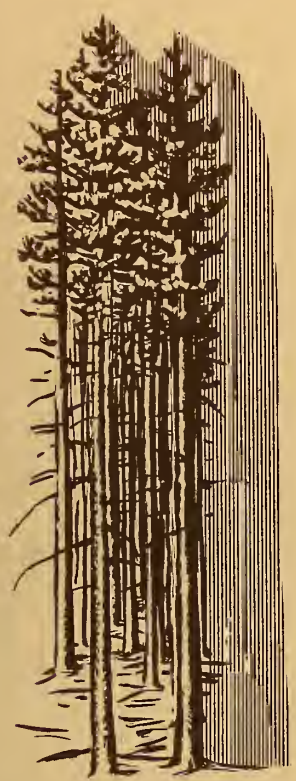
RESEARCH PAPER 30

Lodgepole Pine

in the BLUE MOUNTAINS of NORTHEASTERN OREGON



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FOREST AND RANGE EXPERIMENT STATION
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Research Paper 30

LODGEPOLE PINE IN THE BLUE MOUNTAINS OF NORTHEASTERN OREGON

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INTRODUCTION

Lodgepole pine (Pinus contorta) is a major species in northeastern Oregon. The lodgepole type covers nearly 400,000 acres in the Blue and Wallowa Mountains, and individual trees are scattered over many of the remaining six million forested acres in this area (2).[1/] The type blankets large areas in watersheds in a region where spring floods and summer irrigation are vital factors in the economy. It also serves as a cover for game--grouse, snowshoe hares, deer, and elk. And, it is potentially important for lumber, poles, and pulpwood.

Before 1952, little use was made of this species in the Blue Mountains. There were occasional cuttings for poles or small sawtimber, but generally it was considered a weed, occupying land that should be supporting other trees or grass. Use of lodgepole pine in northeastern Oregon has been increasing in the last six years, however, and has focused attention on the lack of basic knowledge of its habits in the area.

To better understand establishment, development, and characteristics of lodgepole pine stands in the Blue Mountains, a study was started in 1956 by the Pacific Northwest Forest and Range Experiment Station in cooperation with the Pilot Rock Lumber Co. General results of the study are summarized in the pages that follow.

THE BLUE MOUNTAINS AS A HABITAT FOR LODGEPOLE PINE

Soils and Physiography

Geologically, the Blue Mountains consist of numerous layers of basalt, which weathers to heavy silts and silty clays. While these soils are often quite fertile chemically, high clay contents tend to create physical conditions unfavorable for tree growth. The soils dry early in the growing season on ridgetops and basalt rims, where erosion has left only a thin (2 to 8 inches) soil mantle.

After the most recent lava flow, a floury pumicite was wind-transported from an unknown source and deposited over large areas of the Blue Mountains. This material, glassy spicules and beads about the size of a coarse silt, resists weathering and has developed little structure. It is

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[1/] Underscored numbers in parentheses refer to Literature Cited.

relatively low in fertility (12). Soil profiles in this area with a surface layer of pumicite are classified as the Tolo series (5).

Pumicite is infrequent on south aspects, probably because of erosion resulting from the characteristically rapid snowmelt associated with them. On these sites, residual basalt soils are generally exposed. In contrast, north aspects, flat ridgetops, and valley bottoms are usually covered by pumicite varying in depth from a few inches to more than 4 feet. The underlying layer of residual basalt soil may vary from zero to more than 5 feet in thickness (fig. 1).

Elevations in the Blue Mountains range from about 2,500 feet in lower valleys to more than 9,000 feet in the southern part. Summit elevations average 5,000 to 6,000 feet.

Topography is extremely variable from one area to another. Where summits generally exceed 7,000 feet, sharp ridges and peaks slashed by steep, glaciated canyons may be found. In lower regions, broad ridges separated by V-bottomed drainages are common.

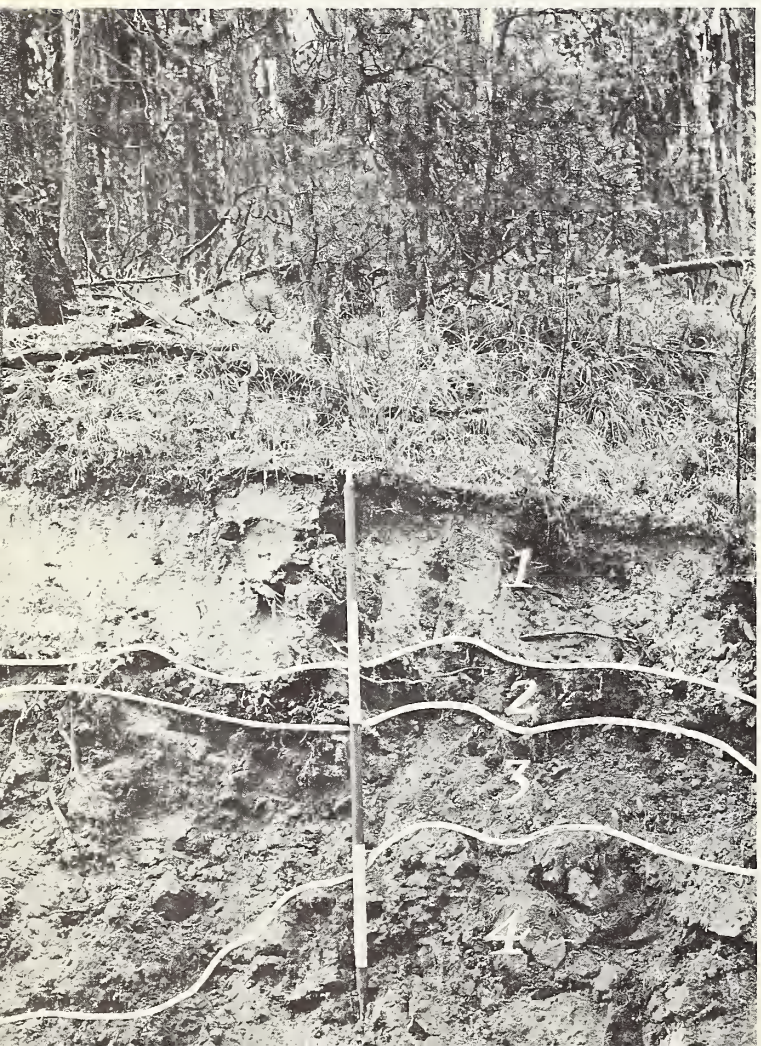

Figure 1.--A typical north-slope soil profile in the Blue Mountains of northeastern Oregon: (1) Pumicite layer, 18 inches thick; (2) residual basalt soil, 4 to 12 inches thick; (3) parent material of broken basalt stones and coarse gravel; and (4) basalt bedrock.

Climate

Average annual precipitation ranges from 16 to more than 35 inches, depending largely on elevation. Most of this falls between November and May. Highest precipitation is in early spring; very little falls during July or August. Local thunder showers account for most of the summer rainfall.

Temperatures vary markedly with elevation and aspect. In much of the area there may be no frost-free months; whereas in lower, protected locations, July and August are usually frost-free.

Vegetation

Shallow basalt soils support natural grasslands that trees do not normally invade. Where deeper soils have formed along faults in bedrock or at the foot of basalt rims, stringers of ponderosa pine[2/] and the Rocky Mountain variety of Douglas-fir may cut across the natural grasslands. Where basalt soils are deep, open stands of ponderosa pine, Douglas-fir, and western larch are common. If pumicite overlies basalt soil, these latter trees, together with grand fir, lodgepole pine, and Engelmann spruce may occur.

Grand fir appears to be a climax species on relatively dry areas (fig. 2), and Engelmann spruce on moist bottomlands. Only on severely exposed ridges and slopes above 7,000 feet does lodgepole pine appear to be climax, along with whitebark pine.

Figure 2.--Grand fir, a climax species, growing on a site suitable for lodgepole pine. Where the fir is not disturbed, lodgepole pine gradually disappears.

2/ Scientific names of plants are listed on the inside back cover.

HOW THE STUDY WAS MADE

Fifty pure lodgepole stands (80 percent by volume) in the Grande Ronde and Umatilla River drainages were studied intensively. Each stand was sampled with eight 1/20-acre plots. In addition, numerous other stands were observed to see if plot results were representative of the Blue Mountains and to gather supplemental information on such items as insects, disease, cone crops, and tree growth characteristics.

On each 1/20-acre plot, the following characteristics were measured:

A. Stand characteristics:

1. Number of trees, by species.
2. Diameter, breast high (d.b.h.) of all trees, by species.
3. Height of three lodgepole pines--one each in the dominant, intermediate, and suppressed crown classes.
4. Age of one dominant lodgepole pine.
5. Radial growth rate of one dominant lodgepole pine.
6. Number and species of reproduction.

B. Ground cover characteristics:

1. Species composition.
2. Current annual herbage production by shrubs, forbs, and grasses and sedges.

C. Soil characteristics:

1. Depth of surface pumicite layer.
2. Depth of underlying basalt soil.

Five lodgepole form factors[3/] were measured for each stand sampled. Also, closed cones that had ripened in 1953, 1954, and 1955 were collected from one tree of each stand. Older closed cones were gathered occasionally.

3/ Form factor = 100 (midbole diameter inside bark)/d.b.h.

DESCRIPTION OF LODGEPOLE PINE IN THE BLUE MOUNTAINS

Where It Grows

Lodgepole pine is adapted to a variety of climates. It grows with ponderosa pine at elevations as low as 3,000 feet and with whitebark pine and subalpine fir at elevations exceeding 7,000 feet (fig. 3). Between these extremes it thrives in a variety of climates with Engelmann spruce, Douglas-fir, grand fir, and western larch.

In contrast to its broad climatic adaptation, the lodgepole type is limited to certain soils. All of the stands studied were found to grow only on pumicite or alluvial material overlying residual basalt soils. The most extensive pure lodgepole stands occur on broad, flat ridgetops typical of much of the Blue Mountains, and on north and east aspects. It also frequently grows along toes of steep slopes and in creek bottoms. Lodgepole pine is seldom found on south aspects or steep slopes, probably because the pumicite has been largely eroded.

Figure 3.--Lodgepole pine occurs over a wide climatic range in the Blue Mountains.

A. A lodgepole pine (left center) is growing in a group of ponderosa pine at an elevation of 3,000 feet, near lodgepole's lower altitudinal limit.

B. At its upper limit, it mixes with whitebark pine (right) or subalpine fir (small group, left center) at nearly 8,000 feet.

Establishment of Pure Stands

Pure stands of lodgepole pine were found where fire had destroyed the preceding tree cover. Snowbreak, windthrow, diseases, insects, or logging, however, can also cause suitable openings for lodgepole pine establishment. Pure stands vary from less than an acre to more than 600 acres in size.

Lodgepole pine has an advantage over other trees in seeding openings--it produces a good seed crop almost every year. Other species, such as western larch, often produce a large seed crop every 2 or 3 years, but these crops may not coincide with weather favorable for seedling establishment. Although most cones are nonserotinous, occasional lodgepole trees in most stands examined bore cones that remained closed, retaining viable seed for decades. Thirty-year-old cones contained seed with an average germination rate of 50 percent. Seed from 15-year-old cones had germination rates as high as 70 percent. Thus, even if a stand were killed before the annual seed crop ripened, some seed usually would be available for regeneration. Observations showed that lodgepole can maintain itself indefinitely in a mixed forest. It frequently seeds into openings in grand fir, Douglas-fir, and western larch.

Age, Stocking, and other Characteristics

In the stands examined there was relatively little age spread; 96 percent averaged 60 to 90 years old (fig. 4). Much of the Blue Mountains was swept by fire between 1870 and 1910, opening large areas where lodgepole pine established pure stands. Stands begin to break up as they pass 100 years of age.

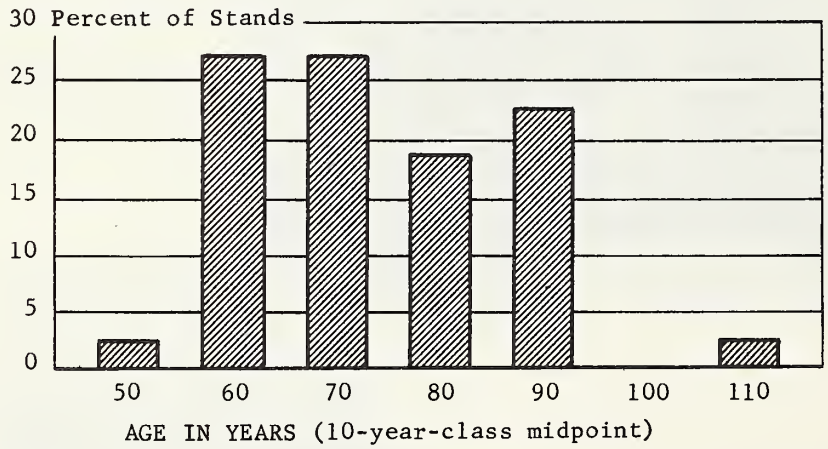

Figure 4.--Percentage distribution by stand age of 44 lodgepole pine stands in the Blue Mountains.

Stocking density in number of stems differs considerably from stand to stand. For example: in 14 stands, 55 to 65 years old, stems a half inch d.b.h. and larger averaged from 320 to 4,100 per acre; stems 5 inches d.b.h. and larger ranged from 110 to 600 per acre. Occasionally, stands contain as many as 10,000 stems per acre (fig. 5), but stands more densely stocked than this are rare.

Stocking within most lodgepole pine stands is patchy. For example, 1/20-acre plots measured in a typical stand showed the following range within a 7-acre area:

Plot	Stems per acre	
	(1/2 in. d.b.h. and larger)	(5 in. d.b.h. and larger)
1	540	320
2	880	280
3	740	380
4	460	320
5	720	400
6	1,220	140
7	1,000	340
8	1,000	420

Trees are uniformly small in most densely stocked stands (fig. 5), but groups of trees up to 15 inches d.b.h. occur in more open stands. The most common average stand d.b.h. falls in the 5—5.9-inch class (fig. 6).

Nine-tenths of the stand form factors fall between 66 and 85 percent. Average form factor is 72.5 percent.

Figure 5.--A stand of lodgepole pine saplings averaging about 10,000 stems per acre. At an age of 65 years, average diameter is 2 inches.

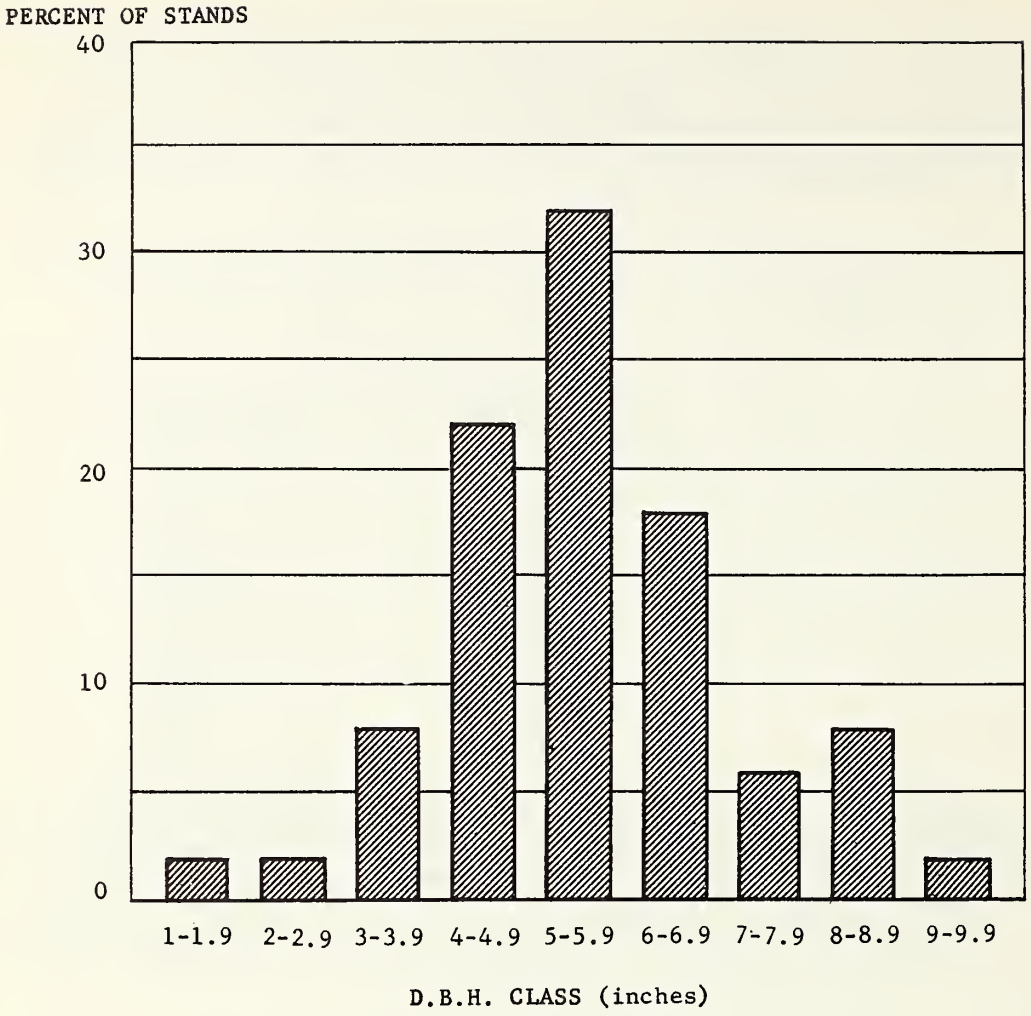

Figure 6.--Percentage distribution by average diameter class of 50 lodgepole pine stands in the Blue Mountains.

Basal area for the stands studied averages 132 square feet per acre, ranging from 52 to 198. Like stems per acre, basal area varies considerably within an even-aged stand. In a representative stand, basal area varied from plot to plot within a 12-acre area as follows:

Plot	Basal area per acre (Square feet)
1	164
2	76
3	152
4	96
5	122
6	104
7	160
8	120

Stand volume is inversely related to number of stems per acre (fig. 7), because d.b.h. and height are affected by density. In stands of more than 200-400 trees per acre, the proportion of volume in larger trees decreases as number of stems increases. This density effect completely masks the relation between volume and age.

Crowns of individual lodgepole pine trees are characteristically short, since most stands in the Blue Mountains are overstocked. The ratio of crown length to tree height averages about 30 percent and may be as low as 20 percent. In many stands it is difficult to find a truly dominant tree. Because crowns are short and often thin, a considerable amount of light penetrates to the forest floor, even where there are several thousand stems per acre.

Relatively good light penetration permits establishment of reasonably vigorous reproduction under most lodgepole pine stands. Although lodgepole seedlings often stock small openings, most of the regeneration under the lodgepole canopy is grand fir, Douglas-fir, or western larch (fig. 8). Engelmann spruce or ponderosa pine seedlings also occur frequently on suitable sites.

Usually lodgepole pine is a reasonably good natural pruner, but in occasional stands dead lower branches persist. Low density in the early development of lodgepole pine stands allows growth of large limbs that do not prune naturally, even after the crown canopy has closed (fig. 9).

Factors That Affect Growth

As stated before, height and diameter growth of lodgepole pine are materially influenced by stocking density. A 90-year-old stand provides a good example. When the stand was 30 years old, fire thinned part of it from about 2,000 to 1,000 stems per acre. Trees in the unburned area now average around 2 inches d.b.h. and 25 to 30 feet tall. Surviving trees in the burned area responded markedly to the release and now average approximately 5 inches d.b.h. and 60 feet tall (fig. 10).

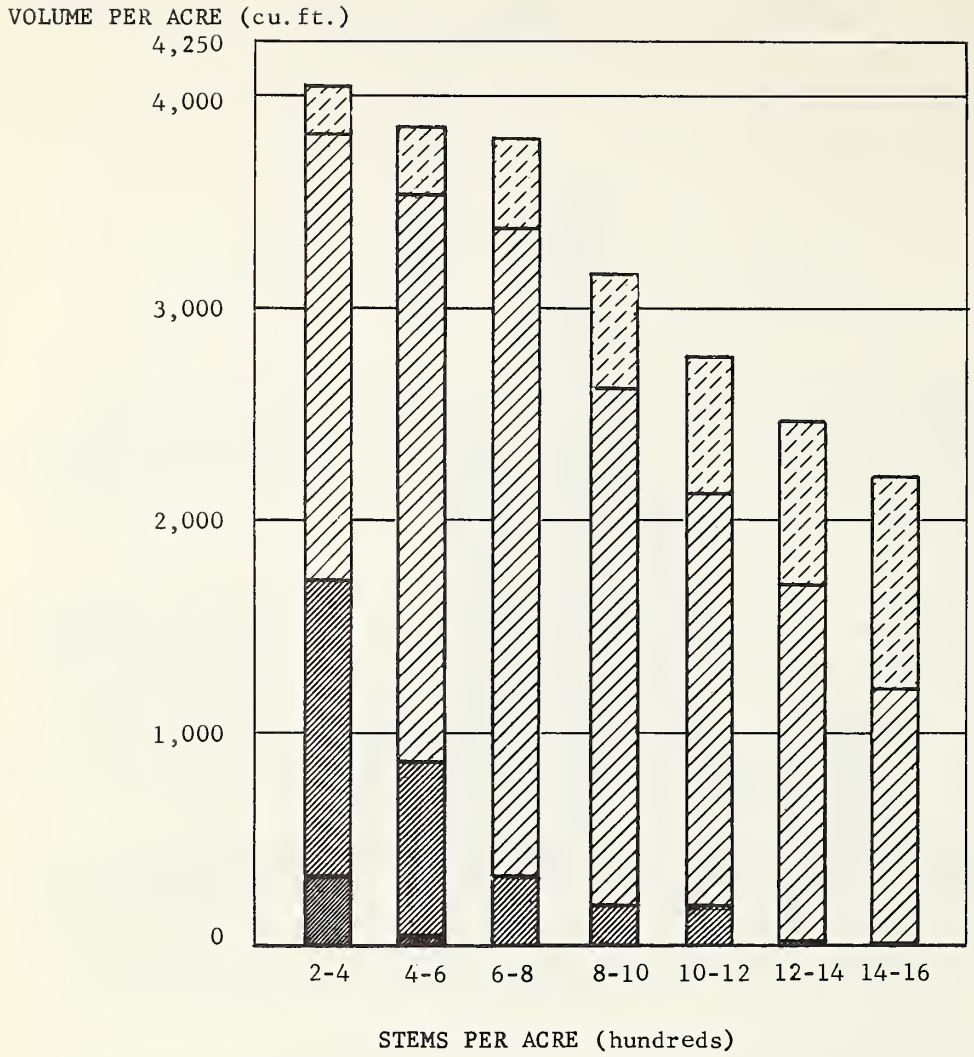

Figure 7.--Lodgepole pine stand volume related to number of stems. (Averages for 40 randomly selected stands ranging in age from 58 to 90 years.)

Dense lodgepole pine reproduction (small seedlings) with western larch (light crowns) and grand fir seedlings in a windthrow opening in a lodgepole stand. The larch and grand fir were established before the windthrow, whereas the lodgepole followed it.

Figure 8

Western larch reproduction under a lodgepole pine overstory.

Figure 9

Good natural pruning is typical of lodgepole pine.

An example of poor natural pruning. The absence of poles on the ground indicates that this stand was relatively open in its early history.

Figure 10.--When this lodgepole pine stand was 30 years old, fire thinned part of it (right) to about half the number of stems as on the unburned part (left). Sixty years later, trees in the thinned area average more than twice the diameter and height of trees in the unthinned area.

Since stocking affects height growth, site index is not always a reliable indicator of site quality for lodgepole. Height of dominant trees was found reduced where there were more than about 800 trees per acre. Consequently, total cubic-foot volume production suffers where stems per acre exceed this figure.

Height growth is also related to topography. Site index averaged 67 for stands of less than 800 trees per acre growing on south and west aspects; 72 on north and east aspects; and 85 on flats. Microclimate, soil moisture, and soil depth may all play a role in these differences. Site index curves used were based on age 80 for lodgepole pine in central Oregon (7).

Diameter growth of lodgepole pine declines markedly by 40 years, and height growth by 70 to 80 years. In dense stands, decline starts earlier. As crowns close, diameter growth falls to a low plane, continuing for many decades without essential change. Since lodgepole pine can maintain life with a very small crown, natural thinning is slow and stagnation may be approached. Growth of trees in such stands may be as poor as 50 annual rings per inch.

Growth of other trees in lodgepole stands normally does not decline at such an early age, even in dense stands. Diameter growth of a lodgepole pine and a neighboring Douglas-fir are shown in figure 11. Whereas growth of the lodgepole pine has slowed steadily to the age of 40 years, the Douglas-fir has maintained fairly even growth during the same period.

In open stands of lodgepole pine, the seemingly inherent decline of diameter growth still sets in at an age of about 40 years. Nonetheless, subsequent growth may be satisfactory. Several open-grown trees (60 years old) on a good site averaged four annual rings per inch during the first 40 years of growth; at 60 years, growth had declined to 7 rings per inch, still a very acceptable rate. These trees averaged about 28 inches d.b.h. Density control is clearly the key to producing lodgepole pine of saw log size.

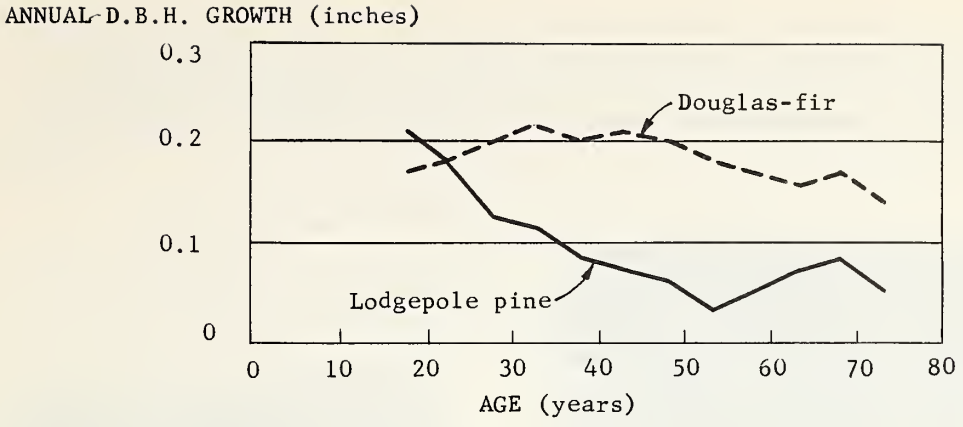

Figure 11.--Diameter growth of a lodgepole pine and a neighboring Douglas-fir of the same age.

Lodgepole pine is characterized by rapid early height growth and often surpasses associated trees. As juvenile growth slows down, however, the other species usually catch up and surpass the lodgepole. In figure 12, the diameter growth of a lodgepole pine and a neighboring western larch of the same age are illustrated. Growth of the lodgepole pine fell off in the

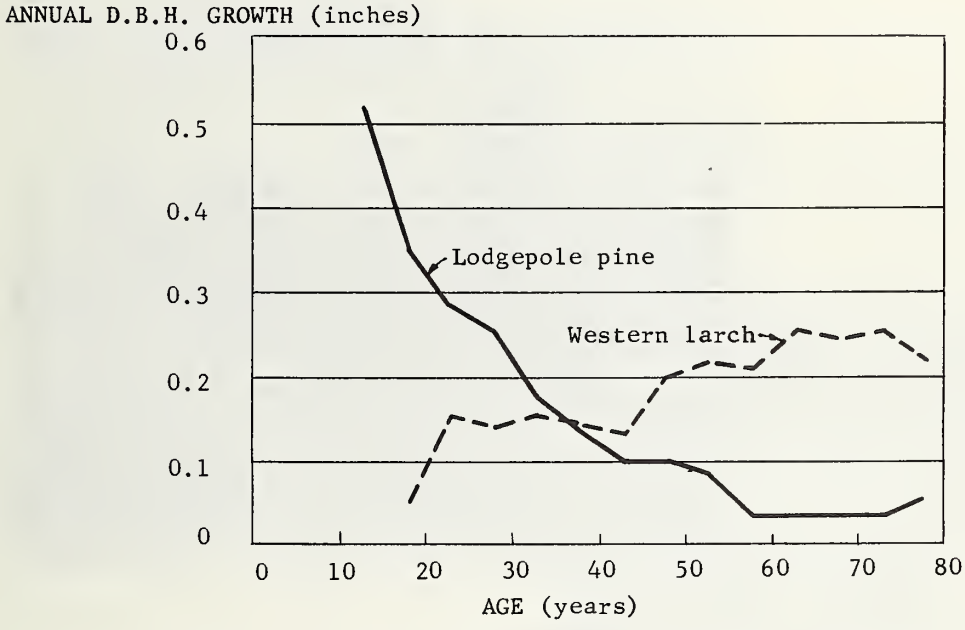

Figure 12.--Diameter growth of a lodgepole pine and a neighboring western larch of the same age.

typical way. The western larch, however, began to grow faster in diameter after overcoming its early height disadvantage. When associated trees grow above the lodgepole pine canopy, their crown advantage is increased and good growth is maintained long after the lodgepole has reached a near-stagnated condition (fig. 13).

The lodgepole pine (left) and western larch (right) are both 85 years old. D.b.h. of the pine is 12.1 inches; of the larch, 15.9 inches.

Figure 13

These lodgepole pine (dark crowns) and western larch (light crowns) are all 95 to 100 years old. Average height of the pine is 70 feet; of the larch, 95 feet.

Damaging Agents

Dense lodgepole stands are extremely subject to both physical and biological damage. Weather, insects and diseases all cause mortality and defect.

Wet, heavy snow in early spring can seriously damage stands with slender stems (fig. 14). Once a small patch of snowbreak starts, it grows larger every year. Trees along the edge of the patch, having lost support, bend into the opening under snow weight.

Figure 14.--A patch of snowbreak in dense lodgepole pine.

Windthrow patches may occur where lodgepole pine is growing on shallow soils (fig. 15), but wind does not ordinarily damage this species seriously in the Blue Mountains. Tall, slender stems can withstand considerable swaying, and the short, thin crowns offer little wind resistance.

Figure 15.--Windthrow of lodgepole pine on a shallow soil. Note shallow root systems.

Insect damage is not now widespread. However, the mountain pine beetle (Dendroctonus monticolae) causes some mortality in decadent stands more than 100 years old (fig. 16). This damage can be expected to increase greatly in the next 40 years, since many lodgepole stands in the area will reach that age. Little damage by the many other insect enemies that attack lodgepole pine was noted in this study.

Figure 16.--The dead trees on the ground and standing in the background in this 110-year-old lodgepole pine stand were killed by the mountain pine beetle.

Diseases causing direct mortality of lodgepole pine are likewise currently unimportant, but very serious problems exist with organisms that inhibit vigor or deform stems. Dwarfmistletoe (Arceuthobium americanum) (fig. 17) causes serious deformation in many stands and frequently weakens individual trees so they fall prey to bark beetles. Dense stands seem particularly subject to extensive dwarfmistletoe infection, apparently because it can spread from tree to tree. In younger stands, dwarfmistletoe frequently grows on stems as well as on branches. Infection in young stands usually starts from scattered infected overstory trees.

Figure 17.--Dwarfmistletoe (left), and a gall caused by the rust Cronartium harknessii (right), on a lodgepole pine sapling.

Stem rusts are prevalent in most lodgepole stands in the Blue Mountains. Cronartium harknessii forms cankers and galls on both stems and branches (fig. 17). C. stalactiforme forms long (up to 30 feet) diamond-shaped flat cankers on stems. Other cankers, whose causal rust has not been identified, are common. These are oval, dead spots on the bark, up to 3 feet long, which girdle up to half the tree circumference. All of these rusts cause dead spots on stems. Resulting deformities make the trees unsuitable for poles and often cause loss of scale or culling for sawtimber. Cankers also form weak points that make the trees susceptible to wind or snow breakage.

The lodgepole needle cast (Hypodermella concolor) appears occasionally, but is not serious at present in the Blue Mountains.

Forage in Lodgepole Pine Stands

Considerable forage is produced under lodgepole pine, but most of the stands are too dense to afford reasonable access to domestic livestock and much of the production is of low-palatable species. Deer and elk seek the cover of lodgepole stands, but do most of their feeding elsewhere.

Average herbage production under the 50 stands sampled was approximately 250 pounds per acre, dry weight. Individual yields varied from 40 to 600 pounds. The larger yields usually occurred under relatively open stands. Although composition varied considerably from stand to stand, shrubs generally made up about 65 percent of the herbage production. Grasses and sedges accounted for 20 percent of the production; and forbs, the remaining 15 percent (fig. 18).

Figure 18.--Ground cover vegetation in a representative lodgepole pine stand, including grouse whortleberry, shinyleaf spirea, pinemat manzanita, strawberry, and pinegrass.

Of the grasses and sedges, pinegrass was most abundant. Other species included elk sedge, northwestern sedge, and western fescue.

Grouse whortleberry (huckleberry) was the most abundant shrub. Big whortleberry (huckleberry), dwarf blueberry, shinyleaf spirea, common snowberry, and rose also were common.

Many forb species grow in lodgepole stands, but few are found consistently. The most widespread included heartleaf arnica, strawberry, white hawkweed, lupine, Fendler meadowrue, mountain thermopsis, and violet. None of these were abundant enough to contribute significantly to the forage.

Several species having little forage value are common in lodgepole stands. These include pinemat manzanita, common pipsissewa, American twinflower, and myrtle pachistima.

Very dense lodgepole stands have almost no ground vegetation, whereas open areas approach full ground cover. The best tree sites tend to have less ground cover than poorer tree sites (fig. 19), and there are more forbs than grasses and shrubs on the best sites.

Figure 19.--In lodgepole pine stands, the amount of ground cover tends to vary with the site.

Lodgepole stand of site class 1. Note the absence of ground vegetation.

Lodgepole stand of site class 3. Here, there is a heavy ground cover of pinegrass.

Lodgepole pine stands occur in areas used extensively by deer and elk during spring, summer, and fall. Pellet group counts and observations of current and past grazing use on shrubs, however, showed that these animals apparently feed little in the lodgepole stands. There is some use in winter, since snow is shallower in the stands than in the open. During this time, their principal forage is lichens growing on lodgepole bark and twigs, as shown in many stands by a lichen browse line.

LODGEPOLE PINE IN THE BLUE MOUNTAINS COMPARED WITH OTHER REGIONS

Lodgepole pine in the Blue Mountains exhibits the same general characteristics found in most other regions (1, 3, 10). Pure stands originate primarily after fire. Cone crops are produced almost every year, with large crops occurring at frequent intervals. Stands may vary from even-aged to all-aged, depending on their development history.

Lodgepole stands in the Blue Mountains, however, differ from those described in other regions in two major respects. First, stands in the Blue Mountains have a remarkably narrow age spread. It is not surprising that stands less than 40 years old are infrequent because of the increased effectiveness of fire prevention and control during the past four decades. But only rarely does one encounter a stand over 90 years old. The oldest tree examined in this study was 173 years old. The next oldest was 150. Trees older than 120 years were exceptional. In the Rocky Mountains, 140-year-old stands appear to be common (6, 13). Trees or stands as old as 450 years have been reported in Montana (10); 250 years, in Colorado (8); and 375 years, in Alberta (3).

The second major difference is the scarcity of "doghair" lodgepole pine thickets in the Blue Mountains. Although overstocked stands are common, stands with more than 4,000 stems per acre are infrequent, and stands with more than 10,000 stems per acre are rare. This may be compared with reports of stands averaging 50,000 stems per acre in Colorado (1), 300,000 in Montana (10), and 500,000 in Alberta (11).

THE POTENTIAL OF LODGEPOLE PINE IN THE BLUE MOUNTAINS

Small tree size has hindered lodgepole pine utilization. Under proper management, however, individual stems can be grown to saw log size at a satisfactory rate. Since the wood has many desirable qualities for lumber (14), its use for sawtimber offers promise.

Until lodgepole pine is managed for saw log production, however, the greatest potential of natural stands is for pulpwood. Lodgepole pine yields high-quality sulfate pulp and also can be pulped by other methods (14).

As markets for pulpwood expand and as efficient techniques are developed for handling small stems, use of lodgepole in the Blue Mountains will increase. A forest chipping operation pioneered by the Pilot Rock Lumber Co. offers a promising approach to handling methods (fig. 20).

Progress in utilizing lodgepole pine in the Blue Mountains is important. Since individual stem growth in most stands suffers from overstocking, a large area of timberland is not contributing its share of usable wood production. Furthermore, available data show that heavy mortality begins shortly after stands reach an age of 100 years. Since many existing stands will reach that age in 20 years and the majority in 40 years, much of the standing timber may be lost if it is not utilized soon. Meanwhile, other important uses of lodgepole pine--as watershed cover and game habitat--are important to the region's economy and warrant further study.

Figure 20.--Chipping lodgepole pine in the forest for fiberboard production. (Photo courtesy of The Timberman.)

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COMMON AND SCIENTIFIC NAMES OF PLANTS MENTIONED

The common and scientific names of trees in this publication follow "Check List of Trees in the United States" (9); names of shrubs, forbs, grasses, and sedges follow "Standardized Plant Names" (4).

Trees

Lodgepole pine	Pinus contorta
Ponderosa pine	Pinus ponderosa
Whitebark pine	Pinus albicaulis
Douglas-fir	Pseudotsuga menziesii var. glauca
Grand fir	Abies grandis
Subalpine fir	Abies lasiocarpa
Western larch	Larix occidentalis
Engelmann spruce	Picea engelmannii

Shrubs

Big whortleberry	Vaccinium membranaceum
Grouse whortleberry	Vaccinium scoparium
Dwarf blueberry	Vaccinium cespitosum
Shinyleaf spirea	Spiraea lucida
Common snowberry	Symphoricarpos albus
Rose	Rosa spp.
Pinemat manzanita	Arctostaphylos nevadensis
Myrtle pachistima	Pachistima myrsinites
American twinflower	Linnaea borealis var. americana
Common pipsissewa	Chimaphila umbellata

Forbs

Heartleaf arnica	Arnica cordifolia
Strawberry	Fragaria spp.
White hawkweed	Hieracium albiflorum
Lupine	Lupinus spp.
Fendler meadowrue	Thalictrum fendleri
Mountain thermopsis	Thermopsis montana
Violet	Viola spp.

Grasses and Sedges

Pinegrass	Calamagrostis rubescens
Western fescue	Festuca occidentalis
Elk sedge	Carex geyeri
Northwestern sedge	Carex concinnoides