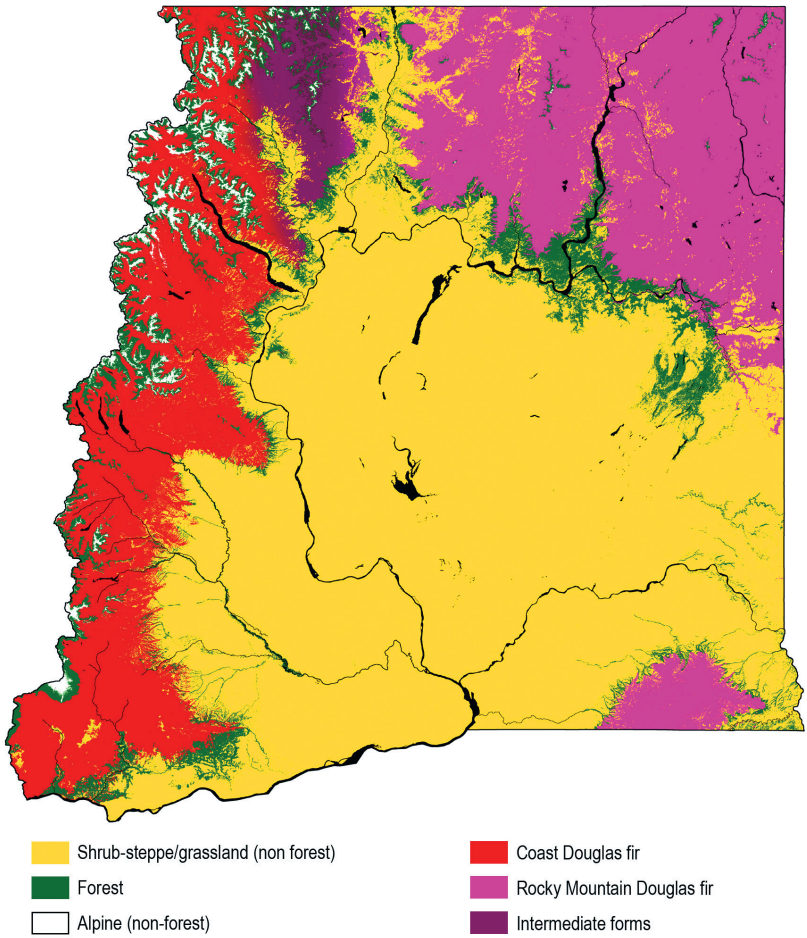
Douglas Fir (*Pseudotsuga menziesii*)

Douglas fir is something of an enigma—it is one of six or seven species of *Pseudotsuga,* the others of which are relatively small trees that play minor roles in forests within their limited ranges in eastern Asia, Mexico, and southern California. Douglas fir is the largest and tallest member of the pine family. Living trees have been documented up to 485 cm (191 in) in diameter, up to 99.4 m (326 ft) tall, and with volumes up to 349 m^3 (12,320 ft^3). Even larger and taller trees once existed

Figure 100. Range of Douglas fir in eastern Washington.



in western Washington. Douglas fir is also the most widespread of all western trees. It can be found growing from southern Mexico to central British Columbia (a distance of 5,000 km – 3,100 mi) and from Colorado to the coast (another 1,600 km – 1,000 mi).

Two distinct varieties are found in eastern Washington—the Rocky Mountain form (*Pseudotsuga menziesii* var. *glauca*) and a coastal form (*P. menziesii* var. *menziesii*). The Rocky Mountain Douglas fir has high relative shade-tolerance, capable of regenerating in the understory of other tree species (primarily pines) throughout much of its native range in the Rocky Mountains. The Coast Douglas fir, which grows from Vancouver Island south into the Sierra Nevada of California, behaves largely as a long-lived pioneer tree, due in part to the tree species with which it grows and the higher productivity and denser forests found along the coast. Both varieties are present in Eastern Washington, with a transition zone occurring between the Methow and Okanogan Valleys (Figure 100). The two varieties are visually distinguished largely by their cones. Those of the Rocky Mountain form tend to be smaller, often with recurved bracts (Figure 101). Foliage

Figure 101. Contrasting branch and foliage sprays from the two Douglas fir varieties. On the left is the coast form, var. *menziesii*, and on the right is the Rocky Mountain form, var. *glauca*. The Rocky Mountain form often has smaller cones and bluer foliage.

Figure 102. The many faces of Douglas fir allow it to behave as a long-lived pioneer, a shade-tolerant understory tree, and to grow in almost any eastern Washington forest type.

of this variety tends to be bluer, as a result of *stomata* on both upper and lower surfaces of the leaves.

Douglas fir might be considered the 'Jack-of-all-trades' among native trees, as it grows in a wide range of habitats and assumes a wide range of identities (Figure 102). This species shares many features with ponderosa pine and western larch; namely, very thick bark at maturity and the ability to withstand moderate to high-intensity fires. It also has moderately hard wood that is decay resistant and very resinous. This resinous feature helps to defend against bark beetle attacks and compartmentalize wood decay, much as its large associates do. Such qualities

enable these species to live to great ages—as both Douglas fir varieties, as well as the pine and the larch, have all been recorded to live to the millennium mark in remote mountain lairs.

Douglas fir also has many of the qualities of its other cousins, the true firs (*Abies*). Throughout the Northern Hemisphere, firs are often among the most shade-tolerant trees within their particular forests. In western Washington, three of the world's most shade-tolerant trees (western hemlock, western redcedar, and Pacific silver fir) dominate the understory of nearly every forest type. In this context, Douglas fir is relegated to the status of a long-lived pioneer. In eastern Washington, however, these three shade-tolerant species are restricted to the wettest areas up against the Cascade Crest or in far northeastern Washington. In the remaining forest zones of eastern Washington, the most shade-tolerant understory tree is often either grand fir or Douglas fir. While more shade-tolerant than Douglas fir, grand fir is also less drought-tolerant. Therefore, the climax species in most ponderosa pine forests of eastern Washington is Douglas fir.

Figure 103. Cross-section of a Douglas fir understory tree within a ponderosa pine stand. The small disk of wood has 103 rings.

With shade-tolerant understory trees such as grand fir or Douglas fir, size and age are even more poorly correlated than they are for ponderosa pine or western larch. Since a Douglas fir seedling can linger in the understory of a pine forest for decades (Figure 103), ***functional age*** is often a more useful concept than actual age. For shade-tolerant canopy trees, the functional age is the age since ***release***— the point at which unrestricted conditions allow for rapid growth. A change in environmental conditions, forest

structure, or community composition may allow a small understory tree that was suppressed and barely growing for decades to ascend into the main canopy. For example, a canopy gap may form when one or more large, overtopping neighbors die from fungi, insects, or wind. As a result, increased light reaches the understory. Many shade-tolerant species undergo a series of suppression and release episodes before reaching the canopy. In closed-canopy forests, it is rare for a seedling to grow uninterrupted into the main canopy.

Bark characteristics

Old Douglas firs are very fire-resistant, due largely to the protective bark that develops with age. In contrast, the thin bark of young trees offers little protection, even from low-intensity fires. The thin bark begins to thicken and develop vertical fissures as trees mature. For the first 100 to 200 years, the bark is hard and bony, and usually brown to gray (Figure 104). Old trees have very coarse and rugged

Figure 104. The hard, bony bark of mature trees. Depending on environmental conditions, Douglas fir bark is either brown or gray. In this case the gray is caused by lichens.

Figure 105. The characteristic colorful and flaky bark of old Douglas firs in western Washington is present in eastern Washington only in the wettest forests.

bark, which occasionally can reach a thickness of 35 cm (14 in).

Bark development in Douglas fir reflects the wide range of conditions in eastern Washington. The companion guide, *Identifying Mature and Old Forests in Western Washington* (Van Pelt 2007), describes the predictable pattern of bark development, from hard, bony bark to soft, papery bark, in detail. This same pattern is visible in eastern Washington, but is limited to wet forests near the Cascade Crest (Figure 105)—please consult this Westside guide when working in wet Cascade forests in eastern Washington. In the drier parts of the region, particularly within the grand fir and Douglas fir vegetation zones, the appearance of old trees can be quite different (Figure 106). As a general rule, bark thickness in eastern Washington Douglas fir is a more consistent feature than either the color of the bark on old trees or the development of the papery sheets of outer bark.

Lower crown characteristics

Douglas fir growth is whorl-based, like that of ponderosa pine. In Douglas fir, the lower crown begins to recede once a stand has achieved canopy closure. The lower branches die when they become too heavily shaded. Once dead, they often rot at their base and drop off the tree, leaving just a small scar in the otherwise unblemished bark (Figure 107). Ultimately, branch scars are hidden by the continually expanding trunk after a period of several decades to more than a century.

During that interval, the bark will be thinner at these spots than in the surrounding areas. If changes in the surrounding forest occur, such as the opening up of the canopy or the death of a neighboring tree, epicormic branches may begin to form at some of these old wounds. Old Douglas fir trees often have an upper crown of original branches and a lower crown composed of the dead remnants of original branches surrounded by younger epicormic branches and fan-shaped epicormic systems (Figure 108).

Figure 106. Hard, but thick bark is common on old Douglas firs in the drier parts of its range in eastern Washington.

Crown form and tree vigor

As a Douglas fir tree ages, it transforms from a simple, whorl-based, conical crown form to a highly individualistic shape. The individuality is in part due to the long lifespan of the species. Over time, shading from neighbors, damage from storms or falling trees, the effects of decay, and differences in their specific growth environments all combine to make each tree structurally unique.

Crown profiles of Douglas fir at three age classes and four vigor classes (A-D) are presented in Figure 109. As with ponderosa pine and western larch, variation in crown structure is a function of age, productivity, and crown damage. Naturally, not all of the trees in one series will advance to the next. For example, competition-based mortality will ensure that most of the trees in classes 1C and 1D do not make it to the next stage.

Figure 107. Branch scars on a mature Douglas fir. The locations of original branches that have since died and fallen off are still evident. One original live branch and some epicormic branches are visible in this photograph.

Figure 108. Epicormic branches. A fan of epicormic branches (visible at the base of this Douglas fir crown) often indicates a tree in late maturity.

Figure 109. Douglas fir crown form and tree vigor in eastern Washington. Idealized forms represent three age and four vigor classes (A-high vigor to D-low vigor) in eastern Washington. 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.

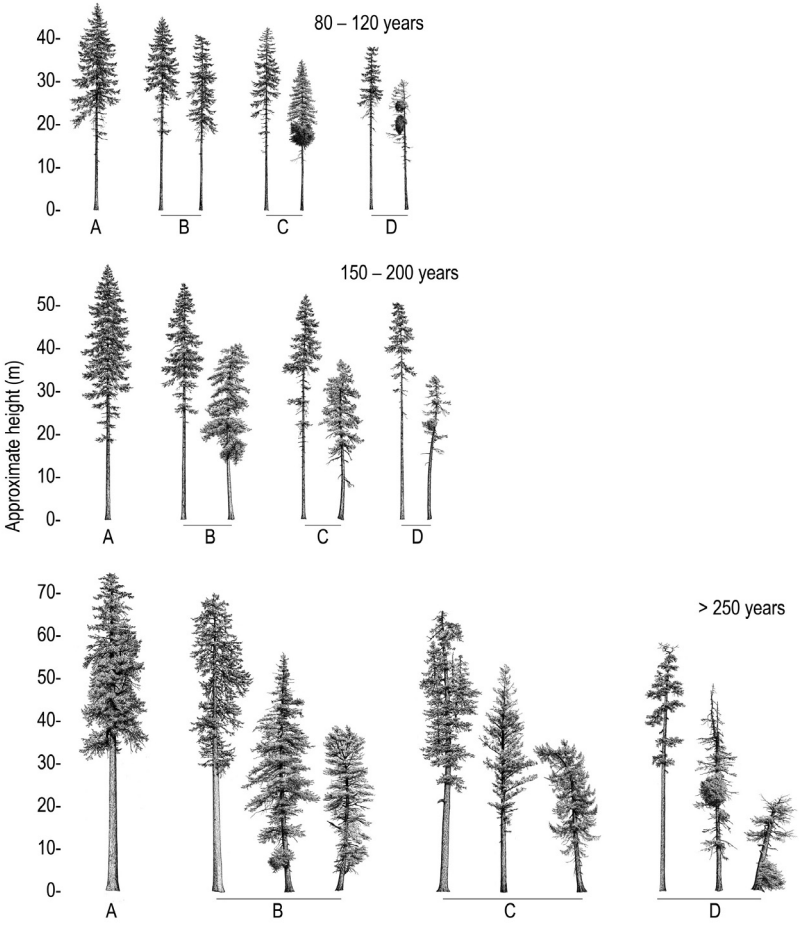


Figure 109. Continued

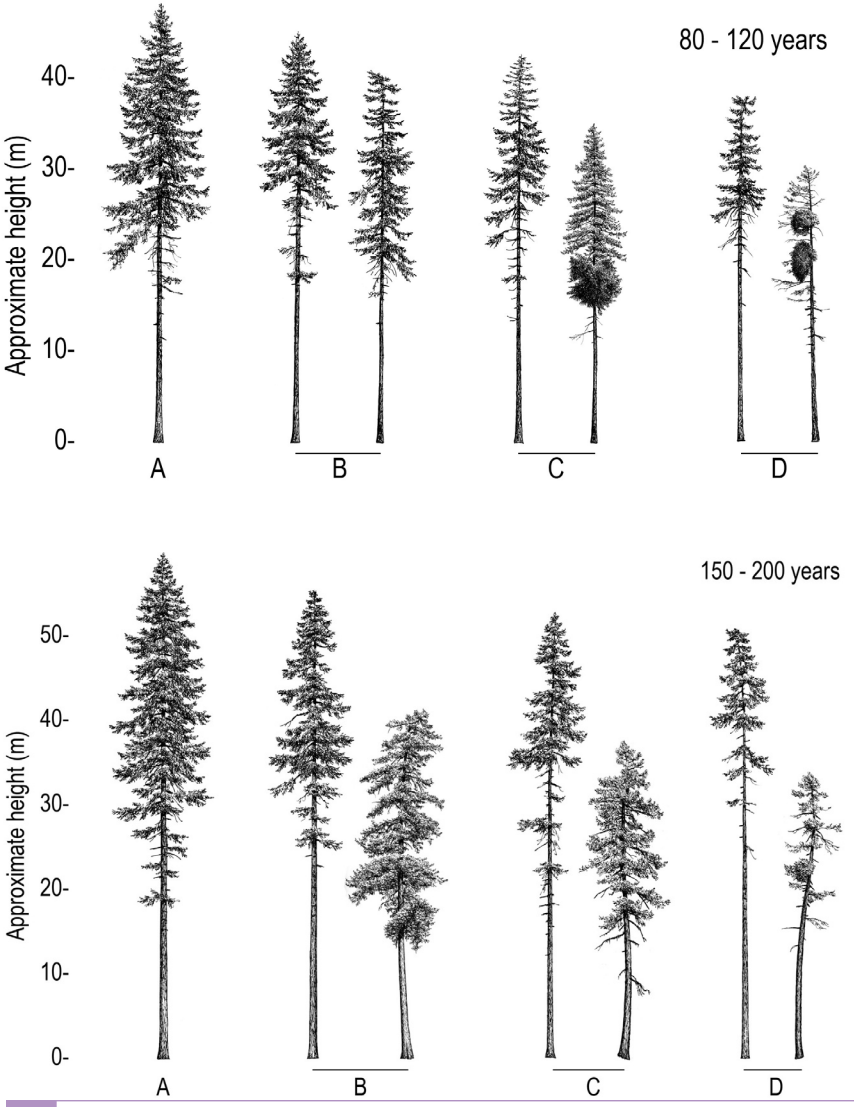
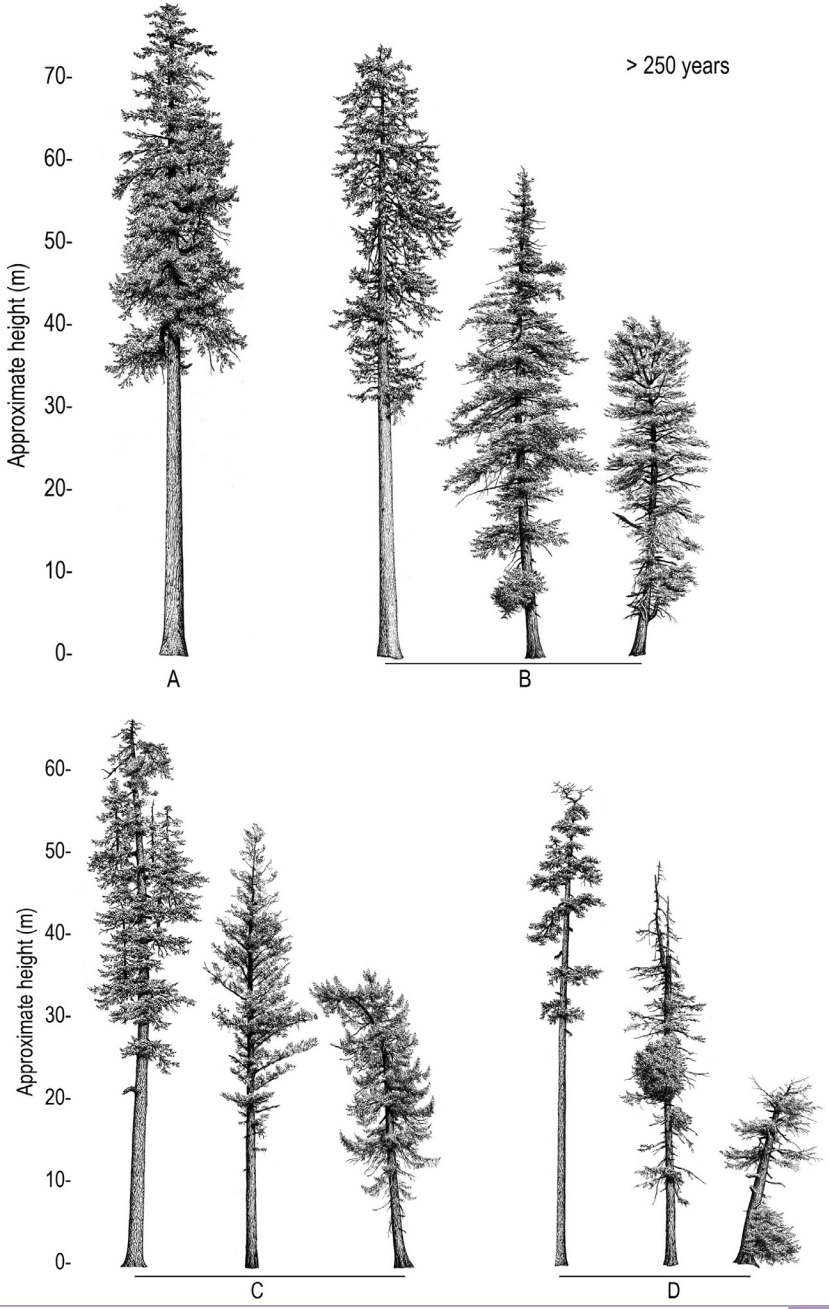


Figure 109. Continued



Rating system for determining the general age of Douglas fir trees

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

	Score
Bark condition, lower one-third of tree	
Hard, bony bark with small fissures	0
Hard bark with moderately deep fissures (4-10 cm – 2-4 in)	1
Deep fissures present (> 10 cm – 4 in)	3
Knot indicators, lower one-third of tree	
Branch stubs present.	0
Old knot/whorl indicators visible	1
No knot/whorl indicators visible	3
Lower crown indicators	
No epicormic branches	0
Small epicormic branches present.	1
Large and/or gnarly epicormic branches present	3
Crown form (refer to Figure 109)	
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

< 3	Young tree
3–6	Mature tree < 150 years
7–10	Mature tree ≥ 150 years
> 11	Old tree ≥ 250 years

Longevity and death

Moderate decay-resistance and resinous wood helps Douglas firs occasionally live to great ages—trees 600 to 800 years old are not uncommon in many parts of its range. Trees 1,000 years or older have also been recorded, including some in dry montane areas similar to eastern Washington. For a Douglas fir tree that has survived to become a canopy tree in an old-growth forest, a delicate balance exists between photosynthesis and respiration. Stresses from fire or competition within dense stands can create vulnerability to bark beetle attacks. Similarly, beetle populations increase following fire, blowdown, or logging as a supply of inner bark becomes more available (Figure 110). An upper age limit for Douglas fir in most eastern Washington forests is determined by the velvet-top fungus. This slow-growing fungus can often take 200 to 400 years before it makes its presence known, and may require several more centuries to cause tree death. This

Figure 110. Douglas fir killed as a result of beetle attack. Beetle populations increase following fire, blowdown, or harvest as a supply of inner bark becomes more available. Under such circumstances, beetle populations can increase to the point where otherwise healthy trees can be killed.

fungus causes decay in the upper roots and lower stems of old trees, weakening them. The sapwood of the tree is unaffected—many infected trees appear healthy and vigorous. Structurally, the base of the tree is compromised and will ultimately fail. Tip-ups with small root plates or snapped boles near the base often indicate death by velvet top fungus (Figure 111).

Figure 111. Death by velvet top fungus often takes the form of short, broken stumps on old trees.