MEETING NOTES
Potamus Planning Area Meeting
March 31, 2009
Heppner, OR

6:00 PM

Attendance:

- Approximately 19 members of the public
- Representatives from the Umatilla NF (Heppner RD and Supervisor's Office)
- Oregon Department of Forestry
- Morrow County
- Heppner Rural Fire Department
- Oregon Department of Fish and Wildlife

Opening Statement and Introduction of Planning Area

Tom Mafera (District Ranger – Heppner RD)

Tom began with a short discussion of past planning efforts on the Heppner Ranger District that addressed vegetation and fuel management needs. He then introduced the next planning area: Potamus watershed. This 50,000 plus acre planning area encompasses the Penland Lake area along with a range of forest types. The Penland Lake area is designated as a community at risk and a wildland urban interface area (WUI) with high priority for treatment, therefore the ranger district would like to approach this project with a collaborative group as outlined in the Healthy Forests Restoration Act of 2002 (HFRA).

The difference between this project and the process used for other planning areas is how the project is developed. Other projects are started with a Forest Service generated proposed action, and is then sent to the public for comment, then a plan is developed and a decision made. HFRA is a different way of doing this planning, allowing us to streamline the process, but involves public collaboration before the proposal is developed.

Agenda Review and Meeting Rules

Joani Bosworth (Public Relations Officer- Umatilla NF)

In this meeting we are going to discuss:

1. Basic fire ecology
2. Fuels conditions
3. Past and potential wildfire
4. Private lands and wildfire
5. Interest of individuals in working with the Forest Service in a collaborative group

Fire Regime and Current Condition

Dave Powell (Forest Silviculturalist- Umatilla NF)

Dave introduced concept of fire regimes, a historical description of fire frequency, severity and seasonality. The Potamus area is largely fire regime I meaning it has a 0-35 year return interval and mostly low severity fire. Scientific literature (Agee, 2002) recommends reducing surface fuels, increasing height to live crown, reducing canopy bulk density, and favoring fire tolerant tree species as treatment to reduce potential fire behavior within these fire regimes.

Table 1.

Species	**Bark thickness**	**Rooting**	**Crown form**	**Foliage flammability**	**Overall resistance**
Western Larch (WL)	thick	deep	high, open branching	low	high
Lodgepole Pine (LP)	thin	medium	mod high/open	medium	low
Douglas Fir (DF)	moderate	deep	mod high/dense	high	med-high
Grand Fir (GF)	thin	shallow	low/dense	high	med-low
Engelmann Spruce (ES)	thin	shallow	low/dense	medium	low
Ponderosa Pine (PP)	thick	deep	high, open branching	low	high

Table 1 shows the six common tree species of the Potamus area and their ratings for characteristics (bark thickness, rooting, etc.) used to identify a species resistance to fire. The table also identifies the overall fire resistance rating for each species.

With respect to fire-survival strategies, plants can be classified as Resisters, Evaders, or Avoiders – many of the trees in the Potamus area are resisters and cope with low to moderate severity fire well.

Mortality from fire with 6ft flame length –

- PP/WL <25%,
- mixed DF/WL <50%,
- mixed DF/GF <75%, and
- mix LP/ES>75%.

Question:

Fire regimes 3 and 4 naturally have fewer fire intervals. Where is the science saying that doing fuels treatments in fire regimes 3 and 4 is beneficial? Fire regimes 3 and 4 are currently in totally natural condition.

Answer: Yes, fire regimes 3 and 4 are characterized as such because they do have more years between fire intervals relative to fire regime 1. In this case, we are also

considering WUI areas and how to meet some goals that pertain to this aspect of the landscape.
Question:
Isn't it worse for wildlife for fire to destroy an entire stand than to do a fuels treatment in the stand?
Answer: It depends on what type of wildlife you are talking about.

Question: Could we write stand specific prescriptions to meet specific goals?
Answer: Yes.

Fire History and Modeling

-Brian Spradlin (Fuels Specialist – Heppner Ranger District)

Brian introduced the group to the fire and insect disturbance history in the local area including large fires of the past and more recent spruce bud worm outbreak areas.

- 1910 fire and the more recent Monument Complex
- Historical fire starts in the past 30 years which have been suppressed throughout planning area.
- Spruce bud worm damage was significant throughout the entire planning area.

He also displayed several maps describing the Fire Regimes within the planning area (I, II, III and IV), crown fire initiation risk, predicted flame length, and location and extent of spruce budworm damage in recent decades.

Question: If fire regime 3 and 4 fire return intervals are up to 200 years how can you say that current conditions are "out of whack" if the last fires in the area were around 100 years ago?
Answer: The years that define fire regimes are rough parameters designed for broad areas. Heppner Ranger District is located on the driest end of the spectrum for these fire regimes. Additionally, three quarters of the planning area is a fire regime 1 which has a top end of about 35 years for a fire return interval. Therefore, most of the area within the planning area is "out of whack".

Question: Where did this data come from?
Answer: The models for flame length and crown fire initiation are based on national data which was modeled with random fire starts over a 10,000 year period.

Local Fire Situations and Conditions

Doug Baxter (Fire Management Officer – Heppner Ranger District)

Doug discussed some of the past large fires that have occurred on the south end of the Umatilla National Forest including the conditions, and local weather patterns that contributed to the rate of spread and size of fires like the Tower Fire.

Private Land Fire Protection and the Morrow County CWPP

Mitch Mund (Stewardship coordinator – Oregon Department of Forestry)

Mitch discussed private landowner responsibilities for structure protection and the funding of ODF to suppress wildfires. He also gave a review of the past National Fire Plan grants that were used in the area and what future options the local land owners may have. The grant monies that they did have to work with landowners have been utilized but they are in the process of applying for more grant money in the future. These grants are competitive but they were able to do some great things with them in recent years.

Question: Does ODF coordinate efforts with the Forest Service across property boundaries?
Answer: Yes, we work together and communicate.

Comment: Penland Lake landowners would like to continue to allow the lake water to be used in wildfire suppression activities.

Comment: Cost share monies have been very successful for several landowners.

Next steps/timelines

Tom Mafera (District Ranger – Heppner RD)

Tom discussed what the next steps would be in the development of this project and how the group would participate. HFRA outlines an integrated plan and WUI area treatment including structure protection and escape routes. We are also interested in treating on a landscape level to restore ecosystems.

- We will plan on having one meeting per month to develop a proposed action.
- Collaborators can bring their ideas to the table.

Proposed Timeline

- Proposed Action July 2009
- Decision March 2010

Q & A:

Question: Has the co-generation plant talked to the Forest Service about using materials that may be produced by this project?
Answer: (Kevin Martin, Forest Supervisor) Yes, we have been in collaborative talks with several companies in the area about the future use of biomass materials from the forest.

Citizens interested in the collaborative effort:

William Lowe, Ken Grieb, Glen Ward, Steve Cherry (ODFW), Mike Gorman, Bruce Young, Debbie Young, Becky Doherty, Steve Rhea (Heppner Rural Fire Dept.), Angie Johnson(ODF), Jay Gibbs, John Moyer, Celia Moyer.

Fire Regimes in the Blue Mountains

In the first public meeting, Dave Powell, Forest Silviculturist, discussed the relevant fire regimes present in the Potamus Planning Area and the expected fire behavior, severity, and return interval associated with each of these regimes. The following information will help define and describe fire regime attributes in greater detail than time allowed at the first meeting.

Dave Powell and Louisa Evers have worked to develop fire regimes specific to the Blue Mountains and their associated effects on the ground. This has led to finer scale definitions tailored to the dry forests of the Umatilla National Forest based on climatic (temperature, moisture, etc.) and elevation attributes unique to the landscape in which we manage. The following texts are useful in understanding how fire historically interacted with vegetation on the Umatilla National Forest.

The Potamus Planning Area is predominantly composed of Fire Regime 1, although Fire Regimes 2, 3, and 4 are all represented (See Map Section). The table below shows the prevalence of each fire regime within the Potamus area.

Potamus Planning Area Fire Regimes	
Fire Regime	**Percent Composition (%)**
I	67%
II	4%
III(a)	14%
IV(a)	15%

Fire Regimes of Oregon and Washington

I. 0-35 years, Low severity.

Typical climax plant communities include ponderosa pine, eastside/dry Douglas-fir, pine-oak woodlands, Jeffery pine on serpentine soils, oak woodlands, and very dry white fir. Large stand-replacing fire can occur under certain weather conditions, but are rare events (i.e. every 200+ years).

II. 0-35 years, Mixed and High severity

Includes true grasslands (Columbia basin, Palouse, etc.) and savannahs with typical return intervals of less than 10 years; mesic sagebrush communities with typical return intervals of 25-35 years and occasionally up to 50 years, and mountain shrub communities (bitterbrush, snowberry, ninebark, ceanothus, Oregon chaparral, etc.) with typical return intervals of 10-25 years. Certain specific communities include mountain big sagebrush and low sagebrush-fescue communities. Grasslands and mountain shrub communities are not completely killed, but usually only top-killed and resprout.

III.35-100+ years, Mixed severity

This regime usually results in heterogeneous landscapes. Large, high severity fires may occur but are usually rare events. Such high severity fires may “reset” large areas (10,000-100,000 acres) but subsequent mixed severity fires are important for creating the landscape heterogeneity. Within these landscapes a mix of stand ages and size classes are important characteristics; generally the landscape is not dominated by one or two age classes. In southeastern Oregon this regime also includes aspen, riparian communities, most meadows, and wetlands.

A. <50 years, Mixed severity

Typical potential plant communities include mixed conifer, very dry westside Douglas-fir, and dry grand fir. Lower severity fire tends to predominate in many events.

B. 50-100 years, Mixed severity

Typical climax plant communities include well drained western hemlock; warm, mesic grand fir, particularly east of the Cascade crest; and eastside western redcedar. The relative amounts of lower and higher severity patches within a given event is intermediate between IIIa and IIIc.

C. 100-200 years, Mixed severity

Typical potential plant communities include western hemlock, Pacific silver fir, and whitebark pine at or below 45 degrees latitude and cool, mesic grand fir and Douglas-fir. Higher severity fire tends to dominate in many events.

IV. 35-100+ years, High severity

Seral forest communities that arise from or are maintained by high severity fires, such as lodgepole pine, aspen, western larch, and western white pine, often are important components in this fire regime. Dry sagebrush and mountain-mahogany communities also fall within this fire regime. Natural ignitions within this regime that result in large fires may be relatively rare, particularly in the Cascades north of 45 degrees latitude.

A. 35-100+ years, High severity, Juxtaposed

Typified by what would normally be considered long interval regime that lies immediately above a shorter interval or lower severity fire regime. Most often the fire originates lower on the slope and burns uphill into regime IVa. In southeastern Oregon, this subregime includes Wyoming big sagebrush communities on deeper soils below 5000 feet elevation. Forest examples include lodgepole pine immediately above ponderosa pine in the eastside Washington Cascades and aspen imbedded within dry grand fir in the Blue Mountains. This regime is often found in lower elevations or drier sites than is considered typical for regime IV.

B. 100+ years, High severity, Patchy arrangement

Typical potential forest communities include subalpine fir and mountain hemlock parkland and whitebark pine north of 45 degrees latitude.

Other community types include mixed Wyoming big sagebrush and low sagebrush on low productivity sites such as scablands, stiff sagebrush, and true old growth juniper savannah (<10% canopy closure). Some forbs are present, such as Sandberg's bluegrass and the availability of many of these areas for burning depends on wet years that result in much greater grass production than is typical. Typical fire return intervals in these communities is 100-150 years.

C. 100-200 years, High severity

Typical forest plant communities include subalpine mixed conifer (spruce-fir), western larch, and western white pine. Important potential forest plant communities include mountain hemlock in the Cascades and Pacific silver fir north of 45 degrees latitude.

Other plant communities include the intergrade between Wyoming big sagebrush and greasewood, shadscale on non-alkali soils, spiny hopsage, and alpine grasslands and heath in southeastern Oregon.

V. >200 years, High severity

This fire regime occurs at the environmental extremes where natural ignitions are very rare or virtually non-existent or environmental conditions rarely result in large fires. Sites tend to be very cold, very hot, very wet, very dry or some combination of these conditions.

Typical plant communities include black sagebrush, salt desert scrub, greasewood on dunes, true old-growth juniper with at least 10% canopy closure and mountain-

mahogany in rocky areas, and alpine communities and subalpine heath in the Blue Mountains and Cascades. Most species tend to be small and low growing. Bare ground is common.

A. 200-400 years, High severity

Forest plant communities are at least somewhat fire adapted. Typical plant communities include Douglas-fir, noble fir, and mountain hemlock on drier sites in parts of western Washington.

B. 400+ years, High severity

Forest plant communities are weakly fire adapted or not fire adapted. Typical plant communities include Douglas-fir, Pacific silver fir, western hemlock, western redcedar, and mountain hemlock on moister sites in western Washington.

C. No Fire

This regime includes forest plant communities with no evidence of fire for 500 years or more. Stands often have extremely deep duff layers on poorly developed soils. Typical plant communities include Sitka spruce and Pacific silver fir along the Oregon and Washington coast and very wet western redcedar sites.

Fire Regimes of the Blue Mountains

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1. Selected characteristics for fire regimes of the Blue Mountains.

Fire Regime Characteristic	HISTORICAL FIRE REGIMES 1 (I)	2 (II)	3 (III)	4 (IV)
Fire return interval (mean; in years)[1]	< 25	< 35	25-90	90-200
FRCC: fire frequency name[2]	Frequent	Frequent	Infrequent	Infrequent
Fire severity on overstory cohort[3]	Low	High	Moderate	High
FRCC: fire severity name[2]	Surface	Replacement	Mixed	Replacement
Fireline intensity (flame length; feet)[4]	< 3	< 3	3-10	> 10
Historical burned area (percent)[5]	75	5	15	5
Mean fire size (acres)[6]	2,953	Unknown	904	Unknown
Fire size variability (acres; min-max)[7]	47-19,959	Unknown	249-1,936	Unknown
Fire timing (seasonality)[8]	Summer and fall	Spring and summer	Summer and fall	Summer and fall

[1] **Fire return interval** (years) is the frequency between successive fire events. Table data for fire return interval was taken from Hall (1976), Heyerdahl and Agee (1996), and Maruoka (1994) for fire regimes 1, 3 and 4, and from Schmidt et al. (2002) for fire regime 2.

[2] **FRCC** (fire regime condition class) is a process for evaluating whether current conditions have departed from historical reference conditions and, if so, the magnitude of the departure; the FRCC frequency and severity names are taken from Hann et al. (2008).

[3] **Fire severity on overstory cohort** is the effect of fire on dominant plants: at least 75% of dominant plants survive low-severity fire, whereas 75% or more are killed by high-severity fire; moderate-severity fires have survival percentages between these extremes (the 75% mortality thresholds were defined by FRCC; see Hann et al. 2008). Table data were taken from Agee (1996).

[4] **Fireline intensity** refers to the energy release rate of a fire. Since intensity is generally proportional to flame length, fireline intensity is typically expressed as a flame length, in feet. Table data were taken from Agee (1996).

[5] **Historical burned area** is an estimate of annual burned area (percent) for the Blue Mountains area prior to Euro-American settlement (defined as pre-1850); table data were adapted from Agee (1996).

[6] **Mean fire size** provides an indication of average wildfire extent (in acres) from a Blue Mountains fire history study (Heyerdahl and Agee 1996, Heyerdahl 1997); see appendix.

[7] **Fire size variability** shows how historical wildfire extent varied (in acres) from a Blue Mountains fire history study (Heyerdahl and Agee 1996, Heyerdahl 1997); see appendix. Note that this characteristic might have been affected by the number of fires sampled (fire regime 1 included 210 fires; fire regime 3 included only 8 fires), and because the mapped fire extent was truncated at the study area boundary for each sampled fire.

[8] **Fire timing** refers to the typical season of wildland fire. Table data taken from Agee (1996).

2. Selected Blue Mountain fire references:

Agee, J.K. 1993. Fire ecology of Pacific Northwest forests. Washington, DC: Island Press. 493 p.

Agee, J.K. 1996. Fire in the Blue Mountains: a history, ecology, and research agenda. In: Jaindl, R.G.; Quigley, T.M., editors. Search for a solution: sustaining the land, people, and economy of the Blue Mountains. Washington, DC: American Forests in cooperation with the Blue Mountains Natural Resources Institute: 119-145.

Agee, J.K. 1998. The landscape ecology of western forest fire regimes. Northwest Science. 72(special issue): 24-34.

Agee, J.K.; Maruoka, K.R. 1994. Historical fire regimes of the Blue Mountains. Tech Notes BMNRI-TN-1. La Grande, OR: U.S. Department of Agriculture, Forest Service, Blue Mountains Natural Resources Institute. 4 p.

Diaz-Avalos, C.; Peterson, D.L.; Alvarado, E.; Ferguson, S.A.; Besag, J.E. 2001. Space-time modelling of lightning-caused ignitions in the Blue Mountains, Oregon. Canadian Journal of Forest Research. 31: 1579-1593.

Hall, F.C. 1976. Fire and vegetation in the Blue Mountains – implications for land managers. In: Komarek, E.V. Sr., chairman. Proceedings of the annual Tall Timbers fire ecology conference No. 15. Tallahassee, FL: Tall Timbers Research Station: 155-170.

Hall, F.C. 1977. Ecology of natural underburning in the Blue Mountains of Oregon. R6-ECOL-79-001. Portland, OR: U.S. Department of Agriculture, Forest Service, Pacific Northwest Region. 11 p.

Hall, F.C. 1980. Fire history – Blue Mountains, Oregon. In: Stokes, M.A.; Dieterich, J.H., technical coordinators. Proceedings of the fire history workshop. General Technical Report RM-81. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station: 75-81.

Hann, W.; Havlina, D.; Shlisky, A. [et al.]. 2008. Interagency fire regime condition class (FRCC) guidebook, version 1.3. http://www.frcc.gov (May 1, 2008)

Heyerdahl, E.K. 1997. Spatial and temporal variation in historical fire regimes of the Blue Mountains, Oregon and Washington: the influence of climate. Seattle, WA: University of Washington, College of Forest Resources. 224 p. Doctor of Philosophy thesis.

Heyerdahl, E.K.; Agee, J.K. 1996. Historical fire regimes of four sites in the Blue Mountains, Oregon and Washington. Final Report. Seattle, WA: University of Washington, College of Forest Resources. 173 p.

Heyerdahl, E.K.; Brubaker, L.B.; Agee, J.K. 2001. Spatial controls of historical fire regimes: a multiscale example from the interior west, USA. Ecology. 82(3): 660-678.

Maruoka, K.R.; Agee, J.K. 1994. Fire histories: overview of methods and applications. Tech Notes BMNRI-TN-2. La Grande, OR: U.S. Department of Agriculture, Forest Service, Blue

Mountains Natural Resources Institute. 4 p.

Maruoka, K.R. 1994. Fire history of *Pseudotsuga menziesii* and *Abies grandis* stands in the Blue Mountains of Oregon and Washington. Seattle, WA: University of Washington. 73 p. Master of Science thesis.

Mutch, R.W.; Arno, S.F.; Brown, J.K.; Carlson, C.E.; Ottmar, R.D.; Peterson, J.L. 1993. Forest health in the Blue Mountains: a management strategy for fire-adapted ecosystems. General Technical Report PNW-GTR-310. Portland, OR: U.S. Department of Agriculture, Forest Service, Pacific Northwest Research Station. 14 p.

Olson, D.L. 2000. Fire in riparian zones: a comparison of historical fire occurrence in riparian and upslope forests in the Blue Mountains and southern Cascades of Oregon. Seattle, WA: University of Washington. 274 p. Master of Science thesis.

Ryan, K.C.; Pickford, S.G. 1978. Physical properties of woody fuels in the Blue Mountains of Oregon and Washington. Research Note PNW-315. Portland, OR: U.S. Department of Agriculture, Forest Service, Pacific Northwest Forest and Range Experiment Station. 10 p.

Schmidt, K.M.; Menakis, J.P.; Hardy, C.C.; Hann, W.J.; Bunnell, D.L. 2002. Development of coarse-scale spatial data for wildland fire and fuel management. General Technical Report RMRS-GTR-87. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station. 41 p (and CD).

Williamson, N.M. 1999. Crown fuel characteristics, stand structure, and fire hazard in riparian forests of the Blue Mountains, Oregon. Seattle, WA: University of Washington. 98 p. Master of Science thesis.

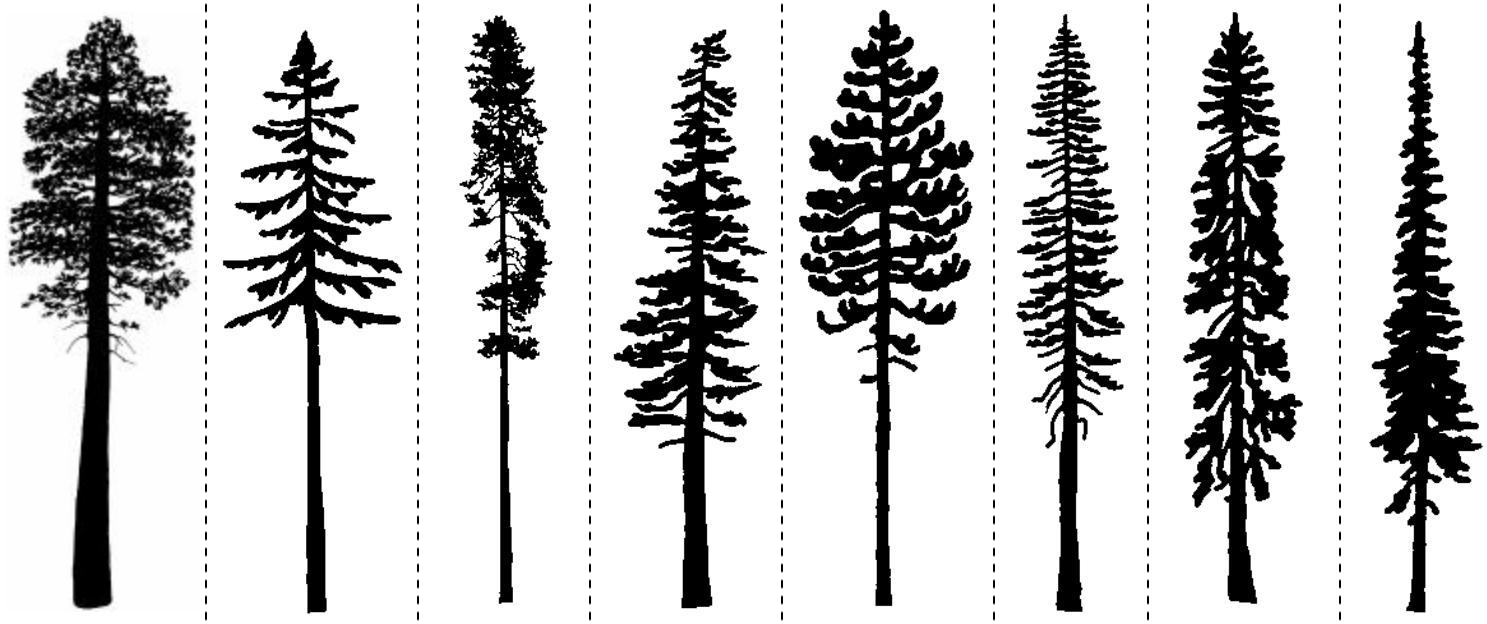
As Thornton Munger noted in 1917, "Light, slowly spreading fires that form a blaze not more than 2 or 3 feet high and that burn chiefly the dry grass, needles, and underbrush start freely in yellow pine forests." For dry forests, these surface fires occurred every 5 to 20 years, and their cleansing influence was as important as sunlight and rain.

Almost immediately after it began in 1905, the Forest Service tried to suppress wildfire on National Forest System lands. This picture shows a firefighter using damp burlap to beat out a surface fire in ponderosa pine forest on the Wallowa National Forest, in about 1910.

Surface fire functioned as nature's thinning agent because it killed many small tree seedlings; by suppressing fire, we allowed tree density to increase dramatically. On dry sites, fire suppression had the unintended consequence of allowing tree species with low fire resistance (grand fir and interior Douglas-fir) to replace a species with high fire resistance (ponderosa pine).

Thinning and prescribed fire treatments, when used in tandem, can restore sustainable and resilient conditions on dry sites. Sustainable conditions consist of a moderately open density (40 to 70 ft^2/ac of basal area), many large trees (up to 60 percent of the basal area occurs in trees with a diameter of 21 inches or more), and a species composition featuring ponderosa pine (up to 70 percent of the composition is pine).

SELECTED FIRE RESISTANCE RATINGS[1] FOR EIGHT COMMON CONIFERS OF THE BLUE MOUNTAINS



	Ponderosa Pine	Western Larch	Lodgepole Pine	Interior Douglas-fir	Western White Pine	Grand Fir	Engelmann Spruce	Subalpine Fir
Outer Bark Thickness	Very thick (.574")	Thick (.466")	Thin (.188")	Moderate (.393")	Moderate (.378")	Very thin (.097")	Thin (.108")	Very thin
Rooting Habit	Deep	Deep	Medium	Deep	Medium	Shallow	Shallow	Shallow
Bark Resin (Old Bark)	Abundant	Very little	Abundant	Moderate	Abundant	Very little	Moderate	Moderate
Branching Habit	Moderately high & open	High & very open	Moderately high & open	Moderately low & dense	High & dense	Low & dense	Low & dense	Very low & dense
Foliage Flammability	Medium	Low	Medium	High	Medium	High	Medium	High
Overall Fire Resistance	High	Very high	Low	Medium to High	Medium	Medium to Low	Low	Very low
Fire Survival Strategy[2]	Resister	Resister	Evader	Resister	Resister	Avoider	Avoider	Avoider

SELECTED FIRE RESISTANCE RATINGS[1] FOR EIGHT COMMON CONIFERS OF THE BLUE MOUNTAINS

[1] Fire resistance ratings were adapted from Flint (1925), Klinka et al. (2000), and Starker (1934); outer bark thickness values, in inches, were taken from Smith and Kozak (1971).

[2] Fire survival strategy is based on a classification by J.S. Rowe, a Canadian ecologist, and they are summarized here from Barnes et al. (1998). Plants have specific functional adaptations to deal with fire, and Rowe distinguished five primary strategies after studying boreal forests:

Invader: these plant species are early arrivers, and they depend on copious amounts of light, wind-disseminated seed to invade a fire from areas outside of it (fireweed and Scouler willow are good examples of the invader group).

Evader: these plant species store their seeds in the canopy, humus, or mineral soil to avoid high fire temperatures, and they respond to fire with rapid seed germination and establishment. The parent plants are generally killed by fire, so evader species persist by producing a new generation from an onsite seed bank. Common examples are snowbrush ceanothus (regenerates from a soil seed bank), and lodgepole pine (regenerates from a canopy seed bank stored in serotinous cones).

Avoider: these plant species arrive late in plant succession, and they prosper where fire cycles are relatively long (such as fire regimes 3 and 4). They essentially lack effective adaptations to either survive a fire, or to regenerate quickly after one. Avoiders are generally the late-seral, shade-tolerant species found in old forests that haven't been disturbed for a long time. For the Blue Mountains, tree species that consistently function as avoiders are Engelmann spruce and subalpine fir. Grand fir is often an avoider, but when it grows on dry-forest sites in fire regime 1, it can function as a resister if it escapes or survives fire long enough to become large and thick-barked. [Some species like grand fir have fairly wide ecological amplitude, which means they can function in a different way from one biophysical setting to another].

Resister: these plants tend to be early-seral, shade-intolerant species with effective adaptations for surviving low-severity fire (such as surface fire with a flame length of three feet or less). Good examples of resisters are thick-barked species with high crowns, such as ponderosa pine and western larch, because these life history traits protect the stem from damage (thick bark) and elevate the tree's heat-sensitive foliage well above the flames (high crown). Douglas-fir and western white pine are mid-seral species with relatively low fire tolerance when young (they are avoiders in this stage of their development), but older trees are reasonably good resisters because their bark is thick and their crowns are well elevated.

Endurer: these plant species handle fire by resprouting after it occurs; fire consumes or kills the above-ground portion of the plant, but they promptly revegetate by sprouting from the root system, root collar, rhizomes, or other below-ground organs protected from heat damage. A good example for this group is quaking aspen: it is a clonal tree species with very low fire resistance (for the existing stems), but it easily survives fire by sprouting prolifically from the root system (using vegetative shoots called suckers).

Barnes, B.V.; Zak, D.R.; Denton, S.R.; Spurr, S.H. 1998. Forest ecology. Fourth edition. New York: John Wiley & Sons, Inc. 774 p. (Rowe's fire adaptation classification is described on page 288).

Flint, H.R. 1925. Fire resistance of northern Rocky Mountain conifers. Idaho Forester. 7: 7-10, 41-43.

Klinka, K.; Worrall, J.; Skoda, L.; Varga, P. 2000. The distribution and synopsis of ecological and silvical characteristics of tree species of British Columbia's forests. Coquitlam, BC: Canadian Cartographics Ltd. 180 p.

Smith, J.H.G.; Kozak, A. 1971. Thickness, moisture content, and specific gravity of inner and outer bark of some Pacific Northwest trees. Forest Products Journal. 21(2): 38-40.

Starker, T.J. 1934. Fire resistance in the forest. Journal of Forestry. 32(4): 462-467.

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