

SPECIES: *Pinus flexilis*

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INTRODUCTORY

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Limber pine at St Mary's Lake, Glacier National Park. Photo by Charles Webber © California Academy of Sciences.

AUTHORSHIP AND CITATION:

Johnson, Kathleen A. 2001. *Pinus flexilis*. In: Fire Effects Information System, [Online]. U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station, Fire Sciences Laboratory (Producer). Available: <http://www.fs.fed.us/database/feis/> [2010, June 21].

ABBREVIATION:

PINFLE

SYNONYMS:

No entry

NRCS PLANT CODE [[115](#)]:

PIFL2

COMMON NAMES:

limber pine

Rocky Mountain white pine

TAXONOMY:

The currently accepted scientific name of limber pine is *Pinus flexilis* James (Pinaceae). It is placed in subgenus *Strobus*, subsection *Strobi* of *Pinus* [[2,21,30,43,44,52,104](#)].

LIFE FORM:

Tree

FEDERAL LEGAL STATUS:

No special status

OTHER STATUS:

No entry

DISTRIBUTION AND OCCURRENCE

SPECIES: *Pinus flexilis*

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GENERAL DISTRIBUTION:

Limber pine occurs from Alberta and British Columbia south to California, Arizona, and New Mexico. It is scattered widely across the Great Basin in Utah, Nevada, and into Colorado, Wyoming, and Montana. Isolated populations occur in the Dakotas [[65,69,86,104,106](#)] and Nebraska [[30,109](#)]. The [U.S. Geological Survey](#) provides a distributional map of limber pine. The [Whitebark and Limber Pine Information System](#) provides distributional information at the stand level.

ECOSYSTEMS [[31](#)]:

FRES20 Douglas-fir

FRES21 Ponderosa pine

FRES23 Fir-spruce

FRES26 Lodgepole pine

FRES29 Sagebrush

FRES34 Chaparral-mountain shrub

FRES35 Pinyon-juniper

STATES:

AZ CA CO ID MT NE NV
NM ND OR SD UT WY
AB BC

BLM PHYSIOGRAPHIC REGIONS [[14](#)]:

- 4 Sierra Mountains
- 5 Columbia Plateau
- 6 Upper Basin and Range
- 7 Lower Basin and Range
- 8 Northern Rocky Mountains
- 9 Middle Rocky Mountains
- 10 Wyoming Basin
- 11 Southern Rocky Mountains
- 12 Colorado Plateau
- 15 Black Hills Uplift
- 16 Upper Missouri Basin and Broken Lands

KUCHLER [[60](#)] PLANT ASSOCIATIONS:

- K008 Lodgepole pine-subalpine forest
- K011 Western ponderosa forest
- K012 Douglas-fir forest
- K015 Western spruce-fir forest
- K017 Black Hills pine forest
- K018 Pine-Douglas-fir forest
- K019 Arizona pine forest
- K020 Spruce-fir-Douglas-fir forest
- K021 Southwestern spruce-fir forest
- K022 Great Basin pine forest
- K023 Juniper-pinyon woodland
- K033 Chaparral
- K037 Mountain-mahogany-oak scrub
- K038 Great Basin sagebrush
- K046 Desert: vegetation largely lacking

SAF COVER TYPES [[28](#)]:

- 206 Engelmann spruce-subalpine fir
- 208 Whitebark pine
- 209 Bristlecone pine
- 210 Interior Douglas-fir
- 217 Aspen
- 218 Lodgepole pine
- 219 Limber pine
- 220 Rocky Mountain juniper
- 237 Interior ponderosa pine
- 239 Pinyon-juniper
- 256 California mixed subalpine

SRM (RANGELAND) COVER TYPES [99]:

- 109 Ponderosa pine shrubland
- 209 Montane shrubland
- 210 Bitterbrush
- 402 Mountain big sagebrush
- 412 Juniper-pinyon woodland
- 413 Gambel oak
- 415 Curlleaf mountain-mahogany
- 504 Juniper-pinyon pine woodland

HABITAT TYPES AND PLANT COMMUNITIES:

Plant community associates of limber pine are described below by state.

California: In the Sierran subalpine, limber pine grows in association with Sierra lodgepole pine (*Pinus contorta* var. *murrayana*), bush chinquapin (*Chrysolepis sempervirens*), greenleaf manzanita (*Arctostaphylos patula*), curlleaf mountain-mahogany (*Cercocarpus ledifolius*), and whitethorn ceanothus (*Ceanothus cordulatus*) [81]. In montane areas of southern California, limber pine is reported with white fir (*Abies concolor*), Jeffrey pine (*P. jeffreyi*), singleleaf pinyon (*P. monophylla*), Sierra lodgepole pine, whitebark pine (*P. albicaulis*), foxtail pine (*P. balfouriana*), Great Basin bristlecone pine (*P. longaeva*), western juniper (*Juniperus occidentalis*), curlleaf mountain-mahogany, and big sagebrush (*Artemisia tridentata*) [68,108].

Colorado: Tree associates include interior ponderosa pine (*P. ponderosa* var. *scopulorum*), Rocky Mountain lodgepole pine (*P. c.* var. *latifolia*), subalpine fir (*A. lasiocarpa*), Engelmann spruce (*Picea engelmannii*), Rocky Mountain Douglas-fir (*Pseudotsuga menziesii* var. *glauca*), white fir, whitebark pine, Rocky Mountain bristlecone pine (*P. aristata*), and quaking aspen (*Populus tremuloides*). Associated understory species include bearberry (*Arctostaphylos uva-ursi*), common juniper (*J. communis*), big sagebrush, purple pinegrass (*Calamagrostis purpurascens*), spike fescue (*Leucopoa kingii*), and Thurber fescue (*Festuca thurberi*) [27,38,42,49,87,100].

Idaho: In Craters of the Moon National Monument, limber pine is commonly associated with antelope bitterbrush (*Purshia tridentata*), rubber rabbitbrush (*Chrysothamnus nauseosus*), and mountain big sagebrush (*A. t.* var. *vaseyana*). Associated grasses include Sandberg bluegrass (*Poa secunda*), bottlebrush squirreltail (*Elymus elymoides*), and Indian ricegrass (*Achnatherum hymenoides*) [12,23]. In the mountains of east-central Idaho, limber pine grows in association with Douglas-fir, subalpine fir, and whitebark pine [17].

Montana: Associated tree and shrub species include Rocky Mountain Douglas-fir, Rocky Mountain lodgepole pine, Engelmann spruce, whitebark pine, subalpine fir, quaking aspen, common juniper, creeping juniper (*J. horizontalis*), and Rocky Mountain juniper (*J. scopulorum*). Associated shrubs include snowberry (*Symphoricarpos* spp.), Wood's rose (*Rosa woodsii*), and russet buffaloberry (*Shepherdia canadensis*). Associated grasses include Idaho fescue (*Festuca idahoensis*), rough rescue (*F. altaica*), and bluebunch wheatgrass (*Pseudoroegneria spicata*) [5,55,83,85,91,107].

New Mexico: In the Sandia Mountains limber pine occurs with Rocky Mountain Douglas-fir, white fir, quaking aspen, Engelmann spruce, and corkbark fir (*A. l.* var. *arizonica*) [7]. It co-occurs with southwestern white pine (*P. strobiformis*) in the Sangre de Cristo Mountains [116].

Nevada and Utah: Limber pine commonly occurs in association with Rocky Mountain bristlecone, interior ponderosa (*P. ponderosa* var. *scopulorum*), Rocky Mountain lodgepole, whitebark, Jeffrey, and singleleaf pinyon pines. It also occurs with Engelmann spruce, white fir, subalpine fir, quaking aspen, common juniper, and Utah juniper (*J. osteosperma*). Associated shrubs include Rocky mountain maple (*Acer glabrum*), Gambel oak (*Quercus gambelii*), and multiple species of sagebrush, mountain-mahogany, ceanothus, currant (*Ribes* spp.), manzanita (*Arctostaphylos* spp.), and snowberry [9,37,82,114].

Oregon: In the Willowa Mountains of eastern Oregon limber pine commonly occurs with Douglas-fir and Rocky Mountain juniper. Herbaceous associates include western yarrow (*Achillea millefolium*), sagebrush fleabane (*Erigeron*

austinae), and silverleaf phacelia (*Phacelia hastata*) [[19](#)].

South Dakota: A population of limber pine in the Black Hills is associated with interior ponderosa pine and white spruce (*Picea glauca*). Understory species include bearberry and common juniper [[50](#)].

Wyoming: Associated species reported for northwestern Wyoming include Rocky Mountain lodgepole pine, Engelmann spruce, whitebark pine, Rocky Mountain Douglas-fir, subalpine fir, Rocky Mountain juniper, and common juniper [[13,24,70](#)].

Published classifications that include limber pine as an indicator or dominant species are presented below:

Arizona [[67,79](#)]

California [[51,92](#)]

Colorado [[8,20,25,42,49,57](#)]

Idaho [[102,103](#)]

Montana [[85,91](#)]

North Dakota [[32](#)]

New Mexico [[20,25,67,79](#)]

Utah [[41,73,127](#)]

Wyoming [[1,102,124](#)]

MANAGEMENT CONSIDERATIONS

SPECIES: *Pinus flexilis*

- [WOOD PRODUCTS VALUE](#)
- [IMPORTANCE TO LIVESTOCK AND WILDLIFE](#)
- [PALATABILITY](#)
- [NUTRITIONAL VALUE](#)
- [COVER VALUE](#)
- [VALUE FOR REHABILITATION OF DISTURBED SITES](#)
- [OTHER USES AND VALUES](#)
- [OTHER MANAGEMENT CONSIDERATIONS](#)

WOOD PRODUCTS VALUE:

The wood of limber pine has little commercial value. Its potential for timber and fuelwood production is low, because the trees are slow growing with irregular form [[1,2,20,42,49,85,96,101](#)]. Limber pine has been used locally for mine props and railroad ties [[102](#)].

IMPORTANCE TO LIVESTOCK AND WILDLIFE:

The large, wingless seeds of limber pine have high energy content. Pine "nuts" provide critical food for rodents and birds, which cache the seeds for later use. Other small mammals and birds benefit from these caches. Bears also feed from caches [[62,66](#)]. Sites with limber pine provide key winter range for deer and elk [[85](#)]. Bighorn sheep use open stands on ridges. Difficult access and low grass production result in low forage value of limber pine stands for livestock [[1,42](#)].

PALATABILITY:

Although limber pine browse is unpalatable to large mammals, it provides some food for birds and small mammals. The palatability of limber pine for livestock and wildlife has been rated as follows [[26](#)]:

	CO	MT	ND	UT	WY
Cattle	Poor	Poor	Poor	Poor	Poor
Domestic sheep	Poor	Poor	Poor	Poor	Poor
Horses	Poor	Poor	Poor	Poor	Poor
Pronghorn	----	----	Poor	Poor	Poor
Elk	Poor	Poor	----	Poor	Fair
Mule deer	Poor	Poor	Poor	Poor	Fair
White-tailed deer	----	----	Poor	----	Fair
Small mammals	----	----	----	Good	Good
Small nongame birds	----	----	Poor	Good	Good
Upland game birds	----	----	----	Good	Good
Waterfowl	----	----	----	----	Poor

NUTRITIONAL VALUE:

Limber pine browse is rated fair in energy value and poor in protein value [26]. The seeds are highly nutritious, providing amino acids, lipids, and averaging 7,178 calories per gram [64].

COVER VALUE:

The degree to which limber pine provides cover for wildlife species is as follows [26]:

	CO	MT	ND	UT	WY
Pronghorn	----	----	Poor	Poor	Fair
Elk	----	----	----	Good	----
Mule deer	----	----	----	Good	----
White-tailed deer	----	----	Good	----	Good
Small mammals	Good	----	----	Good	Good
Small nongame birds	Good	----	Good	Good	Good
Upland game birds	----	Good	----	Good	Good
Waterfowl	----	----	----	----	Poor

VALUE FOR REHABILITATION OF DISTURBED SITES:

Because of its slow growth, limber pine has been used only to a limited extent in land reclamation projects [120]. Vegetation recovery is slow on the exposed, hot, dry, rocky sites where it is found, and soil erosion can prevent complete restoration. However, limber pine's drought tolerance and ability to survive at high elevations indicate that it has potential for use in revegetation projects [104].

Grossnickle and Reid [33] tested the feasibility of including limber pine seedlings in the reclamation of a high-elevation mining site in Colorado. The site was a molybdenum tailing pond buried in deep mine waste rock. One-year-old containerized limber pine, lodgepole pine, and Engelmann spruce seedlings were inoculated with 3 species of ectomycorrhizal fungi prior to outplanting. Because of greenhouse colonization of seedling roots by a 4th "wild" strain of ectomycorrhizal fungus, no uncolonized seedlings were outplanted. Some of the seedlings were also treated in the field with fertilizer or sewage sludge combined with wood chips. All seedlings were protected from wind and sun with cedar shingles. During the 4th growing season, significant ($p = 0.05$) differences in seedling height among the fungal treatments were detected. The addition of the sewage sludge/wood chip slurry improved seedling height of all 3 species in 1 of the fungal treatments. At the end of the 4th growing season, overall survival of limber pine, lodgepole pine, and Engelmann spruce seedlings was 60%, 52% and 62%, respectively. The authors noted that in all instances, seedling mortality appeared to be caused by unfavorable soil and climatic conditions and not by pathogen, insect, or animal damage.

Limber pine cones may yield 1,100 to 1,300 cleaned seeds per pound, and stored seed has been shown viable for at least 5 years. Freshly collected seeds may germinate without pretreatment, but cold, moist stratification of up to 90 days improves germination [59].

OTHER USES AND VALUES:

Limber pine is used in the nursery trade for landscaping [35,36,40].

OTHER MANAGEMENT CONSIDERATIONS:

Management of limber pine forests associated with Douglas-fir typically favors the growth of the economically important Douglas-fir. Of primary management importance in these areas is watershed protection and enhancement.

The slow rate of vegetation recovery in areas where limber pine occurs requires dispersed, low-impact recreation to maintain the aesthetic appeal of these forests [25]. Forage productivity can be increased by periodic surface fires [29].

Limber pine trees are infected and killed by white pine blister rust (*Cronartium ribicola*) throughout the tree's range. *Ribes* species are obligate alternate hosts of the rust [46,47,48,76,116]. Limber pine appears to have less resistance to blister rust than other North American white pines (*Strobi*), with greenhouse infection levels as high as 98 to 100% [45,113]. In a 3-year greenhouse study of relative seedling susceptibility to blister rust, limber pine mortality was 75% (n=348). In comparison, mortality in whitebark pine was 33% (n=207) and 86% in southwestern white pine (n=323) [45].

Limber pine is susceptible to numerous other fungal diseases [101]. It can be heavily infected or killed by limber pine dwarf-mistletoe (*Arceuthobium cyanocarpum*) [12,39,71,72], and is susceptible to infestation by mountain pine beetles, cone beetles, coneworms, and budworms [54,61,101].

The [Whitebark and Limber Pine Information System](#) provides a database for storing and analyzing data on site characteristics, stand structure, regeneration, and mortality and infection rates from white pine blister rust and other damaging agents.

BOTANICAL AND ECOLOGICAL CHARACTERISTICS

SPECIES: *Pinus flexilis*

- [GENERAL BOTANICAL CHARACTERISTICS](#)
- [RAUNKIAER LIFE FORM](#)
- [REGENERATION PROCESSES](#)
- [SITE CHARACTERISTICS](#)
- [SUCCESSIONAL STATUS](#)
- [SEASONAL DEVELOPMENT](#)



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GENERAL BOTANICAL CHARACTERISTICS:

Limber pine is a slow growing, long-lived species, sometimes taking several hundred years to reach maturity [26,75]. Mature trees may exceed 1000 years of age [53,96,127]. Limber pine stands are broadly even-aged [89], though populations also occur in uneven-aged stands and on very harsh sites as widely spaced, isolated individuals [96,102,112]. Trees often have an irregular or multi-stem growth form, and rarely reach over 50 feet (15 m) [11,120,127]. At high elevations they sometimes form krummholz [11,127]. Trunks may reach 6.5 feet (2 m) in diameter [41]. The species is cold and drought tolerant. Trees are ectomycorrhizal, have deep taproots, and are very windfirm [33,120].

Cones of limber pine are cylindrical, 3 to 6 inches (8-15 cm) long. They release their seeds if not preyed upon (see Regeneration Processes). The seeds are large (7-12 mm long) and sometimes have a vestigial wing [21,63,74].

RAUNKIAER [88] LIFE FORM:

Phanerophyte

REGENERATION PROCESSES:

Limber pine reproduces entirely from seed; it does not layer lower branches in the soil [22,122]. Seeds are not effectively dispersed by wind. Small mammals and birds, especially [Clark's nutcrackers](#) and [pinyon jays](#), disperse limber pine seeds [63,64,66,110,125]. The minimum seed-bearing age of limber pine ranges from 20 to 40 years. There are 2 to 4 years between large seed crops [58,59,101]. Seeds from krummholz trees have low germination potential [66].

Clark's nutcrackers have co-adapted an important mutualism with limber pine and are the primary harvester and disperser of its seeds. Limber pine regeneration on burns is largely from germinants of Clark's nutcrackers seed caches [63,64,66,110,125]. The birds begin harvesting seeds in late August, while the cones are still green and slightly closed. They remove the cones by pecking them loose, fly them to perches, and peck between the scales to remove the seeds. As cones begin to open on the trees in September, Clark's nutcrackers remove exposed seeds. An individual bird can store as many as 125 seeds in its sublingual pouch, then flies to a cache area and deposits numerous caches from its pouchful of seeds. In a burned-over area in northern Utah, Clark's nutcrackers cached an estimated 12,140 seeds per acre (30,000/ha) in 1 year [62,101,112].

Mating system: Limber pine seed dispersal by corvids leads to a genetic population structure different from that of wind-dispersed conifers with respect to patterns of gene flow and genetic relationships among neighboring trees. The seed caching by birds influences the distribution, population age structure, and spacing of limber pine. Clusters of seedlings germinating from a single cache may generate multi-stemmed growth forms that contain 2 or more distinct genotypes. A consequence of this growth form is a tendency toward clumped stand structure. Because seeds within an individual cache were often collected from a single parent tree, trees within clumps may be more closely related compared to trees from neighboring clumps [64,110,113], although multi-stemmed growth is most often a result of apical meristem damage that results in several leaders on an individual tree [123]. Tomback and Linhart [112] found that on 361 limber pine sites in Colorado, 30% showed clumping. Several genetic studies have shown that from 0 to 82% of individuals within limber pine clumps are closely related [101,117,123]. On the Pawnee National Grassland, clump members were related, on average, as nearly half-sibs. Genetic consequences of this kinship include possible inbreeding. On the plus side, closely related trees within clumps often form roots grafts, which may increase survivorship and fitness of the entire clump [123].

Pollen phenology also influences gene flow. In Colorado, most sites that differ in elevation by more than 1,300 feet (400 m) in elevation do not have overlapping pollination periods, restricting pollination between populations that are widely separated by elevation; however, pollen transfer between intermediate populations and a high level of gene flow via bird-dispersed seeds appear to maintain interpopulation gene flow [97].

SITE CHARACTERISTICS:

Limber pine grows across a wider range of elevations than any other tree species in the central Rocky Mountains [94], inhabiting some of the driest sites capable of supporting trees [11,85,102,111]. In many high-elevation sites it occupies or forms the upper treeline [30,69,83,94,122], but in northern parts of its range it is found at low elevations along plains grassland edges [22,94,96]. It typically occurs on steep, rocky, well-drained, windswept, and nutrient-poor sites on exposed ridges and summits [1,10,11,32,42]. Limber pine is often reported growing on calcareous soil [11,19,85]. It is also reported on soils derived from many other types of parent material [12,17,23,42,68,101].

Ground cover and litter accumulation in limber pine stands are often sparse, accumulating only under individual trees [11,127]. Severe sheet erosion of fine particles often occurs from summer convection storms over sparsely vegetated sites. Snowpack accumulations on limber pine sites may be light as a result of high insolation and winter winds [127].

Site preference often separates limber pine and whitebark pine, which is ecologically similar in many respects [112]. Limber pine has a wider geographical distribution and altitudinal range than whitebark pine. Relative to whitebark pine, limber pine occurs on warm, dry sites at low and middle elevations. Where their ranges overlap, the 2 species sometimes grow together on droughty soils. Occasionally, limber pine grows at higher elevations than whitebark pine.

South of the range of whitebark pine in California, Colorado, Nevada, and southern Wyoming, the more drought-resistant limber pine replaces whitebark pine and may form the alpine treeline [[74](#),[112](#),[121](#)].

Elevations reported in the literature for limber pine are as follows:

7,500 to 11,000 feet (2,290-3,350 m) in California [[80](#)]
5,000 to 12,500 feet (1,500-3,800 m) in Colorado [[27](#),[42](#),[49](#)]
4,000 to 6,000 feet (1,200-1,800 m) in Montana [[85](#),[91](#)]
6,500 to 11,500 feet (2,000-3,500 m) in Nevada [[114](#)]
5,000 to 7,000 feet (1,500-2,100 m) in Oregon [[19](#)]
6,000 to 11,600 feet (1,830-3,540 m) in Utah [[123](#)]

SUCCESSIONAL STATUS:

According to Tomback and Linhart [[112](#)] limber pine (and whitebark pine) "are pioneering species that are either seral or topodaphic climax species under different environmental conditions. In fact, seed dispersal by Clark's nutcrackers to outlying sites, treeline, and other harsh environments essentially increases the ecological niche breadth (in the Hutchinsonian sense) of these species. Clark's nutcrackers can maintain climax communities, colonize previously unforested sites, or initiate succession."

The later stages of succession in xeric subalpine forests vary due to differences in sites and seed availability. In the Colorado subalpine, Rebertus and others [[89](#)] studied conifer population age structure and succession on 3 burns greater than 100 years old. The sequence of conifer colonization appeared to be consistent: 1st limber pine, then Engelmann spruce, and later subalpine fir, with a delay between the 1st limber pine and later subalpine fir of as long as 140 years. The authors suggested that the early advantage of limber pine was due to avian seed dispersal and exceptional drought tolerance in seedlings. Spatial analysis suggested that limber pine facilitated the establishment of the other 2 species by providing shade or wind protection. On the xeric to slightly xeric sites, limber pine formed broadly even-aged, non-regenerating populations that were gradually replaced by the spruce and fir. On the most extreme sites, limber pine formed all-aged, self-maintaining populations with no evidence of replacement by the other species. The authors note that in lower elevation stands along the Front Range, limber pine is successional to Douglas-fir. In the even lower Pawnee National Grasslands of Colorado, limber pine forms all-aged, self-replacing populations. "Hence, many successional pathways could be operating at different sites or stages in stand development."

SEASONAL DEVELOPMENT:

Limber pine cones ripen from August to September, and seeds are dispersed from September to October [[26](#),[44](#),[58](#),[59](#)]. Cones open in the fall. Observed dates for phenological events of mature in limber pine east of the Continental Divide in Montana and Yellowstone National Park, Wyoming, are given here [[93](#)]:

Shoots start: April 30 to June 6
Buds burst: April 30 to June 26
Pollen starts: June 20 to July 14
Pollen ends: July 4 to July 22
Shoots end: June 22 to August 5
Winter buds formed: June 11 to August 16
Cones full size: August 15 to August 16
Cones open (seed dispersal): August 23 to August 30

Also see [Regeneration Processes](#) regarding pollen phenology.

FIRE ECOLOGY

SPECIES: *Pinus flexilis*

- [FIRE ECOLOGY OR ADAPTATIONS](#)
- [POSTFIRE REGENERATION STRATEGY](#)

FIRE ECOLOGY OR ADAPTATIONS:

The thin bark of young limber pine trees does not protect them from even low-severity fires. Because the bark at the base of older trees is often 2 inches (5 cm) thick, these trees can withstand stem scorch from low-severity fires. Terminal buds are somewhat protected from the heat associated with crown scorch by the tight clusters of needles around them [[1,29,53,85,127](#)].

Wildfires are less frequent in limber pine communities than in other conifer habitats because of limited productivity and fuel accumulation associated with poor soil development, short growing seasons, and late snowmelt [[29,53,78,85,96,117,127](#)]. Keeley and Zedler [[53](#)] categorized 38 pines within a series of 5 fire predictability regimes. They include limber pine among those pines growing in areas with very low site (and therefore fuel) productivity and unpredictable fire return intervals of up to 1000 years. Where enough biomass accumulates to carry fires, limber pine may be cached by Clark's nutcrackers and establish in burned sites previously dominated by other conifers [[53,66](#)].

Where limber pine grows in association with other trees, the fire regimes of those species are relevant. Fire regimes for some associated communities or ecosystems are listed here:

Community or Ecosystem	Dominant Species	Fire Return Interval Range (years)
sagebrush steppe	<i>Artemisia tridentata</i> / <i>Pseudoroegneria spicata</i>	20-70 [15]
mountain big sagebrush	<i>Artemisia tridentata</i> var. <i>vaseyana</i>	20-60 [5,16]
Wyoming big sagebrush	<i>Artemisia tridentata</i> var. <i>wyomingensis</i>	10-70 (40**) [119,126]
curlleaf mountain-mahogany*	<i>Cercocarpus ledifolius</i>	13-1000 [6,95]
mountain-mahogany-Gambel oak scrub	<i>Cercocarpus ledifolius</i> - <i>Quercus gambelii</i>	< 35 to < 100
western juniper	<i>Juniperus occidentalis</i>	20-70
Rocky Mountain juniper	<i>Juniperus scopulorum</i>	< 35
Engelmann spruce-subalpine fir	<i>Picea engelmannii</i> - <i>Abies lasiocarpa</i>	35 to > 200
pinyon-juniper	<i>Pinus</i> - <i>Juniperus</i> spp.	< 35
whitebark pine*	<i>Pinus albicaulis</i>	50-200 [15]
Rocky Mountain lodgepole pine*	<i>Pinus contorta</i> var. <i>latifolia</i>	25-300+ [3,90]
Sierra lodgepole pine*	<i>Pinus contorta</i> var. <i>murrayana</i>	35-200
Jeffrey pine	<i>Pinus jeffreyi</i>	5-30
Rocky Mountain ponderosa pine*	<i>Pinus ponderosa</i> var. <i>scopulorum</i>	2-10
Arizona pine	<i>Pinus ponderosa</i> var. <i>arizonica</i>	2-10 [15]
quaking aspen (west of		7-120

the Great Plains)	<i>Populus tremuloides</i>	[15 , 34 , 77]
mountain grasslands	<i>Pseudoroegneria spicata</i>	3-40 (10)** [3]
Rocky Mountain Douglas-fir*	<i>Pseudotsuga menziesii</i> var. <i>glauca</i>	25-100
oak-juniper woodland (Southwest)	<i>Quercus-Juniperus</i> spp.	< 35 to < 200 [15]

*fire-return interval varies widely; trends in variation are noted in the species summary

**mean

POSTFIRE REGENERATION STRATEGY [[105](#)]:

Initial offsite colonizer (off-site, initial community)

Secondary colonizer (on-site or off-site seed sources)

FIRE EFFECTS

SPECIES: *Pinus flexilis*

- [IMMEDIATE FIRE EFFECT ON PLANT](#)
- [DISCUSSION AND QUALIFICATION OF FIRE EFFECT](#)
- [PLANT RESPONSE TO FIRE](#)
- [DISCUSSION AND QUALIFICATION OF PLANT RESPONSE](#)
- [FIRE MANAGEMENT CONSIDERATIONS](#)

IMMEDIATE FIRE EFFECT ON PLANT:

Limber pine is often killed by fire because of its relatively thin bark. Keeley and Zedler [[53](#)] argue that the lack of evolution of thick, fire-resistant bark in this species is a result of very long and unpredictable fire return intervals in the unproductive sites where it occurs. The degree of stem scorch usually determines the extent of fire injury to trees. Young trees are usually killed by any fire that scorches their stems. Mature trees with thicker bark can survive [[29](#)]. The vulnerability of this species to fire is reduced by the open stand structure, sparse fuels, and sparse undergrowth of limber pine communities [[85](#),[101](#)].

DISCUSSION AND QUALIFICATION OF FIRE EFFECT:

No entry

PLANT RESPONSE TO FIRE:

Regeneration of limber pine and Engelmann spruce was assessed in a high-altitude area disturbed by fire in 1905. The south-facing sites were on Niwot Ridge in Colorado's Roosevelt National Forest. The uppermost elevation of the burn reached slightly below the tree limit at about 11,000 feet (3,355 m). Although limber pine regeneration at the uppermost elevation is less than at lower elevations, limber pine colonization at all elevations began shortly after the fire. The author found no evidence that treeline changed following the fire [[98](#)]. Postfire regeneration of limber pine is a consequence of seed dispersal and caching by Clark's nutcrackers [[53](#),[66](#)].

DISCUSSION AND QUALIFICATION OF PLANT RESPONSE:

In 1976 spring prescribed burning was conducted in open-canopy limber pine stands in the Little Belt Mountains of central Montana at about 5,500 feet (1,675 m) [[55](#)]. Further general site descriptions appear in Keown 1982 [[56](#)]. Air temperatures ranged from 55 to 65 degrees Fahrenheit (13-18 °C). Relative humidity was 20% to 40%, and winds were calm to 25 miles per hour (40 km/h). Fuel moisture was 7%. The management objective was to improve understory browse and forage. Limber pine mortality at postfire year 1 was 20% in grassy stands and as high as 80% in shrubby stands [[55](#)].

The Research Project Summary [Response of vegetation to prescribed burning in a Jeffrey pine-California black oak woodland and a deergrass meadow at Cuyamaca State Park, California](#), provides information on prescribed fire and postfire responses of many plant community species including limber pine.

FIRE MANAGEMENT CONSIDERATIONS:

Fischer and Clayton [29] suggest that limber pine growing in open stands can be maintained by periodic fires that reduce the undergrowth. Where limber pine and Douglas-fir codominate, fire can be a thinning agent that slightly favors limber pine over Douglas-fir in the younger age classes.

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