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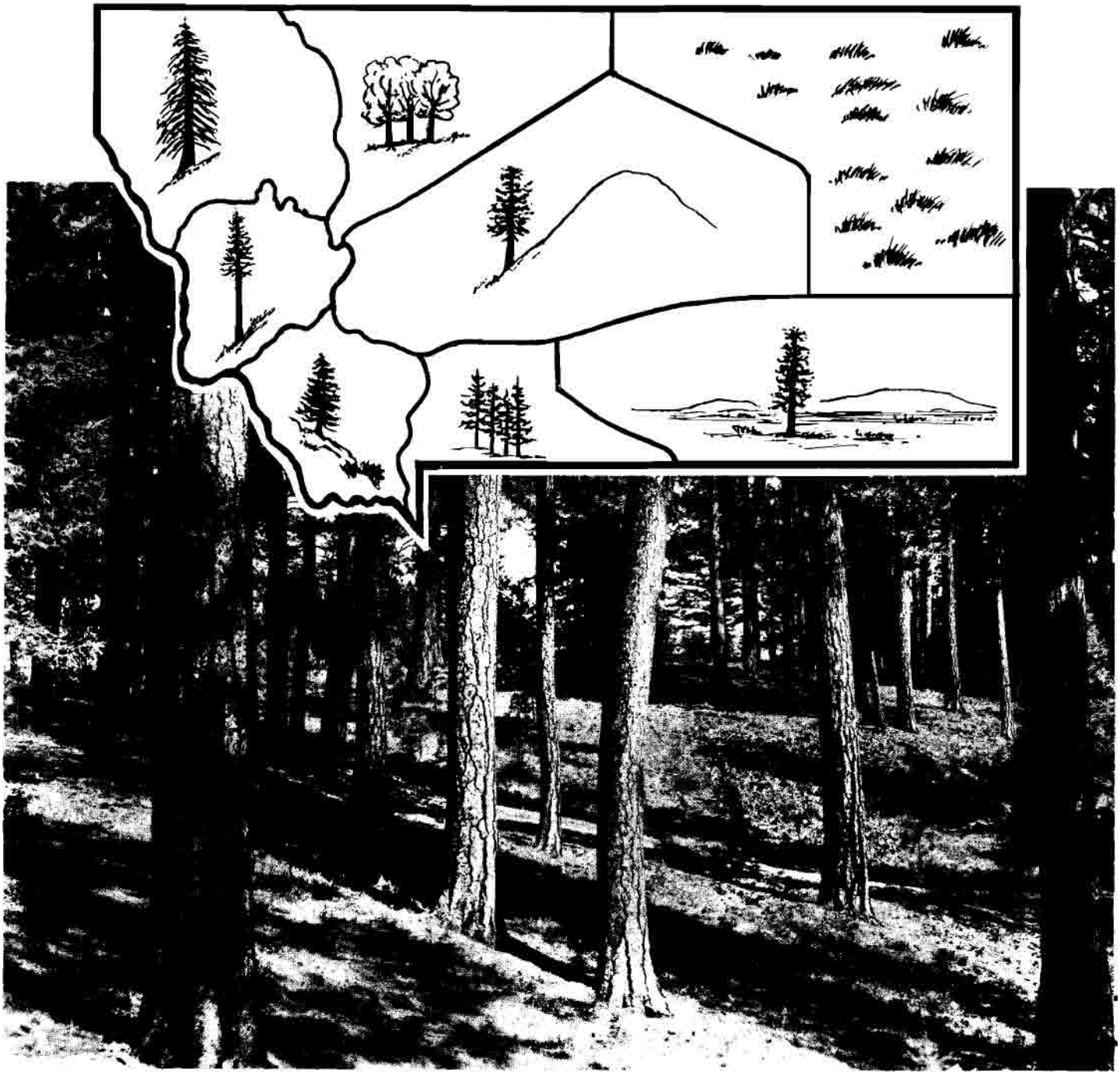

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CONTENTS

RESEARCH SUMMARY

The author categorizes forest vegetation across Montana into eight geographic subdivisions called "forest regions." The regions correlate the influence of climate and general topography to forest vegetation--including the distributions of tree and undergrowth species and forest habitat types. The vertical zonation of forest series (based on the potential climax tree species) also differs from one region to the next. Regional boundaries were fitted to distributions of certain tree and undergrowth species, habitat types, and natural climatic barriers such as the Continential Divide and broad grassland valleys that separate forest environments.

(1) The northwestern Montana forest region has major representation by Pacific Coast species such as Thujaplicata and Clintoniauniflora; its climate is strongly influenced by moist maritime airmasses. (2) The west-central region has a generally drier Pacific-influenced climate and only small amounts of Pacific Coast species; however, it has major representation of intermountain plants like Larix occidentalis and Xerophyllum tenax.

(3) North-central Montana lies in the severe climate of the "chinook wind belt" along the east slope of the Continental Divide. It is distinguished by being too cold for Pinus ponderosa, but having extensive Populus tremuloides groves and Pinus flexilis woodlands. (4) The central Montana forest region has a less severe continental climate and it supports the east-side form of Pinus ponderosa at lower elevations. However, both coastal and intermountain species are essentially absent from its mountain forests.

Both the *(5)* southwestern and (6) south-central forest regions have high base elevations and are without Pinus ponderosa. The former region's forests are generally drier than the latter's and often have sparse undergrowth. (7) Southeastern Montana differs from previously mentioned regions in not having prominent mountains. It has extensive Great Plains Pinus ponderosa forests. (8) Northeastern Montana is a Great Plains area having no forest, except for Populus deltoides groves along major streams.

The regions may be useful as a biologically based stratification for forest research and forest management studies.

INTRODUCTION

This report describes Montana's forests by geographic subdivisions called "forest regions." It emphasizes patterns in species composition (trees and undergrowth) and the relationship of these patterns to climate and topography. The interpretations are based on field experience and data collected during a recent forest habitat type classification (Pfister and others 1977).

There are two primary reasons for delineating the forest regions of Montana. First, the regions serve as a geographic reference for describing patterns of forest vegetation across the State. Second, delineating the regions contributes to regional classifications that are being developed from a national perspective (Bailey 1976, 1978). The geographic subdivisions discussed in this paper are based on the distribution of forest vegetation in relation to climate (as influenced by topography). Thus, these subdivisions are proposed for use only for interpretations related to forest vegetation.

After reviewing definitions provided in Kuchler (1973) and Bailey (1976), the term "forest region" seemed most appropriate for use here. "Region" is a general term that does not necessarily specify a level in the land classification hierarchy, and the term "forest region" has been applied in Canada (Rowe 1972). ("Province" was also considered, but it has a more precise hierarchical definition related to the dominant vegetative types in an area, or to physiography; thus, some of Montana's forest regions occur within grassland provinces.)

Other regional divisions of Montana have been developed from different types of information to meet different objectives. Schmidt and Dufour (1975) emphasized geomorphology in designating six regions within Montana. Those regions were used in assessing research natural area needs from the following viewpoints: forest vegetation, grass and shrubland vegetation, geology, zoology, and aquatics. Crowley (1972) depicted seven major environmental regions within Montana based on characteristics of human environments, including landforms, climate, and elevational zonations of vegetation.

Still others (Kuchler 1964; Payne 1973; Ross and Hunter 1976) have provided maps of Montana's natural vegetative types; but the maps are not focused on regional variation in forest vegetation. In contrast to these references, the Montana "forest regions" proposed here delineate rather broad areas having similar zonation in forest vegetation. These forest regions have general similarities to the forest districts designated by the early Montana botanist, Kirkwood (1922), for describing forest distribution in the Northern Rocky Mountains.

During the Montana forest habitat type study (Pfister and others 1977), 1,500 stands were sampled "subjectively without bias" (Mueller-Dombois and Ellenburg 1974). The stands represent a spectrum of mature forest communities and sites in each mountain range and forested area of the State. As the habitat type classification was being developed from these data, it became obvious that distributions of many tree and undergrowth species (and thus the distributions of the habitat types) are strongly correlated

to patterns of geography and climate within Montana. It became evident that the State could be subdivided into several relatively homogeneous forest regions based on the data, field observations, and information on plant species distributions (Herbarium collections at the University of Montana, Missoula; Montana State University, Bozeman; the USDA Forest Service Forestry Sciences Laboratory, Missoula; personal interviews with local foresters and botanists (see acknowledgments); Booth and Wright 1966, Hitchcock and others 1955-1969, Little 1971, 1976).

A map of forest regions (called "geographic subdivisions") was presented by Pfister and others (1977), and a brief account of each habitat type's distribution was given by region. However, the basis for these regions was not discussed; also, Montana's forest vegetation and environments were not described by region. These topics are addressed here.

The Canadian Forest Service (Rowe 1959, 1972) mapped and described "Forest Regions of Canada," which provides a precedent. Rowe (1972) explained that the Canadian regional designations are generalized, with the broad perspective of Canada as a whole, although the statement was made that it would be possible to designate such regions from a detailed knowledge of specific areas if detailed data existed. The latter approach is used here with detailed data from the habitat type study (Pfister and others 1977) as a basis.

Kuchler (1973) discussed techniques for designating ecologically based "regions." He stated that classifications of natural vegetation types and detailed mapping of their distributions are fundamental for establishing such regions. (It appears that the Montana forest habitat type classification along with the sample plots and other distributional data can provide this basic information.) Kuchler (1973) also concluded that vegetation regions should first be designated within a limited study area, such as a State or geographic region, and later expanded to surrounding areas.

DELINEATING MONTANA FOREST REGIONS

Montana's forests are both extensive and diverse. Forest covers nearly one-fourth of Montana--about 23 million acres according to Green and Setzer (1974)--and substantial amounts of forest are found in all but the northeastern portions of the State (fig. 1). At lower elevations these forests range from luxuriant stands of *Tsuga heterophylla*, *Thuja plicata*, *Pinus monticola*, and other Pacific Coast species in northwestern Montana to open *Pinus ponderosa* woodlands on the Great Plains of southeastern Montana. The high-elevation forests across the Montana Rockies also show substantial variation.

Differences in climate are primarily responsible for geographic variations in the potential climax forest vegetation, expressed in habitat types (Pfister and others 1977). The climatic differences across Montana reflect the greater importance of Pacific maritime airmasses west of the Continental Divide versus continental climatic conditions east of the Divide. Locally, climate (and thus forest vegetation) also is strongly influenced by changes in elevation, aspect, and landform within the Montana Rockies. Soils and underlying geology also affect forest vegetation, but except for certain limestone substrates and extremely rocky sites, the effects do not generally obscure the overriding influence of climate and topography.

The forest regions outlined on figure 1 correlate the influence of climate and general topography to forest vegetation--including the distributions of tree and undergrowth species and forest habitat types and the vertical zonation of forest series (discussed later). Because tree species serve as indicators of climate (Daubenmire and Daubenmire 1968; Pfister and others 1977), their geographic distributions serve as a primary determinant of regional boundaries. (Appendixes A-1 through A-6 illustrate how the distributions of tree species correlate with Montana's forest regions.) Distributions of undergrowth species that have proved useful as indicator plants in major forest habitat type classifications in the Northern Rockies (R. and J. Daubenmire 1968; Pfister and others 1977; and Robert Steele and others[1]), also were used (for examples, see appendixes A-7 through A-10).

It became obvious that many of the tree, undergrowth plant, and habitat type distributions showed similar patterns, and relate to known climatic differences (U.S. Department of Commerce 1971; USDA Soil Conservation Service 1968). Preliminary regional boundaries were drawn to fit these vegetational data. The boundaries then were adjusted slightly to correlate with natural climatic barriers such as the Continental Divide and broad grassland valleys that separate forest environments. Although these regional boundaries were fitted to vegetation data and to topographic barriers as logically as possible, sometimes the general patterns of forest vegetation change gradually over rather broad areas. In these cases, where possible, major topographic features were used for final placement of boundaries. Dashed lines were used to designate regional boundaries in nonforested areas.

The occurrence of the approximately 1,500 sample plots by habitat type and forest region is summarized in appendix B. Plant composition at these forest sites provides basic data for regional boundaries. At a broad level of generalization from this data

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[1]Review drafts of "Forest habitat types of central Idaho" (1975) and those of the Nezperce National Forest (1976). Intermt. For. and Range Exp. Stn., Ogden, Utah.

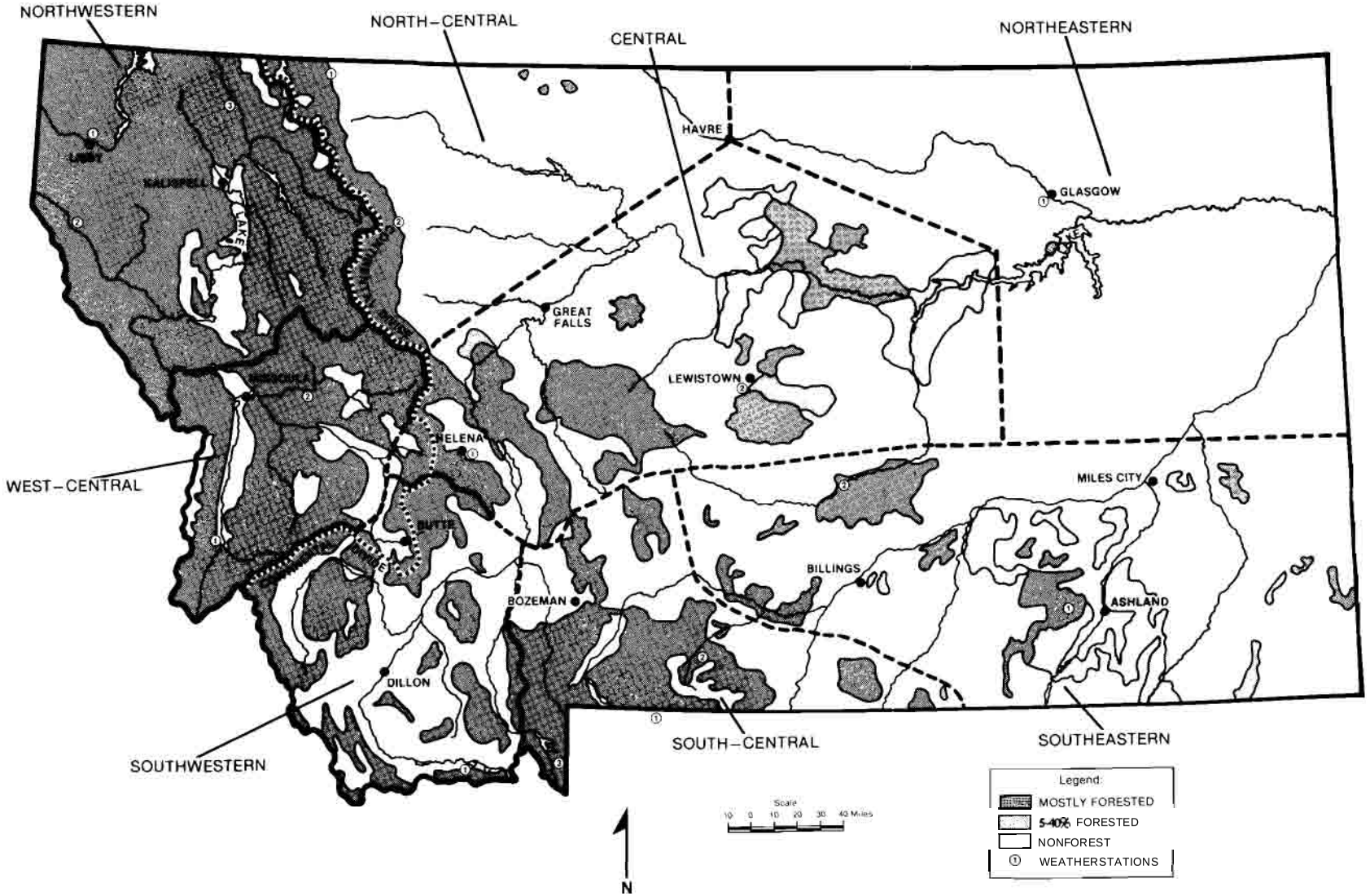


Figure 1.--Montana forest regions and forested areas (from Hutchinson and Kemp 1952, Ross and Hunter 1976, composite satellite photo of Montana, GE Space Systems, Beltsville, Md.) Circled numbers are weather stations listed in table 4.

Table 1.--*Extent (area covered) of forest series (potential climax) in each of Montana's forest regions*

M = major
m = minor
r = rare
. = absent

Series	Forest region: North-western	West-central	North-central	Central	South-western	South-central	South-eastern	North-eastern
Tsuga and Thuja	M	r	.					
Abies grandis	M	m	.	.	.	.	.	.
Picea	m	r	m	M	m	M	.	.
Pinus contorta	r	m	m	M	M	M	.	.
Pinus ponderosa	m	m	.	M	.	r	M	r
Pinus flexilis	.	.	M	m	m	m	.	.
Pseudotsuga	M	M	M	M	M	M	.	.
Abies lasiocarpa	M	M	M	M	M	M	.	.

the extent (area covered) of each climax series can be compared--identified by the most shade-tolerant (potential climax) tree species capable of growing on a given site. Table 1 shows which *series* occur in each of the forest regions. For instance, the Pacific Northwest coastal forest types (*Thuja, Tsuga,* and *Abies grandis* series) are of major importance only in northwestern Montana. Low-elevation forest types (*Pinus ponderosa* climax series) associated with dry, inland climates are abundant only in central and southeastern Montana, and are absent or rare in the north-central, southwestern, and south-central forest regions.

Detailed interpretations (from appendix B data) are presented in table 2, which shows the major habitat types in each of Montana's forest regions. Additional interpretations and adjustments were made in developing table 2 from the sample plot data (appendix B). Certain substrate-oriented habitat types (such as *Picea/Senecio streptanthifolius* and *Abies lasiocarpa/Clematis pseudoalpina* h.t. on limestone substrates) were heavily sampled by Pfister and others (1977), and are not as extensive as appendix B implies. Also, certain areas near the border of a forest region were heavily sampled; thereby more plots were collected from certain habitat types than are indicative of the region in general. For instance, several *Abies lasiocarpa/Clintonia* and *Abies lasiocarpa/Xerophyllum* h.t. plots were taken in unusual locations immediately east of the Continental Divide in north-central Montana.

The distribution of various tree species and undergrowth plants serving as habitat type or climatic indicators is presented in table 3 by forest region across Montana. This table is based on the 1,500 habitat type plots, and the field observations and published information on plant distributions cited previously. The distributions of Pacific Coast and intermountain species are useful for differentiating forests of northern Idaho, northwestern Montana, and west-central Montana, but the other forest regions are characterized largely by a lack of these species. ("Intermountain species" applies to plants found most often between the crest of the Cascade Mountains and the Continental Divide.)

Certain widespread species (like *Vaccinium scoparium, Juniperus communis, Arnica cordifolia, Aster conspicuus,* and even *Pyrola secunda)* generally are accompanied by Pacific Coast or intermountain species west of the Continental Divide; farther east the coastal and intermountain competitors drop out. This situation is documented by the changes in habitat types depicted in table 2. For instance, *Pseudotsuga/Juniperus communis, Pseudotsuga/Arnica cordifolia,* and *Abies lasiocarpa/Arnica cordifolia* appear only east of the Divide.

Figure 2 shows a summary of the characteristics of each forest region. The relationship of forest region and National Forest boundaries is shown in appendix C.

Table 2.--*Major habitat types (Pfister and others 1977) in each of Montana's forest regions (See appendix B for more detailed information on all habitat types)*

Habitat type	Forest region						
	NW	WC	NC	C	SW	SC	SE
Pinus flexilis/Festuca idahoensis		.	x	x	.	.	.
P. ponderosa/Agropyron spicatum		x	.	.	.	.	x
P. ponderosa/Festuca idahoensis		x	.	x	.	.	x
P. ponderosa/Symphoricarpos albus			.	x	.		x
P. ponderosa/Prunus virginiana			.	.	.		x
Pseudotsuga/Festuca idahoensis		.	.	.	x		.
Pseudotsuga/Festuca scabrella	.	.	.	x	.		.
Pseudotsuga/Vaccinium caespitosum	x	x	.	.	.		.
Pseudotsuga/Physocarpus malvaceus	X	x	.	.	.	x	
Pseudotsuga/Vaccinium globulare	X	x	.	x	.	.	
Pseudotsuga/Linnaea borealis		x	.	x	.	.	
Pseudotsuga/Symphoricarpos albus	X	x	x	x	x	x	
Pseudotsuga/Calamagrostis, Cal. phase		x	.	x	x	x	
Pseudotsuga/Cal., other phases	X	x	.	x	.		
Pseudotsuga/Spiraea betulifolia			x	x	.	.	
Pseudotsuga/Arctostaphylos uva-ursi		.	.	x	.	.	
Pseudotsuga/Juniperus communis		.	.	x	x	.	
Pseudotsuga/Arnica cordifolia		.	.	x	x	.	
Picea/Clintonia uniflora	x					.	
Picea/Physocarpus malvaceus	.					x	
Picea/Galium triflorum	.		.	.	.	x	
Picea/Linnaea borealis	.		.	x	x	x	
All Abies grandis h.t.s	x		.	.	.	.	.
Thuja plicata/Clintonia uniflora	X		.	.	.	.	.
Tsuga heterophylla/Clintonia uniflora	x		.	.	.	.	.
Abies lasiocarpa/Clintonia uniflora	x	x	.	.	.		
Abies lasiocarpa/Galium triflorum		x	x	x	.	x	
Abies lasiocarpa/Calamagrostis canadensis	.	.	.	.	x	x	
Abies lasiocarpa/Linnaea borealis	x	x	x	x	x	x	
Abies lasiocarpa/Menziesia ferruginea	X	x	x	.	.		.
All Tsuga mertensiana h.t.s	X	.	.	.	.		.
Abies lasiocarpa/Xerophyllum tenax	X	x	x	.	.		.
Abies lasiocarpa/Vaccinium globulare			.	x	.	x	.
Abies lasiocarpa/Vaccinium scoparium		.	.	x	x	x	.
Abies lasiocarpa/Arnica cordifolia		.	.	x	x	.	.
Abies las.-Pinus albic./Vaccinium scop.		.	x	x	x	x	.
Abies lasiocarpa/Luzula hitchcockii	x	x	x	.	.		
Pinus albicaulis-Abies lasiocarpa	x	x	x	x	x	x	
Larix lyallii-Abies lasiocarpa	x	x	.	.	.	.	
Pinus contorta community types			.	x	x	x	

Table 3.--*Distribution of selected trees and undergrowth indicator plants by forest region across Montana. Northern Idaho data from Daubenmire and Daubenmire (1968)*

x = common
r = rare or scarce
. = absent

Species	Northern Idaho	Forest region NW	WC	NC	C	SW	SC	SE
Coastal species								
Adiantum pedatum	x	r	.	.	.	.	.	.
Asarum caudatum	x	r	.	.	.	.	.	.
Tsuga heterophylla	X	X						
Tsuga mertsnsiana	X	X						
Thuja plicata	x	x	r	.	.	.	.	.
Pinus monticola	x	x	r	.	.	.	.	.
Taxus brevifolia	x	x	r	.	.	.	.	.
Abies grandis	x	x	x-r	.	.	.	.	.
Clintonia uniflora	x	x	x-r	r	.	.	.	.
Intermountain species								
Larix occidentalis	X	X	X					
Larix lyallii	X	X	X	X				
Pinus ponderosa var.-ponderosa[1]	X	X	X					
Xerophyllum tenax	X	X	X	X	r	r	r	
Menziesia ferruginea	x	X	x	X	r	r	r	
Luzula hitchcockii	X	X	X	X	r	r	r	
Widespread species								
Widespread Rocky Mt. trees[2]	X	X	X	X	X	X	X	
Calamagrostis rubescens	x	X	X	X	X	X	x	
Carex geyeri	X	X	X	X	X	X	X	
Physocarpus malvaceus	X	X	x	r	X	r	x	
Eastside species								
Pinus flexilis			r	X	X	X	x	
Senecio streptanthefolius	.			r	X	X	X	
Frasera speciosa				r	X	X	X	
Geranium richardsonii				X	x	X	X	
Pinus ponderosa var. scopulorum[3]					X		r	X
Juniperus horizontalis				X	X	X	X	X
Fraxinus pennsylvanica								r

[1] (Little 1953), having three-needle fascicles only.
[2] Pseudotsuga, Abies lasiocarpa, Picea, Pinus contorta, and Pinus albicaulis.
[3] (Booth 1950 and Little 1953), having many two-needle fascicles.

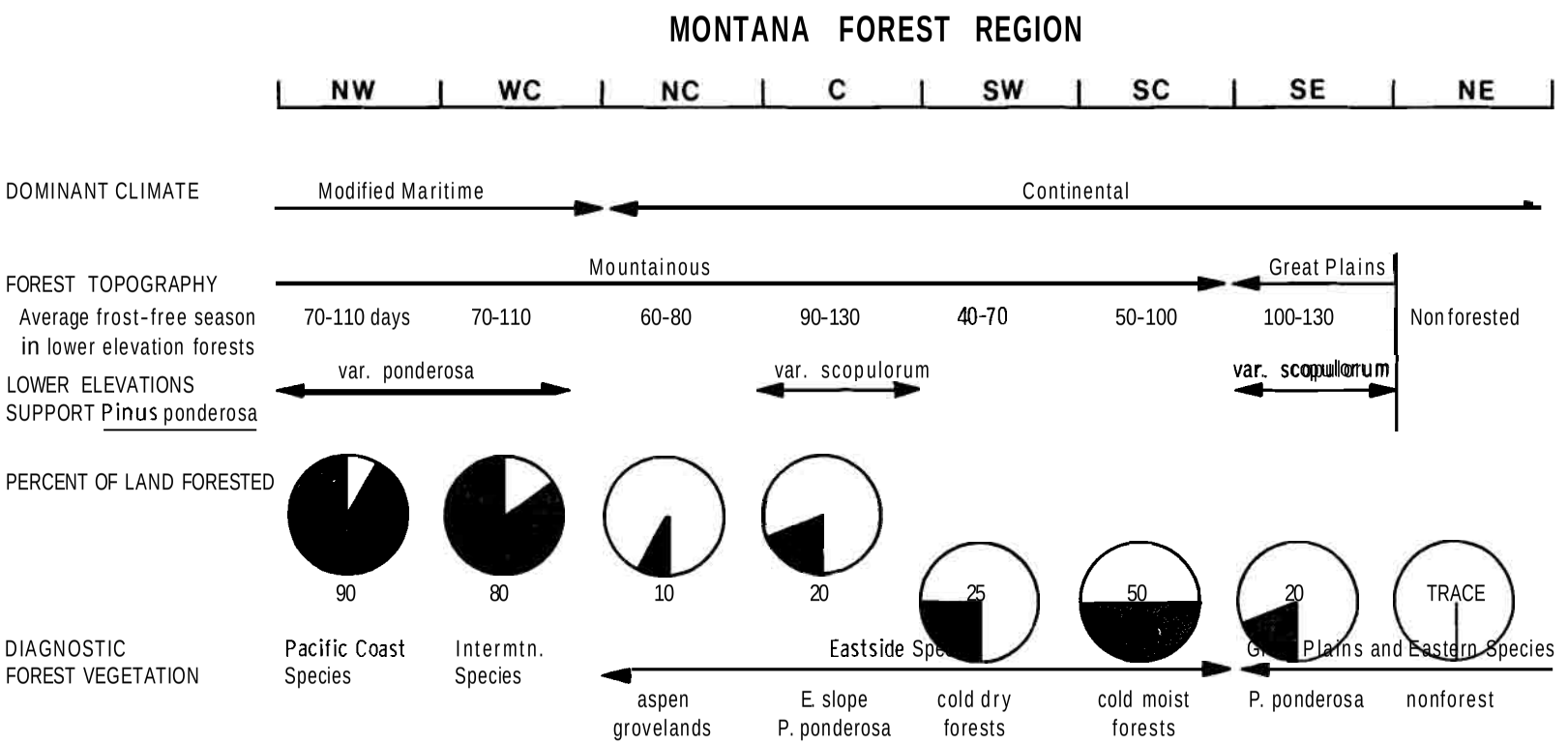
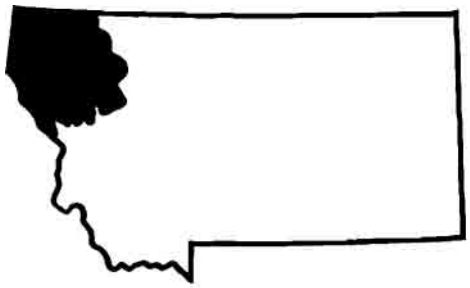


Figure 2.--Summary of the major characteristics of Montana's forest regions. (Average frost-free season, for sites with good air circulation, as interpreted from Caprio 1965.)

FOREST REGION DESCRIPTIONS

Northwestern Montana Forest Region



The northwestern forest region of Montana includes the Kootenai, Flathead, and lower Clark Fork River (as far upstream as Fish Creek and Ninemile Valley) drainages. This region is bounded on the east by the Continental Divide, on the north by British Columbia, and on the west and southwest by Idaho and the crest of the Bitterroot Mountains. The southeastern border of the region is marked by the Rattlesnake Creek and Blackfoot River divides.

Diagnostic forest vegetation

The northwest forest region has an abundance (in all but the drier valleys) of Pacific Coast forest species that are less common or absent elsewhere. Tree species largely restricted to this region include *Tsuga heterophylla, T. mertensiana, Thuja plicata, Abies grandis, Tams brevifolia,* and *Pinus monticola.* Undergrowth largely restricted to this region includes *Clintonia uniflora, Aralia nudicaulis, Gymnocarpium dryopteris* (and other Pacific Coast ferns), *Disporum hookeri, Tiarella trifoliata, Viola glabella,* and *Oplopanax horridum* (nomenclature is from Hitchcock and Cronquist 1976).

Forest distribution

As is the case in other mountainous sections of Montana, the rugged terrain creates an array of habitats and accompanying vegetation, from semiarid grasslands in the rain shadow of large mountain masses to moist mountain valleys, subalpine forests, and alpine tundra. The generalized distribution of forest trees and climax series for an area in the Kootenai River drainage is depicted in figure 3. Major forest habitat types for northwestern Montana are listed in table 2.

About 90 percent of the land in this region is potentially forested (Hutchison and Kemp 1952; Green and Setzer 1974). Throughout much of the region, forest covers even the lowest elevation valleys (as low as 1,800 feet); in the driest valleys southwest of Flathead Lake, grassland prevails below about 3,500 feet elevation. Forest extends over all but the highest peaks (and rockiest sites). The average elevation of alpine tree line is about 8,000 feet.

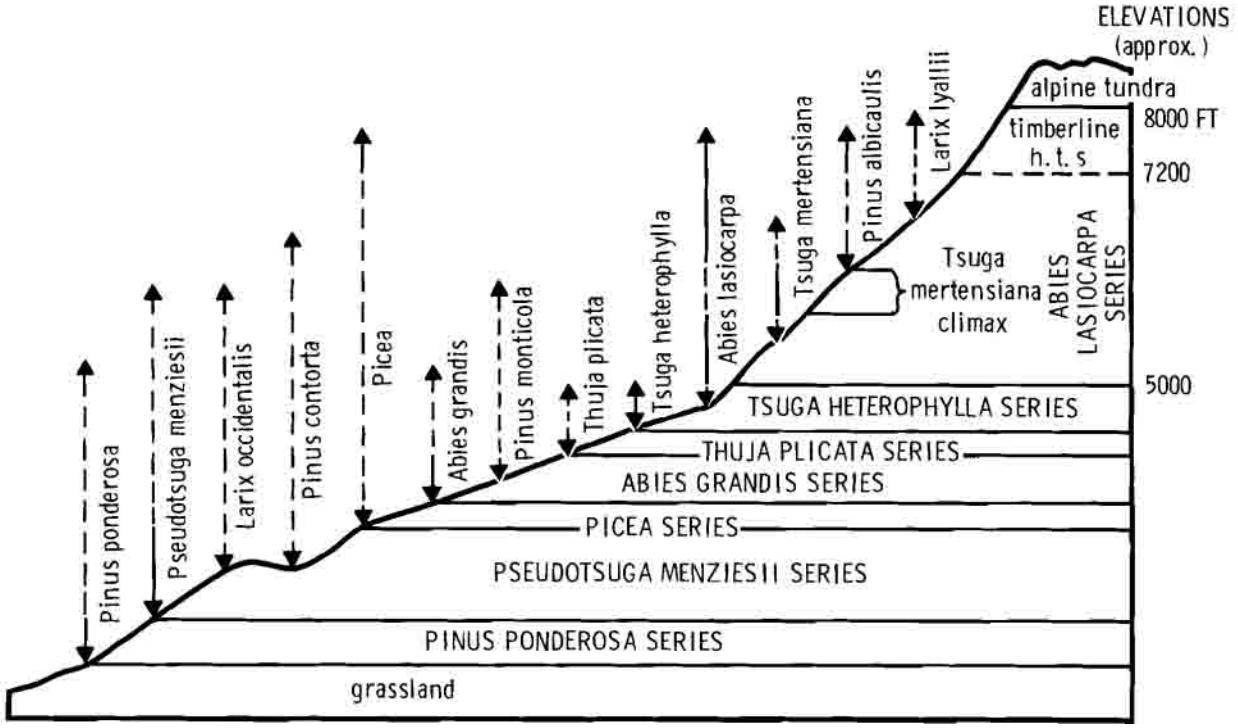


Figure 3.--Distribution of forest trees in an area of the Kootenai drainage in northwestern Montana. Arrows show the relative elevational range of each species; solid portion of the arrow indicates where species is potential climax, dashed portion shows where it is seral. (Modified from Pfister and others 1977.)

Climatic influences

Northwestern Montana is strongly influenced by moist maritime airmasses that typically funnel through this area on their way inland from the Pacific Coast (U.S. Department of Commerce 1971; Daubenmire 1969). The airmasses provide abundant rain and snowfalls and generally humid, cloudy conditions except in midsummer. The airmasses also bring the relatively mild winter temperatures (even at high elevations) that are necessary for the survival of many of the coastal forest species.

The mildest conditions are generally associated with the Kootenai drainage in the western part of the region. In the Kootenai drainage, forests most nearly resemble those of adjacent northern Idaho, representing a still moister and milder coastal climate. *Pinus monticola* is abundant and is generally the tallest and fastest growing tree in northern Idaho. However, eastward through northwestern Montana, *Larix occidentalis* assumes this role (attaining heights of 150 to 170 feet on favorable sites).

Farther east, in the upper Flathead Valley, outbreaks of arctic air occur more frequently in the winter (U.S. Department of Commerce 1971). As a result, *Tsuga heterophylla* and *Thuja* sustain frost damage and become restricted to special sites. These sites either have a climate that is moderated by the presence of a large lake (Flathead Lake and Lake McDonald) or represent sheltered "cove" forests in ravines above the valley bottom frost zones. Still, even in the upper Flathead Valley, tree and undergrowth flora reflect a Pacific influence extending all the way to the Continental Divide itself.

Weather records for Libby and Trout Creek (table 4) represent the milder, western part of this region; whereas the Polebridge station lies in the colder, upper Flathead

Table 4.--*Weather station records from lower elevation forested sites in each of Montana's forest regions. Locations of these stations are shown by number (at left) on figure 1*

Region and station	Estimated climax series	Elev.	Mean mo. temp. Jan.	Mean mo. temp. July	Ave. length of frost-free season - 32°F	Mean annu. precipitation	Mean May-August precip.	Mean annual snowfall
		Feet	*°F*	*°F*	*Days*	*Inches*	*Inches*	*Inches*
Northwestern								
1. Libby (1NE)	PSME	2,080	22	66	79	19	4.5	57
2. Trout Creek (2W)	ABGR	2,480	23	64	50	30	5.5	76
3. Polebridge	PICEA	3,690	17	61	30	23	6.3	122
West-central								
1. Darby (2NNW)	PIPO	3,815	25	65	99	16	5.3	60
2. Greenough	PSME	4,000	18	63	≈45	18	6.1	110
North-central								
1. Babb (6NE)	POTREM	4,300	19	60	60	20	10.1	93
2. Blackleaf (near)	PIFL	4,600	21	60	≈60	15	8.3	--
Central								
1. Helena	near PIPO	3,893	19	68	134	11	5.7	48
2. Lewistown	PIPO	4,130	20	66	107	17	9.6	61
Southwestern								
1. Lakeview	PSME	6,710	10	59	≈30	20	8.4	142
South-central								
1. Tower Falls	dry edge of PSME	6,266	15	58	~90	16	7.7	≈100
Yellowstone N.P.								
2. Mystic Lake	PICO-ABLA	6,558	24	64	≈95	24	10.4	140
3. W. Yellowstone	PICO-ABLA	6,662	12	60	≈30	21	7.0	145
Southeastern								
1. Lame Deer	PIPO	3,331	22	70	≈105	15	8.2	51
2. Roundup	PIPO	3.227	24	72	129	11	6.5	≈36
Northeastern								
1. Glasgow	no forest	2,277	11	72	124	13	7.8	36

Valley. Average annual precipitation in most of the subalpine forests of this region ranges from about 40 to 65 inches.[2]

West-Central Montana Forest Region

The west-central forest region includes the Clark Fork River drainage from the Missoula-Frenchtown Valley upstream, except for the Continental Divide range from Nevada Peak (northwest of Helena) to California Pass (south of Anaconda). This region is bounded on the west by the lofty Bitterroot Range. The Bitterroot Range forms the Montana-Idaho Divide and constitutes a significant barrier to Pacific Coast moisture and thus to coastal plants.

[2]These estimates were based on U.S. Dep. Comm. (1971), U.S. Dep. Comm. weather station data, USDA Soil Conserv. Serv. (1968), Arno (1970), and an isohyetal analysis for the Columbia River drainage prepared by the U.S. Weather Bureau River Forecast Center, Portland, Oregon, in 1968.

Diagnostic forest vegetation

Although it has a relatively mild, Pacific-influenced climate, this region's forests are generally drier than those of either northwestern Montana or adjacent northern Idaho. Thus, the region has only small amounts of Pacific Coast forest species such as *Thuja plicata, Pinus monticola, Taxus brevifolia, Clintonia uniflora, Adenocaulon bicolor, Coptis* spp. (of western North America), and *Tiarella trifoliata*. These species are restricted to moist canyon-bottom sites or seepage areas and generally reach their southeastern limits within this region (table 3). *Abies grandis* is locally common, but is much less abundant than it is in northwestern Montana. West-central Montana is characterized by an abundance of the intermountain forest species--*Larix occidentalis, Larix lyallii, Pinus ponderosa* var. *ponderosa, Xerophyllum tenax, Menziesia ferruginea,* and *Luzula hitchcockii.* These species become rare or absent in the remaining regions that lie farther east (table 3).

Forest distribution

As figure 4 shows, the typical array of forest series here is not as diverse as that in northwestern Montana, because of the scarcity of Pacific Coast species. About

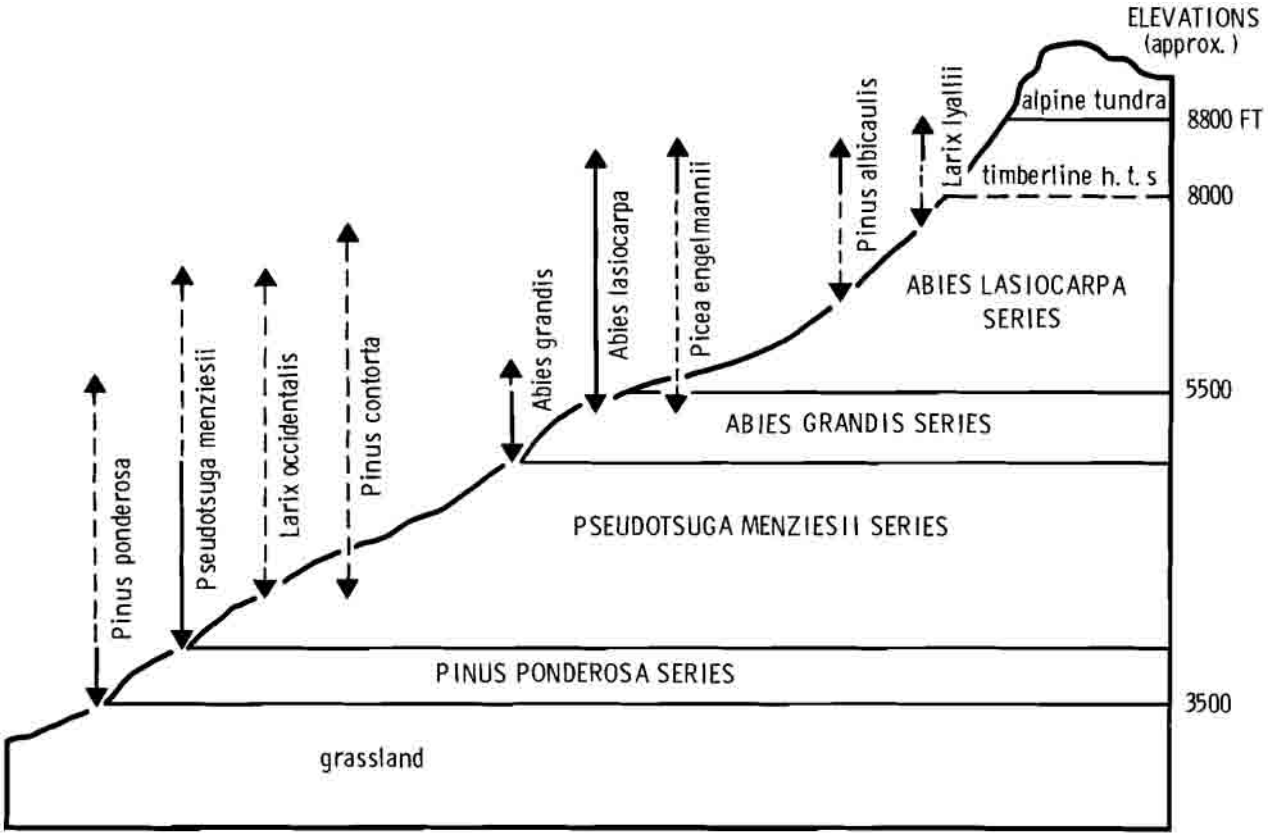


Figure 4.--Distribution of forest trees in an area of west-central Montana. Arrows show the relative elevational range of each species; solid portion of the arrow indicates where a species is the potential climax and dashed portion shows where it is seral. (Modified from Pfister and others 1977).

80 percent of the land in this region is potentially forested. Most of the nonforest land is grassland (*Agropyron spicatum, Festuca idahoensis,* and *F. scabrella* associations of Mueggler and Handl (In press)) that occur in the broader low-elevation valleys. Annual precipitation on these nonforest valley sites is less than 15 inches and soils are well-drained. However, this grassland is not extensive, and lower timberline generally occurs within 1,000 feet of the valley base elevation; thus it is found between about 3,200 and 5,500 feet. Forest extends over all but the highest peaks (and rockiest sites). The average elevation of alpine tree line is about 8,800 feet. Principal forest habitat types of west-central Montana are shown in table 2.

Climatic influences

The comparatively dry, Pacific-influenced climate of this region is illustrated by data from the locations of Darby and Greenough (table 4). Average annual precipitation in the subalpine forests is generally 35 to 55 inches (footnote 2).

Seral *Pinus ponderosa* and *Larix occidentalis* form the largest and most commercially important west-central Montana forest trees; they often attain heights of 130 to 140 feet at maturity. The exception is the southeastern part of this region where valley base elevations are high and forests are dominated by *Pinus contorta*. (However, the intermountain undergrowth species dominate.)

North-Central Montana Forest Region

The north-central Montana forest region includes all the forested terrain along the east slope of the Continental Divide from the drainage of the North Fork of the Dearborn River north to the Canadian border and east to Havre. Adjacent southern Alberta has similar forest environments.

Diagnostic forest vegetation

This area supports the most extensive *Populus tremuloides* groves in the State (Lynch 1955) as well as large patches of *Pinus flexilis* woodland along the lower skirts of the mountains. *Pinus ponderosa* is absent, apparently because of the excessively cold and windy winter conditions. A narrow band of *Abies lasiocarpa* (series) forest along the Rocky Mountain front supports the easternmost occurrences of intermountain undergrowth species, *Menziesia ferruginea, Xerophyllum tenax, Luzula hitchcockii,* and even "cove sites" with *Clintonia uniflora* barely extending across the Divide from northwestern Montana (appendixes A-7, -8, and -10); however, the limited tree flora and its stunted growth are definitely indicative of the severe eastside climatic conditions.

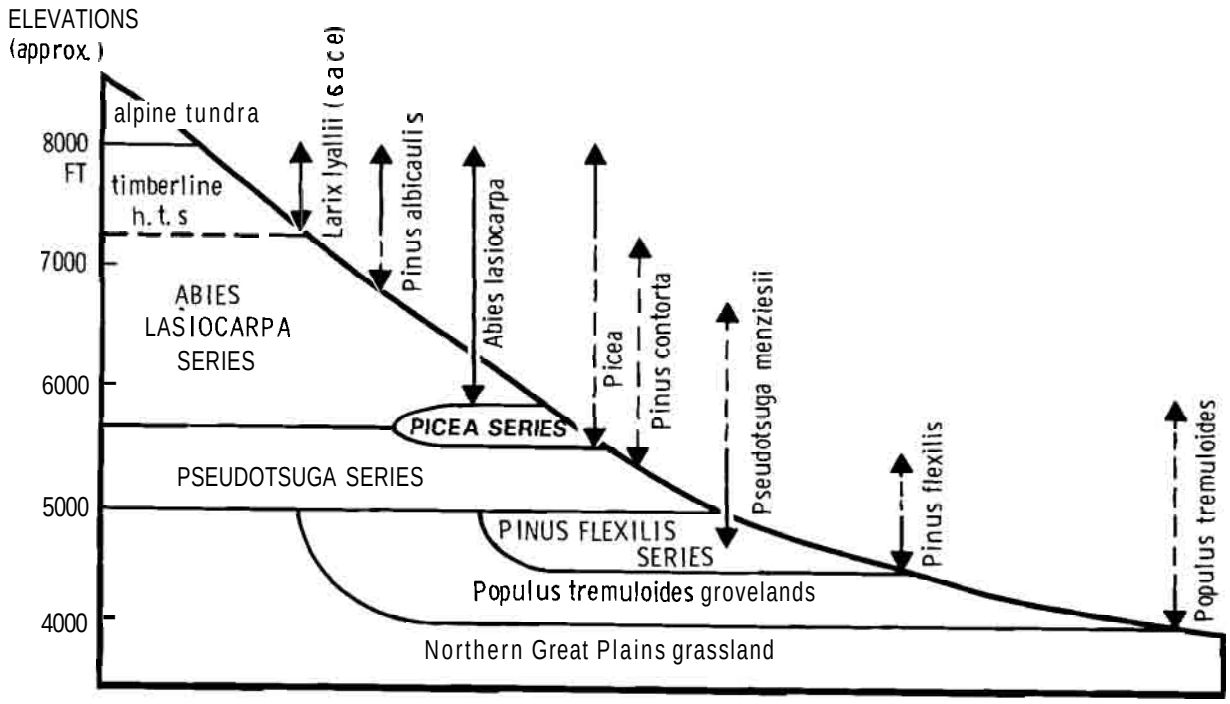


Figure 5.--Distribution of forest trees in an area of north-central Montana. Arrows show the relative elevational range of each species; solid portion of the arrow indicates where a species is the potential climax and dashed portion shows where it is seral.

Forest distribution

Only about 10 percent of the land in this region is potentially forested, most of it occurring in a 20 to 30 mile band along the eastern skirts of the Continental Divide or Front Range of the Rockies. Figure 5 illustrates a characteristic distribution of tree species in this region. A small area of similar forest (8 mi^2), lacking only *Larix lyallii*, occurs on the Sweetgrass Hills (elev. 6,983 feet) 90 miles east of the nearest Front Range stands (Thompson and Kuijt 1976).

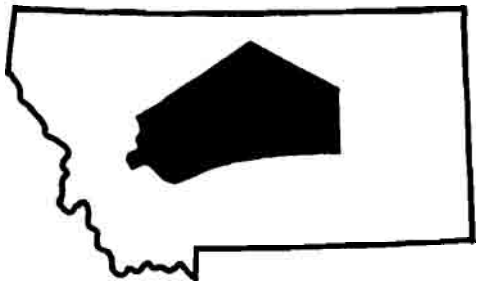
Lower timberline generally occurs between 4,500 and 5,000 feet and forest extends up to all but the highest ridges and peaks. Alpine tree line averages about 8,000 feet. Most of the nonforest land is potentially grassland dominated by *Agropyron, Festuca, Bouteloua,* and *Stipa* (Kuchler 1964; Mueggler and Handl, In press).

Climatic influences

North-central Montana has a continental climate with severe chinook winds and dramatic fluctuations of winter temperatures that often injure forest trees. On wind-exposed slopes, tree growth is stunted by "red belt" conditions. Branches, groups of trees, or even sizable stands are routinely killed by desiccation of foliage caused when warm, dry chinook winds occur while the ground is frozen and little water is available to replace transpiration losses. *Pinus flexilis* (at low and middle elevations) and P. *albicaulis* (at high elevations) are least susceptible to red belt damage.

Growing seasons are short and cool in the lower elevation forest sites (table 4 and figure 2). Except in protected valleys, trees seldom reach 70 feet in height. Average annual precipitation in the subalpine forests is generally 30 to 40 inches (footnote 2), although it is much greater in a few areas along the Continental Divide, particularly in Glacier National Park. The severity of winter temperature fluctuations is illustrated by the world-record temperature drop of 100° F in 24 hours (from +44° to -56°F) at Browning, near East Glacier Park, in January 1916 (McWhirter and McWhirter 1972).

Central Montana Forest Region



The central Montana forest region includes all the forested terrain from the Helena Valley east to Harlowton, Lewistown, and Fort Peck Reservoir, and north to Havre. Specifically, the western edge runs along the Continental Divide from the drainage of the Middle Fork of the Dearborn River south to the Boulder River divide. Forests contiguous with and west of the divide are included from the Avon Valley south to Deer Lodge (from Nevada Peak to Electric Peak along the Continental Divide). Eastward, the area encompasses the Elkhorn Mountains (except for the southwestern portion of that range that drains into the Boulder River) as well as the Big Belt, Little Belt, Castle, Big Snowy, Little Snowy, Judith, Little Rocky, Bearpaw, and Highwood Mountains. The range also contains rather extensive lowland *Pinus ponderosa* (var. *scopulorum*, Booth 1950, Little 1953) forests in the Helena and Lewistown vicinities and in the Missouri River Breaks.

Diagnostic forest vegetation

Most of central Montana has a low-elevation forest belt of *Pinus ponderosa* (var. *scopulorum*). In contrast to westside *P. ponderosa* (var. *ponderosa*), these have many two-needle fascicles and a short growth form. Additionally, central Montana has mountain forests made up of other climax series (table 1). The other eastside region containing *P. ponderosa* (southeastern Montana) does not have additional forest series.

Coastal and intermountain species are essentially absent, while eastside species, including *Pinus flexilis* and *Juniperus horizontalis*, are prominent (table 3). Great Plains grassland elements such as *Bouteloua gracilis* and *B. curtipendula*, *Yucca glauca*, and *Opuntia fragilis*, and *O. polyacantha* are commonly found in the driest *Pinus ponderosa* and *P. flexilis* stands.

Forest distribution

Approximately 20 percent of the land in this region is potentially forested. Most of the nonforest land is potentially grassland dominated by *Agropyron*, *Festuca*, *Bouteloua*, and *Stipa* (Kuchler 1964; Mueggler and Handl, In press). The forests are associated with prominent mountain ranges and the Missouri River Breaks. Forest extends from valley base levels or from lower timberlines on the principal mountain ranges (at 4,000 to 5,500 feet) and covers all but the highest peaks. Alpine tree line averages about 8,500 feet. Figure 6 shows a characteristic distribution of tree species on non-limestone parent materials in central Montana.

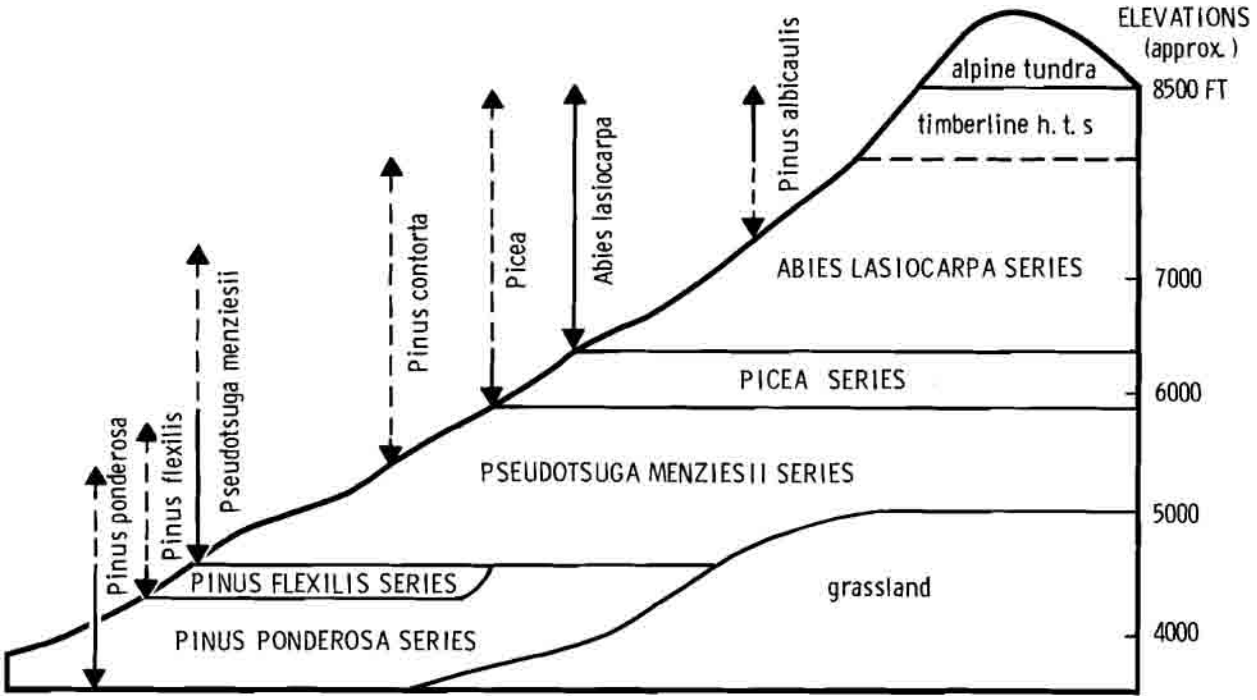


Figure 6.--Distribution of forest trees in an area of central Montana. Arrows show the relative elevational range of each species; solid portion of the arrow indicates where a species is the potential climax and dashed portion shows where it is seral.

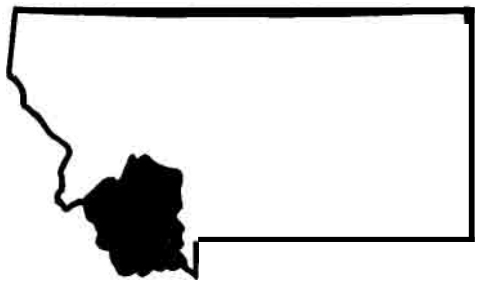
Extensive areas having limestone substrates occur in the mountain ranges of central Montana. The limestone-derived soils drain rapidly and are generally dominated by drier site species than the adjacent nonlimestone sites (fig. 53, 54, in Pfister and others 1977). For example, at medium elevations the limestone sites often support *Pseudotsuga* with a grass-forb undergrowth, while adjacent granitic sites have *Pinus contorta* and *Vaccinium* spp. (Goldin and Nimlos 1977; Weaver and Parry 1978).

Climatic influences

This region has a continental climate, but has forests extending to lower elevations and less severe winter conditions than north-central Montana. The warmer July temperatures and longer growing seasons (fig. 2) in the lower forest zone are indicated by weather station data in table 4. However, except on sheltered sites, trees seldom attain 80 feet in height. Average annual precipitation in the subalpine forests is estimated to be 25 to 35 inches (footnote 2).

In the higher valleys and at high elevations in the mountains, extreme temperature changes accompanied by strong winds inflict red belt damage. For instance, in mid-January 1971 such weather conditions (temperatures fluctuating between -30° and +58° F at Great Falls, accompanied by strong winds) killed about 20,000 acres of *Pinus contorta* forest in the Little Belt Mountains.

Southwestern Montana Forest Region



Area included

The southwestern Montana forest region includes the Jefferson, Madison, and Boulder River drainages, east of the Continental Divide, as well as the forests on both slopes of the Continental Divide range in the vicinity of Butte (specifically from Electric Peak, east of Deer Lodge, to California Pass, south of Anaconda).

As in central Montana, Pacific Coast forest elements are absent and intermountain elements are scarce (table **3).** Rather short, but stout *Pseudotsuga* (or *Pinus flexilis*) occupy the warmest forest sites, and *Pinus contorta* along with *Vaccinium scoparium* undergrowth dominate most high-elevation forests. Undergrowth is notably sparse in the denser forest stands, and in *Pseudotsuga* forests undergrowth often consists primarily of scattered *Festuca idahoensis* and even *Artemisia tridentata* Figure 7 shows a characteristic distribution of tree species in southwestern Montana. Principal forest habitat types are shown in table 2.

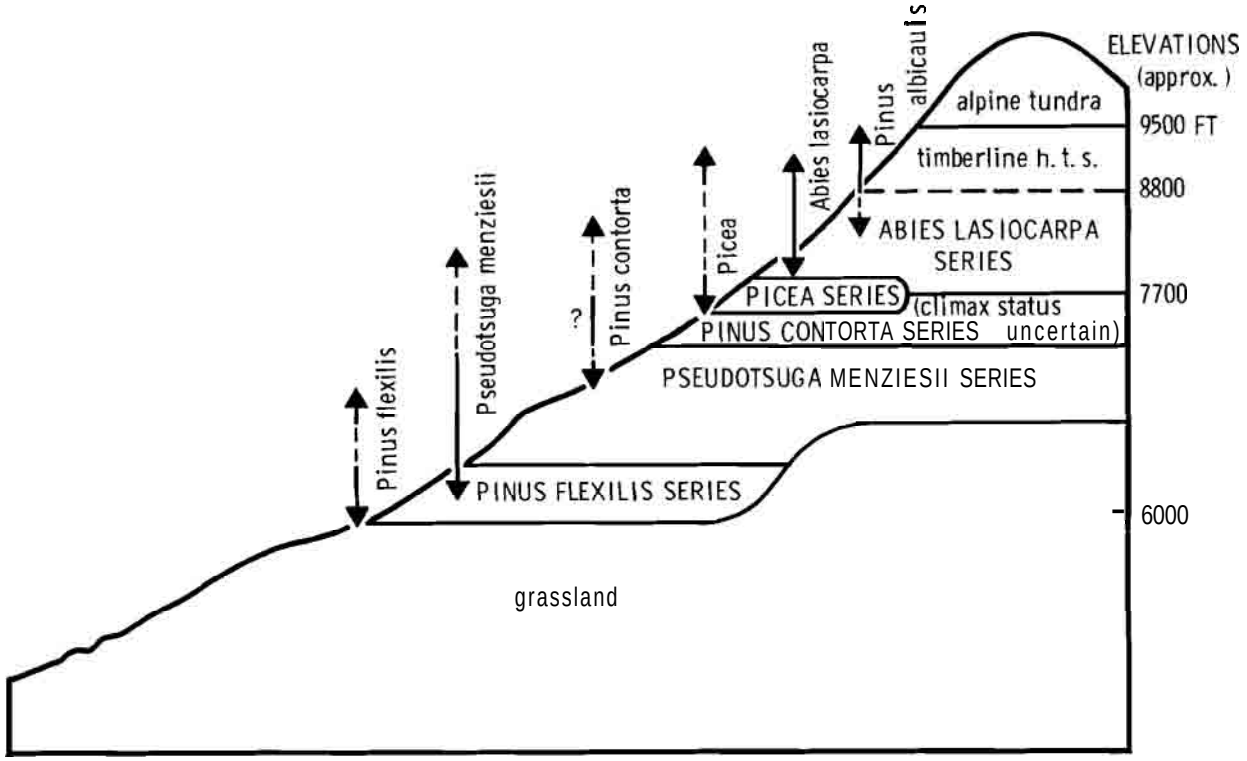


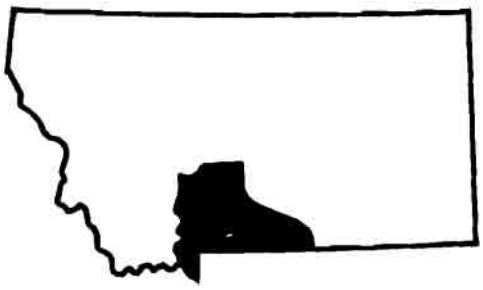
Figure 7.--Distribution of forest trees in an area of southwestern Montana. Arrows show the relative elevational range of each species; solid portion of the arrow indicates where a species is the potential climax and dashed portion shows where it is seral.

Forest distribution

Despite its mountainous terrain, only about one-fourth of this region is forested. Most of the nonforest land is semiarid steppe (*Artemisia*) and grassland (Agropyron, Festuca, and Stipa), along with small areas of alpine vegetation (Kuchler 1964; Mueggler and Handl, In press) above 9,500 feet elevation. Lower timberline generally occurs somewhere between 5,700 and 7,000 feet in elevation. However, some of the mountain ranges south of Dillon are so dry that little forest is supported even at 8,000 feet. Thus, the entire forest belt (between lower and upper timberline) may span only 1,000 to 1,500 feet of elevation, and may be locally absent on exposed south- and west-facing slopes. Similarly high, semiarid mountain ranges, projecting above an *Artemisia* tridentuta steppe (Kuchler 1964), occur in adjacent east-central Idaho (Steele and others (footnote 1)).

Climatic influences

As illustrated by weather records from Lakeview (table 4), this is a cold, dry forest region having high valley-base elevations, and a continental climate. Average annual precipitation in the subalpine forest ranges from about 22 to 35 inches (footnote 2). This forest region evidently has growing seasons too short and cold for *Pinus* ponderosa (fig. 2). The cold, dry conditions are also evidenced by the lack of *Pseudotsuga/Physocarpus* habitat type (tables 2 and **3).** However, chinook winds and temperature fluctuations are less severe than in north-central and central Montana, and red belt damage is less common.



south-central Montana Forest Region

The south-central Montana forest region includes the Gallatin and upper Yellowstone River drainages (along with the Bridger and Crazy Mountains) as well as the Pryor Mountains and the north end of the Bighorn Range. The region encompasses the northern part of an extensive, high-elevation forested upland surrounding Yellowstone National Park. This upland is capped by large alpine plateaus in Montana and Wyoming.

Diagnostic forest vegetation

Most of the forest in south-central Montana is dominated by Pseudotsuga, *Pinus contorta, Picea,* or Abies *lasiocarpa.* The abundance of *Picea/Physocarpus, Picea/Galium triflorum,* Abies *lasiocarpa/Galium triflorum,* and Abies *lasiocarpa/Calamagrostis canadensis* habitat types (table 2) attests to the moistness of many of the forests. Also, scattered populations of *Xerophyllum* and *Menziesia* (appendixes A-9 and -10) are found here, more than 100 miles east of their usual distributional limits near the Continental Divide. In contrast to southwest Montana, one seldom finds extensive stands having a grassland undergrowth (except on limestone substrates), nor does one find very sparse undergrowth related to dry conditions.

Forest distribution

Nearly half of the land in south-central Montana supports forest, and most of the remaining area is potentially grassland--(*Agropyron,* Festuca, Stipa) according to

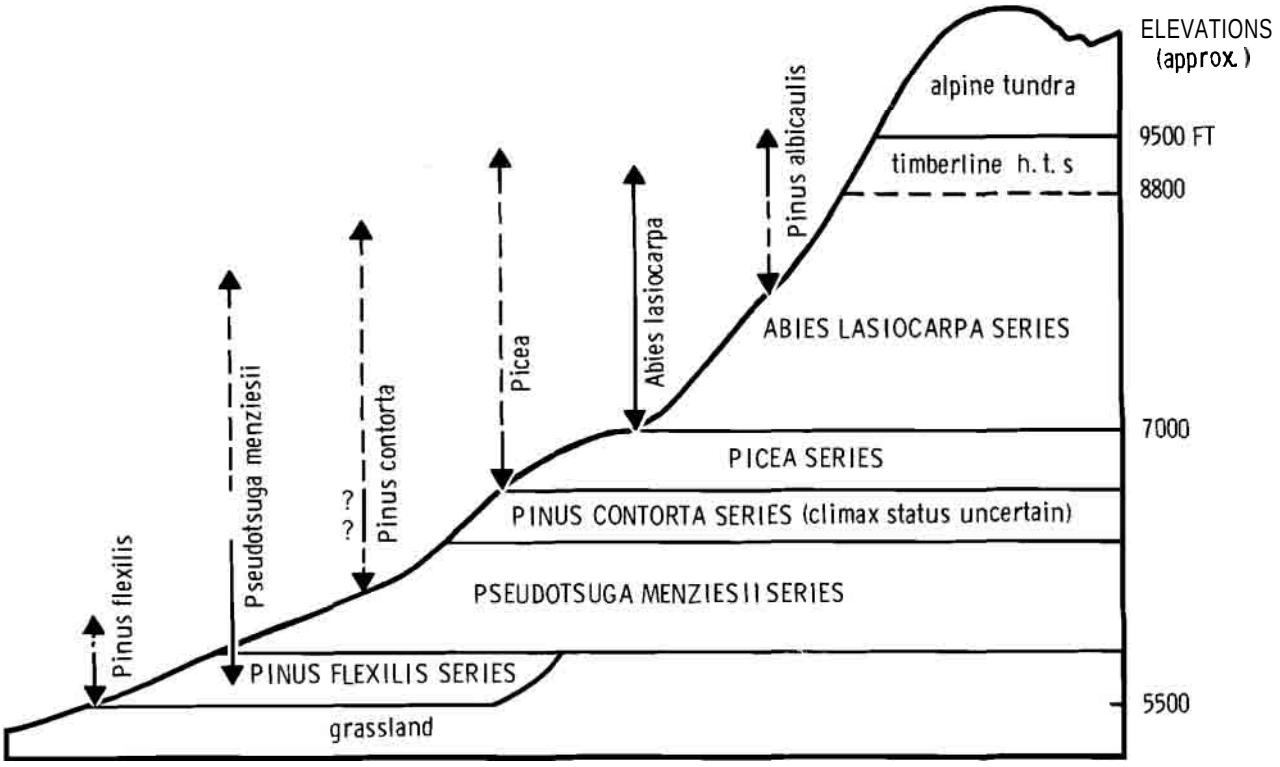


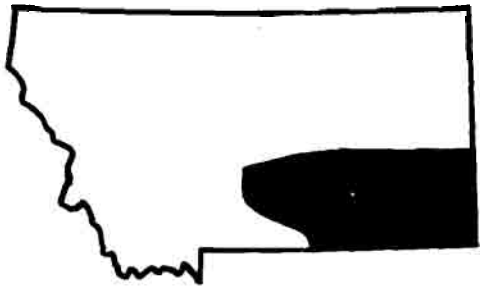
Figure 8.--Distribution of forest trees in an area of south-central Montana. Arrows show the relative elevational range of each species; solid portion of the arrow indicates where a species is the potential climax and dashed portion shows where it is seral. (Modified from Pfister and others 1977.1

Kuchler (1964)--occupying the drier, lower elevation valleys. Lower timberline averages about 5,500 feet and alpine tree line occurs near 9,500 feet. Figure 8 shows a characteristic distribution of tree species in an area of south-central Montana. Table 2 lists principal forest habitat types.

Limestone substrates are abundant in the Pryor Mountains and occur sporadically elsewhere in south-central Montana. These sites, below about an 8,000-foot elevation, generally have forests dominated by *Pinus flexilis* and *Pseudotsuga.*

Climatic influences

South-central Montana has a continental climate, and red belt injury is often severe at lower timberline. The valleys have high base elevations and are too cold (short growing season, figure 2) for any significant amounts of *Pinus ponderosa;* however, forests are generally moister than those of southwestern Montana. Weather records for three forested sites in this region are found in table 4. Average annual precipitation in the subalpine forests is generally 30 to 45 inches (footnote 2).



Southeastern Montana Forest Region

The southeastern Montana forest region includes the extensive pure *Pinus ponderosa* forests on lowlands and hilly terrain (mostly 2,800 to 4,400 feet elevation) in the northern Great Plains. It covers the lower Yellowstone River drainage as far upstream (west) as Big Timber. The region extends up the Musselshell Valley to Harlowton and its northern boundary includes the northernmost pine groves in the vicinities of Roundup, Miles City, and Baker.

Diagnostic forest vegetation

Although *Pinus ponderosa* is the only forest tree, it occurs in rather diverse habitat types (table 2). The driest of these forest sites have very open stands of short trees (35-60 feet), with grassland undergrowth (e.g., *Andropogon gerardii* and *A. scoparius, Agropyron spicatum, Bouteloua gracilis, Carex filifolia*). Conversely, moist north-facing slopes have dense stands of P. *ponderosa* (70-95 feet tall), with a luxuriant shrub and herb undergrowth including many species characteristic of the mountain forests to the west (e.g., *Shepherdia camdensis, Arctostaphylos uva-ursi, Berberis repens, Linmea borealis, Arnica cordifolia, Disporum trachycarpum, Pyrola secunda,* and *Smilacina stellata*).

The presence of *Linnaea* and some other undergrowth species strongly suggests that the more moist habitats would support *Pseudotsuga;* however, the nearest seed source for this species is at least 70 miles away in the Bighorn Range. This conclusion is reinforced by the fact that *Pinus ponderosa* stands developing on the moister sites are more heavily stocked than is characteristic of *P. ponderosa* habitat types elsewhere in the State.

In addition to having a shorter growth form than its counterpart west of the Continental Divide, the *P. ponderosa* (var. *scopulorum*, Booth 1950 and Little 1953) in southeastern Montana has a majority of two-needle fascicles. These may be manifestations of substantial genetic differences between the west slope and Great Plains *P. ponderosa.*

Two eastern deciduous-forest species (*Fraxinus pennsylvanica* and *Prunus americana*) occur along streams and moist lower north slopes in southeastern Montana, and two other such species *(Ulmus americana* and *Quercus macrocarpa)* reach the eastern edge of this region (Little 1971, 1976). Pfister and others (1977) have discussed compositional similarities between the *P. ponderosa* forests of southeastern Montana and those of the Black Hills of western South Dakota as sampled by Thilenius (1972).

Forest distribution

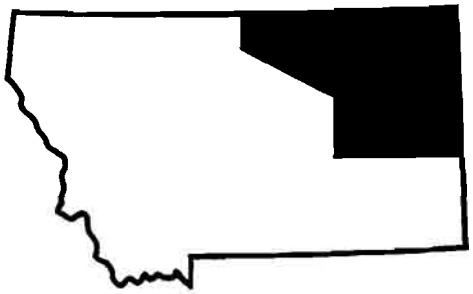
Approximately 20 percent of southeastern Montana supports forest. This is a region without prominent mountains, or mountain forests; thus, it differs from all other forested regions. (Northeastern Montana does not have mountains, but also is without Great Plains *Pinus ponderosa* forest.)

Most of the remainder of the region is Great Plains grassland (*Bouteloua-Stipa-*Agropyron, according to Kuchler 1964). Some of this grassland has widely scattered pines, and thus can be termed a "savanna."

Climatic influences

Southeastern Montana has a continental climate. Summers are longer, hotter, and more humid than those in the mountainous forest regions (table 4 and figure 2). Most of the annual precipitation (ranging up to about 18 inches in moist forest areas) comes in spring and summer rains. Winters are generally dry and cold, but are not as severe as those in the northern parts of Montana east of the Continental Divide.

Northeastern Montana



The northeastern part of Montana includes the area north of Miles City and east of the Missouri River Breaks. Potential natural vegetation is Great Plains grassland (*Bouteloua-Stipa-Agropyron* and Agropyron–Stipa, according to Kuchler 1964) except for stands of *Populus deltoides* lining the principal rivers. This region has no upland forest, except for a few widely scattered populations of stunted *Pinus* ponderosa. (The most notable stand is at the Pines Recreation Area south of Glasgow on Fort Peck Reservoir.) The extremely cold continental winters, coupled with desiccating winds, may be the factors preventing *Pinus* ponderosa from growing here. Average annual precipitation is between 11 and 15 inches in this region (U.S. Dep. Comm. 1971). Table 4 presents climatic data from Glasgow.

RESEARCH AND MANAGEMENT APPLICATIONS

The forest regions presented here were developed to describe distributions of forest habitat types (Pfister and others 1977)--i.e., forest sites and vegetation in mature stands. The regions can also be used in describing distributions of individual forest species or seral forest communities (e.g., *Acer glabrum-Salix* brushfields). The Northern Region of the USDA Forest Service recently adopted forest regions as "seed transfer zones" to help insure that nursery-raised seedlings are sent to a geographic area similar to the one where the seeds were collected.

These forest regions may be useful as a biologically based regional stratification for forest research and forest management studies. For example, it might be useful to stratify productivity estimates (site index and yield capability) of individual habitat types by forest region. Similarly, these forest regions logically could be incorporated in studies of genetic variation in tree species and in tree improvement programs.

Responses of trees and other vegetation to management are often stratified by habitat type, but it may be useful to analyze them by forest region as well. Forest regions offer an additional dimension for interpreting variation in forest vegetation. Forest managers may find appendix C useful for determining the location of forest region boundaries.

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APPENDIX A

Distribution of key tree and undergrowth species in Montana

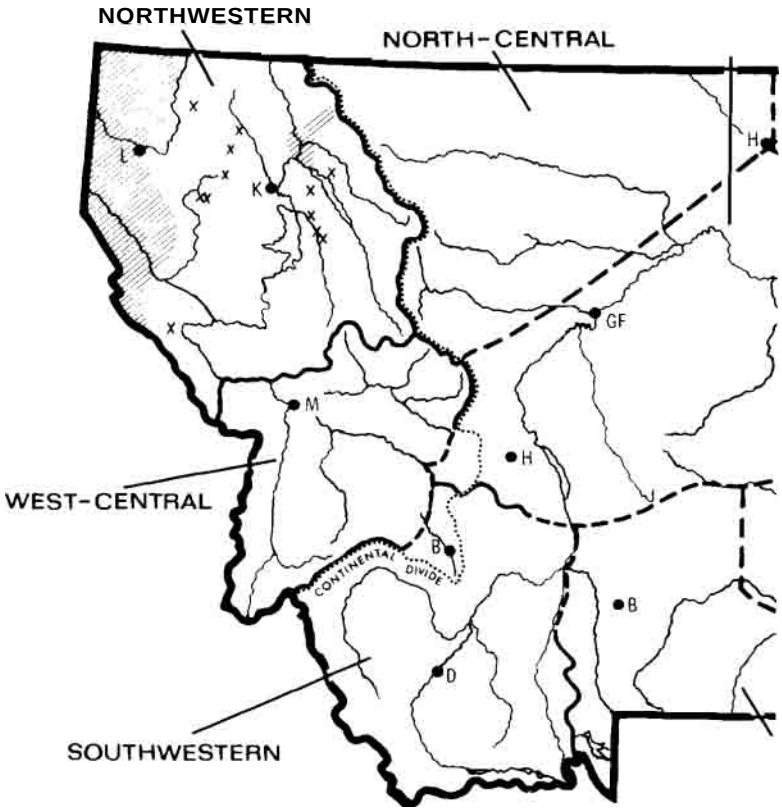


Figure A-].--Natural distribution of **Tsuga heterophylla** *in Montana. (Species common in suitable habitats within shaded area. X's indicate small outlying populations.)*

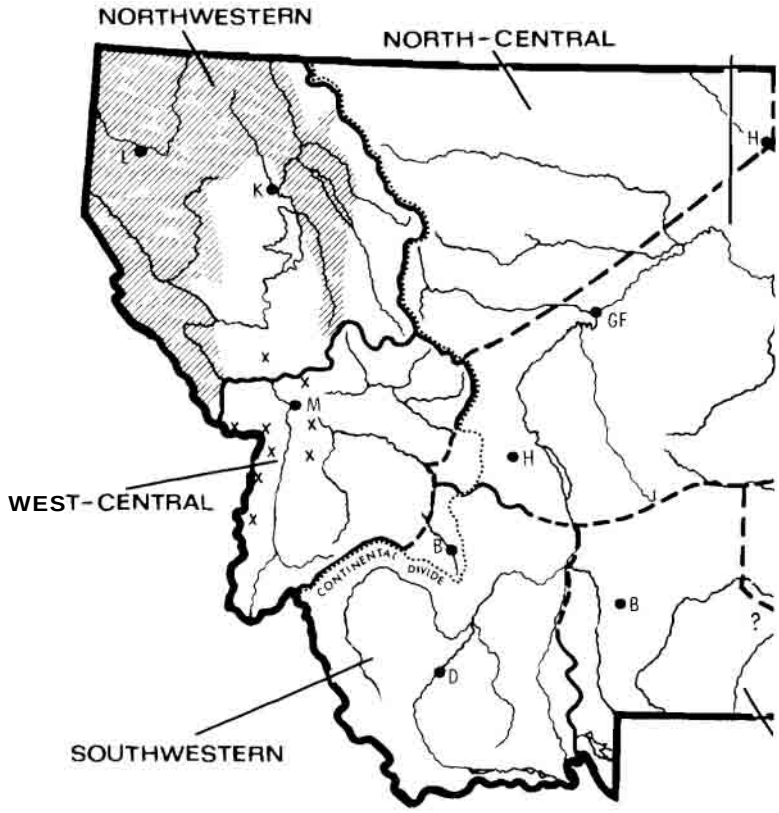


Figure A-2.--Natural distribution of Pinus **monticola** *in Montana. (Species common in suitable habitats within shaded area. X's indicate small outlying populations.)*

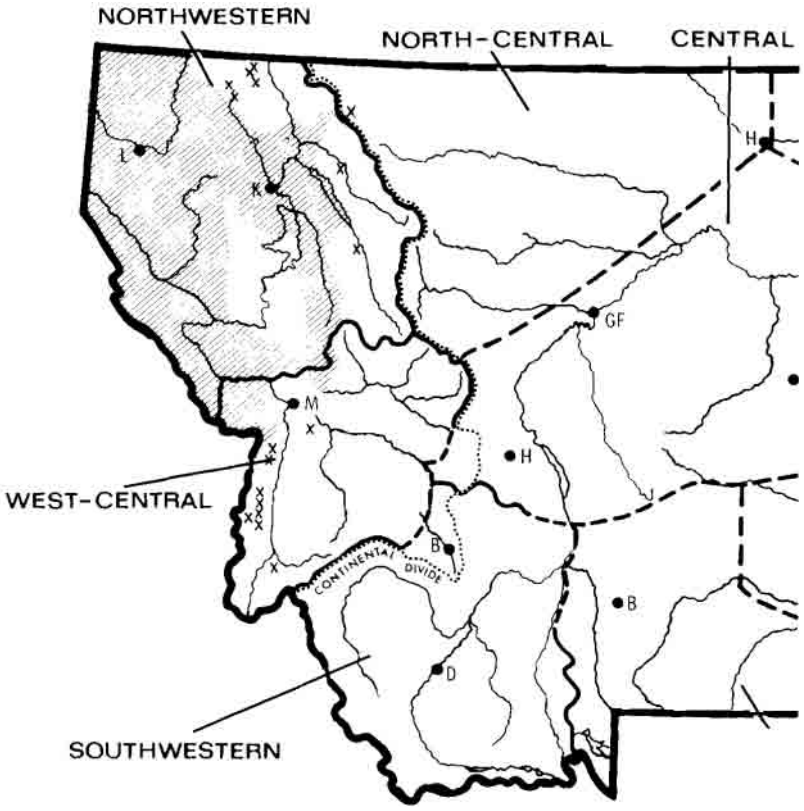


Figure A-3.--Natural distribution of Thuja plicata *in Montana. (Species common in suitable habitats within shaded area. X's indicate small outlying populations.)*

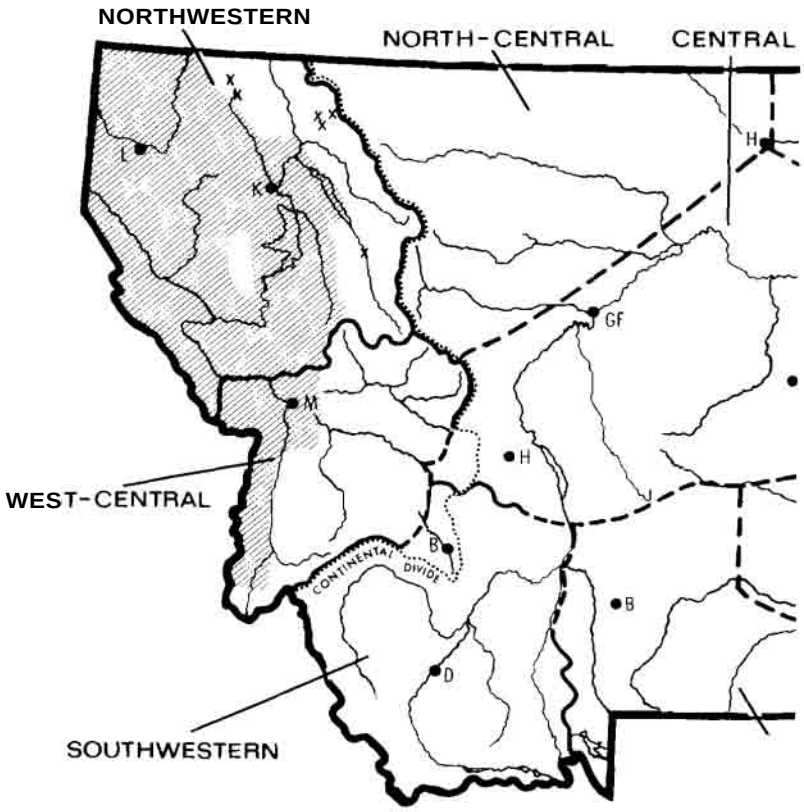


Figure A-4.--Natural distribution of Abies grandis *in Montana. (Species common in suitable habitats within shaded area. X's indicate small outlying populations.)*

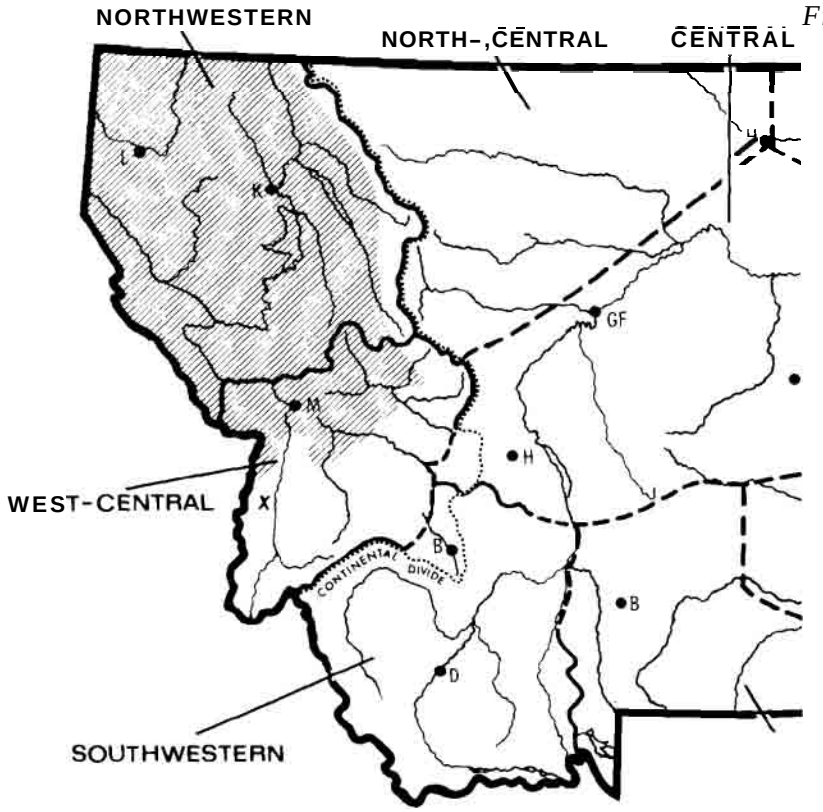


Figure A-5.--Natural distribution of Larix occidentalis *in Montana. (Species common in suitable habitats within shaded area. X's indicate small outlying populations.)*

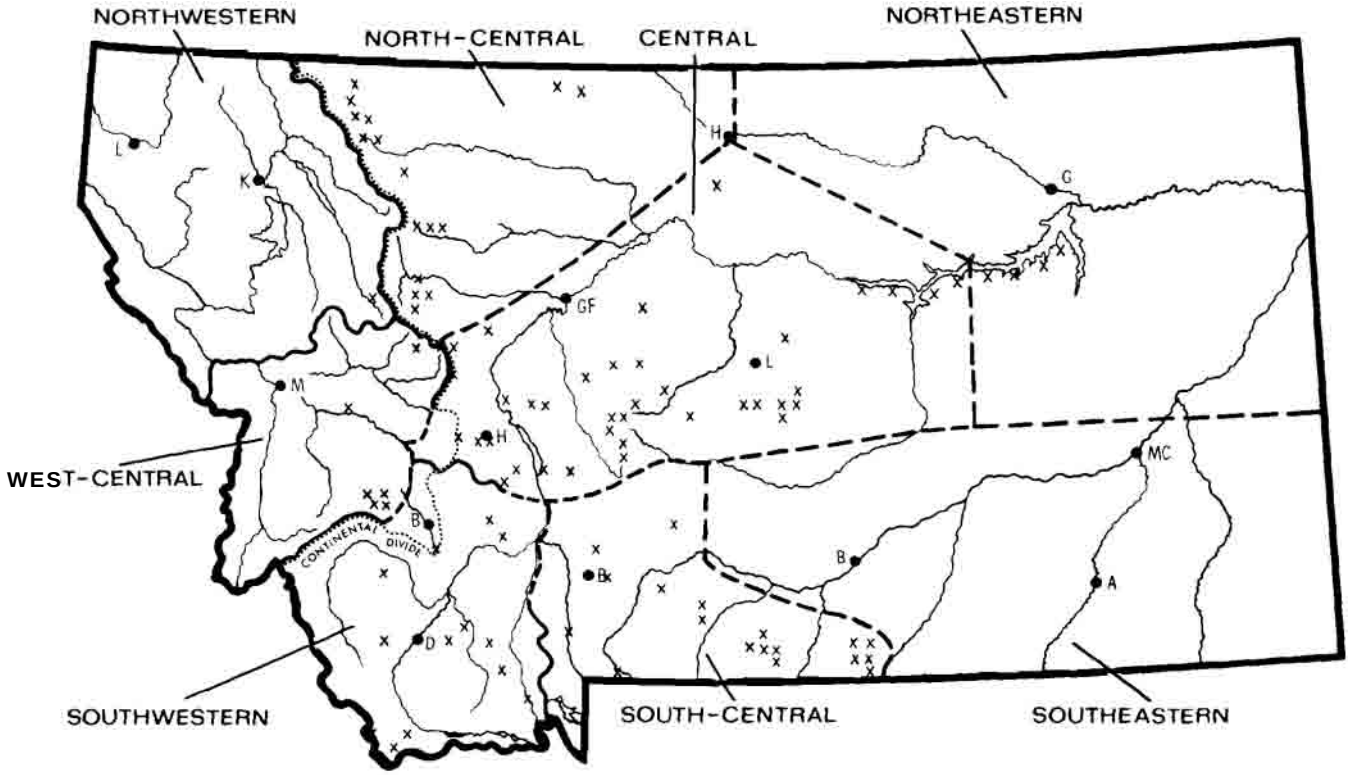


Figure A-6.--Natural distribution of Pinus flexilis *(plot locations and observations only) in Montana.*

Figure A-7.--Natural distribution of Clintonia uniflora *in Montana. (Species common in suitable habitats within shaded area. X's indicate small outlying populations.)*

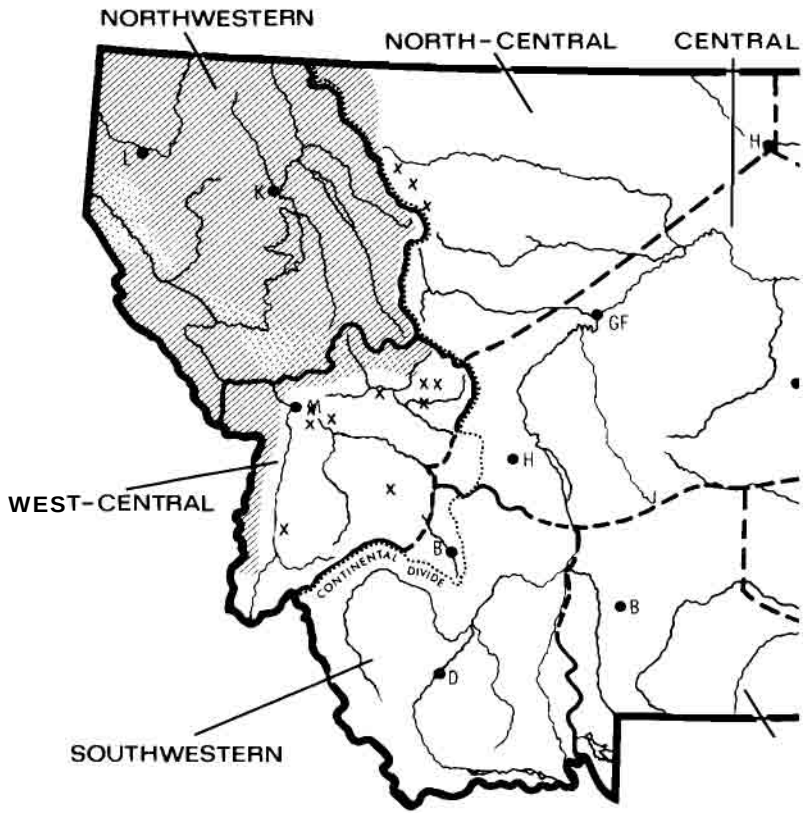
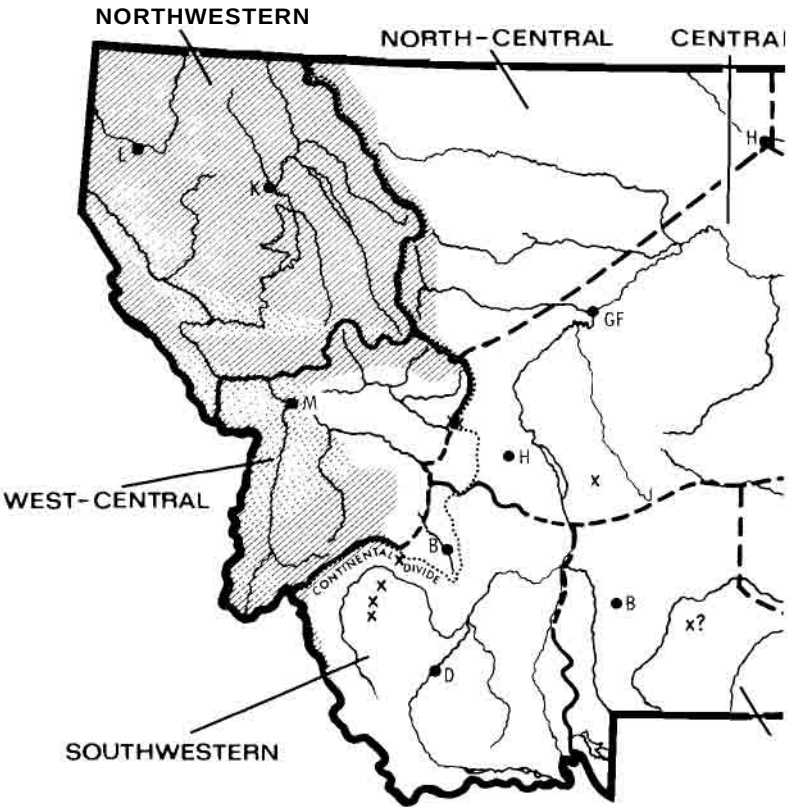


Figure A-8.--Natural distribution of Luzula hitchcockii *in Montana. (Species common in suitable habitats within shaded area. X's indicate small outlying populations.)*



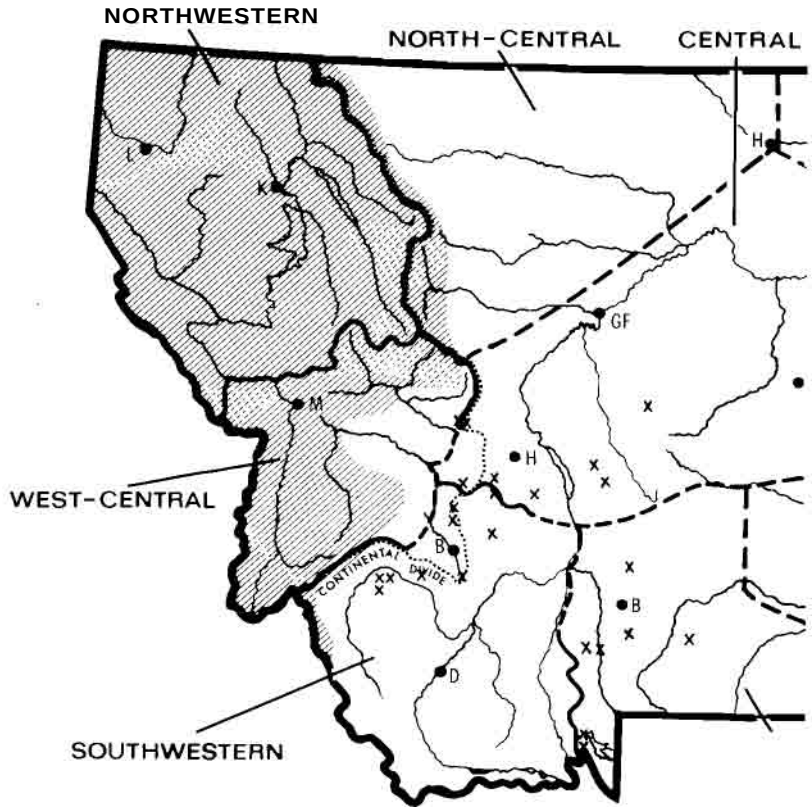


Figure A-9.--Natural distribution of **Menziesia ferruginea** *in Montana. (Species common in suitable habitats within shaded area. X's indicate small outlying populations.)*

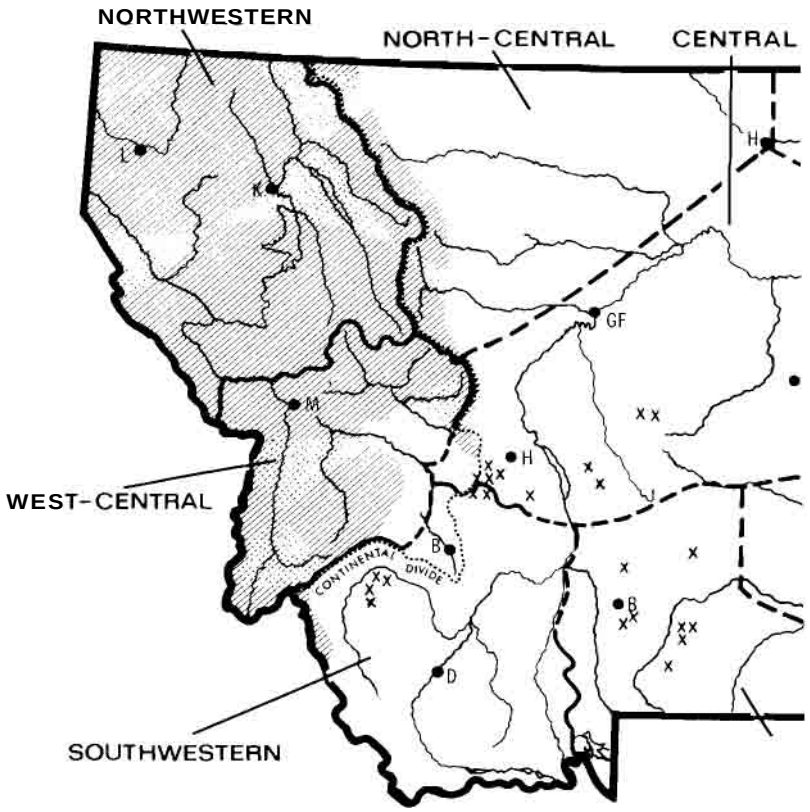


Figure A-10.--Natural distribution of **Xerophyllum** tenax *in Montana. (Species common in suitable habitats within shaded area. X's indicate small outlying populations.)*

APPENDIX B

Number of sample plots (Pfister and others 1977)
by habitat type, phase, and forest region in Montana

Table B-1--Number of sample plots (Pfister and others 1977) by habitat type, phase, and forest region in Montana. (c.t. = community type)

NW = Northwestern Montana
WC = west-central Montana
NC = north-central Montana
C = central Montana
SW = southwestern Montana
SC = south-central Montana
SE = southeastern Montana

Series/habitat type/phase	Montana forest region							
	NW	WC	NC	C	SW	SC	SE	Total
Forested scree	2	7	2	5	.	.	.	16
								16
Pinus flexilis series								
/**Agropyron** spicatum **h.t.**			1	2	2	1		6
/**Festuca** idahoensis **h.t.**								
-**Festuca** idahoensis phase	.		1	2	2	2		7
-**Festuca** scabrella phase	.		1	3				4
/**Juniperus communis h.t.**			1	1	1	4		7
			4	8	5	7		24
Pinus ponderosa series								
/**Andropogon** spp. h.t.	.	.	.	.		.	1	1
/**Agropyron** spicatum **h.t.**	4	7	.	2		.	8	21
/**Festuca** idahoensis **h.t.**								
-**Festuca** idahoensis phase	.	9	.	1		.	4	14
-**Festuca** scabrella phase	2	9	.	5		.	.	16
/**Purshia** tridentata **h.t.**								
-**Agropyron** spicatum phase	.	3	.	1		.	.	4
-**Festuca** idahoensis phase	3	2	.	2		.	.	7
/**Symphoricarpos** albus **h.t.**								
-**Symphoricarpos** albus phase	1	3	.	2		.	2	8
-**Berberis repens** phase	.	.	.	2		.	1	3
/**Prunus** virginiana **h.t.**								
-**Prunus** virginiana phase	.	.	.	.		.	6	6
-**Shepherdia** canadensis phase	.	.		.			2	2
	10	33		15			24	82
Pseudotsuga menziesii series								
/**Agropyron** spicatum **h.t.**	1	4		5	1	2		13
/**Festuca** idahoensis **h.t.**	1	1		.	14	3		19
/**Festuca** scabrella **h.t.**	5	2	.	6				13
/**Vaccinium** caespitosum **h.t.**	15	9	1	2				27
/**Physocarpus** malvaceus **h.t.**								
-**Physocarpus** malvaceus phase	12	23		3	1	6		45
-**Calamagrostis** rubescens phase	1	7						8

(con.)

Table B-1.--(con.)

Series/habitat type/phase	Montana forest region							
	NW	WC	NC	C	SW	SC	SE	Total
Pseudotsuga menziesii series								
/Vaccinium globulare h.t.								
-Vaccinium globulare phase	2	4	.	5	1	1	.	13
-Arctostaphylos uva-ursi phase	2	7	.	.	.	.	.	9
-Xerophyllum tenax phase	6	11	.	1	.	.	.	18
/Linnaea borealis h.t.								
-Symphoricarpos albus phase	3	4	.	2	.	.	.	9
-Calamagrostis rubescens phase	1	5	.	4	2	.	.	12
-Vaccinium globulare phase	.	8	.	1	.	.	.	9
/Symphoricarpos albus h.t.								
-Agropyron spicatum phase	1	6	.	2	.	.	.	9
-Calamagrostis rubescens phase	9	17	.	5	3	6	.	40
-Symphoricarpos albus phase	1	5	3	4	2	3	.	18
/Calamagrostis rubescens h.t.								
-Agropyron spicatum phase	5	5		.	.	.	.	10
-Arctostaphylos uva-ursi phase	2	7	.	2	.	.	.	11
-Calamagrostis rubescens phase	3	23	1	13	15	7	.	62
-Pinus ponderosa phase	3	8	.	3	.	.	.	14
/Carex geyeri h.t.	.	3	.	4	1	2	.	10
/Spiraea betulifolia h.t.	2	2	4	3	.	.	.	11
/Arctostaphylos uva-ursi h.t.	.	.	.	7	.	1	.	8
/Juniperus communis h.t.	.	.	1	6	7	.	.	14
/Arnica cordifolia h.t.	.	.	.	6	7	.	.	13
/Symphoricarpos oreophilus h.t.	.	.	.	.	1	.		1
	75	161	10	84	56	31		416
Picea series								
/Equisetum arvense h.t.	3		2	2	1	1	.	9
/Clintonia uniflora h.t.								
-Vaccinium caespitosum phase	8						.	8
-Clintonia uniflora phase	16					.	.	16
/Physocarpus malvaceus h.t.	.	.		.	.	6	.	6
/Galium triflorum h.t.		3	.	1	2	9	.	15
/Vaccinium caespitosum h.t.	4		1				.	5
/Senecio streptanthifolius h.t.								
-Pseudotsuga menziesii phase			1	2	2		.	5
-Picea phase		.		5			.	5
/Linnaea borealis h.t.		1		5	4	11	.	21
/Smilacina stellata h.t.		1		4	1	4	.	10
	31	5	4	19	10	31		100

(con.)

Table B-1.--(con.)

Series/habitat type/phase	Montana forest region NW	WC	NC	C	SW	SC	SE	Total
Abies grandis series								
/Xerophyllum tenax h.t.	5	1						6
/Clintonia uniflora h.t.								
-Clintonia uniflora phase	4	2						6
-Aralia nudicaulis phase	5	1						6
-Xerophyllum tenax phase	4							4
/Linnaea borealis h.t.								
-Linnaea borealis phase	3	2						5
-Xerophyllum tenax phase	3							3
	24	6						30
Thuja plicata series								
/Clintonia uniflora h.t.								
-Clintonia uniflora phase	13	2						15
-Aralia nudicaulis phase	8	1						9
-Menziesia ferruginea phase	6	1						7
/Oplopanax horridum h.t.	11							11
	38	4						42
Tsuga heterophylla series								
/Clintonia uniflora h.t.								
-Clintonia uniflora phase	27							27
-Aralia nudicaulis phase	11							11
	38							38
Abies lasiocarpa series (Lower subalpine h.t.s)								
/Oplopanax horridum h.t.	4							4
/Clintonia uniflora h.t.								
-Clintonia uniflora phase	18	11	3					32
-Aralia nudicaulis phase	12	4	2					18
-Vaccinium caespitosum phase	8	2						10
-Xerophyllum tenax phase	13	7	1					21
-Menziesia ferruginea phase	12	8	2					22
/Galium triflorum h.t.		10	4	5				34
/Vaccinium caespitosum h.t.		2		3	5			10
/Calamagrostis canadensis h.t.								
-Calamagrostis canadensis phase		8		1	8	6		23
-Galium triflorum phase		2		1	2			5
-Vaccinium caespitosum phase	3	1		1	2			7
/Linnaea borealis h.t.								
-Linnaea borealis phase	1	10	4	2	1	2		20
-Xerophyllum tenax phase	5	8						13
-Vaccinium scoparium phase	2	3	1	4	5	2		17
/Menziesia ferruginea h.t.	19	37	5		2	1		64

(con.)

Table R-1.--(con.)

Series/habitat type/phase	Montana forest region						
	NW	WC	NC	C	SW	SC	SE	Total
Abies lasiocarpa series								
(Lower subalpine h.t.s)								
Tsuga mertensiana/Menziesia h.t.	8	2						10
/Xerophyllum tenax h.t.								
-Vaccinium globulare phase	18	18	3		1			40
-Vaccinium scoparium phase	3	14	3		1			21
Tsuga mertensiana/Xerophyllum h.t.	9	.						9
/Vaccinium globulare h.t.		2		5	3	11		21
/Vaccinium scoparium h.t.								
-Calamagrostis rubescens phase		.		2	3	5		10
-Vaccinium scoparium phase	1	4		3	4	5		17
-Thalictrum occidentale phase		.	.	1	5	4		10
/Alnus sinuata h.t.		1	1	.	2	2		6
/Calamagrostis rubescens h.t.	.		1	1	2	4		8
/Clematis pseudoalpina h.t.	.		1	7	1	6		15
/Arnica cordifolia h.t.			1	8	15			24
/Carex geyeri h.t.								
-Carex geyeri phase			2		1			3
-Pseudotsuga menziesii phase				2	1	3		6
(Upper subalpine h.t.s)								
/Ribes montigenum h.t.					3	3		6
Abies las.-Pinus albic./ Vaccinium scop. h.t.		4	3	9	15	13		44
/Luzula hitchcockii h.t.								
-Vaccinium scoparium phase	5	18	4		2			29
-Menziesia ferruginea phase	14	9	1					24
Tsuga mertensiana/Luzula h.t.								
-Vaccinium scoparium phase	2							2
-Menziesia ferruginea phase	2							2
(Timberline h.t.s)								
Pinus albicaulis-Abies lasiocarpa h.t.s	4	6	3	4	6	7		30
Larix lyallii-Abies lasiocarpa h.t.s	5	29		.	2	.		36
Pinus albicaulis h.t.s		1		3	4	1		9
	168	221	43	63	94	93		682

(con.)

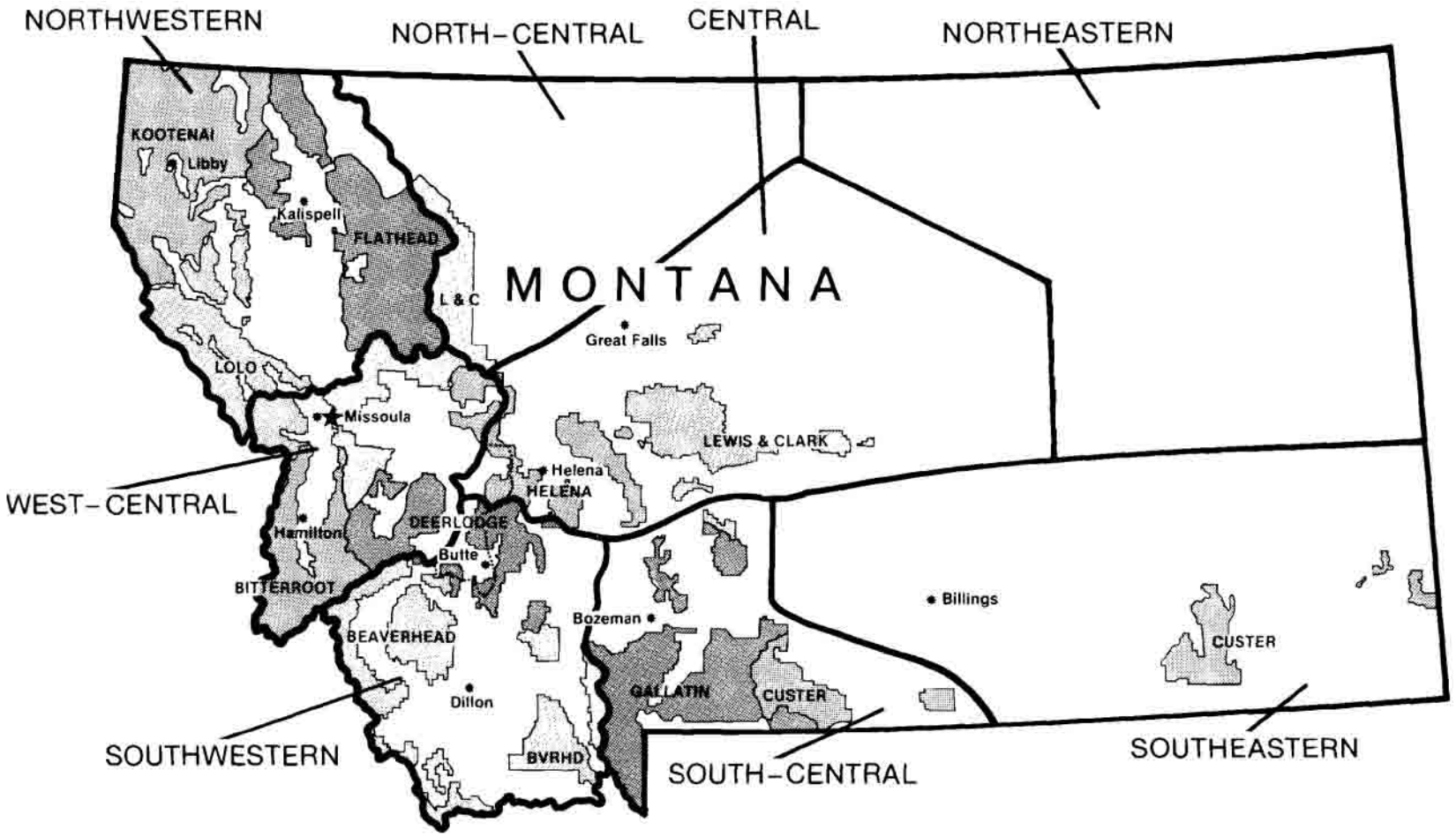
Table B-1.--(con.)

Series/habitat type/phase	Montana forest region: NW	WC	NC	C	SW	SC	SE	Total
Pinus contorta series								
/Purshia tridentata h.t.	.	.	.	.	.	3		3
/Vaccinium caespitosum c.t.	.	4	1	2	5	.		12
/Linnaea borealis c.t.	1	4		2	6	4		17
/Vaccinium scoparium c.t.	1	6		5	6	2		20
/Calamagrostis rubescens c.t.	.	—	—	1	4	1		6
	2	14	1	10	21	10		58
Unclassified stands	11	8	3	12	3	6		43
Total number of plots	399	459	66	217	188	178	24	[1] 1,531

[1] This total includes 35 *Pinus contorta* community type plots also listed under *Pseudotsuga*, *Picea*, or *Abies lasiocarpa* habitat types.

APPENDIX C

National Forests, Indian Reservations, and
National Parks within each forest region in Montana


NORTHWESTERN
NORTH-CENTRAL
CENTRAL
NORTHEASTERN
KOOTENAI
Libby
Kalispell
FLATHEAD
L&C
MONTANA
Great Falls
LOLO
Missoula
LEWIS & CLARK
Helena
HELENA
WEST-CENTRAL
Hamilton
DEERLODGE
Butte
BITTERROOT
Billings
Bozeman
BEAVERHEAD
CUSTER
Dillon
GALLATIN
CUSTER
SOUTHWESTERN
BVRHD
SOUTH-CENTRAL
SOUTHEASTERN

within *in*

National Forests (fig. C-l), Indian Reservations, and National Parks within each forest region. (N.F. = National Forest; R.D. = Ranger District):

Forest region	*Areas included*
Northwestern	Flathead N.F. Kootenai N.F. Lolo N.F. (Thompson Falls, Plains, Superior, and W. and N. portions of Ninemile R.D.'s) Flathead Indian Reservation Glacier National Park (W. slope)
West-central	Bitterroot N.F. (Montana portion) Deerlodge N.F. (Philipsburg R.D., W. portion of Deer Lodge R.D.) Helena N.F. (Blackfoot River drainage portion) Lolo N.F. (Missoula, Seeley Lake, and S.E. portion of Ninemile R.D.)
North-central	Lewis and Clark N.F. (Rocky Mountain Front portion) Blackfeet Indian Reservation Glacier National Park (E. slope)
Central	Helena N.F. (except Blackfoot R. drainage) Lewis and Clark N.F. (except Rocky Mt. Front and Crazy Mts.) Fort Belknap (S. portion) and Rocky Boy Indian Reservation Chas. M. Russell National Wildlife Refuge (W. portion)
Southwestern	Beaverhead N.F. Deerlodge N.F. (except Philipsburg and W. portion of Deer Lodge R.D.'s)
South-central	Custer N.F. (Red Lodge R.D.) Gallatin N.F. Lewis and Clark N.F. (Crazy Mts. portion) Crow Indian Reservation (Pryor and Bighorn Mts. portion) Yellowstone National Park (Montana portion)
Southeastern	Custer N.F. (Montana portion except Red Lodge R.D.) Crow (except Pryor and Bighorn Mts.) and Northern Cheyenne Indian Reservation
Northeastern	Fort Belknap (N. portion) and Fort Peck Indian Reservation Chas. M. Russell National Wildlife Refuge (E. portion)

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ARNO, STEPHEN F.
1979. Forest regions of Montana. USDA For. Serv. Res. Pap. INT–218, 39 p. Intermt. For. and Range Exp. Stn., Ogden, Utah 84401.

In this paper, Montana is divided into eight geographic subdivisions called "forest regions," based on distributions of tree and undergrowth species and the relationship of these patterns to climate and topography. The regions serve as a geographic reference for describing patterns of forest vegetation across the State. Data on the distributions of plant species and habitat types and forest zonation are presented for each region.

KEYWORDS: forest ecology, forest classification, plant geography, Northern Rocky Mountains

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