Figure 66 left. A century may pass before bark growth completely obscures old branch locations.

Figure 67 right. The rough and deeply furrowed bark of old trees shows no indication of where the original branches were located when the tree was younger.

trees has been prepared that represent trees of different ages and degrees of vigor (Figure 69). These were inspired by the profiles developed by Keen (1943), who designed similar drawings for rating resistance to insect attack. While his profiles of ponderosa pines were amazing in their simplicity and utility, the different objectives of this book prompted the creation of a set of new profiles. Although Keen depicted four age classes in his diagram, the youngest is omitted here as this guide is primarily focused on mature and old trees. For a given age, an intermediate vigor class may represent a weak tree on a good site, or a healthy tree on a poor site. Therefore, more than one tree is depicted for intermediate and low vigor categories.

Ponderosa Pine

Figure 68. The thick, colorful bark of old trees is found not only on the trunk, but also extends to the old, original branches.

Figure 69. Ponderosa pine crown form and tree vigor in eastern Washington. Idealized forms represent three age and four vigor classes (A-high vigor to D-low vigor). Vigor is a function of site productivity and response to disturbance and environmental stress. More than one individual is shown for vigor classes B-D to illustrate possible variations. Competition-based mortality usually ensures that most trees in vigor classes C and D do not survive to the next age class. The trees depicted are the same scale in the first image, and at differing scales on the following pages.

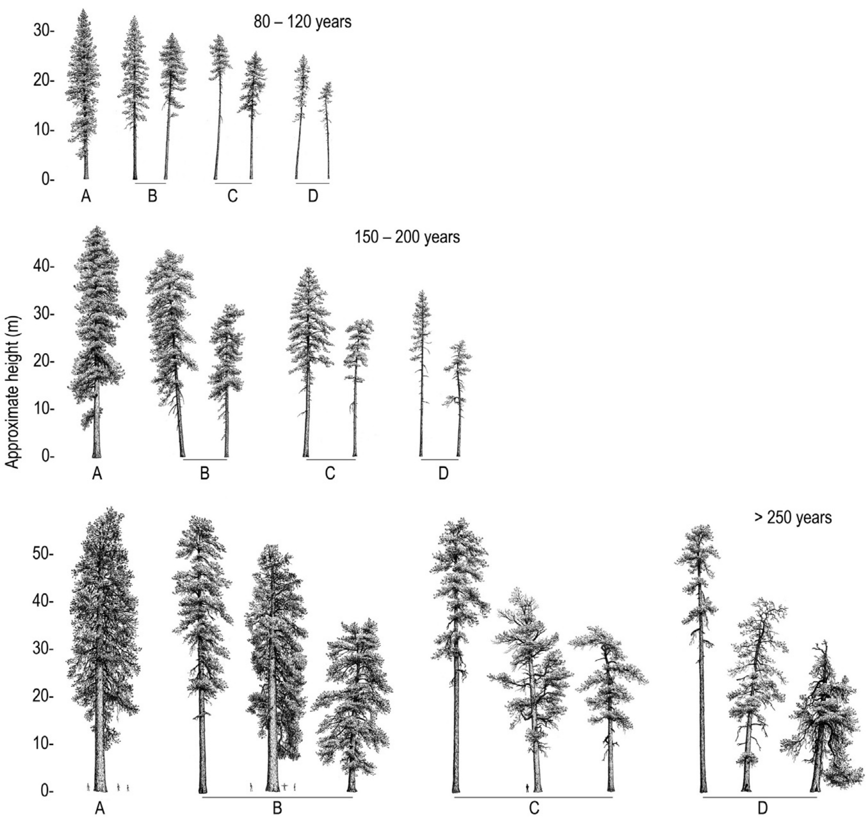
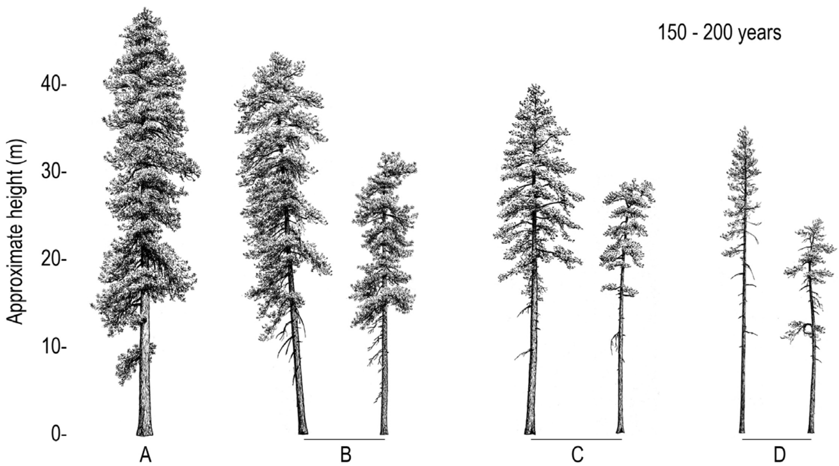


Figure 69 Continued



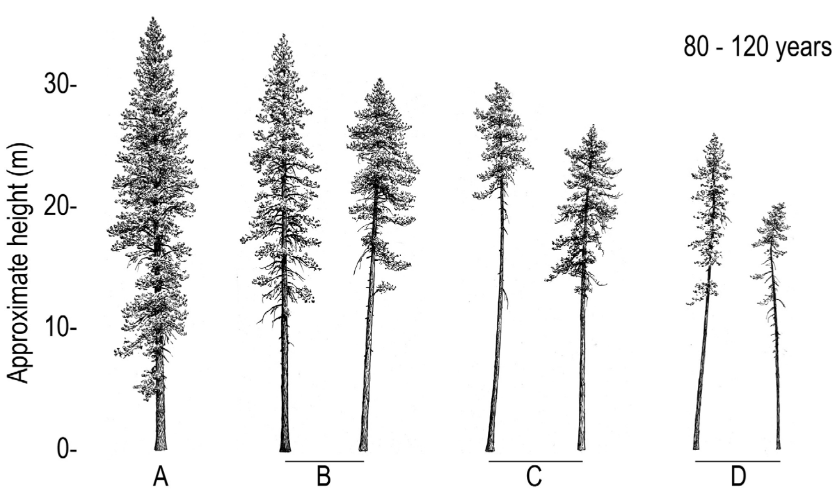
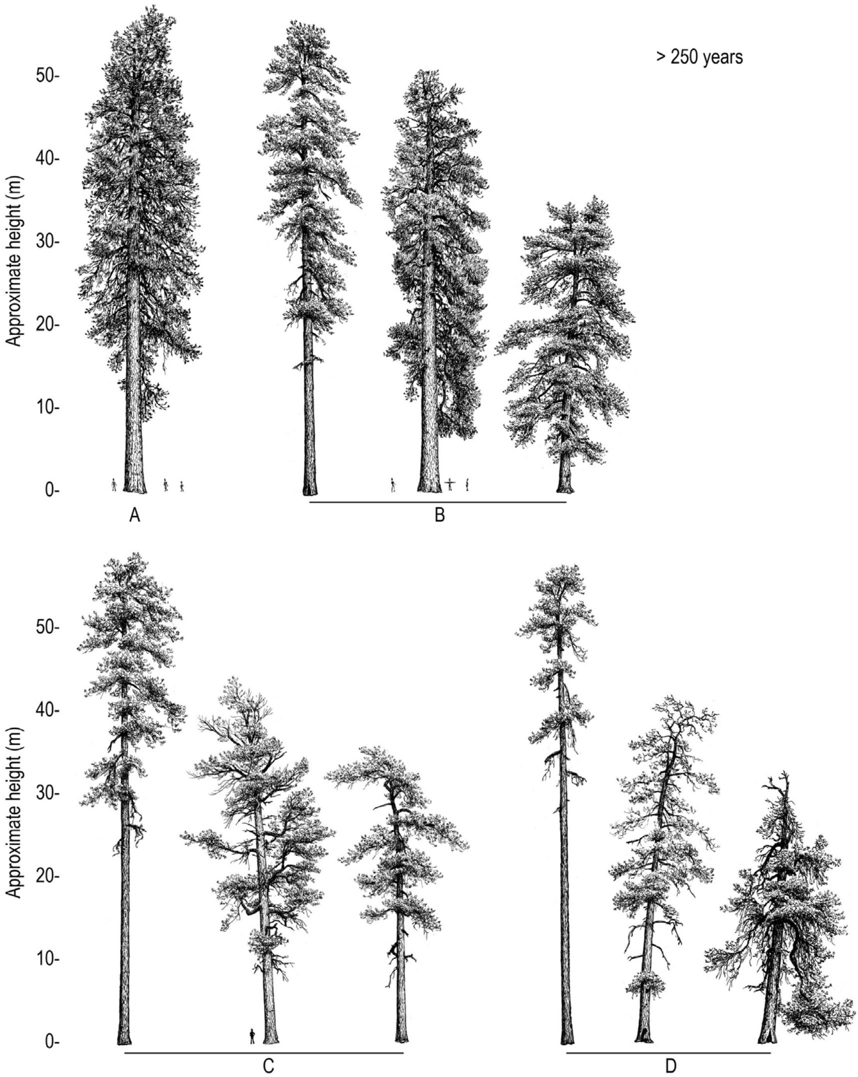


Figure 69 Continued



Rating system for determining the general age of ponderosa pine trees

(Choose one score from each category and sum scores to determine developmental stage)

Lower trunk bark condition	Score
Dark bark with small fissures	0
Outermost bark ridge flakes reddish, fissures small	1
Colorful plates, width about equal to fissure widths	2
Maximum fissure to fissure plate width ≥ 15 cm (6 in) and <25cm (10 in)	3
Maximum fissure to fissure plate width ≥ 25 cm (10 in)	5
Knot indicators on main trunk below crown	
Dead branches below main crown, whorl indicators extending nearly to tree base	0
Old knot/whorl indicators visible below main crown	1
No knot/whorl indicators visible	3
Crown form (refer to Figure 69)	
Similar to a tree in top row	0
Similar to a tree in middle row	3
Similar to a tree in bottom row	5

Scoring Key

< 2	Young tree
2–5	Mature tree < 150 years
6–10	Mature tree ≥ 150 years
> 10	Old tree ≥ 250 years

Longevity and death

How long can ponderosa pines live? A few individuals of the Rocky Mountain form (ssp. *scopulorum*) have been recorded over 900 years old, including a 1,047 year-old tree in Southwestern Colorado. The record for ssp. *ponderosa*, the type we have in eastern Washington, was discovered while carrying out research for this book—a living tree with a ring-count of 907 growing in the Wenatchee National Forest (Figure 70).

The development of spiral grain, uncommon in young trees, often becomes more prominent with age. An examination of old logs or snags reveals little if any spiraling when the trees were younger (the wood nearer the center of the tree). While not limited to ponderosa pine, this character is most often expressed in old trees of this species. A close examination of old conifers, either on rich or poor sites, shows that spiral grain is not rare. Old trees on harsh or rocky sites typically show spiral

Figure 70. Pristine, old-growth pine stand in the South Cascades. Many pines here are 300-600 years old – one tree has been measured at more than 900 years. The steepness of surrounding cliffs has isolated this stand and prevented cattle from ever reaching it.

Figure 71. On harsh sites, spiral grain allows the roots to reach all of the tree's branches. The spiral grain visible in the main trunk can also extend to the branches, giving them a structural advantage in snowy environments.

grain patterns with greater frequency than those on higher productivity sites. But if one looks at old conifers, either on rich or poor sites, it is obvious that spiral grain is not rare. Old trees of many species growing on harsh or rocky sites typically show spiral grain patterns with greater frequency than those on more productive sites. This is evidence of the adaptive advantage the growth pattern affords—the growth pattern results in increased connectivity of roots to all of the branches on a tree, not just the ones in line with the path of the wood cells (Figure 71). The phenomenon probably does not occur any more often in the seedlings of trees on these stressed sites. Instead, it may be that the few trees that survive to become old trees represent the small proportion of the population that developed this

Figure 72. The spiral grain of old trees is often not visible until the bark is removed. In this ponderosa pine log, the tight spiral of the outer wood gives way to progressively weaker spirals towards the center of the log.

character and were consequently more likely to survive (Figure 72). In addition, the crown is not only able to deal with moisture stress better, but the trunk itself is stronger because of the spiral grain. Since bark does not grow in the same manner as wood, it often hides the spiral grain beneath. Lighting scars can reveal a spiral pattern in the underlying wood (Figure 73), evident in both logs and snags.

Very few trees live to old age because of the many mortality agents they face. Drought, fires, insects, disease, competition, logging, and development represent continual threats to living trees. A tree stressed by one of these factors, if not killed outright, will be more vulnerable to bark beetles or disease.

Figure 73. Spiral grain in wood is sometimes masked by the bark, as revealed by this lightning scar on a pine.