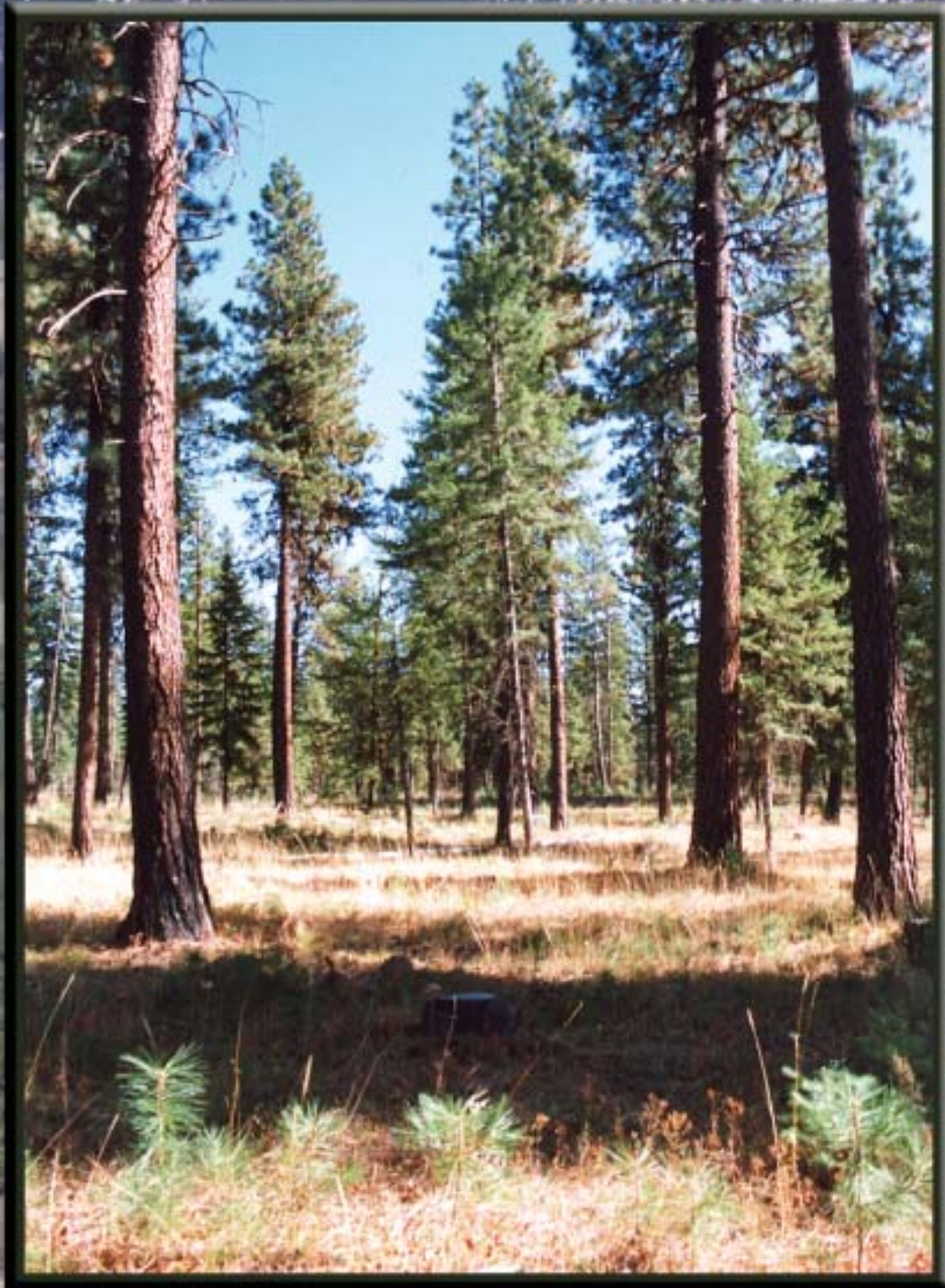


# UNDERSTANDING EASTSIDE FORESTS





# Understanding Eastside Forests

*Prepared for the Oregon Forest Resources Institute  
by*

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## Introduction

Eastern Oregon forests are well known for their scenic, recreational and wildlife habitat values. Unfortunately, they also are well known as sites of wildfire and insect outbreaks. Understanding the ecology and management approaches best suited to eastern Oregon forests is essential to increasing their positive contributions and minimizing the expense and problems associated with them.

How do the forests of eastern Oregon work and how can we manage them to sustainably produce a wide range of benefits? The forested landscape of eastern Oregon is a complex mosaic of forest ecosystems varying from pure stands of juniper, ponderosa or lodgepole pine to mixtures of the pines with Douglas-fir, larch and grand and subalpine fir. The forests are woven into a diverse topography with a wide variety of non-forest systems varying from open grasslands to tall sage. These forestlands are capable of producing many outputs, including clean water, recreation, wildlife habitat, livestock range and timber. The primary commercial outputs are timber, livestock and recreation. Determining a sustainable balance of outputs is not easy.

Current conditions of these forests vary from healthy and resilient to unhealthy and at high risk of wildfire, insects and disease. Wildfires of the past decade have burned tens of thousands of acres. Eastern Oregon forests are also vulnerable to a host of insects and diseases that can kill or degrade trees over large areas in a matter of a few years. Fires, insect attacks and disease all reduce the ability of the forest to provide clean water, scenic vistas and timber and wildlife values. For example, fire can destroy forest stands in a way that eliminates nesting and roosting habitat for spotted owls. Accurate figures on management needs for eastern Oregon forests are not available; however, millions of acres need management actions that would put the forest on a more healthy and resilient path.

Forest managers face difficulty not only in restoring burned-over landscapes, but also in managing existing fire-prone forests to reduce their vulnerability to the effects of wildfire, insects and disease. We understand

how to manage forests to make them more resilient, but it takes skilled evaluation and planning as well as concerted and sometimes costly effort to accomplish the task. The challenge lies in understanding these varied and dynamic forests and taking timely management action to make them more resistant to wildfire, bark beetles, defoliators and mistletoe.

The task is formidable because of the geologic and climatic complexity and a complex management history. These forest ecosystems evolved over more than 10,000 years in a regime of frequent wildfires ignited by native people and lightning. Following Euro-American settlement more than a century of wildfire suppression has restricted the occurrence of fire. As a consequence, these forests became much more dense, accumulated large amounts of fuel and changed structurally. As eastern Oregon was settled, timber was harvested to build homes and communities. Timber harvest for building and furnishing American homes continues to this day. Sheep and cattle intensely grazed the land in the early days of settlement. Forests still provide grazing for livestock at much reduced levels.

The objectives of forest management vary by ownership. Federal forests are still managed for multiple objectives, with emphasis on wildlife habitat and recreational values overshadowing timber production. Ranchers and small woodland owners often focus on production of both timber and forage for livestock. Large private timber interests focus mainly on timber production. Determining the potential of any particular forest area is not easy and choosing management options to accomplish owner objectives is complex.

This paper examines the ecology and management of the commercial forests of eastern Oregon. Included are discussions on the influences of geology and climate on forest site potential, characteristics of important tree species and their tolerance to different environmental stresses, a classification of forest types and how successful management approaches vary among the types. The paper concludes with guidance for sustainable management of eastern Oregon forests.

## Geology and ecology of eastern Oregon forests

A basic understanding of the geology and climate of eastern Oregon and of how forests have developed over time is important in determining the tree species to manage and the management strategy likely to work best. The forests discussed here include those on the eastern slopes of the Cascade Mountains and on the Ochoco, Strawberry and Blue mountains (Figure 1).

The mountains of eastern Oregon originated through a variety of geological processes. They contain a rich variety of ancient to recent rock types formed at great depths and either uplifted into mountains, extruded in huge lava flows or ejected from volcanoes. Some of these formations contain rich fossil records testifying to their formation at a time when oceans covered large portions of Oregon. The climate differed as hardwood forests flourished and prehistoric creatures roamed the landscape. As the Cascade and Coast Range mountains rose, the landscape and climate of eastern Oregon were transformed. In addition, a huge outpouring of molten lava spilled across the surface of the Columbia Basin, leaving multiple basalt layers thousands of feet thick. Erosion processes such as down-cutting by rivers and glaciation subsequently shaped the mountains. In the Wallowa and Steens mountains, glaciation during past ice ages left long, deeply carved valleys through layer upon layer of basalt. The east flanks of the Cascade Mountains were shaped as active volcanoes built towering peaks in sometimes-violent eruptions that covered the surface with various forms of volcanic ash or molten lava.

Less than 7,000 years ago, the violent eruption of Mt. Mazama formed Crater Lake. In eruptions that dwarfed the theatrics of Mt. St. Helens, coarse pumice deposits covered thousands of acres near the mountain and fine ash layers were deposited across millions of acres in northeastern Oregon and beyond. Post-eruption winds sometimes stripped fine ash from south slopes and deposited it on north slopes or ash washed or sloughed off steep slopes and was deposited in valleys or washed out to the ocean. Imagine the differences in growth for forests on soils with many feet of water and nutrient holding fine ash as opposed to soils with little more than a dusting of fine ash particles on bare rock. These geologic processes

**Figure 1**



*The topography, climate and geology of eastern Oregon create a diverse mosaic of forest types.*

**Figure 2**



*A Wallowa Mountains landscape with a wide variety of forest types.*

created variation in landforms and soils that combined with slope, aspect, and elevation to create big differences in tree growth on sites only short distances from one another. Such extreme differences create big challenges to applying the best management practice to each forest acre.

Plant distribution and growth in the Pacific Northwest are most strongly influenced by temperature and drought. The eastern Oregon climate is hot and dry in summer and cool to cold and moist in winter, when much of the annual precipitation (8 to 100 inches) comes as snow. Rainfall increases with elevation, but temperatures drop. The high Cascades form a “rain shadow,” forcing moisture from clouds before they arrive east of the mountains.

During summer, three to five months pass with insignificant amounts of rain, creating stressful drought conditions for trees as water in the soil is depleted. The severity of drought on a particular site depends on many factors, including annual rainfall, elevation, the soil’s ability to hold water (related to soil type rockiness and depth), and evaporative demand (related to aspect - north versus south slope.

**Figure 3**



Deep, ash-filled soils at moderate elevations on north slopes can store winter precipitation and create conditions that support very productive tree stands. Coarse, gravelly deposits on hot, south slopes can create droughty sites with low productivity. The net effect on the landscape is a complex pattern of forest types and growth conditions.

All this variation means that management actions must be tailored to the changing conditions on a small scale.

*A ponderosa pine forest type with pine in both overstory and understory.*

## Major forest types of eastern Oregon

Most private forestlands of eastern Oregon are one of four forest types: lodgepole pine, ponderosa pine, warm mixed-conifer, or cool mixed-conifer. In addition, sub-alpine forests and alpine parklands are found at higher elevations mostly on federal forestlands. A “forest type” indicates the potential for that soil and site to produce certain kinds of forest stands (see Figure 2). Before understanding a forest, it is important to know the forest type (Table 1).

**Table 1**

HOW TO RECOGNIZE EASTERN OREGON FOREST TYPES AND WHICH SPECIES TO MANAGE.		
Tree species present	Forest type	Manage for these species
Only ponderosa pine	Ponderosa pine	Ponderosa pine
Only lodgepole pine	Lodgepole pine	Lodgepole pine
Douglas-fir, grand fir or incense-cedar and ponderosa pine or larch	Warm mixed-conifer	Ponderosa or lodgepole pine, larch, Douglas-fir, grand fir or species mixture
Subalpine or grand fir, lodgepole, Engelmann spruce and larch, with or without other species	Cool mixed-conifer	Lodgepole pine, larch or species mixture

### Ponderosa pine

This driest forest type supports pure or nearly pure ponderosa pine forests (Figure 3). Drier conditions below the ponderosa pine forest type support juniper woodlands, sagebrush and grasslands. The ponderosa pine forest type is so dry that no other commercial tree species can grow there, although western juniper can. Historically, fire visited this forest type at short intervals of 5 to 20 years, keeping stands open. Fires were relatively cool, because fuel accumulations were minimal. This is the climax pine forest type, where ponderosa pine regenerates beneath itself and where, under

pre-settlement conditions, one pine stand was eventually replaced by another pine stand. Today, pine regeneration is often poor or nonexistent because of long summer droughts. The presence of a few Douglas-fir or grand fir trees in the understory indicates a site with more moisture and puts the site into the warm mixed-conifer forest type.

### Lodgepole pine

This forest type supports forest stands with more than 90 percent lodgepole pine. Lodgepole pine dominates the forest on three major site/soil types: pumice flats, frost pockets and high-

**Figure 4**



elevation plateaus. A primary climate factor for lodgepole pine types is heavy frost during spring and summer, when seedlings are growing. Of common eastern Oregon tree species, lodgepole pine is most tolerant of frost, which allows it alone to germinate, survive and grow in the most frost-prone areas. Historically, a common pattern was for lodgepole to regenerate following wildfire. When the stand became overly dense at 75 to 100 years, mountain pine beetle would attack and kill most of the existing stand. This would be followed by an intense wildfire. Lodgepole pine also grows in many mixed-conifer forest types, occurring either as part of the mixture or

*Lodgepole pine stand with a pine overstory and a subalpine understory, indicating that this is a cool mixed-conifer forest type.*

as the dominant pioneer species. At upper elevations, mountain hemlock or subalpine fir forests destroyed by fire regenerate to almost pure lodgepole pine stands. If wildfire does not return for a few centuries, more shade tolerant mountain hemlock, grand fir or subalpine fir eventually replaces the pine. (Figure 4).

Both ponderosa and lodgepole pine forest types are managed for those pine species because they are the only trees that do well on those sites. Ponderosa pine can, however, be managed in nearly pure stands on warm mixed-conifer sites, and lodgepole pine can be managed in pure stands on cool mixed-conifer sites.

## Mixed-conifer

A mixture of conifer species occupies many forest sites across eastern Oregon that are less limited by drought and summer frost. Historically, fire visited these types sporadically at longer intervals (20 to 100 years) than the ponderosa type, and fire intensity varied from light to intense (even stand replacing fires) depending on the length of time between fires and the amount of fuel accumulation. The mixed-conifer forests can be divided into two subtypes based on temperature and moisture conditions:

- The **warm mixed-conifer type** occupies the warmer and drier end of the spectrum. Typically, ponderosa pine dominates in young stands, but where soils are deep, larch may also play the role of a pioneer species. Douglas-fir and grand fir most commonly regenerate in the understory (Figure 5). If left alone these forests become more dense stands of Douglas-fir and grand fir. On the eastern flanks of the Cascades, incense-cedar joins the firs in the understory, and on the southern Cascades, sugar pine joins ponderosa in the overstory. Ponderosa pine also can regenerate vigorously beneath more open stands, often in even-aged patches. Site productivity is higher than on the ponderosa pine type.
- The **cool mixed-conifer type** is indicated by the addition of more moisture-demanding and cold-tolerant species such as subalpine fir, Engelmann spruce and, in a few areas, western white pine (Figures 4 and 6). Typically, either lodgepole pine or larch dominates the early successional stages after stand-replacing fires at upper elevations, but ponderosa pine, Douglas-fir and grand fir also may be present. Engelmann spruce may be part of a mixture or be in almost pure stands at upper elevations or along streams where cold-air drainage and deep frost eliminate the other species.
- On mixed-conifer sites that have been thinned or selectively logged, a variety of species mixes can grow. Even if a site is mostly pine in the overstory, but has seedlings of Douglas-fir, grand fir or incense-cedar scattered about in the understory, it should be classed as warm mixed-conifer type. Engelmann spruce or subalpine fir are key indicators of the cool mixed-conifer type. The pines, larch and Douglas-fir can be found in either type.

**Figure 5**



*A warm mixed-conifer forest type, with a ponderosa pine overstory and under- and mid-stories of grand fir and Douglas-fir.*

**Figure 6**



*A cool mixed-conifer forest type, as indicated by the presence of ponderosa pine, larch, Douglas-fir and grand fir.*

Exceptions to the simple rules for determining forest type occur where fire or harvest and regeneration have modified species distribution. The clues to the true identity of the type must be found in the understory vegetation of shrubs, herbs or grasses. In such cases, help can be found in local plant-association guides (available from a local U.S. Forest Service ecologist or silviculturist).

The productive potential of the different forest types ranges from low in lodgepole pine on pumice to quite high in warm mixed-conifer. Productive potential drops again at the cold end of the cool mixed-conifer type, mainly because of the short, cool growing seasons. The productive potential is important because it determines how well trees grow and how quickly changes in the stand occur. A complex system of determining a site's productive potential is based on the height to which trees can grow in 50 or 100 years. The more productive the site, the taller the trees will grow in the given time. In making management decisions, knowing the productive potential is important in determining the right tree species to plant and manage or what thinning regime to implement.

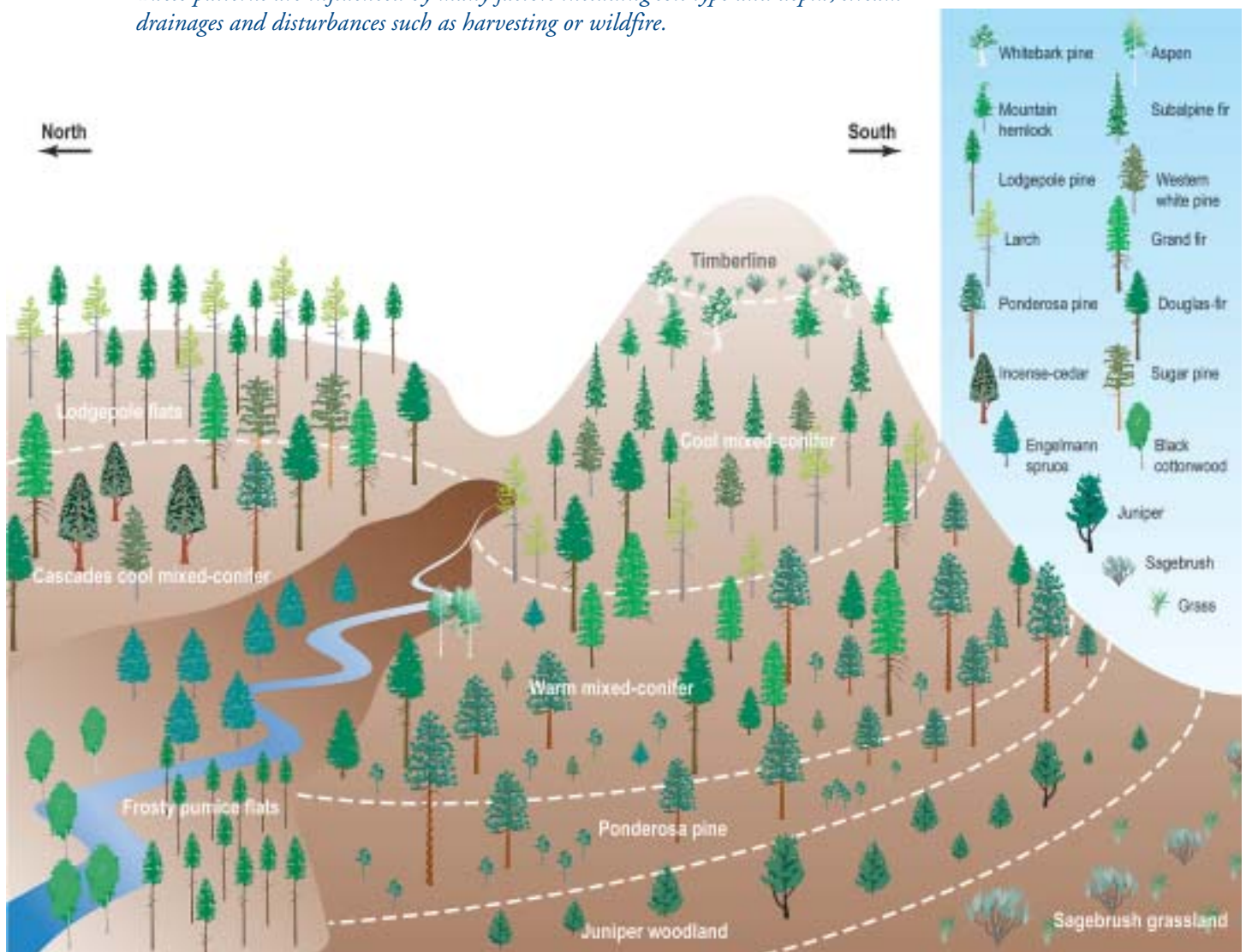
Even though mixed-conifer types can be managed for any one of the species present, e.g. pure ponderosa or lodgepole pine, managing a mixture of species has advantages. In the warm mixed-conifer types, keeping a substantial component of ponderosa pine and/or western larch is desirable because they resist defoliation by spruce budworm or Douglas-fir tussock moth, insects that rise to outbreak levels at 10- to 30-year intervals. Maintaining a diversity of species ensures more management options and is appropriate whenever it fits the owner's objective.

### **Tree tolerance to environmental stresses**

Each tree species has unique capabilities to tolerate stresses such as shade, drought, heat, flooding, wind, frost, fire and attack by insects or disease. Trees that can live through long summer droughts are said to be drought tolerant. Trees that can live in shade are known as shade tolerant. Trees with thick bark are fire tolerant because the bark insulates the tree from heat damage. Tolerances determine where trees survive and grow well, how they compete with other trees and what can be expected under management.

Figure 7 and Table 2 show relative tolerances of each tree species. The numbers in Table 2 are not exact measures, but they show how each species performs *relative* to the other species in that tolerance category. The relative tolerances of different trees helps explain the current condition of many forest stands and is extremely important in making management decisions. For example, the shade tolerance of Douglas-fir and grand fir allowed them to replace less-shade-tolerant lodgepole and ponderosa pine over much of eastern Oregon during the last century. The frost tolerance of lodgepole pine explains its distribution and makes it a candidate for planting in frosty locations, but its low tolerance for bark beetle attack requires careful attention to thinning and harvest.

**Figure 7** *The tree species of eastern Oregon are distributed across the landscape according to topographic and site conditions. General patterns can be discerned as one gains elevation or moves from a south-facing slope to a more northern aspect. These patterns are influenced by many factors including soil type and depth, stream drainages and disturbances such as harvesting or wildfire.*



**Table 2**

**RELATIVE TOLERANCES OF TREES TO ENVIRONMENTAL STRESS FACTORS IN EASTERN OREGON.\***

SPECIES	Tolerance to <sup>a</sup>								Characteristics		
	Shade	Drought	Flooding	Wind <sup>b</sup>	Frost	Fire <sup>c</sup>	Snow load	Pest damage <sup>d</sup>	Lifespan (yr) <sup>e</sup>	Mature ht. (ft) Normal/max. <sup>f</sup>	Knowledge of silvics <sup>g</sup>
<b>Conifers</b>											
Whitebark pine	5	5	2	1	1	3	1	4	500	40/75	little
Mountain hemlock	1	5	3	2	1	4	1	5	400	100/200	little
Subalpine fir	1	5	2	4	2	5	1	5	125	80/200	little
Engelmann spruce	1	5	1	5	1	5	1	4	225	120/165	some
Grand fir	1	4	2	3	3	4	1	5	175	120/210	well
Sugar pine	3	3	3	2	3	3	3	4	500	180/245	some
White pine	3	3	2	3	1	3	3	4	250	170/205	well
Western larch	5	3	2	1	2	1	2	2	250	160/190	well
Douglas-fir	2	2	5	2	3	2	2	4	250	130/180	excellent
Incense-cedar	3	2	3	2	3	3	3	2	300	100/180	little
Lodgepole pine	4	2	1	3	1	5	3	3	100	80/120	well
Ponderosa pine	5	1	2	1	2	1	4	3	300	165/200	excellent
Western juniper	5	1	4	1	2	4	3	1	500	40/60	little
<b>Broadleaves</b>											
Cottonwood	5	4	1	4	4	5	5	4	150	80/120	little
Quaking aspen	5	4	2	2	2	5	5	4	70	55/100	well

\* The numbers are not exact measures but instead show how each species performs relative to other species.

<sup>a</sup> 1 = high tolerance; 5 = low tolerance

<sup>b</sup> Index combines wind firmness (rooting) and trunk resistance to breakage.

<sup>c</sup> Index based on bark thickness and on experience with which species survive after a fire.

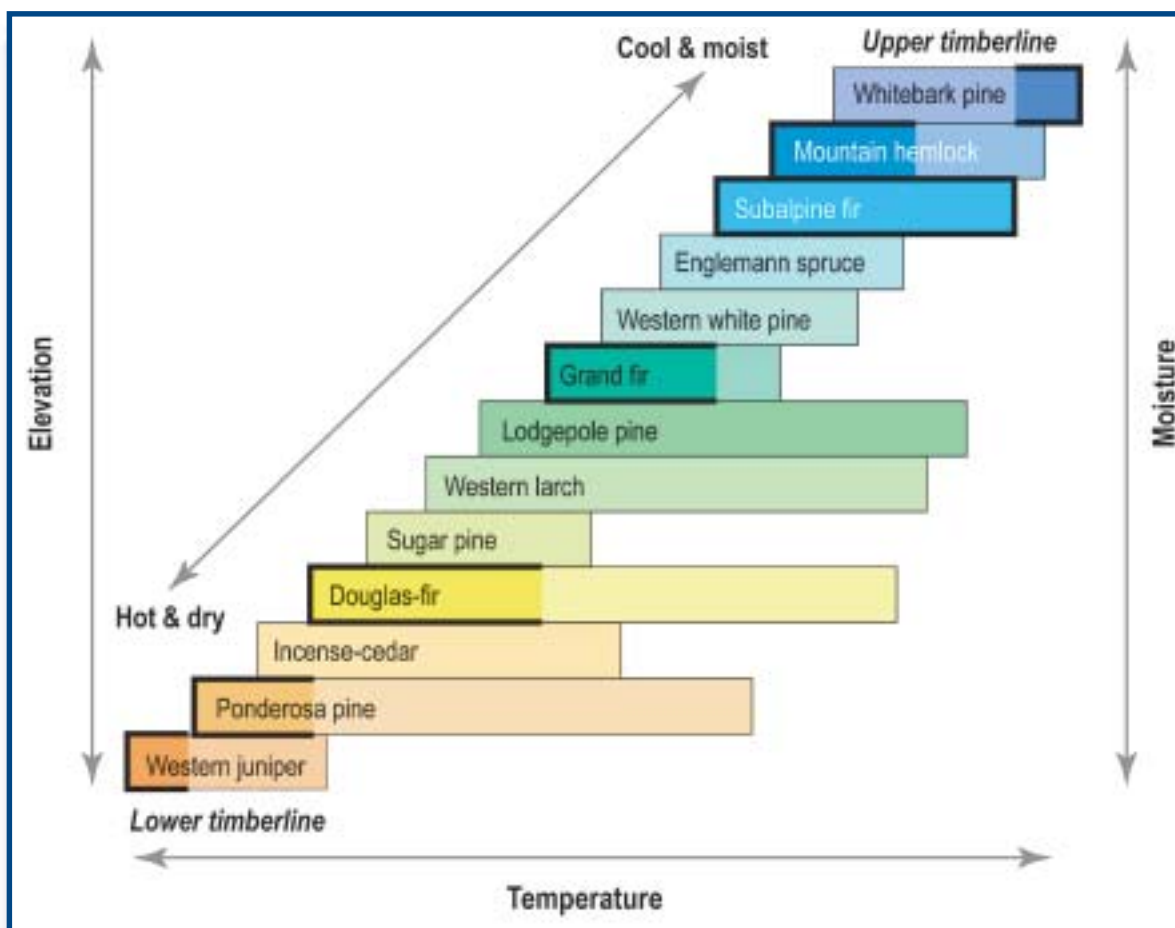
<sup>d</sup> Index combines damage from insects, disease, and animals.

<sup>e</sup> Typical longevity

<sup>f</sup> First number is the common height on good forest sites; second number is maximum height recorded.

<sup>g</sup> Degree to which management of the species is understood.

**Figure 8**



*This diagram shows where each tree species is found in relation to other tree species in a general gradient of moisture and temperature from low to high elevation. It shows the distribution of coniferous trees in eastern Oregon from lower timberline (lower left) to upper timberline (upper right) in order for their normal appearance. Heavier lines in the boxes around species' names show where the given species is more shade-tolerant than any other species on the same site. For example, Douglas-fir growing with ponderosa pine and western larch will regenerate in the understory (modified from Natural Vegetation of Oregon and Washington by Jerry F. Franklin and C.T. Dyrness, 1973).*

## Characteristics of selected eastern Oregon trees

In the following review of special tolerances, conifer species are listed in the general order that they grow, from warm, dry, low-elevation sites to cool, moist, high-elevation sites (see Figure 8). Deciduous trees are listed separately. For help with tree identification, see *Trees to Know in Oregon*, Extension Circular 1450.

### Conifer species

**Western juniper** is intolerant of shade and grows in open juniper woodlands. Tolerant of drought, juniper typically grows where it is too dry for any other tree species. Juniper grows slowly, has poor form and large branches and has had limited commercial value as lumber, fuel for industrial boilers or fence posts. Over the last century because of fire control, juniper has expanded its cover over large areas, but it reduces cover of grass, herbs and shrubs



Ed Jensen

*Ponderosa pine*



Ed Jensen

*Douglas-fir*



Ed Jensen

*Western larch (the yellow trees)*

important to some wildlife and livestock. It is resistant to pest damage, but can be killed by prescribed fire or herbicides to improve range values.

**Ponderosa pine** tolerates drought but not shade. It is second only to juniper in its ability to grow on the driest forested sites where productivity is low; however, it grows better on mixed-conifer sites. It develops thick bark at a relatively young age, so it readily withstands low-intensity surface fires. It is resistant to defoliation and root disease. Ponderosa grows to large size and its high-quality wood has made it the most valued and managed species in the dry interior West. It is susceptible to bark beetle attack when overcrowded, and in some areas it is badly infected by parasitic dwarf mistletoe. Its long life span and ability to grow large make it vulnerable to crowding as stands age into old growth condition.

**Incense-cedar**, where it grows on the eastern flank of the Cascade Mountains, is more shade tolerant than ponderosa pine. It has low market value because of a fungus that causes pockets of rot to form in the wood. It is not favored in management except as a species for diversity.

**Douglas-fir** is more shade tolerant than the pines but not quite as drought tolerant as ponderosa pine. When young, it is susceptible to fire but eventually develops a thick, fire-resistant bark that allows older trees to survive many light surface fires. Because of decades of fire suppression, Douglas-fir is much more widespread now than it was a century ago. Its high-value wood makes it a welcome addition for those interested in timber management. It is, however, susceptible to defoliators, dwarf mistletoe and some root diseases, especially in dense, nearly pure stands. It is resistant to rot from stem damage and less susceptible to bark beetle attack than associated pine species.

**Sugar pine** is less drought tolerant and more shade tolerant than lodgepole and ponderosa pine. In eastern Oregon, it is limited to the eastern flank of the Cascades, increasing its distribution from north to south. Although it is vulnerable to a disease called white pine blister rust, it grows well in warm mixed-conifer forests and has high wood value. It is important for diversity and for its market value.

**Western larch** is not as drought tolerant as pines, grand fir and Douglas-fir and not as shade tolerant as Douglas-fir and grand fir. After fire or clearcutting, western larch grows tall rapidly in the first decade of life, but becomes suppressed in overcrowded stands, growing very slowly. Dwarf mistletoe can be a serious problem. Western larch resists defoliation by spruce budworm and Douglas-fir tussock moth and is resistant to root diseases, but it can be severely defoliated by needle diseases and by the larch casebearer (an insect). However, the impact of the casebearer has been greatly reduced since the introduction of natural parasites as biological controls. Because

western larch is resistant to defoliation and root rots, promoting mixed stands of pine, larch and Douglas-fir on deeper soils and north aspects is advised.

**Lodgepole pine**, only slightly less drought tolerant than ponderosa pine, is especially frost tolerant and has a special ability to grow on soils composed mostly of pumice, a coarse volcanic ash. In central Oregon, it forms pure stands over thousands of acres on deep pumice deposits from Mount Mazama. It also forms pure stands in frost pockets, in wet meadows or on high plateaus where summer frosts can be severe. It easily becomes suppressed in overcrowded conditions and should be thinned to avoid overcrowding. Like ponderosa pine, at high densities it is susceptible to bark beetle attack and suffers from dwarf mistletoe. Also, it is heavily infected and deformed by a disease called western gall rust in some locations. Because its bark is relatively thin, it is easily killed by fire, but it regenerates readily from abundant and frequent seed crops. Lodgepole pine grows well in early years, but cannot grow as tall or as large in diameter as ponderosa pine. However, its wood is valued for both lumber and paper.

**Grand fir** is more shade tolerant than Douglas-fir or the pines, but less drought tolerant. It is a good grower and in most mixtures it grows faster than any of its neighbors (pine, larch, Douglas-fir). It is, however, susceptible to root disease and stem decay, is killed by bark beetles and fire and, like Douglas-fir, is periodically defoliated. Defective trees are quite important for cavity-nesting species. Historically, its white wood was less valuable than ponderosa pine or Douglas-fir, but now it is sometimes preferred in Asian markets. Keeping the amount of grand fir in a stand to less than a third of the basal area helps avoid serious defoliation.

**Western white pine's** natural distribution is confined to small areas of the Willowa and Cascade mountains. It is, however, more abundant in the cool mixed-conifer forests in northern Idaho and western Montana. Because it grows fast and has high wood value, it is a valuable addition to the relatively moist end of the warm mixed-conifer type. It is less drought tolerant than Douglas-fir and moderately shade tolerant. It is susceptible to bark beetle attack when overstocked. Although it is extremely susceptible to white pine blister rust (an introduced fungus), considerable progress has been made in finding rust-resistant strains of white pine.

**Engelmann spruce** is a frost-tolerant species found along streams, where frost is common in summer, and at higher elevations or north slopes, where moisture levels are adequate. Most common in the cool mixed-conifer type, it can grow on periodically flooded or high-water-table sites; however, it is subject to windthrow in such areas. Spruce is shade tolerant relative to the pines. Its wood is



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*Lodgepole pine*

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*Grand fir*

Ed Jensen

*Engelmann spruce*



Ed Jensen

*Subalpine fir*

valued for its lightweight, light color and strength. Spruce is susceptible to spruce bark beetle in overstocked stands or near areas of spruce windfall, but has low susceptibility to spruce budworm.

**Subalpine fir**, a short-lived species (70 to 80 years) found at higher elevations in moist, cool mixed-conifer types, is sensitive to fire. It occasionally is attacked by balsam wooly aphid and can be damaged severely by root and stem decay. It grows in closed forest stands or in subalpine parklands. As a shade-tolerant species, it often seeds under lodgepole or larch in the cool mixed-conifer forest type.

**Mountain hemlock**, found above or mixed with subalpine fir in the cool mixed-conifer type or near timberline in subalpine parklands, is susceptible to root disease, stem decay and dwarf mistletoe. It is found primarily along the crest of the Cascade Range and high in the Wallowa Mountains, where its values for wildlife and watershed probably are greater than its commercial timber value.

**Whitebark pine** is the conifer found at timberline, usually in subalpine parklands. Like other five-needle pines, it is highly susceptible to white pine blister rust. Its seeds are an important source of wildlife food. Like mountain hemlock and subalpine fir, it is found mostly in national forests.

### Deciduous broadleaf species

**Black cottonwood**, which grows in riparian areas along streams or lakes, is important for shading streams and for diversity. The wood is soft and brittle and decays easily, but it is good for pulp and veneer. Deer, elk and cattle frequently browse its leaves and twigs.

**Quaking aspen**, which grows in a variety of locations associated with moist meadows or rocky slopes, is valued for its beautiful white bark and bright fall foliage (Figure 9). This species forms large clonal patches through a process called suckering: roots spreading away from the main stem send up sprouts (called suckers) that grow into trees. The patches may be small or cover tens of acres. Cattle, deer and elk eat the high-protein leaves and twigs. Aspen is prone to stem decay and provides high-quality habitat for cavity-nesters thanks to excavations made by woodpeckers in decayed aspen.

**Figure 9**



*Deciduous species such as quaking aspen provide important diversity values including habitat for cavity-nesting birds and forage for big game animals. It also provides a visual treat with its varied fall colors.*

## Disturbance and change in eastside forests

Forests are dynamic, always changing either slowly or rapidly. We refer to most kinds of rapid change (stand destruction by fire, harvesting or beetle attack) as *disturbance* because it is so noticeable. Gradual changes in forests occur through tree growth and competition among species.

Changes in tree size and form and in stand canopy structure over a few decades are referred to as *stand development*. In a longer timeframe over several decades, changes in forest species composition, tree understory development and stand structure involve a process of change called *succession*.

### Stand development

Typical stages of stand development in even-aged forests are (1) regeneration, (2) stand closure, (3) stem exclusion and/or stagnation and (4) understory reinitiation.

During the regeneration phase, trees are planted or become established naturally and grow without competition among neighboring trees. During stand closure, trees grow taller and crowns expand, closing the canopy until the taller trees use most of the water, nutrients and light, leaving little for understory vegetation. When stand closure occurs in the life of a stand depends on density (trees/acre). As trees grow, they finally reach a point where all the site resources are utilized and less vigorous trees weaken and die or become susceptible to disease or beetle attack. During stem exclusion, less vigorous trees die while more dominant trees survive and continue to grow. Stand stocking, a measure of how completely the trees use site resources, is important in stand development. In fully stocked stands, dominant trees receive enough resources to grow well (10 rings or fewer per inch of radial growth). In overstocked stands, all trees grow slowly (15 to 20 or more rings per inch of radial growth) and trees lack the vigor to resist bark beetle attack. Understory reinitiation occurs as the stand reaches the age/size when large trees die and herbs, grasses and shrubs begin to thrive as more light becomes available beneath the forest canopy.

**Succession:** In the process known as succession, tree, plant and animal species gradually change over periods of several decades or centuries as stands grow dense and modify the microclimate within the forest. A group of early seral species gradually is replaced by species referred to as late successional. A common example is when Douglas-fir or grand fir seed in and grow in the understory of a ponderosa pine stand on a dry mixed-conifer site. Over several

decades, the firs grow up, the stand becomes overstocked and the pines decline in vigor. Eventually, beetles attack and kill the pine, leaving forests increasingly dominated by firs. Fir-dominated stands are susceptible to severe defoliation and mortality, which, in turn, can leave stands susceptible to high-intensity fire.

**Disturbance:** Disturbance can result from fire, timber harvest, grazing, insect attack or disease. Since humans migrated to the Pacific Northwest more than 10,000 years ago, they have considerably influenced the disturbance pattern in the forests of eastern Oregon. The kind and frequency of disturbance in eastern Oregon forests has changed over the last century.

**From fire promotion to fire exclusion:** Before Euro American settlement, fires set by Native Americans or by lightning burned through the forests at regular intervals. The intensity and frequency of burning varied with the degree to which forests dried out on a seasonal or climatic-cycle basis. Fire intensity also was strongly related to the amount, size and distribution of wood/fuel on the site. At low elevations, dry forests, e.g., ponderosa pine and dry mixed-conifer types, had low-intensity fires at frequent intervals (5 to 20 years), resulting in low stocking levels of fire-resistant ponderosa pine and/or larch. At low stocking, these trees grew well and became larger and more fire resistant as bark grew thicker (Figure 10a). Most often, the low-intensity fires killed smaller trees or thin-bark species and consumed understory shrubs and grasses. Fuel loads remained low. At upper elevations, more moist forests did not burn as frequently, thin-bark species gradually seeded in, shrubs grew large and fuels accumulated.

Typically, the longer the interval between fires, the greater the fuel load and the more intense any subsequent fire. Therefore, in cool mixed-conifer types, intense stand-replacement fires occurred at long intervals, ranging up to 100 years or more. After fire, seral species (e.g., lodgepole pine and larch) seeded and formed pure or mixed stands invaded only gradually by shade-tolerant subalpine fir after decades of stand development.

**Fire exclusion and suppression:** Soon after Euro American settlers arrived, they began to suppress fire by restricting ignitions and fighting wildfire. Fires were less likely to burn across areas after grazing had removed grasses and herbs. Since about 1910, efforts to control fire have been increasingly effective (Figures 10b–f). This century-long fire

**Figure 10a–f**

*The historic photos below and on the opposite page show successional trends, as Douglas-fir and grand fir regenerated under ponderosa pine. They also show how the harvest of timber accelerated development of the fir understory.*



**a**



**b**



**c**

suppression has allowed stands to become over dense to the point of overstocking. Fire-sensitive, shade-tolerant species seeded, grew in more stands and spread across the landscape. Timber harvest sometimes slowed the process of stand closure (Figure 10c).

Insects, diseases and pathogens such as dwarf mistletoe were historically a natural part of the disturbance pattern and often interacted with wildfire to influence the distribution of successional stages across the landscape. Stands that had large numbers of trees killed by beetles or root disease became especially prone to intense stand-replacement fires. Decades of fire exclusion have, however, facilitated the movement of bark beetles, defoliators and root diseases through stands and landscapes. Stands are more vulnerable and landscapes contain higher percentages of fire-susceptible trees or stands.

Because the changes caused by fire exclusion were gradual, they went unnoticed until recently when large areas became susceptible to burning at uncharacteristically high intensities. Forest stands in this unstable condition are prone to loss of economic, environmental and social value when most trees succumb to either insect attack or wildfire. Recent intense and widespread wildfires can be attributed to these successional trends. Such fire can severely affect watersheds, reducing their capacity to absorb and filter water during heavy rain or rapid snowmelt.

**Grazing:** As Euro American settlers moved into the region during the 19<sup>th</sup> century, cattle and sheep grazing and timber harvesting joined the list of disturbance factors. Intensive grazing by large herds of sheep and cattle spread across the landscape, often concentrating in riparian areas. Watershed conditions often were heavily affected.

Grazing intensified as ranching became common over much of eastern Oregon. Grazing removed understory vegetation and ranchers seeded many introduced grasses to “improve” grazing. Also, domestic grazing animals spread non-native weeds. Overgrazing in many areas led to an increase of shrubs, which provided increased fuel for wildfire. Overgrazing by sheep or cattle was recognized as a problem around the turn of the 20<sup>th</sup> century and has come under increasing regulation on federal forestland. Ranchers also have modified their forest and range



d



e



f

management practices to improve forage production and to limit damage to watersheds. Still, problems remain. For example, the spread of noxious weeds has degraded range conditions and threatens forest range values over large areas.

**Timber harvesting:** Timber harvest early in the 20<sup>th</sup> century often removed the more valuable ponderosa pine, larch and white pine in a way that was criticized as “high grading” or “taking the best, leaving the rest.” Harvest increased the water and light available for the more shade-tolerant Douglas-fir and grand fir growing in the understory and they thrived (Figure 10f).

All these disturbances had three major implications for forest health:

1. The trend toward overstocking in pine and fir stands reduced the vigor of individual trees and increased the tendency for forests to be attacked by bark beetles.
2. The increased abundance of fire-sensitive species (e.g., Douglas-fir when young, and grand and subalpine fir) in mixed-conifer types led to stands with much higher susceptibility to serious insect defoliation by spruce budworm and Douglas-fir tussock moth. Overstocking fosters attack by bark beetles, root diseases and mistletoe (Figure 11).
3. Finally, the trend to overstocking and multiple-canopy layers (Figures 5, 10e & 10f) led to stands prone to uncharacteristically destructive fires, and large fuel accumulations make fires extremely difficult to control. Even large pine and larch with thick bark are killed as the fires climb high into tree crowns on a fuel ladder of grasses, herbs, shrubs and mid-canopy trees.

**Figure 11**



*Mortality in this stand of ponderosa pine is due to both root rot and bark beetles. It is also susceptible to severe, stand-replacement fire due to the heavy fuel load of dead trees.*

### Historic and current conditions

Forest conditions at a particular location vary according to the forest’s history of management, fire, insect and disease attack and the prevalence of mistletoe. On the negative side, many private forests are overstocked and subject to bark beetle attack. Fire suppression and lack of thinning have allowed stands to grow to over-stocked levels. An even greater area is poorly stocked or stocked with low-quality trees that will provide few wildlife or timber benefits in the future. High-grade harvesting in the past tended to remove only the valuable, well-formed pine or larch, and it left stands dominated by Douglas-fir, grand fir or subalpine trees of poor form and vigor. Such species composition made them susceptible to defoliation by insects. In other cases, bark beetles killed many of the well-formed larger pine and left poor, under stocked forests with little timber value or opportunity for management.

On the positive side, fire or logging disturbance sometimes created soil surface conditions quite favorable for regeneration. Young stands became established and represent good opportunities for future management. In other cases, selective logging resulted in mixed-species and mixed-age stands that have potential to grow high-quality timber and provide good wildlife habitat. Also, where naturally regenerated understories existed, logging the overstory sometimes released seedlings to grow into high-value stands. In many cases, thinning has promoted growth of valuable forage and browse for big game while keeping trees healthy and vigorous.

Riparian conditions also vary widely. A large proportion of streams have been negatively affected because of the tendency of livestock to concentrate near water. Fencing off riparian areas and distributing water tanks have been used to improve the situation; however, many areas need further protection.

Regardless of current conditions, managers need to understand how to manage the stand to best provide a sustainable flow of ecological services (e.g., filtering water), aesthetic and wildlife values and economic benefits from timber and grazing. In the long run, passive hands-off management is seldom a viable path to a sustainable forest.

## Management of eastern Oregon forests

Opportunities for beneficial management abound. Until recently, low timber values and low productivity of eastern Oregon forestlands made intensive management for timber production uncommon. Although many private forest owners have tended their stands and have healthy, productive forests, many other forest areas would benefit from more active management. Recently, higher timber values and the realization that many areas are in poor condition have encouraged more careful intensive management to control stand composition and stocking levels and to promote more stable forests. Thinning forest stands, managing fuels and better management of riparian areas are needed to correct current conditions. Such management would help prevent destruction by insects, disease or fire and would make the yield of values (e.g., wildlife habitat, timber or grazing) more predictable.

Even when current stand conditions are good, normal patterns of forest development and succession ensure that the forest will be different in the future. Because eastern Oregon forests are susceptible to a variety of health problems, the consequences of any management strategy – including hands-off management approaches – must be carefully considered.

Clearly, active management to control species composition, stand stocking levels and fuel loading will create stands that are more resistant to wildfire, bark beetles, defoliators, dwarf mistletoe and root disease. When commercial timber is an objective, these controls are important because they allow the owner to choose when to sell timber rather than being forced to sell after fire or insect damage when log values are low and management options have been lost.

Managing forest stands and landscapes often can ensure that a variety of forest outputs – including timber, habitat for wildlife, livestock production and recreation – are available simultaneously.

## Management implications of landscape patterns

On a landscape scale, forest types form a varied pattern and any one type may cover only a few to thousands of acres (Figure 12). Many management objectives, including control of wildfires or insect outbreaks, can be achieved only by thinking at the landscape scale. Overstocking and species composition problems on many ownerships make the region susceptible to large-scale insect outbreaks or wildfires. Many wildlife species depend on having a mixture of habitats such as open grassy areas for feeding and dense young stands for shelter. Finally, the landscape perspective reminds us that planning and cooperation with neighboring landowners can help make the forest landscape and region more resilient to fire, insects and disease.

Keeping *all* forest acres in good health is important because insect infestations, wildfires and even root diseases move across the landscape from one forest area to another. For example, a bark beetle infestation that starts in an over dense stand on federal land may spread into a recently thinned, adjacent stand on private ownership. Stands that have been properly thinned contain healthy, vigorous trees that will resist most attacks. Likewise, a wildfire that kills all trees in a thick, mixed-conifer stand where beetles have killed a lot of trees also might destroy a thinned stand nearby if thinning slash remains untreated. Stands are more likely to survive fire if the thinning slash has been treated. Reducing fuels lowers fire intensity.

## Summary

In much of Oregon's eastside forests, we cannot choose which tree species to manage because only one will grow there. In such cases, thinning is the main tool for maintaining a healthy forest. In mixed-conifer types, we can choose both the species and stocking level. Experience has shown the value of managing a mixture of a few species. This provides more management options and helps avoid wildfire, insect and disease problems. Combining control of species composition, stocking levels and fuel loading provides the best opportunity to maintain healthy trees and fire-resistant stands. Passive hands-off approaches do not protect stands from fire or insect attack.

**Figure 12**



*Managing a landscape with many forest types and ownerships takes careful planning and good coordination to ensure safety from fire, insects and disease.*



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