

# Field Guide to Old Ponderosa Pines in the Colorado Front Range

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We describe the distinguishing physical characteristics of old ponderosa pine trees in the Front Range of Colorado and the ecological processes that tend to preserve them. Photographs illustrate identifying features of old ponderosa pines and show how to differentiate them from mature and young trees. The publication includes a photographic gallery of old ponderosa pine trees growing on poor, moderate, and good sites. We illustrate trees growing under various forest conditions and with different injuries and histories. The companion general technical report includes a more detailed description of ponderosa pine ecology and the role of old trees in the historical and modern landscapes.

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**Keywords:** ponderosa pine, old growth, Colorado Front Range, fire ecology, montane zone

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All photos and illustrations by Laurie S. Huckaby, unless otherwise noted.

**On the cover:** *An old ponderosa pine growing on an open, south-facing slope in the Arapaho-Roosevelt National Forest. It is more than 350 years old.*

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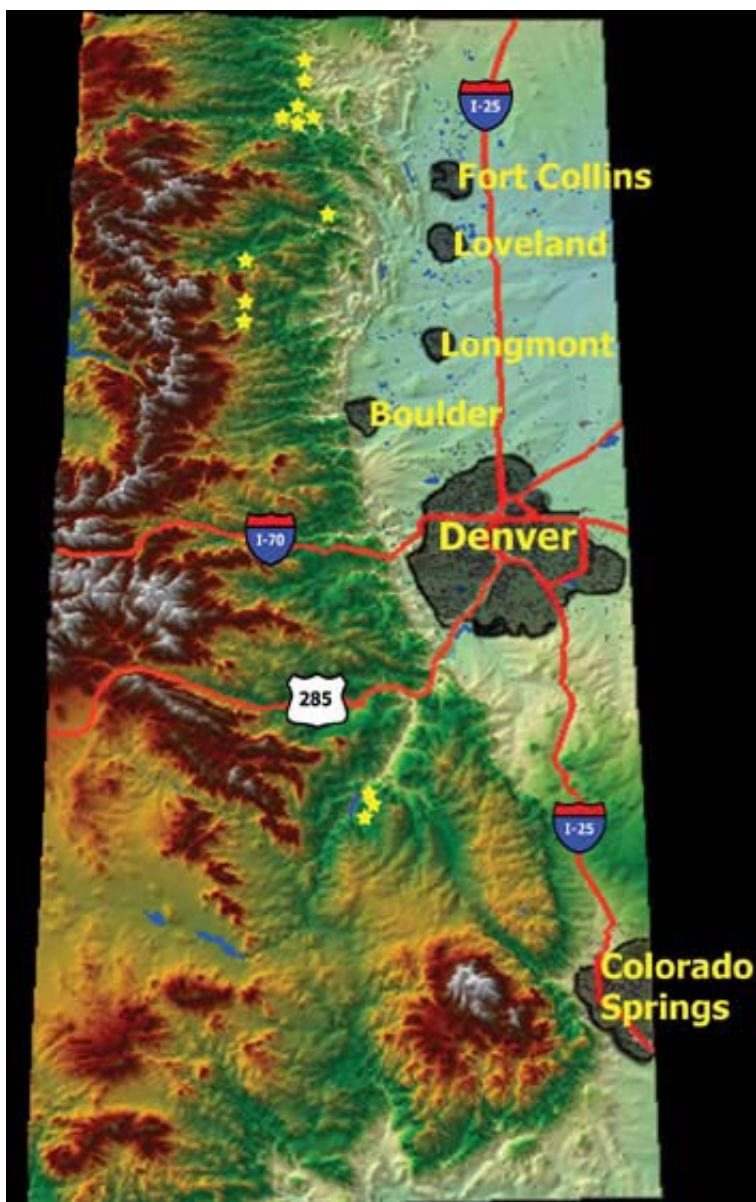
## Introduction

Old trees were historically a major component of montane forests in the Colorado Front Range. They were an integral part of the spatial and temporal heterogeneity inherent in the ecosystem. Now they are relatively scarce. Many were harvested during the Euro-American settlement period in the late 19<sup>th</sup> and early 20<sup>th</sup> centuries. Century-old stumps of trees that were 400 to 500 years old when cut remain like ghosts amid stands of trees that have established during the last 100 years. Other old trees were destroyed in extensive human-caused fires during the same period and later. Surviving old trees are now stressed by competition from dense ingrowth of younger trees and are in danger from insect outbreaks and stand-replacing fires.

Land managers are now aware that modern forest structure differs from that of the pre-settlement landscape, and that change in structure is precipitating a change in disturbance processes such as fire and insect outbreaks. Urban encroachment into the montane zone puts pressure on land managers to mitigate the danger of wildfire. The best way to handle this danger is to restore an ecologically sustainable landscape that resembles the patterns that existed before Euro-American settlement—patterns that encouraged the survival of old trees. Old ponderosa pines are resistant to surface fire, provide food and habitat for wildlife, and are a source of genetic continuity for the forest. They are aesthetically attractive, and they are an intrinsic part of the beautiful, dynamic landscape that draws thousands of people to the Front Range every year. They record the history of climate and fire in their rings. This guide is written to help the reader identify old trees and understand their past and present role as components of forests in the montane zone.

## *Ecological Zones of the Colorado Front Range*

For this publication, we define the Front Range as the area south of the Wyoming border, east of the Continental Divide, west of the Great Plains, and north of Pikes Peak (near Colorado Springs; fig. 1). Two related environmental factors drive ecological processes and the distribution of species of the Front Range: elevation and moisture availability. Going up in elevation has effects similar to going up in latitude. At higher elevations, the growing season becomes shorter, temperatures are cooler, and precipitation is greater. Fire and other disturbances become less frequent at higher elevations. Vegetation changes along this gradient reflect these environmental changes. Our focus is the montane zone, between 6000 and 9000 ft (1850-2770 m) elevation, below the level of persistent winter snowpack. Most of this elevational zone is dominated by forests of ponderosa pine mixed with Douglas-fir, interspersed with shrublands, grasslands or aspen stands.



**Figure 1**—Overhead view of the Front Range showing the elevational gradient. Light green designates the plains at around 5000 ft (1540 m). The montane zone is shown as dark green. The subalpine zone is shown as a gradient of tan to reddish brown; white areas are above 14,000 ft (4300 m). Sampling sites are denoted by yellow stars. (Map by J. Stoker.)

# Ponderosa Pine and the Montane Zone of the Front Range

Ponderosa pine (*Pinus ponderosa* Dougl. ex Laws.) is one of the most widespread tree species in the western United States, ranging from northern Mexico into southern Canada, and from California to Nebraska. The Rocky Mountain variety is called *scopulorum*, to distinguish it from the variety found in the Pacific Northwest and from the subspecies *arizonica*, found in the Southwest near the Mexican border. In the Colorado Front Range, ponderosa pine grows from the border of the prairie and the foothills, up to around 9000 ft (2770 m) elevation, depending on topography. It may be found up to 10,000 ft (3070 m) on warm south-facing slopes. It is the dominant tree in the montane zone (6000 and 9000 ft [1850-2770 m]), where it often occurs with Douglas-fir (*Pseudotsuga menziesii*), especially on north-facing slopes. Ponderosa pines can grow to be very large in other parts of the country, but rarely exceed 100 ft (30 m) in height in the Front Range. It is tolerant of heat, drought, and fire.

Ponderosa pines have needles in fascicles of three, or sometimes two. Each tree produces both male and female reproductive structures; the female strobili mature into woody cones. Seeds are moderate in weight for tree seeds, and may be widely dispersed by wind. Ponderosa pine is susceptible to infestation by dwarf mistletoe (*Arceuthobium vaginatum*) and to attack by several insects, most notably the mountain pine beetle (*Dendroctonus ponderosae*). Ponderosa pine has long been an important tree for timber, though logging has not been a major industry in the Front Range in recent decades.

Ponderosa pine is a long-lived species. The oldest known ponderosa pines are more than 700 years old (843 years, Central Utah; 780 years, Mt. Rosa, CO; 742 years, NW Arizona; OLDLIST database <http://www.rmtrr.org/oldlist.htm>). The oldest known ponderosa pines in the Front Range are a little over 600 years old. However, ponderosa pines that old are uncommon in the Front Range. Trees between 300 and 500 years old are frequent, and trees more than 200 years old are common throughout the Front Range above about 6500 ft (2000 m) elevation. Stands of old-growth ponderosa pine are now relatively rare in the Front Range because of past logging and wildfire (fig. 2). However, individual trees older than 200 years are not uncommon, and in many locations trees that were too small to be cut during the Euro-American settlement period are now around 200 years old.

Historically, fire was the primary regulator of forests in the Front Range. Fire history reconstructions have shown that before Euro-American settlement of the Front Range (beginning with the influx of settlers in the gold rush of 1859), a fire occurred in any given location in the montane zone on average every 10-20 years. Larger fires with variable effects occurred at longer intervals, on the order of 30-60 years. Most pre-settlement fires in the montane zone were of low or mixed severity. By the early 1900s, fire frequency in the montane zone dropped dramatically. In some locations, heavy livestock grazing over the preceding decades had reduced surface fuels and retarded fire spread. Many areas had been recently logged or burned or both, which had also reduced fuels. Most significantly, organized fire suppression became effective during the early 20<sup>th</sup> century and has continued to the present.



**Figure 2**—Old trees in the modern landscape. This group of old trees (designated by yellow arrows) lives on a bench at the base of a west-facing slope along the Mt. McConnell trail off the Pingree Park road at 7592 ft (2336 m) elevation. This is a better site than the sparse, disturbed slopes above. Young ponderosa pines, Douglas-fir, and juniper are filling in the understory in the absence of surface fire. The old trees have smooth orange bark, small live crown ratios, open crowns with large branches and flattened tops, lightning scars, and fire scars. We cored the tree designated by the orange arrow. Its DBH was 24.9 inches (63 cm). Its pith date is 1642. It had a fire scar in 1707.

Douglas-fir trees are now more numerous in the Front Range than they were historically. While Douglas-fir has always shared the montane zone with ponderosa pine (fig. 3a), many more young Douglas-fir survive now than when fire was more frequent. Young Douglas-fir trees have thin bark and a long proportion of live crown to the height of the tree (live crown ratio) that make them susceptible to fire (fig. 3b). Old Douglas-fir are quite resistant to fire. They self-prune as ponderosa pines do, and they have very thick bark. Many of the older trees also have fire scars. The species composition of montane forests is now shifting toward dominance by Douglas-fir.

## *Identification of Old Ponderosa Pines in the Front Range*

### **Appearance of Old Trees (>200 Years)**

At around 200 years of age, ponderosa pines begin to take on distinctive physical characteristics as the result of physiological changes (fig. 4). Trees growing in poor sites or those that are otherwise stressed, as by dwarf mistletoe infestation, may look old earlier. Trees acquire these characteristics gradually as they interact with their environment (fig. 5).





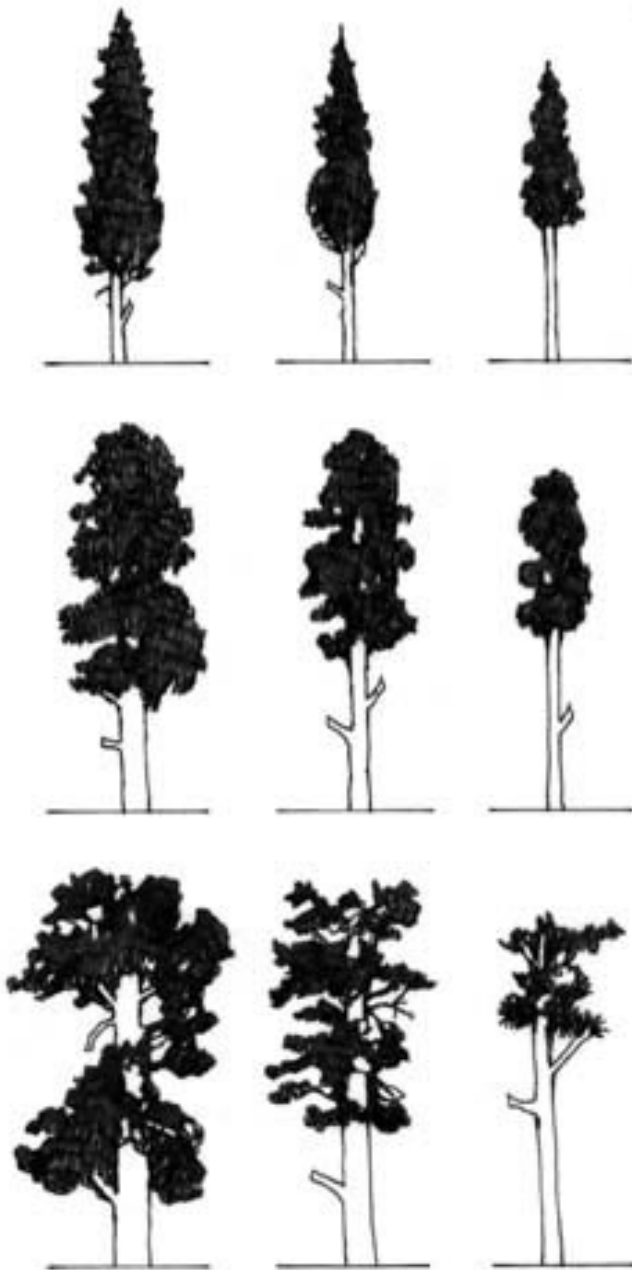
**Figure 3a**—An old Douglas-fir dominates a west-facing slope at Cheesman Lake where the young ponderosa pines are infested with dwarf mistletoe.



**3b**—A young Douglas-fir grows amid a post-Euro-American settlement ponderosa pine forest in Rist Canyon. Young Douglas-fir trees have thin bark and branches that extend all the way to the ground, making them susceptible to burning. Trees like these are common in the understory of ponderosa pine forests in the absence of surface fire.

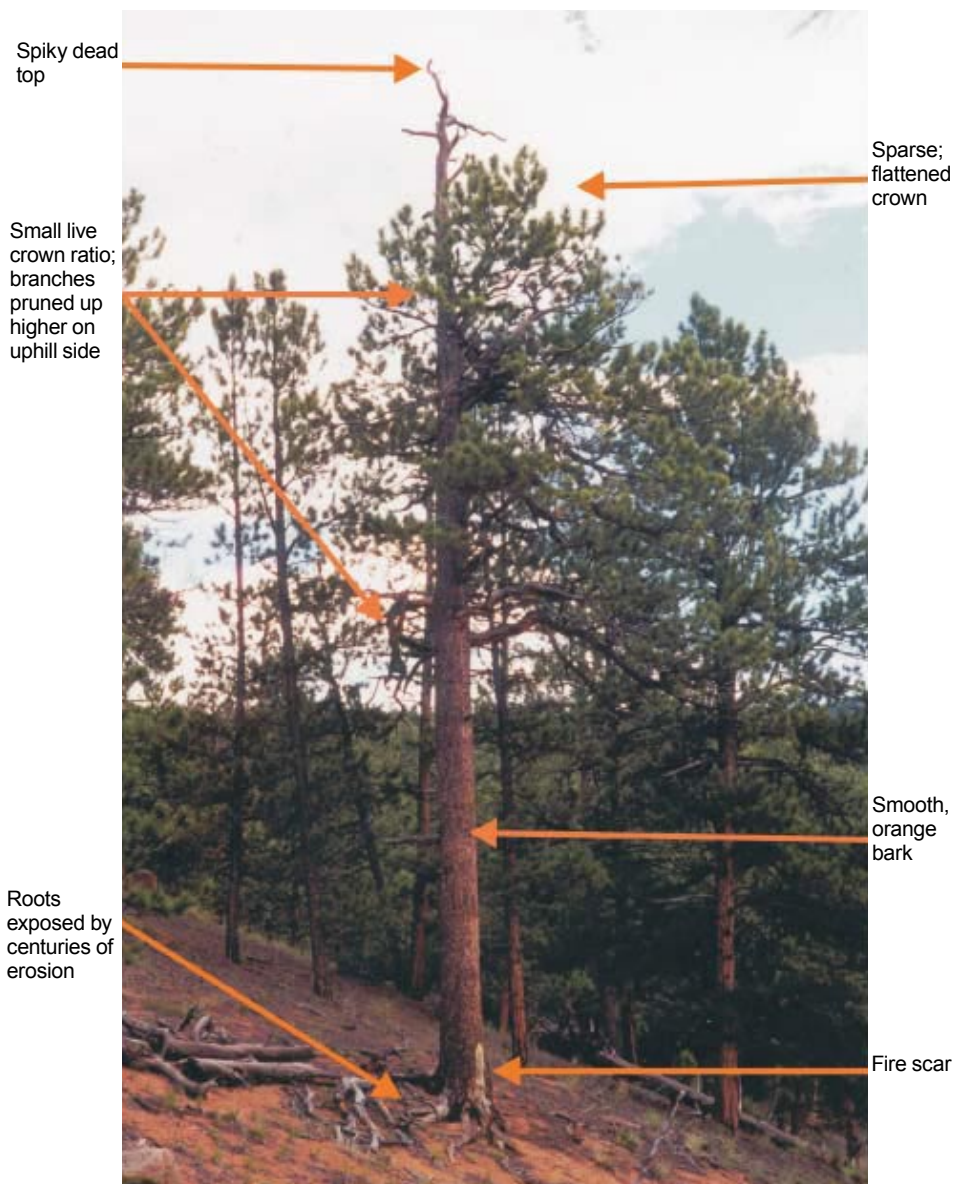
Crown shape is determined in part by the site where the tree lives and by its history, but in general, as a tree ages and stops growing taller, the crown appears to flatten out on the top and to acquire a “bonsai” look (fig. 6). Older trees often have sparse or very open crowns, as fine branches on the interior of the crown have died over the years, leaving a few large branches. Also, the growing tips of the branches are farther from the trunk, and the interior of the crown often has little foliage. The ratio of live crown to the height of the tree becomes less, both through self-pruning and fire pruning. This has the added benefit of removing ladder fuels from the lower part of the trunk, making it less likely that a surface fire will get into the crown.

Old tree trunks become columnar over time due to differential growth in the upper crown. Old trees allocate wood in the upper crown first, and if there is any carbohydrate left, they grow wood in the lower part of the trunk. The tops of old trees are often killed by lightning, fungi, or insects, giving them a spiked appearance. Trees with dead tops are often hollow because the injury allows the entry of fungi.



**Figure 4**—Idealized silhouettes of ponderosa pines of various ages and on various site conditions in the Front Range of Colorado (in the style of the Keen [1955] tree vigor classification for ponderosa pine in Oregon). The horizontal rows represent three age classes: top, the youngest, less than 150 years; middle, transitional trees 150 to 250 years old; and bottom, the oldest, trees more than 250 years old. The three site classes are represented by the vertical columns: left, good sites such as meadow edges and riparian areas; middle, moderate sites such as east-facing slopes or gentle slopes; and right, poor sites such as steep south-facing slopes or ridgetops (drawing by Joyce VanDeWater).





**Figure 5**—Typical characteristics of old ponderosa pines. This classic old tree lived on a south-facing slope at Cheesman Lake. The inside date on a cross-dated core from this tree was 1455, and that was an inch or so short of the pith, which was rotten. Most of the other trees on this slope were around 300 years old. They all burned in the Hayman fire in 2002.



**Figure 6**—Old trees growing on steep, rocky south- and west-facing slopes. These two old trees live on a rocky west-facing slope along the Crosier Mountain trail at 7500 ft (2300 m) elevation. Both have smooth, gray-orange bark, gnarled branches, live crowns pruned up above the ground, and fire scars. The tree on the left also has a lightning scar, and its top is dead, probably killed by lightning.

As ponderosa pines age, their bark becomes pale in color and appears smoother, with finer flakes. The exact color of the bark varies from location to location, perhaps because of genetics. The old trees we found in the northern Front Range were more gray, while those in the southern Front Range were more orange. Sun exposure may also bleach the bark color. Old tree bark lacks the deep fissures and black color of young tree bark (fig. 7a, b).

The longer a tree lives, the more likely it is to be damaged (fig. 8a, b, c, d). Dead tops, broken branches, lightning scars, fire scars, rot pockets, and burls are all signs of past injury. A ponderosa pine with an exposed fire scar face is probably at least 150-200 years old, since spreading surface fires of the kind that cause such scars ceased in most of the Front Range around 1900. Mature ponderosa pines have thick bark that insulates the cambium from heat. Fire scars are caused when heat kills the cambium on a portion of the tree's circumference. In subsequent years, the tree heals by growing wood around the wound. Fire scars create distinctive patterns in the tree's annual rings, which allow dating fires to a precise year.



**Figure 7a**—Typical bark on a young tree near Cheesman Lake; it is dark in color, with deep fissures and big flakes.

**7b**—Typical bark on an old tree near Cheesman Lake; it is mostly pale orange, smooth, with small flakes.



**Figure 8a**—A lightning scar on an old tree near Cheesman Lake. Lightning scars can sometimes look like fire scars, but they are usually long and narrow, extending down from the crown but sometimes not to the ground, and often spiraling around the trunk.



**8b**—Dwarf mistletoe causes characteristic swellings on the branches and may create tangled “witches’ brooms” in the crown. This parasite deforms tree crowns and may cause a younger tree to take on old tree crown characteristics prematurely.





**8c**—Fire scar on an old tree above Trumbull on the South Platte River.



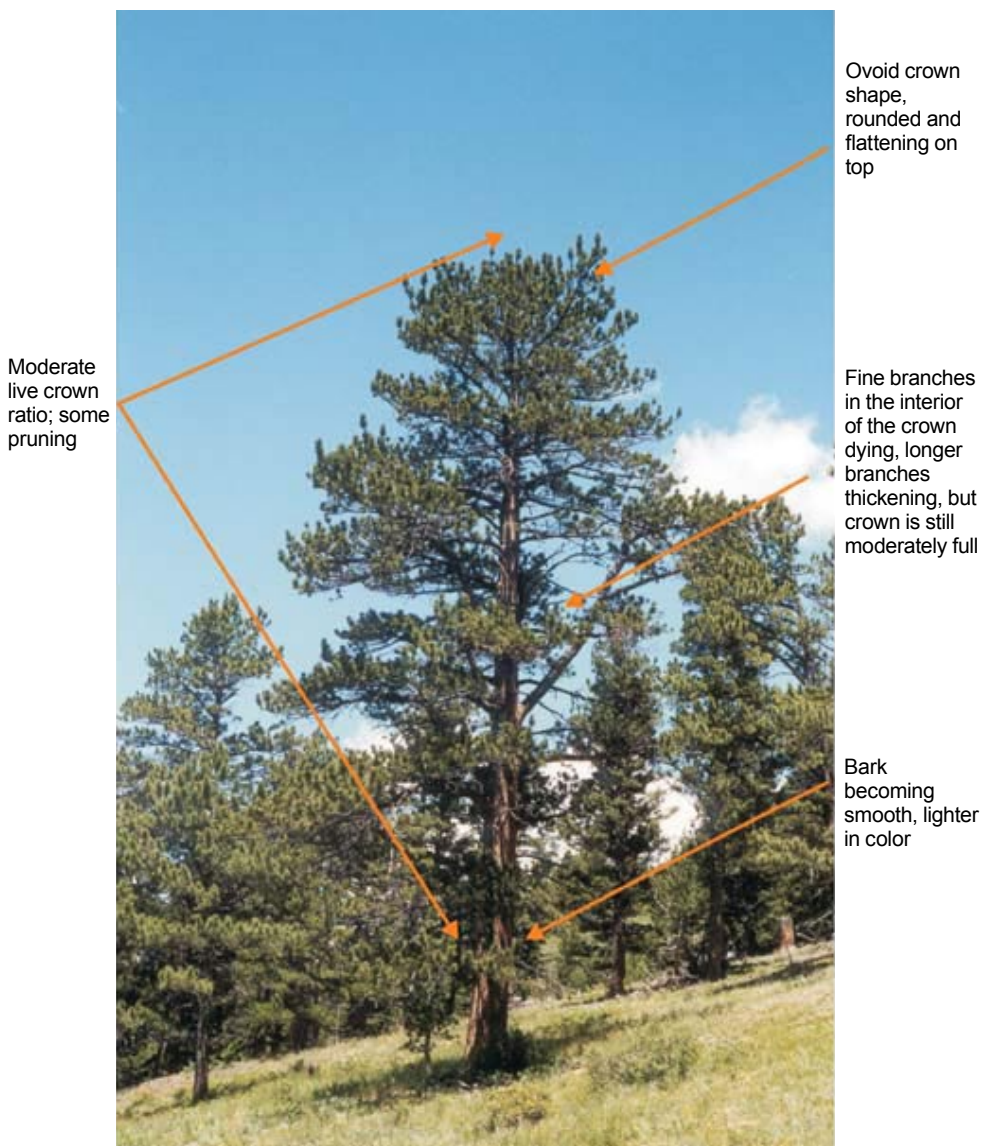
**8d**—Porcupine damage on a ponderosa pine. The aspen behind it was damaged by elk. Porcupine scars can look like fire scars, but they are usually more irregular in shape, and usually do not extend to the ground.

# **The Transition From Young to Old (Canopy Trees 150 to 250 Years Old)**

At around 200 years of age, the form of ponderosa pine trees begins to change (fig. 9). They are still vigorous, but their upward growth is slowing rapidly, so their tops start to flatten out as apical dominance weakens. Lower branches have begun to die and self-prune. The crown begins to open up as dense, small branches die near the trunk. The remaining branches become longer and larger in diameter, and the needles are distributed toward the outside of the crown. The general shape of the crown becomes round or oval rather than teardrop-shaped with a pointed top. The deep fissures in the bark begin to smooth out, and the bark color becomes lighter, more orange or gray than black. Middle-aged trees are old enough to have a fire scar or two, but it has been long enough in most locations since the last surface fire that such scars may have nearly healed and are not readily visible. A healed scar might appear as a deep fissure low on the trunk, rather than the easily recognized “cat-face.” Trees of this age are often the dominants in present Front Range stands. See table 1 for a summary of characteristics of ponderosa pines at different life stages.

**Table 1**—Identifying characteristics of ponderosa pine trees at different life stages.

	Crown shape	Live crown ratio	Branches	Trunk shape	Bark	Likely injuries
<b>Old trees (&gt;200 years)</b>	flattened, “bonsai” shape, sparse and open, may be lopsided	small; often fire-pruned	few but large	columnar	smooth, small flakes, pale orange or gray	fire scars, dead tops, broken branches, lightning scars, rot, burls, exposed roots
<b>Transitional trees (150-250 years)</b>	ovoid, flattening on the top, full and rounded	moderate; perhaps half the trunk, beginning to self-prune	fine branches in the interior of the crown dying, longer branches thickening	beginning to lose taper	orange or gray flakes with dark edges, shallow fissures, becoming smoother	relatively few; possibly healed or mostly healed fire scars, lightning scars, mistletoe
<b>Young canopy trees (&lt;150 years)</b>	pointed top, “teardrop” or “Christmas tree” shape, dense foliage	large	many fine branches, dense foliage near the trunk	tapered	large, coarse flakes, deep fissures, dark gray or black with dark orange	very few; possible mistletoe or lightning scars



Ovoid crown shape, rounded and flattening on top

Moderate live crown ratio; some pruning

Fine branches in the interior of the crown dying, longer branches thickening, but crown is still moderately full

Bark becoming smooth, lighter in color

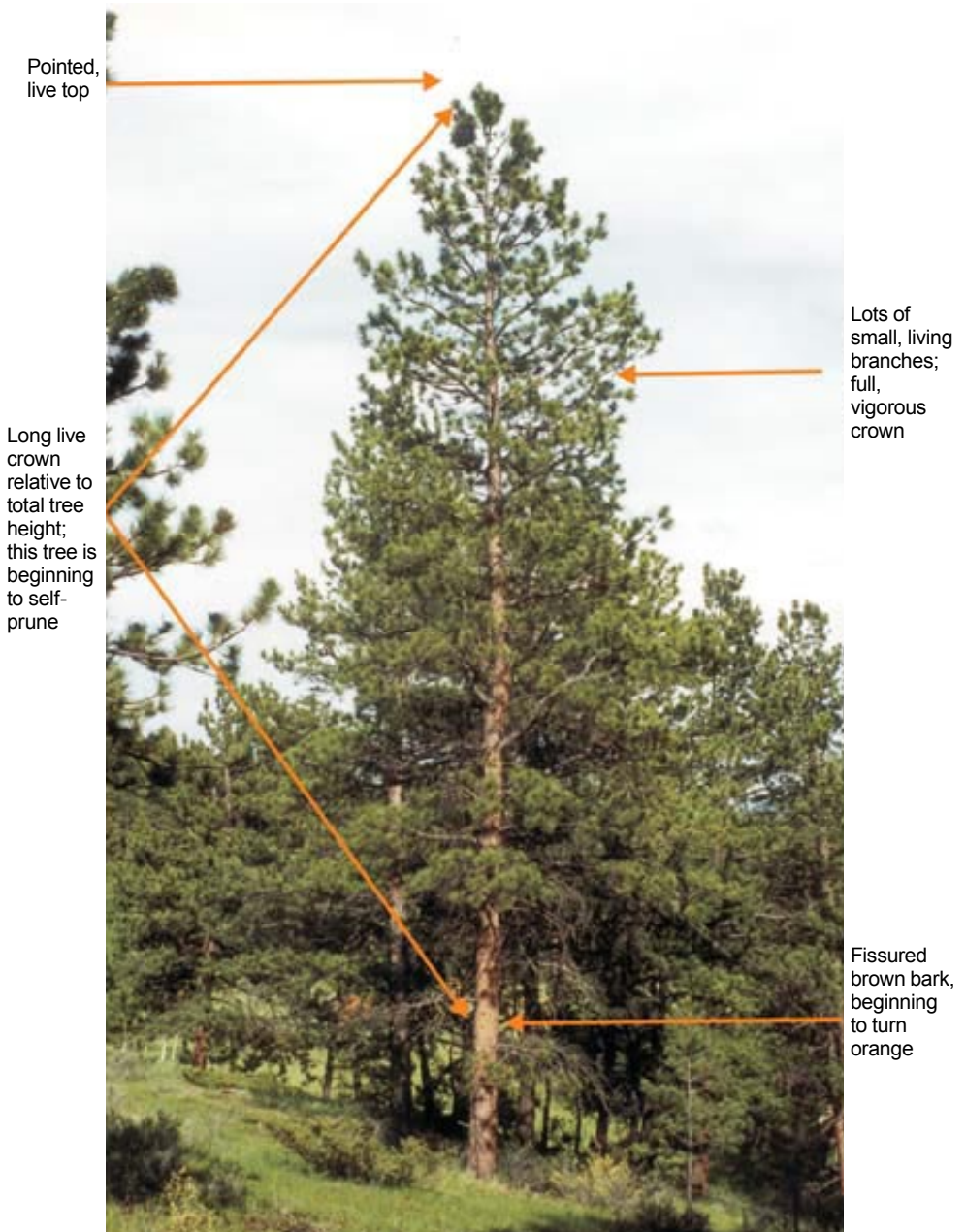
**Figure 9**—A middle-aged tree showing the transition in appearance to old tree characteristics. This tree, growing on a gentle south-facing slope above Lily Lake in Rocky Mountain National Park, is around 200 years old. It is beginning to take on old tree characteristics: its crown is still full but beginning to open up as fine branches die, and its top is ovoid and beginning to flatten. Its branches are beginning to self-prune. Its bark is becoming smooth and orange, losing its deep fissures.



## **Appearance of Young Trees (Canopy Trees <150 Years Old)**

Ponderosa pines less than 150-200 years old usually have pointed tops, because they are still growing taller (fig. 10). Strong apical dominance allows young trees to grow fast and to compete for light. Seedlings less than 3 or 4 years old must compete with grasses and forbs, and their survival is always in question. Once seedlings are about six inches tall, they are considered established, and are likely to survive. However, such small trees are more susceptible to factors in their immediate environment than to larger-scale climatic factors. When they are 3 to 6 ft. (1 to 2 m.) tall, they begin to interact with the other trees around them, and are likely to reach the canopy. How long it takes a tree to reach this size varies tremendously. It may take only 20 years or so on a good site, but even tiny trees may be older than they look, especially on poor sites. We have sampled trees that were only three feet (1 m.) tall but were more than 90 years old.

The trunks of young trees are usually tapered toward the top. Branches grow relatively low on the trunk and have usually not begun to self-prune. The bark of young ponderosa pines is dark gray or dark orange and black, with deep fissures and thick, flaky layers. On some small trees the bark appears almost all black; these slender youngsters are called "blackjacks." Most young trees do not have fire scars. They may have mistletoe, but if trees are infected while young, the mistletoe will be distributed throughout the crown and may distort the shape of the branches. Young trees on good sites may be very large, but they usually have a distinctive pointed top and a full crown that extends most of the length of the trunk. Crowns of healthy young trees have many dense, small-diameter branches, most of which bear live needles, so the crown looks full and thick with few dead branches. Dense forests are more likely to be composed of young trees.

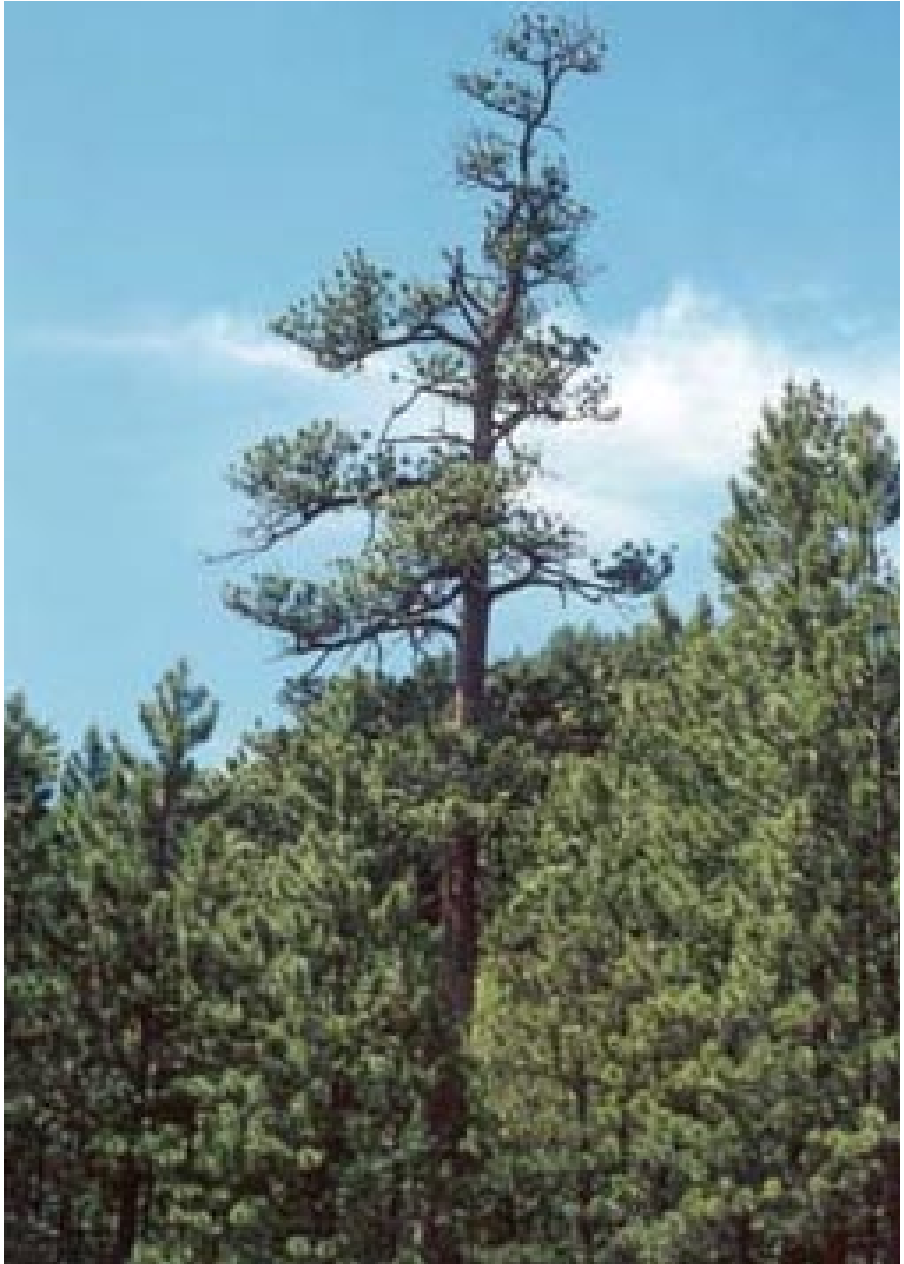


**Figure 10**—Typical characteristics of young ponderosa pines. This vigorous young tree grows along the Crown Point road. Its pith date is 1887. There are many other young trees in this stand.

## Tree Size

Not all old trees are large, and not all large trees are old. However, if a tree is by far the largest or tallest tree in the stand, it is probably older than its neighbors (fig. 11). Ponderosa pines in the Colorado Front Range are usually limited by the availability of water. Trees grow larger and more quickly on sites where water is readily available. Such sites include those along streams, even intermittent streams where water may not flow on the surface year around; flat, grassy areas where water soaks into the soil; and at the base of rock outcroppings, where water collects off the rocks. A 150-year-old tree on a good site may be 30 in. (80 cm.) in diameter.

Where water is less readily available, trees grow more slowly and have a smaller maximum size. Steep slopes, slopes that face south and west and are exposed to sun and wind, ridgetops, rocks, and places where the soil is very shallow or well-drained do not hold water. Trees on these sites must depend on brief pulses of water from rain or snow events. Small, old trees are likely on such sites. A 400-year-old tree might be as little as 12 in. (30 cm.) in diameter. On such sites, trees are usually less subject to competition and to the spread of parasites and diseases. The lack of water means that understory species like grasses and shrubs are sparse, providing little fuel for fires. Fires burning there are not likely to be intense, so old tree survival is enhanced.



**Figure 11**—A case in which size does indicate an older tree: this old tree towers above more recent in-growth at the base of a slope along the Pingree Park Road. Its pith date is 1672 and it has a fire scar in 1846. The old tree has the sparse, pruned crown and smooth orange bark typical of old trees. Its smaller neighbors have full, pointed crowns and dark, fissured bark.

## Open-Grown Versus Forest-Grown

Trees that have grown in the open tend to have a different appearance from those that have grown in a forest. Open-grown trees tend to have fuller, more rounded crowns and a few long, large-diameter branches (fig. 12a). Trees that have grown in a more closed environment will be relatively slimmer, with shorter, thinner branches (fig. 12b). Old trees can be found in closed forest environments, but the oldest trees are usually open-grown, possibly because they lack competition, or because they are less likely to be destroyed in a fire.

Ponderosa pines require full sunlight to grow well, and when stands are dense and trees shade one another, the shaded trees grow slowly, often develop poor form, and may ultimately die. However, such suppressed trees may be relatively old despite their small size (fig. 12c). They can persist for hundreds of years under the shade of other trees. If the other trees are eliminated (by fire or logging, for example), suppressed trees may be released and start growing faster. Douglas-fir does not suffer as much from shading as ponderosa pine. Young Douglas-fir trees actually benefit from shaded conditions where the soil surface is not as hot as in the open.



**Figure 12a—Open-grown tree.** This tree lives in a sage meadow near a south-facing ridgetop along the Redfeather-Rustic road at 8453 ft (2601 m) elevation. Note the full, rounded crown and long heavy branches. Its top is beginning to flatten out, but the lack of surface fire during the 20<sup>th</sup> century has allowed it to keep its lower branches. Its pith date is 1811; its DBH is 21 inches (53.3 cm). The core revealed a healed fire scar near the pith and relatively rapid growth.



**12b—Forest-grown tree.** This tree grows in a relatively dense ponderosa pine forest on an east-facing slope along Highway 7 at 8670 ft (2668 m) elevation. It is a dominant forest-grown tree. Note its straight trunk and narrow crown with short lower branches. Its bark is beginning to look smooth and pale. Its pith date is 1762; its DBH is 22.2 inches (56.4 cm).



**12c—Suppressed tree.** This tree lives on a small, rocky ridge in a relatively dense forest along Highway 7 near Olive Park at 8349 ft (2569 m). It is rotten at the center, but the inside date on the core was 1671, and narrow rings indicated very slow growth. Its DBH is only 10.2 inches (25.9 cm). Note its small size, twisted branches, sparse crown and flattened, deformed top.



## Common Locations of Old Trees

Despite the disruptions to the montane ecosystem in the last 150 years, trees older than 200 years are widespread in the Front Range. Trees in inaccessible locations and on poor sites often were not cut when logging was easier elsewhere. Rock outcroppings, steep slopes, ridgetops (fig. 13), and higher elevations (fig. 14) that were historically less accessible by road, less populated, and less susceptible to fire provided havens for old trees. Rock outcrops in meadows and the edges of meadows also protect old trees from fires.

We found relatively few old ponderosa pines below about 6500 ft (2000 m) elevation. It is unclear whether this is because trees at lower elevations were more accessible from settlements and were cut, or because there were just fewer trees there naturally. Warm south-facing slopes as high as 10,000 ft (2770 m) elevation support old ponderosa pines, and older ponderosas are common in the mixed conifer zone, where they occur with lodgepole pine, limber pine, Douglas-fir, and aspen.

Old trees are often found on south- and west-facing slopes (fig. 15), on and around rock outcrops, at the edges of high meadows (fig. 16), and on the upper third of slopes. Even in areas that were logged and now support young forest, individuals with twisted or scarred trunks, rot, large limbs, and dead tops were passed over by loggers. Old trees often occur in small groups, but it is unusual to find a stand in which all the trees are old. Old-growth stands are usually multi-aged. Of course, none of these suggestions is a rule. We found old ponderosa pines alone, on north-facing slopes, near rivers, in fairly dense stands, and right beside houses and campgrounds. When viewed across a vista, groups of old trees are apparent as taller, rough-looking, browner areas amid the smoother, greener, more uniform-looking young forest.





**Figure 13**—This old tree inhabits a dry, rocky ridge along Highway 7. It is small, deformed, and rotten at the center, but it is more than 350 years old. It has a healed fire scar and a lightning scar, smooth gray bark, a flattened top, and a sparse open crown. Many of its neighbors are of similar age and are stunted by the harshness of the site.



**Figure 14**—Though ponderosa pine forests are most common at lower elevations, older ponderosas can be found on sunny, south-facing slopes above their usual range. They may be relicts from a past climate or fire regime. This lone, old ponderosa pine lives on a south-facing slope at 10,000 ft (3077 m) elevation along the Old Flowers Road trail. Note the clone of young aspen around the old pine.



**Figure 15**—Old trees on open, grassy south and west-facing slopes. This old tree lived on a barren, grassy-shrubby, south-facing slope at Cheesman Lake at 7066 ft (2174 m) elevation; its center was rotten, but its inside date was 1720, and its estimated pith date was 1550. It was typically open-grown, with a flattened top, large, gnarled branches, and pale orange smooth bark. It had a visible fire scar face with several scars.



**Figure 16**—A classic old tree along the Redfeather-Rustic road at 8320 ft (2560 m) elevation; its pith date is 1569, its DBH is 24.4 inches (62.1 cm). It lives on the west edge of a ridge-rock outcrop in the midst of a meadow, and has the typical flattened top, smooth orange-gray bark, and a fire scar.

## *Gallery of Old Tree Photos*

### **How We Found Trees for This Publication**

We searched for old trees along a north-south transect of the Front Range to capture changes in soils and weather conditions that vary along this latitudinal gradient. We took four excursions: one along the dirt road from Rustic in the Poudre Canyon to Redfeather Lakes; one along the Pingree Park and Crown Point roads above the Poudre Canyon; one along the Glen Haven road from Drake to Estes Park (where many old trees occur on private land), and then south along Highway 7 from Estes Park to Allenspark; and one in the Cheesman Lake property in the South Platte basin, which is owned by Denver Water. Based on other research on the Cheesman Lake property, we knew old trees were common there because that area was never logged. Except for Cheesman Lake, we did all our sampling on U.S. Forest Service land. We deliberately avoided canyons that were and are travel corridors, and where fire probably behaved differently. Our sampling locations are marked by yellow stars in figure 1.

We selected trees from which we could get a good picture and age. We photographed them and cored them with an increment borer to determine their ages. Coring does not usually damage the tree. We selected trees in a variety of growing conditions, from harsh to moderate to good sites. We have included a few portraits of young and middle-aged trees under different site conditions for comparison. With each tree portrait, we report the tree's diameter at breast height (DBH; standardized to 1.4 meters above the ground) as a general measure of a tree's size. We also report the tree's age, which we derived by cross-dating cores taken low on the trunk. When trees were rotten, we estimated their ages by estimating the number of rings that would fill out the remaining length of the tree radius and using a negative exponential curve to take into account age-related growth trends. Most of the trees pictured are between 400 and 500 years old. The trees pictured from Cheesman Lake all burned in the Hayman fire in June 2002.

## Figure 17—Old ponderosa pines on poor sites



**17a**—DBH=18.4 inches (46.7 cm), pith date 1545. This was a typically scraggly-looking old tree on a poor, rocky site. Its flattened, very sparse crown, small live crown ratio, and smooth orange bark were exaggerated by the harshness of the site. At 7319 ft. (2252 m.) elevation, this mostly east-facing ridge on the Cheesman Lake property is relatively low and dry, but young Douglas-firs were moving into the understory.



**17b**—DBH=20.8 inches. (52.9 cm), pith date 1574. This tree lived in a common location for old pines: an open, south-facing slope just below a ridgetop at 7000 ft (2154 m) elevation on the Cheesman Lake property. It had a scar face with several fire scars, small live crown ratio, a sparse, slightly flattened, open-grown crown, and smooth orange bark.





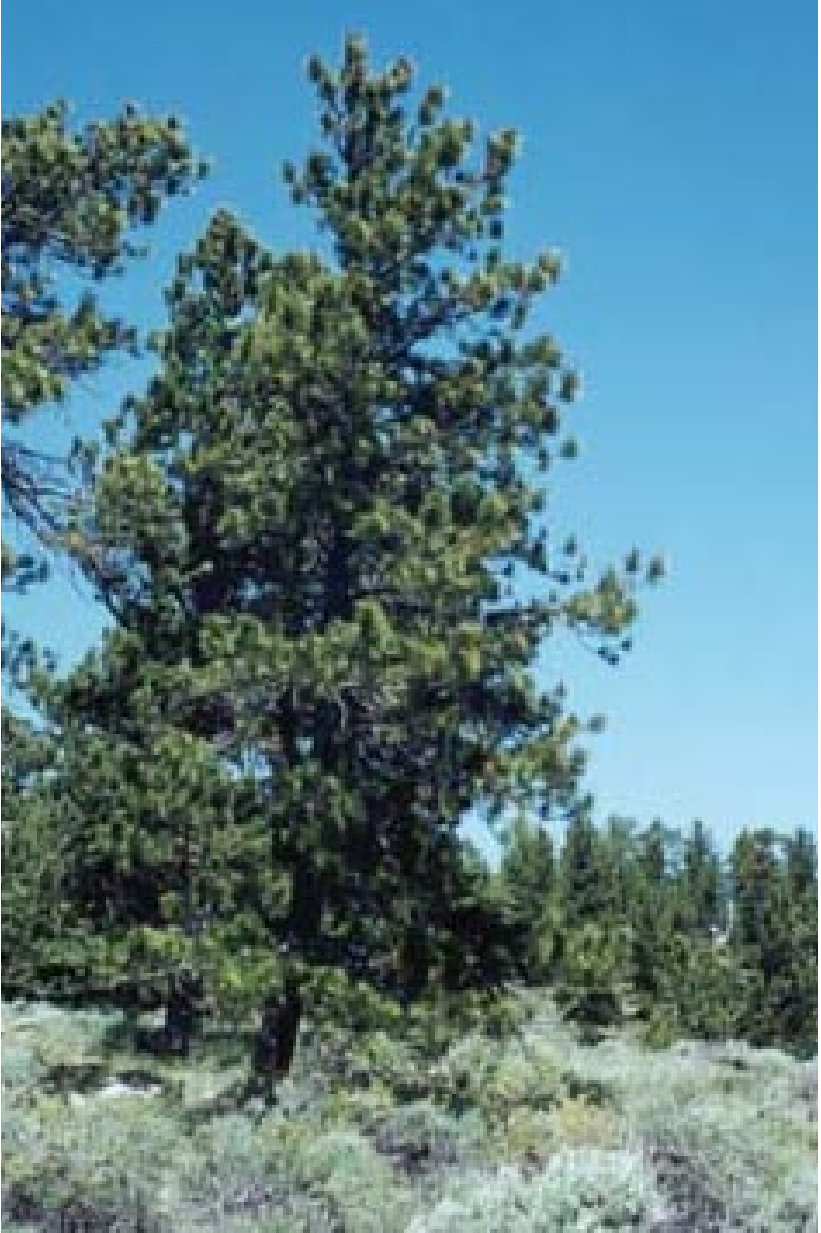
**17c**—DBH=18.8 inches (47.7 cm), pith date 1605. This small old tree grows on a poor, rocky site at 8778 ft (2701 m) elevation. It has been encroached by aspen and lodgepole pine. It has a somewhat flattened top, a very sparse crown and tiny live crown ratio, smooth orange-gray bark, and four fire scars. It lives along Highway 7 at Meeker Park.



**17d**—DBH=21.4 inches (54.3 cm) inside date 1663, est. pith date 1521. This tree lives near seven other old trees on a steep, rocky, west-facing slope at 7592 ft (2336 m) elevation along the Mt. McConnell trail. Evidence of local disturbance includes many fallen trees. It and its neighbors are infested with dwarf mistletoe. Nearby trees have fire scars from 1851, 1707, and 1700. This tree has typical smooth orange-gray bark, a flattened top, twisted and pruned branches, and a big burl (caused by an injury) beside a fire scar. It is rotten in the center.



**17e**—DBH=15.2 inches (38.5 cm), pith date 1560. This group of old trees lives on a rock outcrop in the middle of a meadow along the Redfeather-Rustic road at 8307 ft. (2556 m.) elevation. We cored the tree on the left. The flattened tops, deformed crowns, small live crown ratios and smooth orange-gray bark identify them as both old and stressed.



**17f**—DBH=12.5 inches (31.7 cm), pith date 1889. This younger tree lives on a south-facing slope near ridgetop at 8453 ft (2601 m) elevation along the Redfeather-Rustic road. Its pointed crown, long live crown ratio, and darker bark indicate that it is younger than some of its neighbors, though its small size attests to the harshness of the site.

## Figure 18—Old trees on moderate sites



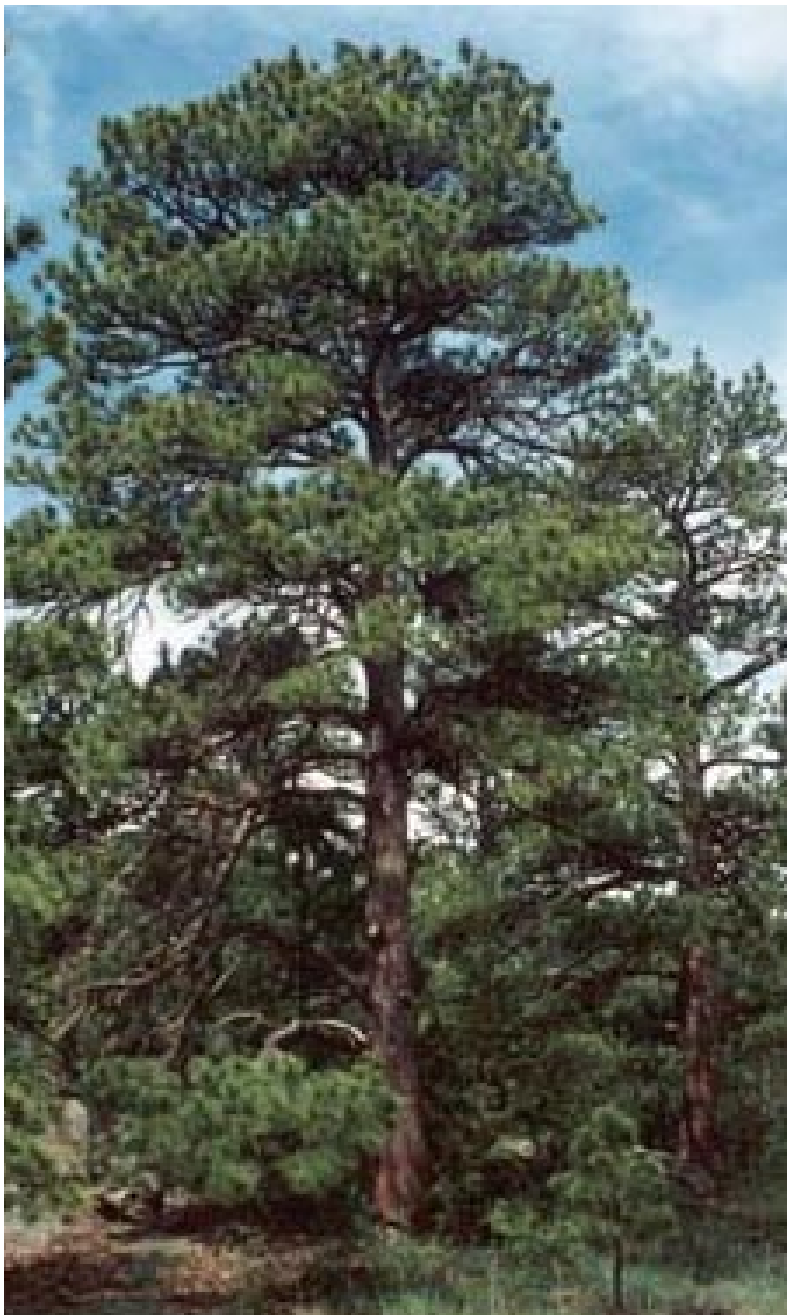
**18a**—DBH=19 inches (48.4 cm), pith date 1589. This tree lives on the edge of a north-facing ridge at 8307 ft (2557 m) elevation along Highway 7 at Olive Park. It is open-grown but not very tall. It has a flattened top, smooth orange bark, large branches, and fire scars on the north side.



**18b**—DBH=20.6 inches (52.3 cm), inside date 1744, est. pith date 1626. This tree lived on an open east-facing slope just below a ridge on the Cheesman Lake property at 7319 ft (2252 m) elevation. The entire stand was old; there were many fallen trees, perhaps killed by a past fire. The tree was rotten in center, possibly because of its dead top. It had very smooth, pale bark and a sparse, open-grown crown.



**18c**—DBH=25.3 inches (64.2 cm), pith date 1595. This open-grown tree grows in an east-facing meadow at 8710 ft (2680 m) elevation along Highway 7. It has classic old-tree characteristics: the flattened, “bonsai” open crown, and smooth orange bark. Though it lacks visible fire scars on the trunk, its lower branches are charred from past surface fires.



**18d**—DBH= 23.4 inches (59.5 cm), pith date 1769. This middle-aged tree lives on a flat, rocky ridgetop along the Pingree Park Road at 7293 ft (2244 m) elevation, in a location that sees heavy recreation use and has much ingrowth of juniper. It has a full, open-grown crown that is beginning to flatten at the top, fire scars, wounds from bear scratches, and bark beginning to shift from dark gray to orange.





**18e**—DBH=24.4 inches (62 cm), pith date 1527. This tree lives on a gentle, open, south-facing slope near the hilltop along the Redfeather-Rustic road at 8453 ft (2601 m) elevation. It has a typical flattened top and smooth orange bark. Because it is on a moderate site, it has a fuller crown than trees of similar age on poor sites. A core revealed a rot pocket from a healed fire scar—perhaps from the same fire that killed the short snag beside it?



**18f**—DBH=15.7 inches (40 cm), pith date 1887. This tree grows on a gentle east-facing slope at the edge of a meadow along the Crown Point road at 8425 ft (2500 m) elevation. It has the typical pointed top of a rapidly growing tree, no visible scars, and a long, full crown. Its bark is fissured, beginning to turn orange, and lower branches are starting to self-prune.

## Figure 19—Old trees on good sites



**19a**—DBH=27 inches (68.5 cm), inside date 1718; est. pith date 1581. This large tree lives on a grassy, shrubby, gentle north-facing slope at 6409 ft (1972 m) elevation above a river valley along the Glen Haven road. Its center is rotten. It is open-grown, with large heavy branches, a dead top, smooth orange bark, a sparse crown, and a large burl near the base.



**19b**—DBH=40.8 inches (103.8 cm), inside date 1729; est. pith date 1486. This ancient tree grows on a flat bench above a southeast-facing slope, just below the ridge at 8453 ft (2601 m) elevation, along the Redfeather-Rustic road. It is the oldest and largest tree in the vicinity. It has a dead top, smooth red-orange bark, small live crown ratio, and large, heavy branches. No fire scars showed on the trunk, but it had an axe scar from long ago. It has been marked by the Forest Service for preservation as a wildlife habitat tree. It was rotten in the center. This was the second-largest and second-oldest tree we found.



**19c**—DBH=31 inches (79.1 cm), inside date=1586; est. pith date 1539. This tree lives in a flat sage meadow at the abandoned townsite of Manhattan, 300 ft (100 m) above a stream at 8460 ft (2603 m) elevation along the Redfeather-Rustic road. The center is rotten. It is typically open-grown, and has smooth orange bark, but because it is on a good site, its old tree crown characters are subtle; the crown is more rounded and full than a tree of similar age on a poor site.



**19d**—DBH=42.5 inches (108 cm) inside date=1710, est. pith date 1614. This tree also lives in a flat sage meadow at the abandoned townsite of Manhattan, 300 ft (100 m) above a stream at 8460 ft (2603 m) elevation along the Redfeather-Rustic road. The tree was so large our borer could not reach the center, so we estimated its pith date. It is the largest tree we sampled. It is typically open-grown, and has smooth orange bark, but because it is on a good site, its old tree crown characters are subtle.



**19e**—DBH=25.4 inches (64.6 cm), inside date 1600, est. pith date 1462. This old tree, surrounded by a cluster of younger ones, lives at 8125 ft (2500 m) elevation along the Crown Point Road at the base of a gentle, east-facing slope near the edge of a meadow. It was rotten in the center. It has a deformed, dying top, lopsided crown with lower branches scorched on the underside, and a scar on the uphill side. If the estimate of age is correct, this is the oldest tree that we sampled.



**19f**—DBH=31.9 inches (81.2 cm), pith date 1879. This large, open-grown young tree was being encroached by younger ingrowth of ponderosa pine and Douglas-fir. Its growth rate was tremendous. It lived on the Cheesman Lake property on a gentle west-facing slope not far from a perennial stream at 7157 ft (2202 m) elevation. It had dark, fissured bark, a long live crown, pointed top, and no scars. It was one of the largest trees we sampled.





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