RESOURCES

NATURAL

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

December 2007

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

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WASHINGTON STATE DEPARTMENT OF
Natural Resources

DOUG SUTHERLAND
Commissioner of Public Lands

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.

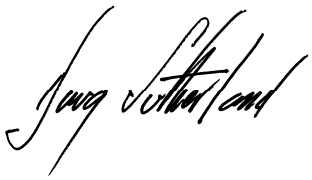
What has become apparent is that Eastside old forest is at high risk of loss due to wildfire and insects. This is mainly due to 150 years of fire suppression that has led to over-crowded forests. If we want a functioning old forest component in Eastside landscapes, stands with old trees need to be managed 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,



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

December 2007

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Contents

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 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).

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.

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

[1]Low = 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).

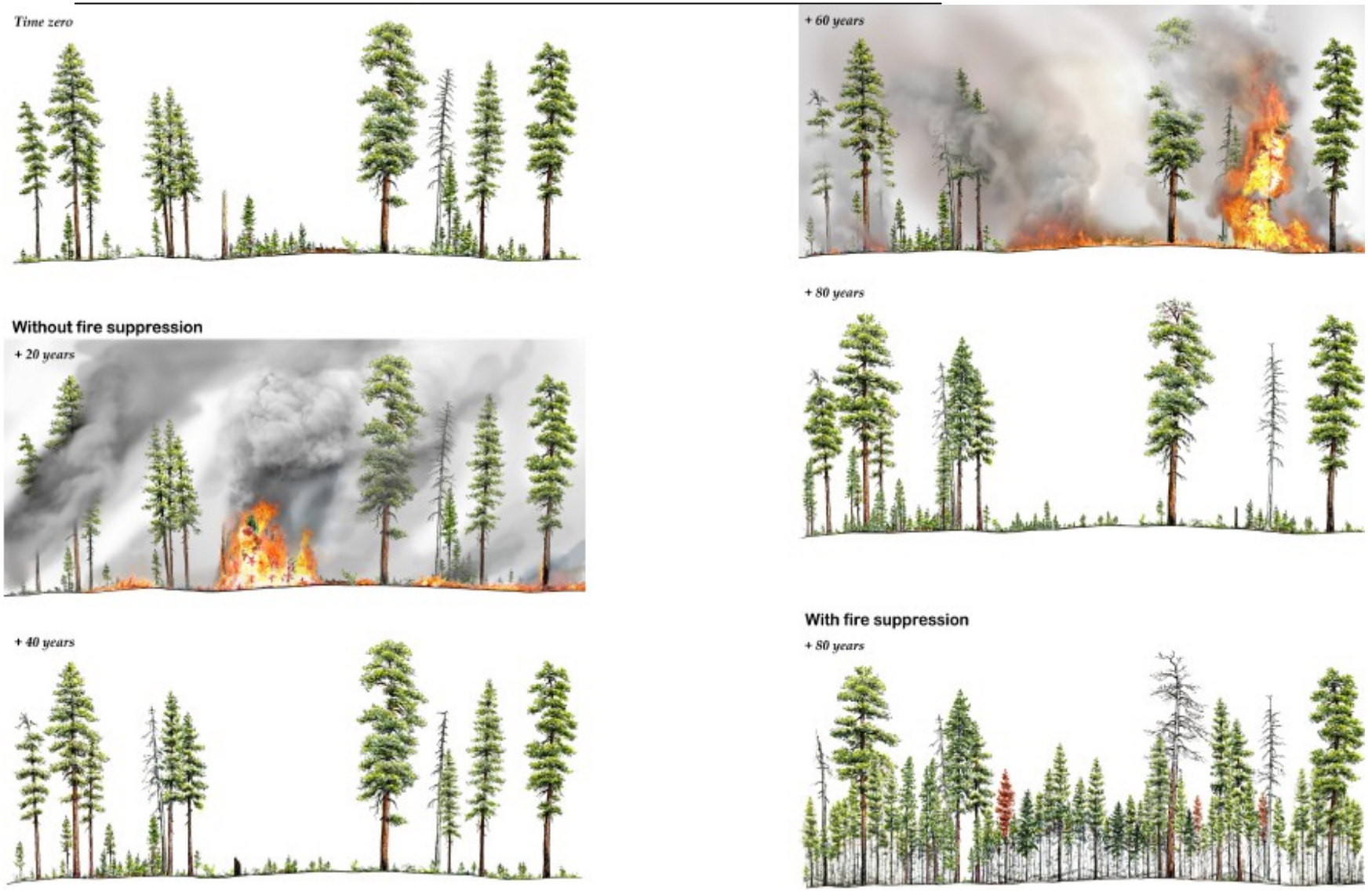

Figure 3. Eighty years in the life of an old-growth ponderosa pine forest. Historically, two to fifteen fires could occur during a century within a given stand. While an occasional crown fire could occur, frequent fires and the open nature of the stands made this scenario uncommon. The upper panel is 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.

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 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.

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

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

modified Westside old forest definitions to account for quicker decay of large dead hardwoods, differing canopy structures, and variable species composition. These forests are not a substantial part of most Eastside landscapes and the panel has not included old forest definitions for them in this document.

Figure 6. An example of an Engelmann spruce-subalpine fir forest, a stand-replacement fire regime forest, with a structure similar to Westside old growth forests. Photo by Robert Van Pelt.

Lodgepole pine forests occupy large areas at middle to high elevations in drier portions of the Cascade Range and in the forested landscapes of northeastern Washington. Generally this forest type is replaced successionally by other forest types. Historically, most lodgepole pine forests experienced fire return intervals of less than 100 years. The fire regimes ranged from mixed severity to stand-replacement regimes (Hessburg and Agee 2003). Due to aggressive infilling with other tree species, relatively frequent stand replacement wildfire, and insect outbreaks (Agee 1993), the forests dominated by lodgepole pine in Washington seldom exceed 200 years in age, in contrast to those found farther east in the Rocky Mountains and elsewhere (e.g., Kaufmann 1996). Hence, the panel has chosen to deal with lodgepole pine forests as a type that generally lacks an old growth condition. Instead, these forests transition to some other forest type that does have an old growth condition (e.g., subalpine fir-Engelmann spruce).

Inventory Design and Analysis Scale

DNR's Forest Resource Inventory System (inventory) in Eastern Washington is based on a strategy that identifies stands defined by similar physiographic and vegetative characteristics. Stands range in size from five to 300 acres. They are delineated by a polygon boundary and are mapped using stereo photo analysis, which incorporates slope, aspect, and elevation along with canopy texture, height and uniformity.

Each stand is considered a population, and in most cases a grid of equidistant points is placed within the stand to establish a sample of five to 30 sample points (plot locations). Field sampling at each point captures observations about the characteristics of trees (both live and dead), understory vegetation, woody debris, and plant association. Parameters such as trees per acre are calculated at both plot and stand levels.

Figure 7. Large old trees such as this ponderosa pine are relatively rare on most land ownerships in Eastern Washington. Photo by Robert Van Pelt.

Large old trees (Figure 7) are relatively rare on Eastside landscapes. While the inventory does identify trees of large diameters where they occur on sample points, the patchy distribution of such trees makes detection at the stand scale difficult because the values of all the plots in a stand are averaged. Due to the rarity of large trees in the sample data, we used individual plot data to capture more instances where large trees are present. To estimate the area of older forests, we used the area that a sample plot represents within each stand, averaging approximately five acres per plot.

Consequently, our screening process may somewhat underestimate the extent of older forests on Eastside DNR-managed state trust lands.

Inventory Parameters Indicating Old Forest Structure

The inventory was not specifically designed to capture old growth characteristics, and while it does include data on tree ages, this data does not necessarily reflect the ages of the oldest trees in the stand, due to the nature of the sampling methodology. Because of this, screening for old forest must rely on forest structure, rather than age.

The old forest screens rely on the presence and abundance of large diameter trees, particularly of ponderosa pine, western larch, and Douglas-fir (seral species). We assumed that the presence of snags, downed wood and multiple canopy layers indicate old forest potential in higher elevation and/or moister environments. For this reason, we developed a large diameter tree scoring process for use at both point and stand scales.

We also tested the Weighted Old Growth Habitat Index (WOGHI), developed for use in Western Washington, to see how well it might work for Eastside old forests. As analysis and field inspection progressed, we found that diameter scores better represented old forest characteristics except in high-elevation and very moist forest types. Consequently, we used the diameter approach for most Eastside forest environments and WOGHI only for the very moist, Westside-influenced forests in the Columbia Gorge area west of the White Salmon

River. The WOGHI was used at the sample point level, rather than the stand level. Depending on the number of sample points in an inventory polygon, the occurrence of large old trees can be diluted when sample point values are averaged to achieve stand-level scores. This dilution occurs where the majority of plots within an inventory polygon do not show evidence of large diameter trees. Using a plot level approach captures more instances where large trees are present. Because the plot locations are known, a technique is applied establishing an area represented by the plot. In this way, the large tree presence can be represented at a finer scale across the landscape.

Indices for the highest elevation forest types, Engelmann spruce-subalpine fir and Mountain hemlock-Pacific silver fir plant association groups, are still under development, and will be included in the panel's companion report on sustaining older forest structure and function.

Table 2. Screening methods used to determine old forest potential

Old Forest Plant Association Group	Screening Method
Aspen	Large Diameter Tree Scoring
Western hemlock east Cascades	Large Diameter Tree Scoring
Grand fir-moist east Cascades	Large Diameter Tree Scoring
Douglas-fir-subalpine fir, lodgepole pine	Large Diameter Tree Scoring
Subalpine parklands	Large Diameter Tree Scoring
Western redcedar-western hemlock – NE Washington	Large Diameter Tree Scoring*
Mountain hemlock-Pacific silver fir	Large Diameter Tree Scoring*
Engelmann spruce-subalpine fir	Large Diameter Tree Scoring*
Douglas-fir-ponderosa pine (dry grand fir)	Large Diameter Tree Scoring
Oak	Large Diameter Tree Scoring
Ponderosa pine-oak	Large Diameter Tree Scoring
Not Available	Large Diameter Tree Scoring
Outliers	Large Diameter Tree Scoring
Wetland / Riparian	Large Diameter Tree Scoring
Westside-type forest in Columbia Gorge	Weighed Old Growth Habitat Index

*These groups are under study to be replaced by a diameter diversity index value or some other scoring system.

The diameter scoring process ranks the presence of large trees within stands or plots, based on trees per acre by diameter group and species (Table 3). Scores were calculated for each

stand and inventory point, then an old forest potential value for the stand or point was assigned according to diameter score (Table 4).

Table 3. Large tree diameter scoring process

Species	DBH[1]	Trees per Acre	Score
Ponderosa pine, western larch, or Douglas-fir	≥40 inches	0	0
		1	2
		2	4
		3	6
		4	8
		5 or more	10
Ponderosa pine, western larch, or Douglas-fir	≥30 inches	0	0
		1-3	2
		4-5	4
		6-7	6
		8-9	8
		≥10	10

[1] Diameter at breast height, measured 4.5 feet above the ground.

Table 4. Old forest potential value assignment based on large tree diameter score

Diameter Score	Old forest potential
≥10	High potential for stand-scale old forest characteristics
6-9	Moderate potential for stand-scale old forest characteristics
3-5	Low potential for stand-scale old forest characteristics, individual tree-scale old forest characteristics likely
1-2	No potential for stand-scale old forest characteristics, individual tree-scale old forest characteristics possible
0	No potential for stand-scale old forest characteristics, individual tree-scale old forest characteristics unlikely

We summed the at least 40 inch and at least 30 inch categories for ponderosa pine, western larch and Douglas-fir. The maximum old forest potential score possible for any stand or sample point was 20. A plot or stand score value of ten or more was considered a very strong indicator of the presence of old forest structures, while a score of five to ten indicated moderate old forest potential.

Old Forest on Lands of Different Inventory Status

The DNR inventory in Eastern Washington covers approximately 661,000 acres of forested ownership. Of these, 495,000 acres (approximately 75 percent of the forested land base) have independent sample data on every stand; 134,000 acres (approximately 20 percent) have a stratified inventory sample[3]; and 32,000 acres (approximately five percent) have no data on which old growth presence can be assessed.

To estimate the area of older forests in Eastern Washington on DNR-managed state trust lands, we used both the standard and stratified forest inventory data; which cover a total of 629,000 acres (approximately 95 percent of the forested state trust land base). An older Land Use Land Cover (LULC) inventory exists on 20,000 acres, mostly in scattered sections north of the Wenatchee River, many of which burned in fires between 1988 and 2006 after the LULC inventory data was collected. DNR does not have good inventory data for this area, and these acres are reported as unknown in the tables.

In addition, there are no inventory data for approximately 12,000 acres that have previously been harvested. For this reason, we assumed these areas do not contain significant old forest, although many harvest units on DNR-managed forested state trust lands retain a significant legacy of large and/or old trees as a part of habitat and legacy tree commitments and standard DNR silvicultural practices.

For the stratified sample data set, statistical estimates were made of the land area that might have old forest potential in these strata. However, due to the nature of the data, there is no way to know precisely where this old forest area is located. The old forest potential value for these areas is summarized separately from that of the area for which sample data exist.

All inventory findings are summarized in Tables 5, 6, 7, and C.1.

[3] A stratified inventory uses statistical techniques to estimate the forest values (trees per acre, tree diameter, basal area, volume, tree species presence, etc), between sampled and non-sampled similar areas.

Table 5. Sampled inventory acres of DNR-managed forested state trust land in Eastern Washington by old forest likelihood category

	Likelihood of Old Forest		
Fire Regime[1]	Minimal	Moderate	High
Low Severity	320,755	10,345	5,859
Mixed Severity	29,759	1,861	1,746
High Severity	78,648	1,206	693
Westside[2]	32,825	473	292
Outliers	4,812	146	169
Total[3]	466,799	14,032	8,759

[1] These are historic fire regimes. Current fire regimes may be more severe.

[2]Westside-influenced forests in the Columbia Gorge area west of the White Salmon River.

[3] Approximately 5,000 sampled inventory acres have no plant association assignment and are not included in this table.

Table 6. Stratified inventory acres of DNR-managed forested state trust land in Eastern Washington by old forest likelihood category

	Likelihood of Old Forest		
Fire Regime[1]	Minimal	Moderate	High
Low Severity	76,084	3,828	2,175
Mixed Severity	18,145	1,054	969
High Severity	26,303	675	486
Westside[2]	0	0	0
Outliers	3,736	158	184
Total	124,269	5,714	3,814

[1]These are historic fire regimes. Current fire regimes may be more severe.

[2] Westside-influenced forests in the Columbia Gorge area west of the White Salmon River

Table 7. Forested DNR-managed acres of forested state trust land by county

County Name	Fire Regime[1]	Low Old Forest Likelihood	Moderate Old Forest Likelihood	High Old Forest Likelihood	Grand Total
Chelan County	Low severity	7,602	121	17	7,741
	Mixed severity	412	0	6	417
	High severity	503	9	0	513
	Outliers	16	0	0	16
Chelan County Total		8,533	131	23	8,687
Ferry County	Low severity	19,284	586	194	20,064
	Mixed severity	305	6	7	317
	High severity	2,011	36	7	2,055
	Outliers	202	0	0	202
Ferry County Total		21,803	628	208	22,638
Kittitas County	Low severity	33,723	1,487	1,251	36,461
	Mixed severity	5,509	349	322	6,180
	High severity	2,793	182	226	3,201
	Outliers	114	0	14	128
Kittitas County Total		42,139	2,018	1,812	45,970
Klickitat County	Low severity	30,348	2,625	1,837	34,810
	Mixed severity	4,011	336	308	4,654
	Outliers	6,296	284	331	6,912
	Westside forest type	30,007	436	259	30,703
Klickitat County Total		70,662	3,681	2,735	77,079
Lincoln County	Low severity	5,940	17	4	5,962
	Mixed severity	11	3	0	14
Lincoln County Total		5,951	20	4	5,975
Okanogan County	Low severity	139,216	4,914	2,092	146,222
	Mixed severity	17,249	875	644	18,768
	High severity	36,322	937	640	37,899
	Outliers	700	6	0	706
Okanogan County Total		193,488	6,733	3,375	203,596
Pend Oreille	Low severity	10,195	107	16	10,318
	Mixed severity	50	0	0	50
	High severity	16,416	244	64	16,724
	Outliers	71	0	0	71
Pend Oreille County Total		26,731	352	80	27,162
Skamania County	Westside forest type	3,137	37	42	3,216
Skamania County Total		3,137	37	42	3,216
Spokane County	Low severity	11,644	138	15	11,797
	Mixed severity	92	0	0	92
	High severity	2,924	2	5	2,931
	Outliers	45	4	0	49
Spokane County Total		14,706	143	20	14,869

County Name	Fire Regime[1]	Low Old Forest Likelihood	Moderate Old Forest Likelihood	High Old Forest Likelihood	Grand Total
Stevens County	Low severity	93,208	1,070	181	94,459
	Mixed severity	3,363	14	9	3,385
	High severity	41,469	336	51	41,856
	Outliers	861	0	4	865
Stevens County Total		138,901	1,420	245	140,566
Whitman County	Low severity	305	11	0	316
Whitman County Total		305	11	0	316
Yakima County	Low severity	46,486	3,130	2,503	52,119
	Mixed severity	16,967	1,333	1,432	19,732
	High severity	2,868	141	185	3,194
	Outliers	248	10	3	261
Yakima County Total		66,570	4,614	4,123	75,307
Grand Total		*592,925*	*19,787*	*12,668*	*625,380*[2]

[1]These are historic fire regimes. Current fire regimes may be more severe.

[2] Does not include approximately 35,000 acres of forested lands which have no information from which old forest presence can be assessed.

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Appendix A. Eastside Old Growth Definition Panel

Panel members: Dr. Jerry F. Franklin (Chair, University of Washington), Dr. Robert Van Pelt (Research faculty, University of Washington), and Dr. Miles Hemstrom (Forest Service, Pacific Northwest Research Station).

DNR and Washington Department of Fish and Wildlife (WDFW) staff: DNR: Sabra Hull - project coordinator, Dr. Rex Crawford - Eastside ecologist, Steve Curry - inventory analyst, Walt Obermeyer – inventory and spatial analyst, Angie Cahill - communications coordinator.

WDFW: Joe Buchanan –forest wildlife biologist

Panel Biographies:

Jerry F. Franklin is Professor of Ecosystem Analysis in the College of Forest Resources, University of Washington, Seattle. Previously, he has been Chief Plant Ecologist, USDA Forest Service, Corvallis, Oregon, and Professor of Forest Science and Botany at Oregon State University. He also served as Director of the Ecosystem Studies Program of the National Science Foundation in Washington, D.C. He holds B.S. and M.S. degrees in Forest Management from Oregon State University, and a Ph.D. in Botany and Soils from Washington State University, Pullman. He is one of the pioneers of forest ecosystem research, with specializations in structure and function of natural forest ecosystems; successional processes following catastrophic disturbances; effects of changing environmental conditions on forest processes; application of ecological principles to the management of natural resources; and theory and practical applications of landscape ecology. He is a past president of the Ecological Society of America, was a panelist on the White House Forest Conference in 1993, and has served on the Board of Governors of the Nature Conservancy. He has worked on scientific policy analyses for Congress, the federal government, state governments, and for British Columbia. He holds the Barrington Moore Award for outstanding achievement in forest research from the Society of American Foresters, as well as numerous other awards. His research is documented in nearly 300 publications. He is currently extensively involved as a consultant and land steward for sustainable forestry projects in southern Chile and Argentina.

Miles A. Hemstrom is a Research Ecologist for the USDA Forest Service, Pacific Northwest Research Station at the Portland Forestry Sciences Laboratory. Miles received his B.S. in Biology from Western State College of Colorado in 1975 and a Ph.D. in plant ecology from Oregon State University in 1979. He did postdoctoral research at Oregon State University (1979-1980), served as Area Ecologist for the Willamette and Siuslaw National Forests (1980-1992), Group Leader for Ecology, Silviculture and Inventory in the Rocky Mountain Region of the USDA Forest Service (1992-1994), Regional Ecologist for the Pacific Northwest Region of the USDA Forest Service (1994- 1999), Science Team Ecologist for the Interior Columbia River Basin Ecosystem Management Project (1999-2001), and Research Ecologist for the PNW Research Station of the USDA Forest Service (2001-present). His current research interests include: 1) understanding and modeling landscape interactions of vegetation, fire and other disturbances, invasive plants, and management in Eastside Oregon and Washington ecosystems; 2) understanding, modeling and inventory of riparian/streamside conditions at watershed and larger scales with a focus on eastern Oregon and Washington; and 3) application of landscape models to landscape planning and assessments.

Robert Van Pelt is currently on the research faculty at the University of Washington in Seattle where he is engaged in canopy research in *Pseudotsuga*, *Sequoia*, and *Picea* forests. Bob received his M.S. in 1991 and Ph.D. in 1995 from the University of Washington. His main research interests are old growth ecology, canopy structure and its control of the understory environment, spatial patterns in old-growth forests, and tree plant geography. Bob gives occasional lectures and leads field trips for the University, and teaches several field classes on Pacific Northwest old-growth forests and Northwest canopy ecology. Bob has published numerous scientific papers and several books, including *Forest Giants of the Pacific Coast*. In addition to his work on the DNR Old Growth Definition Panel, Bob has contracted with DNR to produce two field guides to identification of old forests in Washington. The first of these, *Identifying Mature and Old Forests in Washington*, was published in 2007. The second, *Identifying Old Trees and Forests in Eastern Washington*, is currently in press.

Appendix B. Full Text of the 2004 and 2005 Old Growth Legislation

Text of ESHB 2573, section 905

(1) The Department of Natural Resources shall conduct an inventory on state lands of old growth forest stands as defined by a panel of scientists. The panel of scientists shall include three scientific scholars with well documented expertise in Pacific Northwest forest ecology, one of whom will serve as the chair by consensus of the panel, one representative from the department of natural resources, and one representative from the Washington department of fish and wildlife. The panel shall review the best available scientific information and develop a definition for old growth stands in Washington state. The inventory shall include maps illustrating the distribution of old growth forest stands on state lands, and tables describing the number of acres of stands in each county, the department's administrative unit, and forest type. The maps and tables shall identify both structurally uniform and structurally complex stands. The department of natural resources shall make a report of the inventory to the appropriate committees of the legislature.

(2) For the duration of the study, cutting or removing trees and stands 160 years or older is subject to the department publishing notification of proposed cutting or removal of old growth timber.

(3) This section expires Jun 30, 2005.

Text of ESSB 6384, section 189

A new section is added to 2005 c 488 (uncodified) to read as follows:

FOR THE DEPARTMENT OF NATURAL RESOURCES

Old Growth Forest Inventory (06-2-855)

The appropriation in this section is subject to the following conditions and limitations:

(1) The appropriation in this section is provided solely to conduct an inventory of old growth forests located on state lands east of the crest of Cascade mountains. The

inventory is intended to be a continuation of the inventory conducted pursuant to section 905, chapter 277, Laws of 2004, and must be completed in two phases.

(2) In conducting the inventory required by this section, the department of natural resources shall reconvene a scientific panel with membership consistent with the structure created in section 905, chapter 277, Laws of 2004, and direct the panel to review the best available applicable scientific information. The panel shall also

ESSB 6384.PL p. 62 develop a definition for old-growth trees and stands located east of the crest of the Cascade mountains using attributes measured in department of natural resources inventory plots.

(3) The first phase of the inventory required by this section shall be completed by July 1, 2007. In the first phase, the panel shall identify reference stands for old-growth ponderosa pine, dry mixed conifer species, and pine-oak plant associations.

(4) The second phase of the inventory required by this section shall be completed by December 15, 2007. In the second phase, the department of natural resources shall use the definition provided by the scientific panel under subsection (2) of this section to produce an inventory of old growth forests located on state lands east of the crest of Cascade mountains. The inventory must include:

(a) Maps that illustrate the distribution of forest stands containing old-growth ponderosa pine, dry mixed-conifer species, and pine-oak plant associations, including sites with residual old-growth ponderosa pine trees; and

(b) Tables describing the number of acres of old-growth stands in each county, forest type, and department of natural resources' administrative unit.

(5) The department of natural resources shall report the information required by this section to the appropriate committees of the legislature.

(6) Until the completion of the inventory required by this section, the department of natural resources may not cut or remove any Douglas fir, ponderosa pine, or larch trees from state lands located east of the crest of the Cascade mountains if the tree is one hundred sixty years in age or older and has a diameter of twenty-eight inches or more when measured at breast height, unless removal of the tree is determined by the department of natural resources to be necessary to prevent an imminent physical or ecological hazard or otherwise satisfy a safety concern.

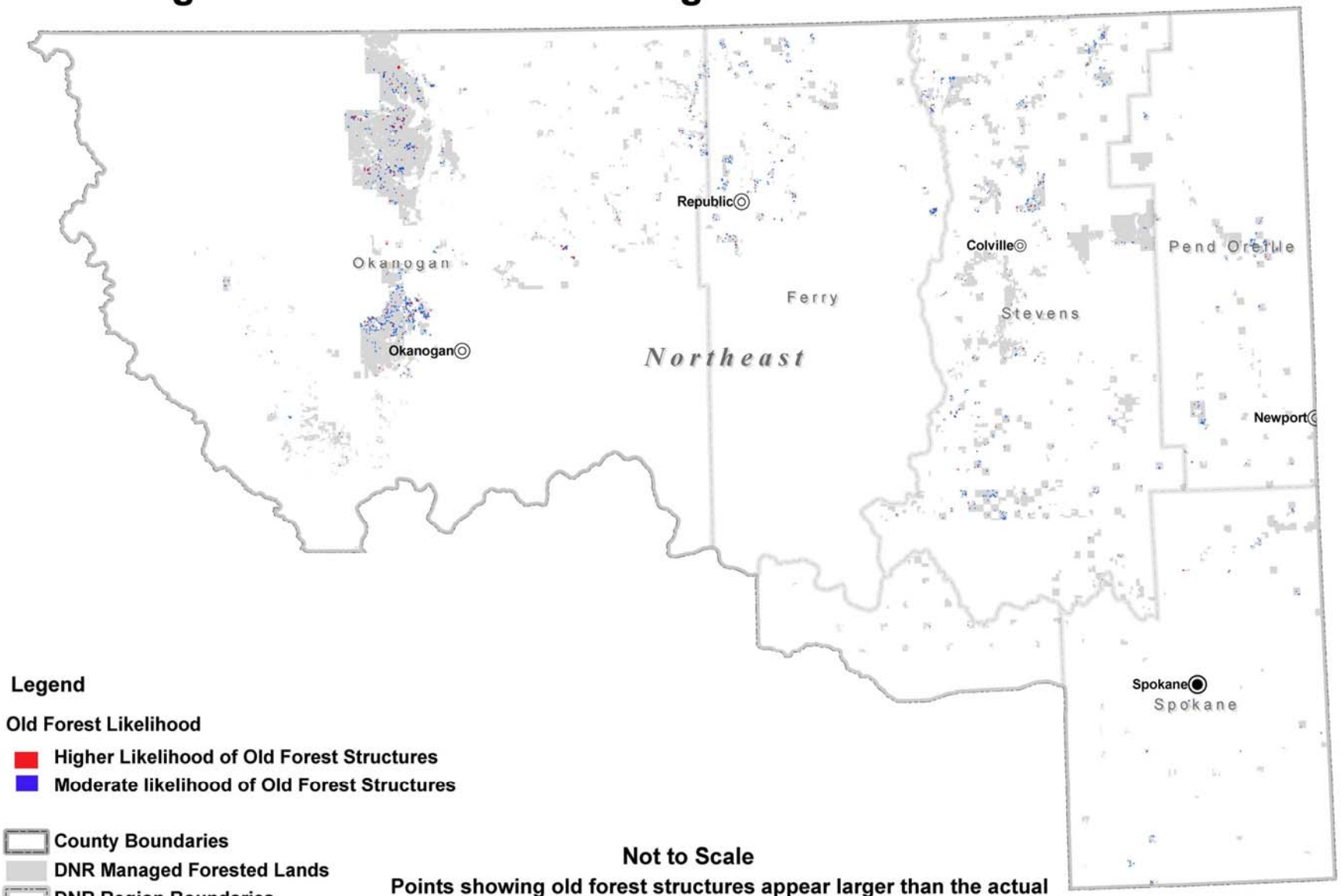
Appendix C

Table C.1. Acres of all Eastern Washington DNR-managed forested trust land by historic fire regime, old forest plant association group (PAG) and old forest likelihood category

		Sampled Acres Likelihood			Stratified Acres Likelihood				
Fire Regime[1]	Old Forest PAG	Minimal	Moderate	High	Minimal	Moderate	High	Unknown	Grand Total
Mixed Severity	Aspen	373	3		196	0	0		572
	Western hemlock east Cascades	2,708	107	90	5	0	0		2,910
	Grand fir-moist east Cascades	10,921	875	774	172	0	5		12,746
	Douglas-fir-Subalpine fir, Lodgepole	13,862	826	859	17,182	1,038	958		34,725
	Subalpine Parklands	1,895	51	23	591	16	6		2,581
High Severity	Western redcedar-western hemlock, NE Washington	56,633	555	97	0	0	0		57,285
	Mountain hemlock-Pacific silver fir	1,105	33	54	257	0	16		1,465
	Engelmann spruce-Subalpine fir	20,910	618	542	26,046	675	470		49,261
Low Severity	Douglas-fir-ponderosa pine,(dry Grand fir)	284,407	9,631	5,653	69,571	3,756	2,170		375,188
	Oak	2,545	35	6	2,208	41	0		4,835
	Ponderosa pine -oak	33,803	679	201	4,305	31	5		39,023
Outliers	n/a[2]	1,352	112	147	1,612	140	184		3,547
	Outliers	2,593	19	3	1,743	18	0		4,376
	Wetland / Riparian	867	15	18	382	0	0		1,282
Westside[3]	Westside forest in Columbia Gorge	32,825	473	292					33,590
(blank)[4]	(blank)	5,186							5,186
	Old standard inventory and other unknowns							31,500	31,500
Grand Total		471,985	14,032	8,759	124,269	5,714	3,814		660,072

[1] These are historic fire regimes. Current fire regimes may be more severe.
[2] No plant association data available.
[3] Westside forest types extending east of the Cascade crest but west of the White Salmon River, using WOGHI to determine old characteristics.
[4] Plant association unobservable, usually indicating young stand conditions at the plot.

Likelihood of Old Forest Structures on Forested DNR-Managed Lands in Northeast Region



Likelihood of Old Forest Structures on Forested DNR-Managed Lands in Southeast Region