Fire in Eastern Washington Prior to Euro-American Settlement

Prior to the arrival of Euro-American settlers in the nineteenth century, fire was the primary type of disturbance driving forest configuration in the region. After a century of fire suppression, many forests make news only when a wildfire sweeps through an area (Figure 15). While stand-replacing fires were historically an important part of many of the forests in eastern Washington, they certainly were not as extensive as they are today.

Many old photos of the American West show pioneers traveling through park-like stands of ponderosa pine, suggesting that this was representative of forest conditions prior to Euro-American settlement (Figure 16). This is a mistaken view for several reasons. First, pioneers were often faced with primitive conditions with no roads and only a wagon or mule team with which to travel. A dense stand with logs strewn about would not have been their first choice of a travel path—open stands would have been the path of least resistance. Second, the open stands of

Figure 16. Historical photographs often show open, park-like stands of Ponderosa Pine, such as this one from the Blue Mountains. Photo courtesy of Baker County Library, Baker City, Oregon.

ponderosa pines were sunny, attractive, and easy to photograph. People always have felt a connection with the park-like stands of pine, and they still are among our most photogenic forest types. Hence, our historical photographic record is biased towards more attractive stands. From an economic point of view, ponderosa pine is one of the more valuable western trees, so these easily accessed stands were among the first to be logged. Park-like stands of pine still do exist—but they no longer are common (Figure 17). Perhaps this scarcity has further accentuated the allure of the old photographs.

Open pine stands were in fact a common forest type in eastern Washington prior to Euro-American settlement. Ponderosa pine defined the lower treeline throughout the eastside and was often the dominant tree species in the grand fir and Douglas fir zones as well. Fire-return intervals in many of these forests were short, so several to a dozen or more fires might occur in a century. Fuel loads within such a frequent fire regime are low, often present only in the form of branch wood, needle litter, grasses, and a few small trees. Under these ***low-severity fire*** conditions, fires often would creep along the ground and consume the relatively small amount of available fuel. Thick-barked trees like ponderosa pine or western larch often would be unaffected since the fire could not penetrate their bark. Of course, each fire was different and would occasionally jump into the crown and kill or weaken an old tree. These low-severity fires allowed old pine or larch forests to drift through time, seemingly unchanged (Figure 18). Certainly, individual trees would establish, grow, and die, but the overall impression of the stand endured.

Fire scars are often a characteristic of low-severity fire forests, and are an important record for future fire historians. Ground fires often leave charcoal on the outside of thick-barked trees, but this charring usually does not affect the living tissue (i.e., cambium, inner bark) underneath the protective bark. A fire scar, however, is evidence that the fire did kill some of the living tissue underneath. The tree responds to such a wound by converting the sapwood near the exposed area into heartwood. Future wood growth expands into the opening and begins to close over the wound (Figure 19). The juvenile bark on the newly forming edge next to the scar remains thin, however. In the event of another ground fire, the tree is likely to be wounded in the same spot. After centuries of repeated fire, the tree becomes a record of fire frequency within the stand (Figure 20). Fires may be more frequent than represented by the scarring pattern, since an individual tree may not have been affected by *every* low-severity fire that occurred. The record therefore represents a *minimum* for the fire frequency—a complete record requires an examination of many fire-scarred trees within a stand.

Active fire suppression efforts during the late nineteenth and most of the twentieth century have altered natural disturbance patterns in areas formerly governed by low-severity fires, with discernable results. The wide, mushrooming band of

Figure 17. Old-growth stands of ponderosa pine, now scarce, will only persist if actively maintained.

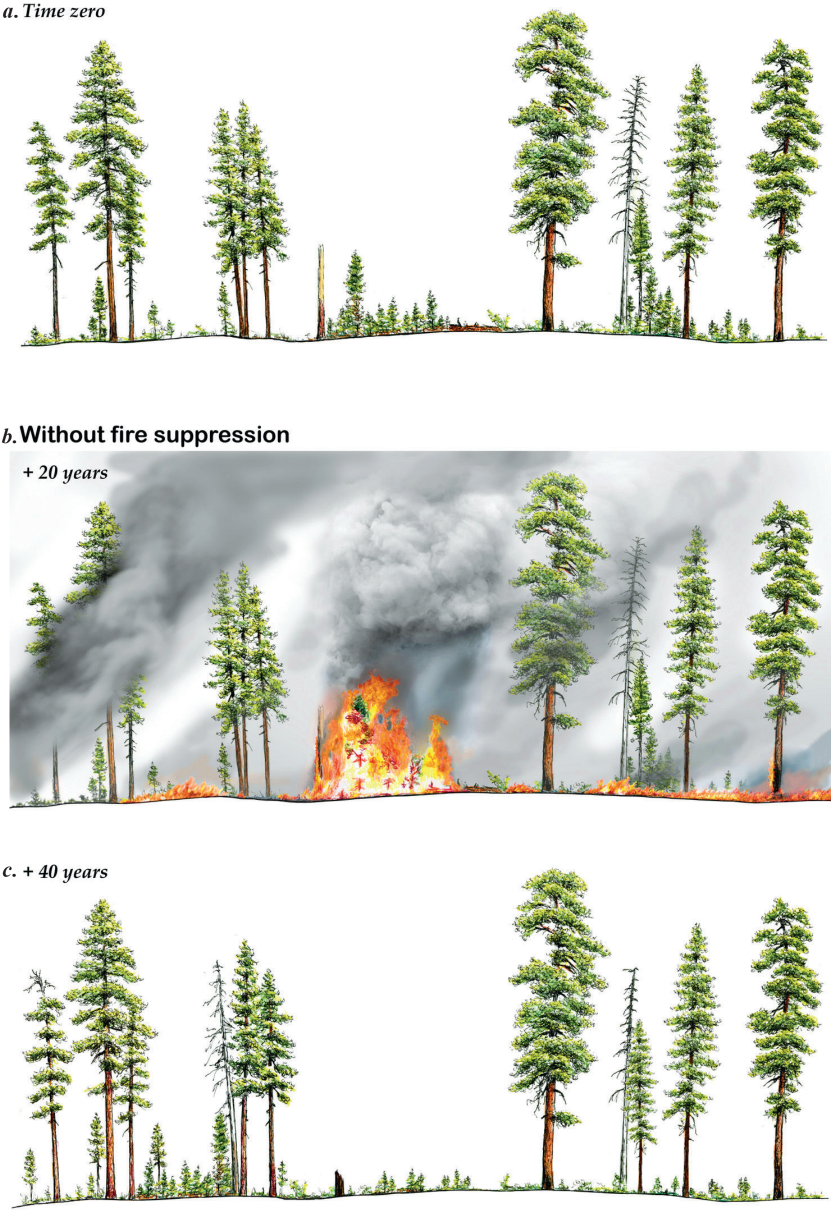


Figure 18. 80 years in an old-growth ponderosa pine forest. Historically, during one century, 2 to 15 ground fires of low to mixed severity would occur in a given stand. Crown fires were uncommon due to reduced fuels from the frequent ground fires. Panel ***a*** shows the profile of a hypothetical

d. ***+ 60 years***

e. ***+ 80 years***

f. **With fire suppression**

+ 80 years

old-growth pine stand. Panels ***b*** to ***e*** illustrate a scenario in which fire maintains the open stand. Although, after 80 years the profile resembles that at time zero, there are significant changes if one follows individual trees. Panel ***f*** illustrates the same forest over the same time period with no fire.

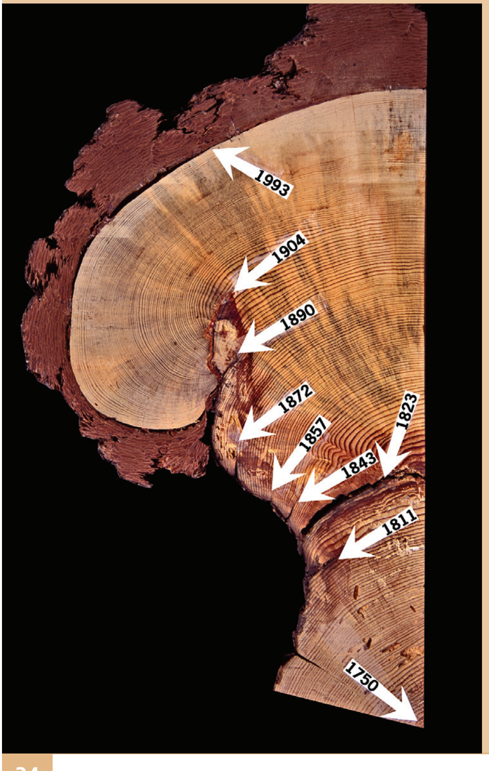


Figure 19 above. Growth pattern following a basal wound often results in a mushroom-shaped base, as this Douglas fir illustrates.

Figure 20 left. Fire scars, characteristic of low-severity events, provide an important record of fire history. Fires may be more frequent than represented by the scarring pattern, since an individual tree may not have been affected by ***every*** low-severity fire that occurred. The record therefore represents a ***minimum*** for the fire frequency; a complete record requires an examination of many fire-scarred trees within a stand.

wood visible up against the bark in Figures 19 and 20 has been benignly termed the ***Smoky Bear effect,*** due to its association with fire suppression. Far from aberrant, this mushrooming pattern is nearly universal in dry forest types throughout western North America. Changes at the stand-level are most often reflected in dramatic increases in stand densities (Figure 18f.).

Figure 21. Fire severity increases with return interval. As more time passes between fire events, understory fuels accumulate, resulting in hotter fires with increased flame lengths. This large ponderosa pine survived, but fuel loading can eventually allow fires to ascend into the main canopy, killing even large trees.

Conditions become increasingly wet at higher elevations or on north-facing slopes. With wetter conditions, fires are less likely to occur, the fire-return interval lengthens, fuels on the forest floor (logs, dead branches, needle litter, etc.) accumulate, and the number of newly establishing trees increases. These factors combine to increase both the intensity and severity of the next fire event (Figure 21). Higher flame-lengths under such a scenario increase the possibility that the fire will jump into the crowns of main canopy trees, possibly killing them. There is a positive correlation between longer fire-return intervals and the probability of a stand-replacing fire.

Figure 22. Pre-Euro-American settlement fire regimes in eastern Washington.

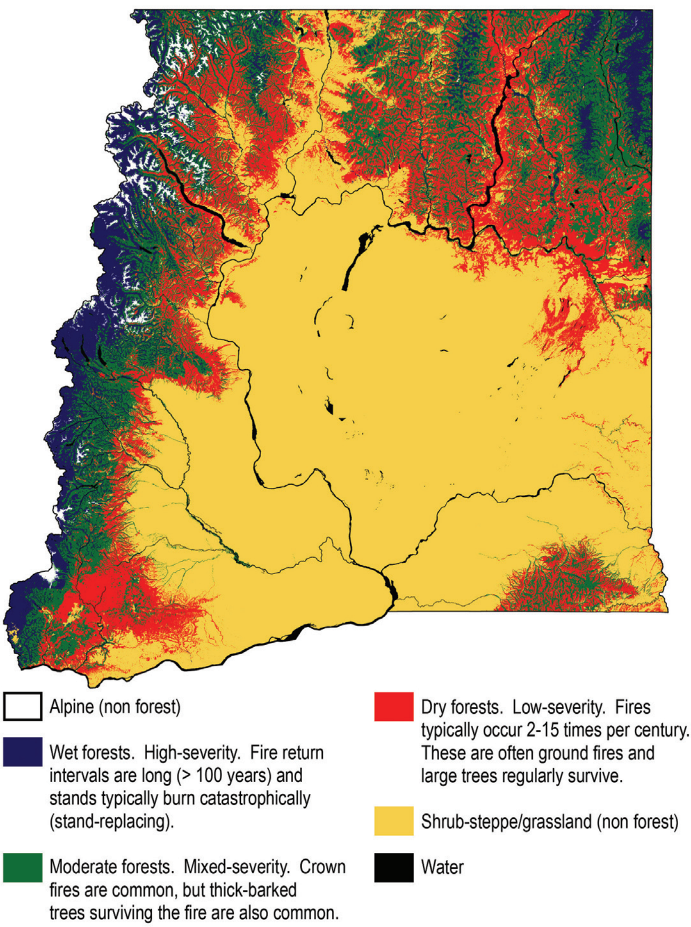
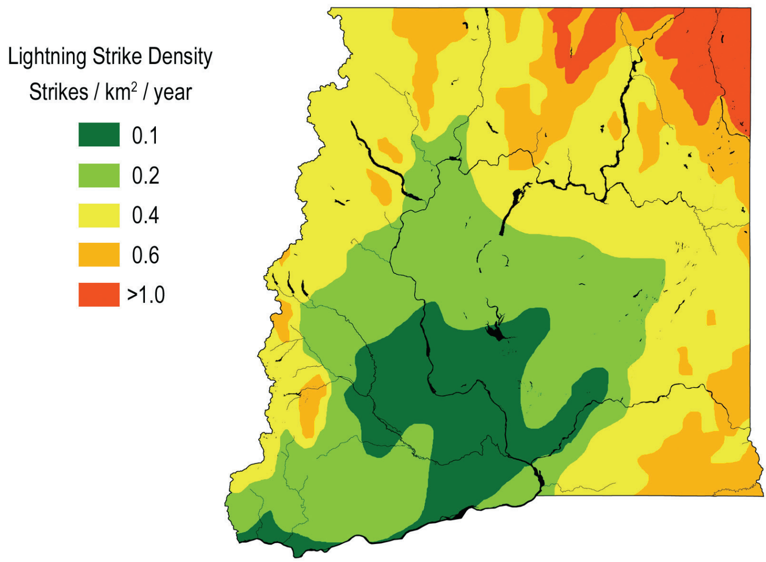


Figure 23. Lightning strike density for eastern Washington. Map derived from U.S. National Lightning Detection Network data.



Since both rain forest and desert conditions exist in eastern Washington, nearly every possible fire scenario is present in the region (Figure 22). Note the similarities between Figure 1 (annual precipitation) and Figure 22 (fire regimes). Precipitation is one of the strongest influences on both vegetation community structure and fire regimes. Other, more subtle patterns also are visible. Slope and aspect also can lead to differences, even in adjacent areas. A dense forest may develop on the cool, north-facing side of a ridge, for example, while the steep, south-facing slope may be too hot or dry to support anything but shrub-steppe vegetation. Sharp contrast also may exist between uplands and the adjoining valley bottoms, where soil moisture is higher from the adjacent stream or river, in addition to the cooler conditions created as cold air drains from the adjacent high mountains.

Ignition sources also are important to consider. Prior to Euro-American settlement, fires were either caused by lightning or intentionally set by Native

Americans. While in retrospect it is often difficult to separate these two (with some exceptions), Native Americans usually set fires for specific reasons in specific places, such as to maintain a desired habitat or vegetation structure for berry picking or hunting. Lightning distribution is more widespread, following a natural pattern as a function of climatic conditions conducive to the formation of cumulonimbus clouds. The frequency of lightning within the Pacific coastal states like Washington is lower than elsewhere in the United States, and as such, they are a poor place to study lightning. That said, there is considerable variation in the frequency of lightning strikes in eastern Washington (Figure 23). Fire probability increases with lightning frequency, all other things being equal. For example, a cedar-hemlock stand growing under the same precipitation regime would be more likely to burn in the Columbia Rocky Mountains than in the Cascades due to more frequent lightning strikes.

In ***mixed-severity fires,*** crown fires may kill portions of the forest while individual trees, patches of trees, or larger areas may only experience ground fires. Fire-tolerant species with thick bark, those located in particular landscape settings such as valley bottoms or ridges, trees with high crown bases, or a combination thereof are the trees most likely to survive (Figure 24). Stand age under low or mixed-severity fire regimes is defined not by the time since the last disturbance, but instead by the ages of trees that survived.

High-severity fires are stand-replacing events discussed in detail in the following section. Unlike low and mixed-severity fires, stand ages under a high-severity fire regime *are* defined by the time since the last disturbance. Survivors of high-severity fires become ***living biological legacies*** in the subsequent stand (Figure 25). A patch of trees missed or only under-burned during a large fire event will behave as a separate stand as the young, surrounding forest grows (Figure 26). The phrase ***legacy trees*** describes this subset of survivors.

Table 1 (page 27) summarizes under which fire severity regime each of the eastern Washington forested vegetation zones fall. Refer to this table to determine whether a stand-based (high-severity) or individual tree (mixed- and low-severity) approach should be used to determine approximate age.

Figure 24 above. Survivors within a burned-over landscape, Entiat River Valley. The open stand condition growing on the thin, rocky soils pictured in the upper left enabled some trees to survive the fire event. The remaining survivors were located in wetter areas associated with stream drainages and valley bottoms.

Figure 25 right. Living biological legacies. Large western larch survived a fire that led to the development of this dense lodgepole pine stand. Note the understory development of subalpine fir beneath the pines.

Figure 26. A patch of larches, spruces, and fir that survived the 85 km^2 (32.8 mi^2) White Mountain Fire of 1988. Survival was likely a result of slightly wetter conditions found near the stream drainage.