitat types and phases

	PSEUDOTSUGA MENZIESII SERIES														
	AGSP h.t.	FEID h.t.	FESC h.t.	VACA h.t.	PHMA h.t.		VAGL h.t.			LIBO h.t.			SYAL h.t.		
					PHMA phase	CARU phase	VAGL phase	ARUV phase	XETE phase	SYAL phase	CARU phase	VAGL phase	AGSP phase	CARU phase	SYAL phase
No. of Stands	13	19	13	27	45	8	13	9	18	9	12	9	9	40	18
TREES															
Juni scop	7(7)	6(2)	3(1)	+(1)	2(4)	1(3)	-(0)	-(0)	-(0)	1(1)	1(1)	-(0)	2(1)	2(7)	2(5)
Pinu flex	3(5)	2(0)	2(8)	-(0)	1(21)	-(0)	-(0)	-(0)	1(1)	-(0)	-(0)	-(0)	1(15)	+(0)	3(3)
Pinu pond	8(28)	2(0)	8(26)	7(31)	6(8)	10(28)	2(3)	10(29)	3(3)	4(10)	3(8)	6(14)	8(24)	6(27)	3(61)
Frax penn	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)
Pseu menz	10(34)	10(53)	10(35)	10(23)	10(58)	10(32)	10(35)	10(30)	10(46)	10(62)	10(41)	10(42)	10(41)	10(50)	9(55)
Pinu cont	-(0)	-(0)	1(0)	8(29)	2(7)	3(2)	9(37)	2(9)	9(27)	1(3)	7(30)	9(17)	-(0)	3(16)	2(13)
Lari occi	-(0)	-(0)	-(0)	7(12)	2(8)	3(0)	5(4)	6(4)	3(20)	4(18)	3(31)	6(11)	-(0)	1(4)	-(0)
Pinu mont	-(0)	-(0)	-(0)	-(0)	+(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	+(3)	-(0)
Pice glau	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	2(0)	-(0)	-(0)	-(0)	-(0)	-(0)
Pice enge	-(0)	-(0)	+(0)	1(2)	-(0)	-(0)	1(3)	-(0)	-(0)	-(0)	3(0)	1(1)	-(0)	1(2)	1(0)
Betu papy	-(0)	-(0)	-(0)	-(0)	+(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)
Abie gran	-(0)	-(0)	-(0)	-(0)	1(1)	1(0)	1(0)	1(3)	1(3)	-(0)	1(3)	1(1)	-(0)	+(1)	-(0)
Thuj plic	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)
Tsug hete	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)
Abie lasi	-(0)	-(0)	1(1)	2(1)	+(0)	-(0)	2(1)	1(1)	5(0)	1(1)	4(1)	6(0)	-(0)	+(0)	1(1)
Tsug mert	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	2(5)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)
Pinu albi	-(0)	1(0)	-(0)	1(2)	+(0)	-(0)	-(0)	-(0)	2(2)	1(1)	-(0)	-(0)	-(0)	1(0)	2(1)
Lari lyal	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	1(3)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)
SHRUBS AND SUBSHRUBS															
Alnu sinu	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	1(3)	-(0)	1(1)	-(0)	2(3)	-(0)	-(0)	-(0)	-(0)
Amel alni	3(4)	1(0)	7(3)	8(4)	7(5)	8(3)	6(1)	8(1)	4(6)	9(5)	4(3)	8(1)	9(4)	7(6)	4(3)
Arte trid	1(0)	6(5)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	1(1)
Holo disc	-(0)	-(0)	-(0)	1(20)	2(18)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	2(8)	1(2)	1(1)
Juni comm	2(2)	2(1)	3(1)	2(1)	1(4)	-(0)	4(7)	1(1)	1(1)	1(3)	5(7)	1(3)	-(0)	3(6)	6(6)
Juni hori	-(0)	1(15)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	2(6)
Ledu glan	-(0)	-(0)	-(0)	+(37)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)
Menz ferr	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	1(1)	1(1)	-(0)	-(0)	-(0)
Oplo horr	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)
Pach myrs	-(0)	-(0)	-(0)	1(3)	1(1)	-(0)	3(4)	1(1)	4(6)	1(1)	1(1)	-(0)	-(0)	1(2)	-(0)
Phyl empe	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)
Phys malv	-(0)	-(0)	-(0)	+(1)	9(51)	10(21)	2(1)	1(1)	1(1)	2(2)	3(3)	3(2)	2(3)	1(2)	1(3)
Prun virg	2(2)	1(1)	5(2)	-(0)	2(4)	3(3)	-(0)	-(0)	1(1)	-(0)	1(3)	-(0)	2(2)	4(3)	6(3)
Purs trid	3(0)	1(3)	2(43)	1(23)	1(1)	1(1)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	1(13)	1(1)
Ribe lacu	-(0)	1(1)	5(2)	-(0)	1(1)	3(-)	1(1)	-(0)	-(0)	2(2)	3(1)	-(0)	-(0)	4(3)	6(3)
Ribe mont	-(0)	1(1)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)
Rubu parv	-(0)	-(0)	-(0)	-(0)	1(2)	-(0)	5(1)	-(0)	1(0)	2(1)	3(2)	-(0)	-(0)	-(0)	-(0)
Shep cana	3(1)	-(0)	1(1)	4(3)	2(1)	3(2)	5(1)	2(2)	1(3)	4(1)	3(1)	8(1)	2(1)	2(4)	4(1)
Spir betu	1(3)	-(0)	2(1)	8(14)	8(5)	9(6)	9(13)	9(9)	9(4)	10(11)	8(3)	10(7)	3(7)	8(11)	7(18)
Symp albu	5(3)	1(1)	2(0)	6(10)	9(15)	9(6)	2(3)	4(2)	2(2)	10(28)	5(3)	2(2)	10(20)	10(34)	10(20)
Taxu brev	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)
Vacc caes	-(0)	-(0)	-(0)	10(14)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)
Vacc glob	-(0)	-(0)	-(0)	2(12)	1(10)	1(1)	10(29)	10(36)	8(37)	4(1)	3(1)	10(28)	-(0)	-(0)	1(3)
Vacc myrt	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	2(8)	1(3)	-(0)	-(0)	-(0)
Vacc scop	-(0)	-(0)	-(0)	1(5)	-(0)	-(0)	4(28)	2(0)	2(35)	-(0)	4(41)	6(9)	-(0)	-(0)	1(1)
Arct uva-	1(1)	-(0)	1(1)	8(36)	2(3)	8(19)	1(1)	10(25)	1(1)	6(9)	5(14)	7(22)	3(1)	3(3)	4(10)
Berb repe	2(1)	1(1)	3(5)	9(3)	8(2)	5(1)	7(2)	9(2)	6(2)	10(5)	6(3)	9(1)	7(1)	9(4)	9(3)
Linn bore	-(0)	-(0)	-(0)	5(15)	3(8)	1(1)	2(1)	-(0)	1(15)	10(20)	10(26)	10(15)	-(0)	-(0)	1(0)
FERNS AND FERN ALLIES															
Athy fili	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)
Equi arve	-(0)	-(0)	-(0)	-(0)	+(1)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)
Gymn dryo	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)
GRAMINOIDS															
Agro scab	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	1(0)	-(0)	-(0)	-(0)	-(0)	+(1)	-(0)
Agro spic	10(25)	8(15)	9(19)	-(0)	2(3)	5(4)	-(0)	1(1)	-(0)	-(0)	-(0)	-(0)	8(16)	3(5)	4(1)
Cala cana	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)
Cala rube	-(0)	2(1)	3(2)	10(30)	8(20)	10(20)	9(12)	10(20)	10(24)	10(18)	10(30)	10(33)	4(29)	10(26)	7(2)
Care geye	2(1)	2(6)	2(6)	6(15)	5(8)	10(11)	7(7)	9(7)	6(5)	7(4)	6(3)	3(6)	4(8)	8(12)	6(1)
Fest idah	5(1)	10(12)	8(21)	+(1)	1(1)	4(1)	-(0)	1(1)	-(0)	-(0)	-(0)	-(0)	7(5)	2(1)	2(1)
Fest scab	2(1)	-(0)	10(20)	3(1)	+(3)	-(0)	1(1)	-(0)	-(0)	-(0)	1(1)	-(0)	4(11)	1(1)	2(1)
Hesp king	1(1)	2(1)	1(1)	-(0)	1(1)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)
Luzu hitc	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)
Oryz aspe	-(0)	-(0)	-(0)	-(0)	+(1)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)
Schi purp	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)
FORBS															
Acta rubr	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	1(1)	-(0)	-(0)	-(0)	-(0)	-(0)
Aden bico	-(0)	-(0)	-(0)	1(1)	1(1)	-(0)	-(0)	-(0)	1(1)	-(0)	-(0)	-(0)	-(0)	1(8)	-(0)
Aral nudi	-(0)	-(0)	-(0)	-(0)	+(2)	-(0)	-(0)	-(0)	-(0)	1(37)	-(0)	-(0)	-(0)	-(0)	-(0)
Arni cord	1(1)	3(1)	4(4)	6(4)	8(8)	5(2)	6(9)	9(9)	6(5)	8(18)	7(10)	6(15)	6(7)	7(8)	4(3)
Arni lati	-(0)	-(0)	1(1)	+(3)	+(1)	-(0)	4(27)	1(3)	2(2)	2(2)	5(14)	6(19)	-(0)	1(1)	1(1)
Bals sagi	7(21)	3(10)	8(13)	1(5)	1(1)	5(4)	1(3)	-(0)	-(0)	-(0)	-(0)	-(0)	6(15)	4(1)	4(1)
Clem pseu	-(0)	-(0)	-(0)	-(0)	+(1)	-(0)	-(0)	-(0)	-(0)	1(3)	2(3)	-(0)	-(0)	-(0)	1(3)
Clem tenu	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)
Clin unif	-(0)	-(0)	-(0)	+(1)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)
Copt occi	-(0)	-(0)	-(0)	-(0)	+(0)	-(0)	-(0)	-(0)	1(2)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)
Corn cana	-(0)	-(0)	-(0)	+(3)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	1(1)	-(0)	-(0)	-(0)	-(0)
Disp trac	-(0)	1(1)	1(1)	1(1)	7(2)	3(1)	3(1)	-(0)	1(1)	4(2)	3(1)	1(1)	1(1)	4(1)	6(4)
Gali bore	3(1)	2(1)	1(3)	3(1)	2(1)	-(0)	2(1)	-(0)	-(0)	4(1)	4(1)	-(0)	1(1)	3(0)	4(1)
Gali trif	-(0)	-(0)	-(0)	1(1)	1(1)	-(0)	1(1)	-(0)	-(0)	1(3)	1(0)	1(1)	-(0)	1(1)	2(1)
Gera rich	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)
Hier grac	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)
Osmo chil	1(1)	1(1)	1(1)	2(1)	4(1)	1(1)	5(1)	1(1)	4(1)	8(3)	3(1)	-(0)	1(1)	5(1)	4(1)
Pyro asar	-(0)	-(0)	-(0)	1(1)	+(1)	-(0)	1(1)	-(0)	-(0)	-(0)	2(1)	2(1)	-(0)	-(0)	-(0)
Pyro secu	-(0)	-(0)	-(0)	1(1)	1(1)	-(0)	8(1)	-(0)	2(1)	7(1)	8(1)	6(1)	-(0)	1(1)	1(1)
Pyro unif	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)
Sene stre	-(0)	1(1)	-(0)	-(0)	-(0)	-(0)	2(1)	-(0)	-(0)	-(0)	1(1)	-(0)	-(0)	+(1)	1(1)
Sene tria	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)
Smil race	1(1)	-(0)	2(1)	2(1)	6(1)	4(1)	5(1)	2(1)	2(2)	7(1)	3(1)	2(1)	2(2)	5(2)	4(4)
Smil stel	1(1)	-(0)	-(0)	1(1)	2(1)	1(1)	2(1)	-(0)	-(0)	4(1)	2(2)	-(0)	-(0)	2(2)	2(1)
Stre ampl	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)
Thal occi	-(0)	-(0)	1(1)	3(3)	6(2)	-(0)	5(9)	-(3)	4(3)	9(9)	5(10)	3(1)	-(0)	5(7)	6(1)
Tiar trif	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)
Trol laxu	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)
Vale sitc	-(0)	-(0)	1(1)	1(1)	-(0)	-(0)	2(2)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	1(1)
Vera viri	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)
Viol cana	-(0)	-(0)	-(0)	-(0)	+(1)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)
Viol orbi	-(0)	-(0)	-(0)	+(1)	+(3)	-(0)	-(0)	-(0)	1(1)	2(1)	2(2)	3(1)	-(0)	+(1)	1(3)
Xero tena	-(0)	-(0)	-(0)	2(14)	1(8)	-(0)	2(1)	9(13)	10(26)	1(1)	2(2)	7(11)	-(0)	1(2)	-(0)

*Code to constancy values: + = 0-5%, 1 = 5-15%, 2 = 15-25%, 3 = 25-35%, 4 = 35-45%, 5 = 45-55%, 6 = 55-65%, 7 = 65-75%, 8 = 75-85%, 9 = 85-95%, 10 = 95-100%

(con.)

(See instructions for use on page 126)

Constancy* and average canopy coverage percent (the latter in parentheses) of important plants in Montana forest habitat types and phases

	PSEUDOTSUGA MENZIESII SERIES (con.)									PICEA SERIES					
	CARU h.t.				CAGE h.t.	SPBE h.t.	ARUV h.t.	JUCO h.t.	ARCO h.t.	EQAR h.t.	CLUN h.t.		PHMA h.t.	GATR h.t.	VACA h.t.
	AGSP phase	ARUV phase	CARU phase	PIPO phase							VACA phase	CLUN phase			
No. of Stands	10	11	62	14	10	11	8	14	13	9	8	16	6	15	5
TREES															
Juni scop	2(2)	2(0)	1(1)	-(0)	2(2)	4(1)	6(4)	1(0)	2(3)	-(0)	-(0)	-(0)	-(0)	1(1)	2(1)
Pinu flex	-(0)	-(0)	+(10)	-(0)	1(15)	2(1)	6(3)	4(0)	3(5)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)
Pinu pond	10(45)	10(36)	2(1)	10(37)	3(13)	5(27)	10(32)	1(8)	2(8)	-(0)	4(5)	1(8)	-(0)	1(39)	2(15)
Frax penn	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)
Pseu menz	10(18)	10(26)	10(60)	10(42)	10(74)	10(60)	10(43)	10(32)	10(63)	4(1)	8(11)	8(19)	10(50)	7(19)	8(11)
Pinu cont	1(0)	9(8)	6(20)	-(0)	3(1)	3(5)	1(15)	9(31)	1(3)	4(5)	10(21)	4(22)	3(25)	6(19)	10(34)
Lari occi	-(0)	3(1)	1(11)	-(0)	-(0)	2(0)	-(0)	-(0)	-(0)	-(0)	6(7)	7(20)	-(0)	-(0)	8(15)
Pinu mont	-(0)	1(3)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	3(2)	1(3)	-(0)	-(0)	-(0)
Pice glau	-(0)	-(0)	+(1)	-(0)	1(1)	1(0)	1(1)	1(0)	-(0)	6(71)	8(21)	8(32)	5(18)	3(53)	6(11)
Pice enge	-(0)	-(0)	+(0)	-(0)	-(0)	-(0)	-(0)	1(2)	1(3)	4(79)	3(39)	3(33)	5(26)	7(58)	4(15)
Betu papy	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	2(9)	-(0)	3(20)	-(0)	-(0)	-(0)
Abie gran	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	1(1)	-(0)	-(0)	-(0)	-(0)	-(0)
Thuj plic	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	1(3)	-(0)	-(0)	-(0)
Tsug hete	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)
Abie lasi	-(0)	-(0)	1(1)	-(0)	4(1)	-(0)	-(0)	1(0)	1(0)	2(0)	6(1)	3(2)	7(5)	5(1)	2(1)
Tsug mert	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)
Pinu albi	-(0)	1(0)	1(3)	-(0)	2(20)	-(0)	1(1)	1(15)	-(0)	-(0)	-(0)	-(0)	2(0)	3(0)	-(0)
Lari lyal	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)
SHRUBS AND SUBSHRUBS															
Alnu sinu	-(0)	-(0)	+(1)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	1(1)	-(0)	1(3)	-(0)
Amel alni	7(1)	6(1)	3(1)	4(1)	1(15)	8(3)	4(1)	-(0)	1(1)	4(1)	10(5)	9(6)	3(2)	5(3)	8(8)
Arte trid	-(0)	-(0)	+(1)	-(0)	-(0)	-(0)	3(1)	-(0)	2(1)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)
Holo disc	1(1)	-(0)	-(0)	1(1)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)
Juni comm	-(0)	2(1)	4(7)	1(1)	7(5)	5(1)	9(15)	10(27)	8(5)	3(1)	6(8)	1(1)	3(2)	3(1)	4(2)
Juni hori	-(0)	1(0)	-(0)	-(0)	-(0)	-(0)	1(3)	1(19)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)
Ledu glan	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	1(1)	-(0)
Menz ferr	-(0)	1(1)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	3(1)	1(1)	-(0)	-(0)	-(0)
Oplo horr	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)
Pach myrs	-(0)	1(1)	+(2)	-(0)	1(3)	-(0)	-(0)	-(0)	-(0)	-(0)	1(3)	3(1)	-(0)	1(1)	-(0)
Phyl empe	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)
Phys malv	3(1)	1(1)	+(1)	1(3)	2(2)	-(0)	3(0)	-(0)	-(0)	-(0)	10(66)	-(0)	10(66)	1(1)	-(0)
Prun virg	1(1)	-(0)	1(16)	1(1)	-(0)	1(1)	-(1)	2(2)	2(1)	-(0)	1(1)	1(9)	5(2)	1(2)	-(0)
Purs trid	2(9)	-(0)	-(0)	1(3)	-(0)	1(1)	1(15)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)
Ribe lacu	-(0)	-(0)	1(1)	-(0)	1(1)	1(15)	1(1)	-(0)	3(1)	8(1)	-(0)	3(1)	2(1)	9(2)	-(0)
Ribe mont	-(0)	-(0)	-(0)	-(0)	1(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)
Rubu parv	-(0)	-(0)	+(3)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	1(3)	3(1)	4(9)	5(0)	4(16)	-(0)
Shep cana	-(0)	5(3)	2(2)	1(2)	-(0)	5(1)	6(2)	8(1)	1(0)	2(1)	4(5)	4(0)	3(1)	4(4)	4(1)
Spir betu	5(5)	7(9)	8(4)	8(8)	8(4)	10(27)	6(8)	9(6)	4(2)	2(2)	9(15)	7(13)	10(3)	5(9)	8(8)
Symp albu	5(2)	6(2)	4(1)	6(2)	7(1)	5(1)	9(1)	4(2)	2(1)	7(1)	10(9)	9(10)	10(5)	8(12)	4(9)
Taxu brev	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	1(1)	1(1)	-(0)	-(0)	-(0)
Vacc caes	-(0)	1(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	10(9)	1(T)	-(0)	-(0)	10(12)
Vacc glob	-(0)	2(2)	1(3)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	1(1)	3(19)	1(8)	2(1)	1(3)	2(1)
Vacc myrt	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	1(1)	-(0)	-(0)	4(3)
Vacc scop	-(0)	3(1)	1(8)	-(0)	-(0)	-(0)	-(0)	1(0)	-(0)	2(1)	3(8)	2(1)	-(0)	1(3)	2(1)
Arct uva-	3(5)	10(37)	3(11)	6(14)	-(0)	3(1)	10(20)	7(1)	1(3)	-(0)	8(5)	2(1)	-(0)	-(0)	8(1)
Berb repe	3(1)	5(1)	7(2)	5(7)	8(1)	6(1)	8(1)	6(5)	5(1)	4(1)	10(8)	8(5)	7(1)	7(6)	8(5)
Linn bore	-(0)	1(1)	1(1)	-(0)	-(0)	-(0)	-(0)	1(1)	-(0)	4(2)	10(20)	9(12)	2(15)	5(28)	8(8)
FERNS AND FERN ALLIES															
Athy fili	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	2(2)	-(0)	1(1)	-(0)	1(2)	-(0)
Equi arve	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	10(40)	3(1)	2(5)	-(0)	6(3)	2(1)
Gymn dryo	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	2(1)	-(0)	-(0)	-(0)
GRAMINOIDS															
Agro scab	-(0)	-(0)	+(1)	-(0)	-(0)	-(0)	-(0)	1(1)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)
Agro spic	9(11)	4(2)	2(1)	5(1)	1(1)	4(8)	8(1)	4(1)	5(1)	-(0)	-(0)	-(0)	2(1)	-(0)	-(0)
Cala cana	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	1(1)	-(0)	-(0)	-(0)	2(2)	-(0)
Cala rube	10(28)	10(25)	10(45)	10(42)	5(2)	6(2)	3(1)	3(2)	3(0)	3(1)	9(22)	5(9)	5(1)	5(15)	10(36)
Care geye	7(23)	5(10)	6(13)	8(5)	9(44)	5(2)	1(1)	4(2)	4(1)	-(0)	1(1)	-(0)	7(17)	1(2)	-(0)
Fest idah	8(9)	5(8)	2(1)	3(1)	4(1)	5(4)	6(3)	-(0)	7(2)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)
Fest scab	3(6)	2(8)	2(1)	1(1)	1(1)	3(2)	5(4)	1(1)	2(1)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)
Hesp king	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	1(1)	-(0)	1(1)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)
Luzu hitc	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)
Oryz aspe	-(0)	-(0)	-(0)	1(3)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	6(2)	8(2)	-(0)	2(1)	2(1)
Schi purp	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	1(1)	-(0)	1(1)	-(0)
FORBS															
Acta rubr	-(0)	-(0)	-(0)	1(1)	-(0)	-(0)	-(0)	-(0)	-(0)	3(1)	3(1)	1(1)	5(1)	10(1)	-(0)
Aden bico	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	4(1)	-(0)	-(0)	-(0)
Aral nudi	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	1(3)	-(0)	7(19)	-(0)	-(0)	-(0)
Arni cord	5(2)	5(4)	9(16)	9(10)	9(23)	6(8)	-(0)	7(4)	9(26)	1(1)	4(1)	1(3)	3(2)	5(6)	8(1)
Arni lati	-(0)	-(0)	1(8)	1(15)	-(0)	1(3)	-(0)	-(0)	1(1)	1(3)	3(8)	3(17)	-(0)	1(1)	2(1)
Bals sagi	9(9)	2(1)	1(1)	4(2)	5(1)	5(6)	8(3)	2(1)	1(1)	-(0)	-(0)	-(0)	-(0)	1(1)	-(0)
Clem pseu	-(0)	-(0)	-(0)	-(0)	1(3)	-(0)	5(0)	2(1)	1(1)	-(0)	-(0)	-(0)	2(1)	1(15)	-(0)
Clem tenu	-(0)	-(0)	-(0)	-(0)	1(1)	-(0)	-(0)	1(1)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)
Clin unif	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	9(3)	6(3)	-(0)	-(0)	-(0)
Copt occi	-(0)	-(0)	+(3)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)
Corn cana	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	3(1)	9(9)	8(5)	-(0)	-(0)	-(0)
Disp trac	-(0)	1(1)	2(1)	1(1)	2(1)	2(1)	1(1)	4(1)	3(1)	-(0)	3(1)	5(1)	10(1)	6(1)	2(1)
Gali bore	1(0)	-(0)	2(1)	2(1)	5(1)	5(1)	6(1)	5(1)	3(1)	6(1)	8(1)	6(1)	10(1)	3(1)	6(1)
Gali trif	-(0)	-(0)	+(0)	-(0)	-(0)	-(0)	1(1)	-(0)	-(0)	9(1)	5(1)	7(3)	10(1)	10(2)	-(0)
Gera rich	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	1(1)	7(1)	-(0)	-(0)	5(1)	6(5)	-(0)
Hier grac	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)
Osmo chil	-(0)	1(1)	3(1)	1(1)	7(1)	1(1)	1(1)	1(1)	4(1)	6(1)	8(1)	7(2)	8(1)	9(1)	2(1)
Pyro asar	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	6(1)	-(0)	4(0)	-(0)	3(1)	-(0)
Pyro secu	-(0)	-(0)	3(1)	-(0)	1(1)	3(1)	-(0)	4(1)	3(1)	6(1)	6(1)	5(1)	8(1)	8(2)	2(1)
Pyro unif	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	2(1)	-(0)	-(0)	-(0)	2(0)	-(0)
Sene stre	-(0)	-(0)	1(1)	-(0)	-(0)	1(1)	-(0)	1(1)	2(1)	-(0)	-(0)	-(0)	-(0)	1(T)	-(0)
Sene tria	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	4(0)	-(0)	-(0)	-(0)	3(1)	-(0)
Smil race	-(0)	1(1)	5(1)	2(1)	6(1)	4(1)	1(1)	2(1)	2(1)	1(1)	4(1)	3(1)	7(1)	5(1)	-(0)
Smil stel	-(0)	-(0)	1(1)	1(1)	2(1)	1(1)	6(1)	3(1)	1(1)	10(3)	6(1)	7(3)	7(1)	8(1)	2(1)
Stre ampl	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	4(4)	1(1)	1(3)	-(0)	6(1)	-(0)
Thal occi	-(0)	-(0)	5(7)	2(1)	7(5)	5(1)	3(1)	5(3)	2(5)	7(2)	6(4)	8(1)	10(1)	7(3)	6(1)
Tiar trif	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	1(1)	2(1)	-(0)	-(0)	-(0)
Trol laxu	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)
Vale sitc	-(0)	1(1)	+(1)	-(0)	1(1)	-(0)	-(0)	-(0)	1(1)	1(1)	-(0)	-(0)	-(0)	-(0)	-(0)
Vera viri	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)
Viol cana	-(0)	-(0)	-(0)	1(15)	-(0)	1(1)	-(0)	-(0)	-(0)	3(1)	3(1)	4(1)	5(3)	3(10)	-(0)
Viol orbi	-(0)	-(0)	+(1)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	1(1)	8(1)	5(3)	2(1)	1(3)	2(1)
Xero tena	-(0)	1(1)	1(1)	1(1)	1(1)	-(0)	-(0)	-(0)	-(0)	-(0)	3(19)	1(1)	-(0)	-(0)	-(0)

*Code to constancy values: + = 0-5%, 1 = 5-15%, 2 = 15-25%, 3 = 25-35%, 4 = 35-45%, 5 = 45-55%, 6 = 55-65%, 7 = 65-75%, 8 = 75-85%, 9 = 85-95%, 10 = 95-100%

(con.)

(See instructions for use on page 126)

Constancy* and average canopy coverage percent (the latter in parentheses) of important plants in Montana forest habitat types and phases

	PICEA SERIES (con.)				ABIES GRANDIS SERIES						THUJA PLICATA SERIES			
	SEST h.t.		LIBO h.t.	SMST h.t.	XETE h.t.	CLUN h.t.			LIBO h.t.		CLUN h.t.			OPHO h.t.
	PSME phase	PICEA phase				CLUN phase	ARNU phase	XETE phase	LIBO phase	XETE phase	CLUN phase	ARNU phase	MEFE phase	
No. of stands	5	5	21	10	6	6	6	4	5	3	15	9	7	11
TREES														
Juni scop	-(0)	2(0)	+(15)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)
Pinu flex	8(8)	-(0)	-(0)	1(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)
Pinu pond	-(0)	-(0)	1(5)	1(37)	8(4)	5(1)	2(0)	3(0)	6(27)	-(0)	2(1)	-(0)	-(0)	-(0)
Frax penn	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)
Pseu menz	10(29)	2(0)	10(19)	9(41)	10(30)	10(13)	10(14)	10(14)	10(26)	10(18)	10(17)	9(10)	10(14)	5(5)
Pinu cont	-(0)	-(0)	10(39)	8(17)	7(15)	5(11)	2(3)	8(5)	8(6)	10(7)	3(11)	1(1)	7(8)	-(0)
Lari occi	-(0)	-(0)	+(0)	-(0)	10(16)	3(0)	10(14)	8(14)	10(19)	10(7)	9(13)	7(9)	10(19)	2(2)
Pinu mont	-(0)	-(0)	-(0)	-(0)	5(0)	2(1)	3(2)	10(4)	-(0)	-(0)	3(5)	2(2)	3(8)	2(2)
Pice glau	6(11)	6(70)	4(34)	4(26)	-(0)	-(0)	5(15)	-(0)	-(0)	-(0)	-(0)	2(9)	-(0)	5(9)
Pice enge	4(26)	4(74)	6(19)	6(26)	3(0)	5(5)	3(26)	5(15)	2(1)	3(1)	9(16)	4(18)	9(13)	3(5)
Betu papy	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	8(5)	3(3)	2(1)	-(0)	2(11)	2(15)	-(0)	4(5)
Abie gran	-(0)	-(0)	-(0)	-(0)	10(19)	10(54)	10(50)	10(38)	10(38)	10(82)	5(29)	7(36)	3(2)	2(8)
Thuj plic	-(0)	-(0)	-(0)	-(0)	2(0)	2(1)	-(0)	3(3)	-(0)	-(0)	10(62)	10(46)	10(28)	8(30)
Tsug hete	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	2(0)	3(1)	-(0)	-(0)	1(0)	2(9)	-(0)	10(40)
Abie lasi	2(0)	8(4)	6(2)	2(0)	3(1)	3(9)	3(2)	8(6)	2(1)	-(0)	7(10)	6(8)	10(25)	7(5)
Tsug mert	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)
Pinu albi	6(1)	2(3)	4(1)	2(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)
Lari lyal	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)
SHRUBS AND SUBSHRUBS														
Alnu sinu	-(0)	-(0)	2(26)	-(0)	3(0)	(0)	-(0)	-(0)	4(1)	3(1)	1(2)	-(0)	3(19)	-(0)
Amel alni	-(0)	-(0)	3(3)	3(1)	7(0)	10(1)	5(5)	10(5)	10(2)	7(1)	5(1)	6(4)	3(1)	2(0)
Arte trid	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)
Holo disc	-(0)	-(0)	-(0)	-(0)	-(0)	3(9)	3(1)	3(0)	4(2)	-(0)	-(0)	1(1)	-(0)	-(0)
Juni comm	10(4)	6(0)	7(4)	6(6)	-(0)	2(1)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)
Juni hori	2(1)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)
Ledu glan	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)
Menz ferr	-(0)	-(0)	1(1)	-(0)	-(0)	-(0)	2(1)	3(3)	-(0)	-(0)	1(1)	1(3)	10(8)	5(1)
Oplo horr	-(0)	-(0)	-(0)	-(0)	-(0)	2(1)	-(0)	-(0)	-(0)	-(0)	-(0)	2(1)	-(0)	10(28)
Pach myrs	-(0)	-(0)	+(15)	-(0)	7(5)	5(3)	-(0)	8(1)	2(15)	7(2)	5(1)	2(9)	7(12)	3(1)
Phyl empe	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)
Phys malv	-(0)	-(0)	-(0)	-(0)	-(0)	2(15)	-(0)	-(0)	8(1)	-(0)	-(0)	1(1)	-(0)	-(0)
Prun virg	-(0)	-(0)	-(0)	4(1)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)
Purs trid	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)
Ribe lacu	2(1)	6(0)	3(1)	4(1)	-(0)	3(1)	2(1)	-(0)	2(1)	-(0)	4(0)	4(1)	4(1)	7(1)
Ribe mont	4(0)	-(0)	-(0)	1(1)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)
Rubu parv	-(0)	-(0)	4(0)	-(0)	5(0)	8(1)	8(3)	3(1)	6(1)	-(0)	7(1)	8(4)	6(1)	7(9)
Shep cana	10(1)	-(0)	6(10)	5(1)	2(1)	2(1)	-(0)	3(1)	2(1)	-(0)	2(1)	-(0)	1(3)	-(0)
Spir betu	2(1)	-(0)	7(3)	9(6)	8(2)	7(8)	5(1)	10(2)	10(2)	3(1)	5(3)	2(9)	3(3)	1(1)
Symp albu	-(0)	-(0)	6(4)	8(8)	-(0)	7(8)	8(11)	3(15)	6(2)	-(0)	3(1)	8(12)	-(0)	5(1)
Taxu brev	-(0)	-(0)	-(0)	-(0)	-(0)	2(1)	3(1)	-(0)	-(0)	-(0)	4(3)	3(6)	7(26)	5(4)
Vacc caes	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	2(1)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)
Vacc glob	-(0)	-(0)	7(13)	2(3)	10(22)	7(2)	2(1)	10(21)	8(2)	10(7)	7(8)	3(6)	9(11)	6(1)
Vacc myrt	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	2(1)	-(0)	-(0)	-(0)	-(0)	-(0)
Vacc scop	-(0)	4(0)	5(18)	1(1)	2(1)	-(0)	-(0)	3(0)	2(3)	3(1)	3(1)	-(0)	1(1)	1(1)
Arct uva-	2(1)	-(0)	6(2)	2(1)	2(1)	2(1)	-(0)	3(0)	4(1)	7(1)	-(0)	-(0)	-(0)	-(0)
Berb repe	4(1)	-(0)	6(1)	7(4)	8(2)	8(3)	7(5)	8(1)	6(1)	7(1)	7(2)	3(6)	-(0)	-(0)
Linn bore	-(0)	-(0)	10(19)	-(0)	-(0)	10(5)	8(8)	8(2)	10(30)	10(2)	9(4)	7(11)	6(9)	2(1)
FERNS AND FERN ALLIES														
Athy fili	-(0)	-(0)	-(0)	-(0)	-(0)	2(1)	2(15)	-(0)	-(0)	-(0)	1(0)	7(3)	-(0)	10(22)
Equi arve	-(0)	-(0)	1(1)	1(1)	-(0)	-(0)	2(1)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	4(1)
Gymn dryo	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	2(0)	6(1)	-(0)	10(28)
GRAMINOIDS														
Agro scab	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)
Agro spic	-(0)	-(0)	-(0)	1(1)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)
Cala cana	-(0)	-(0)	+(1)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)
Cala rube	-(0)	-(0)	9(20)	7(23)	10(14)	7(14)	3(8)	5(19)	10(14)	3(3)	3(1)	-(0)	1(1)	-(0)
Care geye	-(0)	-(0)	3(7)	4(10)	2(0)	2(1)	2(3)	3(1)	4(1)	-(0)	1(1)	-(0)	1(1)	-(0)
Fest idah	8(1)	10(1)	-(0)	1(1)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)
Fest scab	-(0)	8(1)	-(0)	1(1)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)
Hesp king	4(1)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)
Luzu hitc	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)
Oryz aspe	-(0)	-(0)	1(14)	3(1)	-(0)	2(0)	3(2)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)
Schi purp	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	1(1)	1(1)	-(0)	-(0)
FORBS														
Acta rubr	-(0)	-(0)	+(1)	-(0)	-(0)	-(0)	2(1)	-(0)	-(0)	-(0)	3(1)	6(1)	-(0)	8(1)
Aden bico	-(0)	-(0)	-(0)	-(0)	-(0)	7(0)	7(6)	8(5)	2(1)	-(0)	3(1)	9(2)	1(1)	8(5)
Aral nudi	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	8(17)	-(0)	-(0)	-(0)	-(0)	7(14)	-(0)	6(4)
Arni cord	4(2)	4(1)	9(4)	7(13)	-(0)	3(8)	2(3)	-(0)	4(2)	3(1)	-(0)	-(0)	1(1)	-(0)
Arni lati	-(0)	2(0)	2(14)	1(3)	3(19)	7(8)	7(11)	8(18)	4(15)	-(0)	4(12)	2(20)	9(20)	1(1)
Bals sagi	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)
Clem pseu	4(1)	4(T)	1(2)	2(3)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)
Clem tenu	-(0)	-(0)	+(15)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)
Clin unif	-(0)	-(0)	-(0)	-(0)	-(0)	10(4)	8(2)	10(5)	2(0)	-(0)	9(3)	9(10)	9(3)	9(10)
Copt occi	-(0)	-(0)	-(0)	-(0)	3(2)	3(8)	-(0)	3(0)	-(0)	-(0)	2(11)	3(34)	3(2)	1(15)
Corn cana	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	3(9)	-(0)	-(0)	-(0)	3(1)	4(1)	-(0)	1(1)
Disp trac	-(0)	-(0)	2(1)	6(1)	2(1)	5(1)	-(0)	3(0)	4(1)	-(0)	2(1)	-(0)	-(0)	1(3)
Gali bore	6(1)	4(1)	5(1)	7(1)	-(0)	-(0)	2(1)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)
Gali trif	-(0)	-(0)	2(1)	2(1)	-(0)	10(3)	7(1)	3(1)	4(1)	-(0)	5(1)	10(2)	-(0)	10(3)
Gera rich	-(0)	-(0)	2(0)	5(2)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)
Hier grac	-(0)	4(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)
Osmo chil	2(1)	6(1)	5(1)	10(1)	2(0)	7(1)	10(1)	8(1)	4(1)	3(1)	3(0)	10(4)	1(1)	10(1)
Pyro asar	-(0)	-(0)	-(0)	1(1)	2(0)	2(1)	3(2)	3(1)	4(1)	10(1)	5(1)	4(1)	7(1)	3(1)
Pyro secu	10(0)	8(1)	8(1)	7(1)	3(8)	8(0)	5(1)	3(1)	8(1)	7(1)	9(1)	6(1)	9(2)	3(1)
Pyro unif	-(0)	4(1)	+(1)	2(0)	-(0)	-(0)	2(1)	-(0)	-(0)	-(0)	1(1)	-(0)	-(0)	1(1)
Sene stre	8(1)	10(1)	+(T)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)
Sene tria	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	2(1)	-(0)	-(0)	-(0)	1(1)	4(1)	-(0)	1(1)
Smil race	-(0)	-(0)	3(1)	6(1)	-(0)	3(1)	5(1)	3(1)	4(1)	-(0)	5(1)	7(1)	1(1)	3(1)
Smil stel	-(0)	-(0)	2(1)	7(1)	2(1)	8(4)	8(3)	5(8)	8(1)	7(1)	5(1)	7(1)	1(1)	10(1)
Stre ampl	-(0)	-(0)	+(0)	-(0)	-(0)	-(0)	2(1)	-(0)	-(0)	-(0)	1(1)	2(1)	-(0)	5(1)
Thal occi	-(0)	-(0)	5(3)	7(7)	2(1)	5(0)	5(8)	8(6)	6(1)	-(0)	3(1)	3(1)	4(1)	7(1)
Tiar trif	-(0)	-(0)	-(0)	-(0)	-(0)	2(3)	3(3)	-(0)	-(0)	-(0)	4(0)	9(3)	1(3)	10(18)
Trol laxu	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)
Vale sitc	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)
Vera viri	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	1(0)	-(0)	-(0)	6(0)
Viol cana	-(0)	-(0)	1(8)	2(3)	-(0)	2(1)	2(1)	-(0)	-(0)	-(0)	-(0)	1(3)	-(0)	-(0)
Viol orbi	-(0)	-(0)	+(1)	1(0)	2(1)	7(1)	7(1)	8(1)	4(3)	10(1)	7(1)	9(2)	7(1)	8(2)
Xero tena	-(0)	-(0)	-(0)	-(0)	10(13)	3(1)	-(0)	10(24)	-(0)	10(15)	4(2)	-(0)	10(3)	-(0)

*Code to constancy values: + = 0-5%, 1 = 5-15%, 2 = 15-25%, 3 = 25-35%, 4 = 35-45%, 5 = 45-55%, 6 = 55-65%, 7 = 65-75%, 8 = 75-85%, 9 = 85-95%, 10 = 95-100%

(con.)

(See instructions for use on page 126)

Constancy* and average canopy coverage percent (the latter in parentheses) of important plants in Montana forest habitat types and phases

	TSUGA HETEROPHYLLA SERIES		ABIES LASIOCARPA SERIES										
	CLUN h.t.		OPHO h.t.	CLUN h.t.					GATR h.t.	VACA h.t.	CACA h.t.		
	CLUN phase	ARNU phase		CLUN phase	ARNU phase	VACA phase	XETE phase	MEFE phase			CACA phase	GATR phase	VACA phase
No. of stands	27	11	4	32	18	10	21	22	34	10	23	5	7
TREES													
Juni scop	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	1(1)	-(0)	-(0)	-(0)
Pinu flex	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)
Pinu pond	+(15)	-(0)	-(0)	2(5)	1(0)	4(2)	-(0)	-(0)	+(1)	-(0)	-(0)	-(0)	-(0)
Frax penn	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)
Pseu menz	7(6)	5(2)	8(6)	8(24)	7(10)	9(25)	9(24)	8(24)	7(16)	6(3)	+(0)	-(0)	3(0)
Pinu cont	4(5)	1(3)	-(0)	6(18)	4(6)	9(25)	6(13)	5(9)	8(15)	10(47)	7(21)	6(5)	10(45)
Lari occi	8(13)	6(9)	8(6)	8(20)	8(16)	7(11)	8(11)	6(6)	1(39)	1(15)	-(0)	-(0)	-(0)
Pinu mont	8(8)	6(7)	5(2)	2(5)	5(16)	5(1)	3(12)	1(8)	-(0)	-(0)	-(0)	-(0)	-(0)
Pice glau	4(3)	2(3)	3(15)	-(0)	3(19)	5(9)	-(0)	-(0)	1(52)	3(2)	+(3)	2(37)	-(0)
Pice enge	3(7)	3(25)	8(31)	8(26)	7(29)	5(5)	10(16)	10(26)	8(39)	5(4)	10(39)	8(32)	10(7)
Betu papy	4(3)	5(2)	-(0)	+(3)	4(12)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)
Abie gran	3(11)	4(38)	-(0)	3(8)	2(6)	3(1)	2(2)	2(36)	-(0)	-(0)	-(0)	-(0)	-(0)
Thuj plic	9(23)	8(29)	-(0)	+(3)	-(0)	-(0)	+(0)	2(1)	-(0)	-(0)	-(0)	-(0)	-(0)
Tsug hete	10(24)	10(43)	3(3)	1(0)	2(2)	-(0)	1(10)	+(0)	-(0)	-(0)	-(0)	-(0)	1(0)
Abie lasi	4(8)	3(18)	10(26)	10(32)	10(30)	10(12)	10(30)	10(31)	10(33)	10(4)	10(17)	10(24)	10(12)
Tsug mert	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	1(18)	+(37)	-(0)	-(0)	-(0)	-(0)	-(0)
Pinu albi	-(0)	-(0)	-(0)	1(6)	-(0)	1(1)	1(1)	1(8)	1(0)	5(1)	6(3)	-(0)	1(1)
Lari lyal	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)
SHRUBS AND SUBSHRUBS													
Alnu sinu	+(3)	1(3)	-(0)	3(6)	2(13)	1(0)	4(6)	5(5)	1(25)	-(0)	-(0)	-(0)	1(1)
Amel alni	5(1)	7(1)	-(0)	6(2)	7(1)	8(4)	7(3)	3(2)	4(1)	1(1)	-(0)	-(0)	-(0)
Arte trid	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)
Holo disc	+(1)	1(3)	-(0)	-(0)	1(1)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)
Juni comm	1(2)	-(0)	-(0)	1(8)	1(8)	6(7)	1(1)	-(0)	1(0)	7(2)	2(1)	2(1)	3(2)
Juni hori	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)
Ledu glan	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	+(1)	-(0)	1(1)	7(17)	-(0)	6(38)
Menz ferr	4(1)	2(2)	5(8)	4(2)	4(1)	3(0)	5(2)	10(29)	2(1)	1(1)	1(31)	2(1)	-(0)
Oplo horr	+(1)	3(1)	10(38)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)
Pach myrs	8(3)	6(3)	5(1)	6(9)	7(5)	6(10)	8(4)	5(6)	1(3)	1(1)	-(0)	-(0)	-(0)
Phyl empe	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	3(3)	-(0)	-(0)
Phys malv	-(0)	-(0)	-(0)	1(6)	-(0)	-(0)	-(0)	-(0)	+(1)	-(0)	-(0)	-(0)	-(0)
Prun virg	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)
Purs trid	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)
Ribe lacu	1(1)	3(5)	5(2)	4(1)	4(2)	-(0)	3(1)	5(3)	9(1)	-(0)	3(1)	10(1)	3(2)
Ribe mont	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)
Rubu parv	3(0)	7(1)	8(1)	7(5)	10(9)	6(1)	7(4)	8(2)	6(6)	-(0)	+(1)	-(0)	-(0)
Shep cana	1(1)	1(1)	-(0)	2(1)	1(1)	8(3)	2(4)	+(1)	1(5)	4(0)	+(1)	-(0)	4(1)
Spir betu	5(5)	5(7)	3(1)	6(3)	9(6)	10(9)	8(5)	5(3)	5(5)	5(2)	2(1)	2(1)	3(1)
Symp albu	1(1)	5(1)	5(8)	4(5)	6(5)	6(4)	1(1)	+(1)	4(5)	-(0)	-(0)	-(0)	-(0)
Taxu brev	4(18)	5(8)	10(29)	2(1)	6(7)	1(1)	2(2)	3(15)	-(0)	-(0)	-(0)	-(0)	-(0)
Vacc caes	+(1)	-(0)	-(0)	1(0)	1(1)	9(17)	1(1)	-(0)	-(0)	10(21)	-(0)	-(0)	9(20)
Vacc glob	9(13)	7(3)	8(1)	9(12)	8(14)	8(18)	10(27)	10(22)	6(8)	4(4)	3(4)	4(2)	-(0)
Vacc myrt	-(0)	1(1)	-(0)	1(5)	1(0)	1(3)	+(3)	-(0)	1(1)	2(8)	+(1)	-(0)	3(27)
Vacc scop	3(9)	3(1)	3(1)	2(10)	1(1)	2(9)	3(9)	2(2)	4(8)	8(20)	9(28)	10(2)	4(30)
Arct uva-	2(5)	-(0)	-(0)	1(1)	1(1)	10(11)	+(1)	-(0)	+(1)	6(1)	-(0)	-(0)	3(19)
Berb repe	4(1)	4(1)	-(0)	6(3)	6(3)	10(4)	3(3)	2(1)	5(1)	3(1)	+(1)	-(0)	1(1)
Linn bore	8(18)	7(4)	3(15)	6(17)	8(15)	10(31)	4(10)	5(20)	4(10)	4(18)	-(0)	4(9)	6(11)
FERNS AND FERN ALLIES													
Athy fili	+(0)	5(1)	10(17)	+(0)	3(12)	-(0)	+(1)	+(1)	1(0)	-(0)	-(0)	2(1)	-(0)
Equi arve	+(1)	1(1)	-(0)	1(1)	1(1)	-(0)	-(0)	-(0)	2(3)	-(0)	2(1)	6(1)	1(1)
Gymn dryo	2(0)	6(2)	10(12)	-(0)	5(14)	-(0)	+(0)	2(0)	-(0)	-(0)	-(0)	-(0)	-(0)
GRAMINOIDS													
Agro scab	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	1(1)	-(0)	-(0)	-(0)
Agro spic	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)
Cala cana	-(0)	-(0)	-(0)	-(0)	1(0)	-(0)	-(0)	+(15)	1(2)	1(1)	7(21)	10(17)	10(25)
Cala rube	1(14)	-(0)	-(0)	6(8)	2(1)	9(8)	3(4)	1(1)	6(7)	9(37)	1(1)	4(2)	6(17)
Care geye	+(1)	-(0)	-(0)	3(1)	1(0)	1(1)	3(1)	-(0)	4(11)	4(1)	1(5)	2(3)	3(8)
Fest idah	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	1(1)	-(0)	-(0)	1(1)
Fest scab	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	1(1)
Hesp king	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)
Luzu hitc	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	+(1)	-(0)	-(0)	2(5)	-(0)	-(0)
Oryz aspe	1(1)	1(0)	-(0)	+(1)	3(1)	3(1)	-(0)	-(0)	1(2)	-(0)	-(0)	-(0)	-(0)
Schi purp	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)
FORBS													
Acta rubr	1(1)	3(1)	10(1)	2(1)	1(1)	-(0)	1(1)	1(1)	7(2)	-(0)	-(0)	4(2)	-(0)
Aden bico	2(0)	6(5)	5(3)	2(1)	6(1)	1(3)	2(1)	+(1)	-(0)	-(0)	-(0)	-(0)	-(0)
Aral nudi	3(1)	9(5)	5(9)	-(0)	7(17)	1(1)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)
Arni cord	-(0)	-(0)	-(0)	2(9)	-(0)	3(1)	1(1)	-(0)	5(10)	8(2)	3(4)	6(1)	6(8)
Arni lati	1(14)	2(26)	8(7)	9(21)	8(23)	5(5)	8(17)	9(33)	5(25)	1(3)	7(9)	4(9)	4(2)
Bals sagi	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)
Clem pseu	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)
Clem tenu	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	1(1)	-(0)	-(0)	-(0)	-(0)
Clin unif	9(10)	10(9)	10(6)	10(5)	9(9)	10(3)	10(5)	10(7)	-(0)	-(0)	-(0)	-(0)	1(0)
Copt occi	1(15)	1(3)	-(0)	1(17)	2(15)	-(0)	-(0)	4(11)	1(19)	-(0)	-(0)	-(0)	-(0)
Corn cana	3(1)	5(1)	3(1)	2(4)	7(5)	5(4)	1(8)	1(3)	1(19)	-(0)	-(0)	-(0)	-(0)
Disp trac	-(0)	-(0)	-(0)	3(1)	2(1)	-(0)	+(1)	1(1)	4(1)	-(0)	+(1)	-(0)	4(1)
Gali bore	-(0)	-(0)	-(0)	2(0)	-(0)	4(1)	1(1)	-(0)	4(1)	1(1)	+(1)	-(0)	1(1)
Gali trif	3(1)	6(1)	8(1)	4(1)	8(1)	2(2)	4(1)	6(1)	10(1)	-(0)	-(0)	10(3)	1(1)
Gera rich	-(0)	-(0)	-(0)	+(1)	-(0)	-(0)	-(0)	-(0)	4(1)	1(0)	1(1)	4(1)	1(0)
Hier grac	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	3(1)	2(1)	1(1)
Osmo chil	4(1)	6(1)	8(1)	7(2)	9(1)	8(1)	7(1)	6(2)	9(2)	-(0)	5(1)	8(1)	3(1)
Pyro asar	7(1)	5(0)	-(0)	4(1)	6(1)	2(1)	6(1)	5(1)	3(1)	1(0)	3(1)	8(1)	4(1)
Pyro secu	10(1)	7(1)	5(1)	8(1)	7(1)	4(1)	9(2)	9(2)	10(1)	4(0)	5(1)	8(2)	3(2)
Pyro unif	1(1)	2(1)	-(0)	1(0)	1(1)	-(0)	-(0)	1(1)	3(1)	-(0)	-(0)	8(1)	-(0)
Sene stre	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)
Sene tria	-(0)	-(0)	-(0)	2(1)	2(2)	-(0)	1(1)	2(5)	4(1)	-(0)	9(10)	6(5)	1(1)
Smil race	2(1)	2(1)	3(1)	3(1)	3(1)	4(1)	1(1)	1(1)	4(0)	1(1)	-(0)	-(0)	-(0)
Smil stel	6(1)	9(1)	10(5)	3(2)	8(1)	5(1)	4(1)	3(7)	5(1)	-(0)	-(0)	2(1)	3(1)
Stre ampl	+(0)	2(0)	5(1)	2(1)	3(1)	-(0)	-(0)	2(1)	5(1)	-(0)	4(0)	10(1)	3(2)
Thal occi	1(1)	3(1)	10(1)	8(5)	9(1)	3(1)	10(2)	7(4)	10(6)	2(1)	4(10)	10(2)	3(2)
Tiar trif	6(1)	10(6)	10(12)	3(4)	8(4)	1(1)	6(4)	5(10)	1(1)	-(0)	1(1)	-(0)	1(1)
Trol laxu	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	1(1)	-(0)	7(3)	-(0)	1(3)
Vale sitc	-(0)	-(0)	-(0)	1(2)	-(0)	-(0)	-(0)	1(1)	2(1)	-(0)	6(1)	2(1)	3(3)
Vera viri	-(0)	-(0)	8(1)	2(1)	3(1)	-(0)	2(1)	1(1)	2(2)	-(0)	5(4)	2(3)	1(3)
Viol cana	-(0)	-(0)	8(2)	-(0)	1(1)	-(0)	-(0)	1(1)	1(1)	-(0)	+(3)	-(0)	-(0)
Viol orbi	9(1)	9(2)	10(2)	8(2)	7(2)	8(2)	9(2)	9(3)	6(1)	1(1)	5(2)	4(1)	4(1)
Xero tena	5(10)	3(0)	3(1)	6(2)	4(2)	6(44)	10(27)	9(9)	2(6)	1(63)	3(7)	2(1)	3(0)

*Code to constancy values: + = 0-5%, 1 = 5-15%, 2 = 15-25%, 3 = 25-35%, 4 = 35-45%, 5 = 45-55%, 6 = 55-65%, 7 = 65-75%, 8 = 75-85%, 9 = 85-95%, 10 = 95-100%

(con.)

(See instructions for use on page 126)

Constancy* and average canopy coverage percent (the latter in parentheses) of important plants in Montana forest habitat types and phases

ABIES LASIOCARPA SERIES (con.)	LIBO h.t. LIBO phase	LIBO h.t. XETE phase	LIBO h.t. VASC phase	MEFE h.t.	TSME/MEFE h.t.	XETE h.t. VAGL phase	XETE h.t. VASC phase	TSME/XETE h.t.	VAGL h.t.	VASC h.t. CARU phase	VASC h.t. VASC phase	VASC h.t. THOC phase	ALSI h.t.	CARU h.t.	CLPS h.t.
No. of stands	20	13	17	64	10	40	21	9	21	10	17	10	6	8	15
TREES															
Juni scop	1(1)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	1(1)	-(0)	-(0)	-(0)	-(0)
Pinu flex	1(1)	-(0)	1(1)	-(0)	-(0)	+(0)	-(0)	-(0)	+(3)	-(0)	-(0)	1(0)	-(0)	-(0)	10(17)
Pinu pond	3(11)	1(3)	-(0)	-(0)	-(0)	1(7)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	1(0)
Frax penn	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)
Pseu menz	10(29)	10(25)	6(10)	6(16)	2(3)	9(22)	2(4)	3(10)	8(18)	8(26)	1(2)	1(0)	3(33)	10(28)	9(35)
Pinu cont	8(27)	8(17)	10(44)	8(17)	6(5)	9(18)	10(40)	10(11)	10(30)	10(45)	9(47)	9(26)	10(29)	9(45)	3(5)
Lari occi	2(33)	8(16)	1(8)	3(9)	6(7)	4(9)	+(0)	4(12)	+(37)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)
Pinu mont	-(0)	2(8)	-(0)	+(3)	3(3)	3(7)	-(0)	6(3)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)
Pice glau	-(0)	-(0)	1(43)	-(0)	-(0)	-(0)	-(0)	-(0)	1(15)	2(3)	-(0)	-(0)	-(0)	-(0)	5(26)
Pice enge	8(21)	9(9)	9(9)	9(18)	9(5)	7(10)	8(5)	7(3)	6(12)	8(6)	4(5)	10(33)	10(24)	8(12)	4(30)
Betu papy	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)
Abie gran	1(2)	2(2)	-(0)	+(3)	-(0)	2(1)	-(0)	2(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)
Thuj plic	-(0)	-(0)	-(0)	+(1)	-(0)	+(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)
Tsug hete	-(0)	-(0)	-(0)	+(0)	-(0)	+(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)
Abie lasi	10(20)	10(30)	10(14)	10(30)	10(21)	10(26)	10(24)	10(13)	-(0)	10(14)	10(18)	10(32)	10(28)	10(22)	10(22)
Tsug mert	-(0)	-(0)	-(0)	+(3)	10(28)	1(3)	1(2)	10(25)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)
Pinu albi	2(1)	1(0)	4(1)	4(5)	4(3)	4(7)	5(7)	7(2)	6(7)	5(1)	8(2)	6(1)	7(4)	4(0)	3(10)
Lari lyal	-(0)	-(0)	-(0)	+(37)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)
SHRUBS AND SUBSHRUBS															
Alnu sinu	4(4)	2(2)	1(0)	3(13)	-(0)	3(3)	+(1)	2(2)	1(0)	-(0)	1(3)	-(0)	10(36)	-(0)	-(0)
Amel alni	5(1)	6(3)	1(1)	1(0)	-(0)	3(1)	1(1)	-(0)	1(1)	-(0)	-(0)	-(0)	-(0)	3(1)	1(0)
Arte trid	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)
Holo disc	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)
Juni comm	3(1)	2(1)	6(2)	+(1)	-(0)	+(1)	1(1)	-(0)	5(1)	5(8)	2(1)	3(1)	2(1)	6(11)	7(3)
Juni hori	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)
Ledu glan	-(0)	-(0)	1(15)	1(4)	-(0)	-(0)	1(2)	-(0)	+(1)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)
Menz ferr	4(1)	7(2)	1(2)	10(45)	10(41)	3(1)	1(2)	7(3)	-(0)	-(0)	-(0)	-(0)	2(1)	-(0)	-(0)
Oplo horr	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)
Pach myrs	3(2)	6(10)	-(0)	1(8)	1(1)	4(5)	-(0)	1(3)	1(8)	-(0)	1(1)	-(0)	-(0)	1(1)	1(3)
Phyl empe	-(0)	-(0)	-(0)	1(0)	-(0)	-(0)	-(0)	1(85)	-(0)	-(0)	1(1)	-(0)	2(1)	-(0)	-(0)
Phys malv	2(4)	-(0)	-(0)	+(9)	-(0)	-(0)	-(0)	-(0)	+(1)	-(0)	-(0)	-(0)	-(0)	-(0)	1(0)
Prun virg	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)
Purs trid	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)
Ribe lacu	5(1)	1(1)	2(0)	4(2)	-(0)	1(1)	+(1)	1(3)	4(1)	3(1)	1(1)	1(1)	5(1)	4(1)	1(2)
Ribe mont	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	3(4)
Rubu parv	6(1)	6(1)	-(0)	2(1)	-(0)	1(1)	-(0)	1(1)	3(1)	1(1)	-(0)	-(0)	2(3)	-(0)	1(1)
Shep cana	6(2)	3(1)	5(8)	1(5)	-(0)	1(5)	+(1)	-(0)	4(5)	2(8)	-(0)	-(0)	-(0)	4(13)	5(1)
Spir betu	9(4)	7(7)	8(1)	1(1)	-(0)	6(1)	5(1)	1(3)	10(2)	8(4)	4(1)	3(1)	3(1)	5(12)	5(6)
Symp albu	3(1)	2(2)	1(1)	+(1)	-(0)	+(1)	+(1)	-(0)	1(2)	3(1)	-(0)	-(0)	-(0)	5(8)	3(2)
Taxu brev	-(0)	2(19)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)
Vacc caes	1(1)	-(0)	1(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)
Vacc glob	7(6)	10(23)	6(9)	8(13)	9(25)	10(34)	4(1)	10(27)	10(37)	6(2)	1(8)	3(6)	7(11)	5(2)	-(0)
Vacc myrt	1(1)	1(1)	1(1)	1(22)	-(0)	1(8)	2(32)	-(0)	1(9)	-(0)	-(0)	2(8)	3(9)	-(0)	-(0)
Vacc scop	5(2)	5(24)	10(43)	6(21)	9(15)	7(12)	9(58)	9(28)	8(33)	10(52)	10(58)	9(45)	5(1)	4(1)	-(0)
Arct uva-	3(8)	5(3)	4(1)	+(18)	-(0)	1(8)	+(1)	-(0)	+(1)	4(0)	1(1)	-(0)	-(0)	3(2)	1(1)
Berb repe	5(2)	7(3)	5(1)	1(1)	-(0)	3(1)	+(1)	-(0)	5(1)	7(1)	1(0)	1(1)	2(1)	6(1)	7(1)
Linn bore	10(21)	10(10)	10(19)	2(11)	-(0)	1(0)	-(0)	-(0)	+(1)	1(1)	-(0)	1(1)	2(0)	3(0)	-(0)
FERNS AND FERN ALLIES															
Athy fili	-(0)	-(0)	-(0)	+(1)	-(0)	+(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)
Equi arve	1(1)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	1(1)	-(0)	-(0)	-(0)
Gymn dryo	-(0)	-(0)	-(0)	+(1)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)
GRAMINOIDS															
Agro scab	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	1(1)	-(0)	-(0)	-(0)	-(0)	-(0)
Agro spic	1(1)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	1(0)	-(0)	-(0)	-(0)	2(1)
Cala cana	-(0)	-(0)	1(0)	+(8)	-(0)	1(1)	-(0)	-(0)	-(0)	-(0)	-(0)	3(1)	-(0)	-(0)	-(0)
Cala rube	9(6)	6(8)	10(13)	2(3)	-(0)	6(7)	4(2)	2(8)	5(7)	9(13)	5(1)	5(4)	5(1)	10(32)	1(1)
Care geye	2(2)	3(1)	4(3)	+(1)	-(0)	5(2)	7(5)	1(1)	8(6)	8(14)	7(11)	5(4)	3(8)	8(15)	5(3)
Fest idah	-(0)	-(0)	-(0)	-(0)	-(0)	+(1)	-(0)	-(0)	-(0)	-(0)	-(0)	1(1)	-(0)	1(1)	4(1)
Fest scab	-(0)	-(0)	-(0)	-(0)	-(0)	+(1)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	3(1)
Hesp king	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	1(1)
Luzu hitc	-(0)	-(0)	-(0)	+(1)	-(0)	+(1)	+(1)	-(0)	-(0)	-(0)	1(0)	-(0)	-(0)	-(0)	-(0)
Oryz aspe	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	1(1)
Schi purp	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)
FORBS															
Acta rubr	2(1)	-(0)	1(1)	+(1)	-(0)	-(0)	-(0)	-(0)	+(1)	-(0)	-(0)	-(0)	-(0)	1(1)	1(1)
Aden bico	-(0)	1(1)	-(0)	+(1)	-(0)	+(1)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)
Aral nudi	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)
Arni cord	6(6)	1(1)	6(4)	+(1)	-(0)	2(2)	2(1)	-(0)	8(5)	9(5)	4(1)	8(5)	5(13)	9(15)	10(7)
Arni lati	7(24)	8(12)	4(11)	9(21)	5(12)	6(10)	7(6)	4(5)	4(12)	2(19)	5(4)	6(11)	3(20)	1(63)	2(3)
Bals sagi	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)
Clem pseu	1(1)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	7(4)
Clem tenu	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	1(2)
Clin unif	1(0)	2(0)	-(0)	-(0)	-(0)	+(1)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)
Copt occi	-(0)	1(1)	-(0)	+(3)	-(0)	1(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)
Corn cana	-(0)	-(0)	1(3)	+(1)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)
Disp trac	3(0)	1(1)	-(0)	+(1)	-(0)	-(0)	-(0)	-(0)	2(0)	1(1)	-(0)	-(0)	-(0)	3(1)	3(1)
Gali bore	4(1)	-(0)	2(1)	-(0)	-(0)	-(0)	-(0)	-(0)	2(1)	5(1)	1(1)	-(0)	-(0)	5(1)	10(2)
Gali trif	3(0)	2(1)	1(1)	2(1)	-(0)	+(1)	-(0)	-(0)	1(1)	1(0)	-(0)	-(0)	2(1)	1(1)	-(0)
Gerr rich	2(1)	-(0)	1(1)	-(0)	-(0)	-(0)	-(0)	-(0)	+(3)	1(1)	-(0)	2(1)	-(0)	1(0)	-(0)
Hier grac	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	1(1)	-(0)	-(0)	-(0)	4(0)	4(1)	-(0)	-(0)	-(0)
Osmo chil	7(1)	4(0)	2(1)	2(1)	-(0)	3(1)	1(1)	-(0)	7(1)	5(1)	1(1)	8(1)	3(1)	9(1)	7(1)
Pyro asar	3(0)	3(1)	1(1)	5(1)	4(2)	2(0)	-(0)	3(3)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)
Pyro secu	10(2)	7(1)	9(0)	9(1)	7(2)	7(1)	5(2)	7(2)	8(2)	7(2)	2(0)	7(1)	10(1)	9(1)	7(1)
Pyro unif	1(1)	-(0)	-(0)	+(1)	-(0)	-(0)	-(0)	-(0)	+(1)	-(0)	-(0)	-(0)	-(0)	-(0)	1(1)
Sene stre	1(1)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	1(1)	-(0)	3(1)	5(1)
Sene tria	-(0)	-(0)	-(0)	1(2)	-(0)	+(3)	-(0)	-(0)	-(0)	-(0)	1(1)	1(1)	2(0)	-(0)	-(0)
Smil race	5(1)	2(1)	2(1)	1(1)	-(0)	1(1)	-(0)	-(0)	2(1)	2(1)	1(1)	-(0)	-(0)	4(1)	2(1)
Smil stel	2(1)	-(0)	1(1)	+(2)	-(0)	-(0)	-(0)	-(0)	+(1)	-(0)	-(0)	-(0)	-(0)	4(2)	3(1)
Stre ampl	-(0)	-(0)	-(0)	1(1)	-(0)	-(0)	-(0)	-(0)	+(1)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)
Thal occi	8(3)	4(1)	4(8)	4(3)	-(0)	5(3)	1(1)	-(0)	8(1)	4(8)	1(1)	9(6)	5(1)	8(16)	6(4)
Tiar trif	-(0)	1(1)	-(0)	2(2)	-(0)	1(2)	-(0)	1(3)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)
Trol laxu	-(0)	-(0)	-(0)	-(0)	-(0)	+(1)	-(0)	-(0)	+(1)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)
Vale sitc	1(1)	1(1)	1(1)	1(1)	-(0)	2(2)	3(1)	1(1)	2(1)	2(2)	1(0)	4(1)	-(0)	3(1)	-(0)
Vera viri	1(1)	-(0)	-(0)	1(1)	-(0)	+(1)	+(0)	-(0)	1(1)	-(0)	1(1)	-(0)	2(3)	1(1)	-(0)
Viol cana	1(1)	-(0)	-(0)	+(1)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	1(0)	1(3)
Viol orbi	7(2)	8(1)	4(1)	5(1)	2(1)	7(1)	4(1)	-(0)	+(1)	-(0)	-(0)	4(1)	2(1)	1(15)	-(0)
Xero tena	4(2)	10(29)	1(1)	8(17)	10(31)	10(46)	10(20)	10(41)	1(3)	-(0)	2(1)	-(0)	2(3)	1(3)	1(1)

*Code to constancy values: + = 0-5%, 1 = 5-15%, 2 = 15-25%, 3 = 25-35%, 4 = 35-45%, 5 = 45-55%, 6 = 55-65%, 7 = 65-75%, 8 = 75-85%, 9 = 85-95%, 10 = 95-100%

(con.)

(See instructions for use on page 126)

Constancy* and average canopy coverage percent (the latter in parentheses) of important plants in Montana forest habitat types and phases

	ABIES LASIOCARPA SERIES (con.)										PINUS CONTORTA SERIES				
	ARCO h.t.	CAGE h.t.		RIMO h.t.	ABLA-PIAL/VASC h.t.	LUHI h.t.		PIAL-ABLA h.t.	LALY-ABLA h.t.	PIAL h.t.	PUTR h.t.	VACA c.t.	LIBO c.t.	VASC c.t.	CARU c.t.
		CAGE phase	PSME phase			VASC phase	MEFE phase								
No. of Stands	24	3	6	6	44	29	24	30	36	9	3	12	17	20	6
TREES															
Juni scop	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	1(1)	1(0)	-(0)	3(1)
Pinu flex	+(0)	7(2)	2(1)	-(0)	-(0)	-(0)	-(0)	+(1)	-(0)	1(37)	-(0)	-(0)	-(0)	-(0)	-(0)
Pinu pond	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	1(1)	-(0)	-(0)	-(0)
Frax penn	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)
Pseu menz	8(30)	3(3)	10(78)	-(0)	1(1)	1(0)	-(0)	+(3)	-(0)	6(1)	-(0)	8(1)	7(3)	5(6)	5(0)
Pinu cont	7(24)	7(74)	2(3)	-(0)	7(18)	6(12)	4(3)	1(8)	-(0)	1(0)	10(70)	10(60)	10(64)	10(56)	10(62)
Lari occi	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	1(1)	-(0)	-(0)
Pinu mont	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)
Pice glau	1(30)	-(0)	-(0)	5(37)	-(0)	-(0)	-(0)	+(0)	-(0)	-(0)	-(0)	2(2)	1(0)	-(0)	-(0)
Pice enge	6(14)	3(0)	3(3)	3(8)	8(13)	8(12)	8(22)	7(10)	4(11)	2(0)	-(0)	3(1)	8(1)	4(1)	2(1)
Betu papy	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)
Abie gran	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)
Thuj plic	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)
Tsug hete	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)
Abie lasi	10(32)	10(33)	10(19)	10(50)	10(23)	10(29)	9(37)	10(27)	9(16)	7(0)	-(0)	7(3)	6(1)	6(3)	3(0)
Tsug mert	-(0)	-(0)	-(0)	-(0)	-(0)	+(3)	-(0)	-(0)	+(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)
Pinu albi	5(10)	7(2)	3(2)	5(30)	10(33)	10(19)	8(15)	10(32)	9(14)	10(67)	3(1)	6(1)	4(1)	6(1)	5(5)
Lari lyal	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	5(35)	+(0)	10(47)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)
SHRUBS AND SUBSHRUBS															
Alnu sinu	-(0)	-(0)	-(0)	-(0)	+(19)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	1(8)	1(3)	-(0)
Amel alni	+(1)	-(0)	-(0)	-(0)	-(0)	+(1)	-(0)	-(0)	-(0)	-(0)	-(0)	2(1)	1(1)	1(1)	2(1)
Arte trid	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	1(1)	-(0)	-(0)	-(0)	-(0)	-(0)
Holo disc	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)
Juni comm	3(1)	3(1)	2(1)	-(0)	3(2)	+(1)	-(0)	2(3)	1(1)	6(8)	3(1)	5(1)	5(2)	4(1)	7(1)
Juni hori	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	1(3)	-(0)	-(0)	-(0)	-(0)	-(0)
Ledu glan	-(0)	-(0)	-(0)	-(0)	+(3)	1(6)	1(3)	+(1)	3(7)	-(0)	-(0)	-(0)	1(15)	-(0)	-(0)
Menz ferr	-(0)	-(0)	-(0)	-(0)	+(0)	1(2)	9(44)	-(0)	-(0)	-(0)	-(0)	-(0)	1(0)	-(0)	-(0)
Oplo horr	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)
Pach myrs	-(0)	-(0)	-(0)	-(0)	-(0)	1(1)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	1(1)	-(0)
Phyl empe	-(0)	-(0)	-(0)	-(0)	1(14)	2(7)	1(6)	1(9)	7(14)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)
Phys malv	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	1(1)	-(0)	-(0)
Prun virg	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)
Purs trid	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	10(18)	-(0)	-(0)	-(0)	-(0)
Ribe lacu	3(1)	3(0)	3(1)	-(0)	+(1)	1(1)	1(2)	1(1)	-(0)	-(0)	-(0)	-(0)	1(0)	1(1)	-(0)
Ribe mont	3(1)	-(0)	2(1)	10(14)	-(0)	-(0)	-(0)	+(3)	-(0)	2(9)	-(0)	-(0)	-(0)	-(0)	-(0)
Rubu parv	1(2)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	2(1)	-(0)	-(0)
Shep cana	2(10)	-(0)	-(0)	2(1)	-(0)	-(0)	-(0)	-(0)	-(0)	2(1)	-(0)	4(0)	7(5)	2(8)	2(1)
Spir betu	2(1)	7(1)	8(1)	-(0)	1(1)	+(1)	-(0)	-(0)	-(0)	1(1)	-(0)	5(1)	8(2)	7(3)	7(11)
Symp albu	+(0)	-(0)	3(19)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	1(1)	-(0)	-(0)	2(1)	-(0)	2(1)
Taxu brev	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)
Vacc caes	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	10(19)	2(0)	-(0)	-(0)
Vacc glob	1(1)	3(3)	3(1)	-(0)	4(7)	4(13)	6(12)	1(10)	1(1)	-(0)	-(0)	2(1)	5(29)	2(1)	2(1)
Vacc myrt	+(1)	-(0)	-(0)	-(0)	1(14)	1(31)	1(8)	+(63)	-(0)	-(0)	-(0)	2(8)	-(0)	1(3)	-(0)
Vacc scop	1(1)	7(3)	-(0)	2(3)	9(42)	10(36)	9(22)	7(35)	8(11)	2(50)	-(0)	5(18)	8(29)	10(58)	5(5)
Arct uva-	-(0)	-(0)	-(0)	-(0)	+(1)	-(0)	-(0)	-(0)	-(0)	1(1)	10(1)	6(12)	6(2)	4(11)	5(18)
Berb repe	3(1)	3(1)	10(2)	-(0)	+(1)	-(0)	-(0)	-(0)	-(0)	2(2)	-(0)	4(1)	5(1)	4(0)	7(1)
Linn bore	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	3(23)	10(28)	2(1)	2(1)
FERNS AND FERN ALLIES															
Athy fili	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)
Equi arve	-(0)	-(0)	-(0)	-(0)	+(1)	-(0)	-(0)	-(0)	1(1)	-(0)	-(0)	-(0)	1(1)	-(0)	-(0)
Gymn dryo	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)
GRAMINOIDS															
Agro scab	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	+(1)	-(0)	-(0)	-(0)	1(1)	-(0)	1(1)	-(0)
Agro spic	1(1)	3(1)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	3(2)	10(1)	-(0)	-(0)	-(0)	2(1)
Cala cana	1(1)	-(0)	-(0)	-(0)	+(1)	-(0)	-(0)	-(0)	1(1)	-(0)	-(0)	1(3)	1(8)	-(0)	-(0)
Cala tube	2(1)	-(0)	7(2)	-(0)	1(1)	+(1)	-(0)	-(0)	-(0)	3(2)	-(0)	10(36)	10(23)	7(14)	10(36)
Care geye	3(3)	10(37)	10(42)	-(0)	6(11)	7(4)	2(1)	4(5)	1(7)	7(8)	-(0)	5(7)	2(1)	5(4)	7(11)
Fest idah	2(0)	3(1)	-(0)	2(1)	1(1)	-(0)	-(0)	2(3)	-(0)	6(12)	3(1)	2(1)	-(0)	-(0)	2(1)
Fest scab	-(0)	3(1)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	1(1)	-(0)	1(1)	-(0)	-(0)	-(0)
Hesp king	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)
Luzu hitc	-(0)	-(0)	-(0)	-(0)	-(0)	10(10)	9(8)	3(24)	9(13)	-(0)	-(0)	-(0)	-(0)	1(0)	-(0)
Oryz aspe	+(1)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)
Schi purp	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)
FORBS															
Acta rubr	+(1)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	1(1)	-(0)	-(0)
Aden bico	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)
Aral nudi	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)
Arni cord	10(6)	3(1)	8(15)	3(9)	5(5)	1(2)	-(0)	2(2)	-(0)	2(26)	-(0)	7(2)	7(1)	6(3)	7(8)
Arni lati	2(8)	7(3)	2(63)	7(5)	8(9)	7(8)	8(7)	7(7)	6(5)	2(20)	-(0)	-(0)	3(18)	4(2)	-(0)
Bals sagi	-(0)	-(0)	2(1)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	1(1)	-(0)	-(0)	-(0)	-(0)	-(0)
Clem pseu	+(0)	-(0)	2(1)	-(0)	-(0)	-(0)	-(0)	+(1)	-(0)	1(1)	-(0)	-(0)	-(0)	-(0)	-(0)
Clem tenu	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)
Clin unif	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)
Copt occi	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)
Corn cana	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	1(3)	-(0)	-(0)
Disp trac	1(1)	-(0)	5(1)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)
Gali bore	3(1)	-(0)	7(1)	3(1)	1(1)	-(0)	-(0)	+(3)	-(0)	4(2)	-(0)	3(1)	1(1)	1(1)	2(1)
Gali trif	-(0)	3(1)	3(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	1(1)	-(0)	-(0)	-(0)
Gera rich	-(0)	-(0)	2(1)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	1(0)	1(0)	-(0)	-(0)
Hier grac	-(0)	3(1)	-(0)	2(1)	5(1)	4(0)	3(0)	6(1)	6(2)	1(3)	-(0)	-(0)	-(0)	1(1)	-(0)
Osmo chil	9(1)	3(1)	10(1)	7(1)	3(1)	1(1)	-(0)	2(1)	-(0)	7(0)	-(0)	-(0)	2(1)	1(1)	-(0)
Pyro asar	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	1(0)	-(0)	-(0)	-(0)
Pyro secu	8(1)	7(1)	10(1)	5(1)	4(1)	2(1)	3(0)	1(1)	-(0)	1(1)	-(0)	3(0)	7(0)	3(1)	2(1)
Pyro unif	-(0)	-(0)	-(0)	2(1)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)
Sene stre	3(1)	-(0)	-(0)	3(1)	+(1)	-(0)	-(0)	+(1)	-(0)	3(1)	3(1)	-(0)	1(1)	-(0)	3(1)
Sene tria	+(1)	-(0)	-(0)	-(0)	1(1)	1(1)	1(1)	1(2)	1(1)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)
Smil race	+(1)	-(0)	7(1)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	1(1)	1(1)	-(0)	-(0)
Smil stel	+(1)	-(0)	5(1)	-(0)	-(0)	-(0)	+(1)	-(0)	-(0)	-(0)	-(0)	-(0)	1(1)	-(0)	-(0)
Stre ampl	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	+(1)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)
Thal occi	8(6)	7(2)	10(18)	-(0)	2(3)	2(1)	+(1)	1(1)	-(0)	2(9)	-(0)	3(1)	3(1)	1(3)	-(0)
Tiar trif	-(0)	-(0)	-(0)	-(0)	-(0)	+(1)	+(1)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)
Trol laxu	-(0)	-(0)	-(0)	-(0)	+(1)	1(1)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)
Vale sitc	+(1)	-(0)	2(1)	-(0)	4(2)	4(1)	+(3)	1(1)	1(3)	1(1)	-(0)	-(0)	1(1)	2(0)	-(0)
Vera viri	-(0)	-(0)	2(1)	-(0)	1(1)	3(1)	2(1)	+(1)	1(1)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)
Viol cana	-(0)	-(0)	2(3)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)	-(0)
Viol orbi	+(3)	-(0)	2(1)	-(0)	1(1)	4(1)	3(1)	1(1)	-(0)	-(0)	-(0)	-(0)	2(1)	1(3)	-(0)
Xero tena	-(0)	-(0)	-(0)	-(0)	2(31)	9(27)	7(15)	4(14)	3(1)	1(1)	-(0)	1(0)	-(0)	3(1)	-(0)

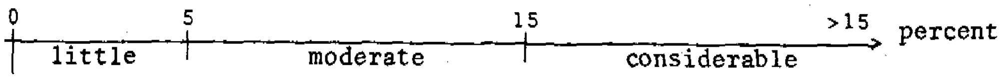
*Code to constancy values: + = 0-5%, 1 = 5-15%, 2 = 15-25%, 3 = 25-35%, 4 = 35-45%, 5 = 45-55%, 6 = 55-65%, 7 = 65-75%, 8 = 75-85%, 9 = 85-95%, 10 = 95-100%

APPENDIX D-1

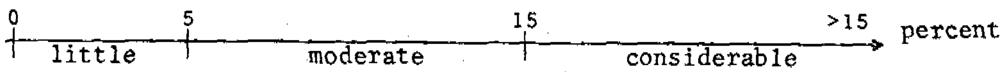
Soils data in the following four-page table are presented by habitat type and phase in a format similar to that for vegetative data (appendix C). COARSE FRAGMENT TYPES are shown as percentage of stands in which a given rock type was the apparent primary residual parent material. TEXTURAL CLASSES are also shown as percentage of stands having a given soil texture. All other categories of data are presented as mean values.

These appendix data and the individual stand data were used in writing the brief soil descriptions for series, habitat types, and phases. The terminology was based primarily on the USDA Soil Conservation Service (1975) definitions with some modifications. The basis for the adjectives as used in our text is:

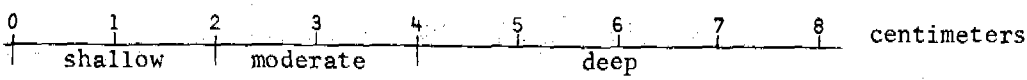
SURFACE ROCK EXPOSED (Includes cobbles, stones, and fixed rock; i.e., material >3 inches)



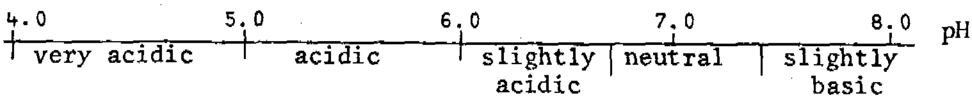
BARE SOIL EXPOSED (Includes soil and gravel; i.e., material <3 inches)



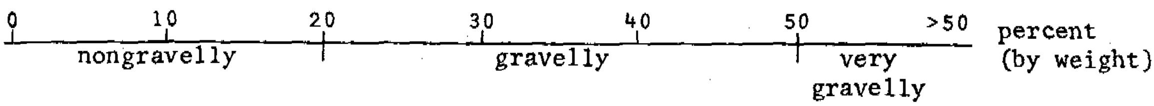
DUFF DEPTH



REACTION



GRAVEL CONTENT (Includes all coarse fragments <3 inches regardless of kind or shape



APPENDIX D-1

General soil characteristics (upper 10 cm) of Montana habitat types and phases (n = number of stands)

Soil characteristics	PINUS FLEXILIS SERIES: PIFL/AGSP h.t. n = 6	PIFL/FEID h.t. FEID phase n = 6	PIFL/FEID h.t. FESC phase n = 4	PIFL/JUCO h.t. n = 6	PINUS PONDEROSA SERIES: PIPO/AGSP h.t. n = 21	PIPO/FEID h.t. FEID phase n = 12	PIPO/FEID h.t. FESC phase n = 15	PIPO/PUTR h.t. AGSP phase n = 4	PIPO/PUTR h.t. FEID phase n = 7	PIPO/SYAL h.t. SYAL phase n = 7	PIPO/SYAL h.t. BERE phase n = 3	PIPO/PRVI h.t. PRVI phase n = 6	PIPO/PRVI h.t. SHCA phase n = 2	PSEUDOTSUGA MENZIESII SERIES: PSME/AGSP h.t. n = 11	PSME/FEID h.t. n = 14	PSME/FESC h.t. n = 13	PSME/VACA h.t. n = 22	PSME/PHMA h.t. PHMA phase n = 41	PSME/PHMA h.t. CARU phase n = 5	PSME/VAGL h.t. VAGL phase n = 10	PSME/VAGL h.t. ARUV phase n = 7	PSME/VAGL h.t. XETE phase n = 9	PSME/LIBO h.t. SYAL phase n = 8	PSME/LIBO h.t. CARU phase n = 10	PSME/LIBO h.t. VAGL phase n = 8
COARSE FRAGMENTS (in percent occurrence)																									
SEDIMENTARY																									
Calcareous	67	50	75	84	53	17	34	50	43	17	100	--	--	27	20	8	--	10	--	--	--	--	--	20	--
Noncalcareous	33	17	--	17	33	25	33	--	--	34	--	100	100	--	13	23	41	27	20	30	43	22	50	20	43
METAMORPHIC																									
Calcareous argillite	--	--	--	--	--	--	--	--	29	--	--	--	--	--	--	8	--	--	--	--	--	--	--	--	--
Argillite	--	--	25	--	9	17	13	--	14	--	--	--	--	18	7	46	41	20	--	20	14	55	37	20	--
Quartzite	--	--	--	--	5	25	13	--	--	--	--	--	--	18	20	8	--	7	--	10	--	--	--	--	14
Gneiss & schist	--	17	--	--	--	8	--	--	--	--	--	--	--	9	7	--	--	6	--	20	--	11	--	--	29
Miscellaneous	--	17	--	--	--	--	--	--	--	--	--	--	--	--	--	8	--	13	20	10	14	11	12	--	--
IGNEOUS																									
Basalt & andesite	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	5	--	--	--	--	--	--	--	--
Quartz monzonite	--	--	--	--	--	8	7	50	--	17	--	--	--	--	20	--	9	3	40	--	14	--	--	20	14
Rhyolite	--	--	--	--	--	--	--	--	14	33	--	--	--	--	--	--	--	5	--	--	--	--	--	10	--
Granite & biotite granite	--	--	--	--	--	--	--	--	--	--	--	--	--	18	13	--	--	5	20	--	--	--	--	10	--
Miscellaneous	--	--	--	--	--	--	--	--	--	--	--	--	--	9	--	--	5	--	--	--	--	--	--	--	--
MIXED	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	3	--	10	14	--	--	--	--
GROUND SURFACE																									
SURFACE ROCK EXPOSED (mean %)	18	12	3	6	3	5	8	4	5	0	0	1	0	11	9	5	1	2	5	2	0	1	1	0	0
BARE SOIL EXPOSED (mean %)	25	8	2	1	7	2	3	17	6	1	0	0	0	13	9	7	0	0	1	0	1	0	0	0	0
DUFF DEPTH (mean cm)	1.3	1.2	1.2	3.2	3.4	3.6	4.4	0.5	2.4	4.5	5.3	5.8	3.5	2.5	2.4	2.5	4.3	4.2	3.0	3.1	3.3	3.3	4.6	6.1	3.5
UPPER SOIL																									
REACTION (mean pH)	7.1	6.8	6.8	7.1	6.5	6.0	6.3	6.1	7.0	6.3	7.0	6.3	5.9	6.6	6.2	6.1	5.5	6.2	5.8	5.9	5.6	5.6	6.2	5.5	5.6
GRAVEL CONTENT (mean %)	38	36	24	27	33	31	41	33	24	31	3	19	25	42	31	37	26	44	38	47	36	58	31	22	34
TEXTURAL CLASS (percent occurrence)																									
Loamy sand	--	--	--	--	5	--	--	--	--	14	--	--	--	18	--	--	--	3	--	--	--	--	--	--	--
Sandy loam	--	17	25	--	5	9	7	--	29	29	--	--	--	27	21	--	76	10	20	--	--	11	12	20	13
Loam	67	33	50	17	29	36	20	--	29	--	--	--	--	18	43	27	24	31	40	42	--	44	25	30	13
Silt loam & silt	33	50	25	67	56	55	73	--	43	29	67	100	100	36	36	73	--	56	40	58	--	44	63	30	75
Silty clay loam & clay loam	--	--	--	17	5	--	--	--	--	29	33	--	--	--	--	--	--	--	--	--	100	--	--	20	--

(con.)

APPENDIX D-1 (con.)

Soil characteristics	PSEUDOTSUGA MENZIESII SERIES (con.): PSME/SYAL h.t.: AGSP phase n = 6	PSME/SYAL h.t.: CARU phase n = 38	PSME/SYAL h.t.: SYAL phase n = 14	PSME/CARU h.t.: AGSP phase n = 9	PSME/CARU h.t.: ARUV phase n = 8	PSME/CARU h.t.: CARU phase n = 50	PSME/CARU h.t.: PIPO phase n = 11	PSME/CAGE h.t. n = 9	PSME/SPBE h.t. n = 11	PSME/ARUV h.t. n = 7	PSME/JUCO h.t. n = 9	PSME/ARCO h.t. n = 11	PICEA SERIES: PICEA/EQAR h.t. n = 3	PICEA/CLUN h.t.: VACA phase n = 4	PICEA/CLUN h.t.: CLUN phase n = 4	PICEA/PHMA h.t. n = 3	PICEA/GATR h.t. n = 10	PICEA/VACA h.t. n = 2	PICEA/LIBO h.t. n = 20	PICEA/SMST h.t. n = 9	ABIES GRANDIS SERIES: ABGR/CLUN h.t.: CLUN phase n = 5	ABGR/CLUN h.t.: ARNU phase n = 3	ABGR/CLUN h.t.: XETE phase n = 3	ABGR/LIBO h.t.: XETE phase n = 2
COARSE FRAGMENTS (in percent occurrence)																								
SEDIMENTARY																								
Calcareous	34	8	35	33	--	6	9	33	18	57	22	9	67	--	--	67	10	--	10	25	--	--	--	--
Noncalcareous	17	29	14	--	--	16	36	33	45	14	22	27	--	--	28	--	10	50	5	--	20	33	--	100
METAMORPHIC																								
Calcareous argillite	--	--	--	--	--	--	--	--	9	--	--	--	--	--	--	--	--	--	--	--	20	--	--	--
Argillite	17	16	21	22	13	16	--	22	18	14	--	9	--	75	57	--	--	50	--	13	--	67	--	--
Quartzite	--	11	--	22	13	6	18	--	9	14	--	9	--	--	14	--	--	--	--	--	--	--	--	--
Gneiss & schist	17	10	14	11	--	8	9	11	--	--	--	--	--	--	--	--	30	--	25	--	20	--	--	--
Miscellaneous	17	6	--	11	13	4	9	--	--	--	--	--	--	25	--	--	--	--	--	--	--	--	67	--
IGNEOUS																								
Basalt & andesite	--	3	--	--	--	7	--	--	--	--	11	--	--	--	--	33	20	--	15	--	--	--	--	--
Quartz monzonite	--	13	--	--	50	7	18	--	--	--	--	--	--	--	--	--	10	--	5	--	20	--	--	--
Rhyolite	--	3	7	--	13	7	--	--	--	--	11	18	--	--	--	--	10	--	10	13	--	--	--	--
Granite & biotite granite	--	5	--	--	--	7	--	--	--	--	22	18	--	--	--	--	--	--	10	25	20	--	--	--
Miscellaneous	--	6	7	--	--	6	--	--	--	--	11	9	33	--	--	--	10	--	15	26	--	--	33	--
MIXED	--	--	--	--	--	3	--	--	--	--	--	--	--	--	--	--	--	--	5	--	--	--	--	--
GROUND SURFACE																								
SURFACE ROCK EXPOSED (mean %)	7	1	3	5	6	2	3	11	5	1	3	4	1	0	0	1	1	0	1	1	1	0	0	0
BARE SOIL EXPOSED (mean %)	2	0	1	0	2	1	0	1	2	5	2	0	3	0	0	0	0	0	0	0	0	0	0	0
DUFF DEPTH (mean cm)	2.6	3.6	4.1	3.7	3.5	4.1	4.5	4.7	2.5	6.0	4.2	4.3	7.3	2.6	6.3	6.5	6.8	2.6	6.4	6.0	4.4	4.5	3.5	3.5
UPPER SOIL																								
REACTION (mean pH)	6.4	5.9	6.5	6.0	5.6	5.7	5.7	6.2	6.3	6.9	5.8	6.0	6.8	5.0	5.5	6.1	6.1	6.1	6.1	5.9	5.7	5.8	5.3	5.6
GRAVEL CONTENT (mean %)	33	33	35	35	24	35	30	42	40	36	27	30	9	19	13	17	12	30	24	17	30	15	23	28
TEXTURAL CLASS (percent occurrence)																								
Loamy sand	--	3	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	5	--	11	--	--	--
Sandy loam	--	13	--	11	38	10	36	11	18	--	25	18	33	--	--	--	--	--	20	--	22	--	--	--
Loam	83	37	57	44	38	37	18	33	27	57	25	46	--	25	14	33	30	50	25	22	22	--	67	50
Silt loam & silt	17	45	43	44	25	53	45	56	55	43	50	36	67	75	86	67	70	50	50	78	33	100	--	50
Silty clay loam & clay loam	--	3	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	11	--	33	--

(con.)

APPENDIX D-1 (con.)

Soil characteristics	THUJA AND TSUGA SERIES: THPL/CLUN h.t.: CLUN phase n = 8	THPL/CLUN h.t.: ARNU phase n = 5	THPL/CLUN h.t.: MEFE phase n = 2	THPL/OPHO h.t. n = 2	TSHE/CLUN h.t.: CLUN phase n = 8	TSHE/CLUN h.t.: ARNU phase n = 4	ABIES LASIOCARPA SERIES: ABLA/OPHO h.t. n = 3	ABLA/CLUN h.t.: CLUN phase n = 20	ABLA/CLUN h.t.: ARNU phase n = 9	ABLA/CLUN h.t.: VACA phase n = 7	ABLA/CLUN h.t.: XETE phase n = 12	ABLA/CLUN h.t.: MEFE phase n = 11	ABLA/GATR h.t. n = 27	ABLA/VACA h.t. n = 8	ABLA/CACA h.t.: CACA phase n = 12	ABLA/CACA h.t.: GATR phase n = 2	ABLA/CACA h.t.: VACA phase n = 3	ABLA/LIBO h.t.: LIBO phase n = 13	ABLA/LIBO h.t.: XETE phase n = 5	ABLA/LIBO h.t.: VASC phase n = 14	ABLA/MEFE h.t. n = 40	TSME/MEFE h.t. n = 2
COARSE FRAGMENTS (in percent occurrence)																						
SEDIMENTARY																						
Calcareous	--	--	--	--	--	--	--	--	--	--	--	--	12	--	--	--	--	39	--	--	2	--
Noncalcareous	26	100	50	--	13	25	33	45	22	14	34	50	16	26	19	--	--	15	40	43	39	50
METAMORPHIC																						
Calcareous argillite	--	--	--	--	--	25	--	--	22	--	--	--	--	--	--	--	--	--	--	--	--	--
Argillite	63	--	50	50	38	25	33	10	22	57	50	30	8	--	--	--	--	--	20	14	15	50
Quartzite	--	--	--	--	25	--	--	--	11	29	--	--	8	25	--	50	--	--	--	7	5	--
Gneiss & schist	13	--	--	--	--	--	--	5	22	--	8	10	20	--	9	--	--	8	20	--	15	--
Miscellaneous	--	--	--	50	25	25	33	25	--	--	8	10	4	--	9	--	--	8	--	--	5	--
IGNEOUS																						
Basalt & andesite	--	--	--	--	--	--	--	--	--	--	--	--	4	--	--	--	--	8	--	7	--	--
Quartz monzonite	--	--	--	--	--	--	--	10	--	--	--	--	--	25	36	--	--	15	20	7	10	--
Rhyolite	--	--	--	--	--	--	--	--	--	--	--	--	4	--	--	--	--	--	--	21	--	--
Granite & biotite granite	--	--	--	--	--	--	--	5	--	--	--	--	8	25	18	50	67	8	--	--	5	--
Miscellaneous	--	--	--	--	--	--	--	--	--	--	--	--	12	--	--	--	33	--	--	--	4	--
MIXED	--	--	--	--	--	--	--	--	--	--	--	--	4	--	9	--	--	--	--	--	--	--
GROUND SURFACE																						
SURFACE ROCK EXPOSED (mean %)	2	10	0	0	0	0	0	1	0	0	0	1	0	0	0	5	0	3	0	1	1	0
BARE SOIL EXPOSED (mean %)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0
DUFF DEPTH (mean cm)	5.9	5.8	5.0	6.0	5.3	5.0	9.0	4.8	7.1	3.7	4.8	6.2	5.9	4.8	3.8	14	6.3	3.8	3.4	4.6	4.7	1.5
UPPER SOIL																						
REACTION (mean pH)	5.5	5.6	5.1	4.9	5.1	5.2	4.8	5.1	5.3	5.2	4.9	5.0	5.5	5.0	4.7	5.7	4.9	6.1	5.4	5.0	4.9	4.5
GRAVEL CONTENT (mean %)	26	25	30	5	22	35	10	25	18	34	40	33	13	17	15	7	4	27	49	20	28	48
TEXTURAL CLASS (percent occurrence)																						
Loamy sand	13	--	--	--	--	--	--	5	11	--	--	--	--	--	8	--	--	--	--	--	--	--
Sandy loam	--	20	--	--	--	--	--	10	11	--	17	10	15	13	17	--	--	--	20	--	7	--
Loam	38	40	--	100	13	50	100	30	56	29	42	30	23	38	25	100	67	62	40	14	48	50
Silt loam & silt	50	40	100	--	88	50	--	50	22	71	42	60	62	50	50	--	33	38	40	79	45	50
Silty clay loam & clay loam	--	--	--	--	--	--	--	5	--	--	--	--	--	--	--	--	--	--	--	7	--	--

(con.)

APPENDIX D-1 (con.)

Soil characteristics	ABIES LASIOCARPA SERIES (con.): ABLA/XETE h.t.: VAGL phase: n = 28	ABLA/XETE h.t.: VASC phase: n = 19	TSME/XETE h.t.: n = 3	ABLA/VAGL h.t.: n = 13	ABLA/VASC h.t.: CARU phase: n = 6	ABLA/VASC h.t.: VASC phase: n = 11	ABLA/VASC h.t.: THOC phase: n = 8	ABLA/ALSI h.t.: n = 5	ABLA/CARU h.t.: n = 10	ABLA/CLPS h.t.: n = 11	ABLA/ARCO h.t.: n = 17	ABLA/CAGE h.t.: CAGE phase: n = 3	ABLA/CAGE h.t.: PSME phase: n = 2	ABLA/RIMO h.t.: n = 3	ABLA-PIAL/VASC h.t.: n = 22	ABLA/LUHI h.t.: VASC phase: n = 25	ABLA/LUHI h.t.: MEFE phase: n = 13	TSME/LUHI h.t.: VASC phase: n = 2	PIAL/ABLA h.t.: n = 15	PIAL h.t.: n = 5	PINUS CONTORTA SERIES: PICO/VACA h.t.: n = 11	PICO/LIBO h.t.: n = 14	PICO/VASC h.t.: n = 17	PICO/CARU h.t.: n = 4
COARSE FRAGMENTS (in percent occurrence)																								
SEDIMENTARY																								
Calcareous	--	5	--	8	10	9	--	--	34	100	21	33	50	25	9	--	--	--	7	40	--	--	--	--
Noncalcareous	26	26	33	16	20	--	25	20	17	--	28	--	50	50	32	20	54	100	57	40	27	21	12	--
METAMORPHIC																								
Calcareous argillite	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Argillite	39	21	--	8	--	18	25	20	--	--	--	--	--	--	--	16	8	--	36	--	--	--	12	--
Quartzite	7	11	--	--	--	9	13	--	--	--	--	--	--	--	5	12	--	--	--	--	18	14	6	--
Gneiss & schist	15	5	--	15	--	9	13	20	17	--	21	33	--	25	23	16	--	--	--	--	--	14	6	--
Miscellaneous	--	10	67	16	--	--	13	--	--	--	14	--	--	--	5	12	15	--	--	--	--	--	6	--
IGNEOUS																								
Basalt & andesite	--	--	--	8	10	9	--	--	--	--	7	--	--	--	--	--	--	--	--	--	--	7	6	--
Quartz monzonite	7	5	--	--	10	27	--	--	--	--	7	--	--	--	9	16	8	--	--	--	45	14	35	50
Rhyolite	4	11	--	8	10	--	--	--	--	--	--	--	--	--	5	8	8	--	--	20	--	7	6	25
Granite & biotite granite	--	--	--	15	30	--	--	20	--	--	--	33	--	--	14	--	--	--	--	--	9	14	12	25
Miscellaneous	--	5	--	8	10	18	13	20	34	--	--	--	--	--	--	4	8	--	--	--	--	7	--	--
MIXED	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
GROUND SURFACE																								
SURFACE ROCK EXPOSED (mean %)	1	3	1	3	2	3	1	1	0	1	2	2	1	1	4	3	3	2	13	2	1	2	5	2
BARE SOIL EXPOSED (mean %)	1	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	6	3	0	0	0	1
DUFF DEPTH (mean cm)	3.3	3.8	2.0	5.3	4.5	3.5	5.6	6.0	4.3	4.2	3.9	4.7	6.7	7.5	4.4	3.9	4.4	2.5	2.8	2.7	4.8	6.4	4.7	2.6
UPPER SOIL																								
REACTION (mean pH)	5.1	4.6	4.8	5.1	5.2	5.1	5.0	4.9	5.5	6.7	5.7	5.2	5.9	4.6	5.0	4.8	4.4	4.7	4.9	6.0	4.9	5.3	5.0	5.6
GRAVEL CONTENT (mean %)	37	36	21	30	19	28	15	18	21	21	19	19	12	2	26	32	31	42	45	25	16	21	26	22
TEXTURAL CLASS (percent occurrence)																								
Loamy sand	4	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	9	14	--	--
Sandy loam	11	5	--	--	22	13	--	--	20	--	--	--	--	--	14	4	15	--	--	--	9	7	25	25
Loam	50	47	--	31	22	63	33	80	20	--	15	67	--	--	32	58	31	50	50	--	27	36	50	--
Silt loam & silt	36	47	100	62	56	25	67	20	60	70	77	33	100	100	50	38	54	50	50	100	55	43	25	75
Silty clay loam & clay loam	--	--	--	8	--	--	--	--	--	30	8	--	--	--	5	--	--	--	--	--	--	--	--	--

APPENDIX D-2

Climatic parameters for stations within selected habitat types in or near Montana (from U. S. Weather Service records unless footnoted) (~ = approximately)

Climax series and station	Estimated habitat types and phase		Mean monthly temperature July	Mean monthly temperature Jan.	Average number of frosts (32°F): June-August	Mean annual precipitation	Mean May-Aug. precipitation	Mean annual snowfall	Township Range Section	Elevation
			°F(°C)	°F(°C)		*Inches*	*Inches*	*Inches*		*Feet*
PINUS FLEXILIS SERIES										
Townsend (near)	AGSP	--	66(19)	17(-8)	1	10.4	6.0	~45	7N2ES31	3,833
Blackleaf (near)	FEID	FESC	60(16)	21(-6)	~5	14.6	8.3	--	26N7WS18	4,600
PINUS PONDEROSA SERIES										
Roundup	AGSP	--	72(22)	24(-4)	0	10.9	6.5	~36	8N25ES13	3,227
Plains	FEID	FEID	67(19)	25(-4)	T	14.0	5.4	~42	20N26WS26	2,473
Canyon Ferry	PUTR	--	71(22)	26(-3)	0	12.1	6.8	~39	10N1WS3	3,850
Lewiston AP	SYAL	--	66(19)	20(-7)	1	16.5	9.6	61	15N18ES20	4,130
PSEUDOTSUGA MENZIESII SERIES										
Libby RS	SYAL	--	66(19)	22(-6)	3	18.5	4.5	--	31N31WS34	2,080
Lincoln RS	SYAL	--	61(16)	17(-8)	14	19.4	7.4	~100	14N9WS24	4,500
Pleasant Valley	VACA	--	60(16)	20(-7)	16	18.9	5.6	--	27N26WS2	3,600
Greenough[1]	VACA	--	63(17)	18(-8)	9	17.8	6.1	~110	13N15WS14	4,000
Ecounit 1.S[1]	CARU	ARUV	63(17)	22(-6)	3	--	4.7	--	13N14WS15	4,350
PICEA SPP. SERIES										
Polebridge	CLUN	VACA	61(16)	17(-8)	14	23.1	6.3	122	35N21WS27	3,690
Yellowstone NE entrance	LIBO	--	56(13)	14(-10)	29	25.7	9.7	169	9S14ES34	7,200
ABIES GRANDIS, THUJA, TSUGA SERIES										
Trout Cr. 2W	ABGR/CLUN	--	64(18)	23(-5)	4	30.0	5.5	~90	24N32ES24	2,480
Heron 2NW	TSHE/CLUN	CLUN	64(18)	24(-4)	2	34.3	6.5	87	27N34WS29	2,240
ABIES LASIOCARPA SERIES										
Lower subalpine h.t.s:										
West Glacier	CLUN	VACA	64(18)	21(-6)	1	28.1	8.0	129	32N19WS36	3,154
Seeley Lake RS	CLUN	XETE	63(17)	17(-8)	6	21.1	6.5	120	17N15WS21	4,030
Roland, Idaho	CLUN	MEFE	62(17)	23(-5)	1	53.8	7.6	274	47N6ES35,ID	4,150
Burke, Idaho	MEFE	--	60(16)	22(-6)	3	48.6	9.1	234	48N5ES11,ID	4,093
Summit (U.S. Hwy. 2)	XETE	VASC	57(14)	15(-9)	18	36.9	9.3	253	30N14WS34	5,213
Kings Hill	VASC	--	59(15)	16(-9)	13	28.7	11.1	270	13N8ES34	7,300
Upper subalpine and timberline h.t.s:										
Hell's Half Acre, Idaho[2]	ABLA/LUHI	VASC	58(14)	--	~8	~40	--	--	27N16ES29	8,117
McCalla Lake[3]	LALY-ABLA	--	53(12)	14(-10)	~16	~45	--	~300	9N21WS28	8,000
Old Glory Mtn., B.C.[4]	~PIAL-ABLA[5]	--	49(9)	12(-11)	~18	28.3	--	212	49° 09' N 117° 55' W	7,700

[1] Steele 1972.
[2] Maintained by Bitterroot National Forest, Forest Service, Hamilton, Montana.
[3] Arno 1970.
[4] Canadian Department of Transport 1967.
[5] Tundra site about 100 feet in elevation above timberline.

APPENDIX E-1

Mean basal areas and 50-year site indexes for Montana stands by habitat type. Means are shown where n = 3 or more; confidence limits (95 percent) for estimating the mean are given where n = 5 or more.

West-side (Kootenai, Flathead, Lolo, and Bitterroot National Forests)

Habitat type	Basal area: (ft²/acre)	Site index by species: PIPO	PSME	PICO	LAOC	PICEA	ABGR	ABLA
SCREE	156 ± 73	44 ± 8	38 ± 6	.	.	.	.	.
PIFL/AGSP	.	.	.	.	.	.	.	.
PIFL/FEID	.	.	.	.	.	.	.	.
PIFL/JUCO	.	.	.	.	.	.	.	.
PIPO/AGSP	101 ± 25	45 ± 9	.	.	.	.	.	.
PIPO/FEID	139 ± 21	46 ± 5	.	.	.	.	.	.
PIPO/PUTR	77 ± 28	45 ± 14	.	.	.	.	.	.
PIPO/SYAL	170 ± ?	44 ± ?	.	.	.	.	.	.
PIPO/PRVI	.	.	.	.	.	.	.	.
PSME/AGSP	.	.	.	.	.	.	.	.
PSME/FEID	.	.	.	.	.	.	.	.
PSME/FESC	126 ± 47	36 ± ?	44 ± 7	.	.	.	.	.
PSME/VACA	192 ± 33	62 ± 8	51 ± 6	57 ± 8	59 ± 5	.	.	.
PSME/PHMA	153 ± 20	59 ± 14	58 ± 6	48 ± ?	57 ± ?	.	.	.
PSME/VAGL	185 ± 33	.	44 ± 4	.	.	.	.	.
PSME/LIBO	226 ± 53	.	56 ± 6	50 ± 9	55 ± ?	.	.	.
PSME/SYAL	172 ± 23	54 ± 5	52 ± 4	.	.	.	.	.
PSME/CARU	191 ± 24	50 ± 8	47 ± 6	48 ± ?	.	.	.	.
PSME/CAGE	186 ± ?	.	.	.	.	.	.	.
PSME/SPBE	142 ± ?	63 ± ?	49 ± ?	.	.	.	.	.
PSME/ARUV	.	.	.	.	.	.	.	.
PSME/JUCO	.	.	.	.	.	.	.	.
PSME/ARCO	.	.	.	.	.	.	.	.
PICEA/EQAR	.	.	.	.	.	.	.	.
PICEA/CLUN	241 ± 38	.	60 ± ?	60 ± 2	.	69 ± 6	.	.
PICEA/PHMA	.	.	.	.	.	.	.	.
PICEA/GATR	.	.	.	.	.	.	.	.
PICEA/VACA	.	.	.	65 ± ?	74 ± ?	64 ± ?	.	.
PICEA/SEST	.	.	.	.	.	.	.	.
PICEA/LIBO	.	.	.	.	.	.	.	.
PICEA/SMST	.	.	.	.	.	.	.	.
ABGR/CLUN	254 ± 94	.	71 ± ?	.	.	73 ± ?	58 ± 15	.
ABGR/LIBO	195 ± ?	.	.	.	.	.	54 ± ?	.
THPL/CLUN	305 ± 96	.	66 ± ?	.	63 ± ?	72 + 14	61 ± ?	74 ± ?
TSHE/CLUN	267 ± 55	(PIMO--62 ± ?)		.	80 ± ?	77 ± ?	50 ± ?	.
ABLA/OPHO	351 ± ?	.	.	.	.	69 ± ?	.	.
ABLA/CLUN	248 ± 24	.	66 ± 7	60 ± 5	63 ± 6	66 ± 6	55 ± 9	59 ± 6
ABLA/GATR	196 ± 47	.	.	50 ± 12	.	58 ± 9	.	67 ± 22
ABLA/VACA	.	.	.	.	.	.	.	.
ABLA/CACA	177 ± ?	.	.	50 ± 7	.	51 ± 5	.	48 ± ?
ABLA/LIBO	166 ± 35	.	46 ± 9	55 ± 7	56 ± ?	.	.	53 ± 12
ABLA/MEFE	172 ± 26	.	50 ± 8	56 ± 6	67 ± ?	60 ± 10	.	57 ± 9
ABLA/XETE	188 ± 26	.	40 ± 6	45 ± 6	51 ± ?	56 ± ?	.	47 ± 6
TSME/XETE	114 ± ?	.	.	.	.	.	.	.
ABLA/VAGL	.	.	.	.	.	.	.	.
ABLA/VASC, THOC	.	.	.	.	.	.	.	.
ABLA/VASC, other	.	.	.	.	.	.	.	.
ABLA/ALSI	.	.	.	.	.	.	.	.
ABLA/CARU	.	.	.	.	.	.	.	.
ABLA/CLPS	.	.	.	.	.	.	.	.
ABLA/ARCO	.	.	.	.	.	.	.	.
ABLA/CAGE	.	.	.	.	.	.	.	.
ABLA/RIMO	.	.	.	.	.	.	.	.
ABLA-PIAL/VASC	.	.	.	.	.	.	.	.
ABLA/LUHI	187 ± 30	.	.	35 ± 8	.	43 ± 9	.	31 ± 5
PIAL-ABLA	146 ± 49	.	.	.	.	.	.	16 ± ?
LALY-ABLA	.	.	.	.	.	20 ± ?	.	14 ± 4
PIAL	.	.	.	.	.	.	.	.
PICO/PUTR h.t.	.	.	.	.	.	.	.	.
PICO/VACA c.t.	.	.	.	.	.	.	.	.
PICO/LIBO c.t.	.	.	.	.	.	.	.	.
PICO/VASC c.t.	.	.	.	.	.	.	.	.
PICO/CARU c.t.	.	.	.	.	.	.	.	.

East-side (Deerlodge, Beaverhead, Helena, Lewis and Clark, Gallatin, and Custer National Forests)

Habitat type	Basal area: (ft²/acre)	Site index by species: PIPO	PSME	PICO	PICEA	ABLA
SCREE	64 ± 24	.	21 ± ?	.	.	.
PIFL/AGSP	89 ± 40	.	.	.	.	.
PIFL/FEID	91 ± 23	.	24 ± 5	.	.	.
PIFL/JUCO	139 ± 79	.	25 ± 7	.	.	.
PIPO/AGSP	111 ± 17	30 ± 10	.	.	.	.
PIPO/FEID	135 ± 36	29 ± 12	.	.	.	.
PIPO/PUTR	96 ± ?	26 ± ?	.	.	.	.
PIPO/SYAL	168 ± 42	41 ± 6	.	.	.	.
PIPO/PRVI	140 ± 10	47 ± ?	.	.	.	.
PSME/AGSP	133 ± 38	34 ± ?	29 ± 4	.	.	.
PSME/FEID	128 ± 39	.	32 ± 5	.	.	.
PSME/FESC	159 ± 85	.	22 ± ?	.	.	.
PSME/VACA	191 ± 130	.	.	49 ± ?	.	.
PSME/PHMA	182 ± 32	.	43 ± 8	.	.	.
PSME/VAGL	163 ± 37	.	41 ± ?	48 ± 15	.	.
PSME/LIBO	192 ± 56	.	.	47 ± ?	.	.
PSME/SYAL	196 ± 26	43 ± 11	41 ± 4	46 ± 7	.	.
PSME/CARU	206 ± 19	45 ± ?	38 ± 3	45 ± 4	.	.
PSME/CAGE	253 ± 67	.	36 ± ?	.	.	.
PSME/SPBE	195 ± 62	.	.	.	.	.
PSME/ARUV	138 ± 35	41 ± 17	28 ± 7	.	.	.
PSME/JUCO	196 ± 34	.	40 ± ?	41 ± 6	.	.
PSME/ARCO	210 ± 44	.	36 ± 4	.	.	.
PICEA/EQAR	203 ± 45	.	.	.	51 ± 11	.
PICEA/CLUN	.	.	.	.	.	.
PICEA/PHMA	199 ± ?	.	58 ± ?	.	50 ± ?	.
PICEA/GATR	234 ± 41	.	.	53 ± ?	58 ± 7	.
PICEA/VACA	.	.	.	.	.	.
PICEA/SEST	.	.	.	.	29 ± ?	.
PICEA/LIBO	177 ± 17	.	40 ± ?	49 ± 4	52 ± 9	.
PICEA/SMST	224 ± 40	.	44 ± 8	.	53 ± 14	.
ABGR/CLUN	.	.	.	.	.	.
ABGR/LIBO	.	.	.	.	.	.
THPL/CLUN	.	.	.	.	.	.
TSHE/CLUN	.	.	.	.	.	.
ABLA/OPHO	.	.	.	.	.	.
ABLA/CLUN	203 ± 73	.	.	.	44 ± 8	40 ± ?
ABLA/GATR	244 ± 27	.	46 ± ?	43 ± ?	53 ± 6	47 ± 5
ABLA/VACA	177 ± 33	.	.	47 ± 3	47 ± ?	.
ABLA/CACA	247 ± 56	.	.	50 ± 13	45 ± 4	43 ± 5
ABLA/LIBO	191 ± 20	.	43 ± 9	46 ± 11	44 ± 5	43 ± 11
ABLA/MEFE	195 ± 41	.	.	.	50 ± ?	52 ± ?
ABLA/XETE	226 ± 39	.	.	43 ± ?	.	.
TSME/XETE	.	.	.	.	.	.
ABLA/VAGL	201 ± 33	.	.	42 ± 4	43 ± ?	42 ± 5
ABLA/VASC, THOC	295 ± 33	.	.	45 ± 4	46 ± 11	40 ± 7
ABLA/VASC, other	175 ± 20	.	.	40 ± 5	45 ± 7	40 ± 5
ABLA/ALSI	.	.	.	.	50 ± ?	46 ± ?
ABLA/CARU	222 ± 85	.	40 ± 10	.	57 ± ?	50 ± 12
ABLA/CLPS	268 ± 51	.	30 ± ?	.	33 ± 5	40 ± 7
ABLA/ARCO	220 ± 41	.	43 ± 6	41 ± 3	45 ± 7	47 ± 3
ABLA/CAGE	.	.	.	.	.	40 ± 12
ABLA/RIMO	.	.	.	.	.	40 ± ?
ABLA-PIAL/VASC	245 ± 24	.	.	33 ± 5	31 ± 5	32 ± 3
ABLA/LUHI	256 ± 73	.	.	.	38 ± 17	34 ± 8
PIAL-ABLA	247 ± 63	.	.	.	.	25 ± ?
LALY-ABLA	.	.	.	.	.	.
PIAL	199 ± 39	.	.	.	.	21 ± ?
PICO/PUTR h.t.	130 ± ?	.	.	40 ± ?	.	.
PICO/VACA c.t.	184 ± 27	.	.	50 ± 5	.	.
PICO/LIBO c.t.	193 ± 29	.	.	52 ± 7	.	.
PICO/VASC c.t.	166 ± 22	.	.	41 ± 4	.	.
PICO/CARU c.t.	159 ± 22	.	.	47 ± 12	.	.

APPENDIX E-2

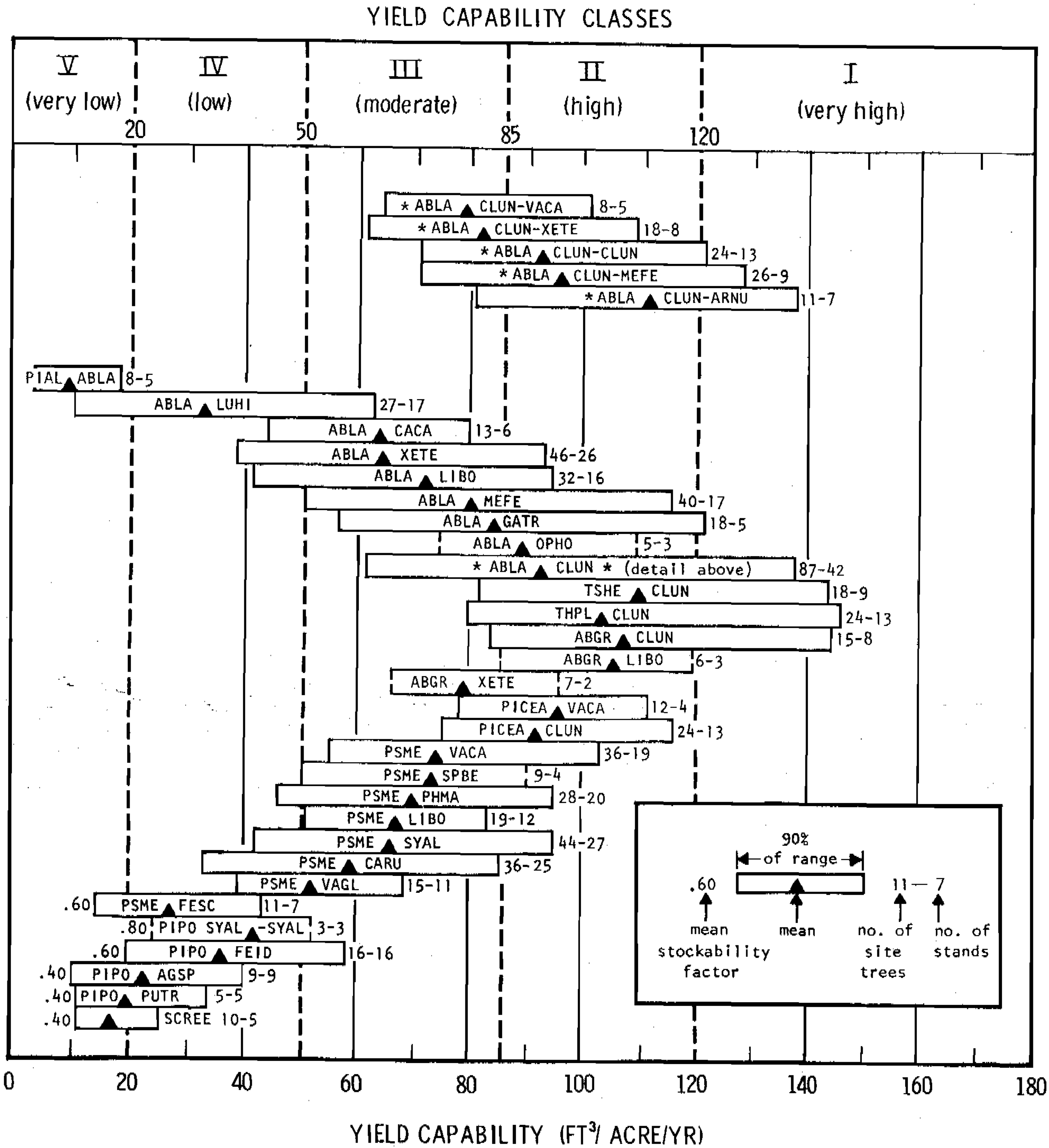
Mean maximum heights (in feet) for Montana stands by tree species and habitat type. Means are shown where n = 3 or more; confidence limits (95 percent) for estimating the mean are given where n = 5 or more.

Habitat type	Maximum height by species for the West-side (Kootenai, Flathead, Lolo, and Bitterroot National Forests)						
	PIPO	PSME	PICO	LAOC	PICEA	ABLA	PIAL
SCREE	106 ± ?	.	.	.	.	.	.
PIFL/AGSP	.	.	.	.	.	.	.
PIFL/FEID	.	.	.	.	.	.	.
PIFL/JUCO	.	.	.	.	.	.	.
PIPO/AGSP	.	.	.	.	.	.	.
PIPO/FEID	106 ± ?	.	.	.	.	.	.
PIPO/SYAL	.	.	.	.	.	.	.
PIPO/PRVI	.	.	.	.	.	.	.
PSME/AGSP	.	.	.	.	.	.	.
PSME/FEID	.	.	.	.	.	.	.
PSME/FESC	89 ± ?	77 ± ?	.	.	.	.	.
PSME/VACA	123 ± 10	104 ± 7	.	128 ± 14	.	.	.
PSME/PHMA	118 ± 20	101 ± ?	.	.	.	.	.
PSME/VAGL	115 ± 15	85 ± 11	.	.	.	.	.
PSME/LIBO	.	89 ± ?	.	106 ± 17	.	.	.
PSME/SYAL	113 ± 18	.	.	.	.	.	.
PSME/CARU	105 ± 7	91 ± 6	.	.	.	.	.
PSME/CAGE	.	.	.	.	.	.	.
PSME/SPBE	.	.	.	.	.	.	.
PSME/ARUV	.	.	.	.	.	.	.
PSME/JUCO	.	.	.	.	.	.	.
PSME/ARCO	.	.	.	.	.	.	.
PICEA/EQAR	.	.	.	.	.	.	.
PICEA/CLUN	.	.	.	135 ± 8	.	.	.
PICEA/PHMA	.	.	.	.	.	.	.
PICEA/GATR	.	.	.	.	.	.	.
PICEA/SEST	.	.	.	.	.	.	.
PICEA/LIBO	.	.	.	.	.	.	.
PICEA/SMST	.	.	.	.	.	.	.
ABGR/CLUN	.	107 ± ?	.	.	.	.	.
ABGR/LIBO	.	98 ± ?	.	117 ± ?	.	.	.
THPL/CLUN	.	127 ± ?	.	149 ± 21	141 ± ?	135 ± ?	.
TSHE/CLUN	.	.	.	129 ± 21	141 ± ?	.	.
ABLA/CLUN	.	124 ± 9	.	133 ± 7	132 ± 32	120 ± ?	.
ABLA/GATR	.	.	.	.	.	.	.
ABLA/CACA	.	.	94 ± 10	.	110 ± ?	.	.
ABLA/LIBO	.	101 ± ?	.	113 ± ?	.	.	.
ABLA/MEFE	.	95 ± ?	88 ± 8	106 ± 17	109 ± 7	96 ± 10	.
ABLA/XETE	.	86 ± 8	82 ± ?	96 ± 10	.	.	.
ABLA/VAGL	.	.	.	.	.	.	.
ABLA/VASC, THOC	.	.	.	.	.	.	.
ABLA/VASC, other	.	.	.	.	.	.	.
ABLA/CARU	.	.	.	.	.	.	.
ABLA/CLPS	.	.	.	.	.	.	.
ABLA/ARCO	.	.	.	.	.	.	.
ABLA/CAGE, PSME	.	.	.	.	.	.	.
ABLA-PIAL/VASC	.	.	.	.	.	.	.
ABLA/LUHI	.	.	67 ± 9	.	94 ± 11	70 ± 8	64 ± 6
PIAL-ABLA	.	.	.	.	.	.	55 ± 8
LALY-ABLA	.	.	.	.	54 ± 10	46 ± ?	.
PIAL	.	.	.	.	.	.	.
PICO/VACA c.t.	.	.	.	.	.	.	.
PICO/LIBO c.t.	.	.	.	.	.	.	.
PICO/VASC c.t.	.	.	.	.	.	.	.

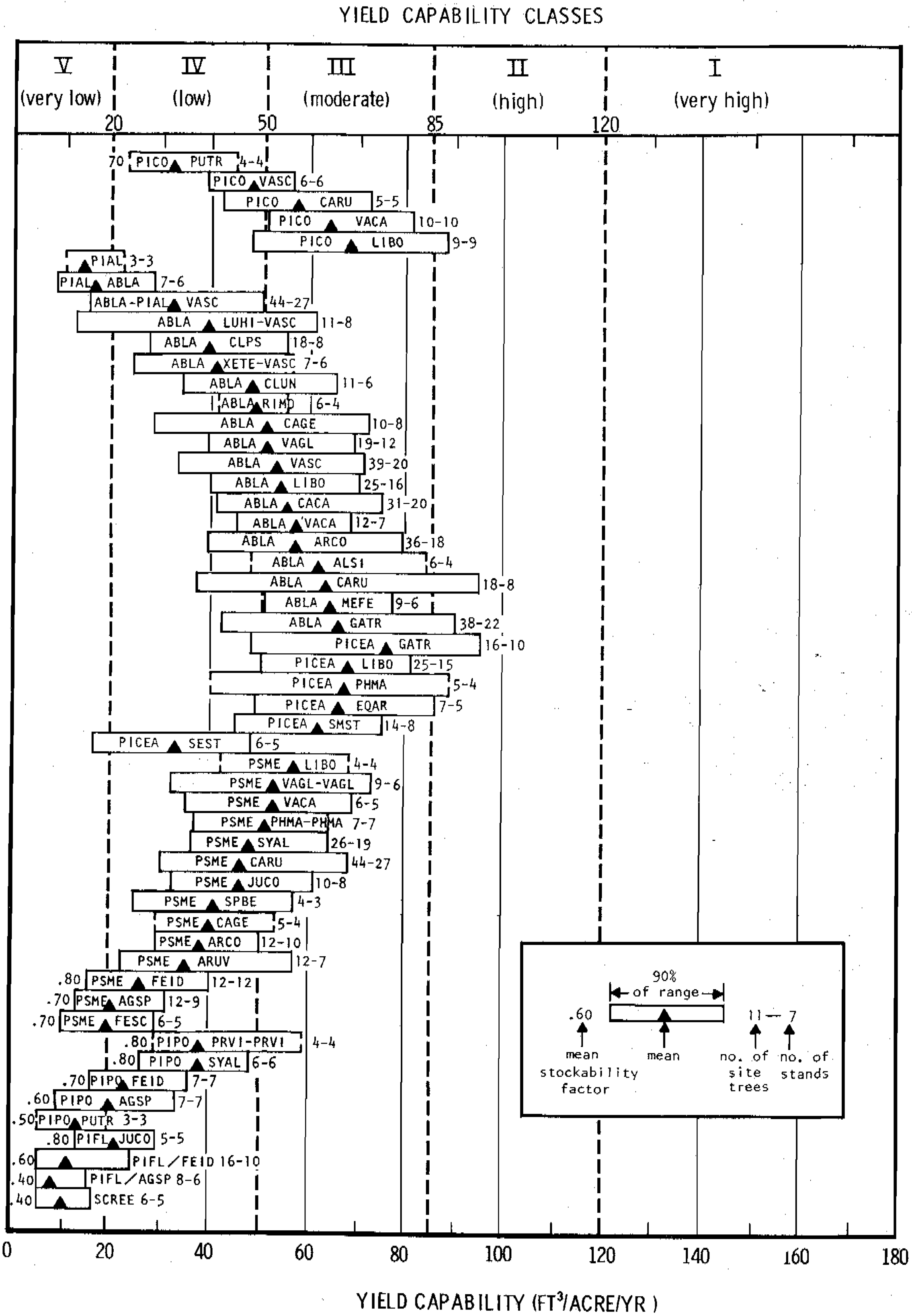
Habitat type	Maximum height by species for the East-side (Deerlodge, Beaverhead, Helena, Lewis and Clark, Gallatin, and Custer National Forests)						
	PIFL	PIPO	PSME	PICO	PICEA	ABLA	PIAL
SCREE	30 ± ?	.	58 ± ?	.	.	.	.
PIFL/AGSP	31 ± 12	.	.	.	.	.	.
PIFL/FEID	39 ± 8	.	43 ± 14	.	.	.	.
PIFL/JUCO	35 ± 11	.	39 ± ?	.	.	.	.
PIPO/AGSP	.	57 ± 12	.	.	.	.	.
PIPO/FEID	.	74 ± 10	.	.	.	.	.
PIPO/SYAL	.	76 ± ?	.	.	.	.	.
PIPO/PRVI	.	83 ± 8	.	.	.	.	.
PSME/AGSP	.	69 ± 19	60 ± 8	.	.	.	.
PSME/FEID	.	.	65 ± 8	.	.	.	.
PSME/FESC	.	67 ± ?	58 ± ?	.	.	.	.
PSME/VACA	.	.	.	.	.	.	.
PSME/PHMA	.	.	75 ± 12	.	.	.	.
PSME/VAGL	.	.	.	71 ± ?	.	.	.
PSME/LIBO	.	.	82 ± 6	.	.	.	.
PSME/SYAL	.	.	87 ± 10	.	.	.	.
PSME/CARU	.	.	77 ± 4	71 ± 8	.	.	.
PSME/CAGE	.	.	76 ± 13	.	.	.	.
PSME/SPBE	.	.	57 ± ?	.	.	.	.
PSME/ARUV	.	76 ± 14	.	.	.	.	.
PSME/JUCO	.	.	69 ± 13	.	.	.	.
PSME/ARCO	.	.	73 ± 8	.	.	.	.
PICEA/EQAR	.	.	.	.	110 ± 7	.	.
PICEA/CLUN	.	.	.	.	.	.	.
PICEA/PHMA	.	.	86 ± ?	.	.	.	.
PICEA/GATR	.	.	.	.	109 ± ?	.	.
PICEA/SEST	.	.	.	.	54 ± 11	.	.
PICEA/LIBO	.	.	87 ± ?	88 ± 11	99 ± ?	.	.
PICEA/SMST	.	.	89 ± ?	.	.	.	.
ABGR/CLUN	.	.	.	.	.	.	.
ABGR/LIBO	.	.	.	.	.	.	.
THPL/CLUN	.	.	.	.	.	.	.
TSHE/CLUN	.	.	.	.	.	.	.
ABLA/CLUN	.	.	.	.	.	.	.
ABLA/GATR	.	.	95 ± 17	84 ± 9	102 ± 5	88 ± ?	.
ABLA/CACA	.	.	.	79 ± 10	101 ± 8	.	.
ABLA/LIBO	.	.	86 ± 8	83 ± 8	.	.	.
ABLA/MEFE	.	.	.	82 ± 12	99 ± 11	87 ± ?	.
ABLA/XETE	.	.	.	71 ± 10	90 ± 27	.	.
ABLA/VAGL	.	.	79 ± ?	80 ± 8	.	.	.
ABLA/VASC, THOC	.	.	.	77 ± 6	90 ± 10	.	.
ABLA/VASC, other	.	.	.	71 ± 4	75 ± ?	.	.
ABLA/CARU	.	.	82 ± 10	.	.	.	.
ABLA/CLPS	.	.	64 ± 7	.	70 ± 8	.	.
ABLA/ARCO	.	.	81 ± 9	78 ± ?	80 ± ?	.	.
ABLA/CAGE, PSME	.	.	89 ± 13	.	.	82 ± ?	.
ABLA-PIAL/VASC	.	.	.	66 ± 8	76 ± 8	60 ± 7	57 ± 5
ABLA/LUHI	.	.	.	.	.	.	.
PIAL-ABLA	.	.	.	.	45 ± 15	29 ± 6	42 ± 7
LALY-ABLA	.	.	.	.	.	.	.
PIAL	.	.	.	.	.	.	52 ± ?
PICO/VACA c.t.	.	.	.	83 ± 7	.	.	.
PICO/LIBO c.t.	.	.	.	92 ± 9	.	.	.
PICO/VASC c.t.	.	.	.	67 ± 5	.	.	.

APPENDIX E-3

Estimated yield capabilities of West-side Montana habitat types based on site index data and stockability factors. (Kootenai, Flathead, Lolo, and Bitterroot National Forests)



Estimated yield capabilities of East-side Montana habitat types based on site index data and stockability factors. (Deerlodge, Beaverhead, Helena, Lewis and Clark, Gallatin, and Custer National Forests)



APPENDIX F

Montana habitat type field form (for 3 plots)

NAME

	DATE			
(CODE DESCRIPTION)	Plot No.			
	Location			
	T, R, S			
	Elevation			
	Aspect			
	Slope	%	%	%
	Topography			
	Configuration			

TOPOGRAPHY:	HORIZONTAL CONFIGURATION:	CANOPY COVERAGE CLASS:	
1-Ridge	1-Convex (dry)	0=Absent	3=25 to 50%
2-Upper slope	2-Straight	T=Rare to 1%	4=50 to 75%
3-Mid slope	3-Concave (wet)	1=1 to 5%	5=75 to 95%
4-Lower slope	4-Undulating	2=5 to 25%	6=95 to 100%
5-Bench or flat			
6-Stream bottom			

NOTE: Rate trees (>4" dbh) and regen (0-4" dbh) separately (e.g., 4/2)

Scientific Name	Abbrev	Common Name	Canopy Coverage Class		
TREES					
1. Abies grandis	ABGR	grand fir	/	/	/
2. Abies lasiocarpa	ABLA	subalpine fir	/	/	/
3. Larix lyallii	LALY	alpine larch	/	/	/
4. Larix occidentalis	LAOC	western larch	/	/	/
5. Picea engelmannii	PIEN	Engelmann spruce	/	/	/
6. Picea glauca	PIGL	white spruce	/	/	/
7. Pinus albicaulis	PIAL	whitebark pine	/	/	/
8. Pinus contorta	PICO	lodgepole pine	/	/	/
9. Pinus flexilis	PIFL	limber pine	/	/	/
10. Pinus monticola	PIMO	western white pine	/	/	/
11. Pinus ponderosa	PIPO	ponderosa pine	/	/	/
12. Pseudotsuga menziesii	PSME	Douglas-fir	/	/	/
13. Thuja plicata	THPL	western redcedar	/	/	/
14. Tsuga heterophylla	TSHE	western hemlock	/	/	/
15. Tsuga mertensiana	TSME	mountain hemlock	/	/	/
SHRUBS AND SUBSHRUBS					
1. Alnus sinuata	ALSI	Sitka alder			
2. Arctostaphylos uva-ursi	ARUV	kinnikinnick			
3. Berberis repens	BERE	creeping Oregon grape			
4. Cornus canadensis	COCA	bunchberry dogwood			
5. Holodiscus discolor	HODI	ocean spray			
6. Juniperus communis (+ horizontalis)	JUCO	common (+ creeping) juniper			
7. Ledum glandulosum	LEGL	Labrador tea			
8. Linnaea borealis	LIBO	twinflower			
9. Menziesia ferruginea	MEFE	menziesia			
10. Oplopanax horridum	OPHO	devil's club			
11. Physocarpus malvaceus	PHMA	ninebark			
12. Prunus virginiana	PRVI	chokecherry			
13. Purshia tridentata	PUTR	bitterbrush			
14. Ribes montigenum	RIMO	mountain gooseberry			
15. Shepherdia canadensis	SHCA	buffaloberry			
16. Spiraea betulifolia	SPBE	white spiraea			
17. Symphoricarpos albus	SYAL	common snowberry			
18. Symphoricarpos oreophilus	SYOR	mountain snowberry			
19. Vaccinium caespitosum	VACA	dwarf huckleberry			
20. Vaccinium globulare (+ membranaceum)	VAGL	blue huckleberry			
21. Vaccinium scoparium (+ myrtillus)	VASC	grouse whortleberry			
PERENNIAL GRAMINOIDS					
1. Agropyron spicatum	AGSP	bluebunch wheatgrass			
2. Andropogon spp.	AND	bluestem			
3. Calamagrostis canadensis	CACA	bluejoint			
4. Calamagrostis rubescens	CARU	pinegrass			
5. Carex geyeri	CAGE	elk sedge			
6. Festuca idahoensis	FEID	Idaho fescue			
7. Festuca scabrella	FESC	rough fescue			
8. Luzula hitchcockii (= glabrata)	LUHI	wood-rush			
PERENNIAL FORBS AND FERNS					
1. Actaea rubra	ACRU	baneberry			
2. Antennaria racemosa	ANRA	woods pussytoes			
3. Aralia nudicaulis	ARNU	wild sarsaparilla			
4. Arnica cordifolia	ARCO	heartleaf arnica			
5. Athyrium filix-femina	ATFI	lady fern			
6. Balsamorhiza sagittata	BASA	arrowleaf balsamroot			
7. Clematis pseudoalpina (+ tenuiloba)	CLPS	virgin's bower			
8. Clintonia uniflora	CLUN	queencup beadlily			
9. Equisetum arvense	EQAR	common horsetail			
10. Equisetum spp.	EQU	horsetails & scouring rush			
11. Galium triflorum	GATR	sweetscented bedstraw			
12. Gymnocarpium dryopteris	GYDR	oak fern			
13. Senecio streptanthifolius	SEST	cleft-leaf groundsel			
14. Senecio triangularis	SETR	arrowleaf groundsel			
15. Smilacina stellata	SMST	starry Solomon's seal			
16. Streptopus amplexifolius	STAM	twisted stalk			
17. Thalictrum occidentale	THOC	western meadowrue			
18. Valeriana sitchensis	VASI	sitka valerian			
19. Viola orbiculata	VIOR	round-leaved violet			
20. Xerophyllum tenax	XETE	beargrass			
		SERIES			
		HABITAT TYPE			
		PHASE			

APPENDIX G--Glossary

The following terms are defined in relation to our specific usage in this report. These definitions should minimize misunderstanding resulting from the fact that technical specialists have various definitions for some of these terms. Hanson (1962) and Ford-Robertson (1971) were used as primary references.

Abundant. When relating to plant coverage in the habitat type key, any species having a canopy coverage of 25 percent or more in a stand.

Accidental. A species that is found rarely or at most occasionally as scattered individuals in a given habitat type.

Association. Climax plant (forest) community type.

Basal area. The area of the cross-section of a tree trunk 4.5 feet above the ground, usually expressed as the sum of tree basal areas in square feet per acre.

Bench, benchland. An area having flat or gently-sloping terrain (less than 15 percent slope), applied usually to the higher ground in a river valley.

Browse. Shrubby forage utilized especially by big game.

Canopy coverage. The area covered by the gross outline of an individual plant's foliage, or collectively covered by all individuals of a species within a stand or sample plot. Canopy coverage is expressed as a percentage of the total area in the plot, or as a canopy coverage class (for example, class #1 = 1 to 5 percent coverage).

Climax community. The culminating stage in plant (forest) succession for a given environment, that develops and perpetuates itself in the absence of disturbance.

Climax species. A species that is self-regenerating in the absence of disturbance with no evidence of replacement by other species.

Climax, types of ... in relation to environment (Polyclimax Concept).

Climatic climax. The climax that develops on "normal" (well-drained, medium-textured) soils and gently sloping topography.

Edaphic climax. A variation from the climatic climax caused by "abnormal" soil conditions.

Topographic climax. A variation from the climatic climax caused by topography that markedly influences microclimate.

Topo-edaphic climax. A variation from the climatic climax caused by the combination of topographic and edaphic effects. (Example: *Larix lyallii* stands occupying north-slope boulder piles.)

Common. When relating to plant coverage in the habitat type key, any species having a canopy coverage of 1 percent or more in a stand.

Community (plant community). An assembly of plants living together, reflecting no particular ecological status.

Constancy. The percentage of stands in a habitat type that contain a given species. (Appendix C-1 uses "constancy classes"--"1" = 5 to 15 percent, "2" = 15 to 25 percent, etc.)

d.b.h. (diameter at breast height). Tree-trunk diameter measured 4.5 feet above the ground.

Depauperate. Describing an unusually sparse coverage of undergrowth vegetation. This condition usually develops beneath an especially dense forest canopy, often on sites having a deep layer of duff.

Ecosystem. Any community of organisms along with its environment, forming an interacting system.

Ecotone. The boundary or transition zone between adjacent plant communities, often representing different habitat types.

Edaphic. Refers to soil.

Forb. An herbaceous plant that is not a graminoid.

Frequency. The percentage of quadrats (tiny plots) in a single sample stand that contain a given species, or more generally the degree of uniformity with which individuals of a species are distributed in a stand.

Graminoid. All grasses (*Gramineas*) and grasslike plants, including sedges (*Carex*) and rushes (*Juncus*).

Habitat type. An aggregation of all land areas potentially capable of producing similar plant communities at climax.

Indicator plant. A plant whose presence or abundance indicates the presence of certain environmental conditions--presence of a habitat type or phase.

Phase. A subdivision of an association and a habitat type representing minor differences in climax vegetation and environmental conditions, respectively.

Phenotype. A group of individuals distinguished on the basis of visible characteristics--in contrast to a "genotype" which is defined on the basis of genetic similarities.

Poorly represented. When relating to plant coverage in the habitat type key, any species that is absent or has a canopy coverage of less than 5 percent.

Riparian. Vegetation bordering watercourses, lakes, or swamps; it requires a high water table.

Scarce. When relating to plant coverage in the habitat type key, any species that is absent or has a canopy coverage of less than 1 percent.

Scree. Any slope covered with loose rock fragments. Forested scree (abbreviated SCREE) is a term for certain topo-edaphic climaxes that are described under OTHER VEGETATION TYPES in this report.

Seral. A species or community that is replaced by another species or community as succession progresses.

Series. A group of habitat types having the same climax tree species. For example the *Pinus flexilis* series contains the *PIFL/AGSP, PIFL/FEID,* and *PIFL/JUCO* h.t.s.

Site index. An index of timberland productivity based upon the height of specific trees at a certain reference age (usually 50 or 100 years).

Stand. A plant community that is relatively uniform in composition, structure, and habitat conditions; thus it may serve as a local example of a community type on a habitat type.

Stockability factor. An estimate of the stocking potential on a given site; for example a factor of 0.8 indicates that the site is capable of supporting only about 80 percent of "normal" stocking as indicated in yield tables.

Stocking. A general term for the number of trees (considering their size class) per acre.

Succession. The progressive changes in plant communities toward climax.

Union. One or more species having similar environmental amplitudes within a geographic area; thus their presence is indicative of certain microenvironmental conditions.

Well represented. When relating to plant coverage in the habitat type key, any species having a canopy coverage of greater than 5 percent.

Yield capability. The maximum mean annual increment attainable in a fully stocked natural stand, expressed in cubic feet per acre per year. (See a forest mensuration textbook for the distinction between "mean annual increment" and "periodic annual increment"; growth in a specific year, or period of years, is termed the latter.)

Pfister, Robert D., Bernard L. Kovalchik, Stephen F. Arno, and Richard C. Presby
1977. Forest habitat types of Montana. USDA For. Serv. Gen. Tech. Rep. INT-34, 174 p. Intermountain Forest & Range Experiment Station, Ogden, Utah 84401.

A land-classification system based upon potential natural vegetation is presented for the forests of Montana. It is based on an intensive 4-year study and reconnaissance sampling of about 1,500 stands. A hierarchical classification of forest sites was developed using the habitat type concept. A total of 9 climax series, 64 habitat types, and 37 additional phases of habitat types are defined. A diagnostic key is provided for field identification of the types based on indicator species used in development of the classification.

KEYWORDS: forest vegetation; Montana; habitat types; plant communities; forest ecology; forest management

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Headquarters for the Intermountain Forest and Range Experiment Station are in Ogden, Utah. Field programs and research work units are maintained in:

- Billings, Montana
- Boise, Idaho
- Bozeman, Montana (in cooperation with Montana State University)
- Logan, Utah (in cooperation with Utah State University)
- Missoula, Montana (in cooperation with University of Montana)
- Moscow, Idaho (in cooperation with the University of Idaho)
- Provo, Utah (in cooperation with Brigham Young University)
- Reno, Nevada (in cooperation with the University of Nevada)

CONTENTS OF POCKET ON

INSIDE BACK COVER

Figure 7.--Key to climax series, habitat types, and phases (4 pages)

Appendix C-2.--Presence list: numbers of sample stands where each species occurred, by habitat type and phase. (2 sheets)

Appendix F.--Montana habitat type field form. (1 page)

Examples of forest habitat types in Montana (1 sheet)

(Appendix C-2 is not included in this PDF file. It has been included as two separate PDF files that are labeled "HabitatTypes_MT_AppC-2a.pdf" and "HabitatTypes_MT_AppC-2b.pdf" and can be downloaded from the same directory where this file is located.)

(Appendix F is located with the other Appendices.)

(The poster is not included in this PDF file. It is labeled "HabitatTypes_MT_examples.pdf" and can be downloaded from the same directory where this file is located.)

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Figure 7. -- Key to climax series, habitat types, and phases.

READ THESE INSTRUCTIONS FIRST!

1. Use this key for stands with a mature tree canopy that are not severely disturbed by grazing, logging, forest fire, etc. (If the stand is severely disturbed or in an early successional stage, the habitat type can best be determined by extrapolating from the nearest mature stand occupying a similar site.)

2. Accurately identify and record canopy coverages for all indicator species (appendix F).

3. Check plot data in the field to verify that the plot is representative of the stand as a whole. If not, take another plot.

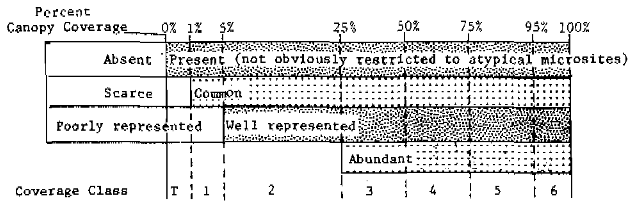
4. Identify the correct potential climax tree species in the SERIES key. (Generally, a tree species is considered reproducing successfully if 10 or more individuals per acre occupy or will occupy the site.)

5. Within the appropriate series, key to HABITAT TYPE by following the key literally. Determine PHASE by matching the stand conditions with the phase descriptions for the type. (The first phase description that fits the stand is the correct one.)

6. Use the definitions diagramed below for canopy coverage terms in the key. If you have difficulty deciding between types, refer to constancy and coverage data (appendix C-1) and the habitat type descriptions.

7. In stands where undergrowth is obviously depauperate (unusually sparse) because of dense shading or duff accumulations, adjust the above definitions to the next lower coverage class (e.g., well represented >1%, common >0%).

8. Remember, the key is NOT the classification! Validate the determination made using the key by checking the written description.



KEY TO CLIMAX SERIES

(DO NOT PROCEED UNTIL YOU HAVE READ THE INSTRUCTIONS!)

1. Habitats on steep slopes (30°) composed primarily of unstable fine rock; undergrowth sparse, poorly developed and quite variable. . . . SCREE (p. 121)
1. Habitats on sites with some soil development and stability; undergrowth rather well developed and somewhat uniform. 2

    2. Tsuga heterophylla present and reproducing successfully . . . . TSUGA HETEROPHYLLA SERIES (item G)
    2. Tsuga heterophylla not the indicated climax 3

3. Thuja plicata present and reproducing successfully. . . . . THUJA PLICATA SERIES (item F)
3. Thuja plicata not the indicated climax. 4

    4. Abies grandis present and reproducing more successfully than Abies lasiocarpa. . . . . ABIES GRANDIS SERIES (item E)
    4. Abies grandis not the indicated climax. 5

5. Abies lasiocarpa, Tsuga mertensiana, or Larix lyallii present and reproducing successfully, or Pinus albicaulis the dominant tree . . . . . ABIES LASIOCARPA SERIES (item I)
5. Not as above. 6

    6. Picea present and reproducing successfully. . . . . PICEA SERIES (item D)
    6. Picea not the indicated climax. 7

7. Pinus flexilis a successfully reproducing dominant; often sharing that status with Pseudotsuga . . . . PINUS FLEXILIS SERIES (item A)
7. Pinus flexilis absent or clearly seral. 8

    8. Pseudotsuga menziesii present and reproducing successfully. . . . . . PSEUDOTSUGA MENZIESII SERIES (item C)
    8. Pseudotsuga menziesii not the indicated climax. 9

9. Pure Pinus contorta stands, with little evidence as to potential climax. . . . . PINUS CONTORTA SERIES (item H)
9. Pinus contorta absent; Pinus ponderosa the indicated climax . . . . PINUS PONDEROSA SERIES (item B)

A. Key to Pinus flexilis Habitat Types

1. Festuca idahoensis well represented or F. scabrella common. . . . . PINUS FLEXILIS/FESTUCA IDAHOENSIS h.t. (p. 25)
    a. Festuca scabrella common. . . . . FESTUCA SCABRELLA phase
    b. F. scabrella scarce . . . . FESTUCA IDAHOENSIS phase
1. F. idahoensis poorly represented and F. scabrella scarce. 2

    2. Agropyron spicatum well represented . . . . PINUS FLEXILIS/AGROPYRON SPICATUM h.t. (p. 24)
    2. A. spicatum poorly represented; Juniperus communis (or J. horizontalis) well represented . . . . PINUS FLEXILIS/JUNIPERUS COMMUNIS h.t. (p. 26)

PUBLISHED AS PART OF "FOREST HABITAT TYPES OF MONTANA" - INT 1977

B. Key to *Pinus ponderosa* Habitat Types

1. *Prunus virginiana* well represented; only in southeastern Montana	PINUS PONDEROSA/PRUNUS VIRGINIANA h.t. (p. 34)
a. *Shepherdia canadensis* well represented	SHEPHERDIA CANADENSIS phase
b. *Shepherdia* poorly represented	PRUNUS VIRGINIANA phase
1. *P. virginiana* poorly represented	2
2. *Symphoricarpos albus* well represented	PINUS PONDEROSA/SYMPHORICARPOS ALBUS h.t. (p. 33)
a. *Berberis repens* common	BERBERIS REPENS phase
b. *Berberis* scarce	SYMPHORICARPOS ALBUS phase
2. *S. albus* poorly represented	3
3. *Purshia tridentata* well represented	PINUS PONDEROSA/PURSHIA TRIDENTATA h.t. (p. 32)
a. *Festuca idahoensis* well represented or *F. scabrella* common	FESTUCA IDAHOENSIS phase
b. *F. idahoensis* poorly represented and *F. scabrella* scarce	AGROPYRON SPICATUM phase
3. *Purshia* poorly represented	4
4. *Festuca idahoensis* well represented or *F. scabrella* common	PINUS PONDEROSA/FESTUCA IDAHOENSIS h.t. (p. 31)
a. *Festuca scabrella* common	FESTUCA SCABRELLA phase
b. *F. scabrella* scarce	FESTUCA IDAHOENSIS phase
4. *F. idahoensis* poorly represented and *F. scabrella* scarce	5
5. *Agropyron spicatum* well represented	PINUS PONDEROSA/AGROPYRON SPICATUM h.t. (p. 30)
5. *A. spicatum* poorly represented; *Andropogon* spp. well represented	PINUS PONDEROSA/ANDROPOGON h.t. (p. 30)

C. Key to *Pseudotsuga menziesii* Habitat Types

1. *Vaccinium caespitosum* present	PSEUDOTSUGA MENZIESII/VACCINIUM CAESPITOSUM h.t. (p. 39)
1. *V. caespitosum* absent	2
2. *Physocarpus malvaceus* or *Holodiscus discolor* well represented	PSEUDOTSUGA MENZIESII/PHYSOCARPUS MALVACEUS h.t. (p. 41)
a. *Calamagrostis rubescens* and/or *Carex geyeri* are the dominant undergrowth	CALAMAGROSTIS RUBESCENS phase
b. *Physocarpus* and/or *Holodiscus* dominate the undergrowth	PHYSOCARPUS MALVACEUS phase
2. *Physocarpus* and *Holodiscus* poorly represented	3
3. *Linnaea borealis* common	PSEUDOTSUGA MENZIESII/LINNAEA BOREALIS h.t. (p. 44)
a. *Symphoricarpos albus* well represented	SYMPHORICARPOS ALBUS phase
b. *Vaccinium globulare* well represented	VACCINIUM GLOBULARE phase
c. Not as above	CALAMAGROSTIS RUBESCENS phase
3. *Linnaea* scarce	4
4. *Vaccinium globulare* or *Xerophyllum tenax* well represented	PSEUDOTSUGA MENZIESII/VACCINIUM GLOBULARE h.t. (p. 43)
a. *Arctostaphylos uva-ursi* and *Pinus ponderosa* common	ARCTOSTAPHYLOS UVA-URSI phase
b. *Xerophyllum* common	XEROPHYLLUM TENAX phase
c. Not as above	VACCINIUM GLOBULARE phase
4. *Vaccinium globulare* and *Xerophyllum tenax* poorly represented	5
5. *Symphoricarpos albus* well represented	PSEUDOTSUGA MENZIESII/SYMPHORICARPOS ALBUS h.t. (p. 45)
a. Bunchgrasses well represented in old-growth stands	AGROPYRON SPICATUM phase
b. *Calamagrostis rubescens* well represented	CALAMAGROSTIS RUBESCENS phase
c. Not as above	SYMPHORICARPOS ALBUS phase
5. *S. albus* poorly represented	6
6. *Calamagrostis rubescens* well represented	PSEUDOTSUGA MENZIESII/CALAMAGROSTIS RUBESCENS h.t. (p. 47)
a. Bunchgrasses well represented in old-growth stands	AGROPYRON SPICATUM phase
b. *Arctostaphylos uva-ursi* common; sites capable of supporting *Pinus ponderosa* and not too dry for *Pinus contorta* (or *Larix occidentalis*)	ARCTOSTAPHYLOS UVA-URSI phase
c. *Pinus ponderosa* common	PINUS PONDEROSA phase
d. Not as above	CALAMAGROSTIS RUBESCENS phase
6. *C. rubescens* poorly represented	7
7. *Carex geyeri* well represented	PSEUDOTSUGA MENZIESII/CAREX GEYERI h.t. (p. 51)
7. *C. geyeri* poorly represented	8
8. *Arctostaphylos uva-ursi* well represented and *Pinus ponderosa* present	PSEUDOTSUGA MENZIESII/ARCTOSTAPHYLOS UVA-URSI h.t. (p. 52)
8. *Arctostaphylos* poorly represented or stands above elevational limits of *Pinus ponderosa*	9
9. *Juniperus communis* (or *J. horizontalis*) dominates the undergrowth	PSEUDOTSUGA MENZIESII/JUNIPERUS COMMUNIS h.t. (p. 53)
9. *J. communis* not the dominant undergrowth plant	10
10. *Spiraea betulifolia* well represented	PSEUDOTSUGA MENZIESII/SPIRAEA BETULIFOLIA h.t. (p. 52)
10. *S. betulifolia* poorly represented	11
11. *Arnica cordifolia* or *Antennaria racemosa* the dominant undergrowth	PSEUDOTSUGA MENZIESII/ARNICA CORDIFOLIA h.t. (p. 54)
11. *A. cordifolia* and *A. racemosa* not the dominant undergrowth	12
12. *Festuca scabrella* common	PSEUDOTSUGA MENZIESII/FESTUCA SCABRELLA h.t. (p. 38)
12. *F. scabrella* scarce	13
13. *Symphoricarpos oreophilus* well represented and *Festuca idahoensis* scarce	PSEUDOTSUGA MENZIESII/SYMPHORICARPOS OREOPHILUS h.t. (p. 55)
13. Not as above	14
14. *Festuca idahoensis* common; *Pinus ponderosa* scarce	PSEUDOTSUGA MENZIESII/FESTUCA IDAHOENSIS h.t. (p. 38)
14. *F. idahoensis* usually scarce; *Agropyron spicatum* well represented; *Pinus ponderosa* usually common	PSEUDOTSUGA MENZIESII/AGROPYRON SPICATUM h.t. (p. 37)

D. Key to Picea Habitat Types

1. Equisetum spp. abundant . . . . PICEA/EQUISETUM ARVENSE h.t.(p. 58)
1. Equisetum spp. not abundant 2

2. Clintonia uniflora, Cornus canadensis, or Aralia nudicaulis present (sites in northwestern Montana). . . . . PICEA/CLINTONIA UNIFLORA h.t.(p. 59)
   a. Vaccinium caespitosum present . . . . VACCINIUM CAESPITOSUM phase
   b. V. caespitosum absent . . . . CLINTONIA UNIFLORA phase
2. Not as above 3

3. Physocarpus malvaceus well represented . . . . PICEA/PHYSOCARPUS MALVACEUS h.t.(p. 6[illegible])
3. Physocarpus poorly represented 4

4. Two of these moist-site forbs present: Galium triflorum, Streptopus amplexifolius, Actaea rubra . . . . PICEA/GALIUM TRIFLORUM h.t.(p. 62)
4. Not as above 5

5. Vaccinium caespitosum present . . . . PICEA/VACCINIUM CAESPITOSUM h.t.(p. [illegible]2)
5. V. caespitosum absent 6

6. Linnaea borealis common . . . . PICEA/LINNAEA BOREALIS h.t.(p. 64)
6. Linnaea scarce 7

7. Smilacina stellata or Thalictrum occidentale present . . . . PICEA/SMILACINA STELLATA h.t.(p. 65)
7. Not as above; Senecio streptanthifolius present; undergrowth depauperate . . . . PICEA/SENECIO STREPTANTHIFOLIUS h.t.(p. 63)
   a. Pseudotsuga menziesii common . . . . PSEUDOTSUGA MENZIESII phase
   b. Pseudotsuga scarce (stands above its elevational limits) . . . . PICEA phase

E. Key to Abies grandis Habitat Types

1. Clintonia uniflora present . . . . ABIES GRANDIS/CLINTONIA UNIFLORA h.t.(p. 67)
   a. Aralia nudicaulis, Gymnocarpium dryopteris, or Athyrium filix-femina common . . . . ARALIA NUDICAULIS phase
   b. Xerophyllum tenax well represented . . . . XEROPHYLLUM TENAX phase
   c. Not as above . . . . CLINTONIA UNIFLORA phase
1. Clintonia absent 2

2. Linnaea borealis common . . . . ABIES GRANDIS/LINNAEA BOREALIS h.t.(p. 69)
   a. Xerophyllum tenax well represented . . . . XEROPHYLLUM TENAX phase
   b. Xerophyllum poorly represented . . . . LINNAEA BOREALIS phase
2. Linnaea scarce; Xerophyllum common . . . . ABIES GRANDIS/XEROPHYLLUM TENAX h.t.(p. 69)

F. & G. Key to Thuja and Tsuga heterophylla Habitat Types

1. Oplopanax horridum well represented . . . . THUJA PLICATA/OPLOPANAX HORRIDUM h.t.(p. [illegible]5)
1. Oplopanax poorly represented 2

2. Tsuga heterophylla present and reproducing successfully . . . . TSUGA HETEROPHYLLA/CLINTONIA UNIFLORA h.t.(p. 74)
   a. Aralia nudicaulis, Gymnocarpium dryopteris, or Athyrium filix-femina common . . . . ARALIA NUDICAULIS phase
   b. Not as above . . . . CLINTONIA UNIFLORA phase
2. Tsuga heterophylla absent or not reproducing successfully . . . THUJA PLICATA/CLINTONIA UNIFLORA h.t.(p. [illegible])
   a. Aralia nudicaulis, Gymnocarpium dryopteris, or Athyrium filix-femina common . . . . ARALIA NUDICAULIS phase
   b. Menziesia ferruginea common . . . . MENZIESIA FERRUGINEA phase
   c. Not as above . . . . CLINTONIA UNIFLORA phase

H. Key for Pinus contorta Communities

1. Clintonia uniflora present . . . . ABIES LASIOCARPA/CLINTONIA UNIFLORA h.t.(p. 82)
1. Clintonia absent 2

2. Two of these moist-site forbs present: Galium triflorum, Actaea rubra, Streptopus amplexifolius . . . . ABIES LASIOCARPA/GALIUM TRIFLORUM h.t.(p. 86)
2. Not as above 3

3. Calamagrostis canadensis well represented . . . . ABIES LASIOCARPA/CALAMAGROSTIS CANADENSIS h.t.(p. 88)
3. C. canadensis poorly represented 4

4. Vaccinium caespitosum present . . . . PINUS CONTORTA/VACCINIUM CAESPITOSUM comm. type(p. 118)
4. V. caespitosum absent 5

5. Linnaea borealis common . . . . PINUS CONTORTA/LINNAEA BOREALIS comm. type(p. 119)
5. Linnaea scarce 6

6. Xerophyllum tenax common . . . . ABIES LASIOCARPA/XEROPHYLLUM TENAX h.t.(p. 94)
6. Xerophyllum scarce 7

7. Vaccinium globulare well represented . . . . ABIES LASIOCARPA/VACCINIUM GLOBULARE h.t.(p. 97)
7. V. globulare poorly represented 8

8. Vaccinium scoparium well represented . . . . PINUS CONTORTA/VACCINIUM SCOPARIUM comm. type(p. 119)
8. V. scoparium poorly represented 9

9. Calamagrostis rubescens well represented . . . . PINUS CONTORTA/CALAMAGROSTIS RUBESCENS comm. type(p. 120)
9. C. rubescens poorly represented 10

10. Carex geyeri well represented . . . . ABIES LASIOCARPA/CAREX GEYERI h.t.(p. 105)
10. C. geyeri poorly represented 11

11. Juniperus communis (or J. horizontalis) the major undergrowth . . PSEUDOTSUGA MENZIESII/JUNIPERUS COMMUNIS h.t.(p. 53)
11. Not as above; Purshia tridentata present . . . . PINUS CONTORTA/PURSHIA TRIDENTATA h.t.(p. 117)

I. Key to Abies lasiocarpa Habitat Types

A. Sites at or above the cold limits of Pseudotsuga and also meeting one of the following criteria:
(a) Pinus albicaulis well represented;
(b) Luzula hitchcockii present;
(c) Ribes montigenum present;
(d) Stands at upper timberline
UPPER SUBALPINE AND TIMBERLINE h.t.s. 17

A. Not as above
LOWER SUBALPINE h.t.s. 1

1. Oplopanax horridum well represented. . . . . ABIES LASIOCARPA/OPLOPANAX HORRIDUM h.t. (p. 81)
1. Oplopanax poorly represented 2

2. Clintonia uniflora present . . . . ABIES LASIOCARPA/CLINTONIA UNIFLORA h.t. (p. 82)
a. Aralia nudicaulis, Gymnocarpium dryopteris, or Athyrium filix-femina common . . . . ARALIA NUDICAULIS phase
b. Menziesia ferruginea well represented . . . . . . MENZIESIA FERRUGINEA phase
c. Vaccinium caespitosum or Arctostaphylos uva-ursi common . . . . VACCINIUM CAESPITOSUM phase
d. Xerophyllum tenax well represented . . . . XEROPHYLLUM TENAX phase
e. Not as above. . . . . CLINTONIA UNIFLORA phase
2. Clintonia absent 3

3. Menziesia ferruginea well represented. 4
3. Menziesia poorly represented 5

4. Tsuga mertensiana well represented . . . . TSUGA MERTENSIANA/MENZIESIA FERRUGINEA h.t. (p. 94)
4. Tsuga mertensiana poorly represented . . . . ABIES LASIOCARPA/MENZIESIA FERRUGINEA h.t. (p. 92)

5. Calamagrostis canadensis, Senecio triangularis, or Ledum glandulosum well represented . . . . ABIES LASIOCARPA/CALAMAGROSTIS CANADENSIS h.t. (p. 88)
a. Galium triflorum or Actaea rubra present. . . . . GALIUM TRIFLORUM phase
b. *Vaccinium caespitosum present* . . . . VACCINIUM CAESPITOSUM phase
c. Not as above. . . . . CALAMAGROSTIS CANADENSIS phase
5. C. canadensis, S. triangularis, and Ledum poorly represented 6

6. Two of these moist-site forbs present: Galium triflorum, Actaea rubra, Streptopus amplexifolius . . . . ABIES LASIOCARPA/GALIUM TRIFLORUM h.t. (p. 86)
6. Not as above 7

7. Vaccinium caespitosum present. . . . . ABIES LASIOCARPA/VACCINIUM CAESPITOSUM h.t. (p. 87)
7. V. caespitosum absent. 8

8. Linnaea borealis common . . . . ABIES LASIOCARPA/LINNAEA BOREALIS h.t. (p. 90)
a. Xerophyllum tenax well represented. . . . . XEROPHYLLUM TENAX phase
b. Vaccinium scoparium well represented. . . . . VACCINIUM SCOPARIUM phase
c. Not as above. . . . . LINNAEA BOREALIS phase
8. Linnaea scarce 9

9. Alnus sinuata well represented . . . . ABIES LASIOCARPA/ALNUS SINUATA h.t. (p. 100)
9. A. sinuata poorly represented 10

10. Xerophyllum tenax common 11
10. *Xerophyllum* scarce 12

11. Tsuga mertensiana well represented . . . . TSUGA MERTENSIANA/XEROPHYLLUM TENAX h.t. (p. 97)
11. Tsuga mertensiana poorly represented . . . . ABIES LASIOCARPA/XEROPHYLLUM TENAX h.t. (p. 94)
a. Vaccinium globulare poorly represented and V. scoparium abundant . . . . VACCINIUM SCOPARIUM phase
b. Not as above. . . . . VACCINIUM GLOBULARE phase

12. Vaccinium globulare well represented . . . . ABIES LASIOCARPA/VACCINIUM GLOBULARE h.t. (p. 97)
12. V. globulare poorly represented. 13

13. Vaccinium scoparium (including V. myrtillus) well represented . . . . ABIES LASIOCARPA/VACCINIUM SCOPARIUM h.t. (p. 98)
a. Calamagrostis rubescens common and Arctostaphylos uva-ursi or Berberis repens present . . . . CALAMAGROSTIS RUBESCENS phase
b. Thalictrum occidentale common or Viola orbiculata or Valeriana sitchensis present . . . . THALICTRUM OCCIDENTALE phase
c. Not as above. . . . . VACCINIUM SCOPARIUM phase
13. V. scoparium poorly represented. 14

14. *Clematis pseudoalpina (including C. tenuiloba) present* or Pinus flexilis common. (Sites usually on calcareous substrates.) . . . . ABIES LASIOCARPA/CLEMATIS PSEUDOALPINA h.t. (p. 102)
14. C. pseudoalpina absent and Pinus flexilis scarce 15

15. Calamagrostis rubescens well represented . . . . ABIES LASIOCARPA/CALAMAGROSTIS RUBESCENS h.t. (p. 101)
15. C. rubescens poorly represented. 16

16. Carex geyeri well represented under well-developed forest canopies . . . . ABIES LASIOCARPA/CAREX GEYERI h.t. (p. 105)
a. Pseudotsuga well represented; Carex geyeri *sharing dominance in the undergrowth with* forbs such as Thalictrum. . . . . PSEUDOTSUGA MENZIESII phase
b. Pseudotsuga poorly represented; undergrowth dominated by C. geyeri alone. . . . . CAREX GEYERI phase
16. C. geyeri poorly represented . . . . ABIES LASIOCARPA/ARNICA CORDIFOLIA h.t. (p. 103)

17. Abies lasiocarpa and Picea engelmannii scarce and Pinus albicaulis the indicated climax. . . . . PINUS ALBICAULIS h.t.s. (p. 114)
17. Not as above 18

18. Timberline habitats; Abies lasiocarpa stunted; Pinus contorta and Menziesia ferruginea absent 19
18. Forest habitats; Abies lasiocarpa tall (generally 50 feet or more at maturity) 20

19. Larix lyallii present. . . . . LARIX LYALLII-ABIES LASIOCARPA h.t.s. (p. 112)
19. Larix lyallii absent . . . . PINUS ALBICAULIS-ABIES LASIOCARPA h.t.s (p. 111)

20. Calamagrostis canadensis, Senecio triangularis, or Ledum glandulosum well represented . . . . ABIES LASIOCARPA/CALAMAGROSTIS CANADENSIS h.t. (p. 88)
20. C. canadensis, S. triangularis, and Ledum poorly represented 21

21. Luzula hitchcockii present or Menziesia ferruginea well represented 22
21. L. hitchcockii absent and Menziesia poorly represented . . . 23

22. Tsuga mertensiana well represented . . . . TSUGA MERTENSIANA/LUZULA HITCHCOCKII h.t. (p. 110)
a. Menziesia ferruginea well presented . . . . MENZIESIA FERRUGINEA phase
b. Menziesia poorly represented . . . . VACCINIUM SCOPARIUM phase
22. Tsuga mertensiana poorly represented . . . . ABIES LASIOCARPA/LUZULA HITCHCOCKII h.t. (p. 108)
a. Menziesia ferruginea well represented . . . . MENZIESIA FERRUGINEA phase
b. Menziesia poorly represented. . . . . VACCINIUM SCOPARIUM phase

23. Vaccinium scoparium (including V. myrtillus) Carex geyeri well represented . . . . ABIES LASIOCARPA-PINUS ALBICAULIS/VACCINIUM SCOPARIUM h.t. (p. 107)
23. Not as above; Ribes montigenum present . . . . ABIES LASIOCARPA/RIBES MONTIGENUM h.t. (p. 106)