

Extent and Distribution of Old Forest Conditions on DNR-Managed State Trust Lands in Eastern Washington

December 2007



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December 14, 2007

Dear Reader,

Support and protection of habitat diversity has become a common goal for the people of Washington State and for Washington's Department of Natural Resources (DNR). One important element of the forest ecosystem is what we generally call 'old growth.' But what constitutes old growth has been of longstanding scientific interest.

Attached is the second of two reports to the Legislature (under 2004 and 2005 legislative direction) regarding old growth and older forest conditions on state lands managed by DNR. The first report addressed old growth forest in Western Washington. The current report includes definitions and an inventory of forested state trust lands east of the Cascade Crest (ESSB 6384 Section 189). For this work, DNR convened a scientific panel—the Old Growth Definition Committee—chaired by Dr. Jerry F. Franklin. The resulting report, "*Extent and Distribution of Old Forest Conditions on DNR-Managed State Trust Lands in Eastern Washington*," focuses on drier forest types dominated by ponderosa pine, western larch, and Douglas-fir. The panel found that roughly 13,000 acres—or 2 percent—of Eastside forested state trust lands are highly likely to have older forest characteristics; and an additional 20,000 acres—roughly 3 percent—are moderately likely to have older forest characteristics.

What has become apparent is that Eastside old forest is at high risk of loss due to wildfire and insects. This is mainly due to 150 years of fire suppression that has led to over-crowded forests. If we want a functioning old forest component in Eastside landscapes, stands with old trees need to be managed to re-establish a more sustainable fire- and disease-resistant condition. This is in contrast to our approach on the Westside, where our old-growth policy is to protect old-growth stands by leaving them in a more unmanaged condition.

Old growth is a very important ecosystem component that provides unique and crucial habitat, and performs specialized ecological functions in DNR-managed forests. Therefore, in addition to the inventory report, we requested that the committee prepare a companion document discussing opportunities and risks associated with sustaining old-forest functions on Eastside state trust lands. The report is expected early in 2008.

A field guide on identifying old trees and forests in Eastern Washington also is being finalized. It is a companion to the *Identifying Mature and Old Forests in Western Washington* field guide produced in summer of 2007. Both guides are authored by Robert Van Pelt. These field guides will be valuable to forestland owners and managers throughout the Pacific Northwest. As they are published, these reports and guides are available on DNR's website.

I greatly appreciate the time and work Dr. Franklin, Dr. Hemstrom, Dr. Van Pelt and other team members devoted to this effort. They have given us a valuable product that serves not only in identification and conservation of these important ecological conditions, but also will guide prudent stewardship for the sustainability of other DNR-managed forests as well.

Sincerely,

A handwritten signature in black ink, appearing to read "Doug Sutherland".

Doug Sutherland
Commissioner of Public Lands

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WASHINGTON STATE DEPARTMENT OF
Natural Resources
Doug Sutherland - Commissioner of Public Lands

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Executive Summary

An inventory was conducted of old forests on state trust lands in Eastern Washington managed by the Washington State Department of Natural Resources (DNR), in response to legislative direction (ESSB 6384, Section 189, 2006). This inventory was conducted with guidance from an independent science panel, chaired by Jerry Franklin of the University of Washington. As directed by the Legislature, the inventory was focused on the dry ponderosa pine-dominated forests but included other forest types as well. For the purposes of this inventory, forests were stratified by ecological and environmental parameters, including by plant association group and fire severity regime.

The DNR-managed forested state trust lands in the inventory were acquired at statehood and are managed to provide revenue for the public schools and universities in the state.

A century and a half of management, including logging, grazing and especially fire suppression across land ownerships in Eastern Washington has resulted in current forest conditions that are markedly different from historical conditions.

Because historical conditions no longer exist to any appreciable extent, the panel chose to describe historical conditions based on scientific literature, current conditions, and our best understanding of a sustainable future condition for dry mixed-conifer forests east of the Cascade Mountains crest. Old forest conditions within these drier forest types exhibit a gradient of old tree densities with a patchy distribution, making stand delineation impractical in many circumstances. For this reason, the panel referred to *older forest* rather than *old growth*, and focused attention on the individual tree rather than at the stand scale. Two additional reports on Eastern Washington old forest are anticipated in winter of 2008: a companion document from the panel commissioned by DNR on sustaining old forest functions on Eastside forested DNR-managed lands, and a field guide for identifying old trees and forests in Eastern Washington by Robert Van Pelt.

Old forest conditions on inventoried lands managed by DNR in Eastern Washington are summarized as follows:

- Roughly 13,000 acres (two percent) of Eastside forested state trust lands are highly likely to have older forest characteristics.
- An additional 20,000 acres (roughly three percent) of Eastside forested state trust lands are moderately likely to have older forest characteristics.
- The majority (roughly 76 percent) of the lands with moderate to high probability of having old forest characteristics are in drier environments that historically

experienced mostly low to mixed severity wildfire. A smaller portion (roughly 23 percent) occurs in higher elevation or moister areas that historically experienced mostly high severity wildfire.

- The highest concentrations of old forest conditions are observed in the Colockum ridge and Loomis forests, where harvesting has been less extensive.



Introduction

In 2004, the Washington State Legislature asked the Washington State Department of Natural Resources (DNR) to inventory and map old growth trees and forests on the lands that it manages using an old growth definition to be developed by an independent scientific panel (ESHB 2573, Section 905)¹. A report, titled “Definition and Inventory of Old Growth Forests on DNR-Managed State Lands,” was issued in June 2005 and included the old growth definitions and an inventory and maps of the old-growth forest on DNR-managed lands in Western Washington. Concerning old-growth forests in Eastern Washington, the report stated:

....substantial study is needed of old-growth issues on DNR-managed Eastside forests. Adequate old growth definitions do not exist for Eastside forest types. Additional field investigations are needed to provide this information... (Franklin et al. 2005, p. iii).

The Washington legislature responded to this report by directing DNR to develop old growth definitions and an inventory for DNR-managed lands east of the Cascade crest (ESSB 6384, Section 189)². The legislation specified a focus upon drier forest types dominated by ponderosa pine, western larch, and Douglas-fir. A scientific panel chaired by Dr. Jerry F. Franklin was convened to prepare this report. In addition, DNR requested that the panel prepare a companion report on the opportunities and risks associated with sustaining old forest functions on Eastside forestlands managed by DNR. The companion report is to be delivered to DNR in winter 2008.

Definitions for Old Trees and Stands East of the Cascade Mountain Crest

This report on the extent and distribution of old forest conditions on trust lands in Eastern Washington incorporates the results of two years of work by the panel on older forest

¹ See Appendix B

² See Appendix B

conditions east of the Cascade Mountains crest. Defining and inventorying older forest conditions in Eastern Washington required a different approach than that used in Western Washington because: 1) greater diversity in environmental conditions, tree species, and historic and current disturbance regimes generates highly diverse kinds of old forest attributes, structures, and functions; and 2) significant and geographically pervasive modification of Eastside forests across ownerships in the last century by such human activities as fire suppression, logging, forest planting, and grazing means that few, if any, existing old forests of the dry mixed-conifer forest types retain useful reference conditions. The near absence of sites that might provide reference conditions similar to those that occurred prior to 1850 provided a particular challenge: it is difficult to provide definitions for old growth where its character and function have been fundamentally altered by past management. For this reason, the panel developed historic reference conditions for the dry forest types based upon scientific and historic studies, given the absence of stands of sufficient quality to fulfill the role of a reference stand. The panel will use the terms *historic conditions* and *current conditions*, and define *future sustainable* older forest conditions based upon what could be restored and sustained using silvicultural approaches.

Historic conditions are described from the scientific literature based upon photographs, accounts of tree ages, stand structures, inventories and other research, and historic descriptions. From these sources we have an understanding of the structure and composition of forests on ponderosa pine and dry mixed-conifer forest sites. Compared to Westside old-growth forests (Franklin et al. 1981), old-growth forests in drier Eastside environments historically had: 1) fewer large old trees per acre and smaller old trees in general, 2) fewer large standing dead trees, 3) fewer down logs, and 4) simpler canopy structure (Agee 1993, Covington and Moore 1994, Hann et al. 1997, Hessburg et al. 1999, Hessburg and Agee 2003). Fuel accumulations were controlled by the relative frequency of wildfire in such forests, which generally resulted in lower intensity fires. Such frequent, low intensity fires characterize the low severity fire regime.

Several existing descriptions of old forests in similar dry environments describe the kinds of structures to be expected in interior Washington (Smith et al. 1991, Green et al. 1992, Mehl 1992, Potter et al. 1992, Hamilton 1993, USDA 1993, Arno et al. 1997, Agee 2003). In these relatively dry settings, large, old, widely spaced ponderosa pine, western larch, or Douglas-fir dominated old forests. Thick bark allows large specimens of these species to survive most low and moderate severity wildfires. Because frequent wildfires also consumed much of the dead wood, large snags and down logs were generally not abundant. Wildfires typically killed a few large trees where fuels were locally abundant or due to some other factor, which resulted in small openings with patches of regenerating conifers and dead wood. Most of the basal area in old forests was in large trees, which existed in a fine-scale mosaic or patchwork of varying all-aged or even-aged stands.

Current conditions represent the current conditions of forests and are largely the result of past management, including fire exclusion. The historic open condition has been largely replaced by recruitment of patches of smaller, younger trees, predominantly of shade-tolerant species. This dynamic ultimately results in a denser forest and greater canopy closure. The uncharacteristically high stem densities of the current stands typically result in much heavier loadings of ground, ladder, and crown fire fuels than existed historically. These denser conditions make the forests and any remnant old trees much more vulnerable not only to

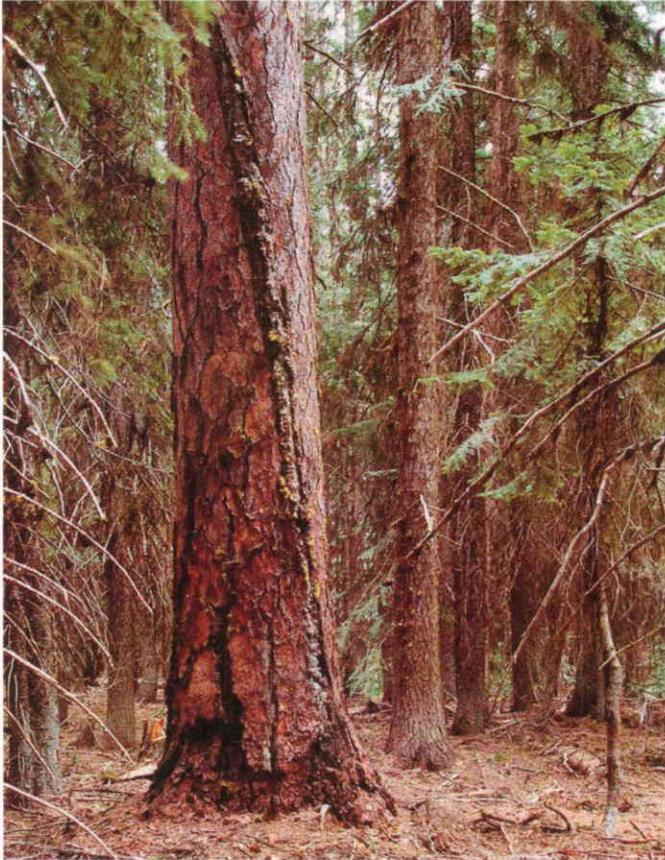


Figure 1. An example of current conditions in Eastside forests characterized by a dense stand of young Douglas-fir and grand fir that has grown up around an old western larch. The density of the young trees not only increases the larch's vulnerability to fire through heavy fuel loading, but also increases its risk of loss to insects due to competition-induced stress. Photo by Robert Van Pelt.

stand-replacement fire but, also, to insect outbreaks (especially bark beetles) because of competition among the closely spaced trees for water and nutrients. Inventory estimates of old forest conditions on Eastside lands managed by DNR are based on current conditions. The inventory of current conditions should not be taken as an indication of old forest area that might be sustained given risks of loss to wildfire and insect outbreaks (Figure 1).

A **sustainable future condition** on Eastside pine and dry mixed-conifer forest sites could be developed by silvicultural restoration to a less dense fire- and insect-resistant condition. This could be done by removing many of the smaller trees, primarily by logging since fuel loadings are too high in many places to allow for re-introduction of fire. Prescribed fire may have a subsequent role in maintaining desired conditions once fuels have been reduced through logging. It would not necessarily be desirable to mimic **historic** conditions, given a context of changing climate and human objectives (such as providing habitat for northern spotted owls). However, the committee believes that many of the ecological attributes of Eastside dry-site old-growth forest can be restored and subsequently maintained through site-specific treatments designed to improve fire and pest resistance. These conditions and a

discussion of risks and opportunities for managing old forest conditions on Eastside lands managed by DNR will be presented in a subsequent report to DNR from the panel.

Patches of older forest within the drier forest types often contain relatively few trees per acre

and exist within a gradient of tree densities that makes delineation of distinct stands difficult. This is particularly true when attempting to classify the age of a small patch of older trees within forests dominated by smaller and younger trees. Consequently, the panel chose to use the term “old forest” rather than “old growth” and focus on the importance of individual old trees rather than stands of trees. The panel defined any tree that originated prior to 1850 as an old tree, matching the approach taken in the Westside old growth definition.

The panel used a combination of three descriptors—tree species, trees per acre, and tree diameter (DBH)—for an initial inventory of areas that might contain old forest characteristics. We called the resulting estimated acreage “potential old forest” because there is a well documented poor correlation between tree diameter and tree age and because the inventory is only a sample rather than a census of forest conditions. We used three tree diameter classes to screen sampled trees according to the likelihood that they originated prior to 1850: 1) trees less than 30 inches DBH are unlikely to be old, 2) trees between 30 and 40 inches DBH likely have some characteristics of old trees and may be old, and 3) trees over 40 inches DBH are very likely to be old. This classification is not perfect because tree diameter and age are only roughly correlated. For example, we found highly productive sites that support ponderosa pines and other species of substantial size that were scarcely 100 years old. Despite their great girth, these trees lacked the bark and branching characteristics that typify truly old trees (Van Pelt in press). The latter characteristics, however, are not captured in inventory data and are useful only for on-site determinations. Similarly, we identified old trees (i.e., that originated prior to 1850) that were less than 40 inches DBH. Our field observations indicate that trees over 40 inches DBH are either old or are prime candidates for recruitment into the old tree class within a few decades. Additionally, we found numerous trees that originated prior to 1850 but that were less than 40 inches DBH. For this reason, we established a threshold of 30 inches DBH to capture old trees that grow on less productive sites (and do not attain great diameters) and comparatively younger candidates for potential recruitment to old forest condition.

Old forest in higher elevation stand-replacement fire regime forests (Engelmann spruce-subalpine fir and Pacific silver fir forests) can be defined by its structure and stand development stage. For the purposes of this guide, old forest is defined as the horizontal and vertical diversification and pioneer cohort loss stand development stages, for these forest types. Detailed descriptions of these stages and how to recognize them are included in *Identifying Old Trees and Forests in Eastern Washington* (Van Pelt in press).

The western redcedar-western hemlock forests of northeastern Washington often have a stand development pattern which may begin following a stand-replacement disturbance, but become truncated by wildfire before reaching old growth stand development stages as described above. Old trees may persist in riparian areas or other fire refugia. A definition of old growth for this forest type is therefore more accurately applied to individual trees than to entire stands.



Inventory of Old Forests on DNR-managed State Trust Lands in Eastern Washington

The estimates of currently existing old forest conditions on lands managed by DNR in Eastern Washington come from an inventory screening designed to identify the presence of large diameter seral trees which indicate the likely presence of old forest structures. Unlike Western Washington, where whole stands often exhibit old growth character, old forest characteristics in Eastern Washington are frequently associated with individual trees or clusters of trees within larger landscapes, particularly in drier environments. The inventory screening approach is designed to generate estimates of areas that may contain old forest characteristics by focusing on the presence and abundance of large, and potentially old, ponderosa pine, western larch, and (to a lesser degree) other tree species. While this approach provides useful estimates about the current extent and general location of areas that might contain old forest attributes, it does not supplant the need for field examination and verification. The guide to identification of Eastside old forests developed by Dr. Robert Van Pelt (in press) should be used by DNR foresters and inventory specialists to confirm old forest characteristics in the course of normal field work.

Methods

Environmental Strata

Disturbance regimes play strong determining roles in the development of old forest characteristics east of the Cascade Mountains crest. Fire frequency and severity, in particular, influenced historical old forest conditions in Eastside forests. The panel divided Eastside forests into three major environmental strata to reflect differences in reference, current, and sustainable old forest conditions. The panel linked environmental strata to published descriptions of plant associations (Table 1).

Table 1. Plant association groups, historic fire regimes, historic fire return intervals (from Hessburg and Agee 2003) and estimated current fire regime on DNR-managed lands east of the Cascade Mountains crest.

| Old forest plant association group name | Historic fire regime ¹ | Historic fire return interval in years | Current fire regime |
|---|-----------------------------------|--|---------------------|
| Oak | low | unknown, probably < 50 yrs | mixed |
| Ponderosa pine, oak | low | 16–38, 7–20, 11–16, 3–36 | mixed |
| Ponderosa pine-Douglas-fir (dry grand fir) | low | 7–11, 10, 10–24, 14, 8–18 | high |
| Aspen | mixed | unknown, probably <150 yrs | mixed |
| Douglas-fir-subalpine fir-lodgepole pine | mixed | 60 | high |
| Western redcedar-western hemlock, NE Washington | high | 50–200+, 50–100, 150–500 | high |
| Grand fir moist, east Cascades | mixed | 16, 47, 33–100, 17, 100–200 | high |
| Western hemlock, east Cascades | mixed | 50–200+, 50–100, 150–500 | high |
| Mountain hemlock-Pacific silver fir | high | 50–200+, 50–100, 150–500 | high |
| Engelmann spruce-subalpine fir | high | | high |
| Douglas-fir- subalpine fir, lodgepole pine, | mixed | 25–75, 109–137, 140–340, 250, 50–300 | high |
| Subalpine parklands | mixed | unknown | mixed |

¹Low = 0-25 percent stand mortality. Mixed = 25-75 percent stand mortality. High = more than 75 percent stand mortality.

Fire regimes reflect the dominant fire severity class. Note that every fire severity class occurs in all old forest plant association groups. The dominant type is the characteristic condition that generated or generates the majority of stand/forest conditions.

Characteristics of Forest Types in Eastern Washington

- 1) **Dry ponderosa pine forests.** Ponderosa pine is the sole dominant early and late successional conifer in the driest forested environments. Forests in these environments generally have little or no representation of other tree species (Williams and Lillybridge 1983, Lillybridge et al. 1995, Williams et al. 1995). Dry ponderosa pine forests (i.e., climax ponderosa pine sites) are uncommon on DNR-managed state trust lands in Eastern Washington, but occur at the low elevation forest fringe; they are abundant in Eastern Oregon and other parts of the interior west (e.g., Hopkins

1979a, b, Williams and Lillybridge 1983, Volland 1985, Johnson and Simon 1987, Johnson and Clausnitzer 1992, Lillybridge et al. 1995, Williams et al. 1995).

Historic wildfires in dry ponderosa pine forests were generally frequent and of low severity, with seven to 38 year fire return intervals (Hessberg and Agee 2003) (Table 1). However, most forest landscapes, even in dry ponderosa pine environments, included some level of mixed and high severity wildfire under natural conditions. In dry ponderosa pine and dry mixed-conifer stands, this often resulted in a patchy

landscape with stand level mosaics dominated by open forests of large trees with patches of smaller trees (Hann et al. 1997, Hessburg et al. 1999) (Figure 2).



Figure 2. An example of a patchy landscape with an open area of large trees in the foreground and dense patches of small trees in the background. Such areas were typical in historic landscapes subject to at least some mixed or high severity fire. Photo by Robert Van Pelt.

The driest forest environments grade into sparse woodlands of ponderosa pine, western juniper, and Oregon white oak, depending on location and environment. In the southern portion of the eastern Cascade Range (such as the Klickitat River area), Oregon white oak and ponderosa pine often form locally extensive woodland plant communities. Under natural conditions, these woodlands were maintained in open structure by summer drought and frequent wildfire (Hemstrom et al. 1987, Agee 1993), and historically had old forest structure similar to the dry mixed-conifer forests described below. Burning by native people may have been an important component of the fire regime prior to 1850 (Agee 1993).

- 2) **Dry mixed-conifer forests.** Douglas-fir, grand fir, and ponderosa pine can regenerate beneath the low density canopies of old ponderosa pine on slightly moister sites, which are often

referred to as “dry mixed-conifer sites” (Williams and Lillybridge 1983, Lillybridge et al. 1995, Williams et al. 1995). While the Douglas-fir or grand fir easily regenerate

in the understories of dry mixed-conifer forests, under historical conditions frequent low severity wildfire destroyed most of this regeneration and generally maintained open stand structures. The historic wildfire regime is characterized as low to mixed severity with fire return intervals of 10 to 50 years or more, depending upon local conditions and chance (Agee 1993, Agee 2003, Hessburg and Agee 2003). Since dry mixed-conifer forests occur on more moist and productive sites than dry ponderosa pine forests, forests on these sites typically incorporated more and larger trees and higher large and total tree basal areas under historic conditions than was the case on climax ponderosa pine sites. Otherwise, old forest structure and composition in dry ponderosa pine and dry mixed-conifer sites was similar under historic conditions (Figure 3).

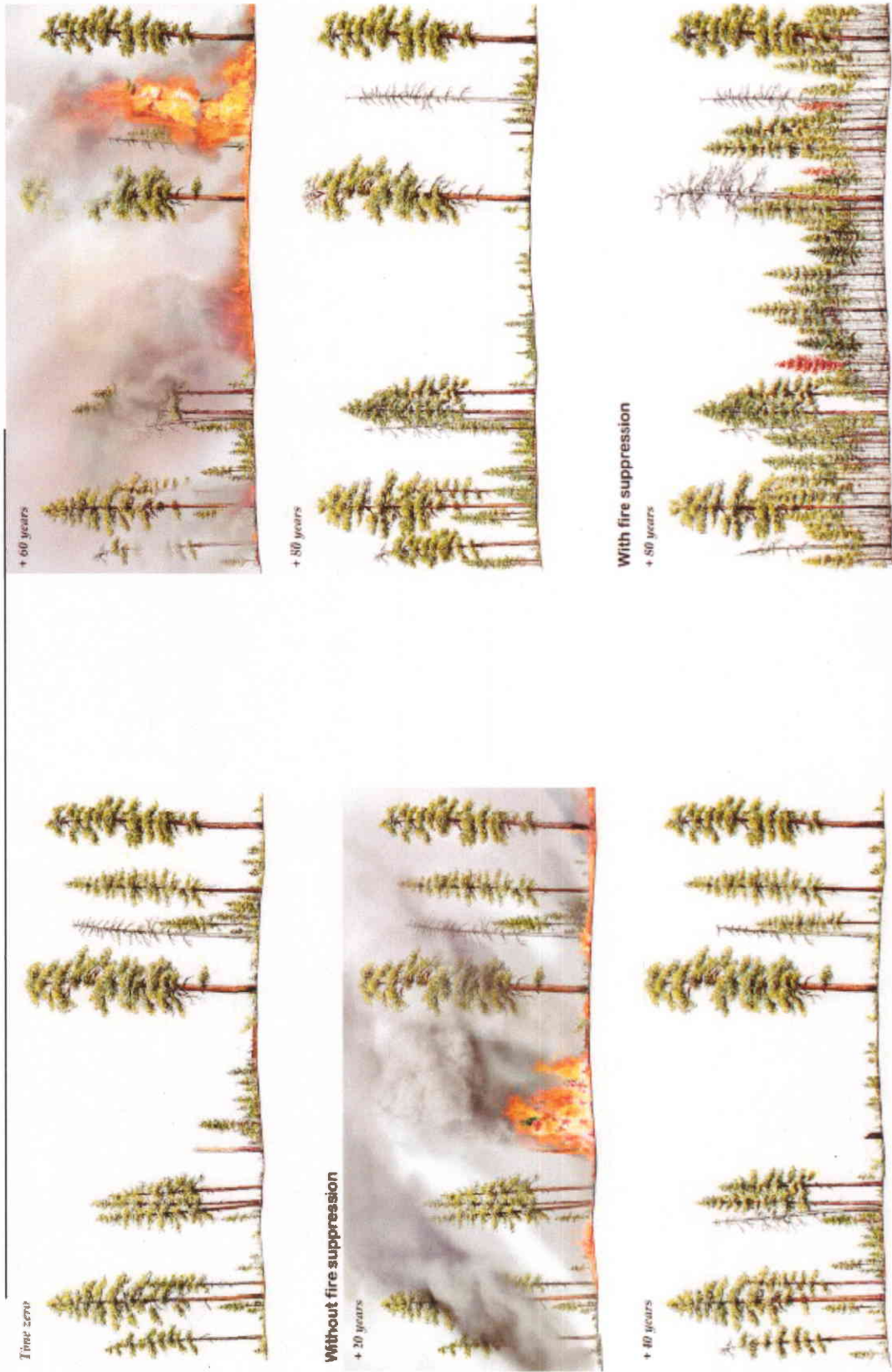


Figure 3. Eighty years in the life of an old-growth ponderosa pine forest. Historically, two to fifteen fires could occur during a century within a given stand. While an occasional crown fire could occur, frequent fires and the open nature of the stands made this scenario uncommon. The upper panel is the profile of a hypothetical old growth pine stand. The next four panels illustrate a possible scenario in which fire maintains the open nature of the stand. Note that although the +80 years panel looks superficially like Time zero, there have been significant changes. The final panel is a hypothetical illustration of the same forest with no fire. Illustration by Robert Van Pelt.

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- 3) **Moist mixed-conifer forests.** Grand fir and Douglas-fir were and are important stand components in relatively moist mixed-conifer forests. Ponderosa pine may also be important, but was probably more prevalent historically in this stand type than it is today. Moist mixed-conifer forests occur in areas of higher precipitation, at higher elevations or on cooler and moister aspects or topographic conditions, compared with dry ponderosa pine and dry mixed-conifer forests. Generally, forest productivity is also higher and historical wildfire return intervals longer than on the drier types. Consequently, old forests in moist mixed-conifer sites likely had larger trees, higher basal area of large trees, more abundant small trees, and more standing and down dead wood compared with those in drier environments (Figure 4). At the wettest end of the moist mixed-conifer spectrum, the forests grade into types in which old forest characteristics are best characterized by Westside stand-level structurally based old-forest definitions (Franklin et al. 2005).

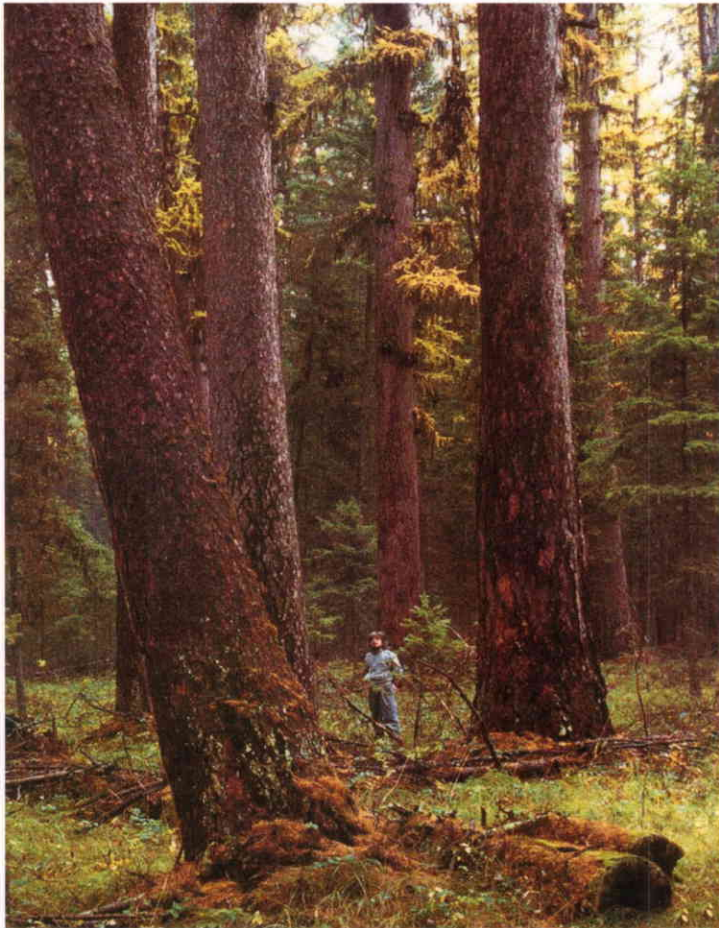


Figure 4. An example of a moist mixed-conifer stand. Tree diameters are larger and down logs more abundant in these moist environments. Photo by Robert Van Pelt.

Wildfires were less frequent and fuel loads higher under historical conditions on moist mixed-conifer sites compared with drier forest types. Moist mixed-conifer forests typically experienced a higher proportion of mixed severity wildfire compared to forests on drier sites. Hessburg and Agee (2003) described the historical wildfire regimes of the Douglas-fir and grand fir series (most of the moist mixed-conifer forests) as low to mixed severity with fire return intervals that ranged from less than 10 to more than 100 years.

Western larch often is an important component of dry Eastside forests at higher elevations (Williams and Lillybridge 1983, Lillybridge et al. 1995, Williams et al. 1995) (Figure 5). Large, old western larches have thick, fire-resistant bark and frequently survive low to moderate intensity wildfires. Under historical conditions, western larch filled an ecological role at upper elevations similar to that of ponderosa pine at lower elevations. Because western larch forests occurred in upper elevation environments, fire regimes tended to be mixed severity because fuel loads were higher and fires less frequent. Otherwise, old forests dominated by western larch under historical conditions had structures similar

to those found in Eastside moist mixed-conifer environments.

- 4) **Stand-replacement fire regime type forests.** Several plant community series (based on potential natural vegetation) with stand-replacement fire regimes are important components of Eastside forested landscapes managed by DNR. A stand-replacement



Figure 5. Western larch is a component of many higher elevation stands in Eastern Washington. Photo by Robert Van Pelt.

or high severity fire regime is one in which infrequent, intense wildfires kill most of the trees. Engelmann spruce-subalpine fir forests occur at upper elevations in environments dominated by long winters, deep snow,

and relatively continental climates throughout the Eastside (Barbour and Billings 2000, Hemstrom 2003) (Figure 6).

Extensions of several Westside forest types with stand-replacement fire regimes occur just east of the Cascade Mountains crest and in the extreme northeastern corner of

Washington, including mountain hemlock, Pacific silver fir, western hemlock, and western redcedar-western hemlock forests.

Historic fire return intervals in these forest types typically exceeded 100 years and fires were usually of high and mixed severity. Old forest structures in these forests were similar to those found in Westside Douglas-fir and western hemlock types and included multiple canopy layers, abundant large old trees, abundant large standing snags (dead trees) and abundant down dead wood.

Historically, many riparian and lodgepole pine forests also experienced high severity, stand-replacement wildfire regimes. Eastside riparian forests are highly variable. Those dominated by conifers are similar to upland forests within the same vegetation zone, but those dominated by a mix of conifers and/or hardwoods (cottonwood or species of alder, birch, maple, or willow depending on environment) may require