Appendix A – Legacy Tree Guide

Middle Fork Weiser River Landscape Restoration Project -

Legacy Tree Guidelines Ponderosa Pine, Western Larch,

and Douglas-fir

Perry and Amaranthus (1997) defined forest legacies as "anything handed down from a pre-disturbance ecosystem". In simplest terms, legacy trees are those that survived the previous stand initiating disturbance event in lethal fire regimes, or survived numerous low to moderate intensity disturbance events in the other fire regimes. Legacy trees tend to emerge above younger trees in some homogenous stand conditions but this can be variable depending on the topography and the time that has elapsed since the last disturbance event.

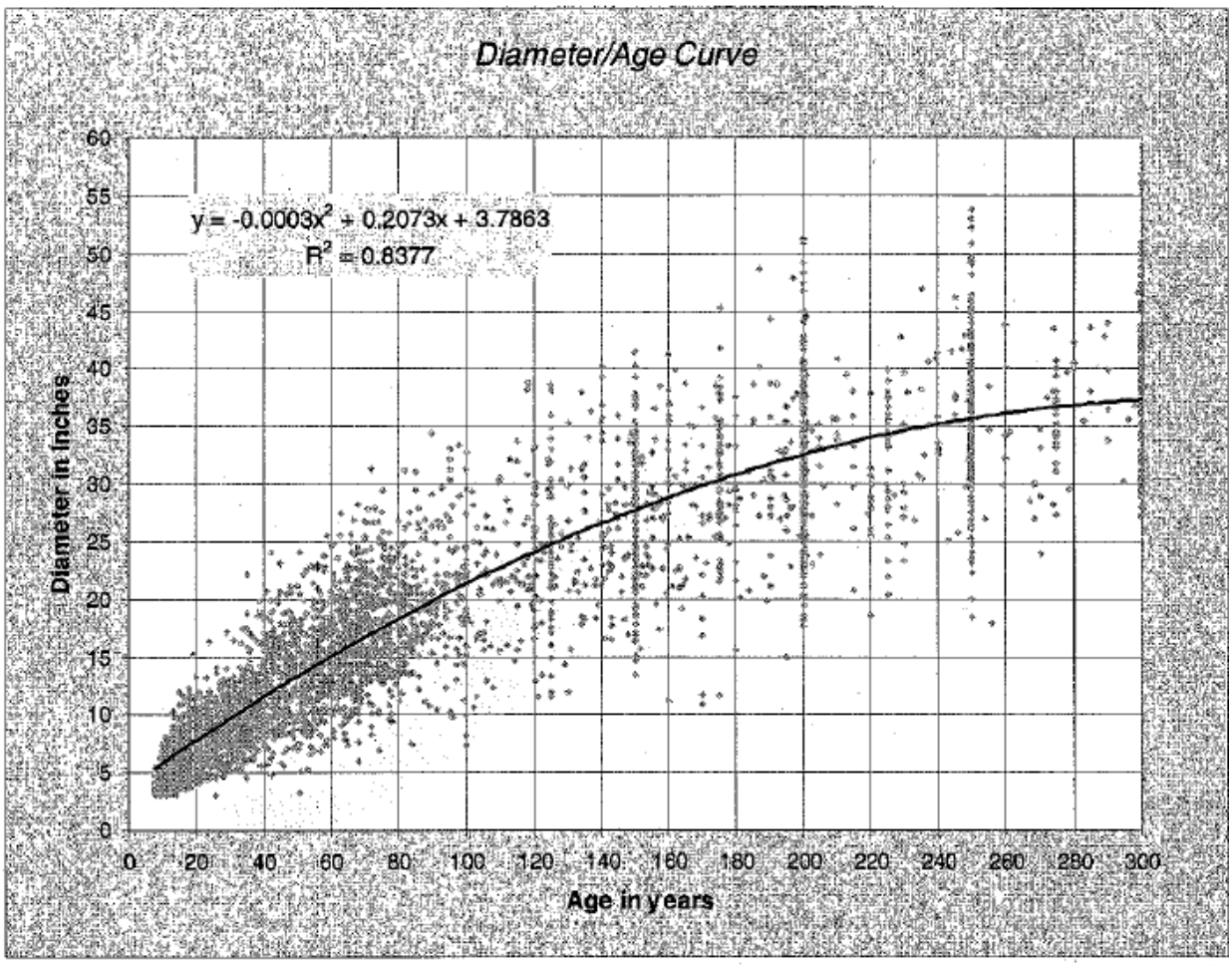
The remainder of this document outlines a process for identifying legacy ponderosa pine, western larch, and Douglas-fir for the Middle Fork Weiser River Landscape Restoration project on the Payette National Forest. For the purposes of this exercise, it was assumed that all legacy trees should exceed 150 years of age. Based on sampling within the project area, most trees that meet the criteria for legacy trees in this guide are at least 150 years old. This is a good indicator that the guide does identify trees that were resilient enough to survive previous disturbance events.

The basis for this guide is *Identifying Old Trees and Forests in Eastern Washington* (Van Pelt 2008). Modifications have been made, based on professional judgment, inventory data on the Payette National Forest (USDA 2004), and sampling conducted in the Middle Fork Weiser River Landscape Restoration project area, to provide a simple process to identify legacy trees. As with all field guides, the scoring system provided in this document will not address every situation and application of both professional judgment and common sense will be necessary and is encouraged.

The intent of this guide is to aid in identification of trees that are greater than approximately 150-200 years in age and have survived previous disturbance events.

It is well documented that diameter is a poor indicator of the age of individual trees (VanPelt 2008, Johnston 2014). Payette National Inventory data (USDA Forest Service 2004) also appear to support this conclusion. The chart on the following page (from the Payette National Forest inventory data (USDA 2004)) indicates that the average DBH of a 150 year old tree is approximately 27 inches but could range in DBH from approximately 13 to 42 inches while the average DBH of a 200 year old tree is approximately 33 inches with DBHs ranging from 17 to 52 inches. The table also indicates that it is rare for trees greater than 40 inches DBH to be less than 150 years in age and for trees greater than 50 inches DBH to be less than 200 years in age.

Based on this information the following indicators will be utilized to identify legacy trees in the Middle Fork Weiser River Landscape Restoration project:



This graph displays the average progression of diameter as trees age. It is not specific to any particular species, as it includes all species from all strata and all working groups.

Data source: individual tree measurements from the 1979, 1991, and 2001 forest inventories. Also included is data from permanent growth plots for young trees. No cull or suppressed trees are included; only trees designated as live, crop, or site trees in the database were used for this graph. Age groupings are apparent around 150, 175, 200, and 250 years because stand exams rarely require exact age measurements beyond a certain age (often around 120-150), and are therefore estimated to the nearest 25 or 50 years.

Ponderosa Pine

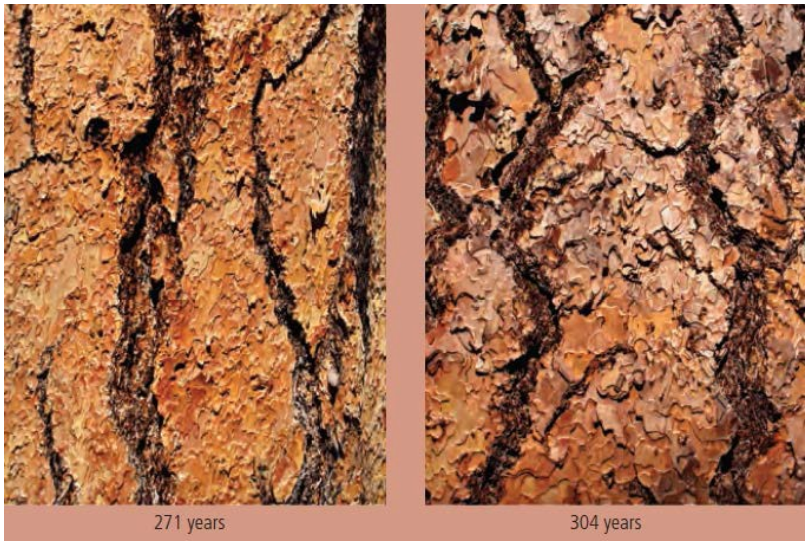
Legacy ponderosa pine tend to have little terminal leader growth, the top of the crown is generally flattened as the lateral branches reach the same height as the terminal, branches throughout the bole become larger in diameter, and lower branches tend to droop. Huckaby et al. (2003) noted that the majority of trees with large fire scarred cat-faces are legacies since most trees established more recently have not been subjected to the same fire regimes as occurred historically.

As with many tree species with wide distributions and ecological amplitudes, age and size of ponderosa pine are not closely correlated (Van Pelt 2008, pg. 75). Because ponderosa pine can grow in vegetation zones ranging from rocky cliffs to riparian zones, the size of the tree reveals little about its age (Van Pelt 2008, pg. 75). However the color and condition of the bark, knot indicators on the main trunk of the tree, and the overall form of the tree's crown do provide an indication of the tree's age.

Unlike trunk diameter, maximum plate width of the bark is well correlated with tree age (Van Pelt 2008, pg. 79). As the tree ages, the outermost bark continues to flake off, causing the colorful plates of outer bark to get wider, while the width of the dark fissures in between those plates remain relatively constant (Figure 1) (Van Pelt 2008, pg. 78). Bark plates substantially wider than the fissures is an indication of old age (Figure 2) (Van Pelt 2008, p. 79).

Figure 1. Bark patterns on mature ponderosa pine. Note residual charcoal in the center photo (Van Pelt 2008, pg. 79).

Figure 2. Bark patterns on old ponderosa pine. The colorful bark plates are generally more than three times wider than the darker fissures that separate them (Van Pelt 2008, pg. 79).



Ponderosa pine growth is whorl-based, like many members of the pine family (Van Pelt 2008, pg. 80). This pattern repeats every year, so that over time the tree will consist of a series of branch whorls, separated by short sections of trunk (Figure 3) (Van Pelt 2008, pg. 80). Over time, branches in the lower crown die due to shading and the lower crown lifts as the tree grows taller (Figure 4) (Van Pelt 2008, pg. 80).

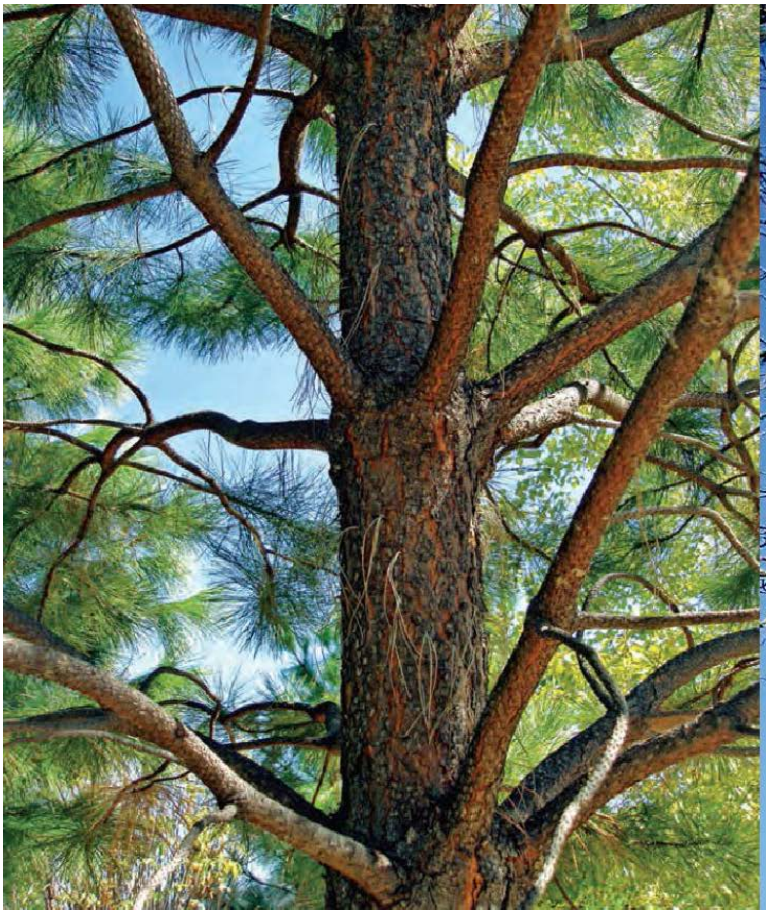


Figure 3. Whorl-based branch growth on a young ponderosa pine (Van Pelt 2008, pg. 81).

Figure 4. The whorl-based branch growth is clearly visible below the receding crown of this ponderosa pine (Van Pelt 2008, pg. 82).

Dead branches are usually present in the lower crowns of 100 year old trees, but eventually fall off, leaving tell-tale signs of where the branches once were (Figure 5) (Van Pelt 2008, pg. 80 and 81). As the tree grows, the bark begins to cover up the locations of these former branches – however, residual evidence may be visible on trees older than 200 years (Figure 6) (Van Pelt 2008, pg. 81). Only in old age are the scars of original branches completely covered (Figure 7) (Van Pelt 2008, pg. 81).

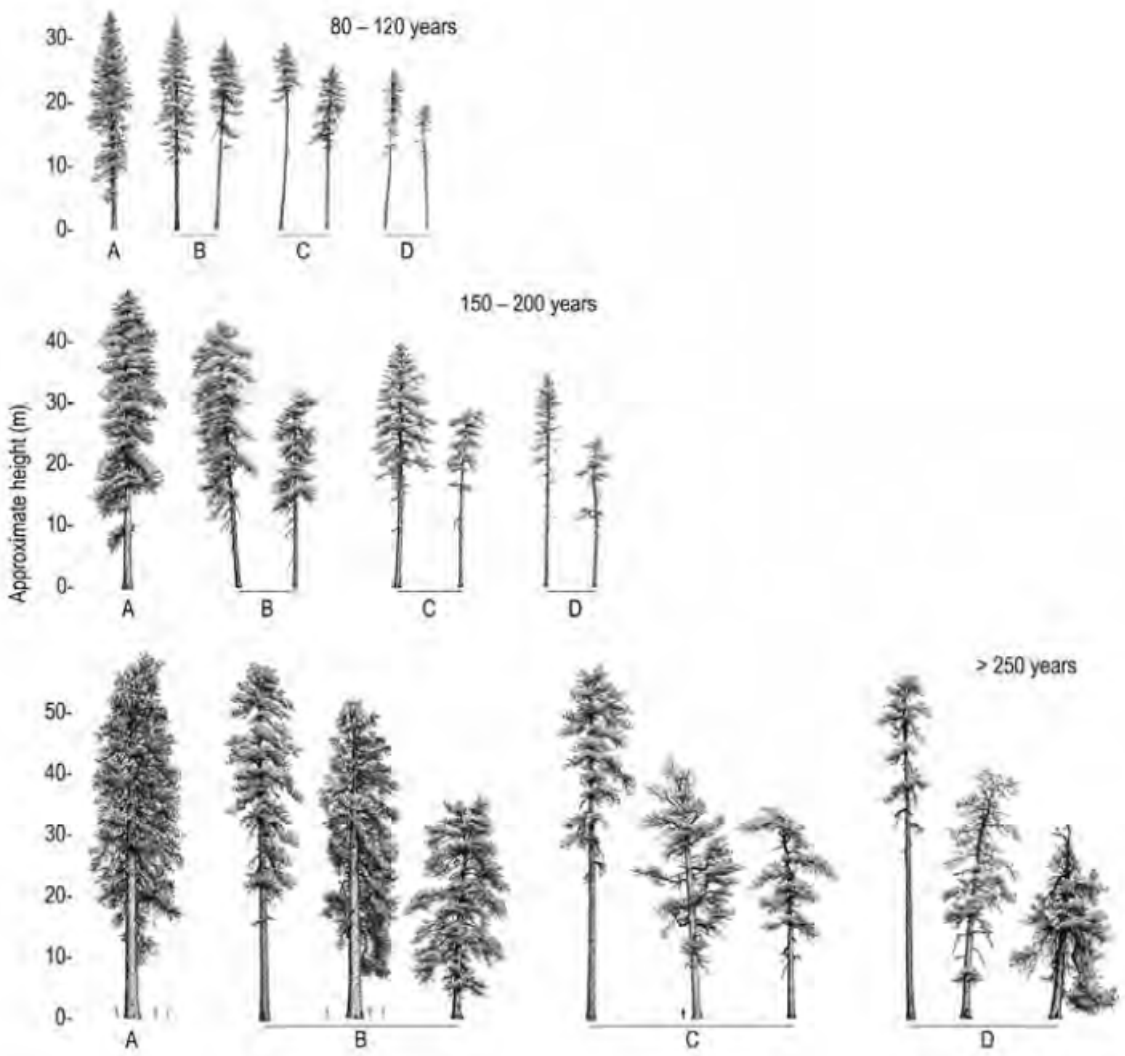
Figure 5. Old branch whorls are still visible decades after the branches have fallen off (Van Pelt 2008, pg. 83).

Figure 6. A century may pass before bark growth completely obscures old branch locations (Van Pelt 2008, pg. 84).

Figure 7. The rough and deeply furrowed bark of old trees shows no indication of where the original branches were located when the tree was younger (Van Pelt 2008, pg. 85).

The appearance of a tree of a given age is affected by a number of factors, including site productivity and overall tree vigor. In general, differences become accentuated with age (Van Pelt 2008, pg. 83). To aid in their identification, a series of crown profiles of trees has been prepared that represent trees of different ages and degrees of vigor (Figure 8) (Van Pelt 2008, pg. 83 and 84).

Figure 8. Ponderosa pine crown form and tree vigor on the Payette National Forest. 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 through 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 image below.



Rating System for Determining Ponderosa Pine Legacy Trees

Lower Trunk Bark Condition*	**Score**
Dark Bark with Small Fissures	0
Outmost Bark Ridge Flakes Reddish, Fissures Small	1
Colorful Plates, Width About Equal to Fissure Widths	2
Maximum Fissure to Fissure Plate Width ≥6 inches and <10 inches	3
Maximum Fissure to Fissure Plate Width ≥10 inches	5
Knot Indicators on Main Trunk Below Crown	**Score**
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 8)	**Score**
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	
≥6 Legacy Tree	

* Determine bark conditions on the uphill side of tree near dbh.

** Choose one score from each category and sum scores to determine developmental stage.

Western Larch

In some ways, western larch fills the niche occupied by ponderosa pine in environments too cold for the pine to tolerate (Van Pelt 2008, pg. 99). Old, but slender trees can be found rising above canopies of Engelmann spruce and subalpine fir at the upper elevations, elsewhere under more favorable conditions, the larch can dominate forest stands with subordinate mixtures of grand fir, lodgepole pine, and Douglas-fir (Van Pelt 2008, pg. 99 and 101).

Like ponderosa pine, western larch develops very thick bark with age. Mature trees often have the rugged, grayish-brown bark of a Douglas-fir (Figure 9) (Van Pelt 2008, pg. 101). Old trees, greater than 250 years, often develop the richly colored bark of a ponderosa pine (Figure 10) (Van Pelt 2008, pg. 101). However, the bark transformation from young to mature to old is not as consistent, nor as predictable, as that of ponderosa pine (Van Pelt 2008, pg. 101). Ultimately, bark characteristics must be used with other characteristics to determine approximate tree age (Van Pelt 2008, pg. 103)

Figure 9. Mature western larch (left) will often have bark that is difficult to distinguish from Douglas-fir (right) (Van Pelt 2008, pg. 102).

Figure 10. The bark of very old western larches (left) is often a mimic for ponderosa pine bark (right) (Van Pelt 2008, pg. 102).

While larch branches do not grow in a whorl-based manner, young trees still develop tiers of original branches. As the stand develops, lower branches are shed as they become shaded (Van Pelt 2008, pg. 106). Depending on the stand's density, the crown base often will recede at a rate comparable to the height growth of the stand (Van Pelt 2008, pg. 106). Similar to ponderosa pine, as the tree grows, bark begins to cover up the locations of these former branches.

As the maturing stand thins, light is able to penetrate below the living crown (Van Pelt 2008, pg. 106). Larches often respond by producing epicormic branches below the base of the live crown (Van Pelt 2008, pg. 106). Epicormic branches, which start from the cambium and not from terminal buds, often occur at the axils of branches and twigs, the sites of old branch wounds, or other locations where the bark is thin (Figure 11) (Van Pelt 2008, pg. 106). The crowns of mature western larch are often a combination of original and epicormic branches, a pattern that becomes accentuated as trees age (Van Pelt 2008, pg. 106). Because epicormic branches form on the outside of the trunk, they can grow in any direction, even tangential to the trunk. Original branches, in contrast, always form perpendicular (radially oriented) to the trunk. If many epicormic branches start from a common locus, a fan-shaped system of branches will result (Figure 12) (Van Pelt 2008, pg. 108).

Figure 11. Epicormic branches developing below the main crown in a maturing western larch (Van Pelt 2008, pg. 105).

Figure 12. Mature western larch. The graceful crown consists of original branches and an unmistakable radiating fan of epicormic branches adorning the base of the crown (Van Pelt 2008, pg. 106).

Crown complexity, arising from damage due to prolonged mistletoe infections or physical events, can assist in determining tree age (Figure 13) (Van Pelt 2008, pg. 109). In a manner similar to the production of epicormic branches, larches have the ability to produce reiterated trunks following crown damage (Figure 14) (Van Pelt 2008, pg. 109). A series of profiles have been prepared to illustrate the crown structures that can occur in western larch during its lifetime, including the variations imposed by site productivity and elevation (Figure 15).

Figure 13. Large limbs with mature bark are a sign of an old tree. In this case, the twisted shape resulted from an old mistletoe infection (Van Pelt 2008, pg. 109).

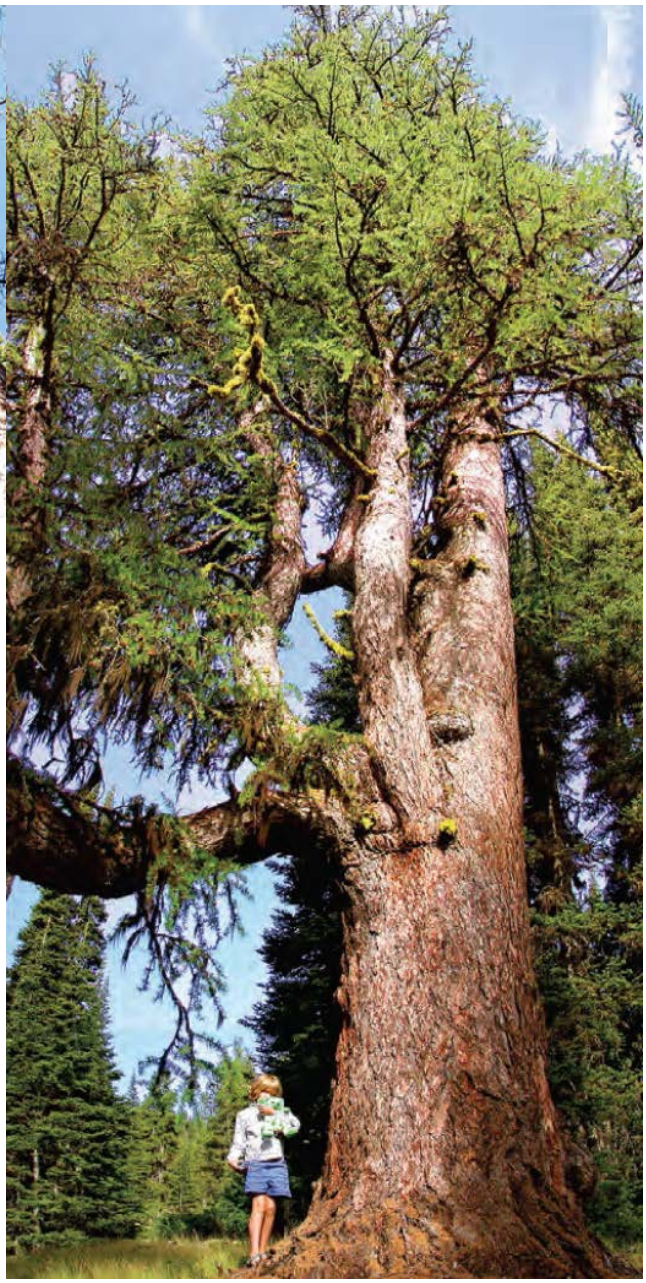
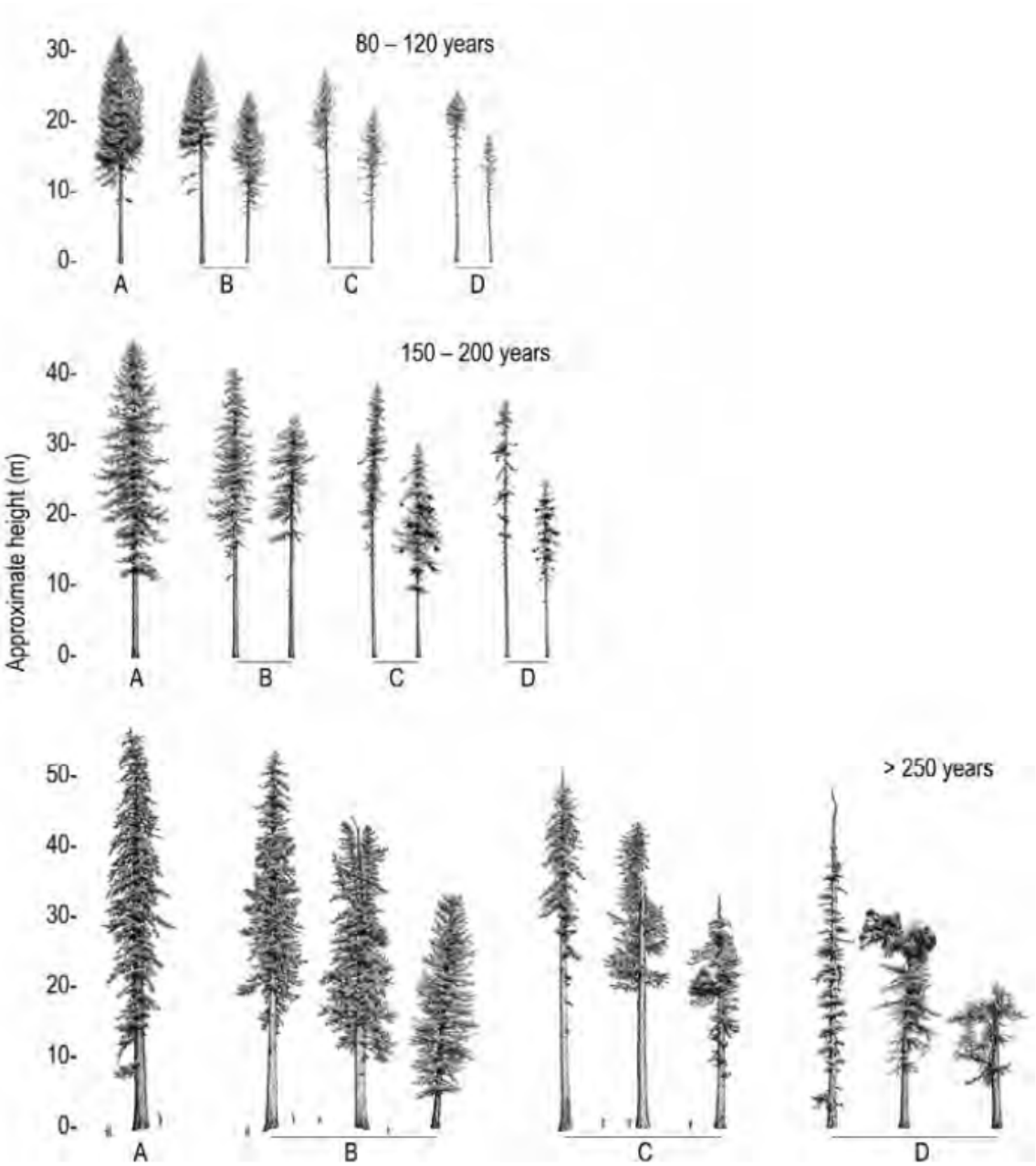


Figure 14. Reiterated trunk formation in western larches. Old trees can recover from crown damage by producing secondary trunks, as illustrated here (Van Pelt 2008, pg. 110).

Figure 15. Western larch crown form and tree vigor on the Payette National Forest. 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 through 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 image below.



Rating System for Determining Western Larch Legacy Trees

Lower Trunk Bark Condition*	**Score**
Hard, Bony Bark with Small Fissures	0
Hard Bark with Moderately Deep Fissures (2 to 4 inches)	1
Deep Fissures Present (>4 inches)	3
Maximum Fissure to Fissure Plate Width ≥6 inches	3
Knot Indicators on Lower One-third of Tree	**Score**
Branch Stubs Present	0
Old Knot/Whorl Indicators Visible	1
No Knot/Whorl Indicators Visible	2
Lower Crown Indicators	**Score**
No Epicormic Branches	0
Small Epicormic Branches Present	1
Large and/or Gnarly Epicormic Branches Present	2
Crown Form (Refer to Figure 15)	**Score**
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	
≥7 Legacy Tree	

* Determine bark conditions on the uphill side of tree near dbh.

** Choose one score from each category and sum scores to determine developmental stage.

Douglas-fir

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 (Van Pelt 2008, pg. 121). Old Douglas-firs are very fire-resistant, due largely to the protective bark that develops with age (Van Pelt 2008, pg. 123). In contrast, the thin bark of young trees offers little protection, even with low-intensity fires (Van Pelt 2008, pg. 123). The thin bark begins to thicken and develop vertical fissures as trees mature (Van Pelt 2008, pg. 123). For the first 100 to 200 years, the bark is hard and bony, and usually brown to gray (Figure 16) (Van Pelt 2008, pg. 123).

Figure 16. 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 (Van Pelt 2008, pg. 123).

Bark development in Douglas-fir reflects the wide range of conditions within which it occurs. In the drier parts of its range, particularly within the grand fir and Douglas-fir vegetation zones, the appearance of old trees can be quite different (Figure 17) from what may be seen in much wetter forests in its range. As a general rule, bark thickness in Douglas-fir is a more consistent feature than either the color of the bark on old trees or the physical characteristics of the outer bark.

Douglas-fir growth is whorl-based, like that of ponderosa pine (Van Pelt 2008, pg. 124). In Douglas-fir, the lower crown begins to recede once a stand has achieved canopy closure (Van Pelt 2008, pg. 124). 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 18) (Van Pelt 2008, pg. 124).

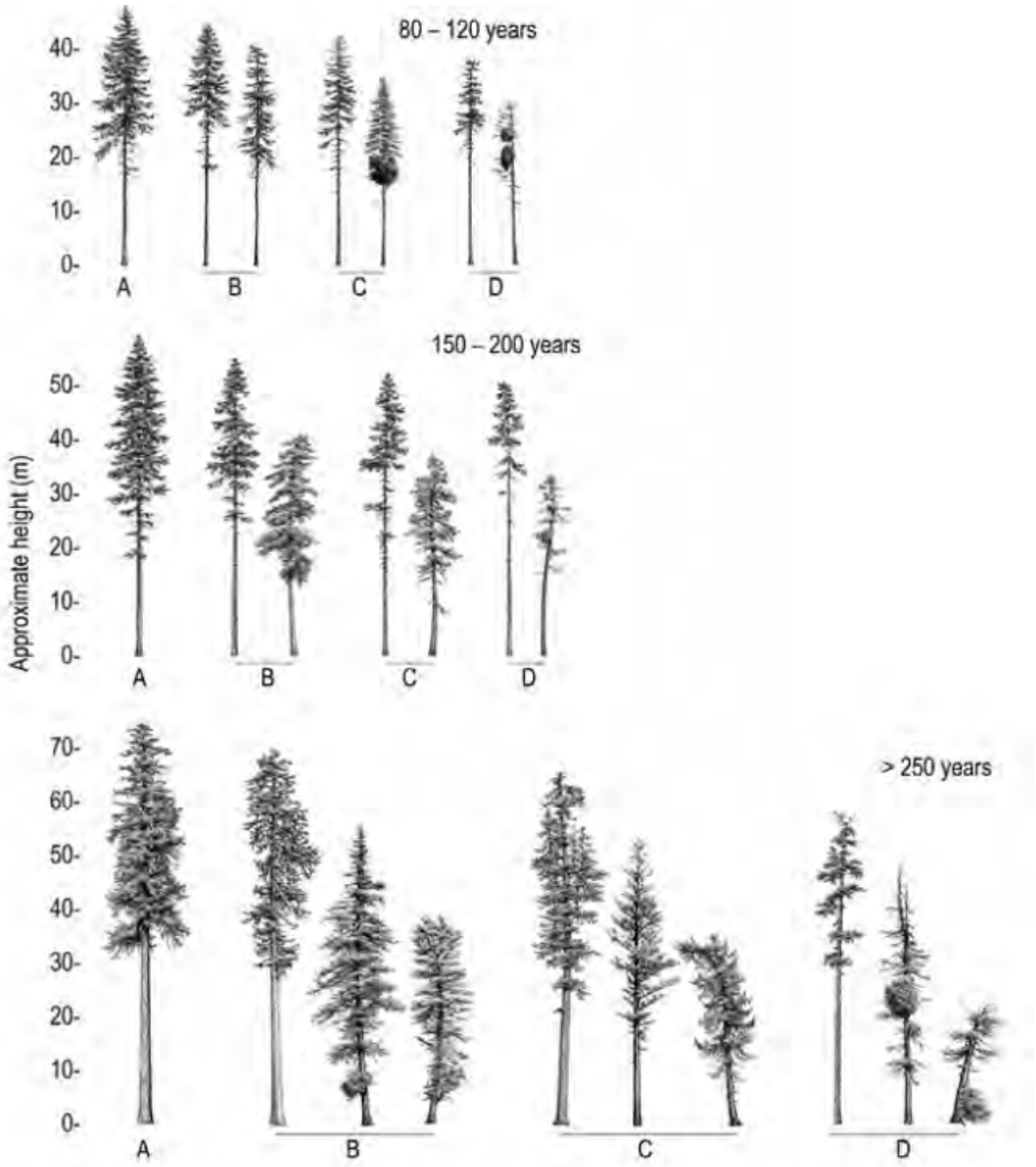
Figure 17. Hard, but thick bark is common on old Douglas-fir in the drier parts of its range (Van Pelt 2008, pg. 125).
Figure 18. Branch scars on a mature Douglas-fir. The locations of original branches that have since died and fallen off are still evident. One original live branch and some epicormic branches are still visible in this photograph (Van Pelt 2008, pg. 126).

Ultimately, branch scars are hidden by the continually expanding trunk after a period of several decades to more than a century (Van Pelt 2008, pg. 124). During that interval, the bark will be thinner at these spots than in the surrounding areas (Van Pelt 2008, pg. 125). If changes in the surrounding forest occur, such as the opening up of the canopy or the death of a neighboring tree, epicormic branches begin to form at some of these old wounds (Van Pelt 2008, pg. 125). 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 19) (Van Pelt 2008, pg. 125).

Figure 19. Epicormic branches. A fan of epicormic branches (visible at the base of the Douglas-fir crown) often indicates a tree in late maturity (Van Pelt 2008, pg. 126).

Crown profiles of Douglas-fir at three age classes and four vigor classes (A-D) are presented in Figure 20 (Van Pelt 2008, pg. 125). As with ponderosa pine and western larch, variation in crown structure is a function of age, productivity, and crown damage (Van Pelt 2008, pg. 125). Naturally, not all of the trees in one series will advance to the next (Van Pelt 2008, pg. 125). 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 (Van Pelt 2008, pg. 125).

Figure 20. Douglas-fir crown form and tree vigor on the Payette National Forest. 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 through 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 image below.



Rating System for Determining Douglas-fir Legacy Trees

Bark Condition, Lower One-third of Tree*	**Score**
Hard, Bony Bark with Small Fissures	0
Hard Bark with Moderately Deep Fissures (2 to 4 inches)	1
Deep Fissures Present (>4 inches)	3
Knot Indicators on Lower One-third of Tree	**Score**
Branch Stubs Present	0
Old Knot/Whorl Indicators Visible	1
No Knot/Whorl Indicators Visible	3
Lower Crown Indicators	**Score**
No Epicormic Branches	0
Small Epicormic Branches Present	1
Large and/or Gnarly Epicormic Branches Present	3
Crown Form (Refer to Figure 20)	**Score**
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	
≥7 Legacy Tree	

* Determine bark conditions on the uphill side of tree near dbh.

** Choose one score from each category and sum scores to determine developmental stage.