Tower Fire

FOREST VEGETATION BAER REPORT

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Introduction

The rehabilitation of areas burned by wildfires has three distinct steps. They are: rehabilitation of damage caused by fire suppression efforts, burned area emergency rehabilitation, and long-term fire recovery efforts.

Burned area emergency rehabilitation (BAER) is designed to alleviate emergency watershed conditions following wildfire to help stabilize soil, control water, sediment, and debris movement, and prevent threats to life, property, and other downstream values, both on-site and off-site. The goal of BAER is to respond quickly after a fire and provide emergency site protection before the first damaging precipitation or runoff event.

BAER may recommend a wide array of treatments for burned areas, such as:

- removal of debris that may clog drainage structures along roads
- seeding of grass to provide temporary ground cover while native plants become reestablished
- construction of temporary channel structures to slow water runoff and capture sediment
- improving drainage on trails to prevent excessive erosion
- felling of trees on the contour to capture sediment

Each fire is different and will require a separate BAER evaluation and individual treatment prescriptions designed specifically for that fire's conditions.

Generally, only the most seriously burned areas are treated as a result of the BAER process. It is often best to let a burned site recover naturally. BAER treatments are designed to speed recovery in specific areas where watershed emergencies threaten life and property.

Long-term fire recovery is designed to recover the burned area beyond the emergency measures implemented by the BAER process. Washed out roads and damaged bridges may be replaced during this phase. Trees may be planted to replace stands killed or seriously damaged by the fire. Fences on range allotments may be rebuilt. Recreation facilities may need to be reconstructed. Fisheries structures or wildlife habitat enhancements may need to be repaired or replaced. These long-term projects are funded by the responsible resource area, such as silviculture, wildlife, or range.

Since planting, fertilization, thinning, and other tree stand activities are considered long-term recovery practices, most of the recommendations in this report do not have a direct bearing on proposed BAER treatments.

Vegetation Types

Pre-fire vegetation types were very diverse, largely in response to a relatively steep elevational gradient ranging from 3,000 feet at the southwestern corner of the fire perimeter to 6,850 feet at Tower Mountain lookout on the extreme eastern edge of the fire.

Predominant forest cover types in the fire area, as arrayed on an elevational gradient from low to high, included dry forests, mesic forests, lodgepole pine forests, and cold forests. Selected characteristics of the forest cover types are provided in Table 1. See the "Coarse Vegetation Map" (map 2 in the appendix) for the geographical distribution of the forest types.

Table 1. Characteristics of forest cover types in the Tower fire area.

FOREST COVER TYPE	PREDOMINANT SPECIES	ECOLOGICAL SETTINGS	PERCENT OF FIRE AREA
Dry Forest	**PP, DF, WJ**	**Warm Dry (WD)**	**15%**
Mesic Forest	**GF, DF, WL, PP, LP, WP**	**Cool Moist (CM)**	**50%**
Lodgepole Pine	**LP, GF, SF, ES, WL**	**CM, CH, LP**	**30%**
Cold Forest	**SF, ES, LP, WL**	**Cold Harsh (CH)**	**5%**

Source/Notes: Predominant species codes are: PP: Ponderosa pine; DF: Douglas-fir; WJ: Western juniper; GF: Grand fir; WL: Western Larch; LP: Lodgepole pine; WP: Western white pine; SF: Subalpine fir; and ES: Engelmann spruce. See Table 2 for further information about the ecological settings on which the forest cover types occur. The "percent of fire area" estimates were derived from the "Coarse Vegetation Map" for the Tower fire area (see map 2 in appendix), and from field reconnaissance.

The wide diversity of site conditions found in the Tower fire is derived from changes in physiography (landform), topography, climate, soils, aspect, geology and other biophysical factors. Each unique combination of those factors results in a site with slightly different temperature and moisture conditions. In the Tower fire area and in other mountainous terrain, temperature and moisture tends to vary predictably with changes in two environmental factors – elevation and aspect (slope exposure).

Since plant distributions are controlled largely by environmental factors, sites with equivalent temperature and moisture conditions will eventually support similar plant communities. Sites with the potential to support similar plant communities (associations) are called *ecological settings*. Lands in the same setting are ecologically similar – they were exposed to similar climatic and disturbance regimes, they have similar productivities, and they respond to management practices in a similar manner. Table 2 summarizes selected characteristics for forested ecological settings of the Tower fire area.

TABLE 2: SELECTED CHARACTERISTICS FOR THE ECOLOGICAL SETTINGS.

Ecological Setting	**Disturbance Agents**	**Fire Regime**	**Patch Sizes**	**Primary Landform**	**Elevation Zone**	**Typical Aspects**
Cold, Harsh (CH)	Wind Insects/Fire Pathogens Avalanches Drought	High	5-1,000	Gentle Tablelands	High	North East Flat
Cool, Moist (CM)	Wind Pathogens Insects/Fire Drought	Moderate or High	300-10,000	Dissected Sideslopes	Moderate	North East West
Warm, Dry (WD)	Fire Insects Pathogens	Low or Moderate	150-2,000	Dissected Sideslopes	Low	South West
Lodgepole Pine (LP)	Insects Fire	High	40-1,000	Gentle Tablelands	Moderate	East North Flat

Sources/Notes: Fire regime ratings came from Agee (1993); disturbance agents, patch sizes, primary landforms, elevation zones, and typical aspects were adapted from Powell (1996). Patch sizes are given in acres.

Fire regime ratings are:

Low: 1-25 year return interval; 0 to 20% mortality of large trees; a nonlethal fire regime.

Moderate: 26-100 year return interval; 20-70% mortality of large trees; a mixed fire regime.

High: > 100 year return interval; > 70% mortality of large trees; a lethal fire regime.

Fire Behavior

Much of the Tower fire area is a good example of the damage caused by a crown fire. A crown fire is one that spreads through the forest canopy. Crowning is one of the most spectacular fire behavior phenomena that wildland fires exhibit. Crown fires are fast spreading and release a tremendous amount of heat energy in a relatively short period of time. Spread rates exceeding 7 miles per hour and flame lengths over 150 feet have been recorded (Pyne and others 1996).

When winds are strong and sustained, a running crown fire may spread for several hours, burning out entire drainages and crossing mountain ridges that would normally serve as topographic barriers. Fully-developed crown fires can be either wind driven or convective (also called plume-dominated fires). Tower was an instance in which a strong convection column (the plume) built vertically above the fire. It is hypothesized that momentum feedback from the vertical velocity within the column causes turbulent indrafts which promote rapid combustion. The resulting increase in turbulence and fire intensity increases both convective and radiant heat transfer, thus accelerating fire spread. This positive reinforcement process results in a towering convection column and spread rates that are exceptionally fast for the prevailing winds – in other words, the fire spreads at its own self-directed speed and that speed is much greater than would be expected from the ambient wind conditions (Pyne and others 1996).

It is also believed that the Tower fire exhibited a dangerous condition called a downburst or microburst, where winds blow outward near the ground from the bottom of the convection cell. These winds can be very strong and can greatly accelerate a fire. Downburst conditions are initiated by evaporative cooling that cools surrounding air, causing it to descend rapidly and spread horizontally at the ground surface (Pyne and others 1996).

Expected Response to the Fire

The Tower fire affected a very large area supporting a wide diversity of plant species, so a detailed table is provided in the appendix (Table 10) that summarizes fire effects information for many common plants of mixed-conifer forests in the central and southern Blue Mountains of northeastern Oregon (Powell 1994). Since table 10 provides information for more than 70 species, including common trees, shrubs, graminoids, and forbs, some characteristics affecting the fire resistance of eight major tree species is summarized separately in Table 3.

We can expect forest recovery to be slow in many portions of the fire, especially for sites that burned at a moderate or high intensity and supported stands with a high proportion of thin-barked species (subalpine fir, lodgepole pine, grand fir, Engelmann spruce, and western white pine). The fire actually created site conditions that are conducive to regeneration of early seral conifers. However, the fire intensity resulting in conducive conditions was also responsible for killing most of the seed trees that are required for establishment of new tree seedlings.

Table 4 summarizes the acreage burned by forest type and fire intensity. It shows that *42% of the Tower fire burned with an intensity that was severe enough to kill most of the trees in a stand*, particularly stands with thin-barked species. If subalpine fir or lodgepole pine were present, low-intensity areas will also experience some tree killing because a small amount of bole scorch can result in lethal cambial girdling for those species. See the "Fire Intensity Map" in the appendix for the geographical distribution of fire intensity classes for the Tower fire area.

Some of the moderate-intensity acreage in the dry forest cover type may not experience catastrophic mortality, depending on species composition, tree age and vigor, and stand structure. Ponderosa pine trees can withstand a relatively high amount of crown scorch (up to 80%), especially vigorous trees in the large-pole and small-sawtimber size classes. Western larch can also survive a very high amount of bole and crown scorch, resulting in it having the highest fire resistance of any conifer in the Tower fire area (Table 3).

Table 3. Bark thickness, crown length, and fire resistance rankings for common tree

species of the montane and subalpine vegetation zones in the Blue Mountains.

BARK THICKNESS	CROWN LENGTH	FIRE RESISTANCE
Ponderosa Pine (thickest)	**Western Larch (shortest)**	**Western Larch (highest)**
Western Larch	**Western White Pine**	**Ponderosa Pine**
Douglas-fir	**Lodgepole Pine**	**Douglas-fir**
Grand Fir	**Ponderosa Pine**	**Western White Pine**
Western White Pine	**Douglas-fir**	**Grand Fir**
Engelmann Spruce	**Grand Fir**	**Lodgepole Pine**
Subalpine Fir	**Engelmann Spruce**	**Engelmann Spruce**
Lodgepole Pine (thinnest)	**Subalpine Fir (longest)**	**Subalpine Fir (lowest)**

Sources: Powell (1994, Table 2). Species rankings are based on the predominant situation for each trait. A species trait is not absolute – it can vary during the lifespan of an individual tree, and from one individual to another in a population. For example, grand fir's bark is thin when young, but relatively thick when mature.

TABLE 4: AREA (ACRES) BURNED, BY FIRE INTENSITY AND FOREST TYPE.

	AREA (ACRES) BY FIRE INTENSITY				
Forest Type	**Low**	**Moderate**	**High**	**Severe**	**Total**
Dry	5,898	2,110	548	2,658 (31%)	8,556
Mesic	12,503	9,429	3,488	12,917 (51%)	25,420
Lodgepole	8,002	3,847	1,851	5,698 (42%)	13,700
Cold	2,840	246	56	302 (10%)	3,142
Total	29,243	15,632	5,943	21,575 (42%)	50,818

Sources: Fire intensity and coarse vegetation maps for the Tower fire area (see appendix). The "severe" column is the moderate and high acreages combined; the percentage shown after each severe value was computed by dividing the severe value by the total for the forest type.

Ponderosa Pine Response. The response of ponderosa pine to crown scorch varies with time of burning since early summer fires cause more damage than late summer burns. Less damage occurs in late summer because tree growth has slowed, terminal buds have formed, and root (food) reserves have been accumulated. Crown scorching in early spring, before or immediately after bud burst, often results in minimal damage to the tree (Crane and Fischer 1986). An important concern is the increased susceptibility of ponderosa pine to bark-beetle attack after crown scorch (defoliation). For ponderosa pine, the risk of western pine beetle attack varies in direct proportion to the amount of crown lost by scorching (Table 5).

TABLE 5: RELATIONSHIP BETWEEN CROWN SCORCH AND MORTALITY CAUSED BY WESTERN PINE BEETLE FOR PONDEROSA PINE (SOURCE: CRANE AND FISCHER 1986).

Percent Scorch (Defoliation)	Percent of Trees Killed by Beetles
0-25	0-15
25-50	13-14
50-75	19-42
75-100	45-87

Forest Insect Response. A recent study of fire-injured trees in the Yellowstone fires of 1988 (Ryan and Amman 1994) showed that insects can be expected to affect other species too:

1. Douglas-firs with more than 50% crown scorch, or more than 75% basal girdling, suffered high mortality from Douglas-fir beetle and wood borers.
2. A large proportion of burned lodgepole pines were killed by beetles (mostly pine engravers) within 3 years of the fire, even though most trees had received less than 25% crown scorch. Although mountain pine beetle was not a major problem following the Yellowstone fires, it has infested large-diameter lodgepole pine in eastern Oregon following root injury or minor basal girdling caused by fire.
3. Engelmann spruce can experience very high levels of spruce beetle infestation following fire injury, either in standing trees or in windthrown stems whose shallow roots were consumed by smoldering fires in accumulations of litter and duff at the tree bases.
4. For subalpine firs, virtually any fire vigorous enough to scorch the bark will cause cambial injury, followed by sloughing of the dead bark. Wood borers quickly and aggressively colonize the fire-damaged trees and thereby contribute to extremely high mortality rates.

Natural Regeneration. The probability of obtaining natural regeneration in the fire area will depend on several factors:

- the availability of surviving trees to serve as a seed source,
- the spatial arrangement of seed trees (their proximity to severely-burned areas),
- whether the survivors are physiologically capable of producing seed in any abundance,
- whether cone (seed) crops are actually produced, and when.

In the case of lodgepole pine, some regeneration may be produced by cones present in the canopy of dead stands, assuming of course that any canopy remained after the fire. In many moderate-intensity areas, all lodgepole pines were killed by the fire, although foliage still persists and will provide some seed if cones were present before the burn. Although lodgepole pine has low serotiny (closed cones) in the Blue Mountains, it is a prolific seed producer and good seed crops occur frequently. If 1996 was a good seed year for lodgepole pine stands in the Tower fire area, we can expect adequate to overly-abundant lodgepole pine regeneration in the future.

Table 6 summarizes silvical characteristics related to seed production. Table 7 provides effective seed dispersal distances that can be expected for important conifers affected by the Tower fire.

Table 6. Minimum reproductive age (years), period when abundant seed crops begin to be produced, and periodicity of good seed crops for common tree species of the montane and subalpine vegetation zones in the Blue Mountains.

TREE SPECIES	MINIMUM AGE (YEARS)	PERIOD WHEN ABUNDANT SEED CROPS PRODUCED	PERIODICITY OF GOOD SEED CROPS
Ponderosa Pine	**20**	**Late (40-60 years)**	**3-10 years**
Douglas-fir	**20**	**Intermediate (20-40 years)**	**3-10 years**
Western Larch	**15**	**Early (10-20 years)**	**3-5 years**
Black Cottonwood		**Early (10-20 years)**	**1-2 years**
Thinleaf Alder		**Early (10-20 years)**	**3-5 years**
Water Birch		**Early (10-20 years)**	**1-2 years**
Quaking Aspen		**Early (10-20 years)**	**3-5 years**
Grand Fir	**15**	**Late (40-60 years)**	**3-5 years**
Western White Pine	**15**	**Late (40-60 years)**	**3-5 years**
Lodgepole Pine	**15**	**Early (10-20 years)**	**1-2 years**
Engelmann Spruce	**25**	**Late (40-60 years)**	**2-6 years**
Subalpine Fir	**25**	**Late (40-60 years)**	**2-3 years**
Whitebark Pine	**60**	**Late (40-60 years)**	

Sources/Notes: "Minimum age," from Keane and others (1996), refers to the age at which the species starts producing seed crops; "period when abundant seed crops produced" and "periodicity of good seed crops," from Daniel and others (1979), refers to the period when the species begins to produce abundant seed crops, and the average time interval between good seed crops.

Table 7. Effective seed dispersal distances for common coniferous trees of the montane and subalpine vegetation zones on the Umatilla National Forest.

SPECIES	EFFECTIVE SEED DISPERSAL
Ponderosa Pine	**Up to 100-120 feet**
Western Larch	**Up to 120-150 feet**
Douglas-fir	**Up to 300-330 feet**
Grand Fir	**Up to 200 feet**
Western White Pine	**Up to 400 feet**
Engelmann Spruce	**Up to 100-120 feet**
Subalpine Fir	**Up to 50-100 feet**
Lodgepole Pine	**Up to 200 feet**

Source/Notes: Nyland (1996). These distances are maximums for the majority of seed; for example, at least 50% of Engelmann spruce seed will fall within 120 feet of the windward edge of an opening, although up to 10% of the seed will be dispersed as far as 300 feet.

After considering the information contained in tables 6 and 7, along with local experience gained by following recovery after other fires (although none of the recent historical fires approached the size of Tower), it was possible to estimate lag times to obtain natural regeneration in the Tower fire area. Those estimates are provided in Table 8. It is difficult to estimate lag times precisely due to variations in fire intensity, burn patterns, and stand mortality, all of which have a bearing on seed availability and the probability of obtaining natural regeneration.

Table 8. Estimates of natural regeneration lag times for the Tower fire area.

FOREST COVER TYPE	EARLY SERAL TREE SPECIES	Natural Regen Period By Fire Intensity LOW	SEVERE
Dry Forest	**PP**	**< 10 years**	**10-15 years**
Mesic Forest	**WL, PP, LP**	**< 5 years**	**5-10 years**
Lodgepole Pine	**LP, WL**	**< 5 years**	**5-10 years**
Cold Forest	**LP, WL**	**< 10 years**	**15-25 years**

Source/Notes: "Early Seral Tree Species" are those species that are ecologically adapted to the site conditions created by a stand-replacing disturbance event such as wildfire. Estimates of natural regeneration (regen) lag times are based on the authors' judgment, and assume that a seed source (living trees of seed-bearing age and vigor) is present within a reasonable distance of the site to be colonized. See Table 1 for tree species codes, and Table 4 for a description of the fire intensity classes.

Fire Effects on Western White Pine Natural Stands and Plantations

The Tower fire adversely affected a number of natural stands of western white pine on the North Fork John Day District (NFJD), including those occurring in Hidaway Meadows, Winom Butte, Pearson Ridge, and the Texas Bar drainage (Map 3, in appendix). Fire intensity was moderate to high in those areas and, as a consequence, an estimated 60-70 percent of the natural white pine populations on the District, and also a high proportion for the Forest, have been extirpated.

In addition to their intrinsic biotic value, these stands represented a major source of reforestation seed for the District. Most of the remaining western white pine on NFJD is inaccessible or has high levels of blister rust. The loss of the 20-acre Texas Bar stand is especially significant since plans were underway to thin and culture it for use as a seed production area. In addition, a number of the white pine trees lost were select parent trees and were being screened for resistance to western white pine blister rust at the Dorena Genetic Resource Center.

Over the last 15 years, western white pine has increasingly been used in District reforestation plantings due to its high survival and juvenile growth rates when established on ecologically suitable sites. An estimated 25-50 percent of these plantings (approximately 300-400 acres) were destroyed by the Tower Fire. The majority of the plantations occurred in the Texas Bar and Oriental Creek areas.

At present, the District has less than 20 pounds of western white pine seed on inventory, enough to yield approximately 153,000 shippable seedlings. Another 9,000 seedlings are at Stone Nursery for 1997 delivery. Together these inventories are sufficient for planting approximately 1,860 acres (20% WWP in mix, 10′x10′ spacing), roughly the acreage in the Tower fire area suitable for planting white pine. Once these sources have been depleted, the District will face a serious dilemma as to where to obtain additional western white pine seed for reforestation.

Fortunately, western white pine exhibits little differentiation over geographic, ecologic, or elevational gradients, and nonlocal seed sources can thus be transferred widely with little risk of maladaptation (Rehfeldt et al. 1984, Steinhoff 1979, Townsend et al. 1972, Rehfeldt and Steinhoff 1970). Recommendations regarding the use of nonlocal western white pine seed are provided in the following section (item #6). In the future (approximately 20-25 years from now), reforestation seed may also be obtained from the Paddy Flat Seed Orchard (Pine RD, Wallowa-Whitman National Forest), which is being established to supply seed for the Umatilla, Wallowa-Whitman, and Malheur National Forests.

Conclusions and Recommendations

1. In areas where the mesic forest, lodgepole pine, and cold forest cover types burned with a low intensity, and in areas where the dry forest cover type burned with a low or moderate intensity, it is unclear how many trees will ultimately survive the fire. Since the abundance, distribution, and species composition of the survivor component will have important implications for artificial reforestation, *we recommend that the District acquire high-resolution (2-meter), color infrared (CIR) photography for the fire area*. CIR photography is ideal for assessing vegetation stress, and would probably be the best remote sensing product for estimating tree mortality (or survival). Acquiring CIR photography at a high resolution would allow it to do double duty – not only could it help identify living and damaged trees, but it would serve as an ideal GIS “base layer” for salvage planning, reforestation, and other post-fire project work.
2. According to field reconnaissance completed by the BAER team and Scott McDonald, it appears that a large acreage of established (certified) and recently-completed plantation was burned in the fire (perhaps 1,200 acres). If that assessment turns out to be accurate, then a silvicultural investment of well over $1,000,000 was lost in plantations alone, with unknown additional losses for thinnings and other cultural treatments. Since the plantations represent a serious loss of timber productivity, and are areas where we have entered into a de facto “contract” with the public, timber purchasers, and other stakeholders to quickly reestablish tree cover in harvested areas (as directed by the National Forest Management Act), *we recommend that the burned plantations be replanted as quickly as possible*.
3. According to reconnaissance completed by the BAER team, and by Vince Novotny, Scott McDonald and other District employees, it appears that large areas were burned with an intensity that warrants consideration for artificial reforestation (perhaps 16,000 acres or more, including the Cable Creek roadless areas). After identifying areas that are likely to regenerate naturally, as discussed in the “Response to the Fire” section above, and after locating areas where planting would need to be postponed until salvage treatments are completed, *we*

recommend that the remaining areas with a high amount of stand mortality (outside of the North Fork John Day Wilderness) be scheduled for planting.

4. *We recommend that all plantings emphasize establishment of early-seral conifers on upland sites*, and appropriate hardwood species (black cottonwood, quaking aspen, thinleaf alder, water birch, etc.) in riparian zones. Table 8 shows the early seral conifers that could be considered for each of the forest cover types. Since lodgepole pine is expected to regenerate naturally on all but the highest intensity burns, we recommend that upland plantings emphasize western larch and ponderosa pine to a greater degree than lodgepole pine.
5. Even though Tower burned as a convection crown fire, which means that stand densities and structures, fuel characteristics, and other factors that typically influence fire behavior had little or no impact in this instance, *we recommend that future stand densities be maintained at levels which minimize the potential for crown fires*. Those recommended levels are provided in Table 9.

TABLE 9: MAXIMUM STAND DENSITIES TO LIMIT CROWN FIRE SUSCEPTIBILITY.

AVERAGE STAND DIAMETER (Inches)	MAXIMUM STAND DENSITY (Trees/Acre) Ponderosa Pine	Douglas-fir	Grand Fir
3.0	584	574	344
7.5	390	238	245
12.5	197	162	157
17.5	170	104	83

Source/Notes: From Agee (1996). These figures refer to single-sized, non-stratified stands that are predominately of a single species. They do not pertain to stands in which differentiation into crown strata has occurred such that ladder fuels from the understory to the overstory are present. To limit future crown fire risk, any stand density treatment (thinnings, weedings, release, etc.) should leave no more than the trees per acre given above. For example, if a pole-size Douglas-fir stand is thinned from below, and the average stand diameter after thinning is about 7.5″, then the residual stocking should be no more than 238 trees per acre (13.5′ spacing) to limit the risk of future crown fire.

6. Several sources of non-local western white pine seed exist which would be suitable for use in District planting mixes. Seed origin should be documented in planting records, and survival and growth performance monitored closely over time so that transfer guidelines can be modified as needed. In order of preference, seed sources considered appropriate for District use include the following:

   a) <u>Other Blue Mountain sources</u>: The Malheur NF has the greatest abundance of western white pine in the Blue Mountains, as well as an active seed collection program. At present, however, no surplus seed is available. The Wildcat and Summit fires (1996) have generated unplanned reforestation needs on the Malheur NF, and it's highly unlikely that surplus white pine seed from this source will be available for years to come.

b) Couer d'Alene Nursery Seed Orchard: Established in late 1970s with tested materials from Northern Idaho (Nez Perce, Clearwater, Panhandle NFs), as well as a few sources from Northeast Washington and Northwest Montana. Blister rust resistance rating is approximately 60%. Harvested seed crops are allocated on an annual basis to R-1 National Forests. The Umatilla has made a request for surplus seed, but supplies are very limited and demands are high.

   Surplus seedlings are currently available from this source for outplanting in 1997 (100M, 2-0 stock) and 1998 (100M, 3-0 stock?). If stock quality is acceptable, we highly recommend the acquisition of these seedlings for District use.

c) Moscow Arboretum: Established in the 1950s/1960s, this orchard now supplies seed for cooperators in the Inland Empire Tree Improvement Cooperative (IETIC). Resistance level is approximately 60%. All surplus seed in storage was sold earlier this summer; future offerings are unknown.

d) Sandpoint Seed Orchard: Estimated resistance is 35%; so plant materials originating from this orchard are not recommended for use on high risk sites. *Coeur d'Alene Nursery currently has 28M surplus seedlings (3-0 stock) available for outplanting in 1997.*

e) Dorena Seed Orchard: Surplus seed and seedlings originating from Zone 3 (Willamette and Deschutes NF) and Zone 4 (Umpqua/Rogue River NFs and a portion of Winema NF) are frequently available to the Forest. Dorena tested seed is assigned a Hazard Use Class (HUC). These values range from 91 to 99, with 99 being the safest seed to use in a high infection risk area. HUC value of Dorena orchard seed is 97, which is fairly high quality seed. *Plant materials from R-1 are preferable to those from this source, however.*

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Appendix

- Fire Effects Information for Plants of Mixed-Conifer Forests (Table 10)
- Map 1: Fire Intensity Map for the Tower fire area (not available in electronic format).
- Map 2: Coarse Vegetation Map for the Tower fire area (not available in electronic format).
- Map 3: White pine populations affected by the Tower fire (not available in electronic format).

Fire Effects Information for Mixed-Conifer Forests

The information in Table 10 provides fire effects information for more than 70 common plant species found on mixed-conifer sites in the central and southern Blue Mountains.

Plants have varying degrees of fire resistance. A plant's response to fire depends on many factors, including the moisture content of soil and duff at the time of burning, the physiological stage of the plant (immature, mature, etc.), and the fire's severity, particularly with regard to the amount of heat that permeates the litter, duff, and upper soil layers (Crane and Fischer 1986). An important factor affecting a plant's fire resistance is whether it regenerates vegetatively (survivor plants) or from off-site or buried seed (colonizer plants).

Fire resistance ratings ("Resistance" in Table 10) have the following interpretation:

- **High –** Greater than 65 percent chance that 50 percent of the species population will survive or immediately reestablish after passage of a fire with an average flame length of 12 inches.
- **Medium –** 35 to 64 percent chance that 50 percent of the species population will survive or immediately reestablish after passage of a fire with an average flame length of 12 inches.
- **Low –** Less than 35 percent chance that 50 percent of the species population will survive or immediately reestablish after passage of a fire with an average flame length of 12 inches.

Post-fire response ratings ("Response" in Table 10) are an estimate of how quickly a plant species will regain its prefire population level. They have the following interpretation:

- **High –** The species population will regain its preburn frequency or cover in 5 years or less.
- **Medium –** The species will regain its preburn frequency or cover in 5 to 10 years.
- **Low –** The species will regain its preburn frequency or cover in more than 10 years.

The site type ratings ("Site Type" in Table 10) describe the temperature and moisture relationships for sites on which the species is abundant and widely distributed.

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Table 10 – Fire effects information for common plants of mixed-conifer forests in the central Blue Mountains.

Code	Plant Name	Fire Resistance	Fire Response	Site Type	Comments About Regeneration Methods
			TREES		
ABLA2	Subalpine fir (*Abies lasiocarpa)*	Low	Low	Cold, Mesic	Entire stands of this high-elevation species are easily killed by fire; colonizes burned areas very slowly.
JUOC	Western juniper (*Juniperus occidentalis)*	Medium	Low	Warm, Dry	Post-fire establishment occurs from seed, much of which is dispersed by animals (rabbits, squirrels, etc.).
LAOC	Western larch (*Larix occidentalis)*	High	High	Cool, Mesic	Our most fire-resistant conifer because of its thick bark, short crown length, and high tolerance to foliage loss.
PIEN	Engelmann spruce (*Picea engelmannii)*	Low	Low	Cold, Moist	Easily killed by fire because of its long, full crown, thin bark, and a shallow root system.
PICO	Lodgepole pine (*Pinus contorta)*	Medium	High	Cool, Mesic	Often regenerates after stand-replacing wildfires, when it forms dense, even-aged thickets.
PIPO	Ponderosa pine (*Pinus ponderosa)*	High	High	Warm, Mesic	Very high fire resistance; experiences reduced diameter growth after high levels of crown scorch.
PSME	Douglas-fir (*Pseudotsuga menziesii)*	High	Medium	Warm, Mesic	Mature trees are fire resistant due to thick bark, but thin-barked poles and saplings are easily damaged by burning.
			SHRUBS		
AMAL	Serviceberry (*Amelanchier alnifolia)*	Medium	High	Cool, Mesic	Sprouts immediately after fire and also reproduces from bird- and mammal-dispersed seed; germinates on bare soil in partial shade.
ARNE	Manzanita (*Arctostaphylos nevadensis)*	Low	Medium	Cool, Dry	Regenerates from the root crown, runners (stolons) or from seed; survives cool fires if the litter/duff was not completely consumed.
BERE	Creeping hollygrape (*Berberis repens)*	Medium	Medium	Cool, Dry	Sprouts from surviving rhizomes after fire; survives all but severe burns that cause high soil heating.
CEVE	Snowbrush ceanothus (*Ceanothus velutinus)*	High	High	Warm, Mesic	Often regenerates prolifically from seeds buried in the soil; seeds can remain viable for hundreds of years.
CELE	Mountain mahogany (*Cercocarpus ledifolius)*	Low	Low	Warm, Dry	Sprouts weakly after low-intensity fires; reproduces from wind- and mammal-dispersed seed (some soil storage); germinates in full sun.
HODI	Oceanspray (*Holodiscus discolor)*	Medium	High	Warm, Dry	Regenerates from the surviving root crown, and from seed stored in the soil; its seedlings establish easily on fresh mineral soil.
PAMY	Myrtle pachistima (*Pachistima myrsinites)*	Medium	Medium	Cool, Mesic	Regenerates from the crown of a deep taproot, or from stem bud sprouts or stored seed; may increase after cool or moderate burns.
PRVI	Common chokecherry (*Prunus virginiana)*	Medium	High	Warm, Mesic	Sprouts prolifically from its root crown; reproduces from bird- and mammal-dispersed seed; germinates in full sun after disturbances.
RICE	Wax currant (*Ribes cereum)*	Medium	High	Warm, Dry	Regenerates from seed stored in the litter/duff, and from basal stem sprouts; susceptible to fire-induced mortality after severe burns.

Table 10 – Fire effects information for common plants of mixed-conifer forests in the central Blue Mountains (CONTINUED).

CODE	PLANT NAME	FIRE RESISTANCE	FIRE RESPONSE	SITE TYPE	COMMENTS ABOUT REGENERATION METHODS
RILA	Prickly currant (*Ribes lacustre*)	High	High	Cool, Moist	Usually increases after burning, even severe fires. Cool or moderate-intensity fires favor establishment of prickly currant seedlings.
ROGY	Baldhip rose (*Rosa gymnocarpa*)	Medium	Medium	Cool, Mesic	Regenerates from the root crown, stem bases, and from seed; it responds vigorously to cool or moderate fires.
SASC	Scouler willow (*Salix scouleriana*)	High	High	Cool, Mesic	Regenerates from the root crown, or by using small, windborne seed; may increase dramatically after fire, especially on moist sites.
SPBE	White spiraea (*Spiraea betulifolia*)	High	High	Cool, Mesic	Regenerates from the root crown, and by use of rhizomes located 2-5 inches beneath the soil surface; usually increases after burning.
SYAL	Common snowberry (*Symphoricarpos albus*)	Medium	High	Cool, Mesic	Regenerates from deep rhizomes, basal stem buds, and seed; favored by cool or moderate fires, but often survives severe ones too.
SYOR	Mountain snowberry (*Symphoricarpos oreophilus*)	Low	Medium	Cool, Dry	Sprouts weakly from the root crown, and from rhizomes; usually maintains prefire cover and abundance after cool or moderate fires.
VAME	Big huckleberry (*Vaccinium membranaceum*)	High	Medium	Cool, Mesic	Regenerates from rhizomes and seed, but post-fire recovery may be slow; fire used by native Americans to maintain huckleberry fields.
VASC	Grouse huckleberry (*Vaccinium scoparium*)	Medium	Medium	Cold, Mesic	Regenerates from shallow rhizomes and seed; usually survives cool or moderate fires that don't consume all of the litter and duff layers.
			GRASSES AND GRASS-LIKE PLANTS		
BRCA	California brome (*Bromus carinatus*)	Medium	Medium	Warm, Dry	Regenerates from the root crown and from wind-disseminated seed; nonrhizomatous; germinates on bare soil in full sun.
BRVU	Columbia brome (*Bromus vulgaris*)	Medium	Medium	Cool, Moist	Regenerates from seed, some of which may be stored in the soil; generally declines following severe fires.
CARU	Pinegrass (*Calamagrostis rubescens*)	Medium	Medium	Warm, Mesic	Regenerates from rhizomes and wind-disseminated seed; survives all but severe fires; germinates on bare soil.
CACO	Northwestern sedge (*Carex concinnoides*)	Medium	Medium	Cool, Moist	Sprouts from rhizomes located in the duff; fires which consume most of the litter and duff will have an adverse impact on this plant.
CAGE	Elk sedge (*Carex geyeri*)	High	High	Warm, Mesic	Sprouts from surviving rhizomes and reproduces from seed stored in the soil; germinates on bare soil after burning or scarification.
CARO	Ross sedge (*Carex rossii*)	High	Medium	Cool, Dry	Regenerates from short rhizomes and from seed stored in the duff and upper soil; germinates on bare soil mainly after scarification.
ELGL	Blue wildrye (*Elymus glaucus*)	Medium	Medium	Warm, Mesic	Regenerates from the root crown, rootstock sprouts, and seed; seed can survive temperatures associated with a moderate-intensity burn.
FEID	Idaho fescue (*Festuca idahoensis*)	Low	Medium	Warm, Dry	Regenerates from the root crown, and from wind-disseminated seed; nonrhizomatous; germinates on bare soil.
FEOC	Western fescue (*Festuca occidentalis*)	Low	Low	Cool, Mesic	Regenerates from the root crown, and from off-site seed; generally declines after fire, although it germinates well on bare, shaded soil.

Table 10 – Fire effects information for common plants of mixed-conifer forests in the central Blue Mountains (CONTINUED).

CODE	PLANT NAME	FIRE RESISTANCE	FIRE RESPONSE	SITE TYPE	COMMENTS ABOUT REGENERATION METHODS
KOCR	Prairie junegrass (*Koeleria cristata)*	Medium	Medium	Warm, Dry	Regenerates from seed – susceptible to mortality from late-spring burns, although this is one of our more fire-resistant bunchgrasses.
PHPR	Common timothy (*Phleum pratense)*	Medium	Medium	Disturbances	Regenerates from the surviving root crown or, more commonly, from seed blowing in from adjacent roadsides and forest openings.
PONE	Wheeler bluegrass (*Poa nervosa)*	Medium	High	Warm, Mesic	Regenerates from surviving rhizomes and seed; seldom damaged by fire unless the litter and duff layers are consumed.
POPR	Kentucky bluegrass (*Poa pratensis)*	High	High	Warm, Mesic	Regenerates from basal stem buds, slender rhizomes, and seed; seldom damaged by fire except for hot, spring burns.
SIHY	Bottlebrush squirreltail (*Sitanion hystrix)*	Medium	High	Warm, Dry	Regenerates from the root crown and seed; since it 'cures' early, this grass survives summer fires better than spring ones.
STOC	Western needlegrass (*Stipa occidentalis)*	Low	Low	Warm, Dry	Regenerates from surviving root crowns and wind-disseminated seed; non-rhizomatous; germinates on bare soil in full sun.
			FORBS		
ACMI	Western yarrow (*Achillea millefolium)*	Medium	High	Disturbances	Regenerates from short, shallow rhizomes and seed; declines after severe fires, but invasion from off-site seed usually occurs rapidly.
ADBI	Trailplant (*Adenocaulon bicolor)*	Low	Low	Cool, Moist	Regenerates from short surface rhizomes and seed; generally survives cool fires although post-fire recovery is usually slow.
ANRO	Rose pussytoes (*Antennaria rosea)*	Low	Medium	Cool, Dry	Regenerates from trailing stolons and wind-blown seed; is apt to increase slightly or remain unchanged after cool or moderate burns.
AQFO	Red columbine (*Aquilegia formosa)*	Medium	Medium	Cool, Moist	Regenerates mostly from seed; likely that moderate or hot fires will have a detrimental effect on this species.
ARMA3	Bigleaf sandwort (*Arenaria macrophylla)*	Low	Medium	Cool, Mesic	Regenerates from shallow rhizomes and seed; decreases slightly or remains unchanged after fire depending on duff consumption.
ARCO	Heartleaf arnica (*Arnica cordifolia)*	Low	High	Cool, Mesic	Sprouts from surviving rhizomes; readily invades burned areas using windborne seed; germinates on bare soil in partial shade.
ASCO	Showy aster (*Aster conspicuus)*	Medium	High	Cool, Mesic	Regenerates from surviving rhizomes and wind-disseminated seed; germinates on bare soil in partial shade.
BASA	Balsamroot (*Balsamorhiza sagittata)*	High	High	Warm, Dry	Regenerates from a root crown and animal-disseminated seed; plant densities are often greater than pre-burn levels by the second year.
CAMI2	Scarlet paintbrush (*Castilleja miniata)*	Medium	Medium	Warm, Mesic	Regenerates from the crown of a deep taproot, and from off-site seed; reestablishment in the post-fire community is somewhat slow.
CHUM	Pipsissewa (*Chimaphila umbellata)*	Low	Medium	Cool, Mesic	Sprouts from shallow rhizomes; usually survives cool or moderate burns that don't consume all of the litter and duff layers.
CIVU	Bull thistle (*Cirsium vulgare)*	Medium	Medium	Disturbances	Regenerates from root sprouts and seed; often increases dramatically after burning and may compete moderately with tree seedlings.

Table 10 – Fire effects information for common plants of mixed-conifer forests in the central Blue Mountains (CONTINUED).

		FIRE	FIRE		

Code	Plant Name	Resistance	Response	Site Type	Comments About Regeneration Methods
CLUN	Queencup beadlily (*Clintonia uniflora)*	Low	Low	Cool, Moist	Regenerates from widely spreading rhizomes, and from seed; generally declines after fire.
ERCO3	Longleaf fleabane (*Erigeron corymbosus)*	Low	Medium	Cool, Dry	Regenerates from off-site seed or a moderately well-developed rootcrown; apt to decrease slightly or remain unchanged after fire.
FRVE	Woods strawberry (*Fragaria vesca)*	Medium	Medium	Cool, Mesic	Regenerates from root crown sprouts, runners (stolons), and seed stored in upper soil; survives cool fires.
FRVI	Blueleaf strawberry (*Fragaria virginiana)*	Medium	High	Cool, Mesic	Regenerates from root crown sprouts and runners (stolons); survives cool fires that don't consume all of the litter and duff layers.
GABO	Northern bedstraw (*Galium boreale)*	Medium	Medium	Cool, Mesic	Regenerates from creeping, underground rhizomes, and from sticky seed; is fairly resistant to light burns but declines after severe fires.
GATR	Sweetscented bedstraw (*Galium triflorum)*	Low	Medium	Cool, Moist	Regenerates using rhizomes and seed; decreases dramatically after severe fires, but can increase following cool burns.
GOOB	Rattlesnake plantain (*Goodyera oblongifolia)*	Low	Low	Cool, Mesic	Regenerates using rhizomes and seed; easily killed by fire because its shallow rhizomes are very sensitive to heat.
HIAL2	Western hawkweed (*Hieracium albertinum)*	Low	Medium	Cool, Dry	Lacks rhizomes or another means of vegetative reproduction, but readily invades burned areas using windborne seed.
HIAL	White hawkweed (*Hieracium albiflorum)*	Low	Medium	Cool, Mesic	Lacks rhizomes or another means of vegetative reproduction, but readily invades burned areas using windborne seed.
LALA2	Thickleaf peavine (*Lathyrus lanzwertii)*	Medium	High	Warm, Dry	Regenerates from rhizome sprouts and seed; similar to other legumes in that this plant is a nitrogen fixer.
LANE	Cusick's peavine (*Lathyrus nevadensis)*	Medium	High	Warm, Mesic	Reproduces from surviving rhizomes and from seed stored in the soil; also a nitrogen fixer.
LIBO2	American twinflower (*Linnaea borealis)*	Low	Medium	Cool, Moist	Regenerates from root crowns, stolons, and seed; survives cool fires if the duff and litter layers were damp and not totally consumed.
LUCA	Tailcup lupine (*Lupinus caudatus)*	High	Medium	Cool, Mesic	Regenerates from a deep taproot and heavy seed; its seed can survive for long periods in the lower duff and upper soil layers.
MITR	False agoseris (*Microseris troximoides)*	Medium	High	Warm, Dry	Regenerates from a deep taproot; increases or remains unchanged after fires which don't consume all of the litter and duff layers.
MIST2	Sideflowered mitella (*Mitella stauropetala)*	Medium	High	Cool, Mesic	Regenerates from the root crown and seed; fires which consume most of the litter and duff are apt to have a detrimental impact.
OSCH	Mountain sweetroot (*Osmorhiza chilensis)*	Medium	Medium	Cool, Moist	Regenerates from a taproot or root crown, and from seeds; flowering usually increases after the tree canopy has been opened by fire.
POPU	Polemonium (*Polemonium pulcherrimum)*	Low	Medium	Cold, Moist	Regenerates from the semi-woody crown of a large taproot, and from seed; usually declines following fire.
PTAQ	Bracken fern (*Pteridium aquilinum)*	High	High	Cool, Moist	Sprouts from surviving rhizomes and spreads vigorously after fire; inhibits conifer regeneration by producing chemicals (allelopathy).

Table 10 – Fire effects information for common plants of mixed-conifer forests in the central Blue Mountains (CONTINUED).

		Fire	Fire		

CODE	PLANT NAME	RESISTANCE	RESPONSE	SITE TYPE	COMMENTS ABOUT REGENERATION METHODS
PYSE	Sidebells pyrola (*Pyrola secunda)*	Low	Low	Cool, Mesic	Sprouts from rhizomes in the lower duff or at the soil surface; commonly decreases after fire unless duff moisture is high.
SEIN	Woolly groundsel (*Senecio integerrimus)*	Low	Medium	Cool, Dry	Regeneration occurs mainly from off-site seed; apt to decrease slightly or remain unchanged after low- or moderate-intensity fire.
SMRA	Feather solomonplume (*Smilacina racemosa)*	Medium	Medium	Cool, Mesic	Regenerates from creeping rhizomes and is fairly resistant to fire damage; usually maintains its prefire frequency after burning.
SMST	Starry solomonplume (*Smilacina stellata)*	Medium	Medium	Cool, Mesic	Sprouts from creeping rhizomes; often decreases after fire, especially severe burns that consume most of the litter and duff.
TAOF	Common dandelion (*Taraxacum officinale)*	Medium	Medium	Disturbances	Regenerates from a deep taproot and light, windborne seed; can quickly colonize burns located near an ample seed source.
VIAM	American vetch (*Vicia americana)*	Medium	High	Cool, Mesic	Regenerates from rhizomes in the upper soil; seldom damaged unless the litter/duff has been consumed; a nitrogen fixer.
VIOR2	Darkwoods violet (*Viola orbiculata)*	Medium	Medium	Cool, Mesic	Regenerates from short, slender rhizomes and seed stored in the upper soil or duff layers; usually declines following fire.

Source: Adapted from Table 5 in Powell (1994). **Notes**: Common and scientific plant names generally follow Hitchcock and Cronquist (1973). Codes were taken from Powell (1989). Fire resistance and fire response ratings, and comments about reproduction methods, were obtained from the following sources: Bradley and others (1992), Crane and Fischer (1986), Fischer and Bradley (1987), Fischer and Clayton (1983), Flinn and Wein (1977), Geier-Hayes (1989), Hopkins and Rawlings (1985), Leege and Godbolt (1985), McLean (1968), Noste and Bushey (1987), Sampson (1917), Steele and Geier-Hayes (1995), Stickney (1986), and Volland and Dell (1981). Valuable information was also obtained from the Fire Effects Information System (FEIS) developed by the Intermountain Fire Sciences Laboratory at Missoula, Montana (Fischer and others 1996). For some plants, no literature sources were found for one or both of the fire ratings, so an estimate was made using information for species with similar morphological or reproductive characteristics.

Fire resistance ratings have the following interpretation:

- High – Greater than 65 percent chance that 50 percent of the species population will survive or immediately reestablish after passage of a fire with an average flame length of 12 inches.
- Medium – 35 to 64 percent chance that 50 percent of the species population will survive or immediately reestablish after passage of a fire with an average flame length of 12 inches.
- Low – Less than 35 percent chance that 50 percent of the species population will survive or immediately reestablish after passage of a fire with an average flame length of 12 inches.

Fire response ratings estimate of how quickly a plant species will regain its prefire population level. They have the following interpretation:

- High – The species population will regain its preburn frequency or cover in 5 years or less.
- Medium – The species will regain its preburn frequency or cover in 5 to 10 years.
- Low – The species will regain its preburn frequency or cover in more than 10 years.

Site type ratings are an estimate of the temperature and moisture relationships for sites on which the species is abundant.