Pinus flexilis James Limber Pine

Pinaceae Pine family

Robert Steele

Limber pine *(Pinus flexilis)*, also known as white pine or Rocky Mountain white pine, is a long-lived, slow-growing tree of small to medium size. Its wood, light in weight, close-grained, and pale yellow, is used for rough construction, mine timbers, railroad ties, and poles. Its harvest is incidental to that of other, more desirable species.

Habitat

Native Range

Limber pine (fig. 1) grows from Alberta and southeastern British Columbia to New Mexico, Arizona, and eastern California. Notable outliers of this general distribution are found in the western portions of North Dakota, South Dakota, and Nebraska, and in eastern Oregon and southwestern California.

In the northern half of its distribution, limber pine is generally found near lower tree line and on dry sites in the montane forests. Between the 45th and 40th parallels, it grows in both lower and upper elevation forests and anywhere in between on dry, windswept sites (fig. 2). Its position gradually shifts upward in more southerly latitudes, so that in southern portions of its distribution, limber pine is more common from upper montane to alpine tree line, with only minor occurrences in the lower forested zones. Because of this adaptability, limber pine ranges in elevation from about 870 m (2,850 ft) in North Dakota (29) to about 3810 m (12,500 ft) in Colorado (7).

Climate

Climatic data for actual limber pine habitat are quite scarce, but the general distribution of limber pine in Alberta, Montana, central Idaho, and east of the Continental Divide in Wyoming and Colorado, is in forested areas having a continental climate *(2,3)*. This climate is typified by a relatively small amount of precipitation, with the wettest months during the growing season, very low humidity, and wide annual and diurnal temperature ranges. Winter conditions may be very cold, but relatively dry, and often include rapid fluctuations in temperature associated with chinook winds. Notable exceptions to this distribution are the small populations in eastern Oregon and adjacent Idaho, which lie within the Pacific maritime influence (3).

In the remainder of its distribution, limber pine grows in climates that tend to have either more evenly distributed yearly precipitation or a winter peak in precipitation along with summer convectional storms. Throughout its broad range, limber pine is mostly absent in areas strongly influenced by Pacific maritime weather patterns. Only at its southern limits in the mountains of eastern and southern California *(10)* does the pine encounter a strong pattern of proportionately high winter precipitation (3). The amount of precipitation, however, is relatively smaller than that of the Pacific Northwest.

Soils and Topography

In some areas, limber pine grows in greater numbers on certain soils, but the relationships vary geographically. In general, the substrates are Entisols. In Montana, limber pine grows mainly on calcareous substrates (26). Similarly, in eastern Idaho and western Wyoming, it grows mainly on soils derived from limestone or sandstone and is notably absent on adjacent granitic substrates *(34)*, yet the population in South Dakota grows on soils derived from granitic rock (38). In central Idaho, limber pine is found largely on soils derived from sedimentary rocks; it is notably absent on granitic substrates, but grows in cracks of recent lava at Craters of the Moon National Monument (33). In eastern Oregon, a recently discovered population is on soils derived from serpentine *(17)*. In Utah, it grows on soils developed from limestone, as on the Wasatch Plateau *(9)*, and on soils derived from quartzites, shales and limestones of the Uinta Range (26). In southern Utah, it is most common on soils derived from sandstone and limestone (44). In northeastern Nevada, it also grows on various calcareous substrates *(25)*, but in California, on substrates derived from granitic, obsidian, and pumice materials (30).

Limber pine grows on a variety of topographies, from gently rolling terrain to cliffs. It is most often found on rocky ridges and steep rocky slopes and can survive in extremely windswept areas at both lower and upper tree line.

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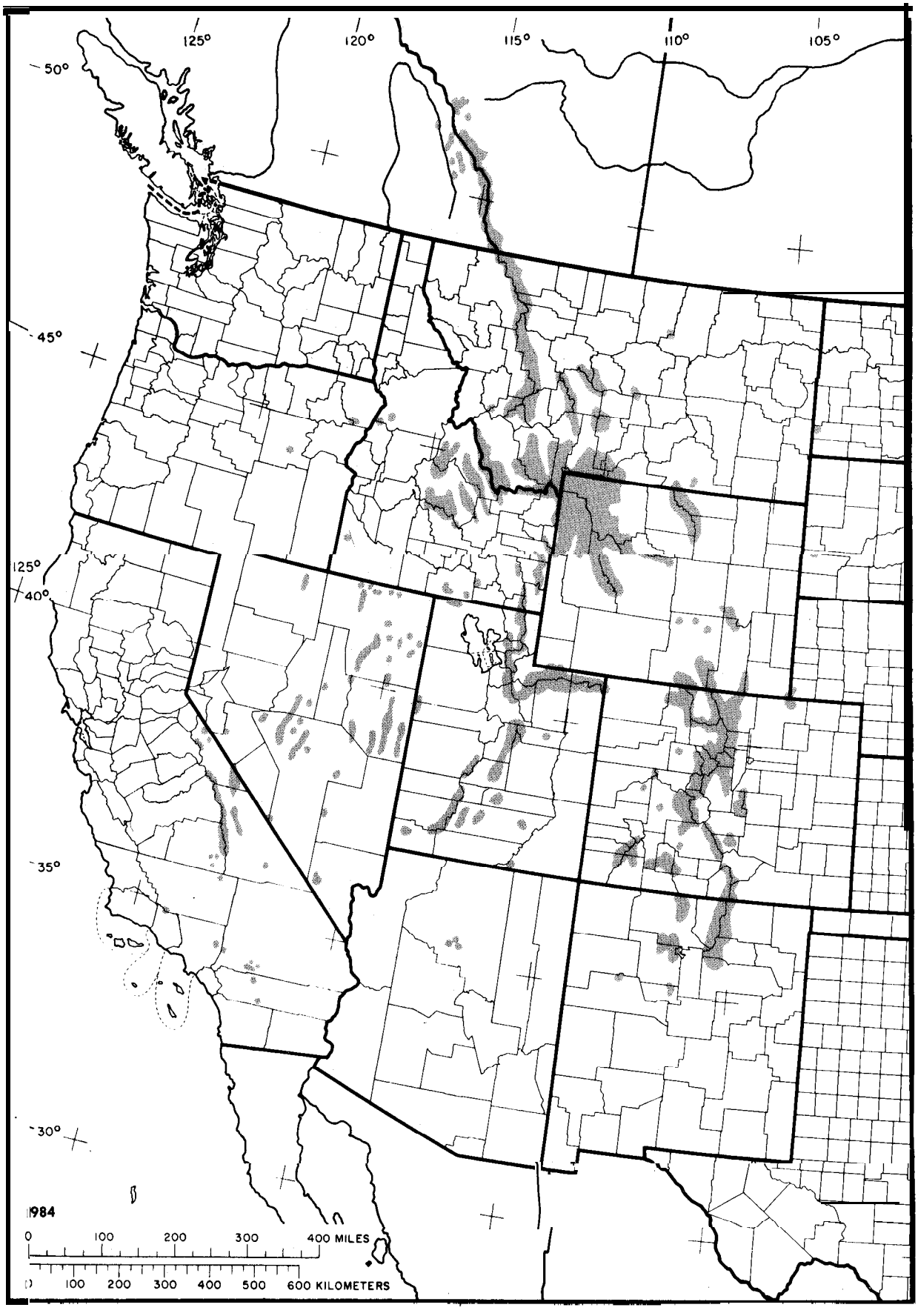

Figure *1-The native range of limber pine.*

Figure 2—*A monarch limber pine at 2896 m (9,500 ft) in the Lost River Range of east central Idaho. The contorted branches, wind-sculptured bole, and barren site attest to the severe environments that this species can endure.*

Associated Forest Cover

As well as being dominant in the forest cover type Limber Pine (Society of American Foresters Type 219), limber pine is a minor component of the following (32); Engelmann Spruce-Subalpine Fir (Type 206), Whitebark Pine (Type 208), Bristlecone Pine (Type 209), Interior Douglas-Fir (Type 210), Aspen (Type 217), Lodgepole Pine (Type 218), and Interior Ponderosa Pine (Type 237).

In Canada, Montana, and central Idaho, limber pine forms pure stands at lower tree line or mixes with Douglas-fir ***(Pseudotsugu menziesii),*** and to a lesser extent, ponderosa pine ***(Pinus ponderosa)*** and Rocky Mountain juniper ***(Juniperus scopulorum).*** It also appears as a minor component in stands of lodgepole pine *(Pinus contorta),* Engelmann spruce ***(Picea engelmannii),*** and occasionally subalpine fir ***(Abies lasiocarpa).*** On some sites in Idaho and Montana, it is associated with whitebark pine *(Pinus albicaulis).* In Canada, it is sometimes found with white spruce ***(Picea glauca).***

Southward into Wyoming, southern Idaho, and northern portions of Colorado, Utah, and Nevada, limber pine may dominate windswept slopes and ridges at upper or lower tree line or appear in stands of white fir ***(Abies concolor),*** lodgepole pine, and Douglas-fir. In this region, limber pine appears most often with Engelmann spruce, subalpine fir, and quaking aspen ***(Populus tremuloides),*** least often with ponderosa pine. In Wyoming, limber pine occasionally coexists with whitebark pine, particularly in the Wind River Range. The two species also coexist on a few sites in northeastern Nevada *(5,25),* but usually where their ranges overlap they occupy different soils.

Farther south in the remainder of its range, limber pine forms open stands near upper tree line, both separately and with Great Basin bristlecone pine *(Pinus longaeva)* (44) but less often with Rocky Mountain bristlecone pine *(Pinus aristata) (6,18).* It is also associated with whitebark pine on the east side of the Sierra Nevada (4). Occasionally, it mixes as a minor seral species with subalpine fir and white fir (23). Where limber pine would normally mix as a seral species with other conifers, as it does farther north, the closely related southwestern white pine *(Pinus strobiformis)* appears in these situations, but this species does not extend onto the dry windy sites where limber pine is climax (23).

Life History

Reproduction and Early Growth

Flowering and Fruiting-Limber pine is monoecious—male and female strobili are borne separately on the same tree. As with most pines, male strobili predominate in the lower crown and female strobili most often develop at the apical end of main branches in the upper crown. Male strobili emerge from buds in the spring and are arranged in small clusters of indistinct spirals. They may be green or yellow to reddish purple but turn brown when mature and about to shed their pollen. Pollen is shed during June and July. Female strobili emerge from buds shortly after the male strobili and are green or red to purple. Cone scales flex and they remain receptive to pollen for only a relatively short time during June and July. After pollination, scales close and the strobili begin to develop slowly.

Fertilization takes place in the spring or early summer, about 13 months after pollination. Cones and seeds mature rapidly following fertilization. As they mature, cones change color from green to lustrous yellow. They are light brown when mature in August and September. Seed dispersal takes place during September and October *(41).*

Seed Production and Dissemination-Large seed crops are produced every 2 to 4 years and seed numbers generally range from 7,050 to 15,000/kg (3,200 to 6,800/lb) and average 10,800/kg (4,900/lb) (38). Seed size varies geographically, with a tendency for increasingly larger seeds in more southerly latitudes *(14,36).* Although some trees produce seed having an ineffective vestigial wing *(21),* most limber pine seeds are wingless.

The seeds are disseminated largely by rodents and birds. Of the birds, Clark's nutcracker is most important; it can transport pine seed for at least 23 km (14 mi) from seed source to communal caching areas (42). It can carry up to 125 limber pine seeds per trip in a sublingual pouch and buries in the ground one to five seeds per cache at a depth of 2 to 3 cm (0.8 to 1.2 in). Estimates indicate that Clark's nutcrackers cached in 1 year about 30,000 seeds per hectare (12,140/acre), most of which were limber pine (22). The birds' preferred cache sites were windswept ridges and southerly aspects where snow does not accumulate and the ground is exposed early in the spring. The locations of most limber pine stands probably reflect the site preferences of dispersal agents rather than those of the pine, since its only other apparent means of dissemination is gravity.

Seedling Development-Germination is epigeal *(41).* Like seed size, rate of seedling development depends on the geographic source. In one study *(36),* 2-year-old nursery grown seedlings from Alberta averaged 4.3 cm (1.7 in), while those from New Mexico had reached 7.4 cm (2.9 in>. Fall-sown seed, properly fertilized, produced a pencil-sized 2-O seedling suitable for field planting *(14).* In the wild, many seedlings develop in clusters from Clark's nutcracker seed caches *(20).* The seedlings withstand this competition well and often retain the clumped habit into maturity.

Vegetative Reproduction-No information is currently available.

Sapling and Pole Stages to Maturity

Growth and Yield-The slow growth rate and poor form normally attributed to limber pine discourages commercial interest in its use for timber and there is little information regarding its growth and yield. There apparently has been no attempt, however, to plant this species on forest sites superior to those chosen by birds and rodents that cache the seed. Where occasional limber pines grow in more densely forested stands with other tree species, sapling and pole size trees are often straight and single stemmed. One study *(29)* suggests, however, that limber pine growth rates may be greater on exposed windy knolls than on warmer south slopes and more moist north slopes.

Rooting Habit--Type of substrate undoubtedly influences the rooting habit of limber pine. On many of the very rocky sites where it grows, the root system must follow the pattern of rock fracturing. As a result, most limber pine are quite wind firm. In nurseries, where there are better soil conditions, it develops a more uniform root system and can be transplanted by the ball and burlap method if previously root pruned (7). Roots of limber pine are also known to associate with a mycorrhizal fungus *(Gomphidius smithii) (40).*

Reaction to Competition-Limber pine is relatively intolerant of shade and therefore seral to most of its associated trees, the exceptions being quaking aspen, Rocky Mountain juniper, and possibly ponderosa pine. It is also considered seral to bristlecone pine and Douglas-fir but will codominate with these species on severe dry sites (23). As a result, on most forest sites, limber pine normally acts as a pioneer species following fire or tree removal. Except on the most severe sites, where trees remain widely spaced, limber pine shows little evidence of maintaining its population in the presence of other conifers. It is most accurately classed as a species intolerant of shade.

Damaging Agents-Fire can easily kill young limber pines because of their thin bark. Fuel loads on most limber pine sites are too light, however, to generate severe fire damage, and most of the large trees normally survive. Porcupines feed on limber pine, especially in the winter months *(11).* Several insects attack the pine in various ways. In Montana, the budworm *(Choristoneura lambertiana ponderosana)* feeds on the new needles of limber pine (37). A cone moth *(Dioryctria* spp.) is presumed to have damaged limber pine seed in North Dakota (29). In northern Idaho, the woolly aphid *(Pineus coloradensis)* attacked limber pine seedlings growing in test plots, but the pine showed considerable resistance to

this insect ***(16).*** Mountain pine beetle ***(Dendroctonus ponderosae)*** also occasionally attacks limber pine *(1).*

Limber pine is susceptible to several major diseases. Spongy root and butt rot ***(Armillaria mellea)*** and the red-brown butt rot ***(Phaeolus schweinitzii)*** attack limber pine over much of its range. The crumbly brown cubical rot ***(Fomitopsis pinicola)*** and red ring rot ***(Phellinus pini)*** commonly cause heart rot in mature and damaged trees *(15,27).* Limber pine is susceptible to white pine blister rust *(Cronartium ribicola)* and can suffer considerable mortality when susceptible species of the rust's alternate host ***(Ribes)*** are nearby. The limber pine dwarf mistletoe ***(Arceuthobium cyanocarpum)*** is a common parasite of this tree. Occasionally, lodgepole pine dwarf mistletoe ***(A. americanurn)*** attacks limber pine, and the Douglas-fir dwarf mistletoe ***(A. douglasii)*** and southwestern dwarf mistletoe ***(A. uaginatum*** subsp. ***cryptopodium)*** occur as rare parasites ***(12).*** Several foliage diseases also attack this tree, the most damaging being brown-felt snow mold ***(Neopeckia coulteri) (15).***

Special Uses

Limber pine is seldom sought for timber, but small quantities are occasionally harvested along with more desirable species. The wood has been used for rough construction, mine timbers, railroad ties, and poles (2).

Although of marginal value for lumber, limber pine has other resource values. Its ability to grow on harsh sites often provides the only tree cover for wildlife. The large seeds are a nutritious food source for birds, rodents, and bears and were used as food by Native Americans and early pioneers *(20,21,29).* In areas where timber is scarce, limber pine may be an important source of fuelwood. Increasing demands for fuelwood could deplete the accessible dead trees and eventually conflict with wildlife needs for shelter and nesting cavities.

Limber pine's abilities to withstand severe wind and dry site conditions are desirable shelterbelt traits, but its slow growth rate may discourage its selection for that purpose, Young trees, however, can withstand considerable bending, a necessary trait for reforestation of snow avalanche paths, and much of the pine's natural habitat lies within avalanche areas. Some limber pine habitats are also valuable watersheds, and as a pioneer species, the pine is a logical choice for initial site protection and for increasing snowpack (39). The pine's characteristic branching pattern also adds to the esthetic appeal of the landscape, especially along ridge lines.

This tree's ability to endure very dry environments has allowed it to attain considerable age in some areas. One tree in southern California was found to be well over 1,000 years old ***(13);*** another in central Idaho was 1,650 years old ***(31).*** This feature makes limber pine a useful species in dendrochronologic studies.

Limber pine has potential as a Christmas tree, but its qualities are surpassed by southwestern white pine *(14,43).* Seedlings from several seed sources have grown too slowly for economical Christmas tree operations but have ornamental value as dwarfed trees and even bonsai ***(14).*** Some bonsai nurserymen also collect dwarfed limber pine from severe windy sites. As an ornamental, this species deserves more attention than current use would indicate. The ornamental trade has selected at least seven cultivated varieties: 'Columnaris'-a fastigiate form; 'Glauca' and 'Firmament'-both-with exceptionally bluish-green foliage; 'Glenmore'-with longer, more silvery foliage; 'Nana'-a dwarf bushy form; 'Pendula'-with pendulous branches; and 'Tiny Temple'-a low growing form *(7,19).*

Genetics

Population Differences

Genetic variation exists within limber pine in a general north-south pattern, but the range of variability for any one trait is small. Some isolated populations in Wyoming, Nebraska, and Colorado appear to be more similar to those from more southern latitudes than to populations at the same latitude *(36).*

Races

Three possible races of limber pine have been suggested, distinguished by height growth of the seedlings: (1) a northern race ranging from Alberta to north central Colorado and northern Utah and including the only sample from California; (2) a southeastern race that includes populations from the Wyoming-Nebraska border, east central Colorado, and north central New Mexico; and (3) a southwestern race in southern Utah and western Colorado (Nevada populations were not sampled) (43). Further study, however, found no geographically associated patterns or trends when a much wider variety of characteristics was analyzed from the same seed sources *(36).*

Hybrids

Although zones of intergradation between limber pine and southwestern white pine are found in north central Arizona and north central New Mexico *(36)*, no true hybrid populations of limber pine have been recorded. Limber pine has been crossed artificially with western white pine *(Pinus monticola)*, southwestern white pine *(P. strobiformis),* Mexican white pine *(P. ayacahuite),* Himalayan pine *(P. griffithii)*, eastern white pine *(P. strobus),* and possibly whitebark pine *(P. albicaulis)* **(35).**

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